DETERMINANTS OF MARKET PARTICIPATION BY SMALLHOLDER SOYBEAN FARMERS IN KAKAMEGA COUNTY, KENYA

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DECLARATION

This thesis is my original research work and has not been submitted elsewhere for the award of a degree.

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DEDICATION

I dedicate this thesis to Jacinta and Simon for the support they offered me throughout this journey.

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ABSTRACT

The importance of soybean (*Glycine max (*L.) *Merrill*) emanates from its multiple uses both as a food and an industrial crop. Despite soybean's numerous uses and its' ability to thrive well in the vast maize system in the country both as a rotation crop and an intercrop, its promotion efforts in Kenya have resulted in little success. Literature shows that the dismal performance of soybean is due to emphasis of promotion efforts on its production without addressing challenges at the marketing stage. Moreover, there is limited literature about drivers of smallholder soybean farmers' market participation. This study was conducted to fill the above knowledge gap. The specific objectives were to: describe characteristics of soybean farmers; assess factors that influence soybean farmers' decisions to sell, choice of market channel and amount sold.

The study used primary data collected from a sample of 148 soybean farmers in Kakamega County. Descriptive statistics and a triple hurdle regression model were applied to analyse the data. Results showed that sex of the farmer, non-farm income, intercropping, input purchase, and quantity of output positively affected the likelihood of the farmer deciding to sell soybean. Regarding choice of market channel, the probability of choosing off-farm market channel was affected by years of schooling, group membership, soybean price, and quantity of output. Access to extension, access to market information, years of schooling, ownership of transport facility, and price positively affected the quantity of soybean sold on-farm. Household size and intercropping reduced quantity of soybean sold off-farm whereas group membership, land owned, input purchase, access to market information, extension, and price increased quantity of soybean sold off-farm.

These findings demonstrate the need for the county government to facilitate access to fertilizer, improved seeds, and inoculants and extension services, which would improve output and

generate marketable surplus. There is also need to empower local groups to improve their capacity as sources for sharing market information and bargaining for better prices with buyers on behalf of the members.

Key words: Soybean, smallholder farmers, markets, triple hurdle model, Kakamega, Kenya.

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LIST OF ABBREVIATIONS AND ACRONYMS

AGRA	Alliance for a Green Revolution in Africa
BNF	Biological Nitrogen Fixation
BSE	Bovine Spongiform Encephalopathy
CCRP	Collaborative Crop Research Program
CGIAR	Consultative Group on International Agricultural Research
CIDP	County Integrated Development Plan
EU	European Union
EUROGAP	European Good Agricultural Practices
FAOSTAT	Food and Agriculture Organization Statistical Database
FGD	Focus Group Discussion
ICT	Information and Communication Tool
IPNI	International Plant Nutrition Institute
ISFM	Integrated Soil Fertility Management
KALRO	Kenya Agricultural and Livestock Research Organization
KNBS	Kenya National Bureau of Statistics
Kshs	Kenya Shillings
MUDIFESO	Mumias District Federation of Soybean Farmers
NGO	Non-Governmental Organization
NARS	National Agricultural Research System

ROP	Rural Outreach Programme
SDG	Sustainable Development Goal
SSA	Sub-Saharan Africa
TL2	Tropical Legume Two
USDA	United States Department of Agriculture
VIF	Variance Inflation Factor
WWF	World Wildlife Fund

CHAPTER ONE : INTRODUCTION

1.1 Background Information

Soybean, *Glycine max (*L.) *Merrill* is an oil crop with high protein content, which makes it an important ingredient in the manufacturing of livestock feeds and a cheap alternative source of protein (Sharma and Baluja, 2015). Livestock feed manufacturing makes up the bulk of industrial soybean usage with the other products being soybean oil, soymilk, soy yogurt, snacks, soya sauce, and protein extracts and concentrates for human consumption (Abate et al., 2012).

The protein from soybean is equal in quality to animal protein from milk and meat (Hassan, 2013). This makes soybean a perfect substitute for animal protein in vegan diets or for individuals with dairy allergy (Hartman et al., 2011). Among grain legumes, soybean has the highest concentration of proteins at approximately 36 to 38 percent compared to an average of about 20 percent provided by the other legumes, 18 percent from meat and 11 percent from egg (USDA, 2019). The main nutrient components of soybean are shown in Table 1.1, in addition to which, soybean contains a wide range of minerals, vitamins and lipids.

Table 1.1: Nutrient Composition of 100g Dry Soybean

Proximate	Soybean seed	Soy meal	Soy flour	Soymilk
Water (g)	8.50	6.94	7.25	85.61
Energy (kcal)	446.00	337.00	327.00	63.00
Protein (g)	36.49	49.20	51.46	2.26
Fat (g)	19.94	2.39	1.22	1.53
Carbohydrate, by difference (g)	30.16	35.89	33.92	9.95
Fiber, total dietary (g)	9.30	0.00	19.50	0.40
Sugars, total (g)	7.33	0.00	16.42	7.86

Source: USDA (2019).

The high nutritional content of soybean makes it an important ingredient in relief food to help combat food insecurity for most of sub-Saharan Africa (SSA) (Van Ittersum et al., 2016). The effects of protein deficiency are severely felt in SSA compared to other parts of the world because of the high significance of starchy staples such as maize in diets and often, animal protein is quite costly for many households. Soybean provides a cheap alternative to animal proteins, making it effective in addressing challenges of food insecurity. This makes soybean an appropriate substitute for animal proteins especially for poor households (Nyongesa et al., 2017).

Besides its nutritional importance, soybean can also be used in integrated soil fertility management (ISFM) as a rotational crop or as an intercrop. According to Hartman et al. (2011), soybean can be incorporated in the cereal-based cropping systems, which dominate most of SSA to supplement nitrogen, organic matter, and suppress parasitic weeds. The role of soybean in biological nitrogen fixation (BNF) process is particularly important when considered in the context of rising prices of chemical fertilizers, as it provides a low cost method for enriching the soils and increasing productivity. Maize legume rotations in Malawi conducted by McKnight Foundation in their Collaborative Crop Research Program (CCRP) improved maize yields from 0.5 ton per hectare to 1.5 ton per hectare demonstrating 300 percent increase in overall yield (CCRP, 2016). A report by Odendo et al. (2013) further recommended soybean as among the most promising grain legumes that should be incorporated in ISFM in Western Kenya in terms of overall crop profitability.

Considerable research has been carried out on soybean in SSA. The Alliance for a Green Revolution in Africa (AGRA) for instance, has financed several projects implemented by the National Agricultural Research Systems (NARS) in eastern, central, southern and western Africa between 2008 and 2019 (AGRA, 2020). The objectives of these projects had been, among others,

to incorporate soybean into ISFM and therefore improve its production and marketing, and subsequently improve household income, and food and nutrition security. Other research work involving soybean has been undertaken by N2Africa, Tropical Legumes Two (TL2) and the International Plant Nutrition Institute (IPNI). The Consultative Group of International Agricultural Research (CGIAR) programs on grain legumes aims to promote soybean among other legumes (CGIAR, 2012). Between 2011 and 2018 Rural Outreach Programme (ROP) implemented ISFM projects in Kakamega to improve maize and soybean productivity (AGRA, 2019). For the period 2017-2022, CGIAR Dryland cereals and legumes agri-food systems proposed to promote soybean among other legumes (CGIAR, 2016). The objectives of these projects have been varied from improving soil fertility, combating malnutrition, fighting poverty, and environmental protection (CCRP, 2016; CGIAR, 2016). Emphasis on markets is vital in order to strengthen the effectiveness of prevailing efforts to improve soybean production level.

1.1.1 Opportunities in Soybean Supply-Demand Gap

Despite the aforementioned merits of soybean, Kenya's national soybean production has stagnated at around 2,000 tons per annum (FAOSTAT, 2019). This is inadequate compared to the national demand estimated at over 100,000 tons per annum. According to Syngenta (2016), Kenya's annual domestic consumption of soybean is 150,000 tons. The large industrial market base, mass feeding programmes and trade regulations are the key opportunities for the growth in the soybean industry. The large industrial market base is provided for by the feed processors and industrial soybean processors for human consumption. This industrial demand is expected to grow even further with the continued increase in the demand for meat and meat products causing increased demand for protein meal owing to intensification of livestock production (Alexandratos and Bruinsma, 2012; OECD/FAO, 2016). The shortfall in soybean supply offers

enormous potential to farmers to participate in soybean by increasing production and greater supply chain participation through markets to increase their household income, improve soil fertility and reduce poverty.

International regulations such as the European Good Agricultural Practices (EuroGAP) require that meat exports to the European Union (EU) should not have been fed animal-based fat or protein as a result of an outbreak of bovine spongiform encephalopathy (BSE) in the 1990s (WWF, 2014). Therefore, soybean is a good alternative source of feed for producers attempting to adhere to these guidelines in order to gain access to such lucrative markets. Additionally, civic unrest is a common occurrence in the East African region and although unfortunate, it guarantees the presence of soybean demand for mass feeding programmes as soybean is normally the main ingredient in relief food due to its high nutrient content. Soybean being an inexpensive protein source is especially relevant in light of the COVID-19 pandemic, that has increased malnutrition in low income households especially among children and mothers and is feared to have further worsened effects of the pandemic on this sub-population (Fore et al., 2020).

1.1.2 Agricultural Market Participation

Given the need for households to diversify their consumption, they consume goods some of which, the household is more suited to produce due to differences in factor endowment. The household can focus on production of goods, which it has comparative advantage in and exchange the surplus for other goods it requires but in which it lacks comparative advantage (Barret, 2008). The welfare gains from this exchange form the basis for the continued emphasis on market-oriented production. Market participation is an aspect of commercialization, which refers to the use of purchased inputs and supply of produce to the market or simply the supply of

produce to the market (Gebremedhin and Jaleta, 2010). For the purpose of this study, market participation refers to the supply of produce to the market by the farmers. Other facets of market participation such as the use of purchased inputs are thus not covered in this study. Increased market participation means a shift in production from subsistence to market-oriented farming with frequent application of markets in exchange of products and services (Amrouk et al., 2013).

The agricultural production in Kenya is dominated by smallholder farming primarily for subsistence (Republic of Kenya, 2019). This scenario has weakened prospects of agriculture-based economic growth. In order to attain economic growth and development, smallholders have to transition from subsistence to market-oriented production. Households benefit from the welfare gained from exchange of goods and the resultant productivity growth.

Agricultural development is important for rural development and markets are crucial in attaining this development. According to Quisumbing et al. (2015) reinforcing the ability of smallholder farmers to commercialize is an important development priority considering that market-oriented production is a profitable livelihood strategy. Better market access has been proven to induce productivity and increase income and investment, therefore stirring rural growth and wealth creation (Olwande and Mathenge, 2012). This forms the key turning point in the agricultural transformation process through welfare gains from resultant mechanization, which frees up excess labour from agriculture. Markets are therefore important for increasing gains from the agricultural sector and realise growth, income distribution, improved food security, and alleviation of poverty.

Barret et al. (2011) concluded that increase in commercial demand of agricultural commodities due to soaring in population and urbanization influences the simultaneous rise in marketable

surplus. Soybean in Kenya is one crop that has failed to follow this trend. According to the study by Nyongesa et al. (2017), farmers expressed that access to market was their main challenge in soybean production. Many farmers who would have otherwise benefitted from remunerative markets provided by commercial processors are yet to gain these benefits. Household consumption has limited capacity to expand the production of soybean and therefore emphasis on markets is essential for the success of current efforts to promote soybean.

1.2 Statement of the Research Problem

Kenya's soybean industry continues to perform poorly despite important uses of the crop as a food and an industrial crop and its role in improving soil fertility coupled with availability of huge local demand. This means that the country continues to spend large amounts of foreign earnings on soybean imports to supplement local production. This is despite local biophysical factors providing optimal conditions for soybean production in Kenya. Previous efforts by both the government and non-governmental organizations (NGOs) to promote production of soybean among the farmers have had dismal results as indicated by the small quantity of production of 2,308 tons in 2018 (FAOSTAT, 2019).

A review of the soybean industry in Kenya reveals that the poor performance of the industry is attributable to marketing challenges (Nyongesa et al. 2017). Evidence from Tirkaso and Hess (2018) affirms that market participation increases technical efficiency in production and that inefficiencies in production are the aftermath of challenges in marketing as opposed to being the cause. In order to benefit from market participation, it is important to identify marketing challenges and interventions with the capacity for improving access to markets. From review of literature, a considerable number of studies have been conducted on factors that affect

agricultural commodities market participation in Kenya (Olwande and Mathenge, 2012; Burke et al., 2015; Sigei, 2014; Makau et al., 2016; Muthini et al., 2017; Olumeh, 2018). However, no study has been done with regard to smallholder soybean farmers' market participation in Kenya. The present study aimed tofill the above knowledge gap.

1.3 Objectives of the Study

The main objective of the study was to assess the determinants of market participation by smallholder soybean farmers in Kakamega County, Kenya. The specific objectives were to:

1. Describe household, farm-level and institutional characteristics of soybean farmers in Kakamega County.
2. Assess factors that influence farmers' decision to sell, choice of market channel, and amount sold.

1.4 Research Hypotheses

1. There is no difference in the household, farm-level, and institutional characteristics between market participants and non-participating households.
2. Household, farm-level, and institutional factors do not influence soybean farmers' decision to sell, choice of market channel, and amount sold.

1.5 Justification

The sustainable development goal number two (SDG 2) aims to "*End hunger, achieve food security and improved nutrition and promote sustainable agriculture"* (United Nations, 2016). The SDG 2 aims to achieve this objective by increasing agricultural productivity through: better access to resources and inputs, markets and value enhancing opportunities and; sustainable food

production that protects the ecosystem. Knowledge on market participation would assist in promotion of relevant market models for achievement of SDG 2.

Kenya has maintained a policy emphasis on market-led agriculture as a vital engine for economic growth. The economic pillar envisioned in Kenya's long term national planning strategy, Kenya vision 2030, enlists agriculture among the key drivers to achieve the target of 10 percent annual economic growth (Republic of Kenya, 2007). This requires that the agricultural sector is commercially oriented through increasing productivity of crops and livestock. By understanding the marketing challenges faced by farmers involved in soybean production, the study provides insights on interventions, which are geared towards commercially orienting the soybean sector. This will also assist in formulation of appropriate policies targeted at supporting soybean farmers depending on the selected marketing channel. The second priority area in Kenya's 'Big Four' development roadmap focuses on food security and improved nutrition (Republic of Kenya, 2018). Under the same agenda, Kenya also seeks to establish commercialized feed systems for livestock, fish, poultry, and piggery to revolutionize feed regime and traceability of animals. Soybean would be a worthwhile contributor to the realization of this objective given its high nutritional content and its importance in commercial feed manufacturing.

Soybean was among the priority crops in the first Kakamega County Integrated Development Plan, (CIDP) 2013-2017, which intended to construct a soybean processing plant, increase production of legumes and promote soil fertility among other goals (County Government of Kakamega, 2013). Although in the recap of achievements of the first Kakamega CIDP there is no mention of soybean, the subsequent CIDP emphasizes on improving crop productivity, soil conservation, and feed formulation for commercial dairy and poultry production (County Government of Kakamega, 2017). Soybean remains crucial to the realization of Kakamega CIDP

given its importance in soil fertility enhancement and livestock feed formulation. Information on the factors that determine soybean farmers' market participation will assist in developing the soybean value chain in the county.

1.6 Organization of the Thesis

This thesis is organized into five chapters. The first chapter provides background information, the research problem, objectives, and justification. Chapter two presents a review of literature relevant to the study. The third chapter elaborates the methods and procedures that were applied in the study. Chapter four presents a discussion of the results, while Chapter five offers the main conclusions and policy recommendations.

CHAPTER TWO : LITERATURE REVIEW

2.1 Overview of Soybean Production

Soybean is among the world's most important oil crops and the most traded grain legume (Abate et al., 2012). The growing significance of soybean can be attributed to the crops' increasing non-food industrial uses and their rising component in food demand. Soybean has been favoured mainly due to the crops' high protein content essential in oil meal for livestock feed and has shown sustained growth in both production and yield. Soybean has experienced the highest growth in production and area cultivated globally from 27 million tons to 269 million tons and 29 million hectares to 97 million hectares respectively in a period of 50 years from 1960 as a result of a surge in its' demand (Hartman et al., 2011). Projections by CGIAR indicate continued growth in soybean demand arising from the need for cheap protein and vegetable oil as well as increased global population (CGIAR, 2016).

In 2017, a total of 352,643,548 tons of soybeans were produced in the world on 128 million hectares of land with the United States of America, Brazil, and Argentina accounting for 80 percent of the total production (FAOSTAT, 2019). On the African continent, South Africa and Nigeria are the leading producers of soybean production. Kenya is a very minute producer even within the African continent. However, in terms countries leading in importation of soybean into the region, Kenya leads the pack. In the event that SSA is self-reliant in soybean production approximately US$2.6 billion in foreign exchange would be saved yearly- this figure is expected to go up to over US$12 billion by 2030 (CGIAR, 2016).

Kenya's soybean production was estimated at 2,154 tons in 2017 and 2,304 tons in 2018 compared to an annual demand of 150, 000 tons per year (FAOSTAT, 2019). This is despite

soybean being suitable for all maize growing regions and can be successfully incorporated in the widespread maize-based cropping systems both as an intercrop and a rotational crop. About 2,500 ha of land are under soybean cultivation with an average yield of 0.8 tons per hectare against yield potential of 1.5-3.0 tons per hectare (Mahasi et al., 2011). Unlike other grain legumes such as common bean, groundnut or cowpea, soybean is not part of the traditional diet of Kenyans and hence the bulk of the produce is used by industrial processors (Chianu et al., 2009). The large - scale industrial processors in the country undertaking soybean processing are BIDCO, Promasidor and Proctor & Allan. Western Kenya is believed to accounts for 50 percent of total local soybean production although regional data on production quantities is unavailable (Collombet, 2013).

2.2 Nutritional Importance of Soybean and Soybean Utilization

Soybean is a high value oil seed crop, which contains nutrients such as proteins, carbohydrates, vitamins, and minerals. Soybean protein is not only inexpensive, but also has a similar profile to animal protein as it contains every single amino acid required by both humans and animals except for sulphur amino acids (Hassan, 2013). The consumption of soybean in Kenya is relatively low mainly due to a lack of awareness on nutritional and health benefits and consumer misconceptions regarding the crop; it is perceived that soybean is food for children (Tinsley, 2009). The nutritional components of soybean are shown in Table 2.1.

Table 2.1: Nutritional Composition of Soybean (mature, raw seed)

Nutrient	Unit	Value per 100 g
Proximates		
Water	G	8.54
Energy	Kcal	446.00
Protein	G	36.49
Total lipid (fat)	G	19.94
Carbohydrate, by difference	G	30.16
Fiber, total dietary	G	9.30
Sugars, total	G	7.33
Minerals		
Calcium, Ca	Mg	277.00
Iron, Fe	Mg	15.70
Magnesium, Mg	Mg	280.00
Phosphorus, P	Mg	704.00
Potassium, K	Mg	1,797.00
Sodium, Na	Mg	2.00
Zinc, Zn	Mg	4.89
Vitamins		
Vitamin C, total ascorbic acid	Mg	6.00
Thiamin	Mg	0.87
Riboflavin	Mg	0.87
Niacin	Mg	1.62
Vitamin B-6	Mg	0.38
Folate, DFE	µg	375.00
Vitamin A, RAE	µg	1.00
Vitamin A, IU	IU	22.00
Vitamin E (alpha-tocopherol)	Mg	0.85
Vitamin K (phylloquinone)	µg	47.00
Lipids		
Fatty acids, total saturated	G	2.88
Fatty acids, total monounsaturated	G	4.40
Fatty acids, total polyunsaturated	G	11.25

Source: USDA (2019).

The main market outlets for soybean in Kenya are the households, institution consumers, industrial consumer markets and animal feed processors. The soybean is mainly used as oil, food

and feed. Soy oil is used in industrial manufacturing of vegetable oil and oil-based products. In fact, cooking oils labelled as vegetable oil are usually soybean oil (Hassan, 2013). The bulk of soy protein is used in feed manufacturing. Soy flour is an excellent food for the diabetics due to its low carbohydrates level and the soy milk is appropriate for use by weaned babies (Maingi et al., 2006). Table 2.2 presents the key uses of soybean.

Table 2.2: Soybean Uses

Soybean component	Products
Oil extraction	Margarine, cooking oil
Food, snack	Soymilk and milk products, porridge, baby food, tofu, soybean flour
Oil, industrial use	Cosmetics, pesticides, soap, herbicides, anti-corrosion agents, core oils, bio fuel, disinfectants, printing inks, paints, adhesives, antibiotics
Hull	Dairy feed
Soy meal	Poultry feed, livestock feed, bear, diet foods

Source: Maingi et al. (2006).

2.3 Review of Theoretical Frameworks on Market Participation

Studies on market participation have mainly used random utility theory, agricultural household models, and transaction cost theory. In the random utility theory, the decision-maker chooses the alternative that gives maximum utility when given a set of alternatives. The choice of the utility maximizing alternative is influenced by both observable characteristics, which form the deterministic component of the utility function and the unobservable characteristics captured by the error term (Green, 2012). The random utility theory has been adopted by Adeoti et al. (2014) and Mignouna et al. (2016) to model market participation among maize producers in Oyo region of Nigeria and to analyse market participation choices and decisions among maize and cowpea

farmers respectively. Abu et al. (2016) also applied the random utility theory to assess market participation and market choice in Ghana for maize and groundnut farmers.

In the agricultural household model, the household produces agricultural commodities with the objective of selling and/or consumption using both inputs produced on the farm or purchased on the market therefore making the household both a producer and consumer. The household's optimization problem is to maximize utility from consumption of agricultural and other tradable commodities subject to a set of constraints. The production and consumption decisions of an agricultural household are seldom separable due to presence of market failures (Otekunrin, 2019). Hence, the non-separable agricultural household model is often used to analyse the households' production and consumption decisions. Camara (2017) used the agricultural household model to assess market participation and the role of the upstream segment in Guinea. Other studies that have adopted the agricultural household model include Siziba et al. (2011) and Makau et al. (2016) to assess determinants of cereal market participation by smallholders in SSA, and the effect of national fertilizer subsidy on farmer market participation in North Rift Kenya, respectively.

Transaction cost theory is underpinned on the premise that market exchange is not without cost. These costs are included as an additional constraint on the decision-makers optimization problem. Farmers incur costs searching for a trading partner, negotiating, transporting produce to the market, and enforcing contracts. These costs can be classified into fixed transaction costs and varying or proportionate transaction costs. Studies that have used the transaction cost theory to model agricultural market participation include Okoye et al. (2016) and Jagwe et al. (2010).

2.4 Review of Empirical Frameworks on Market Participation

Several methods have been used in literature to analyse market participation decisions of agricultural households. Where market participation is a single step decision process, the tobit model has been mostly used to model continuous observations whereas discrete observations can be modelled either by a binary choice model or a multivariate model depending on the number of outcomes realised from the choosers' decision. The Tobit model allows for clustering of zeros due to non-participation and assumes that the participation decision and extent of participation is influenced by the same set of variables.

The study by Bellemare and Barret (2006) indicated that smallholder farmers make sequential decision on market participation where first, the household decides to participate in the market and then makes the second decision on how much to put on the market. Most studies have used either double hurdle method or the Heckman two-step selection to model the two-tier process of market participation. Both models allow for a single variable to affect the decision and extent of participation differently therefore relaxing the assumption of the Tobit model. The Heckman two-step model is designed to correct for selectivity bias due to incidental truncation (Heckman, 1979). This is done by the addition of an additional regressor, the Inverse Mills Ratio (IMR) in the second equation, which is calculated from the outcome of the first decision. The double hurdle model depicts a two-tier corner solution outcome whereby a probit model is used to model the discrete choice of participation and a truncated regression subsequently applied to model the extent of participation (Cragg, 1971).

In double hurdle model, it is assumed that non-participation is as a result of an economic choice. Since missing values are equated to zero, the model might yield erroneous results in instances where the missing values are as a result of incidental truncation (Olwande and Mathenge, 2012).

In order to incorporate the initial production decision in market participation Burke et al. (2015) introduced the triple hurdle model. The argument presented is that not all households are producers, especially for non-staple crops and allow for the generalization of the findings to the whole population. The advantage of the triple hurdle model is that it allows for the existence of both censored and selected zeros in the model and because of the allowance on exclusion restrictions, not all explanatory variables may be included in each model allowing for different sets of variables to affect each participation decision. The current study also uses a triple hurdle model to analyse the 3-step decision of market participation but instead of having the initial production decision, the three decisions are: the decision on whether to sell or not sell any soybean, second: the decision on which channel to sell to, and lastly: how much soybean to sell.

2.5 Review of Empirical Literature on Market Participation

The concept of market participation has been widely assessed by researchers. Previous studies on agricultural market participation have established various factors that influence farmers' decision to sell, choice of market channel and extent of market participation for agricultural output. Using a multinomial logit, Sharma (2015) found that age, education, and distance to milk collection centres were significant determinants of small-scale milk producers' participation in organised markets in India. The study found that distance to the market increased the likelihood of participation in distant modern market channels explained by tendencies by such channels to facilitate output collection from the farmer. Soe et al. (2015) also used a multinomial logit to model the choice of market channel by paddy rice farmers in Myanmar. The distance to the market was found to increase the probability of paddy rice farmers to sell at the farm gate as opposed to other market channels that are far from the farm. The study also found that access to market information, large output quantities, and access to transportation to increase direct access

to remunerative markets. Unlike Soe et al. (2015) and Sharma (2015), the choice of market channel in the current study is analysed as a binary choice between on-farm and off-farm.

Camara (2017) assessed cereals market participation in Guinea using a double hurdle model. The study found that the market price of the cereals must be lower than the production costs for smallholders to be market oriented; otherwise they would opt to meet their consumption needs. The study also found that having more adult male in the household and the number of hired labourers positively determined the likelihood of being a seller whereas the number of off-farm workers in the household negatively affected decision to sell. Conditional on the household having decided to sell, membership to farmer group, adoption to technology, and access to transport equipment increased the extent of market participation. Similarly, Muthini et al. (2017) used double hurdle to examine factors that influence smallholder farmers' choice of mango marketing channels in Kenya. The study found that group membership, access to training services, access to extension services, and having access to market information had an influence on marketing channel selected by the mango farmers. The study also found that group membership was significant in the second decision of intensity of market participation. Similar to Camara (2017) and Muthini et al. (2017), the current study also uses a probit model to model the first market participation decision on whether or not to sell.

In a study of cereals market participation by smallholders in SSA, Siziba et al. (2011) employed the Heckman two-stage method. The study found that socio-economic characteristics had no effect on intensity of market participation although they were significant in determining the initial market participation decision. Group membership, extension, access to research, and access to price information were found to increase the quantity of cereals sold. Zamasiya et al. (2014) also used Heckman two-stage regression to model soybean market participation in

Zimbabwe. The study established that female farmers were more likely to engage in soybean marketing mainly because legumes are considered as a females' crop. Additionally, the study also found that the use of rhizorbial inoculants and improved seed variety positively affected the decision to sell soybean and quantity of soybean sold because they increased marketable surplus. The findings of Zamasiya et al. (2014) informed the present study on important variables to be included in the model. However, the study examines decision to participate in the market and intensity of participation with no regard to choice of market channel, which is incorporated in the present study.

Abu et al. (2016) used a sample selectivity probit model to simultaneously analyse the market participation and market choice for maize and groundnut smallholders in Upper West Ghana between farm gate and market centre. The study found that age and years of schooling of household head increased likelihood of deciding to sell maize. This is because age is positively related to experience, which improves decision making whereas formal education enhances managerial competencies thereby improving capacity to make informed market decisions by the farmer. The study also found that yield and access to transport information positively determine the likelihood of deciding to sell both groundnuts and maize whereas access to credit increased probability of deciding to sell maize. Abu et al. (2016) also found price, age of the farmer, and membership in farmer organisation to positively determine choice of market centres.

Mango et al. (2018) used a simple logistic framework to examine determinants of market participation and marketing channels by smallholder groundnut farmers in Zimbabwe. The study found land size, access to transport information, distance to the nearest town, age and education of the household head influenced the decision to participate in the market. The study also found

that the choice a given market channel was determined by the distance to the nearest town, education level of the farmer, access to remittances, and access to market information.

The study conducted by Burke et al. (2015) used a triple hurdle model to analyse production and market participation by dairy farmers in Kenya. The study found that asset ownership and improved technologies were crucial in determining production decision whereas the decision to participate in dairy market was influenced by access to credit and presence of cooperatives. The intensity of participation in the dairy market was influenced by the milk prices, access to credit, proximity to electricity, and presence of milk cooperative within the village. The study by Burke et al. (2015) forms the basis of conceptualizing the triple hurdle model for the current study.

Gebremedhin et al. (2017) also adapted the triple hurdle model by Burke et al. (2015) to assess small-ruminant production and marketing and its implication to commercial transformation in the Ethiopian highlands. The study found that the small-ruminant farmers are not price responsive suggesting that the market participation decision of the households is not necessarily informed by the objective to maximize profits. Gebremedhin et al. (2017) also noted that distance to the nearest livestock market negatively affected quantity of small-ruminants supplied to the market. The study also found that small-ruminant production is preferred among younger households which are characterised by limited land therefore commercially orienting the sub-sector can be potentially used to improve the welfare of this segment of the population. Both Burke et al. (2015) and Gebremedhin et al. (2017) both conceptualize the triple hurdle model beginning from the production decision as opposed to the current study, which focuses on already producing households.

Okoye et al. (2016) assessed the effect of transaction costs on market participation among smallholder cassava farmers in central Madagascar using the triple hurdle model. The study found that being a member of a group and farming experience increased likelihood of farmers deciding to sell cassava. The study also found that ownership of transportation means, distance to the nearest town and marketing experience had an influence on the choice of off-farm market channel whereas the intensity of market participation was affected by cost of transportation and marketing experience. The study by Okoye et al. (2016) is similar to the current study in that both studies incorporate decision to sell, choice of market channel, and intensity of market participation in the 3-step model. However, the current study differs from Okoye et al. (2016) in that the crop under review is soybean as opposed to cassava and the current study is undertaken in Kenya, which is geographically and economically different from Madagascar.

2.6 A Summary of Key Knowledge Gaps

Available literature indicates various approaches that can be used to study market participation by smallholder farmers including double hurdle, triple hurdle, and multinomial logit. These studies also reveal factors that affect the market participation decision, choice of market channel and the intensity of market participation by smallholder farmer. Although literature is available on agricultural market participation, this is mainly on staples such as cereals and milk (Camara, 2017; Sharma et al., 2015; Siziba et al., 2011; Burke et al., 2015) and may not fully address the issues within soybean, it being a legume oil crop. Additionally, none of the literature is specific on factors that determine market participation for soybean in Kenya. Even though the study by Zamasiya et al. (2014) involved soybean market participation, it was carried out in Zimbabwe and hence cannot be adequately adopted for the case in Kenya. Also, the study did not incorporate the decision on choice of soybean market channel. This study sought to fill this

knowledge gap by exploring factors that influence market participation for soybean farmers in Kakamega County and include the decision on choice of market outlet.

CHAPTER THREE : METHODOLOGY

3.1 Study Area

The study was conducted in Kakamega County, which was purposively selected based on appropriateness of soybean to the county's development agenda and relevance to past and ongoing research and promotion efforts on legumes in the County. The annual rainfall for the region falls between 1,280.1 millimetres and 2,214.1 millimetres per year, temperatures of between 18^{o}C to 29^{o}C and an altitude of 1,240 metres to 2,000 metres above sea level (County Government of Kakamega, 2017). These climatic conditions are well suited for the growth of soybean. Soybean requires minimum temperatures of 15 degrees Celsius to germinate and thrives in temperature range of between 20 and 25 degrees Celsius. An established soybean crop has the capacity to withstand dry conditions.

High population in the County means that there is increasing land scarcity and continued depletion of the soil due to poor farming practices. The 2019 census puts the population of the county at 1,867,579 (KNBS, 2019). High population in the County means that there is increasing land scarcity and continued depletion of soil fertility. This makes soybean appropriate for the county given the crops' ability to improve soil fertility and ultimately increase agricultural productivity.

The maize legume cropping system is also dominant in the area, which makes soybean a suitable crop. Figure 3.1 shows the map of Kakamega County where the study was conducted. The sample was drawn from Butere, Lurambi, Mumias East, Ikolomani and Khwisero sub–counties.

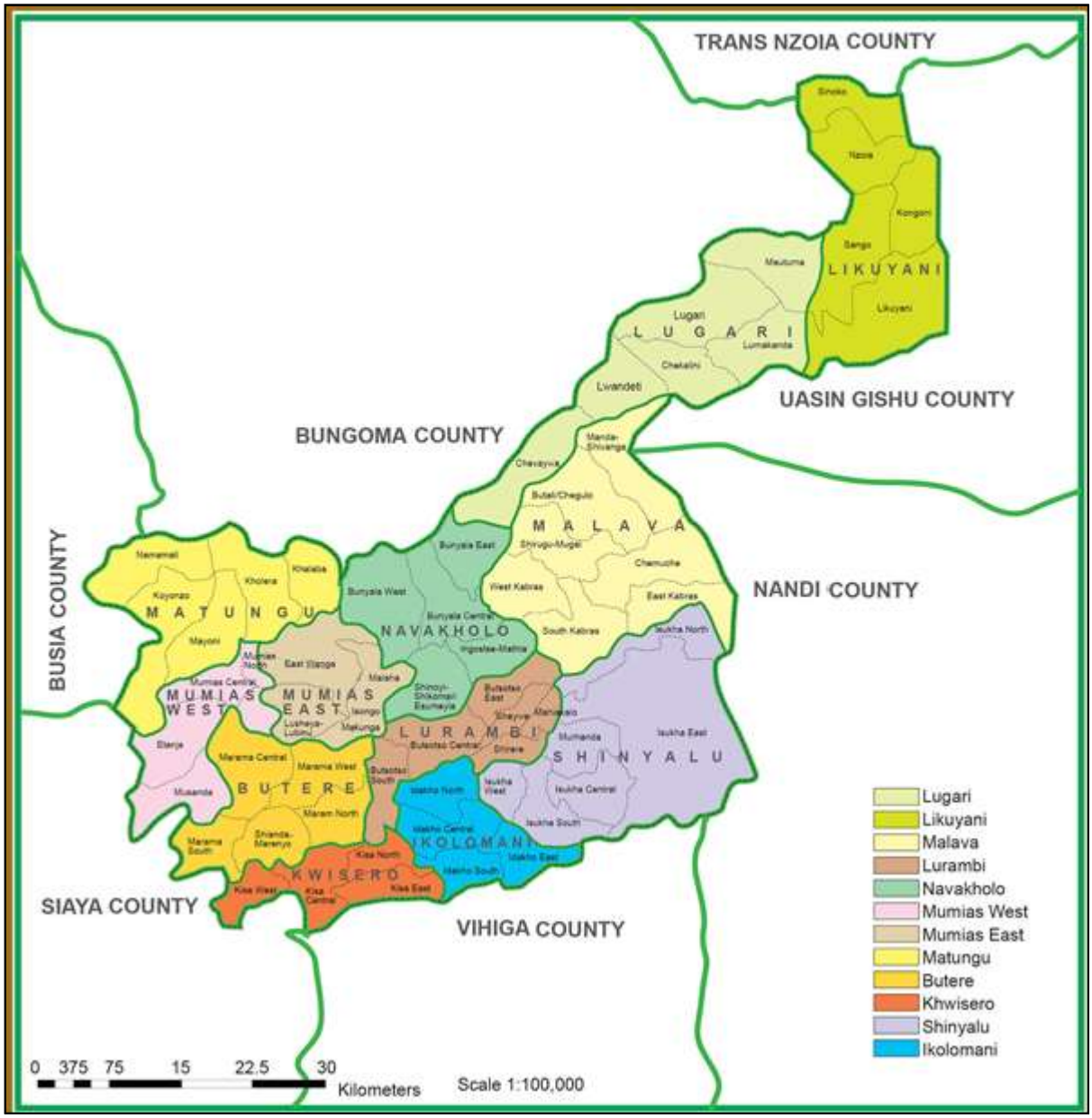

Figure 3.1: Map of Kakamega County

Source: County Government of Kakamega (2017).

3.2 Conceptual Framework

This study focuses on household market participation. Smallholder households make farming decisions, which maximize the utility they derive from cultivating land, utility being a measure of relative human satisfaction (Adeoti et al., 2014). Hence, the household is assumed to

maximize utility by deciding whether to sell soybean or not, choosing a market channel to sell to, and how much soybean to sell to chosen channel subject to a set of constraints. The market participation decision is determined by specific attributes, which have been broadly categorized here into household characteristics, farm level factors, and institutional factors. This interrelationship is illustrated in Figure 3.2. The household makes the binary decision to sell or not to sell soybean, then the households that would have decided to sell soybean are further faced with the decision on whether to sell on-farm or off-farm and how much soybean to sell to the chosen channel, respectively.

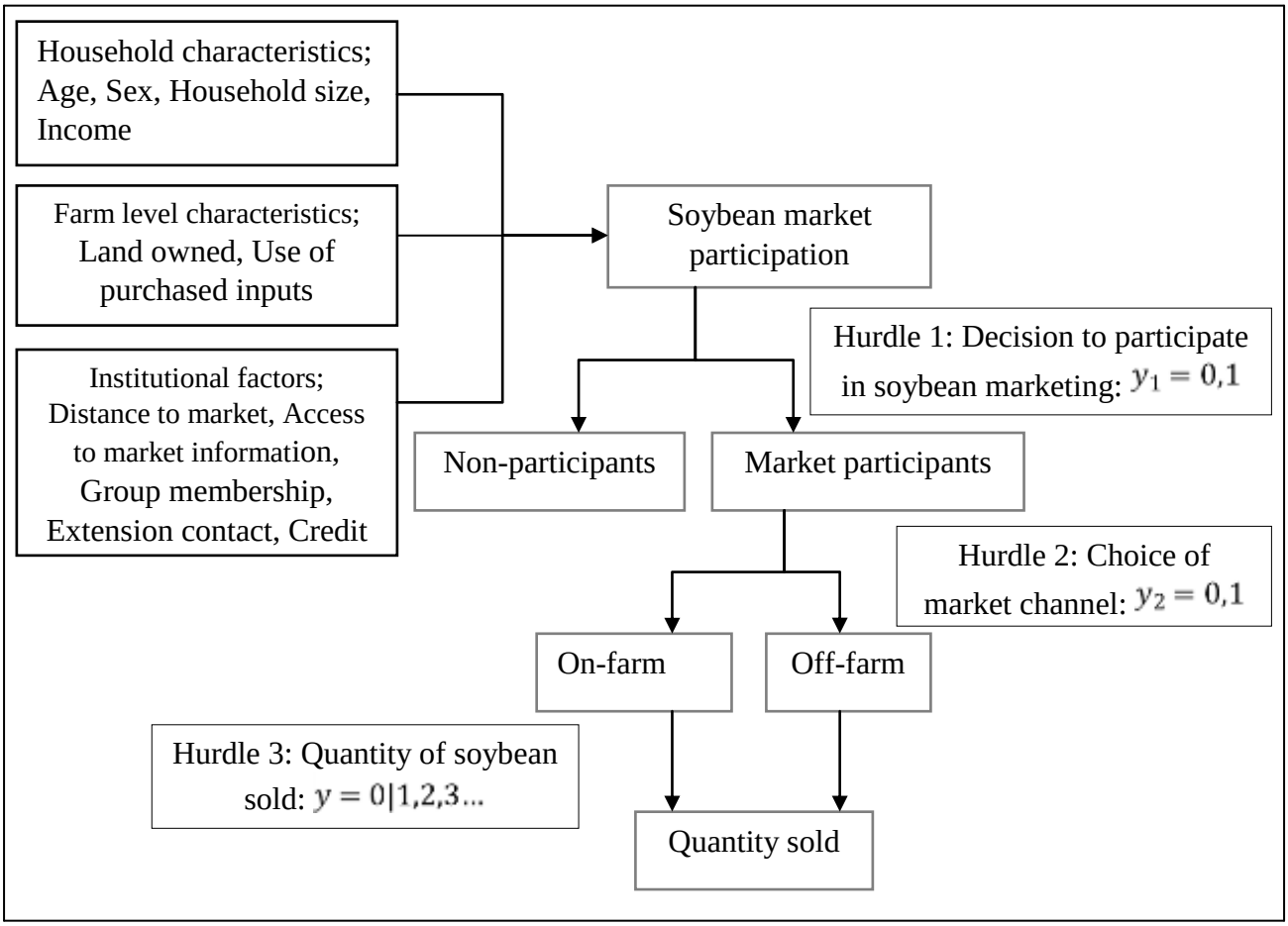

Figure 3.2: Conceptual Framework for Soybean Market Participation

Source: Author's conceptualization.

3.3 Theoretical Framework

The study is based on the random utility model. The farmer seeks to maximize utility from a set of market participation alternatives. The farmer associates each market participation alternative some perceived utility and subsequently selects the market participation alternative that gives the highest perceived utility among the competing alternatives. Since the utilities are unobserved, the choice made reveals the highest utility among the alternatives. The utility assigned to the market participation alternatives is determined by various measurable attributes of the alternative itself and the farmer who is making the decision. Hence, the utility maximization objective is presented as follows (Green, 2012):

$$U_j^i = U^i X_j^i + \varepsilon_j^i \quad (3.1)$$

where U_j^i is the perceived utility of market participation alternative j to the farmer (decision maker) i which is a sum of two components, the deterministic part $U^i X_j^i$ representing the perceived utility U^i and a vector of attributes relative to j and the farmer i, X_j^i and a random residual ε_j^i since utility is not known with certainty.

The farmer will make a market participation decision *k* if its associated utility U_{ik} is greater than utility derived from the alternative market participation options U_{ij} (Greene, 2012). The statistical model showing that choice *k* is made is shown as;

$$prob(U_{ik} > U_{ij}) \; for \; all \; other \; k \neq j \quad (3.2)$$

In the first hurdle, the farmer is faced with a binary choice on whether to sell soybean, (be a market participant) or not (non-participant). Assuming that y_1 is the binary indicator function for market participation, equation (3.1) can be rewritten as follows:

$$y_1 = x_1\beta_1 + \varepsilon, \quad (3.3)$$

where, $y_1 = \begin{cases} 1 \; for \; market \; paricipants \\ 0 \; for \; non - \; participants \end{cases}$

x_1 is the set of independent variables thought to determine decision to sell soybean, β_1 is a vector of parameters to be estimated, and ε is the stochastic error term which is assumed to be independently and identically distributed with mean = 0 and variance = δ^2

The second hurdle is the choice of market channel between on-farm and off-farm. After deciding to sell soybean, the farmer now decides on where to sell soybean. A standard probit can subsequently be used to model this discrete choice. Hence, the utility function in equation (3.1) becomes:

$$y_j = x_j\beta_j + \varepsilon, \quad (3.4)$$

where, $y_j = \begin{cases} 1 \; off - farm \\ 0 \; on - farm \end{cases}$

x_j are variables affecting choice of a market channel, β_j are parameters to be estimated, and ε_j is the error term assumed to be independently and identically distributed with mean 0 and variance δ^2.

The third hurdle is the decision on how much soybean to sell. The outcome contains a mixture of zeros for non-participation and non-zero continuous observations for quantity of soybean sold. Reformulating the utility function in equation (3.1) as a censored regression yields the following latent variable model:

$$y^* = x_i\beta_i + \varepsilon \quad (3.5)$$

where x_i is a set of variables which determine quantity of soybean sold, β_i parameter coefficient, ε is a normally distributed residual with constant variance and y^* is quantity of soybean sold (which is not fully observed due to the censoring). Instead, we observe:

$$y = \begin{cases} 0 \; if \;\; y^* \leq 0 \\ y^* \; if \;\; y^* > 0 \end{cases} \tag{3.6}$$

which can be re-written as:

$$y = \max\left(x_i\beta_i + \varepsilon, 0\right) \tag{3.7}$$

3.4 Sampling Procedures and Sample Size Determination

The study used a multistage sampling approach to select the respondents. In the first stage, purposive sampling was used to select four sub-counties; Butere, Lurambi, Mumias East, Ikolomani, and Khwisero, which were perceived to have a substantial population of soybean farmers in Kakamega County, based on previous soybean promotion efforts undertaken in the County. This selection was informed by the Kakamega County agricultural officer. As opposed to crops such as maize, soybean is not a common household crop and purposively targeting these sub-counties prevented a lot of time being wasted trying to reach the target population of soybean farming households. In the second stage, with the help of a contact farmer from each ward, other soybean farmers were randomly selected and requested to participate in the survey.

The sample size was determined by use of thel formula by Cochran for unknown population (Cochran, 1963).

$$n_o = \frac{Z^2 p(1-p)}{e^2} \tag{3.8}$$

where n_o = sample size, Z = desired critical value of confidence level, p = estimated proportion of interest, and e = desired level of precision.

The study used a confidence level of 95 percent and 5 percent level of precision. Since the exact number of soybean farming households in Kakamega County was unknown, and soybean is not a major crop, a conservative p value of 0.15 was assumed. Hence, the sample size was calculated as follows: $\frac{1.96^2 \times 0.15 \times 0.85}{0.05^2} = 195$ (3.9)

However, due to budget limitations only 148 respondents were interviewed. Studies of the same magnitude have employed a relatively similar sample size (Zamasiya et al., 2014; Sigei, 2014; Osmani and Hossain, 2015). Out of the 148 respondents, 90 sold soybean whereas the remainder, 58, were non-participants in the market.

3.5 Data Collection

The study used primary data. A single focus group discussion (FGD) was conducted with farmers and stakeholders in the soybean value chain in July of 2017. Participants in the FGD were 14 soybean farmers, 2 representatives from Mumias District Federation of Soybean Farmers (MUDIFESO), which is a soybean farmer-based organization in the county, 1 representative from ROP (a local NGO involved with the promotion of soybean production in Kakamega), 1 county agricultural extension officer, and 1 representative from KALRO, Kakamega. During the FGD, participants provided insights and their perspectives on challenges in soybean marketing and the available marketing opportunities in the area. Results from the FGD were used to refine the household questionnaire and to validate results from econometric analysis. Primary data was obtained by use of semi-structured questionnaires administered face – to - face to the household head or spouse; the individual mostly involved in soybean production

in the household. The questionnaires captured data on household and farm characteristics, institutional and support services, and soybean marketing information. The survey was conducted during the end of November 2017 by a team of 4 trained enumerators after a pre-test of the questionnaire on 10 soybean farmers.

3.6 Empirical Data Analysis

3.6.1 Characterization of Soybean Farmers in Kakamega County

The characterization of soybean farmers was achieved through use of descriptive statistics involving frequencies and means to analyse data on measurable household characteristics, farm level factors, and institutional factors among. The means of some of these characteristics were separated on the basis of whether the household sold soybean or not and on whether they sold soybean on-farm or off-farm subsequent on being market participants.

3.6.2 Analysis of Factors that Influence Soybean Market Participation Decision, Choice of Market Channel, and Extent of Participation

Based on the conceptual framework presented in Figure 3.2, the triple hurdle model was specified in relation to the hypothesis that soybean market participation is determined by household characteristics, farm-level factors and institutional factors. This model was used to analyse the 3-step decision of market participation, which was first: the first decision on whether to sell or not sell any soybean, second: the decision on which channel to sell to, and lastly: the third decision on how much soybean to sell. Gebremedhin et al. (2017) and Burke et al. (2015) employed a triple hurdle model in order to incorporate the initial production decision in market participation. The advantage of the triple hurdle model is that it allows for the existence of both censored and selected zeros in the model and allows for both exclusion restrictions and

separability in estimation (Burke et al., 2015). This means that not all explanatory variables may be included in each model and that each model can be fitted separately.

In the first hurdle, a probit model was estimated to represent the discrete choice of market participation where the household decides on whether or not to sell any soybean. Participation was equated to 1 whereas non-participation equated to 0.

Following equation (3.3), the decision to participate in soybean marketing was specified as;

$$soysold = f(Age,Sex,Yrschool,Hhsize,Experience,Nonfarmincome,ICT,Credit,\ Extension, \quad (3.10)$$

For the second hurdle, a probit model was again adopted to estimate the choice of market channel between on-farm and off-farm. Hence, equation (3.4) on choice of market channel was specified as;

$$channel = f(Sex,Yrschool,\ Experience,Nonfarmincome,ICT,Credit, \quad (3.11)$$

The third hurdle on quantity of soybean to sell in kilograms was modelled by use of a censored regression model. Following equation (3.7), the quantity of soybean sold was modelled as:

$$qntysold = f(Yrschool,\ Hhsize,\ Landowned,Nonfarmincome,ICT,\ E xtension,\ Groupmember,\ Distancemkt,\ Ownertranportfacility,\ Mktinfo,\ Output, \quad (3.12)$$

3.7 Description of Variables and their Expected Signs

Table 3.1 provides a list of variables that were hypothesized to determine market participation.

Table 3.1: List of Variables Included in the Triple Hurdle Model

Variable code	Variable measurement	Expected sign		
		Hurdle 1	Hurdle 2	Hurdle 3
Age	Age of farmer in years	-		
Sex of farmer	1 for male and 0 female	+	+	
Years of schooling	Years of formal schooling completed	+	-	+
Household size	Number of household members	-		-
Experience	Number of years in soybean farming		+	+
Land owned	Size of land owned by the household (ha)			+
Non-farm income	Average monthly income from other sources other than farming in Kshs.	+		+
Access to ICT	1 = household owns either a radio/TV or both, and 0 otherwise	+		+
Access to credit	1 if farmer had access to credit services, 0 if not		+	
Access to extension	If farmer had access to extension services (1 = yes)	+		+
Group membership	1 if member of group 0 if not		+	+
Distance to main market	Distance to the main market centre (km)	-	-	-
Ownership of transport facility	1 = if farmer owns bicycle and/or motor vehicle, 0 if otherwise		+	+
Access to market information	If Farmer had access to market information (1 = yes)			+
Output quantity	Amount of soybean produced(kg)	+	+	
Intercropped	If farmer intercropped soybean with another crop (1 = yes)	-		-
Input purchase	If farmer purchased soybean seed, fertilizer, or inoculants (1 = yes)	+		+
Price	Price at which 1 kilogram of soybean was sold		+	+

The rationale for inclusion of different variables in the model is provided below.

Age

The probability of a farmer deciding to sell was expected to decline with age as older farmers are more associated with risk averseness (Siziba et al., 2011). Younger farmers are also more likely to have access to technology, which facilitates access to market information.

Sex of farmer

Sex of the farmer was expected to positively determine both decision to sell soybean and choice of market channel. This is because male farmers have better access to productive resources compared to their female counterparts (Abu et al., 2016). Sex of the farmer was expected to positively affect choice of off-farm market channel due to its ability to absorb more quantities of soybean compared to on-farm market channel. Male farmers have better access to productive resources which allows them to have greater marketable surplus hence they are more likely to choose off-farm market channel which has higher capacity to absorb surplus.

Years of schooling

A farmer's years of formal schooling were predicted to have a positive effect on decision to sell and quantity sold. This is because educated farmers are expected to have improved capacity to take advantage of market opportunities (Burke, 2015). Also, educated farmers are expected to be more likely to participate in commercial input markets which in turn increases marketable surplus (Makau et al., 2016). Years of schooling were also expected to positively influence choice of market channel. More educated farmers are more aware on the dynamics of the market and are likely to participate in organised market channels off-farm (Sharma, 2015).

Household size

The effect of household size on decision to sell and quantity of soybean sold was expected to be negative. Large households consume a larger proportion of the output reducing quantity available for sale thereby negatively influencing both the likelihood and extent of participation in the market (Siziba et al., 2011).

Experience

Experience was expected to positively determine decision on sell of soybeans. This is because more experienced farmers are expected to have more knowledge on better production mechanisms, which in turn increases their marketable surplus. Farmer's experience was hypothesized to positively affect choice of market channel (Emana et al., 2015).

Land owned

It was hypothesized that the size of land owned by the household would have a positive influence on the extent of market participation. This is because land is an important production resource in farming. This argument is supported by Mango et al. (2018) who established a positive relationship between size of land owned and extent of market participation. Large size of land increases the likelihood of the farmer to produce surplus for the market (Osmani and Hossain, 2015).

Non-farm income

Non-farm income was expected to affect market participation decision and extent positively. Non-farm income is presumed to have positive influence on market participation by providing capital for use in production. Siziba et al. (2011) established that high non-form income positively influence extent of market participation as it increases capacity of the farmer to finance production.

Ownership of Information and Communication Tool (ICT)

Ownership of ICT was hypothesized to positively determine decision to sell and quantity sold. Owning communication instruments like radio, mobile phone, and television facilitate access to market information thereby increasing quantity supplied to the market (Gebremedhin et al., 2017; Zamasiya et al., 2014). Also, owning an ICT reduces transaction costs in accessing information (Ogutu et al., 2014).

Credit

Availability of credit was expected to positively influence likelihood of selling soybeans. This is because access to credit is expected to improve the farmer's ability to invest in productivity enhancing inputs. Probability of using local channels was expected to decrease with availability of credit because the farmer has more resources to facilitate access to modern more profitable market outlets (Emana et al., 2015).

Extension

Extension was hypothesized to positively influence the farmers' decision to sell and extent of participation. This is because contact with extension services facilitates provision of crucial support services such as market information and technology transfer that would enable the farmer to sell output (Ndoro et al., 2013; Gebremedhin et al., 2017).

Group membership

Group membership was hypothesized to positively influence both decision to sell and amount sold by reducing transaction costs in marketing and also increasing adoption of improved production technologies (Fischer and Qaim, 2012). Being a member of a group represents the farmers' access to social capital and the ability of collective action to reduce transaction costs by pooling resources.

Distance to main market

The distance from farm/homestead to the market was expected to have a negative effect on decision to sell and quantity sold. Increased distance to the main market increases transaction costs and would therefore reduce likelihood of selling and quantity supplied to the market (Gebremedhin et al., 2017; Woldeyohanes et al., 2015). The distance to the main market was expected to affect choice of market channel negatively. Distance to market decreases probability of participation in distant and formal channels although they may be more profitable (Tesfamariam et al., 2015; Mafukuta, 2015).

Ownership of transport facilities

Ownership of transport facility on choice of market channel was expected to be positive for high value distant markets. The effect of owning a transport facility on quantity sold was also expected to be positive. This is because owning a transport facility such as bicycle and motorbike reduces transport costs hence aiding transportation of output and access to information. Owning transport facility also increases participation in input market (Makau et al., 2016). The increased connectivity to the market would increase the quantity of output placed on the market.

Access to market information

Market information was predicted to positively affect choice of market channel. Having access to market information was expected to positively influence extent of market participation as it reduces transaction costs in marketing therefore facilitating sell of more output quantity to the chosen market (Mango et al., 2018).

Output quantity

Output quantity was expected to positively influence the decision to sell soybean and the choice of market channel. This is because more output means that the farmer has surplus produce to sell.

Intercropping

Intercropping is expected to negatively influence the amount of soybean sold. This is because household which are producing soybean with the intention of selling are more likely to cultivate soybean as a single crop as opposed to mixing it with other crops.

Input purchase

The use of purchased or commercial inputs such as improved seeds and inoculants was hypothesized to increase both the probability of the farmer to participate in selling of soybean and quantity of soybean sold. This is because these inputs increase productivity thereby increasing marketable surplus (Zamasiya et al., 2014).

Price

The price of selling soybean was expected to positively affect choice of market channel. This is because higher prices increase the profit margins therefore enabling farmers to take care of transaction costs. The price was expected to positively affect quantity of soybean supplied to the market. Higher output price acts as incentive for more output being supplied to the market (Gebremedhin et al., 2017).

3.8 Model Diagnostics

3.8.1 Multicollinearity

Multicollinearity refers to a high degree of linear dependency among the independent variables. The Pearson's Correlation coefficient matrix is used to measure strength and direction of a linear relationship between two variables. It was used to show the correlation between continuous variables included in the triple hurdle model and the results are included in Appendix 1. An absolute value of 1 indicates perfect linear relationship of the variables. Presence of multicollinearity is indicated by a pairwise correlation of absolute value 0.5 and above (Gujarati, 2004). None of the coefficients had an absolute value above 0.4 indicating no strong correlation

between the independent variables. Also, the presence of multicollinearity within all the independent variables was tested using the variance inflation factor (*VIF*). The presence of multicollinearity is indicated by a *VIF* higher than 10 (Gujarati, 2004). The results of the *VIF* are included in Appendix 2. These results show absence of multicollinearity with the mean *VIF* of 1.352.

3.8.2 Heteroskedasticity

Heteroskedasticity occurs when the error terms have no constant variance (Wooldridge, 2010). The *White test* was used to establish presence of heteroskedasticity within the variables used the triple hurdle model. The *White test* was preferred over *Breusch pagan* test due to the latter's ability to only test foe linear correlation. The results in Appendix 3 were not significant hence the null hypothesis of homoskedasticity could not be rejected indicating constant variance across the error terms used in the triple hurdle model.

CHAPTER FOUR : RESULTS AND DISCUSSION

4.1 The Characteristics of Soybean Farmers

Table 4.1 shows characteristics of the households who participated in soybean markets and those who did not. The average household size for the soybean farmers was 7 people while the mean age was 50 years. The mean age was consistent with the report by Republic of Kenya (2017) in the Kenya Youth Agribusiness Strategy 2017-2021, which indicates that the majority of people engaged in farming are aged between 50 and 65 years. Both the mean age of the farmers and the mean household size were similar for the market participants and the non-participating households.

Most of the soybean farmers were female at 65 percent. The results are consistent with Zamasiya et al. (2014) who referred to soybean as a predominantly female crop, similar to other legumes. The results of the two-sample of proportions indicated that there were statistically significant differences in proportion of females between market participants and non-participants. Among the market participants, females were 57 percent whereas this proportion was 78 percent among the non-market participants. The results were consistent with the study by Fischer and Qaim (2012) who found that female are disadvantaged in access to resources reducing their ability to commercialize compared to their male counterparts.

Table 4.1: Household Characteristics

Variable	Non-market participants (n = 58)	Market participants (n = 90)	Pooled Sample (n = 148)	Statistical differences between participants and non-participants (*p*-value)
Age (years)	50.62	50.19	50.36 (13.21)	0.847
Sex of farmer (% female)	77.60	56.70	64.90	0.009***
Marital status (% married)	74.10	84.40	79.10	0.123
Experience (years)	4.80	4.60	4.70 (4.82)	0.818
Household size	7.00	6.70	6.90 (3.20)	0.799
Years of schooling	7.90	9.20	8.70 (4.05)	0.055*
Primary occupation (% farmer)	69.00	74.40	72.30	0.053*
Farm income (Kshs)	4111.00	5978.00	5246.00 (5111.00)	0.030**
Non-farm income (Kshs)	4868.00	4534.00	4665.00 (8032.00)	0.806
Ownership of transport facility (% yes)	46.60	62.20	56.10	0.061*
Use of inoculants (% yes)	3.40	31.10	20.30	0.000***
Bought seeds (% yes)	50.00	57.80	60.80	0.031**
Use of fertilizer (% yes)	34.50	72.20	57.40	0.000***
Labour used (% hired labour)	19.00	28.90	25.00	0.015**
Total land size (ha)	0.67	0.80	0.75 (0.63)	0.231
Farm size under soybean (ha)	0.08	0.13	0.11 (0.05)	0.051*
Output quantity (Kgs)	46.16	116.67	89.03 (118.06)	0.000***
Access to credit (% yes)	44.80	67.80	58.80	0.006***
Group membership (% yes)	74.10	87.60	82.30	0.360
Access to extension (% yes)	22.40	47.80	37.80	0.002***

Note: ***, **, * significance levels at 1, 5 and 10 percent, respectively. **Standard deviations for the continuous variables are given in parenthesis**.
Source: Survey Data (2017).

The percentage of married farmers was 79 percent. The percentage of farmers who were married was higher among market participants, compared to the non-participants, this difference was however not significant. The mean soybean farming experience was 5 years. This implies that for most of the farmers, soybean farming is a relatively recent crop. The sampled households had on

average 7 household members and the average years of schooling for the pooled sample were 9 years. The difference in years of schooling between farmers who participated in soybean market and the farmers who did not participate in soybean market was statistically significant. The results are in tandem with arguments by Sharma (2015), who found that higher education improved farmers' capabilities in production and marketing practices.

The primary occupation for most of the soybean farmers was farming at 72 percent. This aspect corresponds with the County Government of Kakamega (2017) which classifies most of Kakamega County rural population as being agriculture-dependent. Most of the market participants practiced farming as their primary occupation compared to the non-participants. The other occupations were spread amongst running a business, formal employment and casual labour as shown in Figure 4.1.

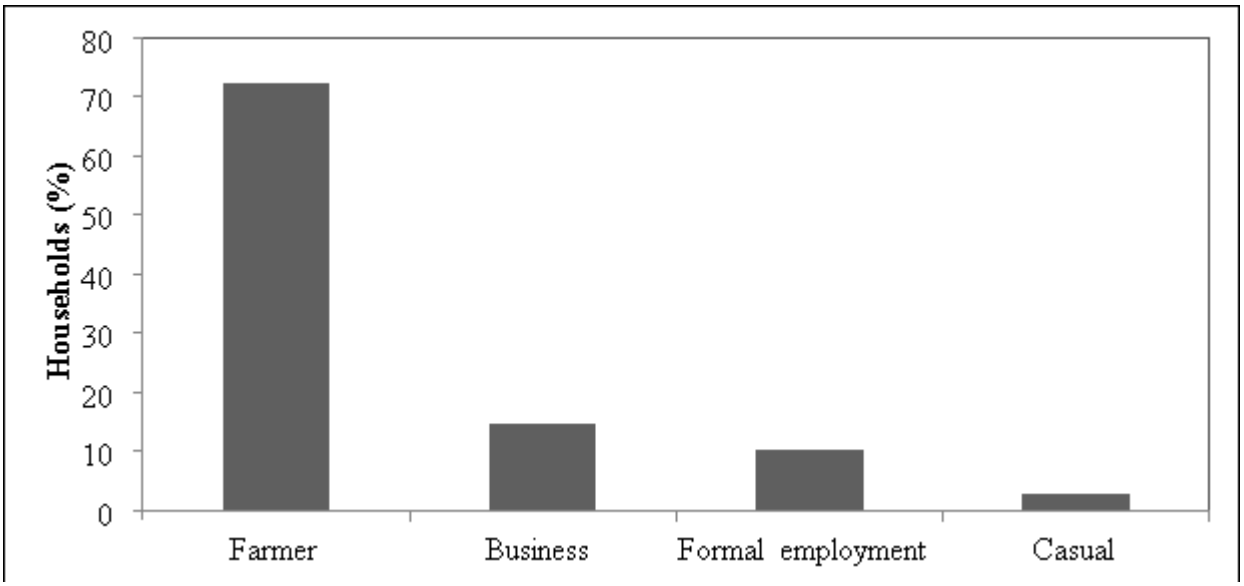

Figure 4.1: Main Occupation of Sampled Soybean Farmers

Source: Survey Data (2017).

There were significant differences in the monthly farm income between the market participants and the non-participants as shown in Table 4.1. The average farm income for the non-participants was Kshs 4,110 and that for the market participants was Kshs 5,978. The average farm income for all of the respondents was almost half of the total average monthly income. Also, the percentage of those households which owned a transport facility was higher among market participants than among the non-participating households.

There were statistically significant differences in use of inputs between the households who sold soybean and those who did not sell any soybean. In the pooled sample, a fifth of the respondents recorded use of inoculants compared to a mere 3 percent among the non-participants whereas, almost one third of the market participants used inoculants. The percentage of households which used fertilizer, both organic manure and/or inorganic fertilizer, in the overall sample was 57 percent. The households that purchased soybean seeds were 60 percent while one quarter used hired labour in soybean production. Compared to fertilizer and inoculants, purchase of seeds had a lower significance, which can be explained by the challenge in accessing quality seeds. During the survey, farmers indicated that soybean crop performed well when they used seeds harvested in the long rains to plant in the short rains during the same year. These observations can be attributed to ease of loss of viability in soybean when not stored properly as indicated in the study by Tinsley (2009).

The main source of soybean seeds was farmer groups followed by open-air market, agro-vet shop, and lastly, purchase from neighbours. Figure 4.2 shows the percentage distribution of where the farmer purchased soybean seeds. The results support findings by Tinsley (2009) who observed concluded that private seed companies avoid soybean because of its self-pollinated

nature, which means farmers are able to replant soybean using retained seed hence diminishing company repetitive profits.

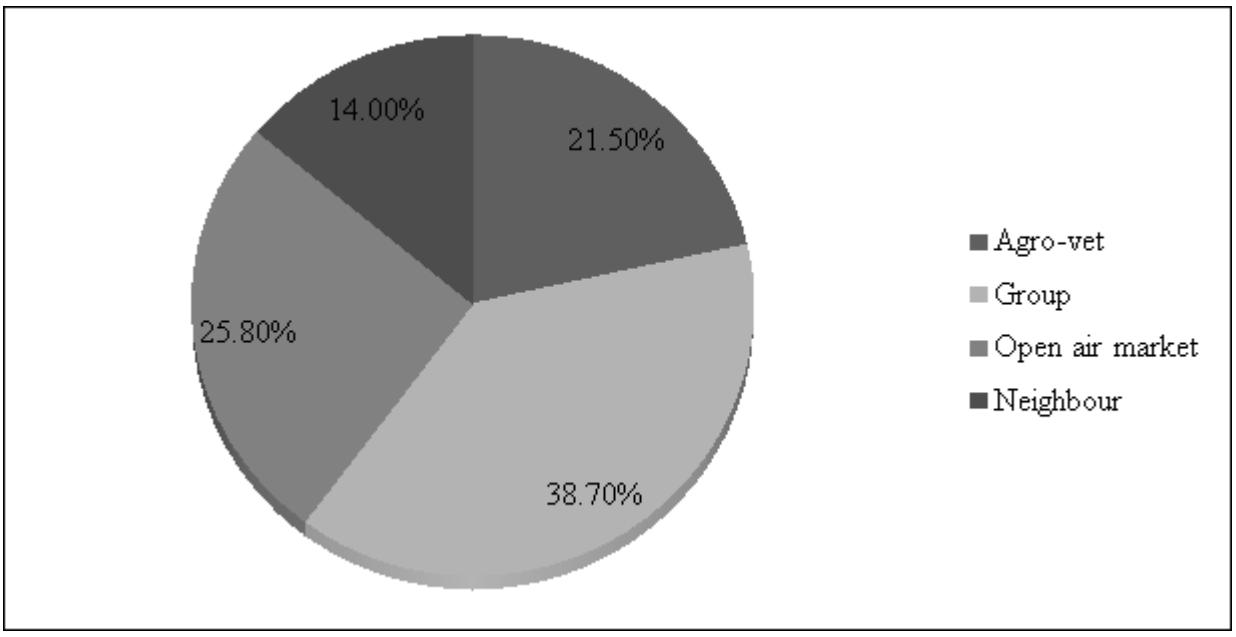

Figure 4.2: Distribution of where Farmers Purchased Soybean Seeds

Source: Survey Data (2017).

The study showed that the mean total size of land owned in the pooled sample was 0.7 ha, which was slightly higher than the mean land holding size in Kakamega County of 0.57 ha according to County Government of Kakamega (2017). This is consistent with literature, which show that farming in Kenya is dominated by smallholder farmers (Republic of Kenya, 2017). The farm size under soybean and the soybean output quantity were higher among market participants compared to the non-participants and were both statistically significant.

In the overall sample, 59 percent had access to credit services. Amongst non-market participants, 45 percent had access to credit whereas amongst the market participants 68 percent had access to credit. This difference in percentage of access to credit between market participants and non-

market participants was highly significant. Group membership in the pooled sample was at 82 percent. Although there were differences in group membership between market participants and the non-market participants, this difference was statistically insignificant. From the FGD, most of the groups were not effective and mainly suffered from poor management and non-commitment by members. Within the overall sample, 38 percent of the farmers had access to soybean-related extension. The difference in access to soybean-related extension was statistically significant, which indicates that more market participants received extension compared to the non-participants.

Data on soybean production were collected for two farming seasons; the short rain season between August and November 2017 and the the long rains period between March and July 2017. Over 90 percent of the households planted soybean in the short rains season as shown in Figure 4.3 compared to about 40 percent who planted soybean in the long rains season. Most of the households planted soybean as a single crop during the short rains with less than 30 percent of them intercropping soybean with other crops. This indicates that in the short rains, most households prefer to plant soybean as a single crop, probably as a rotational crop after harvesting primary crops from the long rains. Figure 4.3 shows the production and intercropping patterns in the two production seasons.

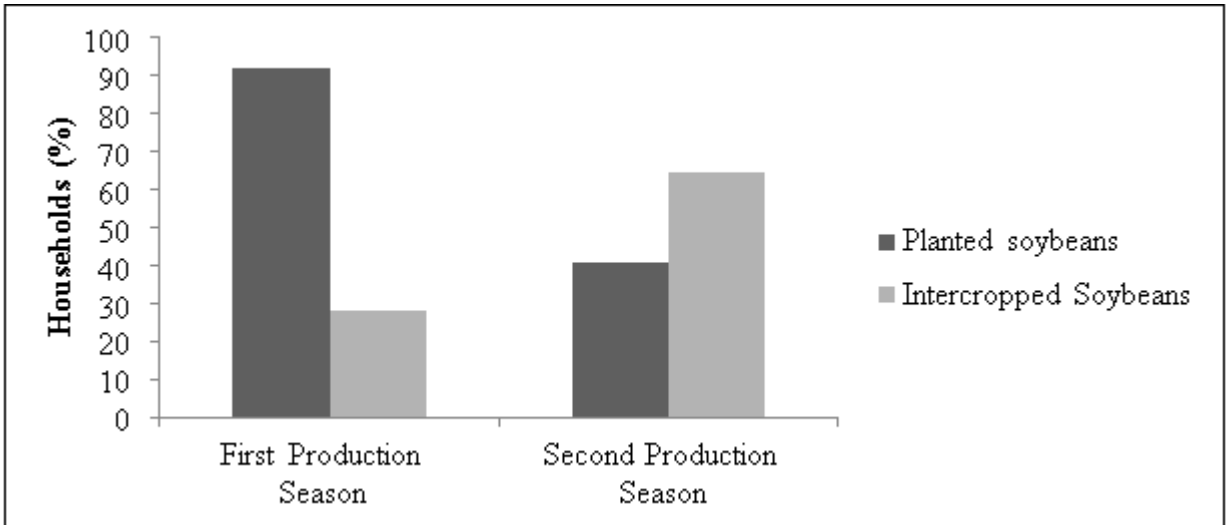

Figure 4.3: Soybean Production in the First and Second Season

Source: Survey Data (2017).

Fewer of the households planted soybean in the long rains season, and those who planted soybean mostly intercropped it with other crops. This can be attributed to the significance of maize as a staple crop and is hence the priority crop of the long rains.

Amongst those farmers who were not members of any social and development group, the main reason cited for not being a member was preference to act alone as shown in Figure 4.4.

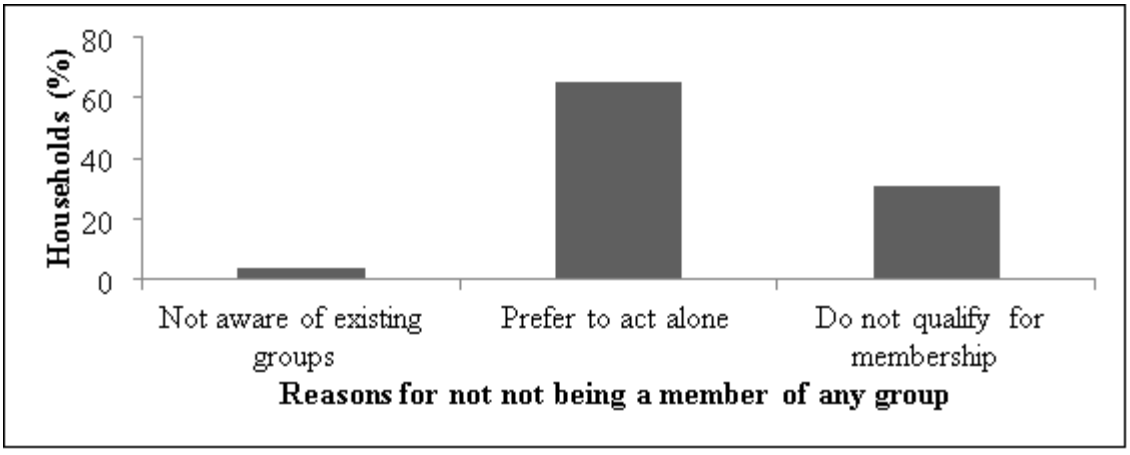

Figure 4.4: Reason for not Being a Member of a Group

Source: Survey Data (2017).

Land preparation and harvesting and threshing were ranked first in most laborious production activities by the soybean farmers. In the second rank and third rank again harvesting and weeding was selected by a majority of the farmers together with weeding. From the results shown on Figure 4.5, planting, followed by weeding were the least labour-intensive activities.

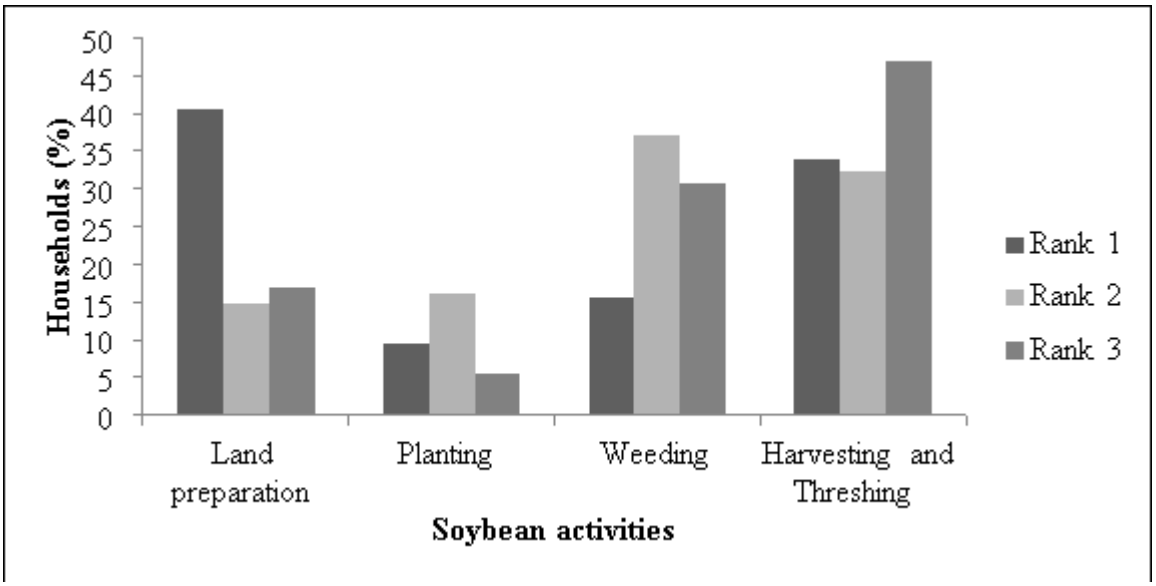

Figure 4.5: Ranking of Soybean Activities in Terms of Labour Intensity

Source: Survey Data (2017).

4.1.1 Characteristics of On-farm and Off- farm Soybean Sellers

Subject to having decided to sell soybean, the market channels used by the farmer were categorised as either on-farm or off-farm. On-farm market channel meant that the buyer collected soybean directly from the farmer hence the farmer did not incur any transportation costs. In off-farm market channels, the farmer transported the soybean either to a group collection centre, the open-air market, or an institution such as school, KALRO, and ROP. More than half the market participants sold soybean off-farm as shown in Table 4.2. The number of farmers who sold soybean on-farm was 33 representing 36 percent of the total market participating households. Off-farm market participants were a year and half older than their on-farm market participating

counterparts. Additionally, on-farm market participants spent on average one year more schooling compared to off-farm market participants. The number of people in the household was about 7 persons whereas experience in number of years farming soybean was 4.6 years for both on-farm and off-farm market participating households.

On-farm market participants produced around 70 kgs of soybean compared to about 150kgs produced by off-farm channel market participants. Quantity of soybean sold off-farm was more than twice that sold on-farm although the mean price of a kilogram of soybean on-farm was Kshs. 14 higher that the mean price received by off-farm market participants. In the FGD, the participants indicated that the price for a kilogram of soybean could be increased up to Kshs. 400 through value addition by transforming the grain into soy-milk or drinking soya, which is popular among Seventh Day Adventist faithful.

Table 4.2: Summary Statistics of Soybean Farmers in On-farm and Off-farm Market Channels

Variable	On-farm (n = 33)	Off-farm (n = 57)
Age	49.30	50.70
Years of schooling	9.69	8.89
Household size	7.10	6.70
Experience	4.60	4.60
Quantity of soybean sold	36.96	85.25
Output	68.78	146.50
Price	79.84	65.84
Distance to the nearest market	3.70	4.60
Sex of the farmer (% male)	42.42	43.86
Access to credit (% yes)	57.57	73.68
Access to market information (% yes)	72.70	59.60
Ownership of transport facility (% yes)	60.61	63.16
Group membership (% yes)	69.69	96.49

Source: Survey Data (2017).

The households who sold soybean on-farm were on average 1 km nearer to the nearest market when compared to those who sold soybean off-farm. Male participants in both market channels were around 40 percent. In terms of access to credit, 58 percent of on-farm sellers' accessed credit compared to 74 percent of off-farm sellers who had access to credit. Also, a larger percentage of on-farm sellers had access to market information as compared to the farmers who sold through off-farm market channel. Both the percentages of sellers with own transport facility and group membership were higher among off-farm sellers when compared with on-farm sellers.

4.1.2 Soybean Value Addition

Farmers carried out various value addition services in addition to drying, cleaning, and sorting. Participants in the FGD indicated that farmers were aware of theses value addition practices. Farmers acknowledged that cleaning and sorting increased the price of soybean and all the surveyed households performed some basic form of cleaning and sorting. The other value addition activities undertaken were roasting, preparation of soy flour and soy-milk, and packaging. Roasting and grinding into soy flour was mainly done by the farmers so as to improve palatability for the soybean consumed in the household. The soybeans were in most instances mixed with other grains and ground to make nutritious porridge formula. Very few farmers practised packaging and these were only members of a group, which had established a shop where they sold soybean products. This group also had received machinery for processing soy-milk although at the time of this survey the machine had broken down and therefore was not operational. Value addition considerably increased returns from soybean. The results in Figure 4.6 indicate that all the farmers practiced drying, cleaning and sorting.

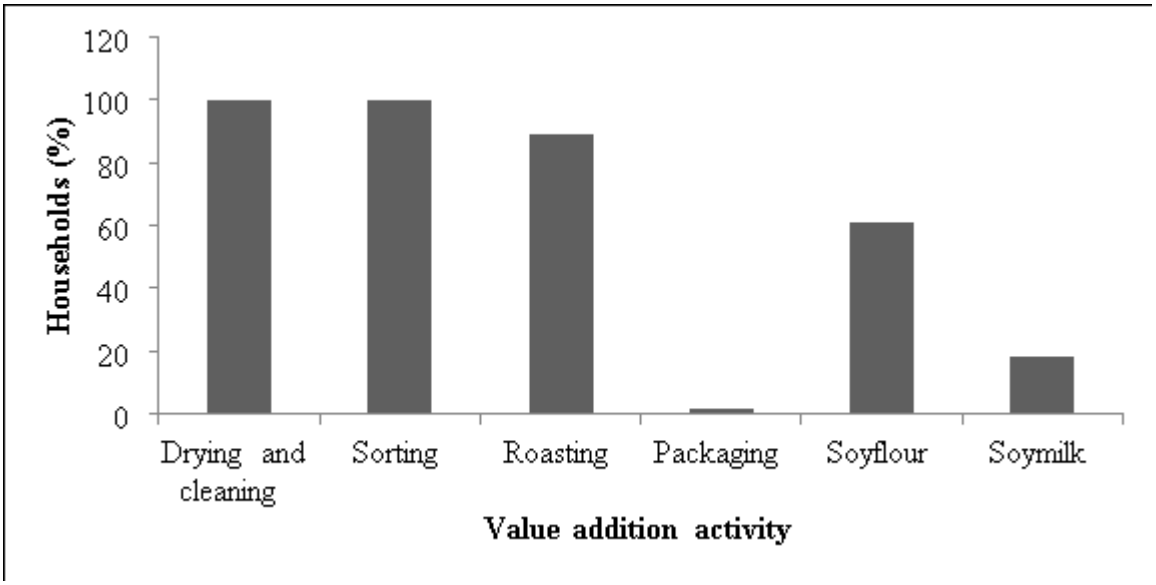

Figure 4.6: Value Addition Practices Carried out by Farmers on Soybean

Source: Survey Data (2017).

4.1.3 Gendered Analysis of Decision-Making in Soybean Production and Utilization

Data from the FGD indicated that most of the decisions regarding soybean were mainly undertaken by the female in the household. This was as expected because soybean is viewed as a crop whose production is dominated by women (Zamasiya et al., 2014). Relatively fewer men were involved in decisions regarding farm labour and harvesting as shown in Figure 4.7. The percentage of men involved in decisions on choice of farm and seed acquisition were about 17 percent and 18 percent respectively compared to the 9 percent and 8 percent engaged in farm labour and harvesting decisions, respectively.

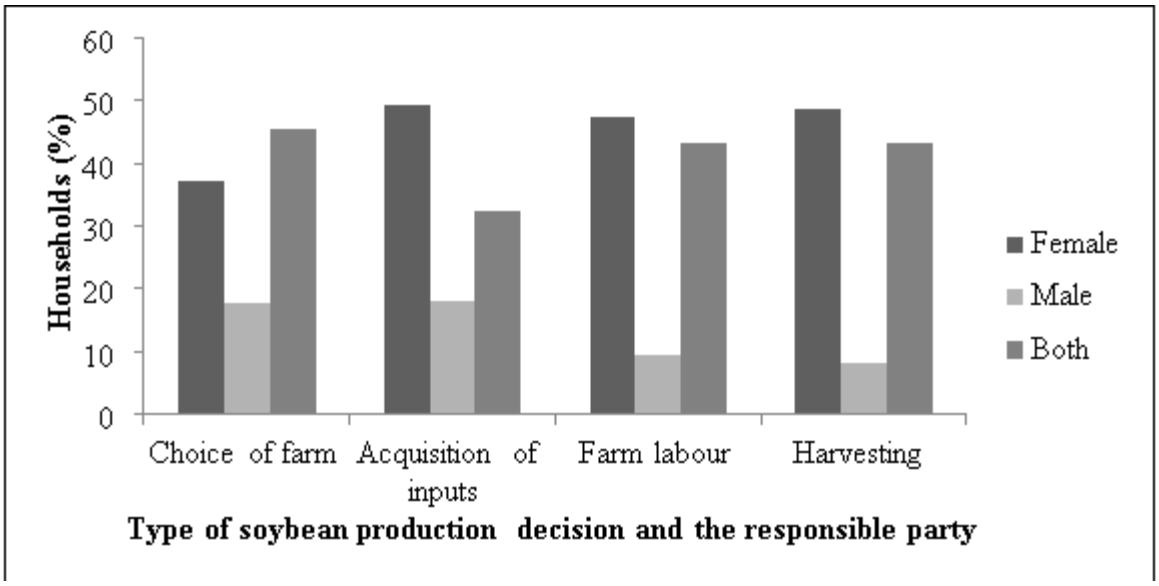

Figure 4.7: Soybean Production Decisions along Gender lines

Source: Survey Data (2017).

When it comes to value addition, 67.6 percent of females make the decision compared to 4.7 percent of their male counterparts. This percentage of female is largely reduced upon decision on how to use money from sale of soybean and in transportation as shown in Figure 4.8. The results allude to disparities in household control of resources between male and female. A relatively high number of men were involved in transportation of soybean at 30.4 percent compared to the other decisions in which male controlled less than 20 percent.

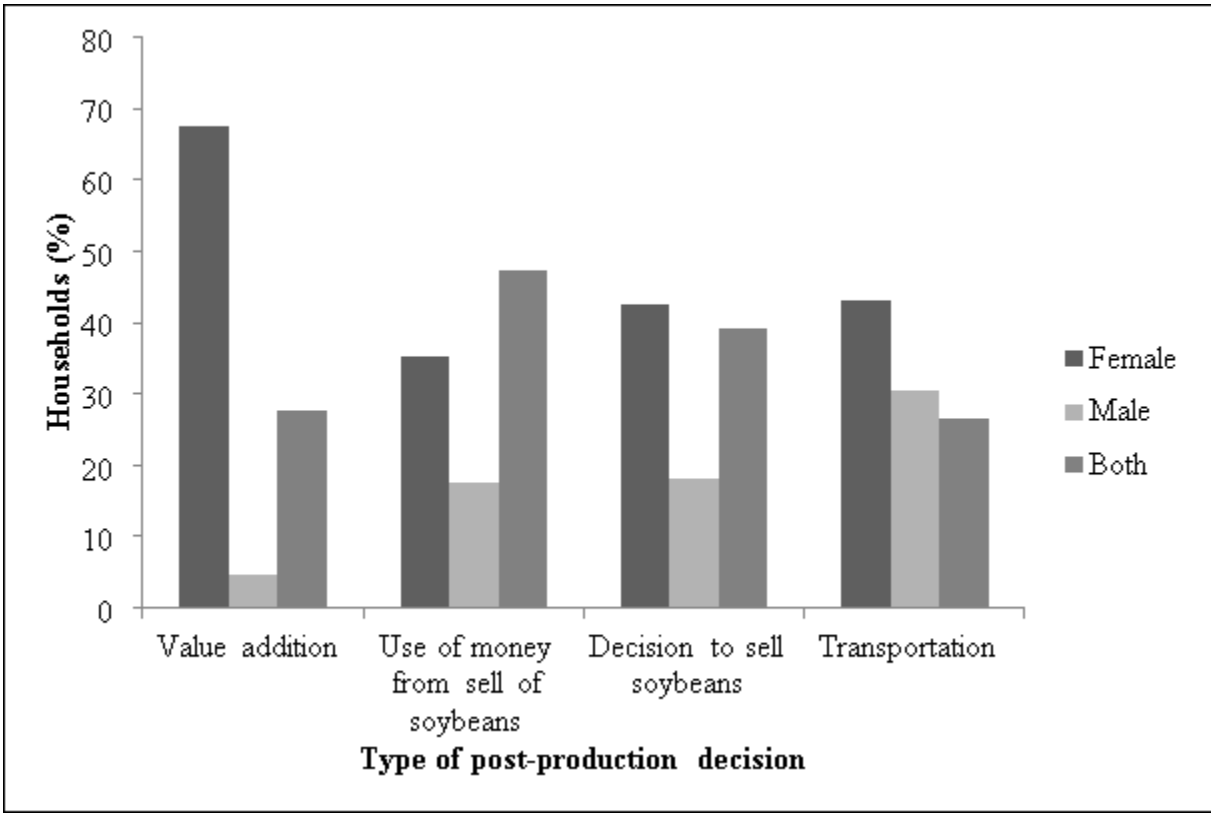

Figure 4.8: Soybean Post Production Decisions along Gender Lines

Source: Survey Data (2017).

4.2 Factors that Influence Soybean Farmers' Decision to Sell

The results of the selection equation are presented in Table 4.3. Marginal effects were used to facilitate interpretation of per unit influence of each independent variable on the probability of selling soybean. The likelihood ratio test of the null hypothesis that farm-level factors, household characteristics, and institutional factors taken jointly have no effect on the decision to sell generated $Chi^2 = 50.621$ with $Prob > chi^2 = 0.000$ indicating level of significance close to zero; hence the null hypothesis is rejected. Household characteristics (sex of the farmer, non-farm income), output quantity, intercropping, input purchase and access to credit were found to be significant in determining likelihood of selling soybean.

Table 4.3: Factors that Influence Decision to Sell Soybean (*Hurdle 1*)

Variables	Coefficient	Standard error	*t*-value	dy/dx
Age (years)	-0.001	0.010	-0.14	0.000
Sex of farmer (1 = male)	0.528	0.284	1.86*	0.150
Years of schooling (years)	0.021	0.037	0.58	0.006
Household size (number)	-0.054	0.042	-1.29	-0.015
Non-farm income (kshs)	0.002	0.000	-2.69***	0.001
Access to ICT (1 = yes)	0.251	0.199	1.26	0.071
Access to credit (1 = yes)	0.445	0.261	1.71*	0.126
Access to extension (1 = yes)	0.398	0.268	1.49	0.112
Distance to main market (km)	-0.038	0.044	-0.87	-0.011
Output quantity (kgs)	0.005	0.002	2.47**	0.001
Intercropped (1 = yes)	-0.592	0.264	-2.24**	-0.167
Input purchase (1 = yes)	1.363	0.618	2.21**	0.386
Constant	-0.423	0.734	-0.58	
Pseudo R^2	0.255	Number of obs		148
Chi^2	50.621	Prob > chi^2		0.000

Note: ***, **, * significance levels at 1, 5 and 10 percent respectively.
Source: Survey Data (2017).

As was hypothesized, effect of sex of the farmer was positive and significant in influencing the decision to sell soybean. Being male increased the likelihood of selling soybean by 15 percent at 10 percent level of significance. This can be explained by the view of Abu et al. (2016) that males and females have different access to productive resources and that females seldom receive assistance on their farms compared to their male counterparts. The result however differs with

that of Zamasiya et al. (2014) who found that women had a higher probability of deciding to sell soybean since men are seldom involved in its production.

The effect of non-farm income positively influenced the decision to participate in soybean marketing at 1 percent level of significance. This is because non-farm income increases the capacity of the farmer to finance production and invest in improved technology. The non-farm income compliments agricultural production by providing resources for investing in the farm, which results in increased output hence more likelihood of selling soybean. The result is however contrary to that of Woldeyohanes et al. (2015), in which case non-farm income was of uncomplimentary nature with agriculture.

Institutional support in form of credit had a positive effect on probability of selling soybean just as it was hypothesized. Having accessed credit increased likelihood of selling soybeans by 7 percent. Having access to credit gives the farmer resources to facilitate purchase of inputs, which in turn increase the productivity of soybean therefore increasing marketable surplus. This observation is in tandem with Olwande and Mathenge (2012) who found that access to credit enables purchase of inputs thereby increasing soybean productivity.

Output quantity significantly increased the likelihood of the farmer deciding to sell soybean. The result is similar to findings by Siziba et al. (2011) and Olumeh (2018). A kilogram increase in the quantity of soybean produced increased the likelihood of the farmers deciding to sell soybean by 0.1 percent. This is because a higher amount of produce means availability of surplus for the market after subsistence use.

Intercropping soybean with another crop was found to negatively affect the likelihood of selling soybean. Those farmers who had planted soybean as an intercrop were less likely to sell soybean by 17 percent. The cereal-legume intercrop used, although excellent in land use and nutrient use

efficiency, this traditional single row relay intercropping cause sub-optimal light interception and low yields (Iqbal et al., 2018).

Purchase of inputs significantly increased the households' probability of selling soybeans by 39 percent. This is because participation in input market increases productivity and marketable surplus hence positively influencing decision to sell. This results tallies with that of Zamasiya et al. (2014) who observed that the use inoculants and improved seed variety increased soybean yield in Zambia therefore increasing market participation.

4.3 Factors Influencing Choice of Market Channels

A probit model was used to analyse factors that affect farmers' choice of soybean market channel. The results are represented in Table 4.4 and show that choice of market channel is influenced by household characteristics (years of schooling), institutional factors (group membership), and farm-level factors (output quantity and price) all with expected signs except price which had an unexpectedly negative effect on choice of market channel. The null hypothesis of the likelihood ratio that choice of market channel is independent generated Chi^2 = 28.859 and $Prob > chi^2$ = 0.001. Therefore, the model as a whole is statistically significant (p=0.001) and thus, the null hypothesis is rejected.

Increasing schooling by 1 year resulted in decreased probability of choosing off-farm market channel by 2.5 percent. The inverse relationship between years of schooling and choice of off-farm is because more educated farmers are likely to have reduced dependency on income from soybean hence opting for the convenience of selling on-farm. Another possible explanation could be that more educated farmers were able to take advantage of the relatively higher soybean prices offered by on-farm market channel.

Table 4.4: Factors Influencing Choice of Market Channel (*Hurdle 2*)

Variables	Coefficient	Std. err	*t*-value	dy/dx
Sex of farmer (1 = male)	0.167	0.335	0.5	0.047
Years of schooling (years)	-0.089	0.047	-1.88*	-0.025
Experience (years)	-0.003	0.037	-0.09	-0.001
Access to credit (1 = yes)	0.327	0.365	0.9	0.092
Group membership (1 = yes)	1.315	0.478	2.75***	0.370
Distance to main market (Km)	0.024	0.061	0.39	0.007
Ownership of transport facility (1 = yes)	-0.069	0.330	-0.21	-0.020
Output quantity (Kg)	0.005	0.002	2.29**	0.002
Price (Kshs./kg)	-0.009	0.005	-1.68*	-0.003
Constant	-0.12	0.827	-0.14	
Pseudo R^2	0.244	Number of observations		90
Chi^2	28.859	Prob > chi^2		0.001

Note: ***, **, * significance levels at 1, 5 and 10 percent respectively.

Source: Survey Data (2017).

Group membership was found to be directly related to the likelihood of selecting off-farm market channels. Off-farm markets require additional transport costs for the produce to reach the market, which results in relatively higher transaction costs compared with on-farm markets. Because groups have the capacity to enable their members to reduce transaction costs through access to productive resources and pooling of resources, group members are therefore more likely to engage in off-farm market channel. Muthini et al. (2017) also noted that groups increased

participation in export market channels, which although advantageous have considerably higher transaction costs.

Output quantity had a positive and significant influence on the likelihood of choosing to sell soybean off-farm. Mafukuta (2015) also found that increased production positively affected choice of formal market outlets. An increase in the quantity of soybean produced by the farmer of 1 kilogram increased the likelihood of selling soybean off-farm by less than 1 percent. This can be attributed to the high capacity of off-farm market channel to absorb surplus compared to on-farm market channel.

Price had a negative and significant influence on the probability of choosing off-farm market channel. A possible explanation from this unexpected result is that although off-farm market channel has the capacity to absorb large quantities of soybean, the accrued benefit of selling small quantities at relatively higher prices on-farm translates into higher profits.

4.4 Factors affecting Extent of Market Participation

The third and last decision modelled was extent of market participation, which was measured as quantity of soybean sold in kilograms in the respective channel. Following Okoye e al. 2016, the sample sizes were computed by adding farmers who sold to the particular channel and those who never sold (non-participants). The results of these outcome equations are represented in Table 4.5. Conditional on the farmer deciding to sell soybean and having selected on-farm market channel, the quantity of soybean sold was influenced by years of schooling, extension, ownership of transport facility, access to market information, and price. On the other hand, conditional on having decided to sell soybean and selected off-farm market channel, the quantity of soybean sold was influenced by household size, land owned, extension, group membership, access to market information, intercropping, input purchase, and price.

Table 4.5: Factors that Influence Extent of Market Participation (*Hurdle 3*)

	On-farm (n = 91)				Off-farm (n = 115)			
Variable	**Coef.**	**Std.err**	***t*-value**	$dydx$	**Coef.**	**Std.err**	***t*-value**	$dydx$
Years of schooling (years)	0.132	0.060	2.19**	0.076	0.038	0.051	0.74	0.016
Household size (number of persons)	0.024	0.059	0.41	0.014	-0.237	0.081	-2.94***	-0.099
Land owned (ha)	0.130	0.116	1.12	0.075	0.263	0.145	1.81*	0.110
Non-farm income (Kshs.)	0.000	0.000	0.09	0.000	0.000	0.000	-0.01	-0.000
Ownership of ICT (1 = yes)	-0.318	0.352	-0.90	-0.183	-0.277	0.312	-0.89	-0.116
Access to extension (1 = yes)	0.889	0.459	1.94*	0.512	1.495	0.367	4.07***	0.625
Group Membership (1 = yes)	-0.604	0.455	-1.33	-0.348	1.500	0.819	1.83*	0.627
Distance to main market (km)	-0.022	0.066	-0.33	-0.013	-0.029	0.059	-0.49	-0.012
Own transport facility (1 = yes)	0.967	0.440	2.20**	0.556	0.550	0.371	1.48	0.230
Access to market information (1 = yes)	1.065	0.483	2.21**	0.613	1.157	0.403	2.87***	0.484
Intercropped (1 = yes)	-0.538	0.439	-1.23	-0.310	-1.648	0.480	-3.43***	-0.689
Input purchase (1 = yes)	-0.613	0.688	-0.89	-0.353	0.963	0.456	2.11**	0.402
Price (Kshs/kg)	0.050	0.006	7.69***	0.029	0.052	0.006	9.04***	0.022
Constant	-3.009	0.921	-3.27***		-1.542	1.254	-1.23	
Pseudo R2				0.514				0.432
Prob > chi2				0.000				0.000
Log likelihood				-60.066				-114.288

Note: ***, **, * significance levels at 1, 5 and 10 percent respectively.

Source: Survey Data (2017).

One surprising result was that non-farm income although positive and significant in influencing the initial market participation decision (Table 4.2), it was not significant in influencing the quantity of soybean sold (Table 4.4). One possible explanation for this phenomenon could be that although increase in non-farm income is likely to induce the household to sell soybean due to the improved capacity to increase production, it is less likely to sell more of the soybean because the household is not income constraint. Hence, it consumes most of the soybean as opposed to selling more to generate income.

Increasing number of years of schooling was found to increase quantity of soybean sold on-farm at 5 percent level of significance. An increase in formal schooling by one year resulted in increased quantity of soybean sold on-farm by 8 percent. More years of education are associated with improved capacity to interpret market signals and understand good production practices.

Large household size was found to reduce quantity of soybean supplied off-farm at 1 percent level of significance. Increasing number of persons in the household by 1 person resulted in decreased quantity of soybean sold off-farm by 10 percent. Large households consume greater quantity of output therefore resulting in reduced amount of produce available for sale.

The size of land owned hard a positive and significant effect on determining the extent of soybean market participation in off-farm market channel. An increase of 1 acre in land owned resulted in increased quantity of soybean sold off-farm by 11 percent. Land is a vital productive asset especially in crop cultivation and therefore owning large size of land would increase the households' capacity to produce market surplus. The household with large parcel of land can apportion more land under soybean production hence increase marketable surplus. The results were concurrent with Osmani and Hossain (2015) who found that large farm size enabled the

farmer to produce surplus for the market. Land owned by the household was found to be significant and positive in increasing extent of participation in off-farm market channel.

Access to extension had a positive and significant influence on the quantity of soybean supplied to the market. Having access to extension service increased the quantity of soybean sold on-farm by 51 percent and off-farm by 63 percent at 10 percent and 1 percent level of significance respectively. This result is similar to that of Gebremedhin et al. (2017) with regard to small ruminants in Ethiopia. Access to extension services is considered crucial in facilitating provision of support services such as market information and technology transfer that enhances productivity which in turn increase marketable surplus (Ndoro et al., 2013).

Group membership was found to increase extent of soybean market participation in off-farm market channel at 10 percent level of significance. Belonging to a group increased quantity of soybean sold by 63 percent all other factors held constant. A similar result was observed by Olwande and Mathenge (2012). This is because groups are important in reducing transaction costs and increasing bargaining power aside from searching for market outlets. Group membership was however not significant in influencing quantity of soybean sold on-farm.

Owning personal means of transportation was found to positively determine extent of soybean market participation at on-farm market channel. This result is supported by Makau et al. (2016) who found that owning a bicycle to increase likelihood of purchase commercial fertilizer, which can be expected to increase marketable surplus hence increasing quantity sold. Owning a transport facility such as bicycle or motorbike reduces transport costs hence aiding access to information and also facilitates access to distant markets thereby increasing amount sold.

Having access to market information was found to positively determine extent of market participation in both market channels. Having access to market information increased the quantity of soybean sold on-farm by 61 percent and off-farm by 48 percent at 5 percent and 1 percent level of significance respectively. Having access to market information reduces transaction costs in marketing therefore facilitating sell of more output quantities.

Intercropping soybean with another crop reduced quantity of soybean sold off-farm by 69 percent at 1 percent level of significance. Soybean productivity decreases when soybean is cultivated with another crop (Bekabil, 2015). This is because the traditional intercropping used by most of the farmers results in poor light penetration (Iqbal et al., 2018).

Input purchase was significant in determining quantity of soybean sold off-farm. Having purchased input increased quantity of soybean sold off-farm by 40 percent at 5 percent level of significance. This is because farmers who participate in input market are mostly more commercially oriented and are therefore likely to sell greater quantities of output. Also, investing in purchased inputs increases productivity, hence increasing quantity of marketable surplus.

The effect of price on extent of market participation was found to be positive for both on-farm and off-farm at 1 percent level of significance. A unit increase in price of soybean resulted in increase in quantity of soybean sold on-farm by 3 percent whereas a unit increase in price of soybean resulted in 2 percent increase in quantity of soybean sold off-farm. The result corresponds with results by Kizito and Kato (2018) and Ndoro et al. (2013). This indicates that soybean is price responsive and high output prices act as an incentive for supplying more quantity on the market. Higher soybean output price increases profit margin hence, the farmer is able to pay for transaction costs associated with marketing.

CHAPTER FIVE : SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The main objective of this study was to assess factors that determine market participation among soybean farmers in Kakamega County. The results showed that soybean production is mostly undertaken by women and is characterized by small quantity of produce harvested. The descriptive statistics show that farmers who were market participants produced more soybean output quantity, had more years of schooling, and had a higher level of farm income compared to their non-participating households. Also, female market participants were significantly fewer compared to the number of female non-participants. Off-farm market channel although they offered lower prices per kilogram of soybean, the quantity of soybean sold was more than twice the quantity of soybean sold on-farm.

The results from the first hurdle showed that the decision to sell soybean was positively determined by sex of the farmer, non-farm income, input purchase and quantity of soybean while intercropping reduced likelihood of deciding to sell soybean. Results from the second hurdle indicated that group membership and quantity of soybean produced increased likelihood of selecting off-farm market channel whereas price and years of schooling reduced probability of choosing off-farm market channel. In the third hurdle, access to extension, access to market information and price of selling soybean increased the amount of soybean sold in both market channels. Land owned by the household, use of purchased inputs, and group membership positively influenced the quantity of soybean sold off-farm whereas household size and intercropping reduced quantity of soybean sold off-farm. Years of schooling and ownership of transport facility increased quantity of soybean sold on-farm.

5.2 Conclusions

The study concludes that while market participation provides an opportunity for welfare gains, many households remain excluded from these benefits due to either non-participation or small amounts of soybean sold. Females are disproportionally excluded from benefits of market participation because, although most of the soybean farmers were female, significantly fewer females were market participants. The findings from this study show that different factors affect the market participation decision, choice of market channel, and extent of participation. Being male was found to be positive in determining decision to sell soybean, suggesting that market interventions need to be targeted to improve the capacity of female farmers to take advantage of marketing opportunities. Non-farm income, use of purchased inputs, and soybean output quantity significantly increased the likelihood of farmers deciding to sell soybean, which implies that increased household resources and marketable surplus are important in realizing market participation.

The positive relationship between group membership and probability of selecting off-farm market channel indicates that collective action is vital in facilitating access to markets. Households with large quantity of soybean production were more likely to sell off-farm showing that off-farm market channel with the higher capacity to absorb surplus is crucial in the market orientation of the soybean sector. In addition to the relatively lower price offered by off-farm market channels, farmers also have to incur transaction costs in terms of transportation which further reduces returns from participating in off-market channel.

Although the effect of price on choice of off-farm market channel was negative, increase in price resulted in increased quantity of soybean supplied to both on-farm and off-farm market channels indicating that soybean is price responsive and better prices can be effectively used to increase

quantity of soybean supplied to the market. The positive effect of access to market information, access to extension, and education level on quantity of soybean sold both on-farm and off-farm suggests that the current level of these factors is suboptimal. Additionally, the size of land owned was found to be a limiting factor in increasing extent of soybean market participation implying that increasing productivity and land use efficiency through appropriate intercropping and rotational cropping should be emphasized over increasing farmland as a way of increasing soybean output quantity.

This calls for measures to facilitate access to production inputs such as fertilizer, improved seeds, and inoculants and extension services, which would result in marketable surplus due to improved productivity. There is also need to empower local groups to improve their capacity as sources for sharing market information and bargaining for better prices with buyers on behalf of the members.

5.3 Recommendations

From the results, it is important that the County government of Kakamega should improve access to soybean inputs of fertilizer, improved seeds, and inoculants to stimulate and enhance growth in soybean market participation. This can be achieved by incorporating soybean in the existing maize fertilizer and seed subsidy program.

The county government should also facilitate establishment of market guarantee between soybean farmers and processing industries. This should be done through strengthening the capacity of farmer groups in negotiating for better soybean prices with the processors and establishing consistency in the availability of such market outlets. Off-farm market channels i.e. group collection centres often used by processors and institutional buyers in the area (schools, KALRO, and ROP) in liaison with farmer groups, can facilitate collection of soybean from farm

gate for producers with a certain threshold of produce as incentive if increasing current prices is not an option. Additionally, there is need for institutional support in access to extension services especially with respect to land use efficiency, seed storage and domestic soybean processing both as a mean of increasing household consumption and increasing profitability from selling surplus.

References

Abate, T., Alene, A., Bergvinson, D., Shiferaw, B., Silim, S., Orr, A. and Asfaw, S. (2012). Tropical Grain Legumes in Africa and South Asia Knowledge and Opportunities. TL II Research Report No. 1, TL2, ICRISAT, CIAT, IATA, Nairobi. http://www.icrisat.org/TropicalLegumesII/pdfs/TropicalLegumes_20120217.pdf.

Abu M., Issahaku H. and Nkegbe P. (2016). Farmgate versus market-centre sales: A multicrop approach. *Agricultural and Food Economics*, 4(21):1-16.

Adeoti, A., Oluwatayo, I. and Raheem O. (2014). Determinants of Market Participation among Maize Producers in Oyo State, Nigeria. *British Journal of Economics, Management and Trade*, 4(7): 1115-1127.

AGRA (2019). Scaling out maize and soybean production and value addition for improved nutrition and incomes among smallholder farmers in western Kenya. https://agra.org/scaling-out-maize-and-soybean-production-and-value-addition-for-improved-nutrition-and-incomes-among-smallholder-farmers-in-western-kenya/. (Last accessed August 24, 2020).

AGRA (2020). Soil Health Program End-Term Impact Study Report. Alliance for a Green Revolution in Africa. Nairobi, Kenya. https://agra.org/wp-content/uploads/2020/09/SHP-Impact-Study-2020.pdf.

Amrouk, E., Poole, N., Mudungwe, N. and Muzvondiwa, E. (2013). The Impact of Commodity Development Projects on Smallholders' Market Access in Developing Countries: Case studies of FAO/CFC Projects. Food and Agriculture Organization of the United Nations, Rome.

Alexandratos, N. and Bruinsma, J. (2012). World agriculture towards 2030/2050: The 2012 revision. ESA Working paper No. 12-03. Rome, FAO.

Barret, C. (2008). Smallholders market participation: Concepts and evidence from eastern and southern Africa. *Food Policy,* 33: 299–317.

Barret, C., Bachke, M., Bellemare, M., Michelson, H., Narayanan, S. and Walker, T. (2011). Smallholder participation in contract Farming: Comparative evidence from five countries. *World Development* 40 (4):715-730.

Bekabil, U. (2015). Empirical review of production, productivity and marketability of soya bean in Ethiopia. *International Journal of u- and e- Service, Science and Technology*, 8(1):61-66.

Bellemare, M. and Barret, C. (2006). An ordered Tobit model of market participation: Evidence from Kenya and Ethiopia. *American Journal of Agricultural Economics*, 88(2): 324–337.

Burke, W., Myers, R. and Jayne, T. (2015). A triple-hurdle model of production and market participation in Kenya's dairy market. *American Journal of Agricultural Economics*, 97(4), 1227-1246.

Camara, A. (2017). 'Market participation of smallholders and the role of the upstream segment: evidence from Guinea', Munich Personal RePEc Archive, vol. 78942.

CCRP (2016). New frontiers in legumes research: Case studies of ten years of research in Malawi CCRP Southern Africa community of practice. The Mcknight Foundation, Collaborative Crop Research Program. https://www.mcknight.org/wp-content/uploads/CCRP-Brochure-26Sep16.pdf.

CGIAR (2012). Research programme on grain legumes: Leveraging legumes to combat poverty, hunger, malnutrition and environmental degradation. Consultative Group of International Agricultural Research. https://cgspace.cgiar.org/bitstream/handle/10947/5316/CRP3.5_Grain_Legumes_03Feb12.pdf?sequence=4&isAllowed=y.

CGIAR (2016). CGIAR Dryland cereals and legumes agri-food systems: Delivering development and dignity through diversification in drylands. Consultative Group of International Agricultural Research.

Chianu, J., Ohiokpehai, O., Vanlauwe, B., Adesina, A., De Groote, H. and Sanginga, N. (2009). Promoting a versatile but yet minor crop : Soybean in the farming systems of Kenya. *Journal of Sustainable Development in Africa*, 10(4): 324–344.

Collombet, R. (2013). Investigating soybean market situation in Western Kenya: constraints and opportunities for smallholder producers. Minor thesis in Plant Production Systems. Wageningen University.

County Government of Kakamega (2013). Kakamega County Integrated Development Plan (CIDP). https://kakamega.go.ke/public-participation-county-development-plans.

County Government of Kakamega (2017). Kakamega County Integrated Development Plan (CIDP). https://kakamega.go.ke/public-participation-county-development-plans.

Cochran, W. (1963). Sampling Techniques (2^{nd} ed.). New York: John Wiley and Sons, Inc.

Cragg, J. (1971). Some statistical models for limited dependent variables with application to the demand of durable goods. *Econometrica*, 39: 829-844.

Emana, B., Ketema, M., Mutimba, J. and Yousuf, J. (2015). Factors affecting market outlet choice of potato producers in Eastern Hararghe Zone, Ethiopia. *Journal of Economics and Sustainable Development*, 6(15): 159-172.

FAOSTAT (2019). Food and Agriculture Organization of the United Nation. Crops Data. Retrieved from FAOSTAT Database, http://www.fao.org/faostat/en/#data/QC. (Last accessed April 8, 2019).

Fischer, E. and Qaim, M. (2012). Linking smallholders to markets: Determinants and impacts of collective action in Kenya. *World Development*, 40(6): 1255-1268.

Fore, H., Dongyu, Q., Beaslay, D. and Ghebreyesus, T. (2020). Child malnutrition and COVID-19: the time to act is now. *The Lancet*, 396: 517-518.

Gebremedhin, B., Shiferaw, K., Gizaw, S., Tegegne, A. and Hoekstra, D. (2017). A triple-hurdle model of small ruminant production and marketing in the highlands of Ethiopia: Implications for commercial transformation. *African Journal of Agricultural and Resource Economics Volume*, 12(3): 257-270.

Gebremedhin, B. and Jaleta, M. (2010). Commercialization of smallholders: Does market orientation translate into market participation? Improving productivity and market success (IPMS) of Ethiopian farmers project Working Paper 22. Inernational Livestock Research Institute., Nairobi, Kenya.

Greene, W. (2012). Econometric Analysis (7th ed.), ISBN 0-13-066189-9, Prentice Hall, New Jersey.

Gujarati, D. (2004). Basic Econometrics. 4th Edition, McGraw-Hill Companies, New York.

Hartman, G., West, E. and Herman, T. (2011). Crops that feed the world-Soybean Worldwide Production, use and constrains caused by pathogens and pests. *Food Security*, 3(1): 5-17.

Hassan, S. (2013). Soybean Nutrition and Health. *Intech*, *Soybean Bio-active Compounds*, 20:453-473.

Heckman, J. (1979). Sample selection bias as a specification error. *Econometrica*, 47:153–161.

Iqbal, N., Hussain, S., Ahmed, Z., Yang, F., Wang, X.,, Liu, W., Yong, T , Du, J., Shu, K., Yang, W. and Liu, J. (2019). Comparative analysis of maize–soybean strip intercropping systems: a review. Plant Production Science 22(2): 131–142.

KNBS (2019). 2019 Kenya population and housing census results. Kenya National Bureau of Statistics, Nairobi. https://www.knbs.or.ke.

Kizito, A. and Kato, E. (2018). Does linking farmers to markets work? Evidence from the World Food Programme's purchase for progress satellite collection points initiative in Uganda. *African Journal of Agricultural and Resource Economics*, 13(2): 169-181.

Mafukuta, M. (2015). Factors having the most significance on the choice and selection of marketing channels amongst communal cattle farmers in Vhembe District, Limpopo Province. *Jounal of Human Ecology*, 19(1-2):77-87.

Mahasi, J., Mukalama, J., Mursoy, R., Mbehero, P. and Vanlauwe, B. (2011). A sustainable approach to increased soybean production in western Kenya. 10th African Crop Science Conference Proceedings October 10-13, 2011, Maputo, Mozambique.

Maingi, J., Gitonga, N., Shisanya, C., Hornetz, B. and Muluvi, G. (2006). Population levels of indigenous *Bradyrhizobia nodulating promiscous* soybean in two Kenyan soils of the semi-arid and semi-humid agroecological zones. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 107(2):149-159.

Makau, J., Irungu, P., Nyikal, R. and Kirimi, L. (2016). An assessment of the effect of a national fertiliser subsidy programme on-farmer participation in private fertiliser markets in the North Rift region of Kenya. *African Journal of Agricultural and Resource Economics*, 11(4):292-304.

Mango N., Makate C., Francesconi N., Jager M. and Lundy M. (2018). Determinants of market participation and marketing channels in smallholder groundnut farming: A case of Mudzi district, Zimbabwe. *African Journal of Science, Technology, Innovation and Development*, 10(3):311-321.

Mignouna, A., Abdoulaye, T., Akinola, D., Kamara, A. and Oluoch, M.(2016). Understanding market participation choices and decisions of maize and cowpea farmers in Northen Nigeria. *Tropicultura*, 34(1):26-39.

Muthini, D. N., Nyikal, R. A., and Otieno, D. J. (2017). Determinants of small-scale mango farmers market channel choices in Kenya: An application of the two-step Craggs estimation procedure. *Journal of Development and Agricultural Economics*, 9(5), 111-120.

Ndoro, J., Hitayezu, P., Mudhara, M. and Chimonyo, M. (2013). Livelihood factors influencing market participation and supply volumes decisions among smallholder cattle farmers in the Okhahlamba Local Municipality, South Africa: Implications for agricultural

extension programming. 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia.

Nyongesa, D., Mabele, R., Esilaba, A. and Mutoni, C. (2017) The economics and gender factor in soya bean production and profitability in Kenya: a case of smallholder farms in Western Kenya, *International Journal of Agricultural Resources, Governance and Ecology*, 13 (3):211–240.

Odendo, M., Onyango, E. and Oucho, P. (2013). Agronomic and financial analysis of maize-legumes production in western Kenya. Joint proceedings of the 27th Soil Science Society of East Africa and the 6th African Soil Science Society, 20-25 October, Nakuru, Kenya.

OECD/FAO (2016). Agriculture in Sub-Saharan Africa: Prospects and challenges for the next decade, in OECD/FAO Agricultural Outlook 2016-2025, OECD Publishing, Paris.

Ogutu, S., Okello, J. and Otieno, D. (2014). The impact of information and communication technology-based market information services on smallholder farm input use and productivity: The case of Kenya. *World Development*, 64: 311-321.

Okoye, B., Abass, A., Bachwenkizi, B., Asumugha, G., Alenkhe, B., Ranaivoson, R. and Ralimanana, I. (2016). Effect of transaction costs on market participation among smallholder cassava farmers in Central Madagascar. *Cogent Economics & Finance*, 4(1), 1-20.

Olumeh, D. (2018). An analysis of the effects of gender and institutional support services on smallholder maize farmers' commercialization decisions in transitional systems in Western Kenya. Msc. Thesis, University of Nairobi, Kenya.

Olwande, J. and Mathenge, M. (2012). Market participation among poor rural households in Kenya. Contributed paper presented at the International Association of Agricultural Economists (IAAE) Triennial conference, Foz do Iguacu, Brazil, 18-24 August, 2012.

Osmani, A. and Hossain, E. (2015). Market participation decision of smallholder farmers and its determinants in Bangladesh. *Economics of Agriculture,* 63(1): 163-179.

Otekunrin, O., Momoh, S. and Ayinde, I. (2019). Smallholder Farmers' Market Participation: Concepts and Methodological Approach from Sub-Saharan Africa. *Current Agriculture Research*, 7(2). 139-157.

Quisumbing, A., Rubin, D., Manfre, C., Waithanji, E., Bold, M., Olney, D. and Meinzen-Dick, R. (2015). Gender, assets, and market-oriented agriculture: learning from high-value crop and livestock projects in Africa and Asia. *Agriculture and Human Values,* 32: 705–725.

Republic of Kenya (2007). Kenya Vision 2030. Nairobi. https://kfcb.co.ke/wp-content/uploads/2016/08/vision_2030.pdf.

Republic of Kenya (2012). National Agribusiness Strategy: Making Kenya's agribusiness sector a competitive driver of growth. Agricultural Sector Coordination Unit (ASCU), Nairobi. http://www.commsconsult.org/wp-content/uploads/2013/11/National_AgriBusiness_Strategy.pdf.

Republic of Kenya (2017). Kenya Youth Agribusiness Strategy 2017-2021: Positioning the youth at the forefront of agricultural growth and transformation. Ministry of Agriculture, Livestock, and Fisheries, Nairobi. https://ypard.net/resources/kenya-youth-agribusiness-strategy.

Republic of Kenya (2018). Eye on the Big Four: Budget watch for 2018/2019 and the Medium-term plan. Parliamentary Service Commission, Parliamentary Budget Office, Nairobi. http://www.parliament.go.ke/sites/default/files/2018-09/Budget%20Watch%202018.pdf.

Republic of Kenya (2019). Agricultural Sector Transformation and Growth Strategy 2019-2029. Ministry of Agriculture, Livestock, Fisheries and Irrigation, Nairobi. https://www.kilimo.go.ke/wp-content/uploads/2019/01/AGRICULTURAL-SECTOR-TRANSFORMATION-and-GROWTH-STRATEGY.pdf.

Sharma, A. and Baluja, Z. (2015). Therapeutic effects of *glycine max* (Soybean): A summary. *International Journal of Research in Pharmacy and Biosciences*, 2(1): 22-27.

Sharma, P. (2015). Determinants of small milk producers' participation in organized dairy value chains: Evidence from India. *Agricultural Economics Research Review*, 28 (2): 247-261.

Sigei, G. (2014). Determinants of Market Participation among small-scale Pineapple farmers in Kericho County. Msc thesis, Egerton University, Kenya.

Siziba, S., Nyikahadzoi, K., Diagne, A., Fatunbi, A. O. and Adekunle, A. A. (2011). Determinants of cereal market participation by sub-Saharan Africa smallholder farmer. *Journal of Agriculture and Environmental Studies*, 2(1): 180-193.

Soe, W., Moritaka, M. and Fukuda, S. (2015). An analysis of the factors influencing marketing channel choice by paddy rice farmers in Myanmar. *Journal of the Faculty of Agriculture, Kyushu University, Japan*, 60(2): 535-542.

Syngenta (2016). Kenya Soybean Evaluation Trial-2016 Long Rains. Syngenta Foundation for Sustainable Agriculture.

http://soybeaninnovationlab.illinois.edu/sites/soybeaninnovationlab.illinois.edu/files/Kenya%20Soybean%20Evaluation%20Trial%202016%20Long%20Rain%20Season.pdf.

Tesfamariam, K., Berhanu, T. and Afera, A. (2015). Determinants of the choice of marketing channel among small-scale honey producers in Tigrai region of Ethiopia. *Journal of Business Management and Social Sciences Research*, 4(4): 295-305.

Tinsley, R. (2009). Assessing the soybean value chain analysis in Kenya. Citizens Network for Foreign Affairs, CNFA, Inc. https://webdoc.agsci.colostate.edu/smallholderagriculture/SoybeanKenya.pdf.

Tirkaso, W. and Hess, S. (2018). Does commercialisation drive technical efficiency improvements in Ethiopian subsistence agriculture? *African Journal of Agricultural and Resource Economics*, 13(1): 44-57.

USDA (2019). United States Department of Agriculture, Agricultural Research Service- National Nutrient Database for Standard Reference Legacy Release. Available at https://ndb.nal.usda.gov/data-documentation.html. (Last accessed July 8, 2020).

Van Ittersum, K., Van Bussela, L., Wolfa, J., Grassinib, P., Van Wart, J., Guilpartb, J., Claessensc, L., De Grootd, H., Wiebee, K., Mason-D'Croze, D., Yangb, H., Boogaard, H., Van Oort, P., Van Loona, M., Saito, K., Adimo, O., Adjei-Nsiah, S., Agali, A., Bala, A., Chikowo, R., Kaizzi, K., Kouressy, M., Makoi, J., Ouattara, K., Tesfaye, K. and Cassman, K. (2016). Can sub-Saharan Africa feed itself? Proceedings of the National assembly of Sciences, 113 (52): 14964-14969.

Woldeyohanes, T., Heckelei, T. and Surry Y. (2015). Effect of off-farm income on smallholder commercialization: Panel evidence from rural households in Ethiopia. Paper read at 29th

International Association of Agricultural Economists Triennial conference, 8-14 August, Milan, Italy.

Wooldridge, J. (2010). Econometric analysis of cross sectional and panel data. The MIT Press,Cambridge, Massachusetts.

United Nation (2016). The Sustainable Development Goals Report 2016. United Nations, New York. https://unstats.un.org/sdgs/report/2016/The%20Sustainable%20Development%20Goals%20Report%202016.pdf.

WWF (2014). The growth of soy: Impacts and solutions. WWF International, Gland, Switzerland http://awsassets.wwfdk.panda.org/downloads/wwf_soy_report_final_jan_19.pdf.

Zamasiya, B., Mango, N., Nyikahandzoi, K. and Siziba, S. (2014). Determinants of soybean market participation by smallholder farmers in Zimbabwe. *Journal of Development and Agricultural Economics*, 6(2): 49-58.

APPENDICES

Appendix 1: Pearson's Correlation Coefficients

Pairwise correlation matrix

Variables	Age of farmer	Yearsoffschooling	Household size	Experience	Land owned	Non-farm income	Distance to main market	Output quantity	Price
Age of farmer	1.000								
Years of schooling	-0.180	1.000							
Household size	0.200	0.072	1.000						
Experience	0.160	-0.123	0.143	1.000					
Land owned	0.185	0.154	0.317	0.028	1.000				
Non-farm income	-0.008	0.348	0.146	-0.038	0.243	1.000			
Distance to main market	-0.142	-0.122	-0.035	-0.229	0.028	-0.120	1.000		
Output quantity	0.074	0.213	0.071	0.101	0.392	0.173	0.013	1.000	
Price	-0.013	0.122	0.052	0.014	0.141	-0.023	-0.030	0.176	1.000

Appendix 2: Variance Inflation Factors

Variable	VIF	1/VIF
Age	1.268	.789
Sex of farmer	1.242	.805
Years of schooling	1.565	.639
Household size	1.277	.783
Experience	1.202	.832
Land owned	1.497	.668
Non-farm income	1.366	.732
Access to ICT	1.599	.625
Access to credit	1.261	.793
Access to extension	1.239	.807
Group membership	1.131	.884
Distance to main market	1.161	.861
Ownership of transport facility	1.321	.757
Access to market information	1.781	.561
Output quantity	1.489	.672
Intercropped	1.198	.834
Input purchase	1.176	.851
Price	1.176	.851
Mean VIF	1.352	.

Appendix 3: *White Test* for Heteroskedasticity

White's test for Ho: homoskedasticity

against Ha: unrestricted heteroskedasticity

$chi2(147) = 148.00$

$Prob > chi2 = 0.4613$

Cameron & Trivedi's decomposition of IM-test

Source	**chi2**	**Df**	***P***
Heteroskedasticity	148.000	147	0.461
Skewness	19.620	18	0.355
Kurtosis	0.710	1	0.398
Total	168.330	166	0.435

Appendix 4: Household Survey Questionnaire

UNIVERSITY OF NAIROBI

Household survey questionnaire for the research study on analysis of determinants and extent of market participation by soybean farmers in Kakamega County, Kenya

The University of Nairobi is conducting research on determinants of market participation by soybean farmers in Kakamega County and its effect on household income. The research seeks to characterize soybean farmers, analyse determinants of farmers' decision to sell soybean, quantity of soybean sold, choice of market channel, and the effect of market participation on household income. Respondents of this survey should be soybean farmers who must be at least 18 years of age. You have been randomly selected to participate in this survey. The information collected through this survey is strictly confidential, will be anonymised and analysed only for research purpose. Your cooperation will be highly appreciated.

For any clarification please contact Edna Amoit 0723048118

Identification

Questionnaire number		Name of enumerator	
Sub-county		Farmers' telephone	
Village		Date	

NB: The responses to the questions regarding soybean production and marketing are based on production seasons for the year 2016 and 2017. The respondent must be a farmer engaged in soybean production.

Soybean production

1. Please fill the table below on soybean production

Season	**Land owned (acres)**	**Land under soybean (acres)**	**Intercropping 1=yes, 0=no**	**Production (kgs)**
2016 Sept-Dec				
2017 Mar-Aug				

2. Number of years farming soybean …….. (Years)

Input use

3. Please fill the table below on soybean seed use

Season	**Quantity used (kgs)**		**Inoculated** 1=yes 2=no	**Mode of acquisition** 1=bought 2=own saved 3=given in group 4=given by friends/family 5=other	**If bought, what is the source** 1=agro-vet 2=group 3=open air market 4=neighbour 5=other (specify)	**Mode of payment for the seeds** 1=cash 2=credit 3=both	**Cost per kg**	**Rank 2 challenges faced in accessing seeds** 1=poor availability of preferred variety of seed 2=high prices 3=poor quality 4=other (specify)	
	R1	R2						R1	R2
2016 Sept-Dec									
2017 Mar-Aug									

4. Please fill the table below on use of fertilizer in soybean production

Season	**Did you use fertilizer in soybean production?** 1=yes 0=no	**Type of fertilizer used** 1=organic/ manure 2=inorganic 3=both	**Quantity used** 1=25kg bag 2=50kg bag 3=wheelbarrow 4=pickup 5=other (specify) Use 1 for organic and 2 for inorganic quantities		**Unit**	**Mode of acquisition** 1=bought 2=own saved 3=given in group 4=given by friends/family 5=other (specify)	**If bought, what is the source** 1=agro-vet 2=group 3=open air market 4=neighbour 5=other (specify)	**Mode of payment for the fertilizer** 1=cash 2=credit 3=both	**Cost per unit**	**Rank 2 challenges faced in accessing fertilizer** 1=poor availability of fertilizer 2=high prices 3=poor quality 4=other (specify	
			1	2						R1	R2
2016 Sept-Dec											
2017 Mar-Aug											

5. What is the reason for not using fertilizer? 1=soils are fertile, 2=fertilizer is costly, 3=burns crop, 4=lack of accessibility, 5=other, specify……..
6. Please fill the table below on labour use in soybean production

Season	Type of labour 1=hired 2=family 3=both	Quantity used (man days per season)	Rank 3most labour consuming activities 1=land preparation 2=planting 3=weeding 4=harvesting 5=threshing	If hired, what is the mode of payment 1=cash 2=credit 3=inkind	Cost per day	Rank 2 challenges faced in acquiring labour 1=unavailability of labour 2=high prices 3=poor quality 4=dishonesty 5=other
2016 Sept_Dec						
2017 May_Aug						

Soybean marketing

7. Was any soybean sold? 1=yes, 0=no If yes, please fill in the table below. **If no skip to question 8**

Market channel	**Do you sell to this channel 1=yes 0=no**	**Which is your main channel (tick one)**	**Quantity sold in kgs** 1=gorogoro (2kg) 2=debe (17kg) 3=50kg bag 4=90kg bag	**Unit**	**Price per kg**	**How is price set** 1=buyer sets price 2=seller sets price 3=group negotiation 4=individual negotiation 5=market driven 6=other (specify)	**Rank 2 merits for using channel** 1=is nearest 2=better prices 3=only available channel 4=pay on time 5= collects from farm 6=is a regular buyer 7=other (specify)		**Requirements of chosen cannel** 0=none 1=quality 2=quantity 3=group membership 4=contract 5=variety 6=other (specify)	**Challenges of using particular channel (rank 2)** 1=transport costs 2=price fluctuations 3=quality requirements 5=delay payment 6=low prices 7=small output quantity 8=other(specify)	
							R1	**R2**		**R1**	**R2**
Ngo's i.e.ROP											
Processors											
Group collection centre											
Institutions											
Open air											
Others, specify ….											

8. What is your main reason for not selling any soybean? (1=small output quantity, 2=lack of buyers, 3=not interested in selling, 4=low prices, 5=other, specify……..)
9. Are there instances where buyer asked for a different variety from the one you had? (1=yes, 0=no)
10. Did you get market information before sale? (1=yes, 0=no)
11. If yes, what was your main source of information? (1=neighbouring farmers, 2=market place, 3=research centre, 4=mobile phone, 5=farmer groups, 6=other, specify……..)
12. What is the distance to the nearest all weather road (est. distance in km) ……
13. What is the distance to the main market centre (est. distance in km) ……

14. Average transport cost to and from the nearest main market (kshs.)……

15. Did you apply for any financial credit during the last 1 year? 1=yes, 0=no If yes, please fill the table below. **If no, please skip to question 16**

Source of credit	**Type of credit** 1=financial 2=in kind 3=both financial and in kind 4=other	**Did you receive it** 1=yes 0=no	**If yes, what proportion of the credit applied for did you receive?** 1=25percent 2=50percent 3=75percent 4=100percent	**Use** 1=buying input 2=paying labour 3=school fees 4=start business 5=market related expenses 6=bought agricultural machinery 7=bought land 8=bought motorbike 9=offset a problem i.e. sickness 9=other (specify)…	**Was any of the credit used for soybean purposes** 1=yes 0=no	**Challenges experienced in accessing credit** 1=lack collateral 2=high interest 3=tedious procedures 4=harassment during repayment 5=loan phobia 6=other
Government grant						
Farmer group						
Ngo						
Bank						
Cooperative						
Sacco						
Friends/relative						
Other (specify)						

16. Reason for not applying for credit (1=loan phobia, 2=doesn't need it, 3=lack collateral, 4=tedious procedure, 5=other, specify…..)
17. Do you perform any of the following value addition activities to soybean before selling? (1=Yes, 0=No). If no skip to question 18

Activity	**1=yes, 0=no**	**Cost of 1kg before value addition**	**Cost of the 1kg after value addition**	**Cost of value addition**	**Price per unit after value addition**	**Importance** 1=fetch higher price, 2=ease transportation, 3=requirement for sale to chosen channel, 4=increase storage duration, 5=high

						market share, 6=other specify
Cleaning						
Sorting						
Soy flour						
Soy milk						
Drying						
Packaging						
Roasting						
Other(specify) ……						

Group membership

18. Are you a member of any social groups? 1=yes, 0=no

Type of group	Are you a member? 1=yes 0=no	Duration of membership (years)	Services offered by the group 1=market information 2=training on value addition 3=credit 4=extension, 5= other (specify)	Challenges 1=lack of commitment 2=poor leadership 3=mismanagement of resources 4=lack of communication 5=other (specify)	Do you market soybean as group? 1=yes, 0=no	If yes, which main channel do you supply to as a group? 1=NGO, 2=processor 3=soybean collection centres, 3=institutions 4=open air 5=others (specify)
SACCO						
Self-help						
Cooperative						
Farmer group						
Other (specify)						

19. What is the reason you are not a member of any farmer group?
    1=not aware they exist, 2=prefer to act as an individual, 3=does not qualify for membership, 4=any other (specify)….

Access to extension

20. Did you receive any extension services in the last one year?
    1=yes, 0=no If yes please fill the table below

Source of extension	**Did you receive extension services from this source?** **1=yes** **0=no**	**Services offered** 1=market information 2=post-harvest management 3=price information 4=agronomic services	**No of visits in the last 1 year** 1=weekly 2=monthly 3=quarterly 4=biannually 5=annually	**Terms of provision** 1=free 2=paid for 3=both 4=other(specify)	**Channel** 1=home visit 2=phone 3=field school 4=other	**Challenges** 1=costly 2=infrequent 3=not timely 4=communication challenge 5= unreliability 6=irrelevant information 7=other(specify)

Government officer						
Ngo/ Private officers						
Farmer to farmer						
Radio						
Farmer cooperative						
Other (specify)…….						

Ownership of transport and communication assets

21. Please fill the table below on assets owned by the household

Asset	**Ownership** 1=yes, 0=no	**Do you use it for soybean production/marketing related activities?** 1=yes 2=no	**Which activity do you use it** 1=sourcing inputs 2=extension services 3=accessing market information 4=transportation 5=production process 6=other, specify	**How often** 1=daily 2=weekly 3=monthly 4= other (specify)
Motorbike				
Bicycle				
Car/truck				
Mobile phone				
Radio				
Television				

Gender roles in soybean value chain

22. Who makes the following decisions regarding soybean in the household

Decision	Male	Female	Both
Choice of farm/size			
Acquiring seed			
Farm labour			
Harvesting			
Transportation			
Selling			

Using money from sale of soybean			
Value addition			

Farmer characteristics

Question	**Response**
23. Age of farmer (years)	
24. Gender of farmer (1=male, 0=female)	
25. Marital status1=Unmarried, 2=Married, 3=Widow/widower, 4=Separated/divorced, 5=Others (specify)	
26. Education 1=primary, 2=secondary, 3=tertiary	
27. Number of years of formal schooling (years)	
28. What is the size of your household?	
29. Number of people working in the household	
30. What is your occupation? 1=farming 2=business, 3=Formal employment 4=Artisan, 5=other, specify….	
31. What is your average farm income per month?	
32. What is your average non-farm income in a month?	

Appendix 5: Checklist Questions for FGD

1. Soybean production; challenges experienced at production level, advantages and uses of soybean.
2. What are the available market channels for soybean?
3. What are the challenges experienced in soybean marketing?
4. What value addition practices do farmers engage in and what is the importance of value addition? What challenges do farmers face in value addition?
5. What are the support services that are available to soybean farmers? What role does extension play?
6. What role do groups play? Challenges faced by groups, and key to successful groups?
7. Who in the household is in charge of decision making in the soybean value chain?