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Determinants of Market Participation by Smallholder Soybean Farmers in Kakamega County, Kenya

Edna Amoit Mbembe*
Department of Agricultural Economics, University of Nairobi, P.O Box 29053-00625, Nairobi, Kenya. E-mail: amoited.21@gmail.com
David Jakinda Otieno
Department of Agricultural Economics, University of Nairobi, P.O Box 29053-00625, Nairobi, Kenya. E-mail: jakinda1@yahoo.com
Rose Nyikal
Department of Agricultural Economics, University of Nairobi, P.O Box 29053-00625, Nairobi, Kenya. Email: nyikalra@gmail.com
Martins Odendo
Kenya Agricultural and Livestock Research Organization (KALRO), P.O. Box 169-50100, Kakamega, Kenya. E-mail: Odendos@yahoo.com

ABSTRACT

Production of soybean in Kenya has remained low despite the crop's importance in nutrition, feed manufacturing and soil fertility management. Inefficiencies in marketing have been established as the major challenge to increasing soybean production in Kenya. In order to understand the determinants of market participation by smallholder soybean farmers, a double hurdle model was applied to analyze primary survey data from 148 farmers in Kakamega County, Kenya. Use of inoculants, quantity of seed planted, fertilizer, and access to credit positively affected probability of selling soybean. Extent of soybean market participation was positively influenced by use of fertilizer, quantity of seed planted, quantity of soybean harvested, access to extension, and output price. These findings demonstrate the need for institutional support in access to extension services and productivity-enhancing technologies such as use of inoculants, improved seed, and fertilizer and establishing market guarantee between soybean farmers and processors to encourage market participation.

Key words: Soybean, smallholder farmers, market participation, double hurdle.

INTRODUCTION

Soybean, *Glycine max (*L.) *Merrill*, is an important oilseed because of its nutrient richness. It has the highest concentration of proteins of all grain legumes at 40 percent compared to an average of 20 percent in other legumes, 18 percent from meat, and 11 percent from egg (Chianu et al. 2008). The protein from soybean is equal in quality to animal protein, which makes soybean a perfect substitute for animal protein in vegan diets or for individuals with dairy allergy (Hartman et al. 2011). Due to its high protein content, it is effective in combating protein malnutrition when consumed as human food. Food insecurity remains a concern for sub-Saharan Africa (SSA), especially because the human population in this region continues to grow at a higher rate than food production (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. Projections by the Consultative Group for International Agricultural research (CGIAR) indicate an upward trend in soybean demand arising from the need for cheap protein and vegetable oil as well as increased population (CGIAR, 2016).

The bulk of industrial soybean usage is in the manufacturing of animal feed (Abate et al. 2011). This demand is expected to continue to grow following increasing demand for meat and meat products in SSA. Additionally, international regulations such as the European Good Agricultural Practices (EuroGAP) require that meat exports to the European Union should not have been fed animal fat or protein (Chianu et al. 2008). Soybean is a good alternative source of feed for livestock producers attempting to adhere to these guidelines in order to gain access to the European market. Soybean is also processed into soybean oil, which is popular because it is cholesterol free. Other products from soybean are soymilk, soy yogurt, snacks, soya sauce, protein extract and concentrates for human consumption. The main nutrient components of soybean are shown in Table 1. Additionally, soybean contains a wide range of minerals, vitamins, and lipids.

Table 1: Nutrient composition of 100g soybean

Proximate	soybean seed	soy meal	soy flour	Soymilk
Water (g)	8.5	6.94	7.25	85.61
Energy (kcal)	446	337	327	63
Protein (g)	36.49	49.2	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)	9.3	0	19.5	0.4
Sugars, total (g)	7.33	0	16.42	7.86

Source: USDA (2018).

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, suppress parasitic weeds, and supplement organic matter. The agricultural system in Kenya is characterized by low agricultural productivity attributed to poor and declining soil fertility and low use of organic and mineral nutrient resources (AGRA and IIRR 2014). The poor soil fertility can be attributed to a combination of poor farming practices and strain from overpopulation. Therefore, soil fertility improvement through organic inputs such as soybean is particularly important when considered in the context of high prices of chemical fertilizers, as it provides a low cost method for enriching the soils. Many resource-constrained households are unable to afford sufficient amounts of mineral fertilizers for sustainable agricultural intensification; and soybean could be a good alternative. Indeed, demonstration fields in Malawi registered an increase in maize yield of 39 percent when soybean was used as a rotation crop (Van Vugt et al. 2018). Maize legume rotations in Malawi conducted by McKnight Foundation registered growth in 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 recognizes soybean as among the most promising grain legumes for incorporation in ISFM in Western Kenya.

Soybean remains crucial in development planning of countries of SSA considering its value in food security and nutrition and as a raw material for domestic industries. On a global scale, soybean has recorded the highest growth in production and area cultivated from 27 to 269 million tons, and 29 million to 97 million hectares respectively in a period of 50 years as a result of a surge in its demand (Hartman et al. 2011). Nevertheless, the SSA region has remained a net importer of soybean and soybean products, with the exception of Uganda which is self-sufficient in soybean production (FAOSTAT 2019). It is estimated that if the entire SSA region can be self-reliant in soybean production, approximately United States Dollar (USD) 2.6 billion would be saved annually in foreign exchange (CGIAR 2016); this figure is expected to go up to over USD 12 billion by year 2030.

Kenya's soybean industry continues to perform poorly despite the aforementioned merits of the crop coupled with availability of huge demand for soybean. Kenya domestic consumption of soybean is 150,000 tons a year (Syngenta 2016), whereas local production ranges from 1500 to 3000 tons annually (FAOSTAT 2019). This means that the country continues to spend large amounts of foreign earnings on soybean imports to supplement local production. In 2018, Kenya imported 68,000 tons of soy meal, this figure having tripled in 10 years (Index Mundi 2019). Kenya also spent USD 12.8 million on importation of soy oil alone in 2016 (FAOSTAT 2019). Efforts by both the government and non-governmental organizations (NGOs) to promote production of the crop among the farmers have had dismal results. The Alliance for a Green Revolution in Africa (AGRA), for instance, has financed several projects implemented by the Kenya Agricultural and Livestock Research Organisation (KALRO) in the country (AGRA and IIRR, 2014). Other research work involving soybean has been undertaken by N2Africa, Tropical Legumes Two (TL2) and the International Plant Nutrition Institute (IPNI). Currently, CGIAR Dryland cereals and legumes agri-food systems, aims to promote soybean among other legumes (CGIAR 2016). The objectives of these projects have been incorporating soybean into ISFM and therefore improve its production and marketing and subsequently improve households' incomes, food, and nutrition security.

A review of the soybean industry in Kenya reveals that the poor performance of the soybean 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. Market participation refers to the use of purchased inputs and supply of produce to the market (Gebremedhin and Jaleta, 2010), although in most cases it is used to refer solely to supply of output to the market. 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. Other factors apart from output price such as institutions and private assets are vital in attaining marketable surplus in agriculture (Barret 2008).

In order to benefit from market participation, it is important to identify marketing challenges and interventions with the capacity for improving access to markets. Considerable literature is already available on factors that affect agricultural commodities market participation but less has been done with regard to smallholder soybean farmers in Kenya. The objective of this study therefore, was to determine factors which influence decision to sell and amount of soybean sold by smallholder soybean farmers in Kakamega County, Kenya. .

MATERIALS AND METHODS

Study area, sampling and data collection

The study was conducted in Kakamega County, one of the regions where there have been previous project efforts to increase productivity of soybean. Data collection was done in Butere, Lurambi, Mumias East, Ikolomani, and Khwisero sub-counties. Figure 1 shows the map of Kakamega County with the various sub–counties where the study was conducted. Kakamega County is in Western Kenya region, which is the leading soybean producing region in Kenya (Syngenta 2016). Kakamega had a population of 1,660,651 in 2009 making it the most populous County after Nairobi with this figure expected to reach 2,184,885 by year 2020 given an annual growth rate of 2.5 percent, with a population density of 682 persons per square kilometre as of

2016 (County government of Kakamega 2017). High population in the County means that there is increasing land scarcity and continued depletion of the soil. The annual rainfall for the region ranges between 1280 and 2214 millimetres per year, temperatures of between 18 and 29 degrees Celsius and an altitude of 1240-2000 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. Established soybean crop have capacity to withstand dry conditions.

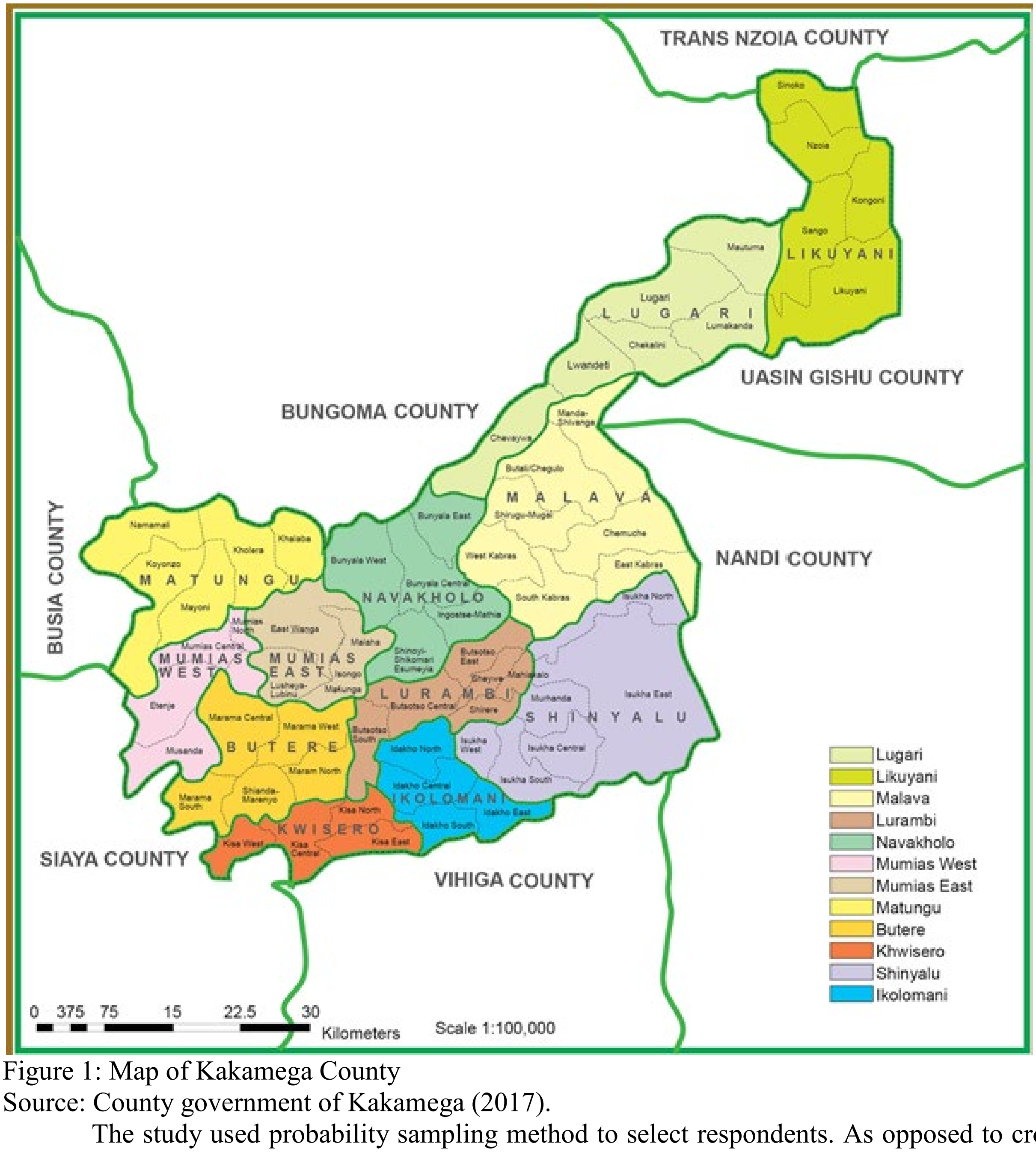

Figure 1: Map of Kakamega County

Source: County government of Kakamega (2017).

The study used probability sampling method to select respondents. As opposed to crops such as maize, soybean is not a common household crop and using random sampling methods would have resulted in a lot of time wasted trying to reach the target population of soybean farming households. In each sub-county, the enumerators were given contact of a single farmer representative from the area that aided in the identification of soybean farmers in the area. This contact farmer functioned as a local guide for the survey. The study sampled 148 households. Studies of the same nature have employed a relatively similar sample size in the range of 100 to 150 (Osmani and Hossain 2015; Sigei 2014: Ndoro et al. 2013). Imitating sample size from similar studies is one of the recommended methods of sample size determination methods put forward by Israel (1992) appropriate for when conducting a census is not feasible and information on the population required for mathematical calculation of a sample size is not present. The survey used semi-structured questionnaires administered face to face to the household head or spouse, the individual mostly involved in soybean production in the household. Prior to the household survey, a focus group discussion (FGD) was conducted with soybean farmers and stakeholders in the soybean value chain who included representatives from Mumias District Federation of Soybean Farmers (MUDIFESO), Rural Outreach Program (ROP), Ministry of agriculture, and KALRO Kakamega. Results from the FGD were used to structure the household questionnaire and inform parts of the discussion.

Data analysis

Studies on market participation have previously used Tobit model to analyse data. The Tobit model allows for clustering of zeros due to non-participation and it assumes that the participation decision and extent of participation are influenced by the same set of variables. However, Bellemare and Barret (2006) noted that smallholder farmers make sequential decisions on market participation; first, the household decides to sell in the market and then makes the second decision on how much to sell. Therefore, most studies have used either double hurdle method or the 2-step Heckman selection to model the two step process of market participation. Both models allow for a single variable to affect the decision and extent of participation differently, thus relaxing the assumption of the Tobit model. The Heckman two-step corrects for selectivity bias due to incidental truncation (Heckman 1979).

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, all data set is observed and non-participation is equated to zero. It is assumed that non-participation is 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 this study, all outcomes for selling soybean were observed. Non- participating households were those households that did not sell any soybean whereas those households that sold soybean were considered as the market participants. Households that did not sell any soybean were assumed to have made an economic decision. Therefore, the double hurdle model was applied to analyse decision and extent of soybean market participation. In the first hurdle, a probit model was estimated to represent the discrete choice of market participation where the household decides on whether to sell or not to sell any soybean. For the second hurdle, a truncated regression was used to model extent of soybean market participation, which was the quantity of soybean sold in Kilograms. The model was specified as:

$I_j^* = Z_j \propto + \varepsilon_j$, the first hurdle …………………………………………..………..…… (1)

I_j^* = latent level of utility derived from market participation

Z_j = parameter coefficient

$\propto$ = set of variables which determine market participation

ε_j = error term with normal distribution

$Y_j = Y_j' \text{ if } = I_j^*>0$ and $Y_j' > 0$, $Y_j = 0$ *otherwise*

$Y_j' = X_j'\beta + \mu$, the second hurdle ……………………..……………………………..….… (2)

Where Y_j' is the amount of soybean sold, X_j' is a vector of explanatory variables that determine extent of participation, β is a vector of coefficients and μ is the error term. Table 2 shows the variables included in the survey and their expected signs.

Table 2: Definition of independent variables and their expected signs

Variable	**Type of variable**	**Variable definition and measurement**	**Expected sign(+/-; ±)**
Age	Continuous	Age of farmer in years	-
Sex	Dummy	1 for male and 0 female	±
Years of schooling	Continuous	Years of formal schooling completed	+
Household size	Continuous	Number of household members	±
Group membership	Dummy	1 if member of group 0 if not	+
Land owned	Continuous	Size of land owned by the household in hectares	+
Farm size under soybean	Continuous	Land area on which soybean was planted last production period in hectares	+
Nonfarm income	Continuous	Average monthly income from other sources other than farming in Kshs	±
ICT tool	Dummy	1 = household owns either a radio/TV or both, and 0 otherwise	+
Output	Continuous	Kilograms of soybean produced (Kg)	+
Output price	Continuous	Price of soybean sold (Kshs/Kg)	+
Credit	Dummy	1 if farmer had access to credit services, 0 if not	±
Extension	Dummy	If a farmer had access to soybean related extension, 1= yes, 0 otherwise	+
Market transport cost	Continuous	Cost of transportation to the main market	-
Ownership of transport facility	Dummy	Whether the household owns a transport facility such as bicycle or motor vehicle, 1= yes, 0 otherwise	+
Use of inoculants	Dummy	1 if farmer uses inoculants to plant soybean, 0 otherwise	+
Bought seeds	Dummy	1 if farmer purchased seeds to plant soybean, 0 otherwise	+
Use of fertilizer	Dummy	1 if farmer used fertilizer in soybean farm, 0 otherwise	+

Model diagnostics

Multicollinearity refers to a high degree of linear dependency among the independent variables. Presence of multicollinearity within the variables was tested using the variance inflation factor (VIF). The presence of multicollinearity is indicated by a VIF higher than 10. The results from the VIF showed absence of multicollinearity since no variable had a VIF greater than or equal to 10 with the mean VIF being 1.39. *Breusch pagan* test was used to test for heteroskedasticity within the variables used in regression. Heteroskedasticity occurs when the error terms have no constant variance. The results were significant indicating high presence of heteroskedasticity hence, the model included robust standard errors in the *stata* command *(vce(robust))* to correct for heteroskedasticity.

RESULTS AND DISCUSSIONS

Characteristics of smallholder soybean farmers

The socio-economic characteristics of soybean farmers are provided in Table 3.

Table 3: Key Sample characteristics

Variables	Mean (n = 148)	Standard deviation	Minimum	Maximum
Dependent variables				
Decision to sell soybean (1 = yes)	**0.61**	**0.49**	**0.00**	**1.00**
Quantity of soybean sold (Kgs)	**70.09**	**82.60**	**1.00**	**360**
Independent variables				
Age (years)	50.36	13.21	21.00	81.00
Experience in growing soybean (years)	4.70	4.82	1.00	37.00
Household size	6.90	3.20	1.00	25.00
Years of schooling	8.70	4.05	0.00	16.00
Average land owned by household (ha)	0.75	0.63	0.00	3.24
Farm size under soybean (ha)	0.11	0.13	0.03	1.21
Soybean output quantity (Kgs)	89.03	118.06	6.00	810.00
Average soybean yield (t/ha)	0.86	0.88	0.07	7.91
Average price of soybean sold (Kshs/kg)	70.98	27.72	35.00	200.00
Average nonfarm income (Kshs.)	4665.00	8032.00	0.00	47000.00
Sex of farmer (1 = male, 0 = female)	0.35	0.48	0.00	1.00
Marital status (1 = married, 0 = otherwise)	0.80	0.40	0.00	1.00
Primary occupation (1= farmer, 0 = otherwise)	0.72	0.45	0.00	1.00
Access to credit (1 = yes, 0 = no)	0.59	0.49	0.00	1.00
Group membership (1 = yes, 0 = no)	0.82	0.39	0.00	1.00
Access to soybean related extension (1 = yes, 0 = no)	0.38	0.49	0.00	1.00
Ownership of transport facility (1 = yes, 0 = no)	0.56	0.50	0.00	1.00
Use of inoculants (1 = yes, 0 = no)	20.30	0.40	0.00	1.00
Bought seeds (1 = yes, 0 = no)	0.61	0.49	0.00	1.00
Use of fertilizer (1 = yes, 0 = no)	0.57	0.50	0.00	1.00
Labour used (1 = hired labour, 0 = otherwise)	0.25	0.43	0.00	1.00

Source: Survey Data (2017).

The percentage of households which sold soybean was 61 selling an average of 70 kilograms. The high percentage of market participation may mean that soybean has high potential as a cash crop and/or perhaps there is limited household utilization of soybean. Tinsley (2009) noted that soybean is less suited to the traditional diet of rural communities as it does not soften when cooked to form stew as common beans. In the FGD, farmers demonstrated knowledge on simple value addition practices that they are able to do at the household level such as frying, roasting, milling flour, and extracting soy milk to improve palatability. The mean age of soybean farmers was 50 years. This is consistent with the observations in the Kenya Youth Agricultural Strategy 2017 to 2021(Republic of Kenya, 2017), which notes that most people engaged in agriculture in Kenya are between the ages of 50 and 65 years. Young people tend to shun farming and soybean farming is no exception. The results also indicate that soybean is a relatively new crop of choice, with many households having embraced soybean production less than 5 years ago.

The average years of schooling were 9 years which indicated that most of the farmers did not have secondary school certificate. This indicated that many households are excluded from formal employment that would require a special skill set that are gained through education. The average household size for the sample was seven people compared to a mean of six people established by Nyongesa et al. (2017) among soybean farmers in Western Kenya.

The study showed that the mean total size of land owned in the pooled sample was 0.75 hectare, which is slightly higher than the mean land holding in the County of 0.57 hectare according to the County Government of Kakamega (2017). The mean farm size under soybean production was 0.11 hectare with an average soybean yield of 0.8 ton per hectare. The yields are low compared with soybean grain yields of 3.8 tons per hectare recorded in Rwanda in inoculated plots (Rurangwaa et al. 2018). Yield rates of between 0.5 and 1.68 tons per hectare have been recorded in parts of Western Kenya and Rift Valley region (Odendo et al. 2013; KALRO 2013). Chianu et al. (2011) found that quantities of fertilizers generally used by smallholder farmers are inadequate which could explain the low yield.

The primary occupation for three quarters of the households was farming. The results were in tandem with County Government of Kakamega (2017) which classifies most of Kakamega County rural population as being agriculture dependent. Three fifths of the farmers purchased soybean seeds, while the rest used seeds recycled from previous seasons. The main source for purchased seeds was farmer groups at 38 percent with neighbours being the least used source as shown in Figure 2. Additionally, farmers indicated in the survey that soybean 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 (Tinsley 2009). The mean price for a kilogram of soybean sold was Kenya shillings (Kshs.) 70. In the FGD participants indicated that the price for a kilogram of soybean can be increased from Kshs. 50 to Kshs. 400 through value addition. Slightly over half of the soybean farmers had access to credit services. This could be attributed to high membership in groups which provided credit services. Four-fifths of the farmers belonged to groups and the most common groups were self help groups such as *chamas* as shown in Figure 3.

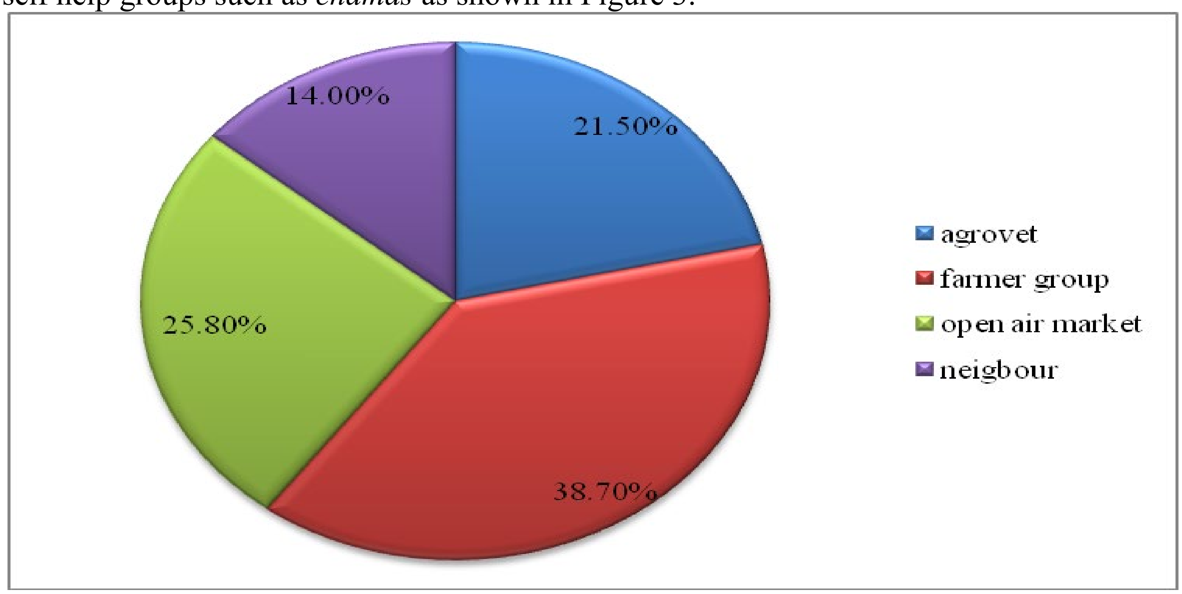

Figure 2: Distribution of where farmers purchased soybean seeds
Source: Survey Data (2017).

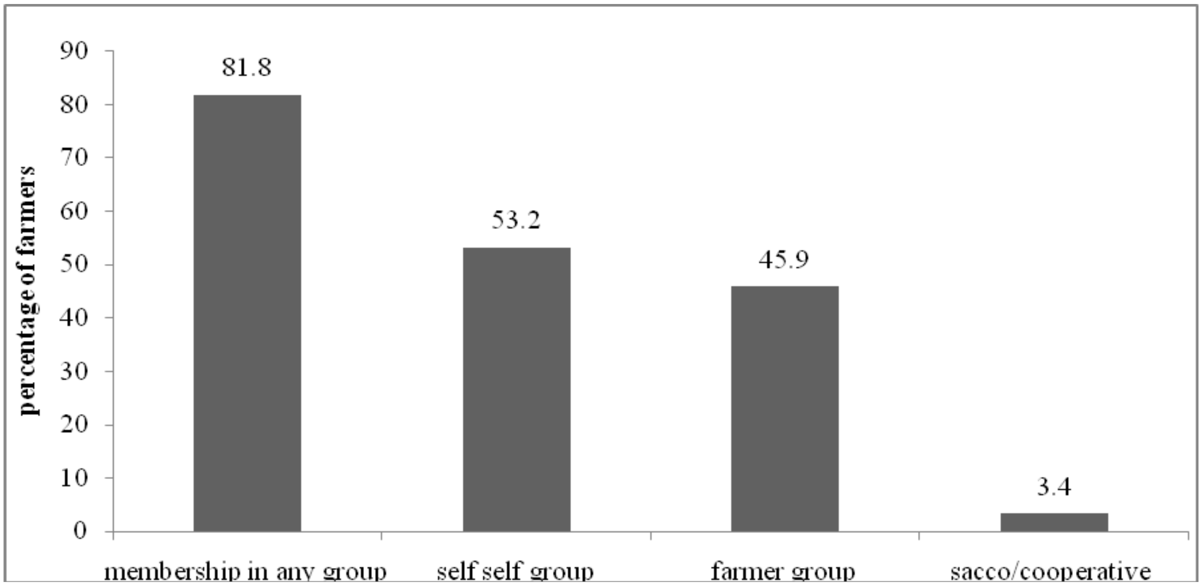

Figure 3: Distribution of membership in different social groups
Source: Survey Data (2017).

Half of the households recorded use of fertilizer in soybean cultivation which included use of organic manure and/or inorganic fertilizers. Only one quarter of the households used hired labour in soybean production, the most widely used type of labour being family labour as shown in Figure 4. The mean nonfarm income earned per month was less than Kshs.5000. Only one third of the soybean farmers were male. The results support the discourse that women contribute immensely in the cultivation of secondary crops such as legumes (World Bank, 2009).

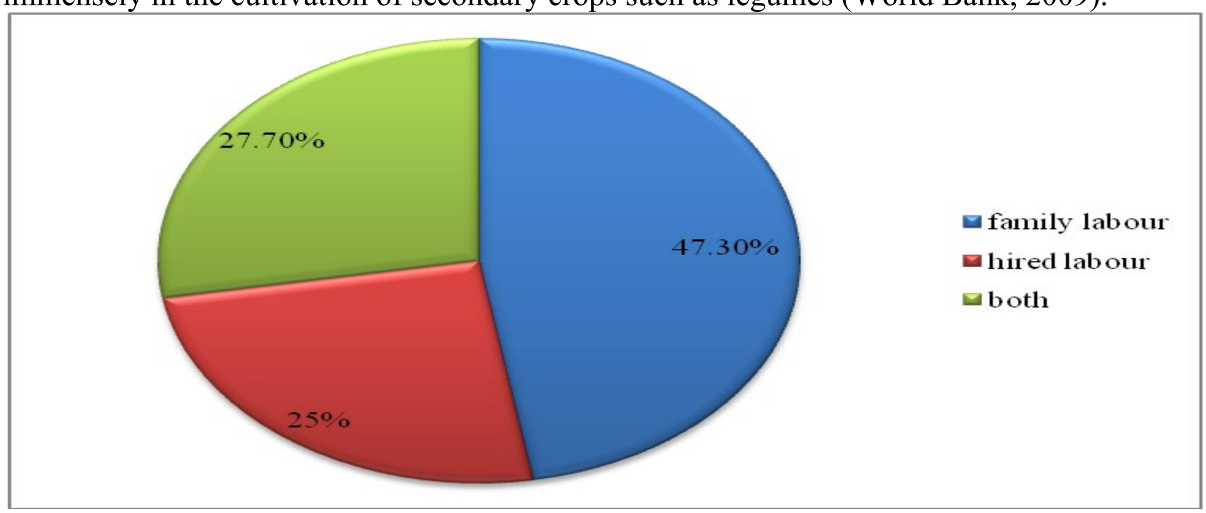

Figure 4: Types of labour used in soybean production
Source: Survey Data (2017).

Factors determining market participation

The results of the double hurdle model are presented in Table 4. Marginal effects were estimated to facilitate interpretation of per unit influence of the variables on market participation.

Table 4: Results of the double hurdle model on determinants of market participation

Variable	1st hurdle (Decision to sell soybean)		2nd hurdle (Extent of market participation)	
	dy/dx	$P > \|z\|$	dy/dx	$P > \|z\|$
Quantity of soybean produced (kg)	-0.0007	0.758	0.4045	0.000***
Farm size under soybean (fraction of total land owned)	0.2800	0.643	51.5717	0.241
Average monthly non farm income (Ksh)	-0.0001	0.003***	0.0019	0.056*
Ownership of transport facility (1 = yes)	0.6755	0.018**	25.8418	0.252
Ownership of ICT tool (1 = yes)	0.5413	0.209	8.6465	0.820
Quantity of seed planted (kg)	0.1912	0.000***	5.0369	0.002***
Use of fertilizer (1 = yes)	0.8722	0.002***	-11.3665	0.498
Use inoculants (1 = yes)	1.1023	0.016**	47.8750	0.006***
Access to soybean related extension (1 = yes)	0.3846	0.192	26.7521	0.099*
Membership in farmer group (1 = yes)	0.0443	0.884	12.4542	0.385
Access to credit (1 = yes)	0.4739	0.090*	-12.9371	0.397
Average transport cost to main market (Ksh)	0.0064	0.032**	-0.0028	0.976
Years in school	0.0191	0.601	-4.3485	0.079*
Household size (number of persons)	-0.1043	0.021**	-3.7521	0.071*
Sex of farmer (1 = male; 0 = female)	0.3527	0.257	-7.3273	0.639
Age (years)	0.0195	0.093*	-0.7749	0.129
Price of soybean (Ksh/kg)	_	_	0.6410	0.091*

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

$Number\ of\ obs = 148 \quad Wald\ chi2(17) = 219.35 \quad Prob > chi2 = 0.0000$

$Log\ pseudolikelihood = -474.39602 \quad Pseudo\ R2 = 0.1093$

Source: Survey Data (2017).

Quantity of soybean produced had a positive and significant effect on extent of soybean market participation. The results are consistent with the findings of Woldeyohanes et al. (2015) and Sigei (2014) which show that producing more quantities of an agricultural commodity leads to more of the commodity being available for supply into the market. A higher amount of produce means availability of surplus for the market.

Nonfarm income had a significant effect on both the likelihood of the farmer deciding to participate in soybean market and the extent of market participation. The effect of nonfarm income was negative for decision to participate in soybean similar to findings by Omiti et al. (2009) whereby nonfarm income reduces households' reliance on farming. This is because farmers with an alternative source of income are less likely to participate in agricultural markets since farmers mainly engage in output sale to satisfy immediate cash needs (Ndoro et al. 2013). However, nonfarm income showed a positive effect on extent of market participation contrary to findings by Woldeyohanes et al. (2015) and Omiti et al. (2009). Nonfarm income provides capital for investing in farming. Owning transport facility was found to be significant and positive in influencing likelihood of household deciding to sell any soybean. This is because owning a bicycle or motorbike reduces transport costs thereby increasing access to market information (Alene et al. 2008).

The effect of extension and membership in farmer group although positive, they were not significant in influencing a household's decision to sell soybean. During the FGD it was noted that many groups experienced challenges arising from poor leadership, lack of commitment from some members, and a lack of adequate resources to finance its objectives. Extension was however significant and it positively determined the extent of soybean market participation similar to a study by Gebremedhin et al. (2017). A study by Alene et al. (2008) found that access to extension increased productivity hence, with more soybean produce there is an increased likelihood of deciding to participate in marketing. Credit had a positive and significant effect on probability of selling soybean. Barret (2008) observed that access to credit enables households to invest in input markets which subsequently increase production.

Quantity of seed used, use of fertilizer and use of inoculants were all positive and significant in determining the households' decision to sell soybean. Use of inoculants and quantity of seed used were also positive and significant in influencing extent of market participation. The use of inputs increases production therefore availing enough soybeans for domestic use and market surplus. Participation in input market increases productivity and marketable surplus hence positively influencing decision to sell. Soybean yields increase with the use of inoculants (Majengo et al. 2011), because the soil bacterium responsible for nodulation does not occur naturally in most SSA soils and seed inoculation is needed before sowing.

The influence of market transport cost on market participation was significant and positive. Distant markets are likely to offer better prices which may then encourage households to sell. Another possible explanation is that households furthest from the market centre may own larger parcels of land that could enable them produce more soybeans for the market. The effect of price on extent of market participation was found to be positive and significant. The results on this variable are similar to the findings by Kizito and Kato (2018), Ndoro et al. (2013) and Alene et al. (2008). High output prices acts as an incentive for supplying more quantity on the market. Being a member of a farmer group, although positive, was not significant in influencing the quantity of soybean sold. Nonetheless, the results were positive similar to conclusions of Olwande and Mathenge (2012).

Years of schooling had a negative effect on the amount of soybean sold. This is contrary to previous studies, which found a positive relationship between years of schooling and the amount of produce brought to the market (Lubungu et al. 2012). Although individual with higher levels of education are able to make more informed production decisions to capitalize on commercial agriculture, this scenario is challenged as educated people tend to invest less in agriculture, only producing for subsistence and engaging in alternative remunerative activities.

Similar to findings by Martey (2012), household size was found to have a negative and significant effect on households' decision to engage in soybean market and the quantity of soybean sold. This is because larger households have a greater domestic consumption resulting in limited surplus produce that can be sold. Age of the farmer had a positive and significant effect on the likelihood of engaging in soybean market. A possible explanation for this observation could be that most of the soybean farmers are older people as shown in the descriptive statistics with a mean age of 50 years (see Table 3).

Conclusions

This study analyzed smallholder soybean farmers' decisions to sell and amount of soybean sold. Descriptive statistics indicate that a majority of the households sold at least some quantity of soybean despite registering low output, perhaps indicating limited household utilization of soybean and its potential use as a cash crop. Results from double hurdle showed that age, household size, quantity of seed planted, and use of inoculants and fertilizer had a significant influence on household's decision to sell. Additionally, access to extension services, years of schooling, household size, and output price were found to be crucial in determining quantity of soybean sold.

From the results, there is potential for growth in soybean production through improving crop yield. The County government of Kakamega can achieve this by incorporating soybean in the pre existing maize fertilizer and seed subsidy program. Alternative crops such as soybean have demonstrated capacity to contribute significantly towards household food security. This is not only due to soybeans' potential as a cash crop, but also through their complementary nature with the maize staple in diet, and in their role in improving soil fertility. Extending similar support of fertilizer and seed subsidy towards soybean would result in increased market surplus due to improved productivity. It is likely that after the felt importance of soybean, the households may then consider expanding actual land under soybean cropping and/or increasing farming intensity.

The county government should 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 output prices with the processors and establishing consistency in availability of such market outlets. With availability of desired markets, farmers would in response apportion more of their land to soybean production and invest in improved technologies that would increase soybean productivity. Additionally, there is need for institutional support in access to extension services especially with respect to seed storage and domestic soybean processing both as a mean of increasing household consumption and increasing profitability from selling surplus. This will lead to growth in quantity of soybean production in the area.

Conflict of interests

The authors have not declared any conflict of interests.

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