Original Research Article

Determinants of participation in contract farming among smallholders' sorghum farmers in Bondo sub-county, Kenya

ABSTRACT

This paper analyzed the determinants of participation in sorghum contract farming using a multi-stage sampling to sample 240 smallholder sorghum farmers (105 participants and 135 non-participants) for the 2020/2021 production year. Primary data was collected using pretested structured questionnaire through face-to-face interviews. Descriptive statistics and an econometric model were used to analyze the data. A binary logistic regression model was applied to determine factors influencing the participation of smallholder farmers in sorghum contract farming. Findings revealed that post-primary education level $(\beta = 0.215; P = 0.04)$, age $(\beta = 0.005; P = 0.00$, gender $(\beta = 0.144; P = 0.02)$, number of active household members $(\beta = 0.09; P = 0.03)$, group membership$(\beta = 0.188; P = 0.00)$, distance to the nearest main road in walking minutes $(\beta = 0.0205; P = 0.00)$, ownership of bicycle $(\beta = 0.210; P = 0.00)$ and ownership of oxen $(\beta = 0.238; P = 0.00)$ positively influence participation in sorghum contract farming, while the distance to the nearest extension agent office negatively influences sorghum contract significantly and negatively $(\beta = -0.004; P = 0.01)$. The results suggest the need to increase access to extension services, implement policies for empowering women and youths to engage in contract farming and sensitize farmers to form groups to enhance information on agricultural innovations and interventions. National and county governments should invest in physical infrastructure, such as roads, to improve access to agricultural information on new interventions.

Keywords: Participation, Contract farming, Sorghum, binary logit, smallholder farmers, Kenya.

1. INTRODUCTION

Agriculture in Africa has numerous economic and social benefits. Smallholder farmers account for more than 60 percent of the total population. The agricultural sector contributes to proximately 23 percent of the Gross Domestic Product (GDP) [1], but the sector's full potential has not been exploited. Previous research predicts that Africa can produce more cereal and grains, accounting for 20 percent of the world total output (2.6 billion tons) [2]. Africa's production of cereals and grains can double or triple with improvements in agricultural yields through intensification. Agricultural intensification entails exploiting yield potential through increased use of fertilizers, improved seeds and irrigation, the land expansion for agriculture, reduction of post-harvest losses, and improvement of infrastructures. In addition, commercializing less commercialized grains such as sorghum and millet is necessary for increased grain production in Africa [2].

Smallholder farmers need to transform from subsistence production to commercial agriculture. Various organizations in the livestock and crop sector have promoted interventions such as contract farming to promote commercialization in agriculture [3]. For example, contract farming has been introduced to enable smallholder farmers to reduce transaction costs and agricultural risks. Subsequently, contract farming promotes household food security, improves productivity, and reduces rural poverty [4]. Contract farming has been introduced to cereal crops such as sorghum to improve the production and productivity of the crop.

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Sorghum is a cereal grain grown as a source of nutrients, animal fodder, forage, brewing, and beverage in Africa. Sorghum is grown as a food crop in Kenya's arid and semi-arid (ASAL) areas. Sorghum grain is important in Kenya and is used to manufacture cakes, porridge, bread, and brewing beer in Kenya. The grain contributes to food security and nutrition as the crop can survive under harsh environmental conditions [5]. Despite the importance of sorghum grain, the crop is mainly grown by smallholder farmers as a subsistence crop, with a few cultivating sorghums for the brewing industry. Demand for sorghum is anticipated to increase by about 2% globally by 2028 [6].

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According to [7] sorghum production globally is 61,364,996, in Africa 26,280,474, and Kenya 135,000 tonnes, as in Table 1. In Kenya, sorghum production has declined from 159877 to 135000 tonnes from 2011 to 2021; sorghum acreage has declined from 254,125 to 197,403 hectares in the same period. The sorghum crop is vital in alleviating poverty, nutrition, and employment potential if commercialized. Interventions have been introduced in Kenya to promote sorghum production for commercialization under contract farming. The government has implemented strategies to upgrade sorghum to a Traditional High-value Crop (THVC) and increased demand for sorghum by the brewing industry [5].

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Table 1: Trends in sorghum production acreage and output from 2011 to 2021

	World		Africa		Kenya	
Year	Acreage	Production (Tonnes)	Acreage	Production (Tonnes)	Acreage	Production (Tonnes)
2011	42,208,379	56,807,955	26,574,518	23,992,068	254,125	159,877
2012	39,261,952	57,320,937	24,233,535	23,582,940	223,799	166,627
2013	43,905,357	61,894,856	28,011,454	25,285,392	223,659	168,857
2014	44,661,817	68,300,901	29,269,020	29,321,916	213,520	177,553
2015	41,833,033	65,939,161	26,073,762	26,110,893	195,507	189,000
2016	44,619,621	63,385,842	30,328,416	30,299,201	184,654	117,000
2017	41,104,213	57,593,407	27,867,038	27,618,888	203,586	144,000
2018	42,027,815	60,032,258	29,585,392	29,988,196	240,403	189,000
2019	39,204,873	56,705,929	27,775,402	27,946,644	240,200	288,000
2020	39,628,192	58,920,811	27,723,818	28,221,379	219,657	315,000
2021	40,925,310	61,364,996	28,134,341	26,280,474	197,403	135,000

Source: [6]

Contract farming involves different crops such as tobacco, sugarcane, tea, avocado, and coffee. Contract farming has also been introduced to cereal crops such as sorghum due to the brewing industry high demand for cereal. The major constraints to sorghum commercialization in Kenya are low production and inadequate marketing channels. Farmers mainly produce sorghum for household consumption, with only a small portion of the total output sold [8]. The low and subsistence domestic production of sorghum makes it difficult for Kenya to meet the consumption and industrial demand. Consequently, the country

heavily relies on sorghum imports from regional countries such as Uganda, Tanzania, and Sudan to meet its demand [9].

However, East African Breweries Limited (EABL) and some county governments of Kenya collaborated to introduce sorghum production under contract farming [9]. The EABL Company has contracted about 30,000 farmers in Western and Eastern Kenya to meet its annual demand of 22 MT of sorghum. The EABL mobilizes and sensitizes farmers on the importance of contract farming. The company conducts farmer training, provides inputs on credit to farmers, and buys sorghum from contracted farmers. It does this in collaboration with the Ministry of Agriculture, Livestock, Fisheries and Irrigation (MoALF& I), Equity Bank, Kenya Arid and Semi-Arid Lands (KASAL) project, Kenya Agriculture and Livestock Research Organization (KALRO), Smart Logistics Ltd and European Cooperation for Rural Development (EUCORD). The main objective of this project is to improve sorghum productivity and increase farmers' income [11]. Despite the economic importance of sorghum contract farming to farmers, the number of contracted farmers is still below the company's expectation. The EABL Company anticipates contracting 45 000 farmers to produce sorghum, but only 30,000 farmers have been contracted in Western and Eastern Kenya to meet the 20,000 metric tonnes of annual demand for sorghum. The demand is expected to increase by double digits [12].

There are research gaps in Kenya on the underlining factors influencing farmers' participation in sorghum contract farming. Recent studies only focus on sorghum beer's value chain and factors affecting sorghum marketing [13]. This research on sorghum contract farming by smallholder farmers in Siaya County was crucial in determining underlining factors influencing participation by smallholder farmers in contract farming. Understanding factors influencing farmers' decision to participate in contract farming is essential for informing the design and implementation of effective policies and programs that promote market development for smallholder farmers. The study results are anticipated to encourage smallholder farmers to participate in sorghum commercialization rather than producing for subsistence.

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2. Methodology

2.1 Study Area

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This study was conducted in Siaya county. Siaya county was chosen because of the extensive sorghum production in the region under contract farming. Siaya county is located to the Northwest of Busia county, Northeast of Vihiga and Kakamega counties, Southeast of Kisumu county and South of Homa Bay county. The county has six sub-countries: Alege, Bondo, Arrieta, Gem, Ugenya, and Agunja. Siaya county is between latitude 0º 26´ South and 0º 18´ North and longitude 33º 58´ and 34º 33´ east. Siaya county lies at altitude of 1,1140m below and at altitude of 1,140m above sea level. Siaya county has a land size of 2,496.1 Km^2 with a population of 993,181 [14]. Bondo and Arrieta sub-counties are in the drier parts while Alege, Gem, Agunja, and Ugenya sub-counties are in wetter part of the county. The county experiences average annual temperature range of between 16.3° C and 29.1° C and average annual rainfall range of 1,800mm to 2,200mm.

Agriculture is the main livelihood source in Siaya county. About 80 percent of the population depends on agriculture for food and income. Among the key development goals of Siaya County government is promoting food self-sufficiency and food security in the county by promoting food crops (mainly sorghum, maize, cassava and beans). Sorghum was selected for the study to evaluate the effect of EABL company intervention on the crop in the region [12].

2.2 Sampling Procedure

The population of interest in the study was sorghum farmers in Siaya county production sorghum under contract by EABL Company and non-contracted farmers. Multi-stage and stratified sampling techniques were used to generate the study sample. In the first stage, Bondo sub-county was purposively selected for the study based on the prominence of sorghum production relative to other sub-counties in Siaya county. In the second stage, East Yimbo, North Sakwa, and West Sakwa wards were purposively selected based on the high number of sorghum farmers compared to West Yimbo, Central Sakwa, and South Sakwa wards. In the third stage, two villages with the most sorghum famers in each ward were

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selected. In each selected village, sorghum farmers were stratified into two; EABL contracted and non-contracted. A sample of 105 contracted and 135 non-contracted sorghum farmers were randomly selected from the strata. Proportionate to size approach was applied to determine the number of contracted and non-contracted farmers to sample from each village.

2.3 Sample Size Determination

Sampling is a selection of a subset of the population of interest in a research study. At the same time, a sample size is a subset to represent the entire population of interest. The required sample size for the study was determined by proportionate to size sampling methodology as per the formula by [15]as shown in the equation below.

$$n = \frac{z^2 pq}{e^2}$$

Where n is the required sample size for the study p is the proportion of sorghum farmers in Bondo sub-county. Data obtained from Bondo sub-county agricultural office showed that 80.63% of the smallholder farmers in Bondo sub-county produced sorghum either under contract or non-contracted, q is weighting variable computed as $q = 1 - p = 1 - 0.8063 = 0.1937$, z representing critical value, which is 1.96 at 95 percent confidence interval and e indicates allowable error term. According to [14]an error of less than 10% is usually acceptable; hence the study used an error of 5%. The computation of the sample size for the study was expressed as follows;

$$n = \frac{Z^2 pq}{e^2} = \frac{1.96^2 \times 0.8063 \times 0.1937}{0.05^2} = 239.99 = 240$$

Therefore, 240 smallholder sorghum farmers were sampled for the study. Proportionate to size was used to distribute the total sample size between contracted (105) and not contracted (135) sorghum farmers.

2.4 Analytical framework

The decision to participate in sorghum contract farming is a binary variable, taking 1 for contracted and 0 for non-contracted farmers. Modeling such a binary response variable is often done through the linear probability model (LPM), logit model, or Probit model. The LPM has weaknesses that the resulting probability predictions are not necessarily bounded in the unit interval, as it can be less than zero or greater than one. Also, LMP implies a constant marginal effect for all the explanatory variables used in the model. Logit and probit models overcome the above drawbacks of LMP. Logit model was chosen over probit model as it is easier to interpret than probit model. Logistic regression is interpreted as the marginal effects [16].

Logistic regression model can be expressed as follows;

$A_i^* = \beta_i X_i + u_i$, where A_i^* a latent response variable β_i is the coefficient of the parameter estimate, X_i is a vector for explanatory variables which influence participation decision, and u_i is the error term. In practice, A_i^* is unobserved. In this case, we observe only a dummy variable defined as; A_i = { 1 if $A^*_i > 0$ contract farming and 0 if $A^*_i < 0$ otherwise}.

The probability of participation in contract farming is denoted as;

$$prob(A_i = 1) = prob(A_i^* > 0) = prob(\mu_i > -\beta X_i) = 1 - F(-\beta X_i) = F(\beta X_i) \quad (1)$$

In this case, F represents the cumulative distribution function (CDF) for a continuous random variable with a probability density function. The expression for the probability of a farmer participating in sorghum contract farming is as follows:

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$$prob\left(A_i = 1/X_i\right) = \frac{1}{1+e^{-BX_i}} = \frac{e^{BX_i}}{1+e^{BX_i}} \quad (2)$$ Under a random sampling technique where all the observations of interest are sampled, the contribution of the i^{th} observation is written as $P_i^{A_i}\left(1-P_i\right)^{1-A_i}$ (3)

Therefore the probability function is represented as; $L = \prod_i^n P_i^{A_i}\left(1-P_i\right)^{1-A_i}$ (4)

By taking the logarithms of both sides and letting P_i to be $\frac{e^{BX_i}}{1+e^{BX_i}}$, the log-likelihood function will be

$$\log L = \sum_i^n A_i \beta X_i - \sum_i^n \log\left(1+e^{BX_i}\right) \quad (3)$$

In this model with binary dependent variable, the parameter estimates of βs was estimated through maximum likelihood and the marginal effect computed as; dp_j/dX_j which gives the rate of change in the probability as a result of a small change in the dependent variable and given as; $B_j P_i\left(1-P_i\right)$ [17].

Empirical model specification

Participation in contract farming is denoted by;

$$A_i = \beta_0 + \beta_1 HHEduclevel + \beta_2 HHGender + \beta_4 HHAge + \beta_4 HHAge15to64 + \beta_5 HHAgeless15great64 + + \beta_6 LandAcreage + \beta_7 OffarmIncome + \beta_8 GroupMembership + \beta_9 DistExtentAgentMins + + \beta_{10} DistMainRoadMins + \beta_{11} DistInputMarket + \beta_{12} FarmStoreOwnership + \beta_{13} BicycleOwnership + \beta_{14} OxenOnwership + \beta_{15} AnimalAsset + \varepsilon_i \quad (4)$$

where $A=1$ for the contracted farmer and 0 otherwise, β_1 to β_{15} are the parameter estimates of the variables and ε_i is the error term.

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Table 2: Description of variable and the expected sign in the logit model

Variable symbol	Variable name	Variable type	Unit of measurement	Expected sign
Contract Participation	Dependent Contract participation	Dichotomous	(0=No 1=Yes)	
	Independent Variables			
Education level	Education level of the household head	Categorical	Categorical	+/-
Gender	Gender of the household head	Dichotomous	0=Female	+/-

			1=Male	
Age	Age of the household head	Continuous	Years	+
Active members	Active household members	Continuous	Numbers	+
Inactive members	Household members Age <15 and >64 years	Continuous	Numbers	_
Land size	Land Acres owned	Continuous	Acreage	+
Off-farm Income	Off-farm Income	Continuous	KES	+/-
Group Membership	Group Membership	Dichotomous	0=No 1=Yes	+/-
Distance to Extension	Distance to nearest Extension Agent office	Continuous	walking minutes	-
Distance to Road	Distance to nearest Main Road	Continuous	walking minutes	-
Distance to Market	Distance to nearest farm input market	Continuous	walking minutes	-
Farm store Ownership	Farm Store ownership (0=No 1=Yes)	Dichotomous	0=No 1=Yes	+
Bicycle Ownership	Bicycle Ownership (0=No 1=Yes)	Dichotomous	0=No 1=Yes	+
Oxen Ownership	Oxen Ownership (0=No 1=Yes)	Discrete	0=No 1=Yes	+
Livestock TLU	Livestock TLU	Continuous	TLU	+

Multicollinearity and heteroscedasticity tests were conducted before running a logistic regression model on variables influencing participation in sorghum contract farming for consistency and reliability of the results. The continuous explanatory variables were tested for multicollinearity using the variance inflating factor (VIF) and contingency coefficient (CC) method for categorical variables. Multicollinearity test results are presented in Table 3, and contingency coefficient results in Table 4. The mean VIF was 1.18, below the threshold level of 10 (Table 3). The mean VIF of 1.18 indicates no serious multicollinearity amongst the continuous explanatory variables in the model.

Table 3: Multicollinearity test for continuous explanatory variables

Variable	VIF	1/VIF
Distance to nearest farm input market in walking minutes	1.42	0.70
Distance to nearest Extension Agent office in walking minutes	1.25	0.80

Livestock (TLU)	1.22	0.82
Age of the household head	1.19	0.84
Distance to nearest Main Road in walking minutes	1.18	0.84
Log Land Acres owned	1.13	0.89
Log Off-farm Income (KES)	1.11	0.90
Number of active household members	1.09	0.92
Number of inactive household members	1.06	0.94
Mean VIF	**1.18**	

The CC values from Table 4 are at least 0.5, indicating no serious level of multicollinearity amongst the categorical explanatory variables. In addition, the heteroscedasticity test was conducted using the Brush-Pagan test. The chi-square value of 21.24 and p-value of 0.8151 indicate the absence of heteroscedasticity.

Table 4: Contingency coefficient test for categorical explanatory variables

Variables	Education level of the household head	Gender of the household head	Group Membership	Farm Store Ownership	Bicycle Ownership	Oxen Ownership
Education level of the household head	1.00					
Gender of the household head	0.35	1.00				
Group Membership	0.13	0.05	1.00			
Farm Store Ownership	0.16	0.09	0.37	1.00		
Bicycle Ownership	0.10	0.20	0.03	0.11	1.00	
Oxen Ownership	0.14	0.05	0.21	0.27	0.18	1.00

3. RESULTS AND DISCUSSION

3.1 Descriptive statistics

3.1.1. Socioeconomic characteristics of contracted and non-contracted sorghum farmers

The summary statistics on selected socio-economic and institutional factors for contracted and non-contracted sorghum farmers in Siaya County are presented in Tables 5 (for continuous variables) and 6 (for categorical variables). Group comparisons for contract participants and non-participants were conducted using a t-test for continuous variables and a chi-square for categorical variables.

Table 5: Differences in selected socio-economic characteristics of contracted and non-contracted sorghum-producing farmers in Siaya county (continuous variables)

	Non-contracted n=135		contracted n=105		Pooled n=240			
Variables	Mean	SD	Mean	SD	Mean	SD	Mean Differences	t-statistics
Age of the household head	52.06	15.78	56.23	12.52	53.88	14.57	-4.17**	-2.22
Number of active household members	2.66	1.6	3.86	2.52	3.18	2.13	-1.20***	-4.48
Number of inactive household members	2.47	1.75	2.8	1.77	2.61	1.76	-0.32*	1.41
Land Acres owned	2.54	3	4.06	3.58	3.78	2.81	-0.54*	-1.47
Off-farm income	2080	52664	4129	7009	2876	6161	-20491.53**	-2.59
Distance to the nearest extension agent in walking minutes	175.52	96.37	140.86	80.15	160.35	91.1	34.66***	2.97
Distance to the nearest main road in walking minutes	23.96	30.32	22.81	34.76	23.46	32.27	1.14	0.27

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Distance to the nearest input			100.	87.5	97.4	84.7		
market in walking minutes	95.15	82.66	38	9	4	1	-5.23	-0.47
Livestock (TLU	2.92	4.14	4.31	3.51	3.53	3.93	-1.38***	-2.74

*, **, *** represent significant level at 10%, 5% and 1% respectively.

The average age of the household heads for the entire sample was 54 years. The mean age of household heads for contracted and non-contracted sorghum farmers were 56 and 52 years, respectively (Table 5). The t-test result shows a statistically significant difference between the two groups at a 5% significant level. As household heads grow older, they are more motivated to participate in contract farming than their younger counterparts. The result was in line with our hypothesized sign. Older farmers have experience in sorghum production and can analyze contract farming intervention regarding its benefits. Similar results were found by [18] in malt barley contract farming.

The average number of active household members for the entire sample was 3. The average number of active household members for the contracted and non-contacted sorghum farmers was 4 and 3, respectively. The t-test results show a significant difference in the numbers of active household members at a 1% significance level. The findings stipulate that households with more active members are more motivated to participate in contract farming than those with fewer active household members.

The total land acreage for the entire sampled household was 3.78 acres. The mean land acreage of contracted households was 4.06 acres, and 3.54 acres for non-contracted farmers. The t-test result showed a 10% significant difference between the two groups. Results show that households with larger land sizes are more inclined to participate in contract farming than those with smaller land sizes. A larger land size allows more land to be allocated to contracted crops, thus increasing the chance of engaging in sorghum contract farming.

The average off-farm income for the entire sampled household was KES 28768.75. The average off-farm income for contracted and non-contracted households was KES 41295 and KES 20804, respectively. The t-test result shows a statistical difference between the two groups regarding off-farm income at a 1% significant level. Households with more off-farm income are more inclined to participate in contract farming than those with lower income. A higher level of off-farm income encourages farmers to participate in sorghum contracts as they can purchase certified seed and quality inputs required to produce the contracted crop.

Overall average walking minutes to the nearest extension agent office was 160.35 minutes. The average walking minutes from the household residential to the nearest extension agent office for contracted and non-contracted were 140.86 and 175.52 minutes, respectively. The t-test results indicate a statistical difference between the two groups in the location from the extension agent office in walking minutes at a 1% significant level.

However, livestock ownership in tropical livestock units (TLU) for the entire sampled household was 3.53. Average livestock holding for non-contracted and contracted were 4.31 and 2.92, respectively. The t-test was statistically significant at 1%, indicating that households with more livestock TLU can participate in contract farming than their counterparts. A study by [18] supports the above findings.

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Table 6: Differences in selected socio-economic characteristics of contracted and non-contracted sorghum-producing households (categorical variables)

Variables		Freq.	Pooled n=240 (%)	Freq.	Non-contracted n=135 (%)	Freq.	Contracted n=105 (%)	χ^2-values
Gender of the household head	Female	76	31.67	54	71.05	22	28.95	
	Male	164	68.33	81	49.39	83	50.61	9.90***
Education level of the household head	No formal	22	9.17	19	86.36	3	13.64	
	Primary	153	63.75	84	54.90	69	45.10	
	Post-Primary	65	27.08	32	49.23	33	50.77	9.52***
Group membership	No	86	35.83	65	75.58	21	24.42	
	Yes	154	64.17	70	45.45	84	54.55	20.35***
Oxen ownership	No	205	85.42	127	61.95	78	38.05	
	Yes	35	14.58	8	22.86	27	77.14	18.57***
Farm store ownership	No	162	67.50	107	66.05	55	33.95	

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	Yes	78	32.50	28	35.90	50	64.10	19.45***
Bicycle ownership	No	101	42.08	77	76.24	24	23.76	
	Yes	139	57.92	58	41.73	81	58.27	28.31***
Wards	East Yimbo	144	60.00	90	52.50	54	37.50	
	North Sakwa	44	18.33	15	34.09	29	65.91	
	West Sakwa	52	21.67	30	57.69	22	42.31	11.11***

*, **, *** represent significant level at 10%, 5%, 1% respectively

Descriptive statistics on categorical variables are presented in Table 6. Results show that contracted and non-contracted sorghum farmers were statistically different across gender, education level, group membership, and ownership of oxen, farm store, and bicycle. A larger proportion of sampled households were male-headed, constituting 68.33%, while female-headed were 31.67%. Amongst the male-headed household, non-contracted and contracted were 49.39% and 50.61%, respectively. In contrast, non-contracted and contracted were 71.05% and 28.95% amongst the female-headed households, correspondingly. The chi-square test was significant at a 1 % significant level showing variations across the two groups regarding gender. Results attribute that male-headed households are more motivated to engage in sorghum contract farming than their female-headed counterparts. The low level of participation by female-headed households in sorghum contract farming is attributed to limited access to farming resources and engagement in domestic activities.

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On the education level, the majority of the sampled household heads (63.75%) had attained primary education, with 27.08% post-primary level and 9.17% having no formal education. Of the household head who had attained primary education, non-contracted and contracted were 54.90% and 45.10%, respectively. Of household heads with post-primary education levels, non-contracted and contracted were 49.23% and 50.77%, respectively. Moreover, most household heads with no formal education (86.36%) are non-contracted, and 13.64% are contracted. A chi-square test was significant at a 1% significant level, expressing differences amongst the groups regarding education level. This indicates a low level of participation in sorghum contract farming by the household heads with no formal education compared to those with at least acquired formal education. Farmers with no formal education are illiterate and unable to read and understand the terms of the contract; thus, they are limited to participating in sorghum contract farming.

However, a larger proportion of sampled households (64.17%) belong to farm groups, while 35.83% were not in farm groups. Of the households that belong to a farm group, non-contracted and contracted are 45.45%, and 54.55%, respectively. Out of the households not in farm groups, 75.58% were non-contracted, and 24.42% were contracted. Households that belong to the farm group are inclined to participate in sorghum contract farming compared to those not in the farm group. In groups, farmers access information, farm technology, and access to input and output markets [18].

Regarding oxen ownership, most sampled households (85.42%) did not own oxen, while 14.58% owned them. Thus, 61.95% of the households that owned oxen did not participate in sorghum contract farming, while 38.05% did participate. Further, 22.86% of the households owning oxen were non-contracted, whereas 77.14% were contracted. Households that own oxen were more motivated to participate in sorghum contract farming than those without. Oxen is the main form of land cultivation in the study area, and farmers who own them could cultivate in good time as the contracting company requires.

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Regarding farm store ownership, most sampled households (67.50%) did not own farm stores, while 32.50% owned them. Of the households not owning farm stores, 66.05% were non-contracted, while 33.95% were contracted. Of the households that owned farm stores, 35.90% were non-contracted, while 64.10% were contracted. The results show that households owning farm stores were more motivated to engage in sorghum contract farming than those without. Ownership of the farm store motivates households to participate in sorghum contract farming as it is easier for farmers with the store to bulk sorghum produce awaiting collection by the contracting company.

Furthermore, most sampled households (57.92%) owned a bicycle, and 42.08% did not have one. Of the farmers owning bicycles, non-contracted and contracted were 41.73% and

58.27%, respectively. Out of farmers who did not own a bicycle, 76.24% were non-contracted, while 23.76% were contracted. The results revealed that households with bicycles were more inclined to participate in sorghum contract farming than households without. Ownership of a bicycle reduces the transportation cost of sorghum produce to the collection centers and makes it easier to access farm inputs.

Regarding wards, most farmers (60.00%) were from East Yimbo, 21.67% from West Sakwa, and 18.33% from North Sakwa. Out of farmers from East Yimbo, 52.50% were non-contracted, whereas 37.50% were contracted. Of the total farmers from North Sakwa, 34.09% were non-contracted, while 65.91% were contracted sorghum farmers. Of the total farmers from West Sakwa, 57.69% were non-contracted, whereas 42.31% were contracted.

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3.2 Econometric results

3.2.1 Determinants of Participation in contract farming

Binary logistic model fitness was conducted using pseudo-R square, P-value, and Log likelihood as indicators were taken into account. A pseudo-R square value should range between 0.20 to 0.40, and a p-value of less than 10% is considered good. The study had a pseudo-R square of 32.44%, Prob>chi^2=0.0000, and the Log-likelihood = -111.1154, meeting the minimum requirement of model fitness match.

Logistic regression was run to determine factors influencing participation in sorghum contract farming in Siaya County. The marginal effect results of the logistic regression model are presented in Table 7. Primary education level, gender, age of the household head, number of active household members, membership to farm group, distance to the main road in walking minutes, and bicycle and oxen ownership were found to positively influence participation in sorghum contract farming. Although the distance to the nearest extension agent office in walking minutes negatively influenced participation in sorghum contract farming.

Table 7: Marginal effects of the decision to participate in contract farming by sorghum farmers in Siaya County

Dependent				
Contract participation (0=No 1=Yes)		**Delta-method**		
Independent Variables	**dy/dx**	**Std. err.**	**z**	**P>z**
Education level of the household head				
(Base No Formal)				
Primary	0.22**	0.10	1.81	0.04
Post-Primary	0.12	0.11	0.97	0.30
Gender of the household (1=female 2=male)	0.14**	0.06	2.19	0.02
Age of the household head	0.01***	0.00	2.52	0.01
Number of active household members	0.03**	0.01	2.15	0.03

Number of inactive household members	0.01	0.02	0.61	0.54
Log Land Acres owned	0.00	0.06	0.02	0.99
Log Off-farm Income (KES)	0.01	0.01	1.08	0.28
Group Membership (0=No 1=Yes)	0.19***	0.06	3.00	0.00
Distance to nearest Extension Agent office in walking minutes	-0.00*	0.00	-1.60	0.10
Distance to nearest Main Road in walking minutes	0.00***	0.00	2.71	0.00
Distance to nearest farm input market in walking minutes	0.00	0.00	0.68	0.49
Farm Store ownership (0=No 1=Yes)	0.09	0.06	1.51	0.12
Bicycle Ownership (0=No 1=Yes)	0.21***	0.05	3.58	0.00
Oxen Ownership (0=No 1=Yes)	0.24***	0.08	2.85	0.00
Livestock (TLU)	-0.01	0.01	-1.07	0.28
Wards (East Yimbo base level)				
North Sakwa	0.27***	0.07	3,70	0.00
West Sakwa	0.06	0.07	0.85	0.39
Number of observations	240			
LR chi2(17)	0.0000			
Pseudo R2	0.3244			
Log-Likelihood	-111.1154			

*, **, *** represent significant level at 10%, 5%, 1% respectively

Household heads with at least acquired primary education have a 22% chance of participating in contract farming compared to heads without formal education (Table 7). This was significant at 5% $(\beta = 0.215; P = 0.04)$. The probable reason is that education imparts farmers with technical skills and knowledge to understand contract farming better. Educated farmers could comprehensively understand the terms and benefits of contract farming compared to less educated ones. Education enables farmers to read and understand contracts and make rational decisions to participate in contract farming. The results are similar to the findings by [19 20, 21, 22, 23, 24, 25,].

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The gender of the household head was significant at 5% $(\beta = 0.144; P = 0.02)$ and directly associated with sorghum contract participation. Male-headed households had about a 14% chance of joining contract farming compared to female-headed households. A plausible explanation is that male-headed households make major farm decisions relating to terms and implementation of the contract compared to female-headed households. The female-headed households are likely to consult widely before signing a contract contributing to their low level of participation. In addition, institutional and cultural factors unresponsive to women's needs disfavors women from participating in contract farming. Generally, there is unequal ownership of productive farm assets, which favors male over female farmers.The results are in agreement with the findings of [26, 27, 28, 25]

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The age of the household head significantly and positively influenced $(\beta = 0.01; P = 0.03)$ sorghum contract farming participation. An increase in the age of household head by one year increases the probability of participating in sorghum contract farming by 1%, holding other factors constant. The result implies the older the farmer, the higher the probability of participating in sorghum contract farming. Older farmers were more willing to participate in contracts than their younger counterparts. The positive sign of age was attached to a common correlation between age and production experience [29]. The reason is that older farmers may have more knowledge and experience in sorghum production. They can analyze and understand the technicalities of contracts and the possible benefits compared to younger farmers. Furthermore, older farmers are risk averse and are willing to engage in contract farming to reduce production and marketing risks. Older farmers have more social networks and thus can access agricultural information than young farmers. In addition, older farmers are more likely to participate in contract farming as most of them reside in rural areas considering agriculture as the main source of income, and may engage in opportunities they persived to benefit them [30]. The above results conformed to the findings of [18,26, 27, 20, 31, 28] who reported that age positively influences participation in contract farming.

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The number of active adults significantly influenced $(\beta = 0.005; P = 0.00)$ participation in sorghum contract farming. Therefore, increasing one active adult member in the household increased the probability of participating in sorghum contract farming by 0.5%, holding other factors constant. This implies that households with more active adult family members were more likely to engage in contract farming than those with fewer active adult members.The reason behind the finding is that active members provide labor for planting, weeding, and harvesting sorghum, thus increasing the chance of participating in sorghum contract farming.Family labor reduces hiring costs and raises farm profitability, making it cheaper to cultivate sorghum under contract farming [28]. This finding agreed with previous studies by [32, 33].

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Membership in a farmer group by a household positively and significantly influenced participation in sorghum contract farming $(\beta = 0.188; P = 0.00)$. Membership in a farm group by a household increases the probability of participating in sorghum contract farming by 18.8%. Households belonging to farmer groups were more likely to participate in sorghum contract farming than households not in groups. Households in farm groups can access financial resources such as credit for acquiring production inputs to participate in commercial production, and in farm group households could easily share agricultural information [30]. In addition, group membership ensures access to agricultural production resources and relevant information that increases social capital, confidence and motivates farmers to engage in contract farming [34]. Moreover, contracting companies prefer dealing with farmers in groups to individual farmers for easy management and accessibility. Lastly, group

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membership is a guarantee to contracts for members to comply with the terms of the contract. The results are consistent with the findings of [18; 35, 24, 21, 25].

Household residential home location to the nearest extension agent office in walking minutes was significant $(\beta = -0.004; P = 0.01)$and negatively associated with contract farming participation. An extra walking minute from the household homestead to the nearest extension agent office decreases the probability of participation in contract farming by 0.9% (Table 7). This shows that households nearer to the extension agent office were more likely to participate in sorghum contract farming than those far from the office. Households located near the extension agent office have easy access to agricultural production knowledge and market information from the office. Extension agents create awareness of the importance of participating in contract farming to households nearer to them, thus encouraging them to engage in contract farming. Furthermore, households nearer to the extension agent office also access extension services, demonstrations, training on better agricultural practices, and awareness of improved farm technologies which hasten the farmers' application of new technologies such as contract farming [36]. Findings were in agreement with [37,19, 28, 38, 39, 25].

Farmers' residential home location to the nearest main road in walking minutes was significant and positively associated with contract farming participation at a 1% significant level $(\beta = 0.02; P = 0.00)$. Additional walking minutes from the farmer's homestead to the main road increases the likelihood of participation in contract farming by 0.2%. Farmers far from the main road had higher chances of participating in contract farming than those near the main road. The results were contrary to the hypothesized sign. Longer distance from the main road motivates farmers to participate in contract farming to reduce transportation costs of acquiring inputs and accessing the output market. This is plausible because sorghum contractor facilitates farmers by delivering inputs and collecting sorghum produce near farmers' homesteads. The above results agreed with the findings of [27, 35]. The findings disagree with that of [40] who found distance to the main road is negatively associated with contract participation.

Furthermore, ownership of bicycles by the farmer was significant and positively associated with sorghum contract farming participation at 1% level $(\beta = 0.210; P = 0.00)$. Bicycle ownership by the farmer increased the chances of participation in contract farming by about 21%. This shows that farmers with bicycles have more chances of participating in contract farming than farmers without. This finding is because a bicycle is viewed as a means of transportation during planting, weeding, and harvesting. Besides, bicycle farmers could easily monitor their farms far from the homestead. The farmers also use bicycles to transport sorghum to collection centers, increasing their probability of participating in contract farming. Lastly, bicycles enable farmers to access farm inputs and agricultural information. The results obtained are in tandem with the findings of [41].

Ownership of oxen by the Farmer was significant and positively associated with contract farming participation at 1% significance level $(\beta = 0.238; P = 0.00)$. Farmers owning oxen have 24% more chances of participating in sorghum contract farming than farmers without oxen. This is because oxen are the main means of land preparation in the study area. For this reason, farmers who own oxen would not need to hire cultivation services from other farmers, thus reducing the cost of land preparation, and can cultivate on time for early planting. The results support the findings of [24, 41].

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The location of the farmers' homestead influenced contract farming participation positively. Famers in the North Sakwa ward were more likely to participate in contract farming than those in East Yimbo Ward. The reason is that farmers in East Yimbo practice watermelon production as an alternative enterprise due to their proximity to Lake Victoria.

4. CONCLUSION

The results of the binary logistic model showed that household head age, gender, primary education level, number of active members per household, group membership, farmers' residence location to the main road in walking minutes, ownership of oxen and bicycles by the household positively and significantly influence participation in sorghum contract farming. The household home location from the nearest extension agent in walking minutes was significant and negatively associated with contract farming participation. There is a need to encourage young farmers and female-headed households to participate in contract farming. Policies to be developed that promote youths' and women's empowerment in the agricultural sector in Kenya. Farmers are to be sensitized to form groups to enhance access to information on agricultural innovations. National and county governments should invest in physical infrastructure, such as roads, to improve access to agricultural information on new interventions.

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CONSENT

Data on consent was collected by authors to shows that the data was collected from willing and voluntary respondents at free will to give information on sorghum production. The is persevered by the authors

ETHICAL APPROVAL

We received ethical approval from the Egerton University Institutional scientific and ethics review committee, Kenya (Approval No: EUISERC/APP/208/2022). The National Commission for Science, Technology and Innovation (NACOSTI-KENYA) permit to conduct out research (Ref No:697736).

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