Asian Journal of Agricultural Extension, Economics & Sociology

Volume 41, Issue 11, Page 352-366, 2023; Article no.AJAEES.109443
ISSN: 2320-7027

Determinants of Participation in Contract Farming among Smallholder Sorghum Farmers in Bondo Sub-County

Reinhard Bonnke Onyango [a*], Job Kibiwot Lagat [a] and John Olwande [b]

[a] Department of Agricultural Economics and Agribusiness, Faculty of Agriculture, Egerton University, P.O. Box 536-20115, Egerton, Kenya.
[b] Tegemeo Institute of Agricultural Policy and Development, Egerton University, P.O. Box 536-20115, Egerton, Kenya.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2023/v41i112292

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/109443

Original Research Article

Received: 24/09/2023
Accepted: 01/12/2023
Published: 07/12/2023

ABSTRACT

Aims: This paper analyzed the socioeconomic and institution factors influencing participation in sorghum contract farming by smallholder farmers in Bondo, siaya county, Kenya. The study results are anticipated to encourage smallholder farmers to participate in sorghum commercialization rather than producing for subsistence.
Study Design: The study applied quantitative research design to determine factors that influences participation in sorghum contract farming by smallholder farmers.

**Corresponding author: E-mail: rbonnke90@gmail.com;*

Place and Duration of Study: The study was conducted in Bondo Siaya county Kenya. Targeted group were smallholder farmers producing sorghum either as contracted or non-contracted. The data was collected on sorghum production during 2020/2021 production year.
Methodology: A multistage sampling technique was used to sample 135 non-contracted and 105 contracted smallholder sorghum farmers for the study. The data was collected using semi-structured questionnaire which was pretest prior to actual data collection. Data collected was analyzed using t-statistics and chi-squire for the descriptive statistics. While econometric analysis applied logistic regression model to determine factors influencing smallholder farmers' participation in sorghum contract farming.
Results: 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 $(\beta = 0.090; P = 0.03)$, group membership $(\beta = 0.188; P = 0.00)$, distance to the nearest main road in walking minutes $(\beta = 0.021; P = 0.00)$, 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. In contrarily, distance to the nearest extension agent office negatively influence participation in sorghum contract farming $(\beta = 0.004; P = 0.01)$.
Conclusion: The results suggest the need to increase access to extension services, implement policies for empowering women and youths to engage in contract farming, sensitize farmers to form groups to enhance working collectively to acquire input and output market. 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

Sorghum is considered the firth most important cereal crop globally after maize, rice, wheat and barley Batista et al. [1]. Asian and Africa account for about 90 per cent of the total world sorghum production Munda et al. [2]. Africa is the largest producer of sorghum globally, accounting for 33 per cent of the total word sorghum production. Sorghum production in Africa dominates globally as there is suitable weather conditions favoring the production of sorghum Munda et al. [2]. Sorghum production is estimated at 61, 364,996T 26,280T and 135,000T globally, Africa and Kenya, respectively in 2021. In Kenya, sorghum production has declined from 159,877T to 135,000T from 2011 to 2021; sorghum acreage has declined from 254,125 to 197,403 hectares in the same period [3].

Sorghum is grown in arid and semi-arid areas in Kenya as an important food crop and drought resistant crop. Sorghum is capable of producing under unfavorable harsh conditions with unpredictable weather patterns Munda et al. [2]. Sorghum crop production contributes significantly to reducing of food insecurity, alleviating poverty, source of nutrition, and employment. In addition, sorghum crop is used as primary ingredient in the brewing of beer as malt. Also, sorghum is use in grain as sweet stalk in food and non-food sectors for manufacturing of products such as alcohol, citric acid, jiggery, maltdextrins, glucose, wax, biofuels, bread, gluten feed, edible oils syrups, sorbitol and modified starch Ratnavathi et al. [4]. The government of Kenya has implemented strategies to upgrade sorghum from traditional subsistence crop to a Traditional High-value Crop (THVC) to increase sorghum production in the county Kazungu et al. [5].

Sorghum is main source of livelihood to most of people in Kenya. It provides livelihood to about 3 million people in the county. Demand of sorghum is generally increasing from 275,000 T per year against production of 150, 000 T [6]. Sorghum has a higher production potential in Kenya arid and semi-arid areas, but if faces numerous challenges that lowers its production and productivity. Most of farmers in arid and semi-arid areas in Kenya depends on local sorghum seed variety, recycle seed, exchange of seed by farmers that has contributed to low yield and quality of sorghum produced by farmers Munda et al. [2]. Low sorghum production in arid and semi-arid areas is attributed to climate change as a result of droughts, unpredictable rainfall and salinity. Production of sorghum over the past years has stagnated as there is limited tolerant sorghum variety adapted for drought prone areas with constant changing weather patterns Njinju et al. [7], [6].

Contract farming involves different crops such as tobacco, sugarcane, tea, avocado, and coffee has been introduced in Kenya for improving production and productivity. Contract farming has also been introduced to cereal crops such as sorghum to meet high annual demand by the brewing company. Sorghum contract farming has stimulated sorghum production from subsistence to commercial production. 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 Musyimi et al. [8]. The low production levels and subsistence domestic production of sorghum makes it difficult for Kenya to meet the annual consumption and brewing company demand. Consequently, Kenya heavily relies on sorghum imports from neighboring countries such as Uganda, Tanzania, and Sudan to meet its domestic annual demand [9].

However, East African Breweries Limited (EABL) and some county governments of Kenya collaborated to promote 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) Wawire et al. [10]. 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 MT of annual demand for sorghum. The demand is expected to increase by double digits in the coming years [11].

Demand of sorghum is higher than domestic production in Kenya resulting to production deficit in the country. Thus, enlargement of production volumes and area is essential. A substantial increase in area under sorghum production requires equivalent increase in the number of farmers participating in sorghum production. Majority sorghum farmers are smallholder farmers. Hence, understanding the underlying factors influencing smallholder farmers' participation in sorghum contract farming is essential. However, few research has been steered in Kenya to evaluate factors influencing smallholder farmers' participation in sorghum contract farming in Kenya, even though the country is dominated by arid and semi-arid areas that makes it suitable for sorghum production. Currently, the existing research on sorghum focus on the challenges facing sorghum production in Kenya, determinants of sorghum productivity, side selling behavior, and determinants of sorghum participation Nyamamba et al. [12]; Okeyo et al. [13]. Consequently, there is a gap to determine factors influencing smallholder farmers' participation in sorghum contract farming that this study tend to fill.

2. METHODOLOGY

2.1 Study Area

The study was conducted in Bondo, Siaya, Kenya. Bondo sub-county was chosen based on extensive sorghum production in the region under contract farming compared to other sub-counties in Siaya.

2.2 Sample Size Determination and Sampling Procedure

The required sample size for the study was determined by proportionate-to-size sampling method as per the formula by Cochran as shown 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 as contracted or without contracts, q is weighting variable computed as $q = 1 - p = 1 - 0.8063 = 0.1937$, z representing critical value, which is 1.96 at 95 per cent 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;

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

Hence, 240 smallholder sorghum farmers were sampled for the study.

Multi-stage and stratified sampling techniques were used to compute the study sample. In the first stage, Bondo sub-county was purposively selected for the study based on the prominence of sorghum production level compared 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 highest number of sorghum famers in each ward were selected. In each selected village, sorghum farmers were stratified into two; contracted and non-contracted. A sample of 105 contracted and 135 non-contracted sorghum farmers were randomly selected from the strata. A proportionate –to-size approach was applied to determine the number of contracted and non-contracted farmers to sample from each village.

2.3 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 using a linear probability model (LPM), logit, and 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 [15].

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 influencing participation decision into sorghum contract farming, 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;

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

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:

$$prob\left(A_i = {}^{1}/_{X_i}\right) = \frac{1}{1+e^{-BX_i}} = \frac{e^{BX_i}}{1+e^{BX_i}} \quad (2)$$

Under a random sampling technique where all the observations of interest are sampled, the contribution of the i^{th} observation is written as

$$P_i^{A_i}(1 - P_i)^{1-A_i} \quad (3)$$

Therefore, the probability function is represented as; $L = \prod_i^n P_i^{A_i}(1 - P_i)^{1-A_i}$ (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 $logL = \sum_i^n A_i \beta X_i - \sum_i^n log(1 + e^{BX_I})$ (5)

In this model with the binary dependent variable, the parameter estimates βs were 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; $B_j P_i(1 - P_i)$ [16].

Empirical model specification participation in contract farming is denoted by;

$$A_i = \beta_0 + \beta_1 HHEduclevel + \beta_2 HHGender + \beta_4 HHAge + \beta_4 HHAge15to64 + \beta_5 HHAgeless15great64 + \beta_6 LandAcreage + \beta_7 OffarmIncome + \beta_8 GroupMembership + \beta_9 DistExtentAgentMins + \beta_{10} DistMainRoadMins + \beta_{11} DistInputMarket + \beta_{12} FarmStoreOwnership + \beta_{13} BicycleOwnership + \beta_{14} OxenOnwership + \beta_{15} AnimalAsset + \varepsilon_i \quad (6)$$

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.

Table 1. 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	The 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 2, and contingency coefficient results in Table 3. The mean VIF was 1.18, below the threshold level of 10 (Table 2). The mean VIF of 1.18 indicates no serious multicollinearity amongst the continuous explanatory variables in the model.

The CC values from Table 3 are less than 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 was obtained, indicate the absence of heteroscedasticity.

Table 2. 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**	

Table 3. 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 influencing smallholder farmers' participation in sorghum contract farming in Bondo sub-county are presented in Tables 4 (for continuous variables) and 5 (for categorical variables). Group comparisons for contracted and non-contracted sorghum farmers were conducted using a t-test for continuous variables and a chi-square for categorical variables.

An average age of the sorghum farmer household heads for the entire sample was 54 years. The mean age of household head for contracted and non-contracted sorghum farmers were 56 and 52 years, respectively (Table 4). The t-test result shows a statistically significant difference in age between the contracted and non-contracted sorghum farmers at a 5% significant level. As sorghum farmer household head grow older, they are more likely to participate in sorghum contract farming than their younger counterparts. The result was in line with the study hypothesized sign. Older farmers have experience in sorghum production and can analyze contract farming intervention concerning its benefits. Similar results were found by Bezabeh et al. [17] in malt barley contract farming.

The average number of active household members for the entire sample was 3 members. While, the average number of active household members for the contracted and non-contacted sorghum farmers were 4 and 3 members, 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 household members are more likely to participate in sorghum contract farming than those with fewer active household members.

Average land acreage owned by the entire sampled farmers was 3.78 acres. On average contracted and non-contracted sorghum farmers owned 4.06, and 3.54 acres, correspondently. The t-test result showed a 10% significant difference in land acreage owned by contracted and non-contracted sorghum farmers. Results show that farmers who owned larger land sizes are more inclined to participate in sorghum contract farming than those with smaller land sizes. A larger land size allows more land to be allocated to sorghum production under contract farming, thus increasing the chance of engaging in sorghum contract farming.

On average, the off-farm income earned for the entire sampled farmers was KES 28768.75 per annum. The mean off-farm income for contracted and non-contracted households were KES 41295 and KES 20804 per annum, respectively. The t-test result showed a statistical difference between the two groups in terms of off-farm income earned per annum at a 1% significant level. Farmers who earned more off-farm income per annum are more inclined to participate in sorghum contract farming than those with lower off-farm income earnings. Additional off-farm income earnings encourage smallholder farmers to participate in contracts as it enables them to acquire certified seed and quality inputs necessary in the production of sorghum under contract farming.

An average walking minutes to the nearest extension agent office was 160.35 minutes from the farmers' home of residence for the entire sample. The average walking minutes from the household residential to the nearest extension agent office for contracted and non-contracted sorghum farmers were 140.86 and 175.52

minutes, respectively. The t-test results indicate a statistical difference between the two groups in terms of residential location to the extension agent office in walking minutes at a 1% significant level.

However, the average livestock ownership in tropical livestock units (TLU) for the entire sampled farmers was 3.53. Average livestock holding for non-contracted and contracted were 4.31 and 2.92, respectively. The t-test result was statistically significant at a 1%, indicating that households with more livestock TLU are more likely to participate in sorghum contract farming than their counterparts. A study by Bezabeh et al. [17] supports the above findings.

Descriptive statistics on categorical variables influencing participation of stallholder farmers in sorghum contract farming are presented in Table 5. 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 farmers were male-headed households 68.33%, and female-headed were 31.67%. Amongst the total male-headed household, non-contracted and contracted were 49.39% and 50.61%, respectively. In contrast, of the total female-headed households non-contracted and contracted sorghum farmers were 71.05% and 28.95%. 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 likely to participate 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 engaging more in domestic activities.

Majority of the sampled sorghum farmers' household heads (63.75%) had attained primary education, 27.08% post-primary and 9.17% no formal education. Of the total sorghum farmers with primary education level, 54.90% of them were non-contracted and 45.10% were contracted. The overall household head with post-primary education levels 49.23% were non-contracted and 50.77% were contracted sorghum farmers. Total household head with no formal education 86.36% of them were non-contacted and 13.64% were contracted sorghum farmers. A chi-square test for education level against contract farming participation was significant at a 1%. This shows that there was a significant difference amongst contracted and non-contracted sorghum farmers in terms of education level. This indicates a low level of participation in sorghum contract farming by the household heads with no formal education compared to those who have at least acquired formal education.

Nevertheless, of the total sampled sorghum farmers' majority (64.17%) belongs to farmer group and 35.83% did not belong to any farmer group. Of the total sampled sorghum farmers who belong to farmer group, most of them 54.55% were contracted while 45.45% were not contracted. Out of total the smallholder farmers who did not belong to farmer group, majority of them (75.58%) were non-contracted, and 24.42% were contracted. Sorghum farmers who belong to the farmer group are inclined to participate in sorghum contract farming compared to those not in the farmer group. In groups, farmers could easily access information about new farm interventions such as contract farming, farming technologies, access to input and output markets Bezabeh et al. [17].

In terms of oxen ownership, most sampled sorghum farmers (85.42%) did not own oxen, and only 14.58% owns oxen. Of the total sorghum farmers who did not owned oxen, majority of them 61.95% were non-contracted and 38.05% were contracted. Conversely, of the total sorghum farmers with oxen majority of them 77.14% were contracted and 22.86% were non-contracted sorghum farmers. Farmers with oxen were more driven to participate in sorghum contract farming than those without. Oxen is the main form of land preparation by most of the farmers in the study area, and farmers who own oxen could timely cultivate as required by the contracting company.

Concerning farm store ownership, most sampled sorghum farmers (67.50%) did not own farm store, while 32.50% owned farm store. Of the total farmers without farm stores, majority of them 66.05% were non-contracted, while 33.95% were contracted sorghum farmers. Of the total farmers with farm stores, most of them 64.10% were contracted and 35.90% were non-contracted sorghum farmers. Farmers with farm store are more agitated to engage in sorghum contract farming than those without. Possession of farm store motivates farmers 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.

Table 4. 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	20803.7	52664.17	41295.24	70092.79	28768.75	61617.58	-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
Distance to the nearest input market in walking minutes	95.15	82.66	100.38	87.59	97.44	84.71	-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.*

Table 5. 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	
	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*

Table 6. Marginal effects of the decision to participate in contract farming by sorghum farmers in Bondo sub-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*

Additionally, most of the sampled sorghum farmers, 57.92% owned a bicycle, and 42.08% did not have. Of the total farmers possessing bicycles majority of them 58.27% were contracted and 41.73% were non-contracted sorghum farmers. Out of the total farmers without a bicycle, majority of them 76.24% were non-contracted, while 23.76% were contracted sorghum farmers. The results revealed that households with bicycles are more likely to participate in sorghum contract farming than households without. Possession of a bicycle reduces the transportation cost of sorghum produce to the collection centres and makes it easier to access farm inputs for sorghum production.

In terms of wards in Bondo sub-county, majority of sorghum farmers 60.00% were from East Yimbo, 21.67% from West Sakwa, and 18.33% from North Sakwa. Out of the total farmers from East Yimbo, majority of them 52.50% were non-contracted, and 37.50% were contracted sorghum farmers. 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.

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 smallholder farmers' participation in sorghum contract farming in Bondo sub-county. The marginal effect results of the logistic regression model are presented in Table 6. 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. Conversely, distance to the nearest extension agent office in walking minutes from farmer residential home had a negative influence on participation in sorghum contract farming.

Farmer household heads who at least have acquired primary education have a 22% chance of participating in sorghum contract farming compared to heads without formal education (Table 6). 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 finding is similar to the results by [18

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 favours male over female farmers. The results are in agreement with the findings of Bogle et al. [25], Fendi et al. [26], Hirpesa et al. [27], Ronchi et al. [24].

Age of the household head significantly and positively influence ($\beta = 0.01; P = 0.03$) 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 that the older the farmer, the higher the probability of participating in sorghum contract farming. Older farmers were more willing to participate in sorghum contracts than their younger counterparts. The positive sign of age was attached to a common correlation between age and production experience Akumu et al. [28]. 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 livelihood, and they engage in opportunities they perceived to be beneficial to them Kimbi et al., [29]. The above results conformed to the findings of Bezabeh et al. [17], Bogle et al. [25], Fendi et al. [26], Jagri et al. [19], Johnny et al. [30], Hirpesa et al. [27] who reported that age positively influences participation in contract farming.

Number of active adult household members had a significant influenced $(\beta = 0.005; P = 0.00)$ on participation in sorghum contract farming. Therefore, additional active adult member by one 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 labour for planting, weeding, and harvesting sorghum, thus increasing the chance of participating in sorghum contract farming. Family labour reduces hiring costs and raises farm profitability, making it cheaper to cultivate sorghum under contract farming Akumu et al. [28]. The study findings were in agreement with the findings of [31], Taslim et al [32].

Belonging to farmer group by smallholder farmers had a positively influence on participation in sorghum contract farming $(\beta = 0.188; P = 0.00)$ in the study area. Smallholder farmers who belongs to farmer group had 18.8% likelihood of participation in sorghum contract farming compared to their counterparts who were not in farmer group. Smallholder farmers who belong to farmer groups can easily access financial resources and credit for acquiring quality production inputs for improving sorghum quality production as required by contracting company. Also, in farmer group smallholder farmers easily acquire new information on sorghum production and interventions such as contract farming Kimbi et al. [29]. In addition, smallholder farmers in farmer group are networked and linked to various stakeholders in sorghum value chain such as input providers, marketers such as contracting companies Rokhani et al. [33]. Contracting companies usually prefer dealing with farmers in groups compared to individual farmers for easy management and accessibility. Lastly, group membership is a guarantee to contracts for members to comply with the terms of the contract. The results are consistent with the findings of Bezabeh et al. [17] [34], [23], Kena et al. [20], Rondhi et al. [24].

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 6). 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 Ndossi et al., [35]. Findings were in agreement with Ganewa et al. [36], [18], Herpes et al. [27], [37], [38], Rondhi et al. [24].

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 Fendi et al. [26], [34]. The findings disagree with that of [39] 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 a 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 centres, 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 [40].

Ownership of oxen by the Farmer was significant and positively associated with contract farming participation at a 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 [23, 40].

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

Sorghum contract farming was mainly dominated by old and male farmers. There is need to empower youths and female through sensitization and favorable policies to encourage them to engage in contract farming for self-employment creation. Majority of the smallholder sorghum farmers were found not to belong to farm groups. There is need to employ more extension official to reach farmers and train them in the importance of working collectively in groups for acquiring inputs and marketing produce as a group for more market bargaining power. National and county government to fund development of more roads in rural area to enable farmers easily access farm inputs and new farm interventions. Lastly, most of farmers were found not to own basic agricultural assets such as bicycle, oxen and farm store. National and county government to provide credits and rural development funds at affordable interest rates to farmers to enable them acquire necessary farm inputs and equipment.

CONSENT

Data on consent was collected by authors to show that the data was collected from willing and voluntary respondents of free will to give information on sorghum production. This 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).

ACKNOWLEDGEMENTS

The authors thank sorghum farmers, extension officers, and East African brewers for their support and information.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Batista PS, Carvalho AJ, Portugal AF, Bastos EA, Cardoso MJ, Torres LG, Júlio MM, de Menezes CB. Selection of sorghum for drought tolerance in a semiarid environment. Genetics and molecular research. 2019;18(1):1-1.

DOI:http://dx.doi.org/10.4238/gmr18194.
2. Mundia CW, Secchi S, Akamani K, Wang G. A regional comparison of factors affecting global sorghum production: The case of North America, Asia and Africa's Sahel. Sustainability. 2019 Apr 10;11(7):2135. Available:https://doi.org/10.3390/su11072135
3. FAOSTAT; 2023. Available:https://www.fao.org/faostat/en/#data/QCL
4. Kazungu FK, Muindi EM, Mulinge JM. Overview of Sorghum (Sorghum bicolor. L), its Economic Importance, Ecological Requirements and Production Constraints in Kenya. International Journal of Plant & Soil Science. 2023:35(1):62-71. Available:https://doi.org/10.9734/ijpss/2023/v35i12744
5. Ratnavathi CV, Patil JV, Chavan UD. Sorghum Biochemistry an Industrial Perspective. Science Direct: Sorghum Biochemistry. 2016;63-105
6. Food and Agriculture Organization (FAO). Index Mundi Statistics. USDA sorghum statistics; 2019.
7. Njinju SM, Gweyi JO, Mayoli RN. Drought-Resilient Climate Smart Sorghum Varieties for Food and Industrial Use in Marginal Frontier Areas of Kenya. InAgriculture, Livestock Production and Aquaculture: Advances for Smallholder Farming Systems. 2022 Apr;2(29):33-44. Cham: Springer International Publishing.
8. Musyimi D, Ouma EO, Auma EO, Too EJ, Ngode L, Kamau CK, Gudu S. Effect of ridging and intercropping on sorghum productivity in arid and semi-arid lands of eastern Kenya. African Crop Science Journal. 2022;30(1):87-100. Available:https:// 10.4314/acsj. v30i1.7
9. Kiambi D, Mugo L. Seed systems and Value Chains in Kenya: Case study on sorghum and cowpeas. ISSD and ABCIC; 2016.
10. Wawire NW, Bett C, Ruttoh RC, Wambua J, Omari FG, Kisilu R, Ketiem P. The Status of Agricultural Mechanization in Kenya; 2016. Available:https://d1wqtxts1xzle7.cloudfront.net/76461233/kafaci_report-libre.pdf?1639634894=&response-content
11. EABL; 2018. Available:https://www.eabl.com/sites/default/files/eabl sorghum research_compressed-compressed1_1_1.pdf.
12. Nyamamba JS, Ayuya OI, Sibiko KW. Determinants of side selling behaviour in emerging sorghum supply chains in Kisumu County, Kenya. Cogent Economics & Finance. 2022 Dec 31;10(1):1986932. Available:https://doi.org/10.1080/23322039.2021.1986932
13. Okeyo SO, Ndirangu SN, Isaboke HN, Njeru LK, Omenda JA. Analysis of the determinants of farmer participation in sorghum farming among small-scale farmers in Siaya County, Kenya. Scientific African. 2020 Nov 1;10:e00559. Available:https://doi.org/10.1016/j.sciaf.2020.e00559
14. Cochran WG. Sampling Techniques (2nd Ed.). New York: John Wiley and Sons, Inc; 2014.
15. Wooldridge JM. Correlated Random Effects Models with Unbalanced Panels. Michigan State University, Department of Economics; 2013.
16. Greene WH. Accounting for excess zeros and sample selection in poisson and negative binomial regression models; 1994
17. Bezabeh A, Belene F, Haji J, Lemma T. Impact of contract farming on income of smallholder malt barley farmers in Aris and West Aris zones of Oromia region, Ethiopia. Cogent Food & Agriculture. 2020;6(1): 1834662. Available:https://doi.org/10.1080/23311932.2020.1834662
18. Hegena B, Teshome A. Vegetable market supply by small holder farmers in Ethiopia. Cogent Social Sciences. 2022;8(1): 2057058. Available:https://doi.org/10.21776/ub.agrise.2021.021.2.2
19. Jagri Binpori R, Awunyo-Vitor D, Wongnaa CA. Does contract farming improve rice farmers' food security? Empirical evidence from Ghana. World Journal of Science, Technology and Sustainable Development. 2021;18(2):130-149. Available:https://www.emerald.com/insight/2042-5945.htm.
20. Kena D, Golicha D, Jemal E, Kanu B, Gayo G. Smallholder dairy producers' participation in dairy marketing in Southern Omo Zone, Ethiopia. Pastoralism. 2022; 12(1):48. Available:https://doi.org/10.1186/s13570-022-00262-4
21. Loquias MP, Digal LN, Placencia SG, Astronomo IJT, Orbeta MLG, Balgos CQ. Factors affecting participation in contract

farming of smallholder cavendish banana farmers in the Philippines. Agricultural Research. 2022;11:146–154.
Available: https://doi.org/10.1007/s40003-021-00544-0

22. Lush YH. Inclusiveness of contract farming along the modern food supply chain: Empirical evidence from Taiwan. Agriculture. 2020;10(5):187.
Available:https://doi.org/10.3390/agriculture10050187
23. Kedir Feyiso, A. Impact of Contract Farming on Smallholder Malt Barley Farmers' income in Lemu Bilbilo District, Arsi Zone, Oromia National Regional State, Ethiopia (Doctoral dissertation, Haramaya university); 2023.
Available:http://hdl.handle.net/10353/21533
24. Rondhi M, Aji JMM, Hasan AF, Yanuarti R. Factors affecting farmers' participation in contract farming: The case of broiler sector in Indonesia. Tropical Animal Science Journal. 2020;43(2):183-190.
Available:https://doi.org/10.5398/tasj.2020.43.2.183
25. Bogle TM, Mehari AP, Bekele KP. Determinants of Smallholder Farmers Participation Decision and Volume of Milk Supply in Girard Jars District, North Shewa Zone, Oromia Region, Ethiopia (Doctoral dissertation); 2022.
Available:http://ir.haramaya.edu.et/hru/bitstream/handle/123456789/4942/Teferi%20BogaleDechasa.pdf? sequence=1
26. Fendi GB, Assefa FD, WAK tola AT. Impact of Sugarcane out grower Scheme on Income of Participating Households: empirical evidence around Wanja/Shao Sugar Factory, Ethiopia; 2o22.
Available:https://doi.org/10.21203/rs.3.rs-295364/v1
27. Hirpesa M, Legesse B, Haji J, Bekele K. Determinants of participation in contract farming among smallholder dairy farmers: the case of North Shewa Zone of Oromia National Regional State, Ethiopia. Sustainable Agriculture Research. 2021; 10(526-2021-493):10-19.
Available:
https://doi.org/10.5539/sar.v10n1p10.
28. Akumu J, Odongo W, Mignola B. Determinants of contract farming for smallholder sunflower producers in northern Uganda. African Crop Science Journal. 2020;28(4):585-594.
Available:https:doi.org/10.4314/acsj.v28i4.8 10.4314/acsj.v28i4.8
29. Kimbi T, Mishili F, Sieber S, Akpo E, Magomba C. Factors influencing brewery contract farming participation among sorghum farmers in selected districts in Dodoma, Tanzania, a logit analysis approach; 2022.
Available:http://www.suaire.sua.ac.tz/handle/123456789/4748
30. Johnny EG, Mariara JK, Mulwa R, Ruigu GM. Smallholder avocado contract farming in Kenya: determinants and differentials in outcomes. African Journal of Economic Review. 2019;7(2): 91-112.
Available:https://www.ajol.info/index.php/ajer/article/view/188379
31. Soullier G, Moustier P. Impacts of contract farming in domestic grain chains on farmer income and food insecurity. Contrasted evidence from Senegal. Food Policy. 2018;79:179-198.
Available:https://doi.org/10.1016/j.foodpol.2018.07.004
32. Taslim A, R Karim MS, Rahman M. Factors Influencing Participation of Farmer in Contract Farming in Narsingdi District of Bangladesh; 2021.
Available:10.9734/ajaees/2021/v39i1130785
33. Rokhani R, Rondhi M, Kuntadi EB, Aji JMM, Suwandari A, Supriono A, Hapsari TD. Assessing determinants of farmer's participation in sugarcane contract farming in Indonesia. AGRARIS: Journal of Agribusiness and Rural Development Research. 2020;6(1):12-23.
Available:doi:https://doi.org/10.18196/agr.6187
34. Hoang V, Nguyen V. Determinants of small farmers' participation in contract farming in developing countries: A study in Vietnam. Agribusiness; 2023.
Available:https://doi.org/10.1002/agr.21795
35. Ndossi J, Akpo E, Ojiewo CO, Ringo J, Kongola E, Vernooy R, Varshney R. Delineating investment opportunities for stakeholders in sorghum seed systems: a logit model perspective. Agriculture & Food Security. 2021;10:1-13.
Available:https://doi.org/10.1186/s40066-021-00306-9
36. Ganewa Z, Baluga T, Alemu A, Mulugetta, M, Legesse T, Kanske D, Asheboro A. Are smallholder farmers benefiting from malt barley contract farming engagement in

Ethiopia? Agriculture & Food Security. 2022;11(1):1-19.
Available:https://doi.org/10.1186/s40066-022-00396-z

37. Mounirou I. Does participation in contracts affect agricultural income? An empirical evidence from parboiled rice farmers in central Benin. Cogent Food & Agriculture. 2020;6(1).
Available:1800237.https://doi.org/10.1080/23311932.2020.1800237

38. Nazifi B, Hussaini YI. Determinants of participation in contract farming among smallholder maize farmers in North-Western Nigeria. Acta Scientiarum Polonium. Agricultural. 2021; 20(4).
Available:https://doi:10.37660/aspagr.2021.20.4.2

39. Ziyadhuma P. Analysis of Factors Influencing Smallholder Farmers 'participation in Tobacco Contract Farming and Its Impact on Land Productivity. A Case of Hurungwe District, Mashonaland West Province, Zimbabwe; 2020.
Available:http://publication.aercafricalibrary.org/xmlui/bitstream/handle/123456789/1272/Prosper%20Ziyadhuma%20Msc%20Economics%20thesis%202020%20%28002%29.pdf? sequence=1&isAllowed=y

40. Nsimbila PM. Determinants of Contract Farming Adoption and its Impact on Productivity of Smallholder Cotton Producers in Tanzania. International Journal of Social and Administrative Sciences. 2021;6(2)55-69.
Available:https://doi.org/10.18488/journal.136.2021.62.5.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/109443