

Determinants of participation in contract farming among smallholdersorghum farmers in Bondo sub-county

ABSTRACT

Aims: This paper aimed at analyzing 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.

Place and Duration of Study: The study was conducted in Bondo Siaya county Kenya. Targeted group were smallholder sorghum farmers either 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-square for the descriptive statistics. While econometric analysis applied logistic regression model to determine factors influencing smallholder sorghum 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 sorghum contract significantly and negatively ($\beta = 0.004; P = 0.01$).

Conclusion: The results suggest the need to increase access to extension services, implement policies for empowering women and youths to engage in contract farming 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.

Keyword's: Participation, Contract farming, Sorghum, binary logit, smallholder farmers, Kenya.

1. INTRODUCTION

Sorghum is considered the firth most important cereal globally after maize, rice, wheat and barley Batista *et al.* [1]. Asian and Africa account for about 90 percent of the total world sorghum production Munda *et al.* [2]. Africa is the largest producer of sorghum globally, accounting for 33 percent of the total word sorghum production. Sorghum production in Africa dominates globally as there is suitable weather conditions favoring the growth 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 159877T to 135000T from 2011 to 2021; sorghum acreage has declined from 254,125 to 197,403 hectares in the same period [3].

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

27 Sorghum is main source of livelihood to most of people in Kenya. It provides livelihood to about 3 million
28 people in the county. Demand of sorghum is generally increasing from 275,000 T per year against
29 production of 150, 000 T [6]. Sorghum has a higher production potential in Kenya arid and semi-arid
30 areas, but it faces numerous challenges that lowers its production and productivity. Most of farmers in
31 arid and semi-arid areas in Kenya depends on local sorghum seed variety, recycle seed, exchange of
32 seed by farmers that has contributed to low yield and quality of sorghum produced by farmers Munda *et al.*
33 [2]. Low sorghum production in arid and semi-arid areas is attributed to climate change resulting in
34 droughts, unpredictable rainfall and salinity. Production of sorghum over the past years has stagnated as
35 there is limited tolerant sorghum variety adapted for drought prone areas with constant changing weather
36 patterns Njinjuet *al.*[7], [6]

37 Contract farming involves different crops such as tobacco, sugarcane, tea, avocado, and coffee has been
38 introduced in Kenya for improving production and productivity. Contract farming has also been introduced
39 to cereal crops such as sorghum due to the brewing industry high demand for the crop. The major
40 constraints to sorghum commercialization in Kenya are low production and inadequate marketing
41 channels. Farmers mainly produce sorghum for household consumption, with only a small portion of the
42 total output sold Musyimi *et al.*[8]. The low production levels and subsistence domestic production of
43 sorghum makes it difficult for Kenya to meet the consumption and industrial demand. Consequently, the
44 Kenya heavily relies on sorghum imports from neighboring countries such as Uganda, Tanzania, and
45 Sudan to meet its domestic demand [9].

46 However, East African Breweries Limited (EABL) and some county governments of Kenya collaborated to
47 promote sorghum production under contract farming [9]. The EABL Company has contracted about
48 30,000 farmers in Western and Eastern Kenya to meet its annual demand of 22 MT of sorghum. The
49 EABL mobilizes and sensitizes farmers on the importance of contract farming. The company conducts
50 farmer training, provides inputs on credit to farmers, and buys sorghum from contracted farmers. It does
51 this in collaboration with the Ministry of Agriculture, Livestock, Fisheries and Irrigation (MoALF& I), Equity
52 Bank, Kenya Arid and Semi-Arid Lands (KASAL) project, Kenya Agriculture and Livestock Research
53 Organization (KALRO), Smart Logistics Ltd and European Cooperation for Rural Development
54 (EUCORD) Wawireet *al.* [10]. The EABL Company anticipates contracting 45 000 farmers to produce
55 sorghum, but only 30,000 farmers have been contracted in Western and Eastern Kenya to meet the
56 20,000 MT of annual demand for sorghum. The demand is expected to increase by double digits in the
57 coming years [11].

58 Demand of sorghum is higher than domestic production in Kenya resulting to production deficit in the
59 country. Thus, enlargement of production volumes and area is crucial. A substantial increase in area
60 under sorghum production requires equivalent increase in the number of farmers participating in sorghum
61 production. Most of farmers engaging in sorghum production in Kenya are smallholder farmers. Hence,
62 understanding the underlined factors influencing participation in sorghum contract farming is essential.
63 However, few research has been steered in Kenya to evaluate factors influencing smallholder farmers'
64 participation in sorghum contract farming in Kenya, even though the country is dominated by arid and
65 semi-arid areas that makes it suitable for sorghum production. Currently, the existing research on
66 sorghum focus on the challenges facing sorghum production in Kenya, determinants of sorghum
67 productivity, side selling behavior, and determinants of sorghum participation Nyamamba *et al.* [12];

68 Okeyoet *al.* [13]. Consequently, there is a gap to determine factors influencing smallholder farmers'
69 participation in sorghum contract farming that this study tend to fill.

70 2. Methodology

71 2.1 Study Area

72 The study was conducted in Bondo, Siaya, Kenya. Bondo sub-county was chosen because of the
73 extensive sorghum production in the region under contract farming compared to other sub-counties in
74 Siaya.

75 2.2 Sample size Determination and Sampling Procedure

76 Sampling is a selection of a subset of the population of interest in a research study. At the same time, a
77 sample size is a subset to represent the entire population of interest. The required sample size for the
78 study was determined by proportionate to size sampling method as per the formula by Cochran as shown
79 in the below.

$$80 \quad n = \frac{z^2 pq}{e^2}$$

81 Where n is the required sample size for the study, p is the proportion of sorghum farmers in Bondo sub-
82 county. Data obtained from Bondo sub-county agricultural office showed that 80.63% of the smallholder
83 farmers in Bondo sub-county produced sorghum either as contracted or without contracts, q is weighting
84 variable computed as $q = 1 - p = 1 - 0.8063 = 0.1937$, z representing critical value, which is 1.96 at 95
85 percent confidence interval and e indicates allowable error term. According to [14] an error of less than
86 10% is usually acceptable; hence the study used an error of 5%. The computation of the sample size for
87 the study was expressed as follows;

$$88 \quad n = \frac{z^2 pq}{e^2} = \frac{1.96^2 \times 0.8063 \times 0.1937}{0.05^2} = 239.99 = 240$$

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

90 Multi-stage and stratified sampling techniques were used to compute the study sample. In the first stage,
91 Bondo sub-county was purposively selected for the study based on the prominence of sorghum
92 production level compared to other sub-counties in Siaya county. In the second stage, East Yimbo, North
93 Sakwa, and West Sakwa wards were purposively selected based on the high number of sorghum farmers
94 compared to West Yimbo, Central Sakwa, and South Sakwa wards. In the third stage, two villages with
95 the highest number of sorghum farmers in each ward were selected. In each selected village, sorghum
96 farmers were stratified into two; contracted and non-contracted. A sample of 105 contracted and 135 non-
97 contracted sorghum farmers were randomly selected from the strata. Proportionate to size approach was
98 applied to determine the number of contracted and non-contracted farmers to sample from each village.

99 2.3 Analytical framework

100 The decision to participate in sorghum contract farming is a binary variable, taking 1 for contracted and 0
101 for non-contracted farmers. Modeling such a binary response variable is often done using a linear
102 probability model (LPM), logit, and probit model. The LPM has weaknesses that the resulting probability
103 predictions are not necessarily bounded in the unit interval, as it can be less than zero or greater than
104 one. Also, LPM implies a constant marginal effect for all the explanatory variables used in the model.
105 Logit and probit models overcome the above drawbacks of LPM. Logit model was chosen over probit
106 model as it is easier to interpret than probit model. Logistic regression is interpreted as the marginal
107 effects [15].

108 Logistic regression model can be expressed as follows;

109 $A_i^* = \beta_i X_i + u_i$, where A_i^* a latent response variable β_i is the coefficient of the parameter estimate, X_i
110 is a vector for explanatory variables influencing participation decision into sorghum contract farming, and

111 U_i is the error term. In practice, A_i^* is unobserved. In this case, we observe only a dummy variable
 112 defined as; $A_i = \{ 1 \text{ if } A_i^* > 0 \text{ contract farming and } 0 \text{ if } A_i^* < 0 \text{ otherwise} \}$.

113 The probability of participation in contract farming is denoted as;

114 $\text{prob}(A_i = 1) = \text{prob}(A_i^* > 0) = \text{prob}(\mu_i > -\beta X_i) = 1 - F(-\beta X_i) = F(\beta X_i) \quad (1)$

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

118 $\text{prob}\left(A_i = \frac{1}{X_i}\right) = \frac{1}{1 + e^{-\beta X_i}} = \frac{e^{\beta X_i}}{1 + e^{\beta X_i}} \quad (2)$ Under a random sampling technique where all the

119 observations of interest are sampled, the contribution of the i^{th} observation is written as $P_i^{A_i} (1 - P_i)^{1 - A_i}$
 120 (3)

121 Therefore, the probability function is represented as; $L = \prod_i P_i^{A_i} (1 - P_i)^{1 - A_i} \quad (4)$

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

123 $\log L = \sum_i A_i \beta X_i - \sum_i \log(1 + e^{\beta X_i}) \quad (5)$

124 In this model with binary dependent variable, the parameter estimates of β s was estimated through
 125 maximum likelihood and the marginal effect computed as; $\frac{dp_j}{dX_j}$ which gives the rate of change in the

126 probability as a result of a small change in the dependent variable and given as; $B_j P_i (1 - P_i)$ [16].

127 Empirical model specification

128 Participation in contract farming is denoted by;

129

130 $A_i = \beta_0 + \beta_1 \text{HHEduclvl} + \beta_2 \text{HHGender} + \beta_4 \text{HHAge} + \beta_4 \text{HHAge15to64} + \beta_5 \text{HHAgeless15great64} +$
 $+ \beta_6 \text{LandAcreage} + \beta_7 \text{OfffarmIncome} + \beta_8 \text{GroupMembership} + \beta_9 \text{DistExtentAgentMins} +$
 $+ \beta_{10} \text{DistMainRoadMins} + \beta_{11} \text{DistInputMarket} + \beta_{12} \text{FarmStoreOwnership} + \beta_{13} \text{BicycleOwnership} +$
 $\beta_{14} \text{OxenOwnership} + \beta_{15} \text{AnimalAsset} + \varepsilon_i \quad (6)$

131 where $A = 1$ for the contracted farmer and 0 otherwise, β_1 to β_{15} are the parameter estimates of the

132 variables and ε_i is the error term.

133 **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	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	+

134
135 Multicollinearity and heteroscedasticity tests were conducted before running a logistic regression model
136 on variables influencing participation in sorghum contract farming for consistency and reliability of the
137 results. The continuous explanatory variables were tested for multicollinearity using the variance inflating
138 factor (VIF) and contingency coefficient (CC) method for categorical variables. Multicollinearity test results
139 are presented in Table 2, and contingency coefficient results in Table 3. The mean VIF was 1.18, below
140 the threshold level of 10 (Table 2). The mean VIF of 1.18 indicates no serious multicollinearity amongst
141 the continuous explanatory variables in the model.

142 **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	

143 The CC values from Table 3 are less than 0.5, indicating no serious level of multicollinearity amongst the
144 categorical explanatory variables. In addition, the heteroscedasticity test was conducted using the Brush-
145 Pagan test. The chi-square value of 21.24 and p-value of 0.8151 was obtained, indicate the absence of
146 heteroscedasticity.

147 **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

148

149 **3. RESULTS AND DISCUSSION**

150 **3.1 Descriptive statistics**

151 **3.1.1. Socioeconomic characteristics of contracted and non-contracted sorghum farmers**

152 The summary statistics on selected socio-economic and institutional factors influencing participation in
 153 sorghum contract farming in Bondo sub-county are presented in Tables 4(for continuous variables) and 5
 154 (for categorical variables). Group comparisons for contracted and non-contracted sorghum farmers were
 155 conducted using a t-test for continuous variables and a chi-square for categorical variables.

156 **Table 4: Differences in selected socio-economic characteristics of contracted and non-contracted**
 157 **sorghum-producing farmers in Siaya county (continuous variables)**

Variables	Non-contracted n=135		contracted n=105		Pooled n=240		Mean Differences	t-statistics
	Mean	SD	Mean	SD	Mean	SD		
Age of the household head	52.06	15.78	56.2	12.5	53.8	14.5	-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	3.7	.17	5.24	2.79	8.75	7.58	**	
Distance to the nearest main road in walking minutes	175.5	96.37	140.	80.1	160.	160.	34.66***	2.97
Distance to the nearest input market in walking minutes	2	96.37	86	5	35	91.1		
Livestock (TLU)	23.96	30.32	1	6	6	7	1.14	0.27
	95.15	82.66	38	9	4	1	-5.23	-0.47
	2.92	4.14	4.31	3.51	3.53	3.93	-1.38***	-2.74

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

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

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

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

180 On average, the off-farm income earned for the entire sampled farmers was KES 28768.75 per annum.
181 The average off-farm income for contracted and non-contracted households were KES 41295 and KES
182 20804 per annum, respectively. The t-test result shows a statistical difference between the two groups in
183 terms of off-farm income earned per annum at a 1% significant level. Farmers who earned more off-farm
184 income per year are more inclined to participate in contract farming than those with lower off-farm income
185 earnings. A higher level of off-farm income earnings encourages farmers to participate in sorghum
186 contracts as they acquire certified seed and quality inputs necessary in the production of sorghum by the
187 contracting company.

188 Average walking minutes to the nearest extension agent office was 160.35 minutes from the farmers'
189 home of residence for the entire sample. The average walking minutes from the household residential to
190 the nearest extension agent office for contracted and non-contracted sorghum farmers were 140.86 and
191 175.52 minutes, respectively. The t-test results indicate a statistical difference between the two groups in
192 terms of residential location to the extension agent office in walking minutes at a 1% significant level.

193 However, the average livestock ownership in tropical livestock units (TLU) for the entire sampled farmers
194 was 3.53. Average livestock holding for non-contracted and contracted were 4.31 and 2.92, respectively.
195 The t-test was statistically significant at 1%, indicating that households with more livestock TLU are more
196 likely to participate in sorghum contract farming than their counterparts. A study by *Bezabehet al.* [17]
197 supports the above findings.
198

199 **Table 5: Differences in selected socio-economic characteristics of contracted and non-contracted sorghum-producing households**
 200 **(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	9.90***
	Male	164	68.33	81	49.39	83	50.61	
Education level of the household head	No formal	22	9.17	19	86.36	3	13.64	9.52***
	Primary	153	63.75	84	54.90	69	45.10	
	Post-Primary	65	27.08	32	49.23	33	50.77	
Group membership	No	86	35.83	65	75.58	21	24.42	20.35***
	Yes	154	64.17	70	45.45	84	54.55	
Oxen ownership	No	205	85.42	127	61.95	78	38.05	18.57***
	Yes	35	14.58	8	22.86	27	77.14	
Farm store ownership	No	162	67.50	107	66.05	55	33.95	19.45***
	Yes	78	32.50	28	35.90	50	64.10	
Bicycle ownership	No	101	42.08	77	76.24	24	23.76	28.31***
	Yes	139	57.92	58	41.73	81	58.27	
Wards	East Yimbo	144	60.00	90	52.50	54	37.50	11.11***
	North Sakwa	44	18.33	15	34.09	29	65.91	
	West Sakwa	52	21.67	30	57.69	22	42.31	

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

202 Descriptive statistics on categorical variables influencing participation of stallholder farmers
203 in sorghum contract farming are presented in Table 5 above. Results show that contracted
204 and non-contracted sorghum farmers were statistically different across gender, education
205 level, group membership, and ownership of oxen, farm store, and bicycle. A larger proportion
206 of sampled farmers were male-headed households 68.33%, and female-headed were
207 31.67%. Amongst the total male-headed household, non-contracted and contracted were
208 49.39% and 50.61%, respectively. In contrast, of the total female-headed households non-
209 contracted and contracted sorghum farmers were 71.05% and 28.95%. The chi-square test
210 was significant at a 1 % significant level showing variations across the two groups regarding
211 gender. Results attribute that male-headed households are more likely to participate in
212 sorghum contract farming than their female-headed counterparts. The low level of
213 participation by female-headed households in sorghum contract farming is attributed to
214 limited access to farming resources and engaging more in domestic activities.

215 Majority of the sampled sorghum farmers' household heads (63.75%) had attained primary
216 education, 27.08% post-primary and 9.17% no formal education. Of the total
217 sorghum farmers with primary education level, 54.90% of them were non-contracted and
218 45.10% were contracted. The overall household head with post-primary education levels
219 49.23% were non-contracted and 50.77% were contracted sorghum farmers. Total
220 household head with no formal education 86.36% of them were non-contracted and 13.64%
221 were contracted sorghum farmers. A chi-square test for education level against contract
222 farming participation was significant at a 1%. This shows that there was a significant
223 difference amongst contracted and non-contracted sorghum farmers in terms of education
224 level. This indicates a low level of participation in sorghum contract farming by the household
225 heads with no formal education compared to those who have at least acquired formal
226 education.

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

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

244 Concerning farm store ownership, most sampled sorghum farmers (67.50%) did not own
245 farm store, while 32.50% owned farm store. Of the total farmers without farm stores,
246 majority of them 66.05% were non-contracted, while 33.95% were contracted sorghum
247 farmers. Of the total farmers with farm stores, most of them 64.10% were contracted and
248 35.90% were non-contracted sorghum farmers. Farmers with farm store are more stirred to
249 engage in sorghum contract farming than those without. Ownership of the farm store

250 motivates farmers to participate in sorghum contract farming as it is easier for farmers with
 251 the store to bulk sorghum produce awaiting collection by the contracting company.

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

260 In terms of wards in Bondo sub-county, majority of sorghum farmers 60.00% were from East
 261 Yimbo, 21.67% from West Sakwa, and 18.33% from North Sakwa. Out of the total farmers
 262 from East Yimbo, majority of them 52.50% were non-contracted, and 37.50% were
 263 contracted sorghum farmers. Of the total farmers from North Sakwa, 34.09% were non-
 264 contracted, while 65.91% were contracted sorghum farmers. Of the total farmers from West
 265 Sakwa, 57.69% were non-contracted, whereas 42.31% were contracted.

266 3.2 Econometric results

267 3.2.1 Determinants of Participation in contract farming

268 Binary logistic model fitness was conducted using pseudo-R square, P-value, and Log
 269 likelihood as indicators were taken into account. A pseudo-R square value should range
 270 between 0.20 to 0.40, and a p-value of less than 10% is considered good. The study had a
 271 pseudo-R square of 32.44%, Prob>chi²=0.0000, and the Log-likelihood = -111.1154,
 272 meeting the minimum requirement of model fitness match.

273 Logistic regression was run to determine factors influencing smallholder farmers'
 274 participation in sorghum contract farming in Bondo sub-county. The marginal effect results of
 275 the logistic regression model are presented in Table 6 below. Primary education level,
 276 gender, age of the household head, number of active household members, membership to
 277 farm group, distance to the main road in walking minutes, and bicycle and oxen ownership
 278 were found to positively influence participation in sorghum contract farming. Conversely,
 279 distance to the nearest extension agent office in walking minutes from farmer residential
 280 home had a negative influence on participation in sorghum contract farming.

281 **Table 6: Marginal effects of the decision to participate in contract farming by**
 282 **sorghum farmers in Bondo sub-county**

Dependent		Delta-method			
Contract participation (0=No 1=Yes)		dy/dx	Std. err.	z	P>z
Independent Variables					
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			

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

284 Farmer household heads who at least have acquired primary education have a 22% chance
285 of participating in sorghum contract farming compared to heads without formal education
286 (Table 6). This was significant at 5% ($\beta = 0.215; P = 0.04$). The probable reason is that
287 education imparts farmers with technical skills and knowledge to understand contract
288 farming better. Educated farmers could comprehensively understand the terms and benefits
289 of contract farming compared to less educated ones. Education enables farmers to read and
290 understand contracts and make rational decisions to participate in contract farming. The
291 finding is similar to the results by [19], Jagra *et al.* [19], Kena *et al.* [20], Loquias *et al.* [21], Lush
292 *et al.* [22], Kedi *et al.* [23], Rondhiet *et al.* [24].

293 The gender of the household head was significant at 5% ($\beta = 0.144; P = 0.02$) and directly
294 associated with sorghum contract participation. Male-headed households had about a 14%
295 chance of joining contract farming compared to female-headed households. A plausible
296 explanation is that male-headed households make major farm decisions relating to terms
297 and implementation of the contract compared to female-headed households. The female-
298 headed households are likely to consult widely before signing a contract contributing to their
299 low level of participation. In addition, institutional and cultural factors unresponsive to
300 women's needs disfavors women from participating in contract farming. Generally, there is
301 unequal ownership of productive farm assets, which favors male over female farmers. The
302 results are in agreement with the findings of Bogle *et al.* [25], Fendi *et al.* [26], Hirpesa *et al.*
303 [27], Ronchi *et al.* [24].

304 The age of the household head significantly and positively influenced ($\beta = 0.01; P = 0.03$)
305 sorghum contract farming participation. An increase in the age of household head by one
306 year increases the probability of participating in sorghum contract farming by 1%, holding
307 other factors constant. The result implies that the older the farmer, the higher the probability
308 of participating in sorghum contract farming. Older farmers were more willing to participate in

309 sorghum contracts than their younger counterparts. The positive sign of age was attached to
310 a common correlation between age and production experience Akumu *et al.*[29]. The reason
311 is that older farmers may have more knowledge and experience in sorghum production.
312 They can analyze and understand the technicalities of contracts and the possible benefits
313 compared to younger farmers. Furthermore, older farmers are risk averse and are willing to
314 engage in contract farming to reduce production and marketing risks. Older farmers have
315 more social networks and thus can access agricultural information than young farmers. In
316 addition, older farmers are more likely to participate in contract farming as most of them
317 reside in rural areas considering agriculture as the main source of livelihood, and they
318 engage in opportunities they perceived to be beneficial to them Kimbi *et al.*,[29]. The above
319 results conformed to the findings of Bezabeh *et al.* [17], Bogle *et al.*[25], Fendi *et al.* [26],
320 Jagriet *al.*[19], Johnny *et al.*[30], Hirpesa *et al.*[27] who reported that age positively influences
321 participation in contract farming.

322 The number of active household members significantly influenced ($\beta = 0.005; P = 0.00$)
323 participation in sorghum contract farming. Therefore, increasing one active adult member in
324 the household increased the probability of participating in sorghum contract farming by 0.5%,
325 holding other factors constant. This implies that households with more active adult family
326 members were more likely to engage in contract farming than those with fewer active adult
327 members. The reason behind the finding is that active members provide labor for planting,
328 weeding, and harvesting sorghum, thus increasing the chance of participating in sorghum
329 contract farming. Family labor reduces hiring costs and raises farm profitability, making it
330 cheaper to cultivate sorghum under contract farming Akumu *et al.* [28]. The study findings
331 were in agreement with the findings of [31], Taslim *et al* [32].

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

346 Household residential home location to the nearest extension agent office in walking minutes
347 was significant ($\beta = -0.004; P = 0.01$) and negatively associated with contract farming
348 participation. An extra walking minute from the household homestead to the nearest
349 extension agent office decreases the probability of participation in contract farming by 0.9%
350 (Table 6). This shows that households nearer to the extension agent office were more likely
351 to participate in sorghum contract farming than those far from the office. Households located
352 near the extension agent office have easy access to agricultural production knowledge and
353 market information from the office. Extension agents create awareness of the importance of
354 participating in contract farming to households nearer to them, thus encouraging them to
355 engage in contract farming. Furthermore, households nearer to the extension agent office
356 also access extension services, demonstrations, training on better agricultural practices, and
357 awareness of improved farm technologies which hasten the farmers' application of new

358 technologies such as contract farming Ndossiet *al.*, [35]. Findings were in agreement with
359 Ganewaet *al.*[36], [18], Herpes *et al.* [27],[37], [38], Rondhiet *al.* [24].

360 Farmers' residential home location to the nearest main road in walking minutes was
361 significant and positively associated with contract farming participation at a 1% significant
362 level ($\beta = 0.02$; $P = 0.00$). Additional walking minutes from the farmer's homestead to the
363 main road increases the likelihood of participation in contract farming by 0.2%. Farmers far
364 from the main road had higher chances of participating in contract farming than those near
365 the main road. The results were contrary to the hypothesized sign. Longer distance from the
366 main road motivates farmers to participate in contract farming to reduce transportation costs
367 of acquiring inputs and accessing the output market. This is plausible because sorghum
368 contractor facilitates farmers by delivering inputs and collecting sorghum produce near
369 farmers' homesteads. The above results agreed with the findings of Fendi *et al.* [26], [34].
370 The findings disagree with that of [39] who found distance to the main road is negatively
371 associated with contract participation.

372 Furthermore, ownership of bicycles by the farmer was significant and positively associated
373 with sorghum contract farming participation at 1% level ($\beta = 0.210$; $P = 0.00$). Bicycle
374 ownership by the farmer increased the chances of participation in contract farming by about
375 21%. This shows that farmers with bicycles have more chances of participating in contract
376 farming than farmers without. This finding is because a bicycle is viewed as a means of
377 transportation during planting, weeding, and harvesting. Besides, bicycle farmers could
378 easily monitor their farms far from the homestead. The farmers also use bicycles to transport
379 sorghum to collection centers, increasing their probability of participating in contract farming.
380 Lastly, bicycles enable farmers to access farm inputs and agricultural information. The
381 results obtained are in tandem with the findings of [40].

382 Ownership of oxen by the Farmer was significant and positively associated with contract
383 farming participation at 1% significance level ($\beta = 0.238$; $P = 0.00$). Farmers owning oxen
384 have 24% more chances of participating in sorghum contract farming than farmers without
385 oxen. This is because oxen are the main means of land preparation in the study area. For
386 this reason, farmers who own oxen would not need to hire cultivation services from other
387 farmers, thus reducing the cost of land preparation, and can cultivate on time for early
388 planting. The results support the findings of [23, 40].

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

393 **4. CONCLUSION**

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

404 affordable interest rates to farmers to enable them acquire necessary farm inputs and
405 equipment.

406 **CONSENT**

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

410 **ETHICAL APPROVAL**

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

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