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Determinants of collective marketing and marketable surplus for smallholder sorghum producers in Oyam district, Uganda

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In 2000, Uganda instituted a tax rebate of 10 to 15% to industries willing to use locally sourced raw materials. This attracted Nile Breweries Ltd (NBL) to start using locally produced sorghum for beer production in 2002 and intervened in the sorghum value chain through mobilization of farmers into producer groups, established bulking centers and appointed buying agents. Despite these interventions, some farmers still sell their sorghum individually to open markets, hence limiting the volumes of sorghum sold through collection centers and eventually to the breweries. This study explored the marketing arrangements of sorghum farmers in Oyam district and their influence on marketable surplus. Using a cross sectional household survey, data were obtained from a random sample of 150 farmers in four major sorghum growing sub counties of Loro, Iceme, Acaba and Aber. T-tests and chi-square tests were used to determine the relationship between socio-economic and farm specific factors and marketing arrangements, and a two-step Heckman procedure was used to ascertain the determinants of collective marketing and the influence of collective marketing on marketable surplus. Chi-square results showed that gender of the household head, marital status, and road type significantly correlated with marketing arrangements while T-test results showed that distances to inputs and buyers significantly influenced marketing arrangements. From the two-step Heckman procedure, the Probit model showed that buyer distance and sales income significantly influenced the probability of collective marketing while the OLS model in the second step showed that marketable surplus significantly increased with input access, and selling price. Sorghum farmers in Oyam district can potentially increase their sorghum marketable surpluses and reduce rural poverty if they fully participate in collective marketing, access inputs and negotiate for better sorghum price with the breweries. Therefore, agri-businesses and policy makers should promote and enhance collective marketing to improve sorghum marketing in Uganda.

Keys words: Sorghum farmers, socio-economic characteristics, collective marketing and marketable surplus.

INTRODUCTION

Worldwide, sorghum ranks the fifth most important cereal crop after wheat, rice, corn and barley (Awika and Rooney, 2004). It is a multipurpose crop with more than 35% of it grown directly for human consumption and the rest used primarily for animal feed, alcohol and industrial products (bread, biscuits, starch, sugar, syrups, beer, and malt products among others). Sorghum is an important crop with unique ability to produce under a wide array of

harsh environmental conditions in arid and semi-arid regions. It has great genetic diversity, making breeding and selection for most desirable traits of economic importance possible and to target majority of the smallholders farmers that face different transaction costs, with limited market access and poor market participation (Key et al., 2000; Renkow et al., 2004).

In Uganda, sorghum is the third most important cereal after maize and rice (Gierend et al., 2014). On average it occupies 265,000 ha of arable land, a production area only slightly smaller than that of maize and millet (NARO, 2000). Sorghum is a staple crop for many people and serves as an important substrate base for locally brewed beers and processed traditional foods (Gierend et al., 2014). The sorghum production belt in Uganda stretches out over the semi-arid regions of the north and north eastern parts of the country and cultivation typically involves low use of external inputs. In these conditions, sorghum yields are below their potential and over the years government interventions have aimed to improve the productivity through development of new varieties, good agronomic practices, post-harvest handling and marketing (Akulloet al., 2009).*"Epuripur"*a local name for white sorghum, one of the three new varieties introduced by the National Agricultural Research Organization (NARO) in Uganda in the 1990s (NARO, 2000) emerged out of a breeding program aimed at quality improvement for food production, brewing properties, drought tolerance, ability to tolerate low fertility levels and other climatic conditions. Nile Breweries Limited (NBL), attracted by a government tax rebate of 10 to15% to industries using local products as opposed to imported products embarked on *"Epuripur"* production in 2002. NBL contracted Afro-Kai Ltd in 2003 to supply *"Epuripur"* sorghum for use in beer brewing. As a way to develop the sorghum value chain, Afro Kai embarked on farmers' mobilization, arranging contracts with farmers, seed supply, monitoring of farming operations, price setting, quality control, setting up of district stores, bag distribution, quality sensitization, bulk consolidation, transport to cleaning plant, cleaning, drying, cleaning, re-bagging, fumigation, and delivery of the harvest to the brewery. However, with all these interventions, a lot of sorghum is sold to informal markets leaving only 14.3% of the sorghum produced reaches the formal market and therefore NBL has not received the necessary volumes (UBOS, 2016).

Growth in marketable surplus determines the level of economic development. Marketable surplus is the quantity of total produce made available for sale to the non-farm population and other sectors. Theoretically, marketable surplus is the portion of produce left over after the farmer meets personal requirements including family consumption, requirements for seeds, requirements for storage, feed for animals and payment to hired labor and artisans in kind, rent to the landlord in case of sharecropping and social and religious payments in kind (Sharma and Wardhan, 2017). Smallholders' marketable surplus is a useful concept as it allows one to see the conditions under which they sell and if that improves their welfare. Further, marketable surplus of food grain among smallholder famers is of interest because it is a prerequisite for market participation that is in turn essential for farmers to raise farm incomes, improve welfare and smoothen food supply. Therefore understanding the concept of marketable surplus helps to speed up the transition process from purely subsistence, to subsistence surplus (semi-commercial) and finally to full commercialization of agriculture (Jabbar, 2010).

According to Key et al. (2000), the low marketable surplus of sorghum is attributable to poor market access conditions, use of poor technologies, limited access to training, credit and extension services. Moreover, the majority of smallholder farmers are scattered and operate individually and this exposes them to high transaction costs which, together with the subsistence nature limits the quantity of sorghum offered to the market (Wiggins et al., 2010). To overcome the bottlenecks in sourcing produce from smallholder farmers, contract farming has been fronted as one of the models. For instance, Elepu and Nalukenge (2009) reported that contract farming had contributed a great deal to the commercialization of smallholder agriculture in Uganda, especially in the sorghum and sunflower sub-sectors. Contract farming is one form of concentration of production and aggregation of produce to supplant the challenges of geographically dispersed smallholder producers. On the other hand, Baumann (2000) criticizes contract farming for exploiting smallholder farmers. Schipmann and Qaim (2011) further revealed that farmers generally preferred non-contract marketing options and that the most important factor is the relationship between farmers and buyers. According to OECD (2006), the most important institutional challenges to smallholder inclusion in commercial value chains concern the formal rules, inter-organizational arrangements, and informal customs that prevent farmers' access to knowledge and technology, credit, markets and farmer-based organizations. Kraybill et al. (2012) and Gow (2000) revealed that all agricultural inputs (labor, fertilizer, chemicals, improved seeds, and agricultural assets) posited a positive impact on output per acre except land which had a negative relationship. In addition, education, agricultural know-how/ experience, and credit had positive effects on per-acre output and these ultimately influence the proportion of marketable surplus.

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However, a knowledge gap exists on the characteristics of smallholder sorghum farmers in Uganda. In addition, the influences of sorghum farmers' characteristics, marketing and institutional factors on a farmer's choice of marketing arrangements and on the proportion of sorghum marketable surplus are not clearly documented. This study therefore was intended to understand and unearth the marketing arrangements among smallholder sorghum farmers in Oyam district of northern Uganda and the influence of marketing arrangements on sorghum marketable surplus. The study further sought to explore: (1) the relationship between socio-economic and farm specific factors to marketing arrangements; (2) how socio-economic factors, proximity of bulking stores, and access to embedded services influence collective marketing of white sorghum in Oyam district, and (3) how selling price, household size and other socio-economic factors influence the level of marketable surplus.

METHODOLOGY

The study by design used a cross-sectional household survey to collect primary data from a random sample size of 150 farmers in Oyam district of northern Uganda. Oyam district was purposively sampled because it is one of the major sorghum producing areas in Northern Uganda. The district is bordered by Gulu district to the north, Pader district to the northeast, Kole district to the east, Apac district to the south, Kiryandongo district to the southwest and Nwoya district to the west. The district administrative headquarters are in Oyam town approximately 78 km (48mi), by road, west of Lira town. The coordinates of the district are: 02 14N, 32 23E.

Lists of major sorghum growing villages were obtained from sub counties to construct the sampling frame that constituted of 4,000 farmers and every 4thperson on the list was selected to participate in the study in order to reduce bias. The study then sought authority and ensured free consent from the respondents. Primary data were collected using pre-tested researcher administered questionnaires which had both open-ended and close-ended questions (Mellenbergh, 2008) and data were entered using SPSS and analyzed using STATA statistical packages.

For the null hypothesis that socio-economic and farm specific factors are not related to marketing arrangements, chi-square and t-tests were used to determine the degree and direction of influence of the smallholder farmers' socio-economic characteristics [(age (years), quantity consumed (kg), seeds quantity (kg), shared quantity (kg), lost quantity (kg), feeds quantity (kg), brewing quantity (kg), quantity sold (kg), input access (km), buyer distance (km), sorghum sales income (Shs), costs (Shs), *"epuripur"* farming experience (years), land use (acres), output quantity (kg) farm size (acres), family size (numbers), farming experience (years), education (years), gender, marital status, location, sorghum variety grown, group work, seed source, road type, price determination, fertilizer use and pesticide use)] on the choice of the different marketing arrangements of sorghum. T-tests were used on continuous variables while Chi-tests were employed on selected categorical variables.

The null hypotheses that socio-economic factors, proximity to bulking store, and access to embedded services positively and significantly influence collective marketing and that selling price, household size and other socio-economic factors positively and significantly influence the level marketable surplus. A two stage Heckman procedure was employed to ascertain the determinants of collective marketing for sorghum by smallholder farmers (Heckman, 1976). In the first stage, a Probit model was executed to analyze the determinants of collective marketing of sorghum farmers. Assuming that the individual household's decision on whether or not to adopt collective marketing is dependent on the expected benefits from their actions, the decision to adopt collective marketing (CM) can be calculated as follows:

$$\boldsymbol{CM^{*} = Wi\theta + \varepsilon i, i(1, 2, \ldots\ldots\ldots\ldots N)} \quad (1)$$

Where CM^{*} is an unobserved latentvariable underlying the farmer's decision to adopt CM. The observed dichotomous variable CM has the value 0 for $CM^{*} \leq 0$ (non-adoption), or 1 for $CM^{*} > 0$ (adoption of CM).

Wi refers to farmer socio-economic characteristics and institutional services (Table 1), and θ are parameters to be estimated. The probability that an individual household adopts CM is:

$$\boldsymbol{Pr(CM = 1) = Pr(Wi\theta + \varepsilon i > 0) = \emptyset(Wi\theta)} \quad (2)$$

Where; $\emptyset(Wi\theta)$is the standard normal cumulative distribution function and *Pr* is the probability to choose collective marketing. From Equation 2, the estimated parameter (θ) is generated. Explicitly, the determinants of collective marketing were ascertained using Equation 3 as adapted from Mugonola et al. *(*2013):

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$$\boldsymbol{Y = \alpha_0 + \beta_1 X_1 + \ldots\ldots + \beta_{11} X_{11} + U_i} \quad (3)$$

Y = CM, a binary response variable equal to 1 if one participates in collective marketing and 0 = otherwise, $\boldsymbol{\alpha_0}$ = constant,$\beta_1 \ldots \beta_{11}$ = parameter estimate, and μ_i = error term. X_1-X_{11} are independent variables as described in Table 1.

The second stage of the Heckman's procedure analyzed determinants of marketable surplus for farmers selling through collection centers. The Ordinary Least Square (OLS) model was fitted in STATA with Invmills predicted from the Probit model as an additional explanatory variable (Equation 4). A test of significance of the Invmills determines the relevance of the selectivity model (Sipiläinen and Oude-Lansink, 2005). The OLS assumes normal distribution of errors. Explicitly; the equation for marketable surplus is:

$$\boldsymbol{Y_i = B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3 + B_4 X_4 + B_5 X_5 + B_6 X_6 + B_7 X_7 + B_8 X_8 + U_i} \quad (4)$$

Y =response variable, "marketable surplus", B_0 = Constant, $B_1 \ldots B_8$ = parameter estimate, U_i = Stochastic error term, $X_1 \ldots \ldots X_8$ =explanatory variables as in Table 2 respectively.

RESULTS AND DISCUSSION

Relationship between socio-economic factors and marketing arrangements

Results of chi-square test presented in Table 3 show that gender (χ^2= 11.807; p<0.01), marital status (χ^2= 13.273; p<0.01), and seed source (χ^2= 3.061; p<0.1) were significantly related to marketing arrangements. Similarly, road type (χ^2= 137.039; p<0.01), sorghum variety (χ^2= 2.94; p<0.1), and pesticides use (χ^2= 3.24; p<0.1) were significantly related to marketing arrangements. The rest of socio-economic factors namely location, group production, price determination and fertilizer use

Table 1. Variables used for determinants of collective marketing in the Probit model.

Variable	Description	Expected sign	Citation
Collective marketing (CM)	Sell as a group through collection centers; 1- yes and 0- no		Coulter, 2007
Gender	1. Male 2. Female	+/-	Pandolfelli et al., 2007; Cunningham et al., 2008; Doss, 2001
Road type	1. Murram road 2. Tarmac road	+/-	Vorlaufer et al., 2012
Location	1. Loro s/c; 2. Iceme s/c; 3. Acaba s/c; 4. Aber s/c	+/-	Fischer and Qaim, 2012; Fafchamps and Hill, 2005.
Costs	Total costs in a season (transport and production)	-	Fischer and Qaim, 2012
Buyer distance	Distance from home to the collection center (km)	+/-	Fischer and Qaim, 2012; Fafchamps and Hill, 2005
Access to credit	1. Yes 2. No	+	Fischer and Qaim, 2012
Access to market info	1. Yes; 2. No	+	Fischer and Qaim, 2012
Education	Number of years in school	-	Vorlaufer et al., 2012
Income (Y)	Total income (shs) earned per season	+	Vorlaufer et al., 2012
Selling price (SP)	Price per kilo (Shs.)	+	Vorlaufer et al., 2012
Seed source	1- Agent2- Shop	+/-	Vorlaufer et al., 2012
Input distance	Distance from home to the input stockiest (Km)	+	Fischer and Qaim, 2012
Output (kg)	Quantity of sorghum harvested in a season	+	Fafchamps and Hill, 2005
Land size	Total size of land used	+	Fischer and Qaim, 2012

Table 2. Variables used in a multiple regression model after Probit for determinants of marketable surplus.

Factor	Measurement	Expected sign	Citation
Selling price (SP)	Price paid per kilo of sorghum (Shs.)	+/-	Fischer Qaim, 2012
Access to market	1-Yes; 2-no	+	Fischer Qaim, 2012.
Access to market information	1-Yes; 2-no	+	Vorlaufer et al., 2012
Access to institutional credit	1-Yes; 2-no	+	Fischer Qaim, 2012.
Out put	Quantity of white sorghum harvested in a season (Kg)	+	Vorlaufer et al., 2012
Acreage	Sorghum farm size(acres)	+/-	Fischer and Qaim, 2012; Goetz, 1992; Tiku and Ugbada 2012
Buyer distance	Distance from home to the market/collection center (Km)	-/+	Vorlaufer et al., 2012; Goetz, 1992
Road type	1- murram; 2- tarmac; 3- feeder road	+	Fischer Qaim, 2012.
Family size	Number of members in a household	-/+	Vorlaufer et al., 2012; Goetz, 1992
Modern technology access	Yes/No (improved varieties and infrastructure)	+	Kraybill et al.,2012
Farming experience	Number of years spent in farming	-	Kraybill et al.,2012
Income	Sorghum sales received from a season	-/+	Kraybill et al.,2012
"Epuripur" experience	Number of years spent farming *"epuripur"* sorghum	-/+	Omiti et al.,2009; Kraybill et al., 2012
Transport means	Means of transportation used to deliver sorghum; 0- free means; 1- otherwise	-	Omiti et al.,2009
Location	Sub county where the farmers resides	-	Omiti et al.,2009
Visit number	Number of extension visits received in a season	+	Kraybill et al.,2012

Table 3. Relationship between socio-economic factors and choice of marketing arrangements.

Socio-economic factors (n=150)			Marketing arrangement		Pearson χ^2
Variable	**Categories**	**Percent**	**Collective selling(n=124)**	**Individual selling(n=124)**	
Location	Loro	65.33	77.55	22.45	5.6909
	Aber	6.67	100.00	0.00	
	Iceme	20.00	90.00	10.00	
	Acaba	8.00	91.67	8.33	
Gender	Male	84.00	87.30	12.70	11.8065***
	Female	16.00	58.33	41.67	
Marital status	Single	4.00	83.33	16.67	13.2729***
	Married	80.67	87.60	12.40	
	Divorced	4.00	50.00	50.00	
	Widowed	11.33	58.82	41.18	
Seed source	Shop	2.67	50.00	50.00	3.0605*
	Agent	97.33	83.56	16.44	
Group production	Yes	13.33	95.00	5.00	3.7919
	No	86.67	80.77	19.23	
Road type	Murram	57.33	100.00	0.00	137.0392***
	Tarmac	17.33	100.00	0.00	
	Feeder	6.67	100.00	10.00	
	None	18.67	7.14	92.56	
Price determination	Buyer	96.67	82.07	17.93	1.0845
	Market price	1.33	100.00	0.00	
	Negotiable	2.00	100.00	0.00	
Sorghum variety	*"Epuripur"*	54.00	77.78	22.22	2.94*
	"Sila"	47.00	83.56	10.96	
Fertilizer use	Yes	3.33	80.00	20.00	0.03
	No	96.67	82.76	17.24	
Pesticide use	Yes	9.33	100.00	0.00	3.24*
	No	90.67	80.88	19.12	

***,**and * are significance levels at 1, 5 and 10% respectively. Standard errors are in parentheses. Source: Author's survey (2017).

exhibited no statistical relationship with marketing arrangements. On the basis of significance of χ^2 findings, the null hypothesis that socio-economic and farm specific factors are not related to marketing arrangements was rejected for the variables of gender, marital status, seed sources, road type, sorghum variety and pesticide use, and accordingly, the alternative hypothesis accepted. However, this study could not reject the same hypothesis for the variables of location, price determination, fertilizer use, and group production. Thus, this study stands to conclude that marketing arrangements are related to gender, marital status, seed source, road type, sorghum variety and pesticide use.

Males grew more sorghum than females (males were 84.00% and females were 16.00%). Similarly, males sold significantly more sorghum than females through a collection center (males = 87.30% and females = 58.33%). This could be due to the fact that women are often neglected since they own no land in a household; which limits their decisions over land than male landowners and that because of their reproductive responsibilities in addition to farming, women may also have higher opportunity costs of time, which may reduce their incentives for participation (Doss, 2001).

Married farmers grew more sorghum than the widowed, singles and the divorced (married=80.67%, widowed=11.33%, singles=4.00% and the divorced=4.00%). Amongst farmers who sold through a collection center, married farmers similarly sold significantly more sorghum than the other groups

(married=87.60%, widowed=58.82%, single=83.33%, and divorced=50.00%). This could be due to the fact that married people have increased productivity since farm labor supported by their children could reduce cost of labor and increase production and therefore influence them to sell through a collection center to access wider markets (Fischer and Qaim, 2012).

Farmers who got their sorghum seeds from agents dominated sorghum growing (97.33%) as compared to those who got their seeds from shops in the market (2.67%). In the same way, farmers who sold their sorghum through the collection center were majorly those who bought their seeds from agents (83.56%) and those who bought their seeds from shops were 50.00%. This is due to the fact that agents are the owners of the collection centers and they gives seeds to farmers on credit on condition that they sell the produce back to them (agent) and this is a strategy of getting assured supply by the agents (Elepu and Nalukenge, 2009).

Most farmers who grew sorghum in Oyam district used murram road (57.33%), 17.33% used tarmac road, 6.67% used feeder road and the 18.67% did not use any road. All farmers who used the different road types sold through a collection center. This is true because agents tend to pick sorghum direct their farmers using their trucks (Fischer and Qaim, 2012; Elepu and Nalukenge, 2009).

Sorghum growing was dominated by *"epuripur"* sorghum growers (54%) as compared to *"sila"* sorghum growers (47.00%). Amongst farmers who sold their sorghum through a collection center, those who grew *"epuripur"* variety were in the same way more than those who grew the *"sila"* variety (*"epuripur"* = 77.78% of 54% of 150and *"sila"* = 83.56% of 47% of 150). Most farmers grew *"epuripur"* sorghum majorly due to the grain weight, early maturity, market ease and high yields. Additionally, it is the variety that was introduced to the farmers by Nile Breweries Ltd (NBL), but the *"sila"* variety came in because NBL failed to control the seed supply (Elepu and Nalukenge, 2009).

Majority of the sorghum farmers did not spray their sorghum (90.67%) as compared to the 9.33% who sprayed. Likewise, majority of the farmers who sold through a collection center did not spray (80.88% of 90.67% of 150, as compared to those who sprayed their sorghum (100% of 9.33% of 150). Majority of the farmers did not spray their sorghum gardens mainly because they lacked sensitization about pesticide use, and enough money to buy pesticides, and that there were no pests so far in the area (Elepu and Nalukenge, 2009).

Differences in socio-economic factors for marketing arrangements

Mean difference results (Table 4), revealed that sorghum production components of output ($t = -2.19$; $p<0.05$), quantity sold ($t=-2.33$; $p<0.05$); and produce retained for feeds ($t = -1.53$; $p< 0.1$) posted statistically significant differences between farmers selling collectively and individually. Other production components were not significant at any level and included quantity consumed, saved seeds, quantity shared, quantity lost due to postharvest factors, quantity stored, and quantity used for brewing. Turning to non-output factors, significant mean differences between collective and individual sorghum selling were posited for the variables of education ($t=-1.91$; $p<0.05$), inputs distance ($t=2.68$; $p<0.01$); and buyer distance ($t = -5.41$; $p<0.01$). Other significant findings were: Seasonal income ($t = -2.33$; $p<0.01$), farming experience ($t=1.44$; $p<0.1$), land use ($t=-1.63$; $p<0.1$) and farm size ($t = -2.16$; $p<0.05$). The rest of socio-economic factors were not significantly different for marketing arrangement and included age, family size, total costs, "*epuripur"* farming experience, extension visits, loan amount and the number of times of receiving information. As such, the null hypothesis that the mean difference in sorghum output components and other socio-economic factors between collective and individual selling farmers is equal to zero was rejected for total output, quantity sold, and retained produce for feeds. Other variables for which the same null hypothesis was rejected include: Education, inputs distance and buyer distance, farming experience, land use and farm size. For all other non-significant different variables, the null hypothesis could not be rejected. Overall, this study stands to conclude that farmers using collective and individual marketing arrangements differed in the variables of farm-level sorghum output, quantity sold and quantity retained for feeds as well as education, inputs distance, and buyer distance among other socio-economic factors.

Sorghum farm-level output in kilogram was significantly higher amongst farmers relying on collective selling (M = 668 kg; SD= 787) compared to those relying on individual selling (M = 321.7; SD = 375). The implication of this finding is that collective selling could be encouraging farmers to grow more sorghum possibly because there could be more incentives for farmers gained from collective marketing, for instance, better output prices. Secondly, networking that comes with collective marketing tend to facilitate information sharing which could be helping to improve farm-level productivity (Elepu and Nalukenge, 2009).

In Oyam district, farmers selling through a collection center spent significantly more years in school (M = 6, SD = 4) as compared to those who relied on individual marketing (M = 5, SD = 4). This could be due to the fact that farmers who attended school learnt the advantages of group work which makes them easily adopt collective marketing as compared to farmers who did not attend school.

Farmers using collective marketing saved significantly more sorghum for feeds in kilogram (M = 3, SD = 6) than farmers selling individually (M = 1, SD = 4). This is

Table 4. Differential means of socio-economic factors for choice of marketing arrangements.

Variable	Mean			t-value
	Combined	Collective selling	Individual selling	
Household age	43.17(13.09)	42.54(12.76)	46.15(14.50)	1.28
Education	5.94(4.16)	6.24(4.14)	4.54(4.06)	-1.91**
Family size	6.89(2.84)	6.91(2.87)	6.81(2.71)	-0.17
Quantity consumed	7.25(22.52)	6.19(20.73)	12.31(29.61)	1.26
Seeds quantity	2.42(7.71)	2.26(7.49)	3.19(8.77)	0.56
Quantity shared	1.86(7.01)	1.98(7.55)	1.31(3.37)	-0.44
Quantity lost	17.75(122.25)	20.63(134.35)	4.04(5.50)	-0.63
Quantity stored	20.39(109.12)	18.04(95.57)	31.54(160.82)	0.57
Feeds quantity	2.96(6.21)	3.31(6.49)	1.28(4.32)	-1.53*
Brewing	0.37(3.18)	0.44(3.49)	0.00(0.00)	-0.65
Quantity sold	553.65(698.39)	613.62(744.02)	267.65(283.81)	-2.33**
Input access	2.15(2.33)	1.92(2.16)	3.24(2.82)	2.68***
Buyer distance	1.49(1.56)	1.78(1.56)	0.12(0.36)	-5.41***
Seasonal income	528553(644196.50)	583794.00(684851.40)	265096.00(280051.20)	-2.33**
Costs	186944(160267.40)	193601.00(164521.40)	155192.00(280051.20)	-1.11
Farming experience	22.44(13.13)	21.73(13.11)	25.81(12.93)	1.44*
Epuripur experience	4.55(3.15)	4.54(2.79)	4.62(4.55)	0.11
Land use	6.75(5.64)	7.09(6.07)	5.12(2.31)	-1.63*
Farm size	2.37(1.35)	2.48(1.41)	1.86(0.93)	-2.16**
Output quantity	607.95(742.76)	667.98(786.57)	321.69(375.49)	-2..19**

***,** and * are significance levels at 1, 5 and 10% respectively. Standard deviations are in parentheses; M = mean, and SD = standard deviation.

contrary to expectations because farmers selling through collection centers always aim at selling higher quantities as suggested by Fischer and Qaim (2012). This finding could be influenced by other factors that are not explained by the study.

On average, sorghum farmers in Oyam district sell 554 kg of sorghum. Farmers who sold their sorghum through a collection center sold significantly higher quantities (M = 614, SD = 744) than farmers who sold individually to local traders (M = 268, SD = 284). This is true first of all because they harvest more quantities than individual sellers (Table 6). Each farmer is given a required quantity of sorghum to be taken back depending on the quantity of seeds given (Elepu and Nalukenge, 2009) as compared to individual sellers who sell according to the need at hand.

Farmers participating in collective marketing significantly travel less distances (km) for inputs (M = 2, SD = 2) than those who sell individually (M = 3, SD = 3). This is true because agents normally take inputs nearer to their farmers as compared to individual farmers who source for inputs on their own (Elepu and Nalukenge, 2009).

The buyer distance travelled by farmers who sell through a collection center is significantly longer (M=2, SD=2) than that for individual sellers (M=0.1, SD=0.4). This is true because individual sellers tend to wait for the buyers from their homes while those selling through collection centers have to travel to the collection centers which later send the sorghum to final buyers very far away.

In Oyam district, a farmer selling through a collection center earns significantly higher income (M = 583,794, SD = 684,851) as compared to those who sell to local traders (M = 265,096, SD = 280,051). It is because collection centers pay higher prices than local traders and that farmers selling through a collection center farm on contract; so their prices are more stable than individual sellers who are at the mercy of the local traders (Elepu and Nalukenge, 2009).

Farmers using collective marketing had significantly lower experience (M = 22, SD = 13) than farmers who sold to local traders (M = 26, SD = 13). This could be due to the fact that farmers trading individually use their experience to make such a decision, and that farmers selling through a collection center use such a chance to improve on their knowhow (KIT et al., 2006).

Farmers selling through a collection center used significantly bigger farm size (M = 2.5, SD = 1.4) as compared to those who sold to local traders (M = 1.9, SD = 0.9). This could be because farm size is one of the requirements for participating in collective marketing, and that physical assets, such as financial capital, land and labor, are other important factors of innovation adoption

Table 5. Probit results for determinants of collective marketing by white sorghum.

Explanatory variable	Dependent variable: Collective marketing	
	Coef	dy/dx
ln buyer distance	1.78(.44)***	0.18(0.03)***
ln selling price	-27.81(8.62)***	-2.78(0.75)***
ln seasonal income	1.54(.52)***	0.15 (0.05)***
Household gender	-1.47(.57)***	-0.15(0.05)***
Seed source	1.95(.91)**	0.19(0.09)**
ln total costs	-.20(.11)*	-0.02(0.01) **
ln input access	-1.85(.42)***	-0.18(0.03)***
Sorghum farm size	.32(.22)	0.03(0.02)
ln output quantity	-1.34(.65)**	-.13(0.06)**
Group production	-2.54(1.53)*	-0.25 (0.15)*
Family size	-.09(.08)	-0.01(0.01)
_cons	187.54(58.22)	-
LR χ^2(11)	83.58	-
Prob>χ^2	0.00	-
Log likelihood	-27.38	-
Pseudo R^2	0.60	-

***,** and * are significance levels at 1, 5 and 10% respectively. Number of observations = 150, and standard errors are in parentheses.

(Boahene et al., 1999).

Determinants of collective marketing of sorghum

Probit results (Table 5) showed that buyer distance, selling price, seasonal income, household gender, seed source, total costs, input distance, output quantity, and group production statistically significantly affected collective marketing. The rest of the factors were not statistically significantly affecting collective marketing and included sorghum farm size and family size. As such, the null hypothesis that the socio-economic factors, proximity to bulking store, and access to embedded services positively and significantly influence collective marketing was rejected for selling price, household gender, total costs, input distance, output quantity, and group production. Additionally, the same hypothesis could not be rejected for buyer distance, seed source, and seasonal income. Overall, this study stands to conclude that collective marketing is influenced by buyer distance, selling price, seasonal income, household gender, seed source, total costs, input distance, output quantity, and group production.

Buyer distance (km) (dy/dx= 0.18, p<0.01)

An increase in distance from home to the market significantly (1%) increases the probability of farmers selling through collection centers by 18% with other factors held constant. Selling through collection centers by distant farmers could be seen as a way of reducing transportation costs due to the fact that farmers who are far are always offered free means by the collection center agents (Ellepu and Nalukenge, 2009). This finding agrees with Fischer and Qaim (2012) that distance increases the probability of participation in collective marketing.

Selling price (shs) (dy/dx=-2.78, p<0.01)

A decrease in selling price significantly (1%) decreases the probability of farmers selling through collection centers by 278% with others factors held constant. This is expected because when selling price increases, a farmer also stands chances of earning higher incomes. The finding is in agreement with Vorlaufer et al. (2012) that farmers respond positively to prices.

Sorghum sales income (shs) (dy/dx= 0.15, p<0.01)

An increase in sales income significantly (1%) increases the probability that farmers sell through collection centers by 15% with other factors held constant. Farmers selling through collection centers normally farm on contract with the collection center agents; so their prices are higher and more stable as compared to individual sellers who are at the mercy of the local traders (Elepu and Nalukenge, 2009). The finding agrees with Vorlaufer et al. (2012) that farmers respond positively to prices.

Table 6. OLS results after Probit for determinants of marketable surplus of sorghum including Invmills as an explanatory variable.

LNsell	Coef.
Household size	.06(.03)*
LNBuyer distance	-1.52(.21)***
LNSelling price	4.44 (.89)***
"*Epuripur*" farming experience	.05 (.03)*
Transport means	-.12(.19)
LN extension visit	.63(.50)
LN Total costs	.14 (.03)***
LN Inputdistance	1.71(.19)***
Invmills	5.72(.43)***
_cons	-32.18(6.23)***
Number of observations	150
F(9,140)	29.85
Prob>F	0.00
R-Square	0.66
Adj. R-square	0.64

***,**, and * are significance levels at 1, 5 and 10% respectively and standard errors are in parentheses.

Household head gender (dy/dx= -0.15, p<0.01)

Other factors held constant, females as household head significantly (1%) decreases the probability of selling through collection centers by 15%. This could be due to their reproductive responsibilities in addition to farming. Additionally, female headed households are resource constrained, thereby affecting production of a marketable surplus. Moreover, female headed households are more likely to be concerned about securing food for the family, such that subsistence oriented agriculture would be pronounced for such households (Ouma et al., 2010). The finding is substantiated by Cunningham et al. (2008) idea that men enjoy trading more than women do.

Seed source (dy/dx= 0.19, p<0.05)

Other factors held constant, buying seeds from agents other than from shops significantly (5%) increase the probability of selling through collection centers by 19%. This is true because agents are the owners/leaders at the collection centers and they always give seeds on credit to farmers on condition that they sell back the produce to them (Elepu and Nalukenge, 2009). The finding is in line with van Wijk and Kwakkenbos (2011)'s idea that access to improved technology enhances farmers' market participation.

Total costs (shs) (dy/dx= -0.02, p<0.1)

Other factors held constant, an increase in total costs incurred by a farmer significantly (10%) reduces the probability of farmers selling through collection center by 2%. This line of argument is substantiated by Makhura (2002) who explained that when smallholder farmers are faced with high transaction costs, they will either stop participation in marketing or resort to other means of marketing such as spot markets.

Input access (km) (dy/dx= -0.18, p<0.01)

An increase in distance from home to inputs shops significantly (1%) decreases the probability of selling through collection centers by 18% with other factors held constant. This is true because higher distances increase transportation costs and time taken on the road. Higher transportation costs and longer time spent to reach input stores discourages farmers from participating in the market (Ouma et al., 2010). The finding agrees with Key et al. (2000) and Makhura (2002) that distance to the market negatively influences both the decision to participate in markets and the proportion of output sold.

Output quantity (kg) (dy/dx= -0.13, p<0.05)

A decrease in output quantity significantly (5%) reduces the probability of selling through collection centers by 13%; other factors held constant. Bigger output quantities influence farmers to sell through a collection center to access wider markets and earn higher profits. The finding agrees with Fischer and Qaim (2012), that low yield discourage collective marketing.

Table 6. OLS results after Probit for determinants of marketable surplus of sorghum including Invmills as an explanatory variable.

LNsell	Coef.
Household size	0.06(0.03)*
LNBuyer distance	-1.52(0.21)***
LNSelling price	4.44 (0.89)***
"*Epuripur*" farming experience	0.05 (0.03)*
Transport means	-0.12(0.19)
LN extension visit	0.63(0.50)
LN Total costs	0.14 (0.03)***
LN Inputdistance	1.71(0.19)***
Invmills	5.72(0.43)***
_cons	-32.18(6.23)***
Number of observations	150
F(9,140)	29.85
Prob>F	0.00
R-Square	0.66
Adj. R-square	0.64

***,**, and * are significance levels at 1, 5 and 10% respectively and standard errors are in parentheses.

Group production (mfx= -0.25, p<0.1)

Exclusion from group production significantly (10%) decreases the probability of selling through collection centers by 25% with other factors held constant. Exclusion by a farmer from group production limits contractual links to both input and output markets, thereby reducing on market participation. This is because farmer groups mobilize producers to participate in markets, enable contractual links to input and output markets and enhances the competitiveness of agro-enterprises. The finding agrees with Shiferaw et al. (2009) that farmer groups increase market participation.

Determinants of marketable surplus of sorghum with the Invmills as an additional explanatory variable

OLS results (Table 6) showed that household size, selling price, *"epuripur"* farming experience, total costs incurred by a farmer, input access, and the Invmills positively and significantly influence marketable surplus. Buyer distance negatively and significantly influenced marketable surplus and factors including transport means, and frequency of contact with extension had no significant effect on marketable surplus. Therefore, the hypothesis that selling price, household size and other socio-economic factors positively and significantly influence the level marketable surplus could not be rejected for selling price, household size, *"epuripur"* farming experience, total costs and input access. However, the same hypothesis was rejected for buyer distance.

The measure of goodness of fit (F(9.140) = 29.85; p<0.01) showed that the overall model was highly significant and so empirical data fitted well the estimation model. The co-efficient of determination (Adj. R^2) was 0.64 which meant that the model selling specification has a strong explanatory power. Accordingly, independent variables collectively explain 64% variance in marketable surplus (Table 6). On the basis of overall model significance, this study can therefore generally infer that marketable surplus was largely improved by selling price, input access, and total costs.

Household size (number) (coeff= 0.06, p<0.1)

Other factors held constant, an increase in household size significantly (10%) increases marketable surplus by 6%. Family size guarantees labor availability and labor availability increases production; which consequently increases marketable surplus (Ouma et al., 2010). This finding agrees with (Omiti et al., 2009) that a larger household provides cheaper labor and produces more output in absolute terms such that the proportion sold remains higher than the proportion consumed.

Buyer distance (km) (coeff= -1.52, p<0.01)

Holding other factors constant, a one percentage increase in distance from farmers to buyers significantly (1%) reduces the level of marketable surplus by 1.52%. This is because longer distances come with higher costs in terms of transport, time and communication. These costs reduce the price received by farmers, which

discourages market participation and marketable surplus of a farmer. The finding agrees with Makhura (2002) that distance to the market negatively influences both the decision to participate in markets and the proportion of output sold.

Selling price (shs.) (coeff= 4.44, p<0.01)

While other factors are held constant, a percentage increase selling price significantly (1%) increases marketable surplus by 444%. This is expected because farmers always respond positively to prices in order to make sufficient profits from sales. This finding agrees with Omiti et al. (2009) that unit price acts as an incentive by significantly increasing the percentage of marketable surplus.

"Epuripur" farming experience (years) (coeff= 0.05, p<0.1). While other factors are held constant, an increase in "*epuripur"* farming experience significantly (10%) increases marketable surplus by 5%. Farming experience reflects the accumulation of expertise in farming but is also linked to repeated transactions which in turn reinforces trust and builds networks that a household needs to facilitate market information exchange Gabre-Madhin (2001), and such expertise and market information stimulates marketable surplus. This finding is in agreement with Ouma et al. (2010) that farming experience increases marketable surplus.

Total costs (Shs.) (coeff= 0.14, p<0.01)

A percentage increase in total costs incurred by a farmer significantly (1%) increases marketable surplus by 0.14%, while other factors are held constant. Costs raise the price effectively paid by buyers and lower the price effectively received by sellers of a good, creating a price band within which some farmers find it unprofitable to either sell or buy (Key et al., 2000), which ultimately reduces marketable surplus of a farmer. However, the finding is contrary to Makhura (2002), that high transaction costs discourage farmers market participation and could be due to other factors that are not explained by the study.

Input access (Km) (coeff= 1.71, p<0.01)

While holding other factors constant, a percentage increase in kilometers from a farmer to input sellers significantly (1%) increases marketable surplus by 1.71%. This is not expected because higher distances increase costs like transportation, time taken on the road, communication, among others, which discourage farmers from participating in the market (Oumaet al., 2010) and therefore ultimately reduces marketable surplus. The finding is contrary to Key et al. (2000) and Makhura, (2002) that distance to the market negatively influences both the decision to participate in markets and the proportion of output sold. This could be due to other factors that are not explained by this study. Therefore marketable surplus is significantly influenced by household size, buyer distance, selling price, *"epuripur"* farming experience, total costs, and input access as discussed above.

The invmills (coeff=5.72, p<0.01) revealed that if it had not been introduced to the model to adjust selection bias, most parameter estimates would be inaccurate, and the effect of the bias would tend to underestimate the probability of a farmer's self-selectivity for collective marketing. These farmers self-select themselves into collective marketing and the factors or conditions that increase a one's probability of being selected for collective marketing include; long buyer distance, low selling price, higher sorghum sales income, males, agency seed source, low costs, and shorter input distances.

CONCLUSION AND RECOMMENDATIONS

A farmer's choice of marketing arrangements is related to household head gender, marital status, seed source, road type, sorghum variety, pesticide use, output quantity, quantity sold, feeds quantity, education, input access, buyer distance, seasonal income, farming experience, land use and farm size. Collective marketing is largely improved by buyer distance, seasonal income, and seed source. On the other hand, due to collective marketing, marketable surplus is largely improved by the selling price, costs, and input access. Surprisingly, farmers self-select themselves into collective marketing considering; buyer distance, selling price, seasonal income, household head gender, seed source, costs, and input access. It is recommended that collective marketing be promoted and enhanced by agri-businesses and policy makers to improve sorghum marketing in Uganda.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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