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Table of Content: Volume 10 Number 7 July 2018

ARTICLES

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Full Length Research Paper

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 4^{th}person 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:

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

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:

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

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

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:

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

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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Technical efficiency and profitability of potato production by smallholder farmers: The case of Dinsho District, Bale Zone of Ethiopia

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The study aimed to analyze the technical efficiency and profitability of potato production by smallholder farmers in Dinsho District of Bale Zone of Ethiopia. Cross sectional data collected in 2015/16 production year from 147 surveyed households was utilized in achieving these objectives. Non-parametric net crop revenue analysis and Cobb-Douglas stochastic frontier approach were used to analyze enterprise profitability and to estimate the technical efficiency levels in potato production, respectively. The result of net crop revenue analysis indicated that potato production was profitable wherein the producers had earned net return of about 11,740.9 ETB (Ethiopian Birr). Further analysis of the gross and net income data showed wide variation of the results between harvesting seasons and off-peak season. The test result of Cobb-Douglas stochastic frontier indicated that the relative deviation from the frontier due to inefficiency was 94%. The mean technical efficiency of farmers in the production of potato was 0.89. The estimated stochastic production frontier model indicated that area of the plots, amounts of NPS fertilizers, amount of seed and labor in man-days were positive and significant determinants of production level. The estimated SPF model together with the inefficiency parameters showed that age, age square, education, land ownership status, extension contact, number of plots (fragmentation), household size and livestock significantly determined efficiency level of farmers in potato production in the study area. To this end, the attention of policy makers to improve agricultural production should not revolve solely around the introduction and dissemination of new technology to increase yield, but also more attention should be given to improve the existing level of efficiency.

Key words: Ethiopia, potato, profitability, stochastic production frontier model, technical efficiency.

INTRODUCTION

Agriculture is the most significant contributor to Ethiopia's national economy (World Bank, 2006). It employs about 85% of the total labor force (MoFED, 2013). Moreover, the share of agriculture to total export proceeds increased consistently from about 63% in 2002/2003 to 82% in 2008/2009, though it slightly declined to 71% in

2010/2011.

In contrast to this, the share of non-agricultural goods (merchandise goods and gold) was, by and large, constant during the same period with a slight increase since 2008/9 (EEA, 2013).

Agriculture accounted for 43% of GDP in 2012/13 fiscal year (MoFED, 2013). The World Bank (2006) noted that "The dominant agricultural system in Ethiopia is smallholder production under rain-fed conditions." The same report shows that there is strong positive correlation between growth in GDP as well as per capita GDP and agriculture and crop production which further demonstrates the importance of agriculture to the Ethiopian national economy. All these factors direct the country's development policies, strategies and objectives towards improving the agricultural sector and the livelihood of rural population. In this context, various efforts were made by the preceding regimes. However, the sector could not produce enough food to support the rapidly increasing population. Consequently, both chronic and transitory food insecurity problems continue at the household level in Ethiopia (FAO/WFP, 2012).

According to the Global Hunger Index (2013), levels of hunger are still "alarming" or "extremely alarming" in 19 countries, including Ethiopia, meaning food security is an urgent issue. Potato (*Solanum tuberosum* L.) has great potential when it comes to food security (UNDP, 2014). Thus, among the crops that have increasingly gained importance to overcome food insecurity problems in Ethiopia is potato. The potential of potato for food security is increasingly being noticed as witnessed by growing interest of private investors and policy makers in this crop. In recent years, potato production has expanded because of the availability of improved technologies, expansion of irrigation structure and increasing market value (EIAR and ARARI, 2013). However, the average yield in Ethiopia reaches only 7 tons/ha when the potential for smallholder is around 25 tons/ha (EIAR and ARARI, 2013). Furthermore, as cited in EIAR and ARARI (2013), for Sub-Saharan Africa (SSA), Scott et al. (2000) projected a 250% increase in demand for potato between 1993 and 2020, with an annual growth of 3.1%. The growth in area under production is estimated at 1.25% a year, the rest of the increase being achieved through predicted growth in productivity. Increased potato productivity will play a buffer role to the increasing food prices; thus, enhance household income in the project countries with a spill over to other countries in SSA.

In the study area also, there is a problem of food insecurity. According to the Dinsho District's Agricultural Office data (2015), more than 8,000 people have received relief food assistance only for the second half of 2015 fiscal year. In this regard, production of potato has great food security potential in the District. Farmers chose to increase the production and marketing of these enterprises, among others based on the potential that the crops had in the study area (Dinsho District Agricultural Office (DDAO), 2014). However, given the mounting pressure on land, sustaining higher rates of growth in agriculture production requires substantial improvements in factor productivity. Consequently, transformation in the structure of production (mostly subsistence-based) to more commercially-oriented production will be key in sustaining growth. In an economy where resources are scarce and opportunities for new technologies are limited, efficiency studies will be able to show that it is possible to raise the productivity by improving efficiency without raising the resource base or developing new technology (Tijani, 2006). Estimate of the extent of efficiency also help in deciding whether to improve efficiency or to develop new technology to raise farm productivity. Consequently, this study was undertaken in Dinsho District of Bale Zone of Ethiopia to assess profitability and technical efficiency of potato production by:

1. Measuring the existing level of technical efficiency in the production of potato in the Dinsho District.
2. Identifying the determinants of technical efficiency of potato production in the study area and;
3. Determining the profitability of potato production in the study area.

METHODOLOGY

Description of the study area

Dinsho District (7°10′ -7.167°N and 39°55′- 39.917°E; DDAO, 2014) is one of the 18 Districts found in Bale Zone. The administrative town of the District is Dinsho, located 400 km from Addis Ababa and 30 km from Bale Zone's administrative town of Robe town. There are 9 rural kebeles and one-town dwellers association in Dinsho District. According to the 2007 National Census, the total population of Dinsho District was 68,675 (48.35% males and 51.65% females); 11.38% of the populations were urban dwellers (CSA, 2007). The people's livelihood strategies mainly depend on mixed farming. The majority (85.98%) of the inhabitants were Muslims, while 13.65% were Ethiopian Orthodox Christians (DDAO, 2014). The altitude of the District is estimated at 1,500 m and 3,644 m above sea level. Two agro-climatic zones cover the

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Table 1. Distribution of sampled kebeles and households.

Total Number of kebeles	Sampled kebeles	Household per kebeles	Sampled households
9	Abbakara	1094	65
	Hoomma	431	26
	Zaalloo Abaaboo	950	56
	3	2475	147

District, namely 'Dega[1]' (95%) and 'Woinadega[2]' (5%) and are indicative of the District's potential of being potato production area. Mean annual rainfall ranges from approximately 3,400 mm to 4,500 mm with mean annual temperatures varying from -3°C to 24°C (DDAO, 2014).

Sample size and sampling techniques

Sample size determination

Sample size was calculated according to Yamane (1967):

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

Where n is the sample size, N is the population size, and e is the level of precision. In order to determine the required sample size (total number of households) for this study following Yamane (1967), at 95% confidence level, 0.5 degree of variability and 8% level of precision:

$$n = \frac{2475}{1 + 2475(0.08)^2} = \frac{2475}{16.84} = 146.95 \approx 147$$ (Total number of farm households)

Sampling techniques

Since farm household heads were responsible for day-to-day farming activities, they were taken as the basic sample unit in this study. Potato was produced by almost all households in the study area. However, to draw the required sample for this study, first complete list of the household data including the socioeconomic characteristics of the households were obtained from the district's agricultural office after which producers and non-producers were differentiated. After that only those households producing potato during the survey period (2015/2016) were included in the sample selection. The distribution of the sampled kebeles and households drawn using random sampling techniques and probability proportional to size of each kebele's population are shown in Table 1.

Sources and method of data collection

This study mainly relied upon primary data sources that were collected from a semi-structured questionnaire given to sampled respondents by trained enumerators. Key informant interview was used to support the information collected though questionnaire. Relevant secondary data sources were also assessed to supplement the primary data.

Methods of data analysis

Non-parametric analysis

Net crop revenue analysis was used to provide descriptive evidence of enterprise profitability through the following steps:

GFB = OPH *AVP (2)

Where: *GFB* is gross field benefits, *OPH* is output harvested, and *AVP* is the average selling price. Based on the GFB value calculated in equation (2), net crop revenue was calculated as:

NR = GFB -TVC (3)

Where: *NR* is net returns, and *TVC* is total variable cost.

Finally from NR, a return to factors used in the production of potatoes was calculated by using return to variable cost (RVC) as follows:

RVC= NR/TVC (4)

Parametric method

Crop production in general in the study area and potato production in particular are likely to be affected by random weather events and pest infestation. Additionally, measurement errors are likely to be high. Thus, given the inherent stochastic nature of crop production (Coelli et al., 2005), the stochastic frontier production function approach appears to be an appropriate method for estimating technical efficiency in agriculture of potato production in Dinsho District. However, the difficulty of specifying in advance an appropriate functional form for the data at hand is one shortcoming of the stochastic frontier model. In stochastic frontier model, the two most important functional forms widely utilized were Cobb-Douglas and Translog production functions. Both functional forms have their own strengths (Haileselassie, 2005) and short- comings (Haileselassie, 2005). Therefore a generalized likelihood ratio test was used to determine an appropriate functional form to fit the data used in the present study. The Generalized log-likelihood ratio (LR) was calculated based on the hypothesis that all interaction terms were zero including the square specification (in the translog functional form):

LR = −2 [L (Cd) − L (Tl)] (5)

Where: LR = Generalized log-likelihood ratio

[1] Commonly used Ethiopian term for areas of altitude above 2400 meters

[2] Commonly used Ethiopian term for areas of altitude between 1800 and 2400 meters

L (Cd) = Log-likelihood value of Cobb-Douglas
L (Tl) = Log-likelihood value of translog

Following Coelli et al. (2005), the farm's technology is represented by a stochastic production frontier as follows:

$Y_i = f(X_i; \beta) + \epsilon_i$: i = 1, 2, 3...n. (6)

Where, Y_i represents output of potato for the i^{th} farmer in quintals/ha, *f(X; ß)* is a suitable production function, X_i are the inputs used in production of potato in units/ha, βi are the coefficients to be estimated, ϵ_i is a composite error term defined as:

$Є i = v_i - u_i$ (7)

Where: v_i represents random errors assumed to be distributed IID N $(0, \delta_v^{\ 2})$ and capture events beyond the control of farmers. u_i (where $u_i \geq 0$; N $(\mu, \delta_u^{\ 2})$) capture technical inefficiency effects in the production of potato. According to Battese and Coelli (1995), the influence of the inefficiency component can be measured by:

$$\gamma = \frac{\delta_u^{\ 2}}{\delta_s^2} = \frac{\delta_u^{\ 2}}{\delta_v^2 + \delta_u^{\ 2}} \quad (8)$$

Where:
γ - is the parameter which measures the discrepancy between frontier and observed levels of output and is interpreted as the total variation in output from the frontier attributable to technical inefficiency. It has a value between zero and one.
$\delta_u^{\ 2}$ - is the variance parameter that denotes deviation from the frontier due to inefficiency;
δ_v^2 -is the variance parameter that denotes deviation from the frontier due to noise;
δ_s^2 -is the variance parameter that denotes the total deviation from the frontier.

The empirical model of the Cobb-Douglas production function for potato production in its logarithmic form is specified as follows:

$$\ln(y) = \beta_0 + \sum \beta_i \ln x_i + v_i - u_i \quad (9)$$

Where:-
y - is the total output of potato obtained during the survey period in quintal,
ln - natural logarithm,
X_1 (Area) – is the total area of land in hectare allocated for potato crop by the i^{th} farmer.
X_2 (Oxen power) - the total number of oxen days used by the i^{th} farmer[3]
X_3 (Amount of seed) - is the amount of seed used in kg,
X_4 (Amount of NPS[4] fertilizer used) - amount of NPS chemical fertilizer used in kg,
X_5 (Amount of Urea used) - amount of UREA chemical fertilizer used in kg,
X_6 (Labour) - is the total amount of labour in man-days equivalent,
β_1 - parameters to be estimated,

The inefficiency model based on Battese and Coelli (1995) was specified as follows:
$u_i = g(Z_i: \sigma i)$

Where,
u_i -Technical inefficiency error term
δ_i - Vectors of coefficients to be estimated
Z_i -Vectors of explanatory variables defined in the next section.

Given the specification of the stochastic frontier production function defined in equation 10, the technical efficiency of the i^{th} farmer is:

$TE_i = exp(-u_i)$ (11)

The ML estimates of technical efficiency effects of the model were estimated using a software package FRONTIER VERSION 4.1 (Coelli, 1996) specifically designed for the estimation of efficiency.

Definition of efficiency variables and hypothesis

Based on previous studies and socio-economic conditions of the study area, the following factors were expected to determine technical efficiency differences among farmers.

Age: is the age of the household head in years which is hypothesized to reflect the experience of the farmer in farming. The finding of Jwanya et al. (2014) showed that the experience of farmer in farming is the significant factor differentiating the technical efficiency of farmers. However, as the farmer gets older his managerial ability is expected to decrease. To see the diminishing effect of age on efficiency a quadratic functional form is specified in the inefficiency effects model. Hence, the age and the age square were hypothesized to have positive and negative effect on technical efficiency of potato production, respectively.

Education: Formal education commonly measured in years of schooling of the farmer has received most of the attention in the frontier efficiency literature. From empirical studies reviewed education is one of the most recognized factors in determining efficiency level of farmers in many area of the world. In this study, education measured in years of schooling was hypothesized to determine TE positively. The results of different researchers in different area showed the same result confirming this hypothesis (Dolisca and jolly, 2008; Bonabana-Wabbi et al., 2012; Jwanya et al., 2014).

Land ownership: this is a dummy variable taking a value of 1 if the household head was cultivating owned and/or hired land and 0 if it was sharecropped land. Land ownership is one of the variables that were considered in performance evaluation. Farmers may tend to be more efficient in managing those lands that are owned and hired than sharecropped lands. This is because; they tend to give priority to their own land in all aspects. They may do so because outputs that will be obtained from sharecropped lands are eventually shared between the owner and the operator farmer. Therefore, farmers who were managing either their own land or hired land were expected to be more efficient than those farmers who were managing sharecropped land.

Farm size: Measured in terms of landholding size in hectares was

[3] One oxen-day is equivalent to plowing with a pair of oxen for 8 hours.
[4] NPS fertilizer is new fertilizer released to the area and used instead of DAP.

expected to determine the efficiency differential of farmers in the study area. As farmers holding large farm size have the capacity to use compatible technologies that could increase the efficiency of the farmer, relatively farmers holding large farm size in the study area were expected to be more efficient.

Extension contact: It is the frequency of contact between extension workers and potato producer. It influences the growth of agricultural by assisting the dissemination of new technologies to farmers as a way of increasing agricultural productivity. Therefore, farmers who have had more extension contact were expected to be more efficient than others. Abdullah et al. (2006) obtained the result where extension contact was the significant variable influencing the efficiency level of producers in the study area.

Household size: It measured the size of households in terms of adult equivalent. In the rural areas, household members are an important source of labour supply used in production of crops. In addition, farmer who has large household size would manage crop plots on time. Thus, household size was hypothesized to determine efficiency level positively.

Sex: this is a dummy variable taking a value of 1 if the household head is male and 0 otherwise. Bonabana-Wabbi et al. (2012) came up with the conclusion that sex of the household head is the important determinant efficiency where females were obtained as more efficient than males. However, according to Abebaw (2003) and Abonesh (2006) male headed household are in a better position to pull labor force than female headed ones indicating more male efficiency. Thus, in this study the sign of sex of household head on efficiency was pre-indeterminate.

Fragmentation: Fragmented lands are difficult for effective management of the crop. A farmer having more plots is expected to loss time by moving between plots. Farmers who have large numbers of plots in the same place would be expected to be more efficient than those farmers owning fragmented plots; because fragmentation of plot would make difficult to perform farming activities on time and effectively. Therefore, fragmentation measured in numbers of plots was hypothesized to determine efficiency negatively. Fekadu (2004) obtained the same result.

Livestock: It refers to total number of livestock owned by the farm households measured in tropical livestock units (TLU). Livestock supplements the production of crops in various ways. The income obtained from livestock serves to invest on crop production especially to purchase inputs. Livestock manure could also be used to improve soil fertility. It is also the main sources of animal labour in crop production. Thus, livestock was hypothesized to determine efficiency positively. In line with this hypothesis, Temesgen and Ayalneh (2005) obtained similar result.

Irrigation: this is a definition of dummy needed; It refers to the access of the farmers to irrigation scheme used to increase the production of potato in the study area. Farmers using irrigation are expected to be more efficient than those farmers producing without using irrigation. Thus, it is a dummy variable hypothesized to affect the efficiency level of farmers positively. Huynh and Yabe (2011) confirmed this hypothesis.

Credit use: It refers to the amount of money borrowed from different credit sources. Credit use for the purpose of purchase of agricultural inputs like improved seed, chemical fertilizers, etc. are expected to improve efficiency level of the farmers. Consequently, households who are getting the amount of credit they required were expected to be more efficient than others. Dolisca and Jolly (2008) reported the amount of credit received is positively related with efficiency. Thus, following this finding the amount of credit received was hypothesized to be positively related with efficiency.

Income from off/non-farm activities: It refers to the sum total of earnings generated in the survey year from activities outside farming like retail trading business, casual work on wage basis, etc. When income earned from crop production and sales of livestock and livestock products are inadequate, households often look for other income sources other than agriculture to finance their farming activities. Consequently, income earned from such activities enables households to increase their efficiency level. Jwanya et al. (2014) reported households earning higher off/non-farm income were more efficient. Therefore, in this study, in line with this finding, household who were earning higher off/non-farm income were expected to be more efficient.

RESULTS AND DISCUSSION

Profitability analysis

Enterprise cost analysis

The summary of total variable cost of potato production consisting of cost of labor (both hired and family labor), cost of fertilizer, cost of chemicals, cost of seeds and cost of oxen labor are presented in Table 2. The opportunity costs were used to calculate the out-of-pocket expenses of some inputs. According to results, cost of seed, oxen, labor and fertilizers were the most important input which contributed significantly to the total variable cost of potato production. In contrast, the share of chemicals from the total cost of production was low. This was attributed to the fact that major activities in production of potato including land preparation, weeding and harvesting were undertaken by utilizing either more labor force or oxen labor, or both. Application of herbicide and pesticide was low and when weeding was necessary, it was mostly done by hand.

Profitability assessment

Results presented in Table 3 show that the net return that the farmers obtained from production of potato was about ETB 11,740.9 per year which implies that potato producers were making a profit at an average price. Returns to variable cost was about ETB 1.51 per year which implies that for each Birr invested in variable input used in production of potato the return would be ETB 1.5 per year.

Seasonal effect

On average, the potato price was ETB 294.28/quintal. The peak potato-harvesting season in the district occurs

Table 2. Enterprise cost analysis.

Input category	Average costs	Share from total variable cost (%)
Family labor	1,757	22.46
Hired labor	83.5	1.07
Total labor	1,840.51	23.53
NPS fertilizer	1,764.54	22.56
Urea	0	0
Chemicals	170.15	2.18
Seed	2,163.44	27.66
Oxen labor	1,883.33	24.08
Total variable costs	5,274.017	100

Table 3. Gross margin analysis of potato production.

Variables	Potato
Average area planted (in ha)	0.513
Average output	66.81
Gross income at average prices	19,661.01
Total variable costs	7,821.97
Net returns	11,839.04
Returns to variable costs	1.51

in October and December. Price analysis revealed a wide seasonal variation in potato prices between harvest and off-peak periods. Price margins of about ETB 500/quintal was observed. As expected, prices were highest during the off-peak periods and dropped during the peak harvesting periods. Potato prices varied from a low of ETB 100/quintal to ETB 650/quintals, corresponding to the peak harvest period and the off-peak seasons, respectively (Figure 1). In addition, there was also a wide variation in gross income and net income earned by surveyed households across seasons. According to results presented in Table 4, gross incomes and net returns were highest during the off-peak seasons and lowest at harvesting. These results highlight the importance of delaying harvesting seasons. In this regard, some farmers in this study area can delay the potato harvesting season by leaving potato products underground and planting other short period products on top for a given period.

Econometric results

Tests of hypothesis

In the first case, the functional form that better fit to the data at hand was tested by using likelihood ratio (LR). Results presented in Table 5 show that the computed LR value was 20.74 and is lower than the upper 5% critical value of the $\chi 2$ at 15d.f (It is the number of interaction terms and square specifications in the translog restricted to be zero in estimating the Cobb-Douglas functional form). This shows that the coefficients of the interaction terms and the square specifications of the input variables under the Translog specifications are not different from zero. As a result, the Cobb-Douglas functional form specified in the methodology was obtained as the best fits for the data. In the second case, the existence of inefficiency component of the total error term of the stochastic frontier specification ($\gamma = 0$ or $\gamma > 0$) was tested using LR statistics. The higher LR value revealed the existence of inefficiency or one-sided error component in the model. According to the results presented in Table 5, the null hypothesis stating that all coefficient of the inefficiency effect model are simultaneously equal to zero was rejected in favor of the alternative hypothesis which stated that all explanatory variables associated with inefficiency effects model were simultaneously different from zero.

The discrepancy ratio (γ) calculated from the maximum likelihood estimation of the full frontier model was 0.940. The results indicate that 94 percent of the variability in potato output in the study area in the survey year was due to technical inefficiency effect, while the remaining 6 percent variation in output was due to random noise effect.

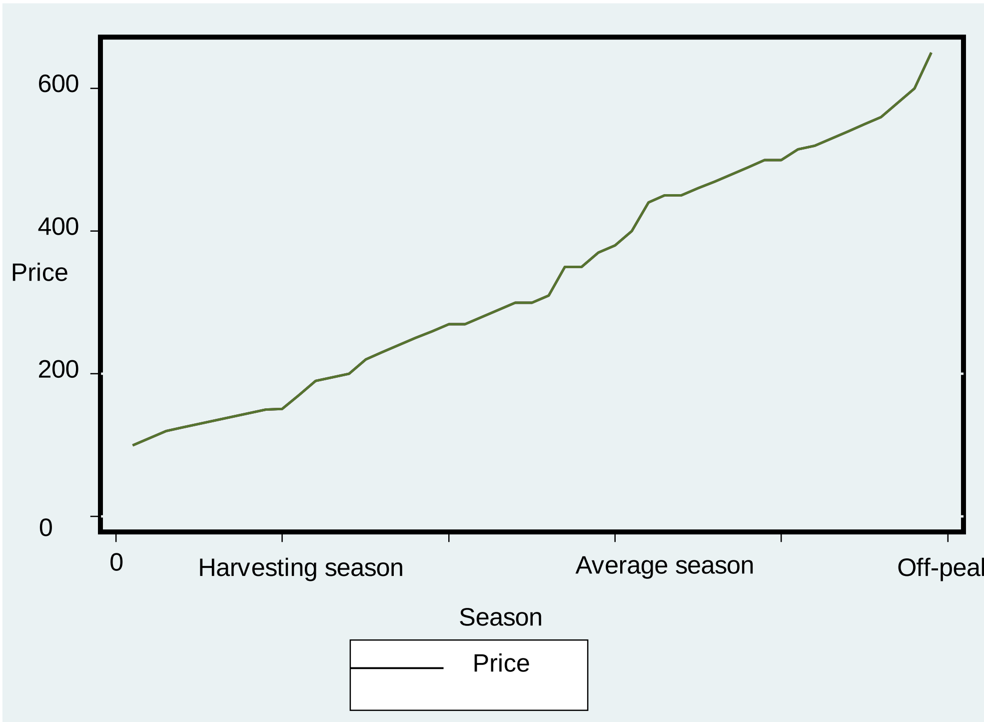

Figure 11. Seasonal price variation of potato

Table 4. Gross income analysis across seasons.

Period	Average gross income	Average net return
Harvesting season	9,948.46	2,126.49
Average season	17,438.54	9,616.57
Off peak season	31,596.03	23,774.06

Table 5. Generalized likelihood-ratio test of hypotheses for parameters of SPF.

Null hypothesis	LR value	Critical value	Decision
H_o: $\beta_{ij=0}$	20.74	25	Accept the null
H_o: $\gamma = 0$	38.37	3.841	Reject the null
H_o: $\delta_1 = \delta_2 = \delta_3 = ... = \delta_{12} = 0$	58.133	18.31	Reject the null

Parameter estimates of SPF model

In the estimation of the Cobb-Douglas production frontier, one stage estimation procedure was utilized in which both the determinants of the production frontier and inefficiency effect were included in the model. In this estimation process two variables including urea and irrigation were hypothesized as the important determinants of production frontier and inefficiency effects, respectively. However, these variables were dropped from the model because they were not used in the potato production under analysis. Farmer in the study area did not include urea as part of their potato production. Irrigation was used for other crops other than

Table 6. Maximum-likelihood estimates of SPF model

Variables	Cobb-Douglas		
	Coefficient	Standard error	t-ratio
Constant[a]	2.14***	0.34	6.30
Area	0.30 ***	0.11	2.70
Oxen	0.16	0.10	1.54
Seed	0.30***	0.06	5.34
NPS fertilizer	0.08 *	0.05	1.82
Labor (MD)	0.32***	0.32	3.42
Sigma-squared	0.360***	0.04	6.023
Gamma	0.940***	0.07	12.91
Log likelihood function	58.29		

a, natural log values of the constant term
***,**, *significant at 1%, 5% and 10% level of significance

potato. Results presented in Table 6 show that area of the plot, seed, NPS fertilizer and labor were positive and significant input variables that affect potato production in the area.

Estimation of farm level technical efficiency

Given the functional form used, the results presented in Table 7 show that the mean efficiency level of the sampled farmers was 89%. This value shows that, on average, farmers can increase their current output level by 11% without increasing the existing levels of inputs. Conversely, farmers on average could decrease inputs (area, NPs fertilizer, and seed) by 11% to get the output they are currently getting if they use inputs efficiently. Moreover, according to results presented in Table 8, in the study area there was significant variation in efficiency level among the sampled farmers. However, given these variation in the efficiency level of the sampled farmers, most of the surveyed households achieved an efficiency level greater than their mean level. This indicates that, in the long run there is a need for introducing of new technology besides improving the current efficiency levels of the farmers to increase the output level of potato in the study area.

Table 7. Estimated technical efficiencies of the sampled farmers

Statistics	TE estimates
Mean	0.89
Standard deviation	0.09
Minimum	0.51
Maximum	0.98

Table 8. Distribution of the sampled farmers by technical efficiency levels

TE level	Percent
0.5-0.6	1.36
0.6-0.7	6.12
0.7-0.8	7.48
0.8-0.9	22.45
0.9-1	62.59

Determinants of technical efficiency

One-stage estimation technique was used in this study. The results of the estimation were presented in Table 9. In the next section, the effect of significant inefficiency variables on the technical efficiency of the farmers in the study area would be discussed by decomposing them into three major groups.

Demographic factors

Age of the household head: This variable was found to be a significant variable in explaining the variation in technical efficiency among farmers considered. These indicate that older age positively affects technical efficiency in potato production, likely because older farmers tend to be more experienced in various timing-related aspects of farm management until they reach

Table 9. Maximum-likelihood estimates of the inefficiency variables.

Variables	Coefficients	Standard error	t-ratio
Constant	3.392**	0.57	5.951
Age	-0.132**	0.053	-2.486
Age square	0.002*	0.001	1.932
Education	-0.185*	0.103	-1.797
Landownership	-3.833**	1.202	-3.190
Farm size	-0.059	0.083	-0.706
Extension contact	-0.552**	0.225	-2.454
Household size	0.270**	0.104	2.581
Sex	-0.718	0.543	-1.322
Fragmentation	-0.266**	0.104	-2.549
Livestock	-0.205*	0.101	-2.025
Credit use	0.0003	0.001	0.505
Income from off/non-farm activities	0.000	0.000	0.000

***, **, * significant at 1, 5 and 10% significance level respectively
Source: Own computation (2016).

certain age level. After that age level, experiences may saturate and the marginal effect on improvement on technical efficiency might decrease. Our finding is consistent with what other researchers have found (Fekadu, 2004; Kinde, 2005; Getachew and Bamlak, 2011), that farm management practices improve over the years as farmers become more experienced. Moreover; farmers may accumulate good command of resources such as labor, oxen and farm tools thus enhancing production efficiency: more farm resources, faster inputs application in crop production and improved farm efficiency (Getachew and Bamlak, 2011).

Education: Statistically, educational level of the household head significantly affects the famer's efficiency level. That is, farmers with more years of schooling were found more technically efficient than their counterparts. Reason being that, educated farmers may have relatively adequate knowledge to apply improved methods to agricultural activities and, consequently, be more technically efficient. This result agrees with the empirical findings of different studies (Getachew and Bamlak, 2011; Huynh and Yabe, 2011).

Household size: Contrary to our expectation, the results showed that larger household size negatively affects efficiency in potato production (coefficient = 0.270, p≤0.05). This result is consistent with the finding of Ani et al. (2013) and Fekadu (2004).

Resource endowments factors

Landownership: The result shows that ownership is positively significant in determining the efficiency level of farmers in producing potato (coefficient = -3.833, p≤0.05). That is, farmers are more efficient in managing their own land or hired land than farmers who manage sharecropped land. This is because farmers tend to prioritize their own land in all aspects. Fekadu (2004) also found similar results in his empirical study.

Fragmentation: Contrary to expectation, number of plots positively affected the technical efficiency level of the farmers in the study area. Farmers who have large number of plots in different areas were more efficient than farmers who had large number of plots in the same area. This is because farmers who were cultivating their crops in different plots are not equally exposed to natural hazards such as frosts which are the most common threats to crops in the area. In other words, fragmentation is one strategy that farmers have to avert hazards to crops. This has an important policy implication in that increasing the number of plots would improve efficiency levels of farmers. The result of this study agrees with those of Kinde (2005) and Getachew and Bamlak (2011). The authors emphasized that farmers may benefit from fragmented plots since in different plots when strategically distributed may reduce the risks that weather variation pose to crops.

Livestock: Livestock supplements the production of crops in various ways. For example, the income obtained from selling livestock can be invested in crop production, especially to purchase fertilizer. Livestock manure could also be used to improve soil fertility. Livestock is also the main sources of animal labor in crop production.

Consequently, the results showed that farmer who have more livestock in TLU than their counterpart are more efficient (coefficient = 0.205, $p \leq 0.1$). Our result contradicts Fekadu (2004) who reasoned that farmers who held higher livestock may give attention to livestock production; hence, they may not be as efficient in crop production. However, in the study area where off/non-farm activities are meager and use of credit was less, livestock are an important additional source of income to farmers and help assess inputs of production.

Institutional factors

Extension contact: Farmers with more number of extension contacts were found more efficient than others. This implies that policies should include a greater intervention by extension workers as an important tool to promote more efficient technical support to farmers in the study area. Fekadu (2004), Haileselassie (2005) and Getachew and Bamlak (2011) found similar results that emphasized the paramount importance of increasing the frequency of development agent visits to improve the technical efficiency levels among farmers.

CONCLUSION AND RECOMMENDATIONS

Apart from difficulties in accurately measuring efficiency levels based on farmers' responses, the findings of this study revealed that there is a considerable variability in the technical efficiency of farmers in the production of potato in the study area. Therefore, to improve technical efficiency levels of farmers in the study area, some measures should be considered. First, sharing the experience of older farmers with those of different age groups could improve the level of efficiency at all levels, especially among youngsters. Incidentally, extension programs can intervene by arranging ways for the experience sharing. Simultaneously, there should be an intervention by governmental and non-governmental organizations to help older farmers by designing farm implements which are labor saving and can easily be handled. Financial constraints could be overcome by establishing and strengthening the religious practice of households by micro-finance institutions and agricultural cooperatives. Creation of off/non-farm job opportunities should also be emphasized, because, they could be a replacement for credit as a source of funds for the farmer, and consequently would improve the efficiency of farmers. More training should be provided to extension agent to improve their level of technical efficiency in helping farmers especially tailored to potato producers' conditions. In addition to strengthening the existing extension service provided to farmers, efforts should be made to provide long term training to farmers. Livestock provide plough power and additional income to households which can be converted into input to increase farm production. Consequently, livestock development packages must be introduced and promoted to increase their production and productivity. Fertilizer was the important determinants of potato production as revealed by SPF. There should be timely supply of fertilizer at a reasonable price to improve the efficiency of farmers in the production of potato and other crops. Therefore, the attention of policy makers to improve agricultural production should not revolve solely around the introduction and dissemination of new technology to increase yield, but also more attention should be given to improve the existing level of efficiency.

CONFLICT OF INTERESTS

The authors declared that there is no conflict of interest.

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The Role of Pastoralists' Indigenous Knowledge and Practices in Reducing Household Food Insecurity in West Pokot, Kenya: A Binary Probit Analysis

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In recent decades, researchers and development practitioners have explored strategies to manage shocks and reduce food insecurity in the arid and semi-arid lands (ASALs) especially through introduction of modern scientific approaches and interventions; for instance promotion of exotic livestock breeds, but these interventions have not yielded desired results. This has been attributed to the fact that most of these interventions ignore pastoralists' own indigenous knowledge and practices and thus tend to have low acceptability. Recognizing the need for context-specific locally-acceptable and adaptable solutions to pastoralists' challenges, the present study assessed the role of indigenous knowledge and practices in reducing food insecurity in pastoralists' households in West Pokot County, Kenya. Data was collected from arid and semi arid locations. A focus group discussion, key informant interviews and individual surveys on 191 households were conducted. Results demonstrate the value attached to traditional customs, guided migratory patterns and sustainable human-environment interactions in adapting to the harsh environment and mitigating food insecurity. Results from a binary probit regression analysis showed that seasonal transhumant migration, traditional pasture conservation and planting indigenous drought tolerant crops have a significant effect in reducing household food insecurity. The findings point to the need for documentation of indigenous knowledge and practices and their integration in long-term programs and plans aimed at building resilience in pastoralist systems.

Key words: Pastoralists, indigenous knowledge, local practices, food security.

INTRODUCTION

Indigenous knowledge (IK) is the insight possessed by local people that enables them to make a living in a given environment (Dinucci and Fre, 2003; Ghorbani et al., 2013; Abate, 2016a). This knowledge is well adapted to the requirements of local people and conditions. Moreover, IK is typically owned by indigineous peolple who are defined as people whose social, cultural and economic conditions makes them stand out from other

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sections of the national community (Emery, 2000). The IK is unique to a partcular culture and society. It regulates customs, traditions, and local decision making in agriculture and resource management. The IK is different from formal knowledge generated by research institutions or private firms. Formal knowledge is written and easily shared across people, cultures and generations, while IK is tacit and engrafted in practices and experiences (Emery, 2000; Oba, 2009). It is worthwhile to note that IK is more experiental than theoretical and is learnt through repetition. Moreover, IK is exchanged orally by demonstration through apprentices, parents to children or neighbor to neighbor. This is only possible where both the provider of IK and the recipient speak similar language and share cultural practices than across cultures.

Over the last few decades, there has been a noted erosion of IK and practices among many indigenous communities (Oba, 2009). It has been perceived that IK is old fashioned and archaic and for many years, it has been disregarded by many practitioners. However, recent studies have shown that IK in most communities is innovative and actually help in reducing and mitigating risks. The practices are creative and incorporate external influence with inside innovations and thus are always dynamic. There is therefore a need to preserve IK, its valuable skills and problem-solving strategies along modern technologies. This requires a clear understanding of the critical role that IK plays in the overall process of sustainable development (Gorjestani, 2004). Sharing IK within and across communities enables development planners to learn the local conditions of the people they work with and this enables design of context-relevant, locally acceptable and adaptable solutions to existing challenges (Emery, 2000; Oba 2009).

Pastoralists are stewards of and users of IK and practices, through which they are able to make a living in the harsh arid and semi-arid lands (ASALs) that characterize many parts of the developing countries. IK enables pastoralists to cope with shocks such as droughts and livestock diseases and thus manage transitory and chronic food insecurity. Understanding IK is therefore a pedestal for researchers and extension workers to find best solutions that are readily acceptable to bolster pastoralists own efforts to make a living.

However, recent occurences of droughts and other related shocks such as livestock diseases and inter-community conflicts undermine pastoralists' resilience to food security. Previous studies highlight the need of integrating IK with scientific knowledge in development of a common understanding of pastoralists' livelihoods (Angassa and Oba, 2007; Abate, 2016b). Mutual understanding between local communities and external practitioners will go along way in identifying best development solutions and innovations to adress challenges such as food insecurity.

The Food and Agriculture Organization of the United Nations (FAO) defines a status of food security to be existing when all people at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs. There are four important components of food securty: availability, access, stability and utilization. Food availabilty is determined by food production and stock level. Access to food is determined by disposable income and food prices. Stability is determined by weather, political and economic conditions. Utilization is determined by dietary diversity, energy and nuitrent intake. Failure to meet food and dietray requirements leads to a situation of food insecurity.

Because of heavy reliance on livestock to meet food and income needs, shocks such as drought and livestock diseases increase pastoralists vulnerability to food insecurity (Opiyo et al., 2014; Ngigi et al., 2015). Many pastoralist communities are characterized by chronic food insecurity (Alinovi et al., 2010). Many studies have focussed on the role of IK in pastoralists' rangeland management (Mapinduzi et al., 2003; Oba, 2009, 2012; Selemani et al., 2012; Abate, 2016a). Dinnucci and Fre (2003) focussed on the role of IK in livestock management among pastoralists in Eritrea. There is a striking knowledge gap regarding the role of IK on reducing household food insecurity among the pastoralists communities. The present study bridges this gap by documenting the IK and quantifying the effects of these practices on households' food insecurity among pastoralists in the marginal ASALs of West Pokot County in Kenya.

MATERIALS AND METHODS

Study area

The study was carried out in West Pokot County, Kenya (Figure 1). It covers an area of 9,169.4 km^2 with an estimated population of 512,690 persons according to most recent national census of 2009. Rainfall varies from 400 to 1,500 mm per annum, while temperatures range from 10 to 30°C. Communities in West Pokot County practice agro-pastoralism, combining mixed farming with nomadic pastoralism with over 90% of the population in the county depend on pastoralism for their livelihoods; mainly agro-pastoralism and nomadic pastoralism. The county indices on poverty, literacy, illiteracy and gender inequality are above the national's average and way beyond the recommended. For example, the food poverty index is nearly 70%, illiteracy is 60% and infant mortality is almost 13% (County Integrated Development Plan, CIDP, 2013).

Focus group discussion

A focus group discussion (FGD) comprising of 20 participants, 15 key informant interviews and individual surveys on 191 households were conducted to collect data. Most of the participants in the FGD were pastoralists with over 20 years of experience. They shared their perspectives on IK for the last 3 to 4 decades. Few youth pastoralists and an officer from the county extension department also attended the FGD to share insights on various aspects. From

Figure 1. Map of West Pokot County showing different livelihood zones.
Source: County Integrated Development Plan (2013).

the focus group discussion and key informant interviews, 15 indigenous practices were identified as having great potential in reducing household food insecurity. These are planned transhumance migration, enclosing grazing land, rotational grazing, post harvest use of crop fields for grazing, night grazing during dry seasons, traditional pasture conservation, use of browse trees as human and livestock food, use of herbs for ethno veterinary treatise, use of naturally occurring salt, traditional bee keeping, planting drought tolerant indigenous crops, herd management practices such as herd splitting, increasing herd size in rainy seasons, altering herd composition of grazers and browsers depending on pasture availability and stocking female dominated herds.

Sampling and household survey

Household survey data was collected from 191 respondents. Sampling was purposively done to capture the arid and semi arid locations to enable a livelihood comparison between the two areas within West Pokot, Kenya. The villages and households within the locations were randomly selected for study. A total of 19 sublocations were studied across the locations. These were Asilong, Chepareria, Chepkopegh, Kacheliba, Kipkomo, Kitelakapel, Kolopot, Kongelai, Korrelach, Lateg, Nakuyen, Orolwo, Pertum, Riwo, SLA, Suam and Ywalateke. The sample size of 191 follows the used in related previous studies such as Selemani et al. (2012); Ghorbani et al. (2013) and Ngigi et al. (2015). This is a better sampling method in situations where it is impossible to carry out a population census or use a formula to get a sample from the entire population because the population size is unclear, for instance due to persistent migration of pastoralists (Israel, 1992). Only household heads or their spouses or household members over 18 years old who had lived in the household for at least 1 year and were familiar with the daily household activities interviewed during the survey. Data was collected through face-to-face interviews using semi-structured questionnaires.

Data analysis

The induced innovation theoretical framework

This study is anchored on the theory of induced innovation (Hayami and Ruttan, 1971; Rodima-Taylor et al., 2012), which hypothesizes that changes in agricultural conditions necessitate innovations meant to cushion individuals from the effects of these changes. In the pastoralists context, different forms of IK and practices are the key innovations that are borne out of the necessity to manage the recurrent and/or unpredictable climatic factors such as prolonged periods of drought, erratic rainfall patterns and non-climatic factors such as livestock diseases, human settlement on transhumant paths and even institutional factors such as policies advocating for sedentarization. Recent studies (Carter, 2009; Chhetri, 2011) have explored the role of public action through research funding on innovation systems. In the present study, emphasis is laid on the role of IK as an innovation in reducing household food insecurity.

Binary probit model estimation

In order to understand the association between indigenous practices and household's food security, a binary probit was estimated. Aspects of food security such as expenditure on food, average meals per day, number of months in a year that the household was unable to meet its food requirements and the duration of the period of lacking food were used to ascertain if the household is food secure or not. This dummy variable is treated as the dependent variable in the Probit model, where $y = 1$ measures the household's inability to meet food requirements, 0 otherwise. *Y* is a continuous latent variable that is rationally bounded between 0 and 1. In practice, the probability that a household is food insecure cannot be observed; rather, the actual outcome of households being food insecure or not can only be observed. Using the observed variables of indigenous practices, the probability of a household being food insecure was estimated by solving the model:

$$y^* = \beta_1 + \beta_2 x_2 + \cdots \beta_k x_k + \epsilon \qquad (1)$$

In Equation 1, x_i is a vector of the observed variables explaining the latent variable and ϵ is the unobserved component of the latent variable. The Probit model assumes that ϵ follows a standard normal distribution (Train, 2009).

The probability of a household being food insecure, $y = 1$ is derived as follows:

$$\Pr\ (y = 1 \text{ given } x) = \Pr\ (y^* > 0 \text{ given } x)$$
$$= \Pr (x\beta + \epsilon > 0 \text{ given } x$$
$$= \Pr\ (\epsilon > -x\beta$$
$$= 1 - N\left(-\frac{x\beta}{\sigma}\right) \text{ (Integrate) } \sigma = 1 \text{ following standard normal distribution.}$$
$$= \Phi\ (x\beta) \qquad (2)$$

The Probit model allows for correlated observations that explain the latent variable (Train, 2009). This provision relaxes the condition of independence from irrelevant alternatives of the logit model and thus, provides a better approach for this analysis since many indigenous practices are correlated with one another. The observed components x_i in this paper are the indigenous practices of a household. The variables are hypothesized to have negative coefficients, implying that practicing these activities is expected to reduce household's probability of being food insecure.

RESULTS AND DISCUSSION

Demographic characteristics of the respondents

As shown in Table 1, in this study, most (82%) of the respondents were male. The average experience in pastoralism livestock production is 13 years. The mean tropical livestock unit (TLU) in this study is 12.48 indicating the importance of a high livestock number to pastoralists as they serve as a measure of wealth and offset losses in the event of droughts and diseases (WISP, 2010; Dinucci and Fre, 2003).

The mean number of years of schooling is 5 years implying most of the household heads did not complete primary school education. The household mean annual per capita income is slightly over Kshs 19,000. This implies that most pastoralist households live below the minimum threshold of two and a half dollars per day. The mean dependency ratio is slightly above 0.5. This means the few household members working have to cater for the needs of the rest of the household members. As in the county development plan (CIDP, 2013) over 70% of the population are poor and cannot meet their basic food and income needs. This implies negatively on other development indicators too for instance infant mortality is about 13% and literacy level slightly above 50% against the nation's average 5 and 60%, respectively (CIDP, 2013). This necessitates the urgency for beneficial complementary and sustainable interventions to reverse this trend.

Land in the arid areas is mostly communally owned with only about 10% of the respondents having private ownership as compared to over 60% of respondents in the semi-arid area who even have proof of land ownership. Over 80% of the respondents from arid areas had access to communally shared pasture grounds compared to less than 10% from the semi-arid lands. This shows that pastoralism in the semi arid area is more sedentary than in the arid areas. These findings concur with Geutjes and Knutsson (2014) who attribute this sedentarization to private land ownership in the semi arid region. The average return transhumant distance moved is 36.82 km. Respondents from the arid region moved the most with an average of about 60 km compared to about 10 km by those in the semi arid areas. Turner et al. (2014) noted that pastoralists can move up to an average of 50 km in transhumance. This enables them explore new water and pasture grounds.

Exposure to shocks

Pastoralists across the world face many shocks in their domain, especially recurrent droughts and livestock diseases, which result to quality deterioration and even death of livestock leading to loss of pastoralists income (Little and Macpeak, 2014; Ngigi et al., 2015). Figure 2

Table 1. Household characteristics.

Household characteristics	Frequency/Mean (n= 191)	Standard deviation
Respondents from arid locations (%)	54.5	-
Gender (% male)	81.7	-
Age (mean)	46.3	10.89
Years of schooling of household head (mean)	5.1	4.30
Number of household members (mean)	7.4	2.36
Household total annual income (mean Kshs)	139143.9	136205.00
Per capita annual income (mean Kshs)	19290.4	17033.23
Dependency ratio	0.5779	0.1240
Years in livestock production (mean)	13.9	9.48
Land size (mean acres)	3.8	3.70
Land allocated to livestock (mean acres)	1.3	0.96
Tropical Livestock Unit* owned by the household (mean)	12.5	10.44
Households accessing communally owned pasture grounds	52.4	-
Transhumance distance moved (mean return kilometers)	36.8	15.43

*Tropical Livestock Units computed as: cattle=1, camels=1, donkeys=0.8, goats and sheep=0.2 and poultry= 0.04 (World Initiative for Sustainable Pastoralism, WISP, 2010). Kshs 100 were equivalent to USD$1 at the time of the survey.
Source: Survey Data (2017).

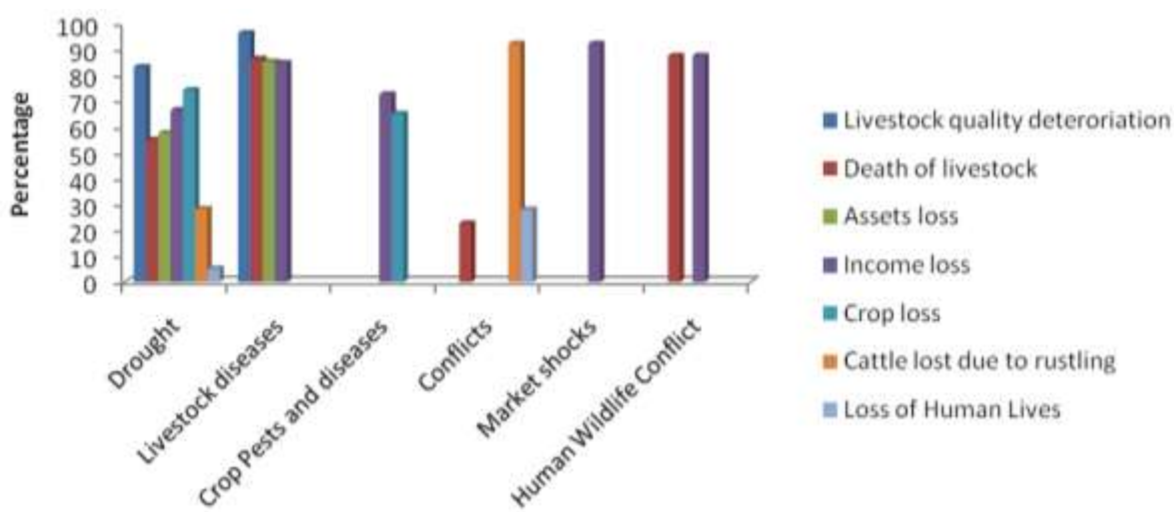

Figure 2. Households' exposure to shocks and their Effects.
Source: Survey Data (2017).

shows the different shocks that the respondents were exposed to and their effects on livelihoods in West Pokot.

Some shocks occur concurrently. It was noted during the FGD and key informant interviews that during drought occurences, many livestock caretakers migrate across the defined transhumant paths. This migration sometimes results to increased incidences of conflicts with other pastoral communities, cattle rustling and even loss of human lives. Livestock pick up diseases in the shared pasture grounds and the most common disease cited was foot and mouth disease (locally known as *ngorion*). The shocks also have multiple effects on the households for example besides livestock loss during drought, households reported crops loss due to lack of rainfall.

Households cope with these immediate shocks differently. Relatively well-endowed households utilize their savings and sell part of their assets (80 and 60%, respectively) to smoothen their consumption patterns. On the contrary, the less endowed households often have to borrow from relatives and friends, send part of their family members to stay with other relatives or depend on aid from government and other humanitarian organizations (58, 36 and 35%, respectively). How households cope with shocks is critical in the attainment of food security.

Table 2. Indigenous knowledge and practices among the pastoralists' community in West Pokot, Kenya.

Indigenous knowledge and practices	Proportion of respondents adopting the practice (%)		
	Arid area (n=104)	Semi arid area (n=87)	Pooled sample (n=191)
Planned transhumance migration	82.0	10.0	49.2
Herd splitting	75.0	22.0	50.8
Increasing herd size during rainy seasons	68.0	51.0	60.2
Altering grazers and browsers composition	100.0	82.0	91.6
Stocking female dominated herds	99.0	93.0	96.3
Night grazing	90.0	20.0	58.1
Traditional pasture conservation	23.0	66.0	42.4
Use of browse trees	100.0	83.0	92.1
Use of wild herbs to treat livestock diseases	94.0	83.0	89.5
Post harvest use of fields	86.0	96.0	90.6
Planting drought tolerant varieties	49.0	50.0	49.7
Use of natural occuring salt	93.0	68.0	81.7
Traditional bee keeping	34.0	10.0	22.5
Rotational grazing	84.0	71.0	78.0
Partitioning grazing land into enclosures	58.0	29.9	92.0

Source: Survey Data (2017).

Carter et al. (2005) noted that if a household's assets and income level fall below a minimum threshold after a shock, then they become entangled in a deprivation trap characterized by food insecurity.

Use of indigenous knowledge and practices to manage shocks

Table 2 shows the different indigenous practices used by pastoralist households to cope with the shocks in West Pokot. Differences in practice across arid and semi arid areas were tested and the results are also shown through the t-statistic measure.

Participants in the FGD, KII and household survey acknowledged that transhumant migration enables them to adapt to changing vegetation patterns in their environment. Herders take the livestock to the shared grazing area (*ka' tich)* before the onset of droughts and they return at the start of rains. Other studies such as Turner et al. (2014) and Abate (2016a,b) have shown that planned transhumant migration enables pastoralists escape shocks such as drought.

Splitting part of the herd into smaller groups and moving some of them to new areas prevent overgrazing calves and lactating cows are left as the other part of the herd is moved. This reduces competition for limited pasture resources and thus ensuring the in-calf, calves and lactating cows which can not walk long distances thrive. A similar observation was noted in a study of pastoralists' indigineous knowledge in Eritrea by Dinucci and Fre (2003).

Regarding the herd composition, increasing herd size in wet seasons helps to cushion against losses during dry periods. Altering herd composition between grazers and browsers also allows pastoralists to make use of varying quality and amount of of vegetation available at different times (WISP, 2010; Abate, 2016a). During wet seasons, grass is plenty and thus they usually stock more of grazers (cows and sheep). In the dry seasons however, grass is scarce and thus browsers like goats and camels thrive well on available trees and shrubs than the grazers.

Female-dominated herds offset the long calving periods, a characteristic of the indigineous cattle and thus ensure stable milk production. This is because milk is an important part of the pastoralists' dietary requirement (Little et al., 2010; Farmer and Mwika, 2012). During drought seasons, herders graze their cattle at night to escape the intense heat at day time. The herders graze their livestock in groups so as to provide security to each other in the event of attacks by cattle raiders or even wild animals. During the day, both the livestock and herders rest under sheds close to water points. This limited movement during the day enables livestock to optimally utilize the little food available and thus survive in the wake of intense drought. Similarly, Butt (2010) noted that reduced livestock movement generally increases livestock productivity.

In seasons of surplus forage, pasture and crop residues, stover are conserved for use during the lean period. Harvested maize, millet and sorgum residues and grass is cut, dried and stored on top of trees and will be released in small amounts for livestock use until the wet season. As shown in Table 2, pastoralists from semi arid areas are more likely to conserve pastures since they have incorporated crop production and thus have more crop residues to store. Also they are more sedentary and their transhumance movement; with an a average return distance of 10 kilometres compared to 50 km for their counterparts in the arid areas.

Agro-pastoralists make good use of their farms after harvesting crops. Livestock are allowed to graze and feed on the crop residues. At the sime time, livestock drop dung as they graze, which is useful in enhancing soil fertility. Pastoralists who do not grow any crops make arrangements with those who do, sometimes as far as in the neighbouring Trans Nzoia county. The farmers allow the pastoralists to graze catle on their farm in exchange of milk or a goat as a gift. This was similarly noted by Dinucci and Fre (2003).

Older key informants and participants in the FGD recalled that in the previous years, drought tolerant crops such as traditional sorghum, millet and cassava varieties were mostly grown. But, with increased demand for maize and its products, many farmers have abandoned the traditional drought tolerant crops for maize. The yileds are low; the respondents recorded an average of 4 bags per acre in the arid areas and 8 bags in the semi arid areas. Such low harvest cannot sustain an average household untill the next harvest season and thus many households who plant maize still cannot meet their annual food requirements. On the other hand, millet, sorghum and cassava thrive well despite the erratic rains and thus households planting them enhance their food security as well as cope with the vagaries of weather (Mulwa et al., 2015).

Natural salt sources *(ngeny')* are important especially to pastoralists in the arid areas. Livestock are taken at least once a week to *ngeny'* sources whose rocks are rich in minerals. Some respondents mentioned that this salt reduces livestock diarrhoea which is a symptom of many livestock diseases. However, most of them also reported that livestock pick up foot and mouth disease (*ngorion),* from this source and many have lost part of their herds in this process. Household who could not afford to buy livestock salt and relied on '*ngeny'* sources excusively were the most affected.

The practice of rotational grazing allows grass and forage to rejuvinate and prevent overgrazing and land degradation (Mureithi et al., 2010). Transhumance movement is key to rotational grazing (Turner et al., 2014). More sedentary households divide their grazing land into enclosures that animals are allowed to graze rotationally. Grass and other pasture species can be grown on these enclosures. This ensures there is enough livestock feed to last through subsequent seasons.

Traditional institutions govern the access and use of communal grazing lands *(ka'tich).* Grazers and browsers are separated at the shared grounds due to different feed requirements. Theft is not allowed. Herders violating any of these rules are penalised. A recent peace agreement between the Pokot and Karamoja of Uganda sharing a common grazing ground saw to it that for any livestock stolen, the herder responsible will have to return it back together with four others as a fine. This has greatly reduced conflict incidences among those two pastoral communities.

Pastoralists posses and use a wide array of ethno veterinary practices (Dinucci and Fre, 2003). They know herbs and trees that can be used to treat different livestock diseases. For example, the roots and leaves of some wild trees possesing ethno veterinary properties are given to cows that have still-births, premature births or abort their calves. This also reduces milk quality deteriaration and possible transmission of foodborne diseases such as Brucellosis to humans.

Honey is produced in traditional log hives that are hung under shady trees especilly along river banks and other quiet places. Bees have a preference for the traditional log hives made from indigineous trees (locally known as *mokong'wo* and *koral*). The logs from the trees are made hollow and the inside of the hollow log burnt. These indigenous trees produce an appealing smell when burnt that attracts bees to the hive. The hive is partioned into two compartments to separate the queen from worker bees thus keeping the honey clean. Honey is important in food preservation and treating wounds.

These practices have enabled pastoralists in West Pokot to continue thriving amidst shocks previously discussed. A binary probit model was fitted to estimate the effect of these practices on the probability of a household being food insecure. Individual household characteristics, dependency ratio, extension advice received from formal sources such as government and informal such as from farmer to farmer and access to credit was included in the analysis. This is because augmenting IK practices and formal knowledge can produce much more desirable results. The results in Table 3 show that indigenous practices have the potential of reducing food insecurity. Marginal effects are computed at means for continuous variables and a discrete change from 0 to 1 for dummy variables. Pseudo R^2 =0.7036 (p= 0.000). Wald Chi^2 (14) =79.96.

The null hypothesis of the Wald Test states that the indigenous practices are independent. The *p*- value (0.000) is highly significant and thus the null hypothesis is rejected since the practices are interdependent. This justifies the use of a probit regression which allows for interdependence amongst variables. The Heteroscedastic consistent estimation (HCE) was used to minimize standard errors in the estimation of the model.

Role of indigenous knowledge and practices in reducing household food insecurity

Pasture conservation, planting drought tolerant varieties, bee keeping all supported with extension advice have a significant effect in reducing household food insecurity.

Table 3. Effects of indigineous practices on household food insecurity.

Variable (Indigenous Knowledge and Practice)	Coefficient	Marginal Effects (dy/dx)
Constant	2.3988**(1.4517)	-
Age	-0.0117 (0.0147)	-0.0012
Gender (1- male, 0 Female)	-0.3114 (0.5422)	-0.3334
Years of schooling	-0.0513(0.0465)	-0.0055
Dependency Ratio	2.4230*(1.2523)	0.2602*
Credit access (1- Yes)	-0.8979*(0.4684)	-0.0964*
Access to extension services (1 - Yes)	-0.8709*(0.5151)	-0.0935*
Herd diversification (1- Yes)	0.9023 (0.8635)	0.9669
Pasture conservation (1- Yes)	-1.0907**(0.3889)	-0.1399**
Enclosing part of grazing land (1- Yes)	-0.5679 (0.4962)	-0.0609
Drought tolerant varieties (1 - Yes)	-1.3028**(0.4229)	-0.1399**
Natural salt (1 - Yes)	1.8230**(0.4435)	0.1957**
Use of wild herbs and browse trees	-1.8323**(0.5121)	-0.1968**
Planned transhumance migration	-0.2666(0.5589)	-0.0286
Bee keeping	-1.1466**(0.4962)	-0.1231**

Statistical significance levels:**5%, *10%; Robust Standard errors are shown in parentheses.
Source: Survey Data (2017).

Uses of wild herbs and browse trees for both food and ethno veterinary have the biggest effect on reducing household food insecurity in this study. The wild herbs and trees thrive well even during dry seasons and a famous tree locally known as *sokoria* provide leaves which are eaten by both humans and livestock. As a last resort, the wild herbs and trees provide food during drought season, enabling households grapple food insecurity.

Pasture conservation smoothens livestock feed availability during dry seasons. This enables livestock produce milk which is an important constitute of pastoral households' diet. Households planting drought tolerant crop varieties are assured of a harvest despite the erratic rains and thus enable them to reduce food insecurity. Honey produced through traditional bee keeping is used as food and medicine. With value addition and marketing support from various NGO's in the area, surplus honey is sold, raising households' income which is used to buy food, enabling households reduce the probability of being food insecure.

The most striking finding of this study was that many respondents who took their livestock to natural salt licks were affected by foot and mouth disease in the previous year. Losing their livestock to the contagious disease imply that their main food and livelihood source were lost and for some time, they were unable to meet their food and income needs. This explains the positive and significant effect on household food insecurity. Households having high dependency ratios rely on the few members who work to meet their food and income needs and in the event of any shock, they will not be able to meet their food needs and thus the positive and significant effect on food insecurity.

Institutional support in form of credit and extension services has a significant effect in reducing household food insecurity. Credit enables households undertake on and off farm investments that in turn raise incomes and increase food security. Extension advice augments local knowledge in good crop and livestock husbandry and thus leads to increased food productivity.

CONCLUSION AND POLICY IMPLICATIONS

This study concurs with previous studies which noted that pastoralists are indeed custodians of indigenous knowledge. Understanding IK enables the development of extension services aimed at pastoralists to their specific needs. Understanding and applying pastoralists' IK by practitioners is effective in reaching out to them because it is an important asset that they posses and use to make a living. Pastoralists value their own IK and this forms a blue print for interventionists to learn and appreciate pastoralists own coping mechanisms and thus contribute to the body of knowledge.

There is an increasing shift in attention in analyzing food security at the household level. This is because managing food access, availability, stability and utilization at a global, regional or national level may not necessarily translate into good nutritional status at the household level. This study has shown that these practices, *inter alia* have the potential of reducing food insecurity at the household level. Traditional pasture conservation, planting drought tolerant crop varieties, traditional bee keeping and use of wild herbs and browse trees significantly reduce household food insecurity. This forms a basis for further research on how best these practices can be incorporated in development programmes. These findings call for the need to document IK and practices, lessons learnt and how it can be applied in other areas. This will ensure that these valuable practices are handed over to coming generations and thus reduce the threat of their extinction.

Planned transhumant migration enables pastoralists escape shocks and thus reduces the effect of these shocks on food security. There is need for more inclusive rather than exclusive rights on land to allow for this movement especially in the arid areas. Traditional institutions regarding access to and use of communally-owned land need to be strengthened by formal institutions. This includes recognition of communal land rights bestowed on communities. This can provide an incentive for pastoralists to manage communal land better. There is also need to address the issue of intellectual property rights to communities who are stewards of IK.

Provision of formal institutional support through provision of formal credit and extension advice is critical to enable pastoralists undertake viable on and off farm investments that can improve their livelihoods and reduce food insecurity. Formal education complements local skills and leads to better decision making. Formally trained members of the household can use their skills both on and off farm and this can help to reduce the dependency ratio and thus reduce food insecurity at the household level. All these combined with traditional knowledge can go a long way in addressing the issue of household food insecurity.

CONFLICT OF INTERESTS

The authors have not declared any conflict interests.

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Determinants of microfinance loan utilization by smallholder farmers: The case of Omo Microfinance in Lemo District of Hadiya Zone, Southern Ethiopia

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This study investigated factors determining microfinance loan utilization by smallholder farmers from Omo Microfinance institution in Lemo District of Hadiya Zone, Southern Ethiopia. Both primary and secondary data were used and a total of 118 sampled farmers were considered for the interview. Both descriptive statistics and independent double-hurdle model were used to analyze the microfinance loan utilization and loan amount received. The results showed that literacy status, household size, size of landholding, perception about loan repayment period and distance from residence to lending center were the significant determinants of microfinance loan utilization by smallholder farmers. The borrower's sex, literacy status, income level, saving level, purpose of loan taking and perception about loan repayment period were found to be the factors influencing loan amount received by smallholder farmers in the study area. The findings generally suggest the need to enhance appropriate actions on determining factors of microfinance loan utilization and its loan amount in order to lessen financial constraints of smallholder farmers through microcredit.

Key words: Lemo District, loan utilization, loan amount received, microfinance, smallholder farmers.

INTRODUCTION

Ethiopian economy depends to a great extent on the growth of agricultural sector. Agricultural sector accounts for about 46% of the country's gross domestic product, more than 80% of exports and employs 85% of the total labor force (CIA, 2014).

In rural areas of Ethiopia, households mainly rely on agriculture to get food, generate income and meet other household financial obligations. However, they suffer from income shocks due to fluctuations in weather condition and farm output prices. When farm households face income shock, they finance their agricultural production and smooth their consumption by using accumulated savings and borrowing from outside. The source of credit for farm households is either formal lending institutions or informal lenders. Their choices of borrowing depend on how they can access credit providers and how they can obtain the loan (Nguyen, 2007).

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One of the major constraints that significantly affect the growth of agricultural production and productivity in developing countries, including Ethiopia, is limited use of modern inputs and technologies. Among others, one cause for this is lack of finance for the rural farm households (Wolday, 2004). Thus, developing rural financial markets is considered as one of the important tools for enhancing adoption of new and improved agricultural technology, rural income generation and poverty alleviation (Zeller, 1995; Addo et al., 2013; Akpan et al., 2013).

Ethiopian government has been working to eradicate the country's major enemy, poverty. One of the powerful tools that help to reduce poverty from households and a nation is provision of microfinance services to the poor in a sustainable way. The microfinance institutions (MFIs) are basically established to serve poor and low-income individuals who lack collateral, steady employment, verifiable credit history, or other requirements necessary to gain access to formal credit (CGAP, 2011; Hundanol and Berhanu, 2012; Dereje et al., 2013). The task of microfinance is crucial in the course of improving low-income and poor peoples' livelihoods. According to Haftom (2011) and Addo et al. (2013), microfinance allows poor people to diversify their sources of income and it is the essential pathway to move out of poverty and hunger. The development of financial sector is, therefore, vital to meet the government's development goal of poverty alleviation.

Despite many efforts made by the government, microfinance outreach is low and has not satisfied the demand of the rural poor in Ethiopia (Getaneh, 2005) in general and in Lemo District in particular. There are three MFIs: Omo Microfinance Institution (OMFI), Wisdom Microfinance Institution and Agar Microfinance Institution that have been providing micro financial services for the poor and low-income people in the District. The outreach of OMFI is relatively higher than other MFIs in the study area. However, many farmers have still not benefited from OMFI's credit service. To this point, no investigation has been undertaken on the factors influencing farmers' microfinance loan utilization and loan amount in the District. This initiated the study to examine determinants of smallholder farmers' microfinance loan utilization and loan amount received from OMFI. This understanding is essential for creating microfinance policy which is favorable to rural poor who are mainly farmers.

METHODOLOGY

Description of the study area

Lemo District is one of the 10 rural Districts of Hadiya Zone. It is located 230 km South of Addis Ababa. According to 2007 Census, the District has a total population of 118,594. Of whom 58,666 were men and 59,928 women; 2,049 or 1.73% of its population were urban dwellers. The district is agro-ecologically divided in to two: highland (*Dega*) and midland (*Woyna Dega*) which accounts for about 5 and 95%, respectively.

Sampling technique and sample size determination

The study was carried out in Lemo District of the Zone. To select respondent farmers, two-stage sampling technique was employed. There are 33 peasant associations (PAs) in the District. All PAs are the beneficiaries of OMFI's credit service: both in cash and kind form. Three PAs namely: Ambicho Gode, Jawe and Shurmo were randomly selected. By taking the list of farm household heads from each selected PAs, 118 representative farm household heads were randomly selected in probability proportion to size of each PA's population.

Data sources and methods of data collection

Both primary and secondary data sources were used in the study. Semi-structured interview schedule was used to generate the primary data from the selected interviewees. The data were collected with the help of enumerators under supervision of the researchers. Secondary data were obtained from published and unpublished documents of different organizations.

Methods of data analysis

Both descriptive statistics and econometric model were used to analyze the data. The respondents' demographic and socio-economic conditions as well as institutional factors were analyzed using mean, frequency and percentage. Furthermore, the variables hypothesized to influence farmers' microfinance loan utilization from OMFI were tested for statistical mean and proportion differences using t-test and Chi-square (χ^2) test, respectively.

Positive amount of loan received by smallholder farmers is seen after making decision in two distinct stages, that is, in the first stage, smallholder farmers make a decision whether to use microfinance loan or not and in the second stage, those farmers who once decided to use a loan again decide how much loan to take. Therefore, this study used independent double-hurdle model in which the two decisions by smallholder farmers are determined sequentially. It is an appropriate model in the absence of selection bias. The model makes use of two regressions in the two hurdles. For the first hurdle, that is, to identify key factors influencing microfinance loan utilization decision by smallholder farmers, the model makes use of a univariate probit regression while for the second hurdle, that is, to identify the determinant factors of loan amount received by smallholder farmers it applies the truncated regression. The independent double-hurdle model for both loan utilization equation and loan amount equation are specified as follows:

$$Y_{i1}* = X_i'\beta + \nu_i \qquad (1)$$

$Y_i = 1$, if $Y_{i1}* > 0$, that is, if a farmer utilized microfinance loan and

$Y_i = 0$, otherwise

$$Y_{i2}* = Z_i'\alpha + u_i \qquad (2)$$

Table 1. Mean and proportion difference tests of variables between loan users and non-users.

Variables	Overall mean/proportion	Users mean/proportion	Non-users mean/proportion	t/ χ^2-value
Dummy variables				
Sex (male=1)	0.88	0.92	0.86	1.098
Literacy status (literate=1)	0.62	0.86	0.45	20.204***
Access to credit from other lenders (yes=1)	0.48	0.43	0.52	0.996
Perception of loan repayment period (constraint=1)	0.29	0.08	0.43	17.422***
Perception about interest rate charged on microcredit (high=1)	0.09	0.06	0.10	0.598
Collateral (couldn't provide=1)	0.22	0	0.38	23.682***
Continuous variables				
Household size (adult equivalent)	6.56	7.48	5.91	3.217***
Size of landholding (ha)	0.69	0.88	0.56	4.295***
Livestock ownership (TLU)	3.06	2.45	3.90	-3.983***
Household income level (ETB)	14570.51	13800	15100	-0.694
Saving level (ETB)	306.61	701.63	26.01	27.801***
Distance (km)	8.18	7.10	8.94	-3.155***

Source: Own survey result, 2014; ***represent significance at 1% significance level.

$Y_i = Y_{i2}* = Z_i'\alpha + u_i$, if $Y_{i1}* > 0$ and $Y_{i2}* > 0$ and

$Y_i = 0$, otherwise

Where: $Y_{i1}*$ is a latent variable describing farmers loan utilization, X is the vector of variables explaining utilization of microfinance loan, β is the vector of parameters to be estimated in the first hurdle, $Y_{i2}*$ is a latent variable describing factors influencing loan amount received by farmers, Z is the vector of variables explaining loan amount, α is the vector of parameters to be estimated in the second hurdle, Y_i is the observed value (that is, loan amount), and v and u are error terms and are assumed to be independent and normally distributed with mean zero and constant variance. Farmers are represented by subscript i.

RESULTS AND DISCUSSION

Descriptive statistics of sampled smallholder farmers

The summary statistics of the variables used in the analysis, and mean and proportion difference tests of the variables between microfinance loan users and non-users are presented in Table 1. Out of the total respondents, about 62% were literate and the rest 38% were illiterate. Of a total of 73 literate smallholder farmers, about% 58 have utilized microfinance loan and the rest have not. Of the total 45 illiterate smallholder farmers, only 16% have utilized microfinance loan and the majorities, 84% have not utilized it. An average household size of the sampled farmers was 6.56 persons in adult equivalent. It was larger for borrower farmers than non-borrower farmers. An average size of landholding by sampled smallholder farmers was 0.69 ha. It was larger for borrower farmers than non-borrower farmers. An average livestock possession by loan user farmers was 2.45 in TLU while it was 3.90 for non-user farmers. It revealed that those smallholder farmers who had more livestock have not utilized microfinance loan as much as those farmers who had less livestock in the study area.

Saving helps farmers to access microfinance loan and to receive larger size of loan. Saving level by respondent households was higher for credit users than non-users. About 78% of respondent farmers reported they had no problem to form self-selective group collateral and the remaining 22% reported that they have been facing challenges in providing collateral. An average distance from farmers' residence to the lending center was shorter for credit user farmers than non-user farmers in the study area. Out of the sampled respondents, about 71% perceived the loan repayment period as good to make the repayment from the returns of their farm activities while the rest 29% perceived it as not good. Almost all sampled farmers (92%) perceived the interest rate charging on credit as not high while the remaining 8% perceived it as high.

In the study area, the sources of credit for farmers were formal, semi-formal and informal lenders. Majority of borrower farmers utilized the loan obtained from OMFI for

Table 2. The first-hurdle (Probit regression) estimates of determinants of microfinance loan utilization by smallholder farmers.

Variable	Coefficient	Standard error	Marginal effect
Constant	1.96	2.403	
Sex	0.19	0.510	0.067
Literacy status	1.24***	0.340	0.410
Household size	0.12*	0.065	0.045
Level of household income	-0.39	0.262	-0.143
Size of landholding	0.97**	0.481	0.361
Livestock ownership	-0.07	0.110	-0.025
Access to credit from other lending sources	-0.09	0.304	-0.032
Perception about loan repayment period	-1.10***	0.399	-0.353
Perception on interest rate	-0.43	0.569	-0.146
Distance from residence to lending center	-0.11**	0.050	-0.043
Observations		118	
LR Chi^2 (10)		64.610***	
Pseudo R^2		0.403	
Log likelihood		-47.784	

Source: Own survey results, 2014; ***, ** and * represent significance at 1, 5 and 10% significance level, respectively.

production purposes. In general, out of 49 respondent microfinance users, about 86% took a loan for production purposes while the rest 14% took a loan as for production purposes but utilized it on non-production activities.

When the primary data were collected, the sampled borrower farmers were asked to report the amount of loan they have taken out from OMFI in both cash and kind form. Out of total sample farm households, only 41.5% have utilized loan from OMFI in the prior year of the survey.

Determinants of microfinance loan utilization by smallholder farmers

The result of the first-hurdle (Probit model) regression is presented in Table 2. The result shows five variables which significantly influenced the probability of utilizing microfinance loan by smallholder farmers. Saving level, purpose of loan taking and collateral are omitted/dropped due to collinearity by dependet variable.

Literacy status

It was found to be an important determining factor that influences smallholder farmers' microfinance loan utilization in the study area. Keeping other things constant, being literate, farm household head increased the probability of utilizing microfinance loan by 41% and this was statistically significant at 1% significance level. It influenced farmers' microfinance loan utilization positively. This result is similar to the findings of Bakhshoodeh and Karami (2008), Ibrahim and Aliero (2012) and Abunyuwah and Blay (2013) which revealed that rural farmers with better literacy qualification had more likelihood of accessing credit from formal financial institutions.

Household size

Size of household member revealed significant influence on smallholder farm households' decision to utilize microfinance loan. It was positively related to farmers' microfinance loan utilization in the study area. The model result predicted that as the number of household member increased by 1 adult equivalent the probability of microfinance loan utilization increased by 4.5% keeping other things constant. Actually, as the size of household member increases, the farm household's need to take a loan increases too. This is because as the number of the household member increases, the amount of money needed for smoothing household consumption also increases and thus, a household has a higher demand for credit. This result is consistent with study of Hao (2005).

Size of landholding

Land is one of the main factors of production in agricultural. In the study, size of landholding was found to be a significant determining factor of farmers' micro-finance loan utilization in the study area. Keeping other things constant as the size of landholding increased by 1 hectare, the probability of microfinance loan utilization increased by 36.1%. The reason for this might be that larger farms require higher input use which in return needs higher financial resources utilization either through

Table 3. The second-hurdle (truncated regression model) estimates of loan amount received by smallholder farmers.

Variables	Coefficient	Standard error
Constant	7.82	6.34
Sex	0.060*	0 .031
Literacy status	0.052**	0.026
Household size	0.003	0.003
Income level	-0.083***	0.012
Size of landholding	0.004	0.021
Livestock ownership	-0.006	0.006
Saving level	0.131***	0.018
Purpose of loan taking	0.635***	0.034
Access to credit from other lending sources	-0.042	0.028
Perception about loan repayment period	-0.102***	0.032
Perception on interest rate	-0.030	0.039
Sigma	0.057	0.043
Observation	49	
Wald chi^2 (11)	95.1***	
Log likelihood	70.258	

Source: Own survey results, 2014; ***, ** and * represent significant at 1, 5 and 10% significance level, respectively.

owning or borrowing. This result is consistent with the findings of Mohamed (2003), Kiros (2012) and Abunyuwah and Blay (2013) which revealed credit utilization had a positive relationship with farm size.

Farmers' perception about loan repayment period

In the study, it was negatively related to farmers' microfinance loan utilization. Keeping other things constant, perceiving a loan repayment period as not good reduced the likelihood of microfinance loan utilization by 35.3% and this was statistically significant at 1% significance level. The perception about loan repayment period by smallholder farmers is for the short term period. This result is consistent with the previous findings of Sisay (2008) and Chauke et al. (2013) which revealed that access to credit is negatively influenced by the perception of loan repayment period.

Distance from farmer's residence to the lending center

There was a negative relationship between distance and farmers' microfinance utilization. In the study, as distance from farmers' residence to the lending center increased by 1 km, the probability of farmers' microcredit utilization reduced by 4.3% and this was statistically significant at 5% significance level. This implies that farmers residing farther away from the credit lending center had less likelihood of utilizing microcredit than those farmers reside closer to the lending center. This is because farmers with long distance may be challenged in transportation and may not get information easily. This result is similar to the findings of Bakhshoodeh and Karami (2008), Akpan et al. (2013) and Sebu (2013) which revealed that access to credit and distance from borrowers' residence to lending center had negative relationship.

Determinants of loan amount received by smallholder farmers

Table 3 presents the result of the second-hurdle (the truncated tobit model) regression. The model estimated the determinants of farmers' loan amount received from OMFI in the study area. Out of the hypothesized variables, six were significantly influencing the loan amount received by farmers.

Sex

The sex of farm household heads was found to be a significantly influencing factor of the loan amount received by farmers from OMFI in the study area. The sign of its coefficient indicates that the loan amount was positively related to being male-headed farm household. The result of the truncated regression model revealed that, keeping other things constant, being male-headed household increased the loan size by 6% at 10% significance level. The reason for this might be female headed households might have engaged on activities which do not require larger loan as compared to male headed households. This result is consistent with the previous findings of Mohamed (2003), Mpuga (2004), Ololade and Olagunju (2013) and Otunaiya et al. (2014) which revealed that being a female reduces the probability of receiving larger loan amount.

Literacy status

The loan amount taken out by sampled farmers was higher for literate respondents than illiterate respondents. The reason might be that literate farmers could plan and engage on different farm enterprises that need more money to run their enterprises and hence, increase their need for larger amount of loan. The model output predicted that literacy of farm household head increased the loan size by 5.2% citrus Paribas. It was found to be statistically significant predictor of loan amount at 5% significance level. This result corresponds to the findings of Mohamed (2003), Lensink et al. (2005), Abunyuwah and Blay (2013) and Addo et al. (2013) which revealed that loan amount taken by literate households were larger than that of illiterate households.

Income level

Level of household income earned per annum by smallholder farm households was found to be a significant determining factor of loan amount received from OMFI in the study area. As level of income earned per annum increases, the operating expenses spent on input procurement to produce any production activities could be more covered by increased income. If a farm household has a higher income per annum he/she might not go to borrow from external credit sources. Earning higher income level would likely reduce the amount of microfinance loan utilization by smallholder farmers. In this study, the level of income earned per annum was negatively related to the loan amount received by smallholder farmers. The truncated regression result revealed that as the level of household income earned per annum increased by 1%, the loan amount received by smallholder farmers would reduce by 8.3%. This was statistically significant at 1% significance level (Table 3).

Saving level

As prerequisite, the borrowers should have save some amount of money in OMFI in order to obtain a loan from that institution. The lending institution requires borrowers to start saving in it before six months of the time to go to ask for credit. The borrowers must save a minimum of 20% of the loan amount they want to obtain. This implies the more money households save in OMFI, the more chance they get a larger loan from OMFI. As magnitude of saving by farmers increased by 1%, the size of loan increased by 13.1% and it was a statistically significant predictor of loan amount at 1% significance level.

Purpose of loan taking

The reason for taking loan is an important element that formal credit lenders want to know before offering credit. The lender (OMFI) has been providing loan for the purpose of financing agricultural production, petty trades, hand crafts and services. These are all income generating activities. Those farmers requested a loan primarily for the purpose of production activities have got larger loan size than those farmers applied for other than production activities. In the study, the purpose of loan taking for production activities increased the loan amount by 63.5% and it was found to be statistically significant at 1% significance level. This result differs from the finding of Lensink et al. (2005).

Farmers' perception about the loan repayment period

In the study, farmers' perception about the loan repayment period as not good reduced the loan amount by 10.2% at 1% significance level. It was negatively related to the loan amount received by smallholder farmers. This is because those farmers who perceived the loan repayment period as not good to make the repayment from the returns of their farm output would not get confidence to take larger amount of loan. On the other hand, those farmers who perceived the loan repayment period as good might request the amount of loan he/she wants to borrow without any fear and could obtain up to the maximum amount of loan allowed by the lending institution.

CONCLUSION AND RECOMMENDATIONS

In Ethiopia, among other things, limited access to credit has remained one of the basic problems that slow down agricultural production, productivity and related agribusiness in many rural areas where smallholder farmers dwell. In line with this, the study was conducted with the main aim of identifying determinant factors influencing farmers' microfinance loan utilization in Lemo District of Hadiya Zone, Southern Ethiopia. Both primary and secondary data sources were used to obtain all the necessary data. The data was analyzed using descriptive statistics and independent Double-hurdle model. The model results revealed farmers' literacy status, household size, size of landholding, perception about loan repayment period and distance from farmers' residence to the lending center as the factors significantly influencing farmers' microfinance loan utilization. On the other hand, the farmers' sex, literacy status, household income level, saving level, purpose of loan taking and perception about loan repayment period were found to be the factors significantly influencing loan amount received by farmers. The study results show that there was inadequate flow of credit to smallholder farmers in the study area.

Based on the result of this study, the following policy implications are suggested for the future intervention strategies aimed at improving famers' microfinance loan utilization and loan amount in Lemo District in particular and in southern Ethiopia where OMFI are working in general.

1. To improve microfinance loan utilization and loan amount received by farmers, the concerned bodies should make an effort to educate and train farmers by giving special emphasis to illiterate and female-headed farmers.
2. OMFI have to adjust the loan repayment schedule in accordance with farmers' preferences that is suitable for farmers to make the loan repayment from the returns of their activities. They should give due focus to counseling and educating farmers to utilize the loan in profitable enterprises that enable smallholder farmers to make the repayment on time.
3. In the study, saving level has positively affected loan amount received by farmers. Therefore, OMFI and other concerned bodies should motivate and educate farmers to save in formal financial institutions like OMFI.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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