A triple-hurdle model of small ruminant production and marketing in the highlands of Ethiopia: Implications for commercial transformation

Berhanu Gebremedhin[1], Kaleb Shiferaw[1], Solomon Gizaw[1], Azage Tegene[1] and Dirk Hoekstra[1]
[1]International Livestock Research Institute (ILRI) Ethiopia
Corresponding author: Berhanu Gebremedhin, b.gebremedhin@cgiar.org

Abstract

The over 55 million sheep and goats in Ethiopia serve as important sources of cash income and protein for rural households. Despite the policy direction of commercial transformation of smallholder agriculture for over a decade in Ethiopia, little transformation has been observed in the small ruminant subsector to date, calling for a rigorous empirical analysis of the factors that influence household decisions to produce and market small ruminants. The confluence of productivity-increasing technologies and practices and profitable market opportunities is essential to achieve sustainable development and transformation of the agricultural sector. We use the triple-hurdle econometric model to analyse household decisions to engage in small ruminant production, their market position and the intensity with which they participate in the market. By integrating production, market position and volume of sales, the triple-hurdle model estimates parameter values that can be used to make inferences about the study population, where some part of the population are non-producers. Results are based on a data set collected from 5,000 households and 497 rural communities in the highlands of Ethiopia. Our results show that access to credit encourages engagement in small ruminant production, suggesting that liquidity constraint is an important barrier to overcome in promoting market-oriented small ruminant production. Engagement in small ruminant production is also more likely in relatively remote areas that are farther away from markets and roads and higher altitude areas with adequate grazing and browsing resources. However, in areas where small ruminant production is likely, market access stands out as an important determinant of household market position. Younger households with limited land resources, male-headed households and households with a relatively higher labour supply are also more likely to be engaged in small ruminant production. Flock size is an important determining factor of market participation and volume of sales. The small ruminant subsector is price non-responsive, suggesting that households liquidate their animals because they are in need of cash, not necessarily to maximize profit. Implications to facilitate the commercial transformation of produce are drawn.

Keywords: Triple-hurdle model, commercial transformation, small ruminants, market access, Ethiopia

Introduction

Ethiopia is endowed with more than 55 million sheep and goats (Commissariat for Food Security (CSA) 2014), which serve as important sources of cash income and protein for the rural households (Ayele et al. 2006). Cognizant of the importance of small ruminants to the livelihoods of the rural population, the government of Ethiopia (GoE) has been transforming the subsector into a market-oriented production system for more than a decade (Ministry of Finance and Economic Development (MoFED); National Planning Commission (NPC) 2016). However, the transformation process of the subsector has been sluggish at best.

The confluence of productivity-increasing technologies and practices and profitable market opportunities is essential to achieve sustainable development and transformation of the agricultural sector (Haggblade et al. 2010; Minten and Barrett 2008; Omiti et al. 2009). The small ruminant subsector is no exception. Small ruminant market development is expected to generate important market signals for smallholders to invest and actively participate in the market and improve their wellbeing (Tiffen et al. 1994).

The Ethiopian small ruminant subsector falls short in both productivity and market participation measures. The yield per carcass weight of sheep and goats for Ethiopia in the 2012/13 production season was estimated at 10 kg/animal and 8.5 kg/animal, respectively, while the average for Africa was 14 kg/animal and 11.2 kg/animal for sheep and goats, respectively (Food and Agriculture Organization of the United Nations (FAO) 2014). Poor management practices and lack of adequate health services also lead to high mortality and morbidity. In the 2012/13 production season the mortality rate was estimated at 18% and 16% for sheep and goats, respectively, while the morbidity rates were estimated at 22% for sheep and 19% for goats (CSA 2014), which obviously would affect commercial off-take rates.

The sluggish transformation of the traditional small ruminant subsector in Ethiopia calls for a rigorous empirical analysis of the factors that influence household decisions to produce and market small ruminants. Such an analysis is important in order to draw policy implications to facilitate the transformation process. Several studies have been conducted on small ruminant production and marketing practices in Ethiopia (Kebede et al. 2012; Kocho et al. 2011; Legesse et al. 2013, 2010, 2008; Tadesse et al. 2014, 2015). However, to our knowledge, no study has integrated production, market participation and intensity of market participation decisions by smallholders.

Moreover, market participation studies on small ruminants in Ethiopia have been mainly based on small sample sizes that are limited to particular production areas such as a district or a few districts, making generalization at national level difficult. Our analysis is based on data collected from a representative sample size of 5,000 households in the major four highlands regions of Ethiopia (Tigray, Amhara, Oromia and Southern Nations, Nationalities and Peoples (SNNP)), where about 75% of the country's small ruminant population is produced. Using the data set from such a broad sample of small ruminant producers, the paper aims at identifying factors that influence household decisions with regard to production, marketing and intensity of market participation using a triple-hurdle model that integrates the three decision choices.

Our results show that engagement in small ruminant production is more likely in relatively remote areas that are farther away from markets and roads and higher altitude areas with adequate grazing and browsing resources. Younger households with limited land resources, male-headed households, and households with a relatively higher labour supply are also more likely to be engaged in small ruminant production. Flock size is an important determining factor of market participation and volume of sales. The small ruminant subsector is price nonresponsive, suggesting that households liquidate their animals in need of cash, not necessarily to maximize profit.

The paper is organized as follows. The next section presents our conceptual framework. Section three describes estimation approach. Section four presents data and descriptive statistics. Section five presents and discusses the econometric results of the triple-hurdle model. Section seven concludes the paper and presents implications.

Conceptual framework

The conceptual framework followed in this paper is based on the theoretical framework developed by Barrett (2008) and Boughton et al. (2007). The key features of the models are that farm households' access to markets is not uniform because households face differential transaction costs due to household- and farm-specific characteristics as well as meso-level factors related to market infrastructures and institutions, and the degree of competition among market intermediaries. Participation in small ruminant production and marketing are, therefore, modelled as functions of transaction cost factors (tc), household characteristics (hc), farm characteristics (fc), asset endowment (ae), access to services (as), community level variables (cc), agro-ecological zones (az) and prices (p). Hence, the full triple-hurdle model is specified as follows:

srprod = srprod (tc, hc, fc, ae, as, cc, az, p)
srmrpos = srmrpos (tc, hc, fc, ae, as, cc, az, p)
netsell = netsell (tc, hc, fc, ae, as, cc, az, p)
netbuy = netbuy (tc, hc, fc, ae, as, cc, az, p)

Where: srprod is a binary indicator of whether a household is involved in small ruminant production; srmrpos is a multinomial indicator of the market position of the household (1 = net buyer, 2 = autarkic, 3 = net seller); netsell is the net number of small ruminants sold by the household; and netbuy is the net number of small ruminants bought by the household. The net quantities of buying and selling are modelled separately as the effects of the right-hand side variables on these outcomes may be different (Key et al. 2000). Exclusion restrictions are possible so not all explanatory variables may be included in each model (Burke et al. 2015).

Estimation

A household's market participation decision can be thought of as a three-stage decision problem where clearance from the previous stage is required for each successive stage. The first stage is production decision (i.e. whether to engage in small ruminant production or not), followed by the decision on market position (net buyer, autarkic and net seller) for producers. Conditional on the decision on market position, the last stage is the decision on intensity of market participation either as net seller or as net buyer.

The estimates for the parameters can be obtained by running a relevant separate regression model for each stage (Burke et al. 2015). Since the dependent variable at the first stage is binary, a probit model is used. For the second stage an ordered probit model is used to estimate the parameters. Finally, a lognormal regression model is estimated to examine the intensity of market participation for net sellers[1]. All estimations are made using Stata, version 14 (StataCorp. 2015).

We used household labour supply as an exclusion variable to estimate the second-stage model since the availability of labour is expected to affect the decision of whether or not to produce small ruminants but not the decision on market participation. We also used variables that measure access to market information as exclusion variables to estimate the third-stage models. Access to information can be considered as a fixed transaction cost factor, which affects only the decision on market participation but not the intensity of participation.

1 Since we could not find effective identification variables for net buyers, we only present and discuss estimation results for net sellers.

Data and descriptive statistics

Results are based on analysis of data from a survey of 5,000 smallholder households and 497 rural *kebeles*[2] in the four highland regions of Ethiopia (Tigray, Amhara, Oromia and SNNP). Ten zones were selected for the study from which 62 districts[3] were identified. The study area accounts for about 13.6% of the national area, 30% of the national sheep population and 22.5% of the national goat population[4]. For sampling purposes, the study districts were stratified into 10 agro-ecological zones, and farm households were selected randomly based on proportional to size sampling technique. Data were collected on household characteristics, farm operations, household asset ownership, farm characteristics including land holding, flock and herd size and structure, access to physical and institutional infrastructure and household cash earnings. The survey was conducted in 2014 and referred to the 2012/2013 production season.

Female-headed households account for less than one fifth of the total households (Table 1). Female-headed households also account for about 16% of those involved in small ruminant production. Among net sellers, 15% are female-headed households.

For those who engaged in small ruminant production, the average herd size is about 7.85 animals, with corresponding average sizes of 9.73 for net sellers and 5.05 for net buyers. More than two thirds of the small ruminant stock are female animals. During the production year, a household on average lost about 10% of its flock, mainly due to diseases, which accounted for about 71% of the deaths. Other causes of small ruminant deaths include ageing, injuries due to accidents and predators.

Landholdings are small, at about 1.38 ha on average. The value of household physical assets, which include agricultural tools, water cans, water pumps, wheelbarrows, animal carts, mobile phones, radios, television, bicycles, motorcycles and other goods, pack animals, beehives and urban property, is estimated at ETB 17,660 (Ethiopian birr[5]) and this slightly increases for small ruminant producers. Based on the large standard deviation, it looks as if household wealth varied considerably. About 43% of household heads are able to read and write, with 18%, 19% and 5% of households having formal schooling of 1–4 years, 5–8 years and more than 8 years, respectively.

2 A rural kebele is the lowest administrative unit in Ethiopia and comprises of 4–5 villages.Among the surveyed districts, 31 are intervention
3 districts of the Livestock and irrigated value chains for ethiopian smallholders (LIVES) project implemented by the International Livestock Research Institute (ILRI) in partnership with other national and international organizations to demonstrate market-oriented transformation of smallholder agriculture in Ethiopia.The remaining 31 districts are control districts for impact evaluation. For more information, please visit www.lives-ethiopia.org.
4 The national figures used to compute these percentages exclude the lowland non-sedentary zones of the Afar and Somali regions.
5 The official exchange rate of USD 1 was equal to ETB 20.4322 as of 23 February 2015

Table 1. Distribution of explanatory variables

Explanatory variables	Total households (N=4618)	
	Mean	Std. Dev.
Household characteristics		
Age of household head *(year)*	45.32	12.18
Male-headed household *(yes=1)*	0.81	0.39
Dependency ratio	1.06	0.83
Number of working age household members (no.)	3.18	1.48
Land owned *(ha)*	1.38	1.36
Value of physical assets[6] *(ETB 1,000)*	17.66	56.12
Household non-farm income *(ETB 100)*	36.6	77.03
Large ruminant herd size *(no.)*	4.19	4.25
Small ruminant flock size *(no.)*	-	-
Proportion of female animals in the small ruminant flock *(%)*	-	-
Number of dead animals in the small ruminant flock	-	-
Head education		
No formal education *(yes=1)*	0.57	0.49
1 to 4 years *(yes=1)*	0.18	0.38
5 to 8 years *(yes=1)*	0.19	0.39
More than 8 years *(yes=1)*	0.05	0.23
Access to services and infrastructure		
Distance to nearest all-weather road *(walking minutes)*	48.08	71.84
Distance to nearest livestock market *(walking minutes)*	86.38	62.62
Credit use *(yes=1)*	0.19	0.39
Involvement in extension program for small ruminants *(yes=1, no=0)*	-	-
Access to market information on small ruminants *(yes=1, no=0)*	-	-
Ownership of radio *(yes=1, no=0)*	0.39	0.49
Community characteristics		
Population density (persons/ha.)	3.15	2.97
Availability of communal grazing land (ha/tropical livestock unit (TLU))	0.07	0.12
Wage rate (ETB/hour)	59.67	22.23
Agro-ecological zone 1(=1 if altitude is > 2300 m)	0.26	0.44
Agro-ecological zone 2 (=1 if altitude is 1,500–2,300 m)	0.67	0.47
Agro-ecological zone 3 (=1 if altitude is <1500 m)	0.07	0.26
District prices[7]		
Small ruminant average selling price (ETB)	723.03	122.31
Large ruminant average selling price (ETB 1,000)	5.40	1.13
Average selling price of butter (ETB/kg)	104.92	18.83

The nearest all-weather road and livestock market are located on average within 48.13 and 86.63 minutes of walking distance from a homestead, respectively. About 19% of households took out an agricultural loan during the year. Not surprisingly, about two thirds of small ruminant producers are located in the higher altitude areas where the altitude ranges from 1500–2300 miles above sea level and where the annual rainfall ranges from 900 mm to more than 1400 mm. In the study area, cattle (oxen) and dairy products (butter) represent potential alternative sources of income to

6 Excluding small and large ruminants.

7 These are district level averages of observed prices collected in the survey.

small ruminant production. Thus, in addition to the price of small ruminants, district market prices of butter and oxen are included in the analysis.

Results and discussion

This section first presents estimation results for the triple-hurdle model consistent with the choice models outlined earlier. To identify the market position model, we imposed an exclusion restriction on the household labour supply variable, which is found to be statistically significant in the production decision equation (P=0.000) but not in the market position equation (P=0.386). Then, in order to check whether the error terms in the first and second stages are conditionally uncorrelated, a standard t-test is used on the coefficient estimate of the IMR1. We failed to reject the null hypothesis that the coefficient estimate for IMR1 is not different from zero (P=0.116), and IMR1 is excluded from the second-stage estimation on market participation.

Similarly, to identify the market intensity model, we used access to market information variables (ownership of radio and access to small ruminant market information) following Goetz (1992), who argues that information costs are fixed transaction costs that influence market entry but not intensity of market participation. The Wald test of the hypothesis that the coefficients of the two variables are jointly equal to zero is rejected in the market participation equation (x^2 = 5.58, 2 degrees of freedom, P = 0.062). Nevertheless, we fail to reject the same null hypothesis in the intensity of participation equation for net sellers F (2, 1176) = 0.826, P = 0.442, indicating that these two variables can be used to identify the intensity of participation equation for net sellers.

To test whether the error terms in the second and third stages for net sellers are uncorrelated, a standard t-test is used on IMR_s for net sellers. We failed to reject the null hypothesis that coefficient estimates for IMR_s are not statistically significantly different from zero (P = 0.526). Thus, IMR_s is excluded from the regression equation for net sellers.

Regression results of the first, second and third stages (for net selling only) are given in Table 2. The probit model for production decision correctly predicts 64.7% of the categorical outcomes. The overall percentage correctly predicted by the ordered probit model of discrete market participation is about 43%. The R-squared for the log-linear model (continuous values) of net sellers is about 0.30.

Table 2. Model estimates for production, market position and volume of sales/purchases in small ruminant production in Ethiopia

Explanatory variables	Production (Stage 1)	Market position (Stage 2)	Net sales (Stage 3)
Household characteristics			
Age of household head (*year*)	0.0220**	0.0002	0.0053
	(0.025)	(0.989)	(0.575)
Age of household head squared (*year*)	-0.0002***	0.0000	-0.0000
	(0.009)	(0.956)	(0.808)
Male-headed household (*yes=1, no=0*)	0.1447***	-0.1351	0.0064
	(0.007)	(0.848)	(0.891)
Dependency ratio	0.0416	0.0189	0.0028
	(0.139)	(0.564)	(0.900)
Number of working age household members (*no.*)	0.0735***	–	–
	(0.000)		
Land owned (*ha*)	-0.0540***	-0.0127	0.0208)
	(0.002)	(0.543)	(0.164)
Household wealth *(ETB 1,000)*	-0.0001	-0.0004	0.0000
	(0.717)	(0.369)	(0.959)
Household non-farm income (*ETB 100*)	-0.0000	0.0001	0.0002
	(0.966)	(0.783)	(0.190)
Large ruminant herd size (*no.*)	0.0736***	-0.0188***	-0.0121**
	(0.000)	(0.002)	(0.016)
Small ruminant flock size (*no.*)	–	0.1169***	0.0659***
		(0.000)	(0.000)

Explanatory variables	Production (Stage 1)	Market position (Stage 2)	Net sales (Stage 3)
Small ruminant flock size squared (*no.*)	_	-0.0016***	-0.0005***
		(0.000)	(0.000)
Proportion of female animals (%)	_	-0.0053***	-0.0029***
		(0.000)	(0.001)
Number of dead animals	_	-0.087***	-0.0534***
		(0.000)	(0.000)
Head education			
1 to 4 years (*yes=1, no=0*)	0.0779	0.0590	-0.0630
	(0.154)	(0.379)	(0.150)
5 to 8 years (*yes=1, no=0*)	0.0663	0.0703	-0.0271
	(0.231)	(0.305)	(0.537)
More than 8 years *(yes=1, no=0*)	0.1702*	0.0003	-0.0527
	(0.070)	(0.998)	(0.477)
Access to services and infrastructure			
Distance to nearest all-weather road (*walking minutes*)	0.0007**	0.0003	0.0001
	(0.010)	(0.323)	(0.724)
Distance to nearest livestock market (*walking minutes*)	0.0005*	-0.0010**	0.0001
	(0.092)	(0.016)	(0.634)
Credit use (*yes=1, no=0*)	0.1322***	0.0150	-0.0148
	(0.008)	(0.805)	(0.696)
Involvement in extension program (*yes=1, no=0*)	_	0.0992	0.0652*
		(0.142)	(0.050)
Access to market information (*yes=1, no=0*)	_	-0.0797	_
		(0.272)	
Ownership of radio (*yes=1, no=0*)	0.2094***	-0.1061**	_
	(0.000)	(0.039)	
Community characteristics			
Population density (*persons/ha.*)	-0.0280***	0.0099	0.0116
	(0.000)	(0.360)	(0.116)
Grazing land (*ha/TLU)*	0.3861**	0.2210	0.1408
	(0.023)	(0.270)	(0.311)
Wage rate (*ETB/hour*)	0.0042***	-0.0023**	-0.0021***
	(0.000)	(0.049)	(0.007)
Agro-ecological zone 1(*=1 if altitude is > 2300 m*)	0.8405***	0.3528**	0.2701***
	(0.000)	(0.003)	(0.003)
Agro-ecological zone 2 (*=1 if altitude is 1,500–2,300 m*)	0.4062***	0.1480	0.1897**
	(0.000)	(0.199)	(0.030)
District prices			
Small ruminant average selling price (*ETB 100*)	0.0002	0.0001	-0.0056
	(0.992)	(0.996)	(0.740)
Large ruminant average selling price (*ETB 1,000)*	0.0348	0.0062	0.0744***
	(0.159)	(0.842)	(0.000)
Average selling price of butter (*ETB/kg*)	0.0003	-0.0025*	-0.0037***
	(0.810)	(0.098)	(0.000)
Constant	-2.1102***		0.1746
	(0.000)		(0.554)
Ancillary parameters			
Constant cut1		-1.4783***	
		(0.000)	
Constant cut2		0.0064	
		(0.987)	
IMR_b			
Percent correctly predicted/goodness of fit	64.7%	42.9%	30.41%
Observations	4,618	2,442	1,208

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1

We find that household age has a parabolic relationship with involvement in small ruminant production with the negative effect kicking in at age 44, which is about the same as the average age in the sample households. A 30-year-old (the 10th percentile) farmer has a 52.3% probability of involvement in small ruminant production compared to a 70-year-old, who has a probability of 45.6%. This is probably because younger households have relatively limited access to other productive resources such as crop land (Bezu and Holden 2014) and, as such, would tend to depend on agricultural activities that require less land, such as small ruminant production.

The average probability of a given female-headed household being a small ruminant producer is 49%, as compared to 54% for an otherwise similar male-headed household. This is in agreement with the finding of Duku et al. (2011) in Ghana. Access to credit also has a statistically significant and positive effect on the probability of engaging in small ruminant production.

Education, as source of power to process and interpret information, and ownership of a radio as a source of information seem to encourage engagement in small ruminant production. Households who keep large ruminants are also more likely to keep small ruminants, suggesting that there is complementarity in production between the two enterprises, such as in grazing behaviour (Schwartz 1983).

Population density detracts from involvement in small ruminant production. An increase of one standard deviation in population density (three persons per ha) decreases the probability of participating in small ruminant production by 8.3 percentage points. The negative effect of population density on small ruminant production may be due to its effect on land degradation and thus the availability and productivity of grazing and browsing resources (Sibanda et al. 2011).

As expected, households with smaller farm land sizes are more likely be engaged in small ruminant production, indicating that those households who face shortage of land are likely to diversify away from land-based enterprises (Barrett et al. 2001). For example, an increase of land size by one standard deviation (1.36 ha) decreases the probability of engaging in small ruminant production by about 7.2 percentage points.

Despite the complementarity between large ruminants and small ruminants in production, the two enterprises seem to be substitutes as sources of cash income to the household. Households with large cattle ownership are more likely to be autarkic than to be net sellers and are more likely to be net buyers than to be autarkic. Income from large ruminants may also be used to purchase small ruminants, either for consumption or as an investment. We also find a negative relationship between sales volume for a given net seller and number of large ruminants. However, the average partial effect of inflow of large ruminants on the unconditional expected value of net sales was found to be positive, at 1.8% for each additional large ruminant that joins the farmer's herd.

As expected, small ruminant flock size and structure have a strong and statistically significant effect on the market participation decision as well as volume of sales. A household with a larger small ruminant flock is more likely to be autarkic than a net buyer and more likely to be a net seller than autarkic. Wanyoike et al. (2015) found a similar result in northern Somalia for small ruminants and Lubungu (2016) for cattle in Zambia. Flock size does have a quadratic effect on market participation, where the negative effect sets in at 38 head of animals, under the current production system. The turning point flock size is almost five times the average flock size, showing that the current flock size is suboptimal to promote market participation of households, holding other factors constant. The average producing household in our sample has a 35% probability of being a net selling household if its flock size is three (the 25th percentile), as compared to a 60% probability for a flock size of 10 (the 75th percentile). Flock size also has a quadratic effect on net selling, where the turning point flock size is 68 animals. Each additional animal that joins the herd increases the volume of unconditional expected sales by 8.7 %. These results strongly indicate that increasing flock size needs attention in efforts aimed at promoting market-oriented transformation of the sector.

Results also show that the proportion of female animals in the flock is significantly negatively associated with market participation. Given that a household is engaged in small ruminant production, a typical household with a third of its flock size (5th percentile) being female animals has about 56% probability of being a net seller, as compared to a 48% probability if female animals account for three fourths (75th percentile). Similarly, among net sellers, proportion of

female animals has negative effect on the number of animals sold. Our results predict that on average a 10 percentage point increase in proportion of female animals decreases the unconditional expected number of small ruminant sales by about 5.7%. This is because female animals are mainly kept for reproduction purposes (Wanyoike et al. 2015).

Animal death, likewise, exerts a negative effect on the ordered market participation variable. The more animal death a flock suffers in a period, the more likely it is to be autarkic than a net buyer and the more likely to be autarkic than a net seller. The negative effect also extends to the net sellers, where each additional animal death leads to an 8.5% decrease in the number of animals sold.

Although being further away from markets or all-weather roads favours small ruminant production, conditional on being a producer, distance to market detracts from being a net seller over being autarkic or net buyer. The average producing household in our sample would have a 51% probability of being a net selling household if the walking distance to the nearest livestock market were 40 minutes (25th percentile), as compared to a 48% probability if the livestock market were located some two hours away (75th percentile). This is probably because remote villages offer less opportunity for off-farm employment (Renkow et al. 2004) and, as such, engagement in small ruminant production becomes an attractive livelihood diversification strategy. We do not find a statistically significant relationship between sales volume for a given net seller and distance to a livestock market.

Involvement in small ruminant-focused extension services increases volume of net sales by 10%, all else equal. This is consistent with other studies where extension services have been linked with market orientation in developing countries (Holloway et al. 2000; Lerman 2004). This suggests the potential positive effect of extension services in promoting market participation of households.

We find that household decision to engage in small ruminant production, market participation and intensity of market participation in the small ruminant market are not affected by the price of small ruminants, suggesting that small ruminant production is not price responsive. Small ruminant producers may be selling animals primarily because of cash needs while market-oriented production is low (Kocho et al. 2011). Butter price has a negative effect on both market participation and intensity of participation, suggesting that butter is considered a substitute source of cash income for households. We find a positive association between prices of large ruminants and volume of small ruminant sales, perhaps because cash proceeds from the sale of small ruminants is used to invest in large livestock. In a previous study in eastern Ethiopia, it was observed that involvement in small ruminant fattening was used as a stepping stone to large ruminant fattening (Gebremedhin et al. 2012).

Conclusion and implications

Despite the policy and operational direction of smallholder commercialization pursued by the GoE for over a decade now, the small ruminant sector has seen little transformation to date. The sluggish market-oriented transformation of the small ruminant sector requires an empirical analysis of the factors influencing household decisions in the production and marketing of small ruminants. Such analysis would inform policymaking and development practice to facilitate the transformation process. This paper is an attempt to respond to the need for better understanding of small ruminant production and marketing in Ethiopia.

Using a cross sectional data set from 5,000 households in the highlands of Ethiopia, we estimated a triple-hurdle model to analyse the determinants of household decision to engage in small ruminant production; their market position as net buyers, autarkic or net sellers; and the volume of sales for net sellers.

We find that small ruminant production is preferred by younger households with limited access to land, implying that targeting young people and the landless for market-oriented small ruminant production may serve as a source of employment and income for such segments of the population. The grazing and browsing system of small ruminant production and management also seem to provide better comparative advantages to male-headed households than to female-headed households, suggesting that a change in production practice may be needed to make female-headed

households beneficiaries of the sector. Introduction and promotion of zero grazing can be one option. Access to credit encourages engagement in small ruminant production, suggesting that liquidity constraint is an important barrier to overcome in promoting market-oriented small ruminant production.

Although large and small ruminants seem to be complementary in production, they tend to be substitutes as sources of cash income to the household. Small ruminant flock size is an important determinant of market position and volume of sales, with the likelihood of being a net seller continuously increasing up to a flock size of 38 animals, compared with the average flock size of 7.8. Moreover, net selling households with larger small ruminant flock size are more likely to sell more, showing that the current flock size is suboptimal to promote a market-oriented small ruminant sector. The insight gained from the effect of flock size on marketing behaviour of households is reinforced by the negative effect of animal deaths on market position and volume of sales. These results imply improvements in fertility, productivity, management to improve growth rates and disease control to reduce young mortality are crucial requirements in the sector.

We find that small ruminant production in the highlands of Ethiopia is not price responsive, suggesting that small ruminant producers may be selling animals primarily because of cash needs, while market orientation is low. The negative effect of butter prices on market position and volume of sales of small ruminants indicate that households consider the two products as substitute sources of cash income. The positive association between prices of large ruminants and volume of small ruminant sales shows that cash proceeds from the sale of small ruminants is used to invest in large livestock.

Acknowledgement

We are grateful to the Global Affairs Canada for the financial support. We are also deeply grateful to the many farmers who patiently and willingly responded to our numerous questions.

References

Ayele, G., Jabbar, M.A., H., T., Mulugeta, E. and Kebede, G. 2006. Seasonal and inter-market differences in prices of small ruminants in Ethiopia. *Journal of Food Products Marketing* 12(4):59–77.

Barrett, C., Reardon, T. and Webb, P. 2001. Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy* 26(4):315–331.

Barrett, C.B. 2008. Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food Policy* 33(4):299–317.

Bezu, S. and Holden, S. 2014. Are rural youth in ethiopia abandoning agriculture? *World Development* 64:259–272.

Boughton, D., Mather, D., Barrett, C.B., Benfica, R. and Abdula, D. 2007. Market participation by rural households in a low-income country: An asset-based approach applied to mozambique. *Faith and Economics* 50:64–101.

Burke, W.J., Myers, R.J. and Jayne, T.S. 2015. A triple-hurdle model of production and market participation in Kenya's Dairy Market. *American Journal of Agricultural Economics* 97(4):1227–1246.

CSA, 2014. *Agricultural Sample Survey 2013/14* [2006 E.C.] *Volume VII Report on Crop and Livestock Product Utilization* (Private Peasant Holdings, Meher Season), Report. Addis Ababa: CSA.

Duku, S., Price, L.L., Tobi, H., Zijpp, A. and van der, 2011. Influence of male or female headship on the keeping and care of small ruminants: the case of the transitional zone of Ghana. *Livestock Research for Rural Development* 23(1).

FAO (Food and Agriculture Organization of the United Nations) 2014. FAOSTAT database. (Available from http://faostat.fao.org/site/362/) (Accessed 10 October 2014)

Gebremedhin, B., Hoekstra, D., Bogale, A., Berhe, K. and Tegegne, A. 2012. *Improving productivity and market success (IPMS) of Ethiopian farmers project working paper* summary report of market-oriented developmental changes in the IPMS Pilot Learning Woredas. (No. 30). Nairobi.

Goetz, S.J. 1992. A selectivity model of household food marketing behavior in sub-Saharan Africa. *American Journal of Agricultural Economics* 74(2):444–452.

Haggblade, S., Hazell, P. and Reardon, T. 2010. The rural non-farm economy: Prospects for growth and poverty reduction. *World Development* 38:1429–1441.

Holloway, G., Nicholson, C., Delgado, C., Staal, S. and Ehui, S.,2000. *How to make a milk market: A case study from the Ethiopian highlands* (No. 28) Socio-economics and Policy Research Working Paper. Nairobi.

Kebede, T., Haile, A. and Dadi, H. 2012. Smallholder goat breeding and flock management practices in the central rift valley of Ethiopia. *Tropical Animal Health Production* 44(5):999–1006.

Key, N., Sadoulet, E. and de Janvry, A. 2000. Transactions costs and agricultural household supply response. *American Journal of Agricultural Economics* 82(2): 245–259.

Kocho, T., Abebe, G., Tegegne, A. and Gebremedhin, B. 2011. Marketing value-chain of smallholder sheep and goats in crop-livestock mixed farming system of Alaba, Southern Ethiopia. *Small Ruminant Research* 96(2–3):101–105.

Legesse, G., Siegmund-Schultze, M., Abebe, G. and Zárate, A.V. 2013. Determinants of the adoption of small ruminant related technologies in the highlands of Ethiopia. *Tropical and Subtropical Agroecosystems* 16(1):13–23.

Legesse, G., Siegmund-Schultze, M., Abebe, G. and Zárate, A.V. 2010. Economic performance of small ruminants in mixed-farming systems of Southern Ethiopia. *Tropical Animal Health and Production* 42(7):1531–1539.

Legesse, G., Siegmund-Schultze, M., Abebe, G. and Zárate, A.V. 2008. Small ruminant production in two mixed-farming systems of southern Ethiopia: status and prospects for improvement. *Experimental Agriculture* 44(3):399–412.

Lerman, Z. 2004. Policies and institutions for commercialization of subsistence farms in transition countries. *Journal of Asian Economics* 15(3):461–479.

Lubungu, M. 2016. Factors influencing livestock marketing dynamics in Zambia. *Livestock Research and Rural Development* 28.

Minten, B. and Barrett, C.B. 2008. Agricultural technology, productivity, and poverty in Madagascar. *World Development* 36:797–822.

MoFED, 2010. *Growth and transformation plan (GTP) 2010/11-2014/15*. Addis Ababa: MoFED

NPC, 2016. *Growth and transformation plan II (GTP II) (2015/16-2019/20)*. Addis Ababa: NPC.

Omiti, J.M., Otieno, D.J., Nyanamba, T.O. and Mccullough, E. 2009. Factors influencing the intensity of market participation by smallholder farmers: A case study of rural and peri-urban areas of Kenya. *African Journal of Agricultural Resource Economics* 3:57–82.

Renkow, M., Hallstrom, D.G. and Karanja, D.D. 2004. Rural infrastructure, transactions costs and market participation in Kenya. *Journal of Development Economics* 73(1):349–367.

Schwartz, H.J. 1983. Improved utilization of arid rangelands through multiple species herds. In: *5th World Conference on Animal Production*. Tokyo: Japanese Society of Zootechnical Science (pp. 625–626)

Sibanda, A., Homann-Kee, T., van Rooyen, A., Dimes, J., Nkomboni, D. andSisito, G. 2011. Understanding community perceptions of land use changes in the rangelands, Zimbabwe. *Experimental Agriculture* 47(S1):153–168.

StataCorp. 2015. Stata: Release 14. Statistical Software.

Tadesse, D., Urge, M., Animut, G. and Mekasha, Y. 2014. Perceptions of households on purpose of keeping, trait preference, and production constraints for selected goat types in Ethiopia. *Tropical Animal Health Production* 46(2):363–370.

Tadesse, E., Negesse, T. and Abebe, G. 2015. Sheep production and marketing system in southern Ethiopia: the case of Awassazuria district. *Tropical Animal Health Production* 47(7):1417–1425

Tiffen, M., Mortimore, M. and Gichuki, F. 1994. *More people, less erosion: environmental recovery in Kenya*. Chichester, UK: Wiley.

Wanyoike, F., Mtimet, N., Ndiwa, N., Marshall, K., Godiah, L. and Warsame, A. 2015. Knowledge of Livestock Grading and Market Participation among Small Ruminant Producers in Northern Somalia. *East African Agricultural and Forestry Journal* 81(1):64–70.