Determinants of livestock market participation among pastoral communities of Tana River County, Kenya

Alphayo I. Lutta[1] · Oliver V. Wasonga[1] · Lance W. Robinson[2] · Moses M. Nyangito[1] ·
Jason Sircely[2]

Abstract

Livestock production in arid and semi-arid areas is an important source of household food and income. Selling or buying of livestock and their products is important among pastoral communities who derive their source of livelihoods from livestock production. This study sought to determine factors that influence the initial decision of pastoral communities to participate in livestock markets and the extent or level of participation in livestock markets. Semi-structured questionnaires were used to collect data from pastoralists through face-to-face interview. The data were analysed using descriptive statistics and Heckman two-stage selection model that allows for determination of the discrete probability of participation and the extent of participation. The results show that most households participated in the livestock markets as sellers rather than buyers with herd recruitment and restocking for market participants being mainly through birth, borrowing or loaning female cows from friends. The number of livestock sold or bought by pastoralists at any given market price was significantly affected by the non-price constraints such as distance to the market, group marketing, age and education level. The decision of whether to participate and the level of market participation were significantly determined by pastoralists attaining and maintaining sufficiently large herd sizes and hence become willing to liquidate animals through the market. Sole emphasis on livestock marketing may not significantly manage risks unless there is proper understanding of pastoral long-term incentives to keep livestock. Therefore, developing livestock markets in pastoral areas should be along with investment on rangeland rehabilitation that enables reciprocal access of resources which allows them to maximize herd sizes.

✉ Alphayo I. Lutta
  lutaalpha@gmail.com

1 Department of Land Resource Management and Agricultural Technology, Faculty of Agriculture, University of Nairobi, P.O. Box, 29053-00625 Nairobi, Kenya

2 Sustainable Livestock Systems, International Livestock Research Institute, P.O. Box 30709, 00100 Nairobi, Kenya

1 Introduction

Arid and semi-arid areas face a number of challenges including security of tenure, scarcity of human capital, high transaction costs, poor marketing structures as well as variable weather conditions (Galvin 2009, Ulrich et al. 2012). One of the basic livelihood strategies that are viable in these areas is livestock production (Onono et al. 2013). Due to spatial–temporal variability of rainfall and other climatic factors, crop production is not sustainable economic activity of pastoralists and hence livestock remains the only viable source of livelihood (Mganga et al. 2015). The livestock sector in Kenya accounts for ten to 15 per cent of gross domestic product (GDP), about 30 per cent of agricultural GDP and employs 50 per cent of the agricultural labour force (GoK 2015). Livestock production is thus an important risk reduction strategy and the main source of livelihood for pastoral communities (Karanja et al. 2018; Zaal et al. 2011). Enhancing livestock productivity is therefore a pathway out of poverty for communities living in semi-arid areas (Thornton 2010).

The most rampant challenges facing the livestock market sector include inadequate pasture and water, livestock market and price instability, poor marketing infrastructure, poor market organization, and information, inefficiency in marketing chains and low purchasing power for consumers (Muthee 2006). The demand for livestock products is likely to increase due to more consumption of livestock products arising from increased human population and urbanization (Rutto et al. 2013; Jari and Fraser 2009). With the increased demand, livestock sector provides greater prospects for the economic growth of pastoralists whose main source of livelihood is livestock production (Thornton 2010).

However, despite the substantial projections for increased demand for livestock products, livestock market participation in semi-arid areas is often low coupled with little market off-take rate (Olwande and Mathenge 2012). Marketing of livestock is important in enhancing food security and sustainable livestock keeping among pastoralists in northern Kenya (Behnke 2010; Le Heron 2016). Consequently, to ensure accelerated development in the semi-arid areas it is important to focus on their comparative advantage, livestock production (Bollig 2016). These include ensuring access to livestock markets that can improve pastoral livelihoods through sustained economic growth.

Various studies have been done to determine factors affecting the participation of farmers in livestock markets. In a study to determine factors affecting milk market participation and volume of supply among dairy farmers in Ethiopia, Berhanu et al. (2014) found that age of household head, farming experience, milk yield per day, milking cow ownership and landholding size played a significant role in milk market participation. Similarly, Ayele et al. (2019) found that sex, age, education level of household head, family size, and number of beef cattle owned, crop income and access to market information significantly affect smallholder farmers' market participation decision in beef cattle market. For pastoral production systems, factors that influence pastoral participation in livestock markets could be categorized into three: socio-economic factors, institutional factors and market factors (Zaal 2011; Olwande and Mathenge 2012; Onano et al. 2013; Thornton 2010). A study by Barret and Luseno (2004) on household-level livestock marketing behaviour among Northern Kenyan and Southern Ethiopian pastoralists found that most households participate in the livestock market and that they participate most actively when prompted by environmental stress, albeit almost entirely as sellers rather than buyers. However, according to Muthee (2006) and Behnke (2010) the poor state of transport and marketing infrastructure makes it difficult to move animals to markets, especially those evacuating animals from

up-country source markets to terminal markets posing a challenge in access to markets. To increase livestock productivity and market value for the animals, it is important to address challenges affecting livestock marketing among pastoralists such as high transaction costs, information asymmetry and production challenges resulting in poor-quality animals. This study analysed the determinants of livestock market participation among the pastoralists of Tana River County of Kenya. This information is vital in understanding socio-economic, institutional and market factors that influence the participation of pastoralists in marketing of their livestock. Lack of knowledge about factors that determine livestock market participation among the pastoral communities often leads to misguided interventions that have little impact on improving household welfare of pastoralists (Alkemade et al. 2013; Ehui et al. 2009).

2 Methodology

2.1 Study area

The study was done in Tana River County (Fig. 1) which covers 38,682 Km^2 in Kenya's coastal region with a population size of 315,943. The County is characterized by hot and dry climate within ecological zones ranging from III in the very high grounds to VII in the plains or lowlands. Average annual temperatures are about 30 °C with the highest being 41 °C around January–March and the lowest being 20.6 °C around June–July. The total annual rainfall ranges between 220 and 500 mm with long rains occurring in April and May and short rains in October and November with November being the wettest month (Kipchirchir 2014). Seventy per cent of the population rely on livestock production as their
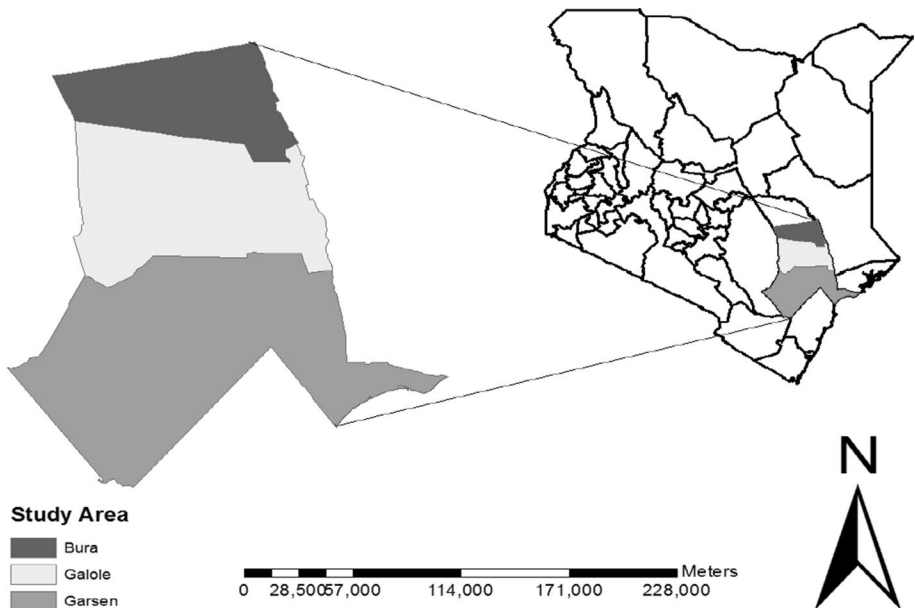

Fig. 1 The study area

main source of livelihood (Kipchirchir 2014) contributing about 68 per cent of household cash income. According to MoALF (2016), the average household livestock herd size in pastoral zone is 28 Tropical Livestock Units (TLU) (21 cattle, 28 goats and 21 sheep), while in the marginal mixed farming livelihood zone, the herd size is 8 TLU (3 cattle, 21 goats and 14 sheep). In the mixed farming, herd size is 8 TLU (2 cattle, 15 goats and 5 sheep).

The Orma, Wardey and Pokomo are the dominant ethnic groups in the area who practice extensive livestock production (Andersson 2005). The County is prone to frequent droughts, unreliable, localized and erratic rainfall which make livestock production the most suitable economic activity in these areas.

2.2 Study design and sampling

A descriptive survey design was used to gather data from the smallholder livestock farmers living in Tana River County. A multi-stage sampling procedure was used in the selection of a representative sample. Three sub-counties, namely Bura, Galole and Garsen, inhabited by the agro-pastoralists and the mobile pastoralists were purposively selected in the first stage of sampling. The second stage involved a systematic random sampling to select five locations from each sub-county. At the third stage, simple random sampling was used to select two smaller administrative units (sub-locations) within each location. Ten respondents were randomly selected from each administrative unit to give a total of 300 respondents. The required sample size was determined by Cochran's proportionate to size sampling methodology (Mugenda and Mugenda 2003).

$n = \frac{z^2 pq}{e^2}$ where n = sample size; Z = confidence level (α = 0.05). Hence, Z = 1.96, p = proportion of the population containing the major interest (0.75), q = 1−p and e = allowable error (0.05).

2.3 Data collection

Semi-structured questionnaire was used to collect primary quantitative data on the determinants of market participation among the smallholder livestock farmers and their socio-economic characteristics and constraints of pastoralists' access to markets. Pretesting of the questionnaire was administered through face-to-face interviews in the targeted communities to test its validity with farmer's conditions before the actual data collection. A total of 50 households were interviewed during the pretesting of the questionnaire. Minor modifications were done through feedback from household interviews and with participation of a multidisciplinary team. Qualitative data were collected using focus group discussions and key informant interviews. A total of 12 focus group discussions were conducted covering, four in each sub-county with 10–12 persons. This also included discussions with 24 key informants involving individuals from institutions that have vested interest in the natural resource management and livelihoods of communities from the county.

2.4 Data analysis

The data were analysed using descriptive statistics and the Heckman's two-stage model. The t test statistic and chi-square statistic were used to test for significance in differences in the socio-economic characteristics of those who participate in livestock markets and those

who do not participate. Chi-square test was used for nominal data with categorical variables, while t test was used to test the differences in means of the continuous variables. Different models including Tobit model, double-hurdle model and Heckman two-stage models have been used to examine the determinants of market participation (Komarek 2010). Tobit model presumes that the factors determining the probability of whether to participate in the market or not and those that determine the level of participation in terms of the sales volume are the same. It assumes that the decision to participate and the level of participation are made simultaneously. It also assumes that zero values traded by a household are a rational choice even when there are market barriers that prohibit market entry.

Double-hurdle model and Heckman two-stage models relax these limitations by allowing for separate determination of the discrete probability of participation and the level of participation. The model, however, has the limitation of incidental truncation where by all sample populations are used in the first stage to determine whether they participate or not using a probit regression and on the other hand, a truncated regression is used in the second stage to determine the level of participation on households participating in livestock marketing (Sigei et al. 2014). This model was therefore not preferred due to sample selection problems and the case of incidental truncation.

Heckman two-stage model was therefore used because it is appropriate for independent analyses of the dependent variables for the decision to either participate in marketing of livestock and the extent of participation (Hoffman and Kassouf 2005). The two stages in the Hechman two-stage model resulted in two equations: the first equation was for whether or not the livestock keeper participates in marketing and the second one was for estimating the extent of market participation, which refers to the proportion of livestock sold by the market participant.

Two steps were used in this model. The first step was using a probit model in determining the selection equation that shows the discrete probability of whether to participate or not, and the second step involved the use of ordinary least squares (OLS) regression to determine the outcome of the first decisions in terms of the extent or level of participation after selecting whether to participate (outcome equation). The probit model was used to predict the probability of a livestock keeper to either sell or not sell their livestock as in Eq. 1.

$$Pr\big(Z_i = 1 | w_i, \alpha\big) = \Phi\big(h\big(w_i, \alpha\big)\big) + \varepsilon_i \tag{1}$$

where Z_i is an indicator variable equal to unity for livestock keepers that participated in the livestock marketing; $_\phi$ is the standard normal cumulative distribution function; w_i is the vector of factors determining the decision to participate in livestock market; α is the vector of coefficients to be estimated; and ε_i is the error term assumed to be distributed normally with a mean of zero and a variance σ2. The variable z_i takes the value of 1 if the marginal utility the household i get from participating in marketing of livestock is greater than zero, and zero otherwise. This is shown as follows:

$$Z*_i = \alpha w_i + u_i \tag{2}$$

where $Z*i$ is the level of utility pastoralists get from participating in the market, ui is the error term assumed to be distributed normally with a mean of zero ui ~ N (0, 1), and

$$Z_i = 1 \ if \ Z*_i > 0 \tag{3}$$

$$Z_i = 0 \ if \ Z_i^* \leq 0 \tag{4}$$

An additional regressor was included in the second step as shown in Eq. 5:

$\frac{\varphi(h(w_i\alpha))}{\varphi(w_{i,}\alpha)}$ (5) where φ is the normal probability density function; the second stage equation is given by

$$E = (Y_i|Z = 1) = f(x_i, \beta) + \lambda \frac{\varphi(h(w_i\alpha))}{\varphi(w_{i,}\alpha)} \tag{6}$$

where E in the equation is the expectation operator; Y is the number or proportion of livestock that were sold; x is a vector of independent variables which determine the number of livestock that were sold by each market participant; and β is the vector of the estimated coefficients. In this case, Y_i can be written as:

$$Y_i * = {}^\beta xi + y\lambda_i' + u_i \tag{7}$$

Y_i^* is only for those who sell their livestock in markets,
where

$$u_i \sim N(0, \sigma_u). (Z_i = 1), \ \text{and hence} \ Yi = Yi * . \tag{8}$$

Therefore, the probability $P_{(0,1)}$ of either participating in the livestock markets or not is estimated as

$$P_{(0,1)} = \beta_0 x_0 + \beta_1 x_1 + \beta_2 x_2 + \dots \beta_n x_n + e \tag{9}$$

where participating in the livestock markets is denoted by 1 and not participating in the livestock market is denoted by 0; β_0 is a constant,

$\beta_1 \dots n$ are those parameters that are estimated as vector of independent variables as shown.

The extent of market participation is determined using ordinary least squares as follows:

$$Y = \beta_0 x_0 + \beta_1 x_1 + \beta_2 x_2 + \dots \beta_n x_n + e \tag{10}$$

where Y is the proportion of livestock sold or bought, β_0 is a constant, $\beta_1 \dots n$ are parameters of the explanatory variables to be estimated, x_i are vector of explanatory variables. The explanatory variables used in the model include gender, education, herd size, size of the household, market price, age, extension service access, group marketing and distance to market.

The two equations for the two steps are specified as follows:

Step 1: (selection equation)

$$P_i(0, 1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon$$

$$P_i(0, 1) = \beta_0 + \beta_{1age} + \beta_{2gender} + \beta_{3Education} + \beta_{4Householdsize} + \beta_{5Occupation} + \beta_{6income} + \beta_{7price} + \dots + \varepsilon_i$$

Step 2: (outcome equation)

$$= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon$$

Proportion of livestock sales or bought.

$(Y_i) = \beta_0 + \beta_1 age + \beta_2 gender + \beta_3 Education + \beta_4 HH\ size + \beta_5 Occupation + \beta_6 Income + \beta_7 price + \beta_8 Distance\ to\ market + \beta_9 market\ information + \beta_{10} Herd\ size + \beta_{11} Group\ marketing + \beta_{12} Extension\ service\ldots\ldots + \varepsilon_i$

2.5 Explanatory variables used in the model and their expected effects

Factors that influence pastoral participation in livestock markets can be categorized into three: socio-economic factors, institutional factors and market factors.

Age of household head Age is a continuous independent variable measured in years. The coefficient for age of the household head could be positive or negative. When age of the household head is used as a proxy for experience in marketing, it is expected to improve the intensity of market participation hence a positive coefficient. Older pastoralists might have accumulated capital with long-term relationship with their clients and therefore selling more. They may also be able to make decisions based on the past experiences (Sall et al. 2000). Young people on the other side might be willing to take risks (Zegeye et al. 2001). Age's coefficient may also be negative because older households tend to have more dependants causing more consumption, hence lowering marketable surplus (Ehui et al. 2009). Younger people may also be enthusiastic to participate in the livestock market. Young people may also be more receptive to new ideas and are less risk averse than the older people (Barret et al. 2003).

Gender of household head Gender is a dummy independent variable that takes the value of 1 if a household head is male and 0 when female. In pastoral communities, gender of the household head may have a significant impact in the market participation decision. According to the pastoral traditions, livestock is owned by the males; therefore, because males are resource endowed than their counterpart female, they are likely to participate more in livestock marketing than their female counterparts. Female-headed households are therefore resource-constrained, hence affecting the production of marketable surplus (Guiterrez 2003). According to Cunningham et al. (2008), men are likely to sell more livestock due to their shrewdness in bargaining, negotiating and enforcing contracts. Female-headed households are more negatively affected by the transaction costs of searching for buyers and enforcing a sale transaction as opposed to the male-headed households (Jagwe et al. 2010). If this observation holds in the present study, the gender coefficient would be positive; otherwise, a negative sign would be expected.

Education Education is a continuous independent variable measured in formal years of schooling by the head of household. Human capital, represented by the household head's formal education, is posited to increase a household's understanding of market dynamics and therefore improve decisions about the amount of output sold (Makhura et al. 2001). Therefore, education was hypothesized to positively influence the market participation.

Household size Household size is a continuous independent variable measured in number of members in a household. The household size explains the family labour supply for production and household consumption levels (Alene et al. 2008). A positive sign implies that a larger household provides cheaper labour and produces more output in absolute terms such that the proportion sold remains high. A negative sign on the other hand means that a larger household is labour-inefficient and produces less output, leaving smaller and decreasing proportions for sale.

Herd size Herd size is a continuous independent variable measured in the number of livestock reared by a household. Active livestock markets depend on pastoralists attaining and maintaining sufficiently large herd sizes that they become willing to liquidate animals through the market. When livestock prices are rising in the post-drought period, households with large herd sizes are able to sell surplus animals and take advantage of favourable prices, while those with few animals tend to hold on to them, unless forced to sell by consumption needs (Lutta et al. 2019). Poorer households with few herd sizes also rely on market purchases for restocking, as they do not have sufficient scale of herd size for breeding operations (Barrett and Luseno 2004). Herd size can have either positive or negative influence on market participation.

Household income Relatively wealthy pastoralists, with greater herd size, have considerably higher expenditure rates (Barrett and Luseno 2004) and thus use livestock markets more frequently to cash out animals. Alene et al. (2008) also noted that non-farm income contributes to more marketed output if the non-farm income is invested in farm technology and other farm improvements. Otherwise, marketed farm output drops if non-farm income triggers off-farm diversification. To meet both household consumption requirements and market demand, a household intuitively needs to generate surplus output.

Distance to market It is a continuous independent variable measured in kilometres. The closer a household is to the nearest market, the lesser would be the transportation cost, loss of livestock weight due to longer trekking hours, and better access to market information and facilities. Key et al. (2000) and Makhura (2001) found that distance to the market negatively influences both the decision to participate in markets and the proportion of output sold. Poor communications and transport infrastructure and high risk of livestock theft create transaction costs that are so high as to wipe out any gains from trekking animals to market to sell. The distance to the nearest market was hypothesized to affect livestock market participation negatively.

Extension information Extension services is a dummy independent variable taking the value of 1 if a household had access to extension services and 0 otherwise. Extension services provide the requisite technical assistance, skills knowledge, link households with markets and provide the right information (Rehima et al. 2013). Access to extension information is therefore hypothesized to positively influence livestock market participation.

Market price Market price is an incentive for sellers to supply more in the market (Alene et al. 2008). The higher the prices, the more likely are pastoralists willing to sell more livestock. Therefore, market price as an independent variable was hypothesized to positively influence market participation.

Access to market price information Access to market price information is a dummy independent variable taking the value of 1 if a household had access to market information services and 0 if not. Household's marketing decision is based on market demand, supply and price information. Therefore, the farmers with price information have more propensity of participating in the market than those without (Barrett 2009).

Group marketing Group marketing is a dummy independent variable taking the value of 1 if a household markets as a group and 0 otherwise. Marketing in a group enables the farmers to pull their resource together and take advantage of economies of scales in marketing (Key et al. 2000). In essence, marketing experience captures the aspects relating to social networks and linking with marketing players, which accrue over time. The existence of such links reduces transaction cost in searching for the trading partners, contracting, negotiating and enforcing contracts, which in turn increases market participation (Makhura 2001). This was therefore hypothesized to positively influence market participation.

3 Results

Most of the respondents (70.33%) participated in livestock markets as either sellers or buyers of livestock. Market participants ($N=211$) were associated with a large herd size (mean TLU 25 ± 10), while non-market participants ($N=89$) had a smaller herd size (mean TLU $=14\pm8$). The assumption of homogeneity of variances was tested and satisfied via Levene's F test, $F_{(298)}=7.12$, $P=0.672$. As shown in Table 1, the independent samples t test was associated with a statistically significant effect, $t_{(298)}=-5.02$, $P=0.00$ which shows that the market participants were associated with a statistically significant larger mean herd size (25 TLU) than the non-market participants (14 TLU).

Table 2 indicates that the average age of livestock keepers who participated in the livestock market was 38 years, while those who did not participate in the livestock markets was 49 years. The *t* test results showed that age was statistically different ($p=0.000$) between those who participated and those who did not participate in the livestock markets, with market participants being relatively younger than the non-market participants. The results also show that the average size of the households who participated in the livestock markets was 7 members, while for those who did not participate in livestock markets was found to be 6 members. This was, however, not statistically different ($p=0.12$), meaning that the size of the household for livestock market participants was almost the same as for non-participants. Similarly, the difference between the mean distance to the nearest livestock market for market and non-market participants was not statistically different ($p=0.26$), hence almost equal.

Table 3 shows that 86.3% of those who participated in the livestock markets were male-headed households, while 13.7% were female-headed households. In contrast, 45% of those who did not participate in the livestock market were male-headed households, while 55% were female-headed households. Gender was statistically significant ($\chi2=79.4$, $df=1$, $p<0.001$), indicating that more male-headed households participated in the livestock market than the female-headed counterparts. More than half (62.6%) of those who participated in livestock markets were members of user associations, while only 41.6% of non-livestock market participants were members of user associations. These differences were statistically significant ($\chi2=60.42$, $df=1$, $p=0.002$). As shown in Table 3, herd recruitment and restocking for market participants were mainly through birth (72.9%), borrowing or loaning female cows from friends (9.6%) and buying from the markets (17.5%). Through social networks, a household that losses an entire herd may borrow from the neighbours and take care of the animals and retain the calves as a way of ensuring such households rebuild their own herds. Most (90%) households participated in the livestock marketing, mostly as sellers rather than buyers. More than half (53.1%) of those who participated in livestock market had at least attained basic education compared to 46.9% who had not attained primary education. On the other hand, only 49.4% of non-market participants had attained primary-level education. The education level was statistically different between those who participated in the livestock markets and those who did not participate ($\chi2=32.72$, $df=1$, $p=0.062$). The results also show that majority (61.1%) of market participants had access to extension services. More than half (58.3%) of those who participated in markets and those who did not (56.2%) indicated that they believe the market prices offered in terminal markets are favourable. However, the differences were not statistically significant ($\chi2=32.72$, $p=0.23$); hence, market price did not influence market participation.

As shown in Table 4 the constraints that were identified to be responsible for hindering pastoralists' access to livestock markets included lack of adequate pasture and water to

Table 1 Explanatory variables used in the model

Variable	Description	Measurement	Expected effect
Dependent variable			
Mktpart	Market participation	0 = Non-participant 1 = Market participant	
NOSOLD	Extent of participation	Proportion of livestock sold/bought	
Independent variables			
Age	Age of household	Number of years	–
Gender	Gender of HH head	0 = Female 1 = Male	+
Educ	Education level of HH head	0 = Primary level 1 = Secondary level 2 = Tertiary level	–
Herd size	Number of livestock	TLU	+
Income	HH income	KSH	,
Dist	Average distance to sale point	Kilometres	+
Mktinfo	Availability of market information	0 = No 1 = No	+
Mktprice	Average price at which each unit is sold	Ksh	+
Mktroad	Condition of the road		+
TransMode	Mode of transport to the nearest market	0 = Trek 1 = Truck	

Table 2 Mean difference (t test) between market and non-market participants

Characteristic	Market participant		Non-market participant		t-ratio	Sig
	Mean	SD	Mean	SD		
Age (years)	38	12	49	14	5.95***	0.000
Household size (number of family members)	6	1.6	7	1.5	−2.55	0.12
Herd size (TLU)	25	10	14	8	−5.02***	0.000
Distance to the nearest market (KM)	45	0.42	48	0.35	10.87	0.26

***Significant at 1% level; **significant at 5% level; *significant at 10% level

feed livestock leading to weak animals that are hardly bought on the market (20%), over-exploitation by the middlemen (17%), which reduces their sales margins, lack of migratory (locally called *malka*) corridors to allow movement of animals to access dry season grazing areas (15%), poor road infrastructure and marketing facilities (14%), long distances and associated risks such as the local taxes and insecurity (12%), high transaction costs such as taxes and permits for moving animals (10%), lack of holding facilities and fattening areas which leads to over-supply at the terminal markets (7%), insufficient extension services (2%) and poor access to animal health services (1%).

3.1 Factors influencing livestock market participation

Table 5 shows factors that influence market participation of pastoralists in Tana River County. The results of the Heckman two-step procedure that was used to determine whether or not a livestock keeper participates in livestock marketing and the proportion of livestock sales for those who participate in the market show that the inverse Mills ratio (IML/Lambda) term was significant and positive at 0.002.

This means that there is a positive correlation between the error term in the selection equation and the primary equation, implying that unobserved explanatory factors have a significant influence on the dependent variable. The herd size, group marketing, age, gender, price information, education level of household heads and access to extension services significantly influenced the probability of the livestock keeper to participate in livestock marketing.

Factors that significantly influence the extent of participation included herd size, group marketing, distance to the nearest market, market price and gender as shown in Table 6. Market price and distance to the nearest market did not influence the decision of whether one participates in markets or not but were statistically significant in influencing the proportion of livestock sales for those who made decisions to participate. Herd size had the most significant influence on whether or not to participate and the extent of participation in livestock markets in terms of the proportion of livestock sales followed by membership in resource user association.

An increase in the size of the herd increased the probability of participation in livestock market by 70%, all other factors held constant. Besides, herd size significantly influenced

Table 3 Chi-square results for mean differences between market and non-market participants

Characteristic	Category	Market participation		Non-market participation		χ^2	Sig
		Freq. ($N=211$)	Proportion (%)	Freq. ($N=89$)	Proportion (%)		
Gender	Male	182	86.3	40	45	79.40	0.001
	Female	29	13.7	49	55		
Education	Completed primary level	112	53.1	44	49.4	32.72	0.062
	Not completed Primary level	99	46.9	45	50.6		
Herd recruitment	Purchased	37	17.5	0	0	5.67	0.56
	Borrowed/loan	20	9.6	16	17.9		
	Birth	154	72.9	73	82.1		
Herd composition	Female Livestock	186	88.2	77	86.5	28.69	0.67
	Male livestock	25	11.8	12	13.5		
Extension service given	Yes	129	61.1	42	47.1	9.38	0.002
	No	82	38.9	47	52.8		
Member of user group	Yes	132	62.6	37	41.6	60.42	0.000
	No	79	37.4	52	58.4		
Market price	Favourable	123	58.3	50	56.2	46.39	0.23
	Not favourable	88	41.7	39	43.8		
Market information	Yes	168	79.6	23	26.1	0.899	0.034
	No	43	20.4	66	73.9		
Income (Ksh)	<10,000	101	47.8	45	50.6	89.44	0.04
	>10,000	110	52.2	37	49.4		

Source: Household interviews ($N=300$)

Table 4 Constraints for pastoralists' access to livestock markets

Constraints to market participation	Frequency (N=300)	Proportion (%)
Exploitation by the traders (middlemen)	51	17
Marketing costs (permits and taxes, transport, lodging fees)	30	10
Poor road network	42	14
Lack of livestock fattening lots	21	7
Lack of migratory routes (Malka corridors)	45	15
Insufficient extension services	6	2
Inadequate market information	6	2
Inadequate pasture and water leading to weak animals	60	20
Long distances to the markets	36	12
Poor animal health services	3	1

Table 5 Factors influencing the decision to participate in livestock marketing

Variable	$\delta y/\delta x$	Coef	SE	$P>|z|$
Herd size	0.706	8.9055***	1.7229	0.001
Group membership	0.206	3.2053***	0.9670	0.003
Extension services	0.0118	1.1023**	0.353	0.013
Age	− 0.0044	− 0.4117	1.118	0.1613
Gender	− 0.0467	− 1.004**	1.387	0.0469
Education	0.0159	2.199	0.967	0.123
Market information	0.0002	4.618*	2.690	0.086
Market price	0.014	1.483	1.129	0.189
Distance to the market	− 0.0388	− 0.6784	1.589	0.173
Cons		15.849	6.1439	0.010
Mills lambda	− 0.7028***	− 0.7028	0.189	0.002
Rho	− 0.1425			
Sigma	4.9309			

***Significant at 1% level; **significant at 5% level; *significant at 10% level

the extent of livestock market participation with households who had large herds selling more animals than those with smaller herds.

4 Discussion

Pastoralists are embracing the cash economy as they actively use markets to sell animals largely to meet their immediate cash needs and also to dispose surplus animals, notably immature males and barren females to reduce pressure on resources. Very few pastoralists buy animals for restocking, as herd rebuilding is largely through calves born from the household's herd. This could explain why pastoralists with large herds participated more in the market as sellers. Expected financial gains have been observed to influence market

Table 6 Factors influencing extent of market participation

Variable	Coefficients	SE	*P* >|z|
Age	− 1.1366*	0.4525	0.012
Education	1.110*	0.47512	0.099
Extension services	1.1023	0.353	0.13
Herd size	1.695***	0.453	0.000
Gender	− 1.004	1.387	0.11
Group marketing	1.0364***	0.3008	0.001
Market information	1.175	0.4530	0.117
Market price	1.067*	0.129	0.089
Distance to the market	− 1.422***	0.4459	0.001
Cons	− 1.718	1.269	0.10

***Significant at 1% level; **significant at 5% level; *significant at 10% level

participation decisions for those households with large herds. This is evident in the current study with market price significantly influencing the extent of market participation among the interviewed households. According to Alene et al. (2008), market price is an enticement for market sellers to supply more goods in the market because it determines the amount of income to be earned from the sales. For example, during post-drought periods, the demand for livestock increases due to reduced supply, therefore pulling up the prices of livestock in the markets. Wealthy pastoralists, who have large herds, seize the opportunity of selling some of their livestock at favourable prices, while those with smaller herds hold on to the few animals that remain after the drought to rebuild their household herds. They would only be forced to sell their animals when they need money for urgent consumption needs. When forage and water conditions improve, livestock are usually very productive, and most pastoralists would not want to sell them, hence reducing the supply of livestock in the markets which pulls the prices up. Livestock being a productive asset that generates future income to the households through milk production and calving, higher prices may therefore not be an incentive for pastoralists to respond to markets unless there is surplus for sale. These results are similar to those of Barrett et al. (2003) who found that pastoralists in Northern Kenya, who have large herds, sell their surplus animals when prices are favourable, while those with small herds hold on to their few animals for future returns and consumption. As shown in the results of the current study, prices were not significant in influencing whether a household participated in livestock markets or not but only influence the extent of participation for those who participated in markets.

Traditionally, pastoral communities rationally accumulate herds due to good financial gains obtained from a live animal for a long period of time and only respond to markets when they have a cash need and not to make profit regardless of higher prices. Muthee (2006) demonstrated that livestock offers the best rate of returns over a long period of time in terms of the income generated from livestock products such as milk and calves than the return obtained from the proceeds obtained from the sale of an animal and deposited in a bank. Similarly, McPeak (2004) found that livestock had an annual average return of between 6 and 15% which is more than the return accrued when livestock is sold and money stored in banks. In their study, McPeak (2004) found that once one accounts for the bank charges, a cash deposit equivalent of about 25 goats' value or more had an approximate return of 2% per year over a four-year period.

Property rights in pastoral areas can also be complex, with implications for livestock marketing patterns. Inadequate access to forage and water may result in the loss of animals, and poor households may therefore be loaned or gifted some animals by the wealthy neighbours or relatives who have large herds (Lybbert et al. 2004, McPeak 2004). Such livestock with encumbered property rights are associated with lower net sales as pastoralists hold on to herds given through customary livestock loans and gift practices that bestow incomplete property rights on those who receive them (Barrett and Luseno 2004). Consequently, animals temporarily herded for others cannot be sold. This underscores the significance of property rights in influencing livestock market participation.

Low market participation was also observed among respondents with alternative livelihoods and higher income and also enjoys better access to town centres and infrastructure. Most of them were sedentarized and practiced farming along river Tana which reduces the herd sizes they can manage within their fixed farms that are subject to considerable spatial–temporal variability in forage and water. As a result, their herd sizes are relatively smaller and livestock market participation rates were lower. This is similar to the findings of Bellemare and Barrett (2004) who found a positive significant causal relationship between herd size and the proportion of livestock sold when other household-level covariates as well as location- and period-specific effects are held constant.

The extent of livestock market participation among the interviewed households was significantly influenced by gender of the household head. A strong bargaining power is usually exhibited by the male-headed households, which in turn increases the probability of participating in livestock markets and the extent of livestock sales. Men therefore tend to sell more livestock due to better prices resulting from their strength in bargaining and negotiating for better prices than their female counterparts (Cunningham et al. 2008). Traditionally, pastoral livestock is owned mainly by the males; therefore, men are likely to participate more in livestock marketing than their female counterparts (Guiterrez 2003; Jagwe et al. 2010).

Education creates more awareness on the proper methods of herd management which positively influence the probability of pastoralists to sell or buy livestock from the markets. Education level of the household influences the access to proper information that is important for decision-making, income and subsequently livelihood security of a household, hence the likelihood of enhancing the extent of livestock market participation (Makhura 2001).

The provision of livestock extension services also determined the proportion of livestock sold in the markets. Household members who get a chance to be trained or receive information on livestock management tend to have larger herd sizes and the knowledge of the right time to sell the animals and retain some for herd rebuilding. Extension officers receive information on market dynamics and are able to disseminate it to the communities. Those who strategize their activities in accordance with the information received from extension officers have greater odds of making opportune decisions at the right time, and therefore, reducing uncertainties associated with livestock marketing (Jari and Fraser 2009). They are also able to advice on proper livestock management practices which increase the margins from livestock sales.

Group marketing facilitates the pulling together of resources by pastoralists to gain from the economies of scale. In groups, households are able to get the requisite market information that is essential for livestock production and marketing (Olwande and Mathenge 2012). Through the groups, pastoralists are able to cooperate among themselves and consolidate supply of livestock which reduces transport costs and improves their collective bargaining power (McKague et al. (2009). In essence, marketing in groups increases social networks and

linkages with market players, which accrue over time (Poulton et al. 2006). Membership in groups which is used as a proxy for group marketing therefore influences both the decision of whether or not to participate in livestock markets and the level of participation.

Livestock markets in semi-arid areas are far apart, and the distances that the pastoralists have to cover in order to sell their animals are very long which affects the proportion of livestock sold. Due to the long distances to the nearest markets, the costs of moving animals to the markets are high. Considering that some pastoralists in the study area take more than three days on the road looking for good markets for their animals, the monetary value of the time spent in marketing is high. This is due to the high opportunity cost of time spent in marketing as they would be looking after other livestock in the three days spent in marketing (Ahuya et al. 2005). Consequently, they have to incur costs such as transportation, food and lodging.

The opportunity cost of livestock marketing is lower when pastoralists, besides going to the market to sell their livestock, do other transactions and return to their homes the same day. But in the case of those who have to trek the animals to markets for days, the monetary value of time spent is high, raising the marketing costs that would discourage more active market participation. Distance to point of sale is therefore a major limitation of the level of participation (Bahta and Bauer 2007). As found out by Omiti et al. (2009), geographic isolation through distance creates a wedge between farm gate and market prices for sellers in very remote areas. Given the monetary and non-monetary costs of market participation in the study area, sales or purchase of less than one TLU is largely uneconomical. The fewer sales of goats or sheep are for meeting immediate cash needs such as food purchases, school fees and/or medical expenses and not for profit.

Cases of insecurity may also force pastoralists to relocate from relatively remote and dangerous areas to more populated areas nearer to market, thus increasing the likelihood of market participation. Insecurity is also more likely to force pastoralists into the market to purchase animals to replace those lost to raiding. In their study on factors affecting milk market participation and volume of supply in Ethiopia, Berhanu et al. (2014) found that insecurity significantly increases the likelihood of market participation and also had a positive and statistically significant effect on net livestock purchases.

Livestock markets play a significant social role by reducing the vulnerability of producers to land access constraints and climate variations. Gautier et al. (2016) asserts that markets function as institutions that mediate strategies such as livelihood diversification, mobility and wealth stores which contribute to reducing vulnerability. However, markets can also increase the vulnerability of producers, for example when producers have no alternative other than selling to traders who control prices (Reid and Vogel 2006; Turner 2000). According to Thornton (2010), livestock marketing provides pastoralists the means of restructuring or rebuilding herds, through conversion of one livestock species for another and by exchanging male for female animals. Most pastoralists appear not to use markets much at all for purchases, almost exclusively for sales. If pastoralists do not use markets for restocking or restructuring herds due to limited cash liquidity, then herd structure may impede marketing as well, in so far as herders try to hold on to fertile females and quality bulls for breeding.

5 Conclusion

This study sought to determine the factors that influence the decision to participate in livestock marketing and the extent of participation. The results show that non-price constraints significantly affect the amount of livestock offered for sale at any given price level. Market

prices were not significant in influencing whether a household participated in livestock markets or not, but they influence the extent of participation for those who participated in markets. Access to extension services, market information and group membership positively influence the decision to participate in livestock marketing. The extent of market participation is positively influenced by market price, distance to the nearest market, education of household head and herd size. Pastoralists with larger herds participate more actively in markets than those with smaller herds. To increase livestock market participation, it is therefore important to understand the long-term incentive for the pastoralists to hold livestock. Semi-arid areas of Kenya offer limited livelihood alternatives other than livestock production, and although the sale of livestock may increase household income, it may come at a cost of reduced future income. Pastoralists with smaller herds therefore limit the sales to animals needed to raise cash for immediate needs. The study therefore concludes that in order to stimulate livestock marketing it is important to support viable pastoralism that will ensure improved livestock production. This will require proper grazing management practices such as access to dry season grazing areas through opening of the migratory corridors to allow reciprocal access of water and pasture across the seasons, construction of water harvesting structures such as the water pans, and strengthening the traditional institutions that ensure proper governance of natural resources.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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