Salamula et al. Pastoralism: Research, Policy and Practice (2017) 7:26
DOI 10.1186/s13570-017-0096-y

Pastoralism: Research, Policy and Practice

RESEARCH Open Access

Socio-economic determinants of pastoralists' choice of camel production in Karamoja sub-region, Uganda

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Abstract

Camel production is a potential avenue for improved food and income security in dryland areas of East Africa. Despite this potential, there is a dearth of information on the increasing choice of camel production among pastoralists in the region. Camel-owning households were obtained through snowball sampling approach whereas those without camels were obtained randomly in the vicinity of those who had camels. A total of 116 respondents were interviewed in Moroto and Amudat districts of the Karamoja sub-region, Uganda. Descriptive statistics and binary probit regression analysis were conducted on the data. Results showed that 45% of the sampled households owned camels with an average camel holding of 17.96 ± 22.12 heads. There were more cows (9.67 ± 12.368) than bulls (3.85 ± 7.149) in the camel herds. Only 8% and 26% of camel herders had access to extension services and financial credit respectively. The binary probit regression model revealed that age of the household head, household size, on- farm income and herd size significantly influenced the decision to undertake camel production in the region. Furthermore, all the household members were engaged in different camel management activities; however, herding was mainly the responsibility of the children (34.9%) and adult males (32.1%). Milking was mainly done by women (33.6%) while disease management was done by adult males (48.7%) and the elderly (22%) in the household. Provision of higher milk quantities (44.3%) and camels being in the lineage (13.6%) were cited as the key motivations for camel rearing. On the other hand, 56% of respondents observed that the initial high cost of camel acquisition was the main limitation to owning camels. This study has shown that decision-making in transitioning to camel production in Karamoja is a result of socio-economic attributes including pastoralists' perceptions of associated costs and benefits arising from camel production. Therefore, it is vital to strengthen innovative financing mechanisms and traditional systems such as agistments that can support pastoralists willing to acquire camels. There is need for extension services that target camel rearing where women and children are involved given their central role in camel management.

Keywords: Camels, Determinants, Pastoral, Resilience, Semi-arid

Introduction

Livestock production is a significant livelihood endeavour among pastoral communities in arid and semi-arid regions contributing to food and nutritional security, income generation and general household well-being (Ngugi and Sanginga 2013). Nonetheless, pastoral communities struggle with challenges caused by adverse climate variability and change that often affect livestock production and productivity (Elhadi et al. 2012). According to Thornton et al. (2009), climate variability and changes are expected to have several impacts on fodder crops and grazing systems through changes in herbage growth, composition of pasture, herbage quality and greater incidences of drought in livestock systems among others. In many pastoral regions and landscapes, climate variability and change are already having considerable impacts on livestock production, evidenced by reduced feed intakes, reduced growth rate, increased frequency of abortion, decreased birth rate and increased mortality rates within livestock (Bidoli et al. 2013; Masuku et al. 2014; Senbeta 2009).

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According to Opiyo et al. (2016), pastoral communities remain vulnerable to climate-induced stresses owing to their low adaptive capacity and over-dependence on climate-sensitive livelihood activities. Their vulnerability to increasing climate change is further augmented by socio-economic, political and ecological factors including, among others, inadequate sources of income, limited livestock-marketing opportunities, political marginalization, changing land tenure, unclear property right regimes and breakdown of traditional social and resource governance institutions (Bryan et al. 2013; Wasonga et al. 2012).

Livestock remains an important component for livelihood sustainability in pastoral areas (Krätli et al. 2013). And for households in these expanses, a food insecurity crisis is a reflection of a livestock crisis. As such, livestock is an important asset for increasing resilience of vulnerable people through risk diversification and asset accumulation (Silvestri et al. 2012). However, climatic variability will intensify the vulnerability of traditional livestock production systems, potentially lessening the effectiveness of livestock as a sustainable livelihood option (Nyariki et al. 2012; Sejian et al. 2015).

Melesse (2015) reported that adoption of better technologies is fundamental for the transition and transformation of production systems. Pastoral communities in East Africa including the Samburu, Turkana, Pokot, Maasai, Boran, Somali and Rendile, among others, have seen increased adoption of resilient livestock species such as camels and herd diversification as a strategy to cushion themselves against the effects of extreme climate events (Fratkin 2001; Jones and Thornton 2009; Kagunyu and Wanjohi 2014; Österle 2008; Sperling 1987).

Similarly, to adapt to impacts of climate variability and climate change such as food insecurity, pasture and water scarcity among others, the Karamojong of Uganda have over time embraced camel rearing (Egeru et al. 2014; Egeru et al. 2015). The National livestock census of 2008/9 showed that Karamoja sub-region had nearly 33,000 camels (MAAIF and UBOS 2009).

According to Deressa et al. (2009), the household decision to adopt improved livestock technologies including resilient livestock species is dependent on several environmental and socio-economic factors. The ecological factors reported to influence adoption of livestock production technology included availability of feed and water, and risk of diseases also influenced adoption of livestock production technology. Martínez-García et al. (2015) highlighted the socio-economic determinants of adopting improved livestock technologies as including: education, age, experience, availability of labour, household income, access to credit and farm characteristics. Non-adoption of technologies is attributed to different factors such as lack of knowledge on how to use/manage the technologies, high acquisition costs, capital constraints, lack of extension services, lack of credit and government policies (Martínez-García et al. 2015).

Whereas studies by Egeru et al. (2015) indicated the existence of camel production in Karamoja and also documented the perceived livestock forage availability in the sub-region including forage suitable for camels, there has not been any attempt to understand why the Karamojong have continued to rear camels. According to Zanu et al. (2012), it is critical in the resilience-building process in pastoral areas to identify factors that contribute to adoption of new livestock technologies as well as those that represent main constraints to diffusion and adoption process. Tefera et al. (2016) further note that understanding factors affecting household decisions is important for the adoption of productivity-enhancing technologies. This study therefore set out to investigate the socio-economic determinants of choosing camel production in Moroto and Amudat districts of Uganda. The study also explored the camel herd characteristics and labour requirements, as well as the motivational and constraining factors for engagement in camel production.

Study area

The study was conducted in Moroto and Amudat districts of the Karamoja sub-region which lies between latitudes 1° 30′ and 4° N, and longitudes 33° 30′ and 35° E in north-eastern Uganda. The region boarders South Sudan in the north and Kenya in the east (Egeru et al. 2015). Karamoja experiences a semi-arid climate with a sporadic uni-modal rainfall pattern experienced between May and August and an intensely hot dry season occurring from November to March (BakamaNume 2010). Rainfall in the sub-region ranges between 350 and 1000 mm per annum, variable in space and time (Nalule 2010), with the annual total rainfall making the region characterized as a sub-humid system. The temperatures in the region are high, ranging from a minimum of 15 °C to 18 °C and a maximum of 28 °C to 32.5 °C (Mubiru 2010). The vegetation in Karamoja sub-region is mostly savannah characterized by indigenous tropical grasses with nearly all the over-storey composed of Acacia species (Egeru et al. 2014; Nalule 2010). Numerous water sources exist in the sub-region from which the communities in Karamoja and beyond, especially the Turkana and Pokot from Kenya and Toposa from South Sudan, draw water for domestic use and for their livestock (Swidiq et al. 2014).

Livestock-based livelihoods still remain the best economic mainstay of households in Karamoja (Levine 2010). The 2008/9 National Livestock Census estimated livestock population in the region at 2,253,960 cattle, 2,025,293 goats, 1,685,500 sheep, 960 donkeys and 32,870 camels (MAAIF and UBOS 2009). Camels have been reported to be owned by just a few individuals in Karamoja sub-region, especially in the drier parts of Moroto district among the Matheniko (ACF 2008) and among the Pokot

in south-western Karamoja (Rugadya 2006). Amudat and Moroto districts were purposively selected because they have the highest number of camels in Karamoja sub-region (MAAIF and UBOS 2009).

Methods

Data collection

A multi-stage sampling technique was used to select the target areas as well as the respondents. Sub-counties within each district were stratified based on the estimated population of the camels, that is low, medium and high, and the sub-counties with the highest camel populations were selected for consideration, that is Rupa sub-county in Moroto district and Loroo and Amudat sub-counties in Amudat district. For the selection of respondents to be included in the cross-sectional survey, the choice-based sampling scheme (Donkers et al. 2003) that involves stratifying the population based on the dependent variable (in this case, camel ownership) was employed. Cram et al. (2009) indicated that choice-based sampling is particularly useful when the outcome to be explained is rare. The households within the selected sub-counties were grouped into two categories, that is those with and without camels. Since the camel-owning population was rare and unknown, a snowball-sampling technique was used to obtain households owning camels.

To determine the number of households without camels to be interviewed within the second category, a probability formula was adopted from Saxena et al. (2010), that is:

$$n = z2 \times p \times q / e2$$

where n is the required sample size, z is 1.96 at 95% level of confidence, p is 0.95 (which is approximately 95% and accommodates the margin of the households without camels in Karamoja sub-region) and $q = 1 - p$, i.e. 0.5, and $e = 0.05$ (which is the margin of error at 5%). This gave a sample size of 72 households without camels. However, this value was lowered to match up the low sample size that emerged from the snowball sampling of camel herders so as to avoid sample size bias during analysis. Therefore, a total of 116 households were sampled out of which 52 owned camels while the 64 did not.

Individual interviews were used to gather information on the determinants of decision to own camels, camel-herding characteristics and management practices, motivators and barriers to camel production. The target respondents were household heads and other camel herders as these were assumed to be more knowledgeable about production and management of camels. A semi-structured questionnaire was used to guide the interviews. Guided interviews were used during data collection. This process allowed the enumerators to explain to the respondents the purpose of the study and interview. This approach was preferred owing to the high illiteracy rates (88%) in the sub-region (Mafabi 2007). The enumerators also translated all the questions into the local dialect - *Ngakaramajong* - for ease of understanding and dialogue. This approach provided respondents with opportunity for informed consent and full participation in the study.

Data analysis

Choice of camel production model specification

The study analysed the determinants of engagement in camel production using a binary choice model: the probit regression model. This model was chosen since the dependent variable is binary in nature and takes on a value zero or, otherwise, one. Further, the probit model is suitable for estimating parameters of interest when the dependent variable is not fully observed. The probit model constrains the probability to (0, 1) interval and assumes that the probability that an event will occur is non-linear and that the random error terms follow a normal distribution.

The model is based on the probability of success of an event which in this case it is the decision to own camels. The probability that an individual will choose to own camels depends on an underlying response variable that the expected utility from owning camels is greater than the utility of not. The random utility function (y^*) for a herder in Karamoja facing a decision to rear camels can be specified in Eq. 1 below:

$$Yi = 1 \text{ if } Y^* = i(x_i\beta + \varepsilon) > 0, 0 \text{ if otherwise} \quad (1)$$

where Y is a dummy variable capturing household's ownership of camels (1 = if household owns camels, 0 = otherwise), β = ($\beta 0$, $\beta 1$, $\beta 2$……βk) is a vector of unknown parameters, i is the choice of the practice, xi is a vector of covariates (explanatory variables), that is socio-economic and demographic characteristics of the individual, and ε is the error term.

The empirical model that determines the factors influencing herders' decisions to undertake camel production is specified in Eq. 2. A household (i) makes a decision to own camels (Y) if the expected utility from camel ownership is positive. Household ownership of camels is associated with socio-economic and production characteristics that can be described as follows:

$$Yi = \beta 0 + \beta 1\text{Ag} + \beta 2\text{HHS} + \beta 3\text{FI} + \beta 4\text{OFI} + \beta 5\text{HS} + \beta 6\text{AES} - \beta 7\text{DDS} - \beta 8\text{DEO} + \varepsilon \quad (2)$$

where

Ag = age of respondent/camel owner
HHS = household size
FI = on-farm income
OFI = off-farm income

HS = herd size
AES = access to extension services
DDS = distance to veterinary drug store
DEO = distance to nearest extension office

Extension support was captured in two forms, that is access to extension services and distance to the nearest extension office. Access to extension services was aimed at determining whether or not a household was visited by an extension worker, whereas distance to the nearest extension office was meant to determine how close an extension office was in case a household wanted to obtain livestock-related services. Access to extension services was a dummy variable hypothesised as 1 if the household was ever visited by an extension officer and 0 if otherwise. A dummy variable is an artificial variable created to represent an attribute with two or more distinct categories/levels (Skrivanek 2009).

The positive or negative sign of the coefficient (β) indicates the direction of the relationship between a given independent variable (x) and the dependent variable (y).

Marginal effects were calculated to determine how much each of the independent variables changes the likelihood of respondents falling in either categories of the dependent variables. The marginal values give the effect that a unit change in the single independent variable has on the likelihood of camel ownership, keeping all other variables at their mean values.

Prior to probit model estimation, the variance inflation factor (VIF) was employed to test the presence of multi-collinearity among independent variables. According to Robinson and Schumacker (2009), the threshold for the VIF is 10. The results showed that VIFs for all the variables were less than the threshold that is between 1.08 and 1.76, indicating that multi-collinearity was not a problem in the model. Robust standard error calculation was used to deal with the problem of heteroscedasticity.

Results

Characteristics of sampled households

The average age of camel herders was 54 whereas that of the non-camel herders was 46 years. The average number of members per household was 11 for both camel-owning and non-camel-owning households. Majority (98%) of the households owned livestock, with an average herd size of 15.5 tropical livestock units. Households with camels had on average a higher on-farm income (UGX. 1,628,802 (US$483)) compared to those without camels (UGX. 643,164 (US$191)). On the other hand, households without camels had on average a higher off-farm income (UGX. 487,172 (US$145)) compared to camel-owning households (UGX. 318,039 (US$94)).

The other specific attributes are presented in Table 1.

Camel acquisition and herd composition

Majority of the camel owners were male with just a few female-headed households owning camels (Table 2). These were mainly widows. Results revealed that majority of the camels owned had been inherited, with a few of the households having acquired camels through purchase and as bride price (Table 2). The average camel herd size per household was 18 ± 22 heads. Generally, the camel herd was mostly made up of cows,[1] and only a small number of camel owners had received extension support related to camel rearing (Table 2).

Table 1 Characteristics of camel-owning and non-camel-owning households

		All households	Camel households	Non-camel households
Explanatory variable		Mean ± SD	Mean ± SD	Mean ± SD
Age of household head (years)		49.62 ± 14.98	54.2 ± 13.8	45.91 ± 14.98
Household size (people)		11.35 ± 5.88	11.46 ± 5.48	11.27 ± 6.23
On-farm income (Uganda shillings(UGX))		1085002 ± 1471227 [a]	1628802 ± 1728317 [a]	643164 ± 1044305 [a]
Off-farm income (Uganda shillings(UGX))		411353 ± 1172925 [a]	318039 ± 526810 [a]	487172 ± 1507846 [a]
Herd size (TLU) (excluding camels)		15.53 ± 25.92	22.16 ± 35.49	10.14 ± 11.88
Herd size (camels only)			17.96 ± 22.12	
Extension support	Yes	21.2%	23.1%	19.7%
	No	78.8%	76.92%	80.3%
Access to credit	Yes	29.2%	25.5%	32.3%
	No	70.8%	74.5%	67.7%
Distance to the nearest input stockist (km)		8.31 ± 6.76	9.19 ± 6.47	7.63 ± 6.94
Distance to the nearest extension office (km)		6.69 ± 5.82	6.41 ± 5.65	6.91 ± 5.98

Tropical livestock units (TLU) for livestock include camels = 1.1, cattle = 0.5, goats = 0.1, sheep = 0.1, donkeys = 0.5 and chicken = 0.01 (FAO 2003)
[a]1 US dollar = 3370 Uganda shillings at the time of data collection

Table 2 Camel acquisition and herd composition

Attribute	Indicator
Sex of household head (n = 52)	
Male	81%
Female	19%
Source of initial camel stock	
Inherited	48.1%
Bought	40.4%
Received as bride price	3.8%
Received as gift	7.7%
Average camel herd size	17.96 ± 22.12
Adult camel herd size (mean)	13.52 ± 17.27
Number of calves (mean)	4.53 ± 5.763
Number of cows (mean)	9.67 ± 12.368
Number of bulls (mean)	3.85 ± 7.149
Received extension support focusing on camel rearing	8%

Factors influencing the decision to own camels

The probit regression model was significant at 1% significance level (P = 0.0058) indicating that all the espoused determinants jointly influenced the decision for camel production. The age of the household head, on-farm income, household size and herd size (TLUs) significantly influenced the decision to own camels (Table 3).

The age of the household head was positively and significantly related to the probability of owning camels, which could be attributed to the fact that older individuals often have more experience with livestock management and have also accumulated capital assets over the years. This finding relates to the estimated mean age values for camel and non-camel households, where there is a higher average age for camel owners. The marginal effects indicated that if the age of the household increased by one unit, the change in the probability of a household owning camels increased by 1.4%. The results also showed that households that had larger livestock herds were more likely to own camels given the social, economic and cultural value attached to livestock in pastoral communities. Increasing the herd size by one unit increases the change in the likelihood of owning camels by 0.75%.

On-farm income was also found to be a positive determinant of ownership of camels. The present results therefore suggest that the more income a household accrues from sale of livestock and their products the more likely that household would own camels that would further increase on-farm income. Therefore, a unit increase in the income from sale of farm produce would increase the change in the probability of owning camels by a very small extent. On the other hand, it was observed that a unit increase in the household size by one person led to a decreased change in the probability by 3.1% of a household owning camels.

Household labour engagement in camel management

The findings revealed that while almost all household members were involved in different camel management activities, specific roles and responsibilities were assigned to different individuals depending on sex and age. The strenuous herding activities and calf management were mostly left to children below 18 years of age who were guided and helped by adult males whereas women were mostly involved in milking activities (Table 4). The elderly in the household were mainly involved in treating camels for diseases. In general, the adult males and adult children between 10 and 18 years of age were greatly involved in camel management activities.

Motivational and constraining factors for engagement in camel production

Camel owners revealed that their main reasons for owning camels included higher milk quantities from camels compared to other livestock (44.3%), family historical traits in camel rearing (13.6%) and existence of plenty of forage for camels in the study area (10.2%). Other reasons included the fact that owning a camel was an

Table 3 Determinants of camel of production in Karamoja sub-region, Uganda

Determinants	Coefficients.	Robust std. err.	Marginal effects
Age of household head	0.035598[c]	0.01103	0.0141323
Household size	−0.07823[c]	0.029503	−0.0310558
on-farm income	2.95E − 07[a]	1.60E − 07	1.17E − 07
Off-farm income	−1.48E − 07	1.20E − 07	−5.88E − 08
Total livestock units	0.018985[b]	0.008232	0.0075371
Received extension	0.256995	0.3203	0.1022319
Distance to the nearest input stockist	0.024776	0.024034	0.009836
Distance to the nearest extension office	−0.03359	0.027677	−.0133359
Constant	−1.57425	0.627032	

Number of observations = 107, Wald chi^2 (9) = 21.54, log pseudo likelihood = −58.320446, pseudo R^2 = 0.2076, prob. > chi^2 = 0.0058
[a], [b], [c] indicate statistical significance at 10%, 5%, 1% respectively

Table 4 Labour requirements for camel management

Management practice	% share of involvement in camel management				
	Adult males (18–65 years)	Adult females (18–65 years)	Adult children (10–18 years)	Young children (5–10 years)	Elderly (above 65)
Milking	28.0	33.6	25.0	5.6	7.8
Herding	32.1	8.8	34.9	18.6	5.6
Watering	35.0	21.9	22.8	8.0	12.2
Calf management	21.7	14.7	28.3	23.9	11.4
Salt management	34.1	26.4	15.9	6.6	17.0
Spraying	48.7	14.0	14.0	1.3	22.0

indicator of wealth status (1%), camels being valued higher than other livestock during dowry payment (1%), and camels' ability to go for many days without water (1%).

On the other hand, non-camel-owning households cited high initial cost of camel acquisition (56.1%), lack of camels in their lineage (12.1%), death of previous camel stock (9.1%) and lack of experience in camel production (7.6%) as key constraining factors to engagement in camel production. Other factors reported included camels being easily raided and key targets for raids (3%), lack of labour (3%) to manage camel herds and prevalence of camel diseases (1.5%).

Discussion

Household characteristics

Camel-owning households on average had a higher on-farm income compared to those without camels. Sale of camels and their products such as milk fetches more income compared to sale of other livestock species and crop produce and could be the reason for the higher on-farm income in camel-owning households. According to Watson et al. (2016), camels reproduce slowly but the demand for and price of camels is high.

On the other hand, non-camel-owning households had higher off-farm income compared to camel-owning households. These households perhaps take on off-farm income strategies as a way of meeting household consumption needs and also buffering against risks presented by market failures and climatic fluctuations that cripple crop production and also lower the productivity of traditional livestock systems. This study also established considerably a large proportion of female households in Karamoja sub-region. While this appears a unique development, in the context of the sub-region, this should not be strange in any measure. This could be attributed to the historical civil unrest and cattle-rustling episodes that bedevilled the sub-region. From the late 1970s through 1980s to early 2000s, the sub-region experienced intensified proliferation of small firearms especially the AK47 riffles that became a change agent to social construction of the societies in the region (Quam 1997; Mirzeler and Young 2000; Mkutu 2006; Bevan 2008). A wash with these guns, livestock raiding in the region changed characteristics to commercial raiding from the traditional intentions that were meant for herd reconstitution during a bad year and/or after a raid (Mkutu 2007; Agade 2010; Eaton 2010). Raids and counter raids within and between tribal communities (Knighton 2006; Eaton 2008) led to several deaths in the region that left several women widowed; this group became heads of households (Farr et al. 2009; Jabs 2010; Ayoo et al. 2013).

Camel acquisition and herd composition

The results showed that camel herders were predominantly male. In this region, men are traditionally responsible for the family's most valuable assets, a fact embedded in many pastoral communities (Huisman 2001). Also, the large proportion of male herders is crucial in transferring and adoption of technologies given that decision-making is mostly left to men in most African societies (Adams and Ohene-Yankyera 2014).

Further, this study revealed that most of the camels owned were inherited implying a strong adherence to the tradition in the study area. A study by Noor et al. (2012) also revealed that most of the camel herders in the pastoral production system of Isiolo County, Kenya, had inherited their starting stock from their parents. Inheritance of camels is a common practice among the pastoral communities in East Africa. This practice is also common among the Karamojong, Turkana and Pokot of Kenya. According to Hartley (1984), the transhumant movement of the Turkana from Kenya across the border to the neighbouring Karamoja resulted into peaceful associations among the pastoralists and inter-marriages with the Matheniko of Moroto, enabling this community to also acquire camels. Additionally, the fact that a good number of camel herders had acquired their animals through purchase could be indicative of the increasing appreciation for the role camels play in the livelihoods of this pastoral community. This is also linked to the main motivation for camel ownership in the study area, cited by the pastoralists as consistent provision of high quantities of milk by camels even in the dry season when cattle are moved to other locations in search for forage,

thus maintaining household nutritional security all year round. Camels have the potential to cushion the Karamoja community against the negative impact of climate variability and change and could therefore become an important undertaking in the region which is prone to droughts in the coming years.

The study further showed that cows constitute majority of the camel herds. This is also related to the main reason for keeping camels which pastoralists cited as camels' ability to continuously provide high milk quantities all year round. According to Teka (1991), having a camel herd with more cows guarantees a stable recovery after drought or disease outbreak, thus ensuring continuity of camel rearing in a community. A highly female-dominated camel herd is also a strategy for household food provisioning by ensuring consistent milk supply to the household even during extreme events such as drought. The findings therefore demonstrate the importance of camels in ensuring food security, thus building the resilience of the pastoral households in this sub-region marred by recurrent droughts. The results correlate with earlier findings by Ishag and Ahmed (2011) who noted that cows made up about 70% of the camel herd in Sudan. Similarly, Teka (1991) and Aujla et al. (1998) reported that the camel herds in Somalia and Pakistan were mostly composed of cows.

Determinants of camel production

Socio-economic determinants namely age of the household head, household size, herd size and on-farm income were found to influence the likelihood of owning camels in the study area. A study by Martínez-García et al. (2015) similarly reported that the farmer's age, main source of income and herd size were among the factors that influence adoption of animal husbandry technologies among farmers in Central Mexico.

Age of the household head was positively and significantly correlated to the ownership of camels which could be attributed to the fact that the pastoral and agro-pastoral societies such as in Karamoja are heavily reliant on the age and regiment system in which older individuals that have more livestock assets have greater chances of acquiring status in the community. According to Rwezaura (1989), where a society is based on a hierarchal organization with a tighter control of elders, the elders often command a greater wealth control. This appears to be the likely predicament playing out in Karamoja with respect to camel production. This in particular could be proven by the lower average age of the non-camel-owning household heads who also highlighted that the initial cost of acquiring camels was prohibitive. Studies by Dossa et al. (2008) and Kabubo-Mariara (2008) showed a connection between age and wealth particularly of livestock in pastoral production systems.

In addition to the age of the household head, large households with presumably more dependents were less likely to own camels. This study earlier revealed that camels are expensive to acquire, hence hindering financially constrained households that might want to own them. Therefore, it can be explained that in large households, financial resources are appropriated to the most pressing needs such as food and health care instead of acquiring camels that are expensive. According to Ansah et al. (2015), larger household size would translate into availability of labour. However, Yirga (2007) reported that the available household labour could be diverted to off-farm activities that generate income to ease the consumption pressure imposed by a large family. This implies that there is limited labour available for camel husbandry and related management activities, which often do not translate into quick income. Studies by Ansah et al. (2015) and Das (2016) also reported a negative correlation between family size and adoption of livestock production technology in Ghana and India.

The study further revealed that the more income a household accrues from the sale of farm produce, the more likely that household would own camels. Robinson and Zappacosta (2014) reported an increase in the livestock prices in the Karamoja. This aspect would perhaps motivate pastoral households that initially did not own camels to acquire them since camels yield more income than other livestock species when sold. This would ensure a household's financial security.

The study also revealed that households with larger livestock holding are more likely to own camels given the social, economic and cultural value attached to livestock in such communities. Livestock ownership is a sign of wealth to pastoralists (Watson and Van Binsbergen 2008), and wealth is often positively associated with the adoption of new and improved livestock technologies (Martínez-García et al. 2015) because wealthier individuals are more able to bear the risk that comes with new enterprises. In Karamoja, majority of the population derive their livelihood from livestock keeping (Lind et al. 2016). Therefore, increase and diversification of the herd through adoption and ownership of resilient livestock species, namely camels, enables the pastoralists to meet their nutritional needs while maintaining productive assets and also acts as insurance in times of drought. This enhances the resilience of such pastoral communities to the impacts of climate variability in the region. Camels are known to be resistant to harsh conditions and are reliable milk producers during dry seasons and drought years when milk from other livestock species is scarce (Farah et al. 2004). A study by Ansah et al. (2015) similarly reported a positive relationship between herd size and adoption of improved livestock breeds.

Delivery of agricultural extension services in Uganda has been a major concern in promoting agricultural production. In the studied communities, it was evident that the majority of camel herders did not receive extension services as well as veterinary support, mainly due to the distant locations between the government offices and the households. This is aggravated by the nomadic nature of the pastoralists. Further, while extension officers are expected to reach out to the people in need of these services, the lack of logistical support to the extension officers greatly constrains their ability to deliver the services. As a result, only a few herders manage to travel to the main trading centres that are on average 8 km from their homesteads, to purchase veterinary drugs, and majority of the herders rely on indigenous knowledge in camel disease management.

Camel management

Camel management in the studied communities is a responsibility of all household members but with differentiated roles based on sex and age. The camel management activities are varied, and they include herding, milking, watering, calf management, salt management and disease control. In the camel production system of Sudan, Shuiep et al. (2014) reported a similar finding where camel management was the responsibility of all household members. In the communities of Amudat and Moroto, elders are responsible for managing the health of the camels which could be attributed to their indigenous ethno-botanical and ethno-pharmacy knowledge which is often enriched with age. Gradé et al. (2009) clearly stated that elders are the custodians of ethno-veterinary knowledge in the Karamoja sub-region.

The adult children aged between 10 and 18 years were mainly responsible for herding and managing the camels because of cultural labour disintegration, their physical and behavioural attributes and financial constraints to hiring labour. According to earlier studies (e.g. Rugadya 2006; Ssenkaaba 2015; Stites et al. 2007), the day-to-day maintenance of livestock in Karamoja is the responsibility of children particularly young boys who are responsible for herding the livestock, while the elders and the youthful boys (also known as *Karachunas*) are often tasked to protect the animals from raids, attacks and threats such as wild animals. Similarly, studies in Sudan (e.g. Hartley 1984; Mukasa-Mugerwa 1981; Shuiep et al. 2014) also indicated that camel herding is the responsibility of children and men. Women are on the other hand mainly tasked with milking of camels since the lactating animals and their calves are often left around the homestead when the other camels are taken for grazing and watering. According to Bruggeman (1994), milking and the production of butter-oil in Karamoja are traditionally female tasks, but when livestock are kept far away from the permanent settlement, young men will do the milking. While a similar pattern was reported in Pakistan (Aujla et al. 1998), a different pattern was reported in Sudan where milking of camels in Sudan was done by hired labour that are skilled and more knowledgeable in handling camels (Babiker and El-Zubeir 2014; Shuiep et al. 2014).

Conclusions

The results revealed that inheritance is the major source of initial camel-rearing stock and that herd diversification is a common practice among the Karamojong community. The study also revealed that older individuals, with less household members and large livestock herd sizes and more income generated from the sale of livestock and livestock products, were more likely to take on camels. Higher milk yield from camels compared to other livestock and family historical traits in camel-rearing emerged as the main motivation for owning camels. The constraining factors given were high initial cost of camel acquisition and lack of camels in their lineage, hence limited skills in handling camels. The results show that pastoralists' socio-economic attributes are relevant in understanding the decision to own camels by a household. Since camel rearing could become an important food source in the sub-region in the near future, the factors that positively influence camel ownership should be improved whereas efforts should be put into ameliorating those that negatively influence camel ownership. The majority of camel herders lack access to livestock extension services and credit facilities. For improved camel production in the region, this study recommends that the herders should be availed with important information on camel management. Building the capacities of extension agents in camel production is also key to better camel production in the region. There is also need to come up with a trainer-of-trainers approach in the areas where there are inadequate extension services so as to address the constraints faced by camel keepers. Village savings groups should also be established to increase access to credit.

Endnote

[1]A female camel is referred to as a cow.

Acknowledgements

We thank the Regional Universities Forum for capacity building in Agriculture (RUFORUM) for funding this research. Our sincere gratitude is also extended to the people of Karamoja for providing the required information and for the hospitality shown during the research. We also appreciative of the assistance we got from the team of research assistants who tremandaously aided in translations and data collection.

Authors' contributions

JBS identified and recruited the research assistants and collected and analysed the data. All authors read, corrected and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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Received: 1 March 2017 Accepted: 16 June 2017
Published online: 18 September 2017

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