African Crop Science Journal, Vol. 30 Issue Supplement, s1 pp. 185 - 196 ISSN 1021-9730/2022 $4.00

DOI: https://dx.doi.org/10.4314/acsj.v30i1.13S

FACTORS DETERMINING INTENSITY OF CAMEL ADOPTION IN SEMI-ARID NORTH-EASTERN UGANDA

R. ASIIMWE, J.B. SALAMULA[1], J. NAMAAWA[1], G.M. DIIRO and A. EGERU[1,2]

School of Agricultural Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda
[1]Department of Environmental Management, School of Forestry, Environmental and Geographical Science, Makerere University, P. O. Box 7062, Kampala, Uganda
[2]Regional Universities Forum for Capacity Building in Agriculture, P.O. Box 16811, Wandegeya, Kampala, Uganda
Corresponding author: robertasiimwe4@gmail.com

ABSTRACT

Integration of camel (*Camelus dromedarius*) production in the traditional livestock systems is increasingly gaining significance as a strategy for household adaptation to prolonged and recurrent droughts in African arid and semi-arid lands. There is increasing interest in promoting camels as a strategy to mitigate the effects of prolonged droughts in communities where camels have not been reared before. However, the intensity of camel adoption and the factors that drive camel adoption process in semi-arid Uganda are not clear. The objective of this study was to determine the level of intensity and socio-economic factors influencing the intensity of camel adoption in Karamoja sub-region in Uganda. Econometric results show that age the of a household head was significantly associated with the intensity of camel adoption; whereas household size, credit access and crop area cultivated significantly decreased with the intensity of camel adoption in the region. Increasing camel adoption was possible with increasing access to capital; as well as carefully balancing the competition for labour with crop cultivation.

Key Words: Adaptation, climate change, livestock

RÉSUMÉ

L'intégration de la production de chameaux (*Camelus dromedarius*) dans les systèmes d'élevage traditionnels prend de plus en plus d'importance en tant que stratégie d'adaptation des ménages aux sécheresses prolongées et récurrentes dans les regions arides et semi-arides d'Afrique. Il y a un intérêt croissant pour la promotion des chameaux comme stratégie pour atténuer les effets des sécheresses prolongées dans les communautés où les chameaux n'ont pas été élevés auparavant. Cependant, l'intensité de l'adoption des chameaux et les facteurs qui motivent le processus d'adoption des chameaux dans la région semi-aride de l'Ouganda ne sont pas clairs. L'objectif de cette étude était de déterminer le niveau d'intensité et les facteurs socio-économiques influençant l'intensité de l'adoption de chameaux dans la sous-région de Karamoja en Ouganda. Les résultats économétriques

ont montré que l'âge du chef de ménage était significativement associé à l'intensité de l'adoption de chameaux ; tandis que la taille des ménages, l'accès au crédit et la superficie cultivée ont considérablement diminué avec l'intensité de l'adoption de chameaux dans la région. L'augmentation de l'adoption de chameaux était possible avec un accès accru au capital; ainsi que d'équilibrer soigneusement la concurrence pour la main-d'œuvre avec la culture des plantes.

Mots Clés : Adaptation, changement climatique, élevage

INTRODUCTION

Studies have revealed increasing interest in the integration of camels into mainstream herds and preference for camel to cattle in dry lands by some communities, which did not hitherto keep camels (Farm-Africa, 2002); as a response to the devastating effects lengthy droughts on cattle and other livestock species. In their assessment of the impacts of the 2008-2009 droughts in northern Kenya, Zwaagstra *et al.* (2010) found that communities increasingly integrated camels into their herds as a coping strategy to drought occurrence. Further, Kagunyu and Wanjohi (2015) reported that pastoralists in drought prone areas of northern Kenya preferred rearing camels to other livestock species; due to high death rates of the latter and their inability to go without water for many days during drought.

Pastoral tribes in northern Kenya (Samburu and Turkana) have begun to increase the number of camels that they manage, substituting them for cows to have more drought-resilient herd (Kagunyu and Wanjohi, 2014, 2015). Kenya camel population increased from 0.8 million in 1999 to three million in 2009 (Kagunyu and Wanjohi, 2014).

Camels are important livestock species in the subsistence economy of rural pastoral communities, especially in arid and semi-arid lands (Aujla *et al.*, 2013). They contribute to household food security through meat and milk (Ahmad *et al.*, 2010); are used as pack animals for transport, and provide household income through sale of live animals, meat, milk and other by-products such as hair and hides (Faye *et al.*, 2010; Aujla *et al.*, 2013). Field (2005) estimated that the volume of milk produced by camels is six times that produced by indigenous cattle found in the dry lands; especially during the dry periods. Mochabo *et al.* (2005) further observed that camels are given as bride price in Kenya and are kept as security against calamities and natural disasters such as drought and disease that may be devastating to other livestock species kept.

In the East African pastoral and agro-pastoral region, researchers and development partners are increasingly getting interested in promoting camels as a strategy to cope with the effects of prolonged droughts (Nalule, 2010; Kagunyu and Wanjohi, 2014, 2015). Salamula *et al.* (2017) studied the factors that determine adoption of camels. However, rigorous empirical evidence on intensity of camel adoption in Uganda remains scarce. The objective of this study was to determine the intensity and factors influencing intensity of camel adoption in Uganda.

METHODOLOGY

Study area. This study was conducted in Karamoja region in north-eastern Uganda, which experiences a semi-desert type of climate, with sporadic uni-modal rainfall patterns experienced between May and August; and an intensely hot dry season occurring from November to March (Mubiru, 2010; Nalule, 2010). The rainfall ranges between 350-1000 mm per *annum*, variable in space and time (Mubiru, 2010; Nalule, 2010). However, there is a general increase in the rainfall of this sub-region despite the existence of below normal rainfall amounts (Egeru *et al.,* 2014). The temperatures range between a maximum of 28-32.5 ^{o}C to and a minimum of 15-18 ^{o}C.

This area has suffered climate variations, manifested *via* extended dry spells, cyclic droughts and erratic rainfall patterns which have affected crop production and livestock production (Mubiru, 2010).

Sampling and data. The study used a comparative approach of camel and non-camel rearing households. Two districts (Moroto and Amudat) were purposively selected for the study due to their possession of a high camel population. Basing on a reconnaissance field visit, the areas known for camel rearing were marked out and selected for the study. These areas included sub counties of Rupa in Moroto district, Amudat, Looro and Amudat TC in Amudat district.

A list of camel rearing parishes was obtained with the assistance of a sub-county local leaders and livestock production officers. The study population was stratified into camel and non-camel households. The parishes included in the study were randomly selected from the obtained list. Villages and then participating households were then randomly selected from the respective sampling frames. Replacements were made in case of absence of target responds or unwilling households. The sample size for the study was determined using the Equation 1 adopted from Banda (2015):

$$n = \frac{Z^2}{e^2}\left(\frac{p.q.N}{(N-1)+Z^2.p.q}\right) \text{ ..... Equation 1}$$

Where:

n was the sample size determined, p was the proportion of pastoral households in the region, a proportion of 0.8 was used as reported from the reconnaissance study; q represented the proportion of non-pastoral households; Z was the number of standard deviations at a given confidence level (i.e. 95 per cent in this study) equal to 1.96; *e* was the acceptance error (0.05) and N (25,000) the estimated number of households in the selected sub counties, giving an estimated sample size of 245 households.

Due to respondent unavailability, time and resource constraints, 122 households were interviewed. With further cleaning, the sample size reduced to 116 households which were used in the analysis due to missing information for some respondents.

Data were collected through Key Informant Interviews (KII) and household level interviews between January-February 2016. Key Informants Interviews were conducted to provide information on the institutional arrangements and efforts towards camel production in the area. District production departments (2), political leaders at the sub-counties (3), veterinary (1) and extension personnel (4) were interviewed. KII also guided the characterisation of the study population and preparation of the sampling frame for the parishes and households in the elected villages. In the later stages, KII were used to validate information obtained from the household interviews.

A key informant question guide was used to guide the discussions. Information of interest included the institutional efforts towards livestock value chain development, marketing infrastructure for livestock and livestock products, livestock extension services, input delivery systems, condition of infrastructure such as roads, schools, water sources and health units, efforts to promote camel production as well as other non-livestock-based approaches of building household resilience to drought.

Household level data were collected using a semi-structured questionnaire. The questionnaire was administered with the help of local language interpreters. Household head, spouse or older children familiar with household routine activities and camel related activities were the main respondents. The questionnaire captured information on personal identification, basic household information, household direct productive assets such as land, livestock, crops and indirect productive

assets such as transport and communication equipment, on farm and off-farm, migration and remittances. Information on social and economic connectivity of a household was also collected. Questions on household food security status in the last one year were included to establish a household's drought resilience and coping abilities. Furthermore, information on numbers of camel kept, camel products obtained, proportions of products consumed and sold and sale prices. This allowed the description of households' camel adoption behaviours, inputs required, and outputs obtained both qualitatively and quantitatively in the study area.

Analytical framework. The study examined the determinants of the level and intensity of camel adoption of the camel, using the conventional random utility model. In this framework, individuals were assumed to make rational decisions by choosing to increase the number of camels kept, if doing so maximised their expected utilities. Following Hanemann (1984) and Baltas and Doyle (2001), a random utility function for a smallholder farmer in Karamoja facing a decision to increase number of camels kept was specified as in Equation 2.

$$V_{ij} = \overline{V}_{ij} + \varepsilon_{ij} = X_{ij}\theta + \varepsilon_{ij}, i = 1,...,n$$

..... Equation 2

Where:

V_{ij} - utility of alternative *j* for consumer *i*, is a function of the deterministic component $\overline{V}_{ij}$ and the random component, ε_{ij}; X, is a vector of observed socio-economic and demographic characteristics of the individual, and *e* is the stochastic component of the utility function representing the unobserved attributes affecting individual *i*'s choice of the practice, heterogeneity in tastes and measurement errors.

A rational pastoral household would choose increase camels kept if the expected utility derived from an additional camel (V_{i1}) was higher than that generated from the status quo ((V_{i0}), given the constraints, such as access to resources, information, and knowledge about camels. This study used descriptive methods to compute intensity of adoption of camels in the study area. The intensity of adoption was captured as the proportion of Camel Tropical Livestock units (TLUs) in the herd to the total herd TLUs as specified in equation (3).

$$\text{Intensity of adoption (Ic)} = \frac{\text{Camel TLUs owned by the household}}{\text{Total TLUs owned by the household}}$$

..... Equation 3

A TLU is a standardised animal unit obtained by multiplying total number of animals with a conversion factors that considers feed requirements for the animals. The conversion factors used were cattle and donkeys =0.5, goats and sheep=0.1 and Chicken=0.01 (FAO, 2003).

A fractional response model was used to estimate the determinants of adoption intensity since the dependent variable was bounded between zero and one (Papke and Wooldridge, 1996). Intensity of adoption estimation could be done using the ordinary least squares estimation methods, but this has two major draw backs. First, there is a possibility of obtaining estimated intensity outside the zero-one range, yet the dependent variable (intensity of adoption) is a proportion bound between zero and one. Secondly, the assumption that there exists a linear effect of explanatory variables on the response variable may not be exactly realistic in the current scenario. To this, a fractional logit model which assumes a logistic distribution of the random disturbances and binds the estimated intensity of adoption between zero and one (Papke and Wooldridge (1996) was adopted for the study. The general model for intensity of adoption is specified in Equation 4.

$$E(\log[y_i/(1 - y_i) \,1\, x) = x\beta$$ ..... Equation 4

Where:

y_i was defined as proportion of camel TLUs in the herd, β is a K x 1 vector of parameters, x is an N x K matrix of explanatory variables.

The variables included in the empirical models were drawn from empirical studies on household technology adoption behaviour (Akinbode and Bamire, 2015; Diiro and Sam, 2015; Mwangi and Kariuki, 2015). These included household head characteristics such as age, main occupation (dummy 1= pastoralist 0 otherwise) and marital status (dummy 1= married 0 otherwise). Household level variables selected were members' completion of primary education, household size, dependence ratio, experience of feeling of food scarcity, asset ownership, tropical livestock units of large ruminants excluding camels, tropical livestock units of small ruminants. access to credit, number of alternative sources of income and proportion of off-farm income to total household income, crop area cultivated, receiving remittances and membership to social groups. Community level variables were distance to input stockist, and access to livestock extension services. A location dummy (1= Moroto and 0 = Amudat) was used to control for district specific effects.

Socio-economic and demographic characteristics. Table 1 presents a summary of socio-economic, demographic and community level variables characterising households disaggregated by camel adoption status. These statistics show that the two categories were generally comparable with respect to most of the attributes, except in income (per *capita,* farm and non-farm) and age of the household. Camel adopters were older and reported higher per *capita* and farm incomes than the non-adopters

RESULTS

Intensity of camel adoption. On average a household had 18 camels comprising of mostly females (Table 2). With regard to districts, an average adopting farmer reported more camel heads in Amudat (22 camels) than their counterparts in Moroto (14 camels).

Table 3 shows that the TLUs for camels was 9.2 (Table 3), representing about 25% of the TLUs for all livestock tended in a household. Other large ruminants such as cattle and donkeys formed the largest share of the TLUs in camel rearing households (42%). An average household had about 18 camels, with about eight female camels, five male camels and five calves. Camel adopters had significantly more TLUs (35.7 %) relative to only 13.2% reported by their non-adopting counterparts.

As indicated in Figure 1, about 60% of the households obtained camels through gifts, inheritance or bride price; compared to buying or exchanging with other livestock (40%). This highlights the social cultural importance of camels in the adopting communities in general. However, marked differences existed between the two districts. About 80% of farmers surveyed in Moroto district acquired their first stock of camels through inheritance, gifts or bride price; whereas most camel farmers (about 60%) in Amudat purchased their first stock.

Factors influencing intensity of camel adoption. Based on Table 4, the intensity of adoption was positively and significantly associated with age of the household head and the location of the household. On the contrary, the intensity of adoption was negatively related to household size, credit access, household experience of food insecurity and crop area cultivated.

The age of a household head exhibited a positive and significant effect on intensity of camel adoption (P<1%). A one percentage point increase in age of the household head increased the marginal change in intensity of camel adoption by 0.007 percentage points; holding other factors constant. Similarly, location of the household had a positive and

TABLE 1. Socio-economic and demographic characteristics of the surveyed households in Karamoja in Uganda

Variable	All households (n=116)		Camel households (n=52)		Non-camel households (n=64)		t-statistic
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Per *capita* income (US Dollars)	47.96	89.343	68.14	123.338	31.56	40.617	-2.230**
Occupation of household head (1=pastoralist; 0 otherwise)	0.74	0.440	0.75	0.437	0.73	0.445	-0.190
Age of household head (years)	49.62	14.975	54.19	13.776	45.91	14.982	-3.070*
Years of experience in rearing camels			26.05	20.281			
Marital Status (1=married polygamous; 0 otherwise)	0.74	0.439	0.81	0.398	0.69	0.467	-1.446
Household size (continuous)	11.05	5.138	11.27	5.010	10.88	5.272	-0.410
Household member completed primary	0.17	0.379	0.19	0.398	0.16	0.366	-0.507
Dependence ratio	0.67	0.818	0.71	0.823	0.64	0.819	-0.423
On-farm Income (US Dollars)	319.12	432.714	479.06	508.339	189.16	307.149	-3.791*
Off-farm Income (US Dollars)	120.99	344.978	93.54	154.944	143.29	443.484	0.771
Proportion of off-farm income to total income	0.36	0.379	0.26	0.353	0.44	0.381	2.667*
Access to credit (1=yes; 0 otherwise)	0.29	0.457	0.25	0.440	0.32	0.471	0.783
Number of alternative sources of income (continuous)	1.00	0.780	0.92	0.788	1.06	0.774	0.9567
Assets owned (0=only Agric. 1=agric & non-agric)	0.66	0.510	0.73	0.490	0.61	0.523	-1.279
Crop area cultivated	4.40	3.691	4.86	4.037	4.02	3.371	-1.220
Feeling of food scarcity (1=yes, 0=no)	0.93	0.254	0.88	0.323	0.97	0.175	1.788***
Months of scarcity	5.49	4.622	5.00	4.847	5.89	4.622	1.010
Meals consumed per day in times of scarcity	1.45	0.450	1.47	0.504	1.43	0.450	-0.336
Proportion of food consumed in scarcity	0.59	0.595	0.66	0.726	0.54	0.471	-1.063
Received extension	0.41	0.495	0.48	0.505	0.36	0.484	-1.319
Member of social group	0.41	0.494	0.31	0.466	0.49	0.504	0.291
Received remittances	0.21	0.407	0.15	0.364	0.25	0.436	1.269
Distance to nearest agriculture input shop	8.31	6.756	9.19	6.473	7.63	6.942	-1.204
Distance to nearest agriculture extension office	6.69	5.817	6.41	5.648	6.91	5.980	0.446
Distance to nearest health center	4.08	3.520	4.17	3.555	4.01	3.520	-0.242
Distance to nearest primary school	2.67	3.110	3.04	4.258	2.36	1.604	-1.154
Distance to nearest secondary schools	11.09	6.663	11.44	7.124	10.83	6.355	-0.469

Note: ***significant at 10% **significant at 5% *significant at 1%

TABLE 2. Number of camels owned by a household in study districts in Karamoja in 2015, Uganda

Type of camel	All camel households (n=52)			Amudat district (n=27)			Moroto district (n=25)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Male	4(7.15)	0	50	4(3.26)	0	15	4(9.68)	0	50
Female	10(12.37)	1	70	12(15.29)	2	70	7(7.99)	1	30
Calves	5(5.76)	0	31	6(6.93)	0	31	3(3.75)	0	13
All camels	19(22.12)	1	116	14(18.97)	1	90	22.7(24.75)	5	116

Figures in brackets are standard deviations

significant effect on intensity of adoption (P<10%). Household in Moroto had 0.96 adoption intensities higher than those in Amudat. In addition, households in Moroto were 0.092 percentage points more likely to increase their intensities compared to their Amudat counterparts; holding all other factors constant.

There was a negative and significant relationship (P<0.05) between intensity of adoption and household access to credit. Households that had accessed credit in the past 12 months were less likely to increase the proportion of camels in their herds; compared to their counterparts who had not received credit. Precisely, access to credit led to a 0.12 percentage point decrease in change in adoption intensity for households that accessed credit compared to those that did not. Similarly, households that had experienced food insecurity were significantly (P<0.01) less likely to increase camel intensity in their herds. Food insecurity was associated with a 0.218 percentage point decrease in change in intensity of adoption for households that experienced it, as compared to those that did not experience it (Table 4).

Household size also presented a negative and significant effect on intensity of adoption (P<0.05). Following one percentage point increase in household size, change in adoption intensity reduced by 0.01 percentage points holding other factors constant.

Crop area cultivated was also negatively and significantly (P<10%) influenced the intensity of camel adoption. A one percentage point increase in acreage cultivated decreased the change of adoption intensity by 0.009 percentage points holding other factors constant. Respondents stated that camels were rarely used for transport, which would have been of supplementary service to crop production through provision of transport services. In addition, respondents reported that camels damaged crops when not confined in fences; a factor that attracted extra costs to the overall farm investment.

TABLE 3. Livestock ownership among camel and non-camel adopting households (TLU) in Karamoja in Uganda

Type of livestock	Camel households (n=52)	Non-camel households (n=64)	t-statistic
Camels	9.2 (15.46)		
Other large ruminants	15.0 (21.34)	7.2 (9.72)	-2.616**
Small ruminants	4.8 (9.18)	2.9 (2.78)	-1.770*
Total TLU	35.7(42.07)	13.2(15.73)	-3.954***

*10, ** 5 and *** 1% level of significance; Standard deviation in parentheses

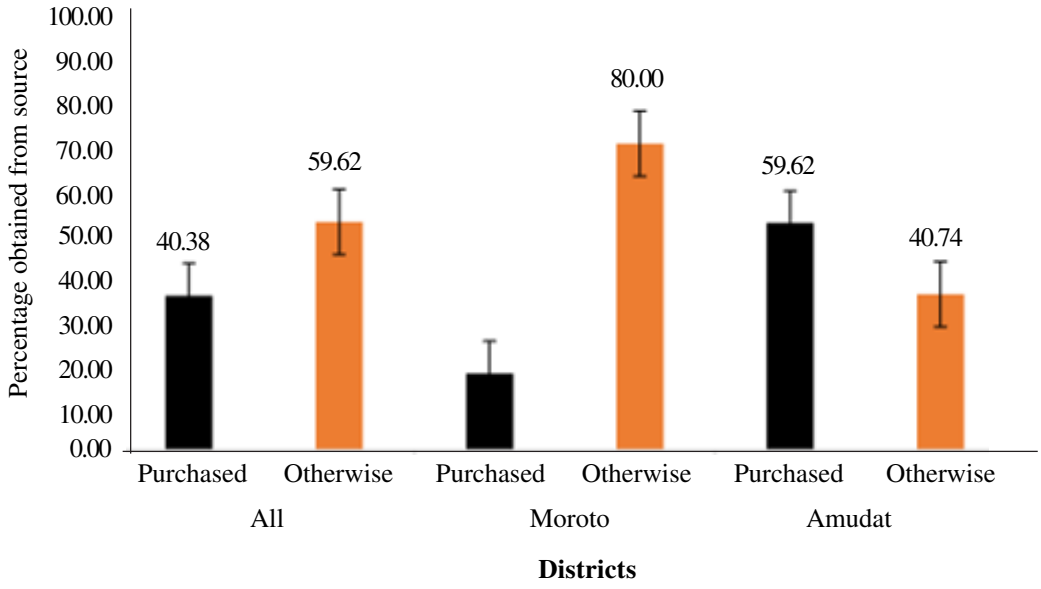

Figure 1. Source of initial camel stock for adopting households in Karamoja sub-region in Uganda.

DISCUSSION

Age of household head. The positive relationship between intensity of adoption and age of the household head (Table 4) reveals the role of experience, resource or capital accumulation and decision making in determining intensity of camel adoption. Older household heads are more likely to have accumulated wealth and have increased knowledge and experience to evaluate new farming approaches and practices than the younger counterparts (Mwangi *et al.,* 2015; Mubiru *et al.,* 2018). In addition, as people grower older in the ASALs of east Africa, herd stability increasingly becomes a priority, thus leading to decisions that are more likely to support herd stability. These factors, coupled with increased desire for social prestige from accumulated wealth, could well explain this trend of events (Banda and Tanganyika, 2021). It was also observed that contrary to cattle that migrate in search of pasture and water, camels tend to remain in the homesteads. This encourages settlement of the household that is more likely to be a characteristic of older

TABLE 4. Fractional Logit Estimates of the factors influencing intensity of camel adoption in Karamoja sub-region in Uganda

Proportion of camel TLUs to total TLUs	Coefficient	Standard errors	Marginal effects
Constant	-3.243***	1.154	
Age of the household head (years)	0.070***	0.016	0.007
Occupation of the household head (dummy 1=pastoralist)	0.090	0.479	0.009
Marital status (dummy)	0.413	0.528	0.040
A household member completed primary (dummy)	0.049	0.553	0.005
Household size	-0.108**	0.047	-0.011
Dependence ratio	0.008	0.251	0.001
Number of alternative sources of income	0.492	0.308	0.048
Proportion of off-farm income to total income	-1.061	0.671	-0.103
Asset ownership (1= agricultural and non-agricultural assets, 0=only agricultural assets)	0.302	0.479	0.029
Experienced feeling of food scarcity (dummy)	-2.246***	0.554	-0.218
Access to credit (Dummy)	-1.254**	0.510	-0.122
Household received remittances (dummy)	-0.671	0.475	-0.065
Membership to social groups (dummy)	0.465	0.516	0.045
Household received animal related extension (dummy)	-0.182	0.412	-0.018
Crop area cultivated (acres)	-0.100*	0.056	-0.009
District (dummy 1=Moroto; 0=Amudat)	0.951*	0.493	0.092
Number of observations	114		
Wald chi2(16)	44.340		
Prob> chi^2	<0.000		
Pseudo R^2	0.185		

*10, ** 5 and *** 1% level of significance

household heads than the younger household heads.

Credit facilities. The results of this study suggest that households borrowed to smoothen consumption and not to make investments, hence the negative relationship between credit access and the intensity of camel adoption. This implies that households' acquisition of credit was driven by short-term response to shocks. Household are more likely to prioritise consumption expenditures over investment in resource allocation decisions (Fischer and Chhatre, 2016). In this case, households solved their pressing consumption needs (food shortage for example) using the credit obtained rather than using it for increasing camels in the herd, until their immediate needs were satisfied.

Access to credit increases adoption of technologies requiring significant capital investments such as larger livestock (Mohamed and Temu, 2008). Camels were reported to cost between US$ 200-300 for an adult female and up to US$ 500 for a fully mature male. Households decided to borrow money to cope with a shortage in cash to either make an investment or to smoothen consumption (buy food, medicine, or pay for education). Cash shortages that drive the need for extra sources of income to fill the gaps are more felt in larger than in smaller households.

Household size. The negative effect of household size on camel adoption may be due to the increase in expenditures on household needs such as food, health care, and education, which may reduce the saving propensity of the household, thus increasing the likelihood of borrowing to smoothen consumption. This then could reduce the ability of acquiring relatively expensive assets such as camels, even though the labour to attend to them may be available. Considering that camels are expensive to acquire, higher household size (10 people per household compared to 5 people as national average (UBoS, 2016)) would hinder increasing adoption intensity.

Household size can drive technology adoption in either direction depending on where the technology leans most between capital and labour requirements. In the case of labour-intensive technologies, higher household size allows the household to relax the labour constraints and hence adopt more of the technology (Mwangi *et al.,* 2015). On the other hand, higher household sizes imply higher consumption needs which could reduce adoption of capital-intensive technology as the household tends to spend more on consumption than saving for investment.

Area under crop cultivation. The effect of crop cultivation may have been to discourage sedentary lifestyles and encourage settlement; so did the rearing of camels. Increasing intensity of camel adoption and crop area cultivated should bear complementary effects by encouraging settlement of pastoral households. However, these two could potentially compete for the same resources, mainly labour. As the households indulge more in crop cultivation, the intensity of camel adoption goes down (Table 4). In addition to competition for labour, the two enterprises demand completely different managerial experience that may not be equally available from a single manager. Therefore, pastoralists find themselves with some sort of tradeoff decision to make, that is either to master livestock at the expense of crop production or otherwise.

CONCLUSION

The increase in both the age and size of households living in Moroto increased the intensity of adoption of camels; whereas increase in credit access, household's experience of food insecurity and crop area cultivated decreased the intensity of camel adoption. The study recommends introduction or promotion of on-farm productivity

enhancing technologies (ox-drawn ploughing equipment and proper herbicides use) for cultivated crops to allow for balancing time for both crop cultivation and tending to livestock, without aggravating the negative impact of crop area expansion on intensity of camel adoption.

ACKNOWLEDGEMENT

The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) funded this research.

REFERENCES

Ahmad, S., Yaqoob, M., Hashmi, N., Ahmad, S., Zaman, M.A. and Tariq, M. 2010. Economic importance of camel: unique alternative under crisis. *Pakistan Veterinary Journal* 30(4):191-197.

Akinbode, W.O. and Bamire, A.S. 2015. Determinants of adoption of improved maize varieites in Osun State, Nigeria. *Journal of Agricultural Extension and Rural Development* 7(3):65-72. doi: 10.5879/JAERD2014.0605

Aujla, K.M., Rafiq, M. and Hussain, A. 2013. The marketing system of live-camels and camel products in the desert ecologies of Pakistan. *Pakistan Journal of Agricultural Research* 26(2):130-142.

Baltas, G. and Doyle, P. 2001. Random utility models in marketing research: a survey. *Journal of Business Research* 51: 115-125.

Banda, T. F. 2015. Determinants of household resilience to dry spells and drought in Malawi: A case of Chipoka. (Master of Science in Agriculture and Applied Economics Masters), University of Malawi, Malawi. 118pp. https://agecon search.umn.edu/record/243469/

Banda, J.L. and Tanganyika, J. 2021. Livestock provide more than food in smallholder production systems of developing countries. *Animal Frontiers:* 11(2):7-14, https://doi.org/10.1093/af/vfab001

Diiro, G. M. and Sam, A. G. 2015. Agricultural technology adoption and nonfarm earnings in Uganda: A semiparametric analysis. *The Journal of Developing Areas* 49(2):145-162.

Egeru, A., Wasonga, O., Kyagulanyi, J., Majaliwa, G. M., MacOpiyo, L. and Mburu, J. 2014. Spatio-temporal dynamics of forage and land cover changes in Karamoja sub-region, Uganda. *Springer* 4(6):21.

Farm-Africa. 2002. Micro-enterprise development. Best practices from FARM-Africa Nairobi. http://www.fao.org/tempref/docrep/nonfao/LEAD/X6174e/x6174e00.pdf. Accessed 20 December 2020.

Faye, B., Abdelhadi, O., Ahmed, A.I. and Bakheit, S. A. 2010. Camel in Sudan: Future Prospects. *Livestock Research for Rural Development* 23(10):11-26.

Field, C.R. 2005. Where there is no development agency: A manual for pastoralists and their promoters Aylesford:

Fischer, H.W. and Chhatre, A. 2016. Assets, livelihoods, and the 'profile approach' for analysis of differentiated social vulnerability in the context of climate change. *Environment and Planning A: Economy and Space* 48(4):789-807. doi: 10.1177/0308518X15623278.

Food and Agriculture Organisation of the United Nations (FAO). 2003. Compendium of Agricultural – Environmental Indicators 1989-91 to 2000 Rome, Italy.

Hanemann, W.M. 1984. Discrete/Continuous Models of Consumer Demand. *Econometrica* 52(3):541-551.

Kagunyu, A. and Wanjohi, J. 2014. Camel rearing replacing cattle production among the Borana community in Isiolo County of Northern Kenya, as climate variability bites. *Pastoralism Journal* 4(13):1-5. doi: 10.1186/s13570-014-0013-6

Kagunyu, A. and Wanjohi, J. 2015. The emergency of Euphorbia tirucallias drought

feeds for camels in northern Kenya. *Pastoralism: Research, Policy and Practice* 5(17):4-27. doi: 10.1186/s13570-015-0038-5

Mochabo, K.O.M., Kitala, P.M., Gathura, P.B., Ogara, W.O., Catley, A., Eregae, E.M. and Kaitho, T.D. 2005. Community perceptions of important camel diseases in Lapur division of Turkana District, Kenya. *Springer* 37:187-204.

Mohamed, K. and Temu, A. 2008. Access to credit and its effect on the adoption of agricultural technologies: The case of Zanzibar. *African Review of Money Finance and Banking* 2008: 45-89. http://www.jstor.org/stable/41410533.

Mubiru, D.N. 2010. Climate change and adaptation options in Karamoja. A report submitted to Food and Agriculture Organization and European Union, 62. Kampala: https://pdfs.semanticscholar.org/eae4/e9dab59ab65ebf737bccd15dbb1aba64bf33.pdf.

Mubiru D.N, Radeny, M., Kyazze,F.B, Zziwa, A., Lwasa, J. Kinyangi, J. and Mungai, C. 2018. Climate trends, risks and coping strategies in smallholder farming systems in Uganda. *Climate Risk Management* 22: 4-21, doi:10.1016/j.crm.2018.08.004

Mwangi, M. and Kariuki, S. 2015. Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. *Journal of Economics and Sustainable Development* 6(5):208-216.

Papke, L.E. and Wooldridge, J.M. 1996. Econometric methods for fractional response variables with an application to 401(K) plan participation rates. *Journal of Applied Econometrics* 11:619-632.

Salamula, J.B., Egeru, A., Asiimwe, R., Aleper, D.K. and Namaalwa, J.J. 2017. Socio-economic determinants of pastoralists' choice of camel production in Karamoja sub-region, Uganda. *Pastoralism: Research, Policy and Practice* 7(26):10-19. doi: 10.1186/s13570-017-0096-y

Uganda Bureau of Statistics (UBoS). 2016. The National Population and Housing Census 2014 – Main Report Kampala, Uganda.

Zwaagstra, L., Sharif, Z., Wambile, A., Leeuw, J. d., Johnson, N., Njuki, J. and Herrero, M. 2010. An assessment of the response to the 2008-2009 drought in Kenya: A report to the European Union Delegation to the Republic of Kenya.