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DETERMINANTS OF SELLING LIVESTOCK TO PAY WATERING CHARGES BY PASTORALISTS IN SEMI-ARID AREAS OF MONDULI DISTRICT, TANZANIA

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ABSTRACT

In semi-arid areas, the practice of selling livestock is crucial to support the livelihood of pastoralists and to pay for watering charges. However, it is not a widespread practice in developing countries such as Tanzania. This paper investigates why pastoralists in the semi-arid areas of Monduli District, Tanzania sell their livestock to pay for watering charges. The study used a cross-sectional research design and gathered primary data through a semi-structured questionnaire from 367 randomly selected pastoralist households. Furthermore, triangulation was achieved by using focus group discussions and conducting interviews with key informants.

The data was analyzed using SPSS for both descriptive (frequencies and percentages) and inferential statistics (binary logistic regression model). The binary logistic regression model was used to examine the determinants of the practice of selling livestock to pay watering charges by pastoralists. Content analysis was utilized to analyze the qualitative data. The findings show that the level of education ($p=0.015$); hiring of a tractor water bowser ($p=0.002$) and access to extension services ($p=0.002$) at $p<0.05$ were positively significant determinants of selling livestock to pay watering charges for livestock by pastoralists. The study recommends that the Ministry of Agriculture, Livestock Departments, and Non-Governmental Organizations to work together to establish subsidies or financial assistance programmes for pastoralists in order to lower the cost of employing mechanized water delivery technologies such as tractor water bowser.

INTRODUCTION

Semi-arid regions in Sub-Saharan Africa (SSA) frequently face water scarcity, posing challenges to fulfilling human and livestock water requirements (Mdemu, 2021; Hindiyeh *et al*., 2023; Rao *et al*., 2019). Livestock rearing is an everyday economic activity in these regions (Kimaro *et al*., 2018; de Glanville *et al*., 2020; Leweri et al., 2021). Existing scientific studies indicate that water charges impose a financial burden on the local population (Fielmua and Dongzagla, 2020; Hope and Ballon, 2019). To cope with the expenses, some individuals or communities may resort to selling their livestock as a means of generating income to pay for water services (Mfinanga et al. 2023).

The act of selling livestock holds excellent significance for pastoral communities that heavily depend on livestock production as their primary source of income. By selling livestock, individuals and communities can generate income to cover the costs of accessing water resources for their animals (Herrero *et al*., 2012; Miruka *et al*., 2018). This can help sustain their livestock-based livelihoods and ensure water availability for the animals' well-being and productivity. In addition, selling livestock to pay water charges for livestock stands as an innovative strategy employed by pastoralists to secure water for livestock. Rodger (1983) defined innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption". Innovation is considered as the practical implementation of ideas that result in the introduction of new goods or services or improvement in offering goods or services. In this study selling live livestock to pay water charges for livestock is an innovation because it reduces the challenges of water access for livestock and it has solved problems related to water scarcity for livestock such as migration, land degradation, land and water use conflicts between pastoralists and farmers (Mfinanga *et al*., 2023).

A review of the literature has shown that past studies focused on determinants of livestock market participation by pastoralists (Godfrey, 2010; Lutta et al., 2020; Seid, 2019; Bassa and Woldeamanuel, 2018; Mbembela, 2019); selling of livestock and food security (Gitungwa et al., 2021; Benti et al., 2021; Gebresenbet, 2021; Nderumaki et al., 2016), determinants in participation in commercial fodder market (Sala *et al.,* 2020; Mutuku *et al*., 2023). In addition, most scientific studies in Sub-Saharan Africa focus on water access and sanitation for human consumption due to significant water security challenges in the region. Furthermore, Barret (2004) and Arethun and Bhatta, (2012) contend that the marketing of goods depends on location. Therefore, despite the growing body of literature on this topic of the marketing of livestock, there is still a need to investigate factors affecting the selling of live livestock to pay water charges for drinking water for livestock during drought season in semi-arid areas.

Pastoralists in semi-arid places, such as Tanzania's Monduli District, rely heavily on livestock rearing. However, the necessity to pay watering fees is putting a strain on the viability of their livestock-based economy. The purpose of this study is to look into the elements that impact

pastoralists' decisions to sell their livestock to afford these fees. Understanding these aspects is critical for establishing effective solutions to reduce the economic impact on pastoralist communities while guaranteeing water resource sustainability. The study's research question is: What are the primary elements influencing pastoralists' decisions to sell livestock to pay for watering expenses in the semi-arid areas of Monduli District, Tanzania? By investigating this subject, we can get insights into the socioeconomic dynamics and decision-making processes of pastoralists in response to the financial demands imposed by watering costs, which will ultimately guide policy interventions and sustainable resource management practices in the region.

THEORETICAL FRAMEWORK

The study was guided by the Adoption of the Innovation Framework by Botha and Atkins (2005). Innovation refers to any idea, technology, practice or system that is new to any individual (Rogers, 2003; Botha and Atkins, 2005). In this framework, Botha and Atkins (2005) argue that contextual factors (technological and institutional factors) and individual (personal) factors influence the adoption of innovation. In light of the adoption process, this study focused on the adoption of innovative practices by pastoralists hereafter water use strategies for livestock namely (selling of livestock to finance water services for livestock). This framework was applied because it allows the study of combinations of the characteristics of an innovation impact on individual decision-making about the innovation (Botha and Atkins 2005). Therefore, this study focuses on the adoption of practice of selling live livestock to pay watering charges for livestock.

CONCEPTUAL FRAMEWORK

The conceptual framework developed from the adoption of the innovation framework by Botha and Atkins, (2005). The framework has a dependent variable namely the adoption of water use strategies for livestock (selling of livestock to finance water services for livestock) being related to three (3) groups of independent variables namely the personal adopter characteristics, technological and institutional factors (Figure 2). This study sought to establish the determinants of the adoption of selling livestock to finance water services for livestock among pastoralists in Monduli District, Arusha region. This study was limited to contextual factors

hereafter namely technological, institutional, and individual factors which were independent variables and it was assumed that these variables have a positive and direct influence on the adoption of selling livestock to pay watering charges for livestock by pastoralists in Monduli district. The technological factors in this study were the use of tractor water bowser, motorcycles and donkey carts or tied jerry cans onto donkeys.

In terms of individual factors, these were the age of the household head, education level, sex of

the household head and wealth of the household including the number of livestock owned by the household head, income of the household head and household labour support which were assumed to influence the adoption of selling of livestock to pay water charges (Figure 2). Also, institutional factors including access to extension services assumed to influence positively the adoption of selling livestock to pay for watering charges for livestock (Figure 2).

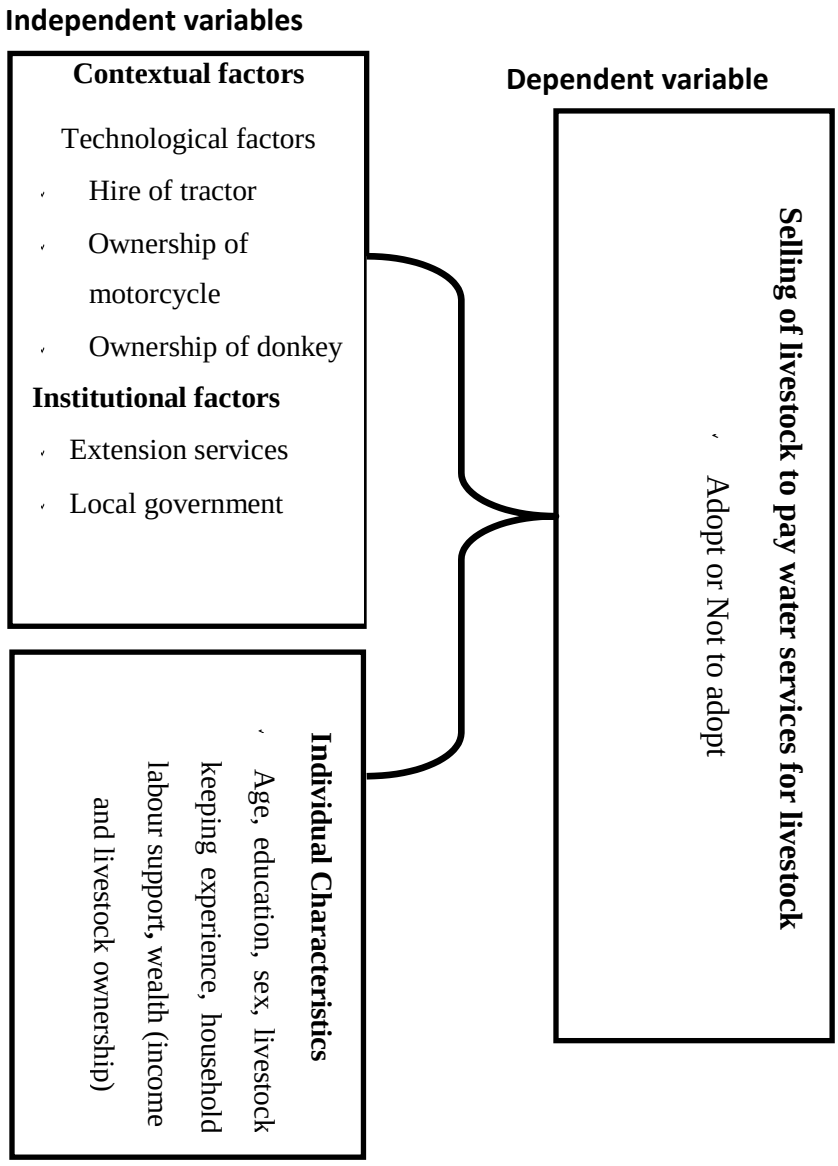

Figure 1: Conceptual framework adapted from Botha and Atkins, (2005).

LITERATURE REVIEW

Individual socio-economic factors and adoption of innovation

Rodgers (2003) and Bakkabulindi (2014) argue that individual characteristics of adopters include things like education level, demographic characteristics, and income level of the person influencing the adoption of innovation. For example, previous studies by Asmera and Melkamu (2020) and Zenebe *et al.* (2020) show that age correlates significantly negatively with the adoption of innovation. On the other hand, other studies (Ayenew *et al.,* 2020; Akroush, 2017) indicate that age is significantly positively associated with the adoption of innovation. These contradictory findings support Rogers' (2003) claim that "there is inconsistent evidence about the relationship between age and adoption of innovation. Therefore, it's worth investigating the influence of age specifically on the adoption of practices of selling live livestock to pay watering charges for livestock.

According to Rogers (2003), adopters are wealthier in terms of socioeconomic status, and wealth. Mekonnen (2017) is of the opinion that household that owns more capital, especially the number of livestock, human capital like household labour support, education level of household members, engage with off-farm income and any other assets that constitute household income are ready to adopt rainwater harvesting technologies. Pastoralists are ready to adopt because livestock is their main source of income that supports their livelihood and needs to be developed. Therefore, there was a need to investigate how the socio-economic status of household heads correlates particularly with the adoption of water use strategies for livestock hereafter in this study are selling of livestock to finance water services for livestock and charco dam rainwater harvesting technologies for livestock.

Technological factors and adoption of innovation

The second factor affecting adoption is technological factors. Feenberg (2012) argues that technology is a human activity or a tool for achieving a goal. Technological factors include things like infrastructure that enhance the business environment (Kozubikova and Kotaskova, 2019). According to Christensen, (2013 claims that the relevance cost and benefit of technology influence the adoption of innovation. For example, the use of donkeys, tractor water bowser and motorcycles once accessible is assumed to depend on pastoralists selling livestock to buy tools used in transporting water for livestock and other uses.

Institutional factors and adoption of innovation

The institutional factors namely the infrastructures of the economies, and legislation (Mingaleva and Mirskikh, 2009). According to North (1991), institution refers to the humanly devised constraints that structure political, economic, and social interaction. In this study, the institutional factor is extension services offered to pastoralists as supported by Ayenew *et al.* (2020).

METHODOLOGY

The study area

The study was conducted in Monduli District; Arusha Region situated at latitude 3° 20' South and longitude 36° 15' East. Monduli District is a semi-arid area characterized by climate variability including drought and unreliable rainfall ranging between 200mm and 600mm (Kimaro *et al.,* 2018). Moita and Makuyuni wards were selected out of 20 wards of Monduli District purposively because they are located in lowland ecological zone areas characterized by semi-arid rangelands and livestock keeping is the main economic activity.

Research design

The study used a cross-sectional research design whereby primary data were collected from the pastoralists at one point in time. A cross-sectional research design was used because it provides a comprehensive picture of the problem being investigated (Clark and Ivankova, 2016).

Data collection method

The study applied, mixed methods which involved gathering and analyzing both quantitative and qualitative data in a single study (Creswell *et al.,* 2011). The approach is useful because it can provide a comprehensive understanding of the study results (Clark and Ivankova, 2016). To implement this method, the main focus was on the quantitative approach, complemented by a qualitative approach. A total of nine (9) Focus Group Discussions (FGD) were conducted, with four FGDs exclusively for men in the Moita Ward and three FGDs exclusively for men in the Makuyuni Ward. To ensure balanced participation, one FGD composed of women was conducted in each ward, making a total of two female FGDs because women speak less when they are mixed with men during FGD (Stewart *et al*., 2002). Each FGD consisted of 6-10 pastoralists, which is appropriate for such discussions (Mishra, 2016). Additionally, a checklist

was used to interview sixteen (16) key informants, including three Rural Water Sanitation Authority Officers, seven Village Executive Officers, two Ward Executive Officers, two Extension Officers, and two Traditional Leaders.

The study population, sampling procedure, and sample size

The research study focused on pastoralists who relied on domesticated animals for over 50% of their income. The study used a multistage sampling approach. Firstly, Monduli District was chosen from seven districts in the Arusha region due to its semi-arid climate. Secondly, two out of 20 wards were chosen: Makuyuni and Moita, as they were located in lowland ecological zones suitable for livestock. Finally, three villages in Makuyuni ward - Makuyuni, Naiti, and Mbuyuni - and four villages in Moita ward - Moita Kipok, Moita Kiloriti, Moita Bwawani, and Kilimatinde - were purposively selected. The household was the sampling unit, and the head of each household was the respondent. The definition of a household included individuals sharing the same center and under the direction of a recognized head (National Bureau of Statistics, (NBS), 2014). The sample size of 367 pastoralist households was determined using Yamane's (1967) formula (equation i)

$$n = \frac{N}{1+N\,(e)^2} = \frac{4{,}390}{1+4{,}390\,(0.05)^2} = 367 \quad \text{..... (i)}$$

To determine the sample size for a study of 4390 households of pastoralists, the following formula was used: n represents the sample size, N represents the population, and represents the level of precision or sampling error, which was set at 5%. Additionally, the sample size for each village was calculated using Salkind's (2010) proportional formula (equation ii). $n_b = \frac{N_h}{N} x\ n$

..... (ii)

Where n_b is the sample size for village h, N_h is the pastoralists for village h, N is the total population size, and n is the total sample size. Through this formula, the researcher obtained the sample sizes of each village as follows: Moita Kiloti = 45, Moita Kipoki = 39, Moita Bwawani = 63, Kilimatinde = 38, Makuyuni = 97, Naiti = 39, and Mbuyuni = 46. Thereafter, a simple random sampling technique with the aid of a lottery method was applied to select the respondents from each village.

Measurement of study variables

Independent variables

The individual socioeconomic characteristics of pastoralists, technological and institutional

factors included in this study were sex, age, education, livestock keeping experience, off-farm income, household size and Livestock Tropical Unit (TLU). Sex was coded 1 if the pastoralist's head of household was male and 0 otherwise. Age was measured in years; education was measured in the number of schooling years. Livestock keeping experience was measured in the number of years keeping livestock. Off-farm income was measured in terms of income in Tanzania shillings (TSH) earned from off-farm income-generating activities per annum and Tropical Livestock Unit (TLU) was measured by the number of livestock owned by the household. Njuki *et al.* (2011) defined it as a single unit computed from different livestock species representing the entire livestock owned by the household.

In terms of technology, factors were measured as follows; ownership of a donkey was coded 1 for those who owned a donkey and 0 otherwise, the motorcycle was coded 1 for those who owned a motorcycle 0 otherwise and hiring of a tractor water bowser was coded 1 for those sold livestock to hire tractor water bowser and 0 otherwise. Likewise, institutional factors access to extension services was coded 1 if the pastoralist household head had at least one visit and 0 otherwise.

Dependent variable

In this study, the dependent variable used in the binary logistic regression model was the selling of livestock to pay watering charges for livestock. In the case of selling livestock to pay watering charges for livestock is a binary event, it takes the value of 1 or 0 otherwise.

Data analysis

Quantitative data analysis

The quantitative data were analyzed by using SPSS version 20. SPSS was used to analyze descriptive statistics of the socio-economic, technological and institutional factors of the surveyed households. In the case of inferential statistics, the quantitative data were coded and entered in the SPSS version 20 for analysis. The inferential statistics the binary logistic model was used to analyze the determinants of the adoption of practices of selling livestock to pay watering charges for livestock.

Estimation of the model

The binary logistic regression model was applied because the dependent variables were dichotomies that is non adoption (0) and adoption (1) (Mhango, 2020). Prior testing the equation,

the issue of multi-collinearity was examined using Variance Inflation Factors (VIF). Multicollinearity is a statistical condition for which two or more predictor variables are closely connected in a multiple regression model (Daoud, 2017). The binary logistic regression model (equation iii) was applied as follows;

Equation (i) binary logistic regression model as specified by Agresti and Finlay (2009):

$$\text{Logit}(Pi) = \log(Pi/1-Pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k \quad \text{(iii)}$$

Where:

Logit (Pi) = natural log of an event occurring (dependent variable), which is the probability of a household to practice selling of live livestock, (1= adopt the practice of selling live livestock, 0 = reject selling of live livestock).

Pi = probability of (event), this is the likelihood of an event occurring.

1-Pi = probability of (non-event), which is the likelihood of the event not to occur.

B_0 = is the equation's constant.

β_1 to β_k = coefficients of the independent (predictor, response) variables.

k = the number of independent variables.

X_1 to X_k = independent variables entered in the model.

Qualitative data analysis

A researcher transcribed verbatim from Swahili to English the audio recordings of the Focus Group Discussions and key informant interviews. The researcher compared the audio recording transcripts to the written transcripts as closely as feasible to guarantee data transcription uniformity. The obtained information was then interpreted using a thematic analysis framework by Braun and Clarke (2006). The framework consists of six steps including becoming familiar with the data, generating initial codes, searching for themes, reviewing themes, defining themes and writing up. Then the consistency and relevancy of coding were done independently by researchers who were not involved in the data collection. Ibrahim (2012) supports this technique, arguing that in thematic analysis, the reliability and validity of qualitative data should be evaluated by an external reviewer.

The analysis focused on addressing questions related to the water use practice of selling livestock to pay watering charges for livestock. Specifically, the focus was on the determinants of the adoption of the practice of selling live livestock to finance watering charges for livestock.

RESULTS AND DISCUSSION

Socio-economic, institutional and technological factors of surveyed households

Table 2 presents descriptive statistics on the use of frequency and counts of the socio-economic characteristics of the surveyed household. The result shows that 98.9% of the respondents were from male-headed household while 1.1% was from female-headed household. This result varies at large from the national household budget survey 2011/2012 which pointed out that the overall national Female-Headed Household (FHH) accounts for 25% (FAO, 2014). Also, findings show varied ages of the respondents whereby 36% of the respondents aged between 36-45 years ranked first and the least 12.5% % aged between 18-35 years (Table 2). This finding implies that the head of households is young active individuals who contribute labour in livestock production activities. The cause of this result was young adult individuals were more willing to engage in livestock production after receiving their share of livestock from their parents. The findings show that nearly half 46.9% of all respondents had primary education followed closely by 45.8% with non-formal education (Table 2). These findings show that the majority of pastoralist household heads in the study area had either primary education or had never attained formal education. Furthermore, during the Focus Group Discussions at Naiti, Moita Bwawani, Kilimatinde and Kiloriti villages it was agreed that the cause of this situation is the lack of awareness and adult education programs for members of society who have no access to formal education systems.

The results in Table 2, indicate that only 30.2% out of 367 pastoralist household heads received training and extension services. The Moita ward had a significantly lower percentage at 7.2%, while the majority of 92.8% were in the Makuyuni ward. These extension services were provided through household visits to individuals and groups, specifically on selling live livestock to pay for watering charges, and as a means of destocking during drought seasons to reduce water access expenses. Additionally, Focus Group Discussions in the Moita ward reported that it was a way to lower water charges for livestock after destocking.

Regarding technological factors, 67.8% of pastoralists opted to sell their livestock to pay for the hiring of a tractor water bowser to access water services for their livestock. This was the leading technological choice, followed by the use of motorcycles at 59.7% (Table 2). In addition, it was agreed during the Focus Group Discussion in Makuyuni village that the hire of a tractor water bowser was preferred for accessing water for livestock due to its ability to carry a large volume of water that is sufficient for both livestock and domestic use.

Table 2: Socio-economic characteristics of the surveyed household

Variable		Moita ward		Makuyuni ward		Total	
		n	**%**	**n**	**%**	**n**	**%**
Sex	Male	185	100	178	97.8	363	98.9
	Female	0	0	4	2.2	4	1.1
Age	18-35	30	16.2	16	8.8	46	12.5
	36-45	68	36.8	65	35.2	132	36
	46-60	51	27.6	61	33.5	112	30.5
	>60	34	18.4	41	22.5	7	20.4
Education	Non-formal	87	47	81	44.5	168	45.8
	Primary	81	43.8	91	50	172	46.9
	Secondary	15	8.1	8	4.4	23	6.3
	Tertiary	2	1.1	1	0.5	3	0.7
	Adult	0	0	1	0.5	1	0.3
Institutions							
Access to extension services		8	7.2	103	92.8	111	30.2
Technology							
Donkey ownership		42	41.6	59	58.4	101	27.5
Hire water bowser		136	54.6	113	45.4	249	67.8
Motorcycle ownership		108	49.3	111	50.7	219	59.7
Household size	1-3 people	3	1.6	3	1.6	6	1.6
	4-6 People	25	13.5	52	28.6	77	21
	≥7 people	157	84.9	127	69.8	284	77.4

Model Results on the determinants of selling livestock to pay watering charges by pastoralists

Before running the binary logistic regression model analysis, the following diagnostic tests were conducted: Multicollinearity, and the likelihood ratio tests. The results in Table 4 indicate that there is no problem of multicollinearity since the Variance Inflation Factor (VIF) to all predictor variables is less than 10 as recommended by Pallant (2011). Also, the likelihood ratio test was significant since a p-value of >0.05 was appropriate, implying that the fitting effect between the models and the data was good.

The determinants of selling livestock to pay watering charges by pastoralists

According to the study, the level of education of the respondents was a significant factor

($p<0.05$) that positively affected the decision to sell live livestock in order to pay for watering charges (Table 3). The odds ratio was 2.44 with a p-value of 0.015, which means that pastoralists with formal education are 2.44 times more likely to sell their livestock to finance the watering of their livestock. The findings from six FGDs conducted in Moita Kilorit, Moita Bwawani, Moita Kipok, Makuyuni, Naiti, and Mbuyuni villages revealed that education plays a

role in encouraging pastoralists to adopt the practice of selling livestock to finance water services for their animals. Further investigation during the FGDs showed that education enables pastoralists to exchange information on the benefits of selling livestock while still maintaining their herd size by ensuring access to water services.

This finding from FGD aligns with a key informant's report from Naiti village who had to say that;

"…Livestock is my life. I value my cows, goats, and sheep. I have a plan for harvesting them every year to provide water and grass during droughts. I sell some to save money for watering animals. (Naiti village informant, 7/25/2020) …". (A key informant at Naiti village, 25th July 2020).

This study is in line with that of Lutta *et al.* (2021) conducted in Tana River County in Kenya who found that the education level of pastoralists household heads was significantly related to the number of livestock sold by pastoralists with the guarantee of access to resources especially drinking water for livestock which allow them to capitalize on herd sizes. This study established this finding because the selling of live livestock was the main source of income that covers water charges for drinking water for livestock.

The finding indicates that the hiring of tractor water bowser was significant ($p<0.05$) and positively related to the adoption of the water use strategy of selling livestock to finance water services for livestock with an odds ratio of 3.05 and p-value of 0.002 (Table 3). This implies a one-unit increase in the hiring of tractor water bowser increases the likelihood of selling live livestock to finance water charges for livestock. The cause of this finding is the pastoralists were able to manage the costs of hiring tractor water bowser technology after adopting the selling of livestock and acquiring funds. Moreover, pastoralists were aware of the benefit of using tractor water bowser over others in transporting large volumes of water within a short period. Another reason for this result was cheap to hire a tractor water bowser rather than buying a new one. These findings are in line with results from Focus Group Discussions (FGDs) in Moita Bwawani, Moita Kipoki and Moita Kilorit villages, which indicates that pastoralists sold their livestock to raise funds for hiring tractor water bowser to carry water for livestock. Moreover, FGDs results show that water charges per tractor with a capacity of 10,000 litres ranged between TSH

40,000 to TSH. 60,000. This situation motivated pastoralists to sell animals to obtain funds for hiring tractor water bowsers.

This was further confirmed by one key informant at Makuyuni village said,
"…Summer has arrived, and I'm out looking for a market where I can sell some of my livestock to get money for hiring a tractor water bowser with a carrying capacity of 10,000 litres for

storing water for my livestock. …" (A key informant at Makuyuni village, 30th June 2020).

This finding is supported by Takele and Selassie (2018) who found that tractor hiring was significant and positively related to cash availability from the selling livestock among agro-pastoralist in Ethiopia.

Table 4: Determinants of adoption of water use strategies for livestock

Independent variable	Selling of livestock			
	B	**OR**	**p-value**	**VIF**
Age	-0.0026363	-0.37	0.710	1.12
Sex	4.611886	0.02	0.985	1.01
Household size	0.0058749	0.26	0.792	1.53
Number of livestock owned by HH TLU	0.0004974	0.37	0.711	1.6
Education	0.3956714	2.44	0.015*	1.13
Hiring tractor water bowser	0.9452078	3.05	0.002*	1.32
The use of motorcycle	0.1955734	1.02	0.308	1.11
Donkey ownership	0.2561705	1.21	0.225	1.12
Livestock keeping experience	-0.0006565	-0.78	0.436	1.13
Off-farm income	4.71e-08	0.87	0.383	1.01
Access to extension services	0.8473493	3.13	0.002*	1.03
Cons	-4.345031	-0.02	0.985	

Likelihood Ratio Test $\chi 2=70.29$, $p=0.000$ *=significant at 0.05 level

The findings indicate that access to livestock extension services was significant ($p<0.05$) and positively related to the adoption of the strategy of selling livestock to pay watering charges for livestock at an odds ratio of 3.13 and p-value of 0.002(Table 3). This implies that pastoralists with access to extension services were 3.13 times more likely to sell livestock compared to those with no access to extension services. During the FGDs with pastoralists in Makuyuni, Mbuyuni and Naiti villages, it was informed that pastoralists received extension services on selling livestock to obtain money for buying drinking water for livestock, and this strategy was a destocking technique applied during drought season.

It was further informed that they were guided to sell some livestock either on a weekly or

monthly basis so that they can get enough funds to cover charges for livestock water, especially during the six-month drought season that normally, begins in June and ends in November every year. This finding is contrary to those from key informant's interviews at Kilimatinde village which revealed that some pastoralists have never visited by extension workers on the aspect of using livestock to finance water charges for livestock during water shortage season and destocking to reduce livestock which eventually reduces the number of livestock. One of the

key informants at Kilimatinde village summarized said that;

"*…The village has not received any extension workers to provide guidance on reducing livestock during drought season by selling them to meet the needs for water and pastures. It is possible that this is due to the lack of working water projects in the area. The locals rely on small traditional shallow wells that they have built themselves along the riverbed after the rainwater dries out to obtain water…". (*A key informant at Kilimatinde village, 4th August 2020).

This finding is in line with that of Elhadi *et al.* (2012) with the opinion that extension services influence critical decisions concerning the sale of livestock. They found pastoralists selling their livestock to obtain money for financing water services for livestock during drought seasons in semi-arid areas. Overall, the findings of this study proved that pastoralists benefit from training and extension services since they are able to sell live animals to fund livestock water services. Therefore, this study's finding supports the adoption theory that extension services is the determinant of the adoption of innovation in particular the practice of selling livestock to pay watering charges for livestock.

CONCLUSIONS AND RECOMMENDATIONS

The study concludes the following: To begin, pastoralists' degree of education has a considerable impact on their decision to sell livestock to cover watering expenditures. This highlights the intricate link between livestock management knowledge, awareness, and economics.

Second, the study findings indicate that the cost of adopting mechanized water delivery techniques might be a financial hardship for pastoralists, prompting them to seek other options such as selling their livestock to cover livestock watering charges.

Lastly; access to extension services directly affects pastoralists' decision to sell livestock to pay watering charges. When pastoralists have access to these services, they obtain valuable knowledge and direction, which leads to the adoption of ways that can assist in alleviating the financial burden of watering their livestock.

The study proposes several recommendations. Firstly; it suggests that the Ministry of Education, NGOs, and community leaders should collaborate with local communities and organizations to improve access to education for pastoralist communities. It can be achieved through constructing schools, offering scholarships or financial incentives for education and executing adult education programs. Secondly; the Ministry of Agriculture, Livestock Departments, and Development Organizations should work together to establish subsidies or financial assistance programmes for pastoralists in order to lower the cost of employing

mechanized water delivery technologies. This can include giving grants or low-interest loans to help with the construction of water storage facilities and the maintenance of water infrastructure.

Lastly; the study suggests that the Ministry of Agriculture, NGOs, and Extension Workers collaborate to enhance extension services for pastoral communities. This involves training and deploying additional extension workers to provide guidance on sustainable livestock management, water conservation and cost-effective watering methods.

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