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Original Article

Water Use Strategies for Livestock by Pastoralists: The Case of Semi-Arid Areas in Monduli District, Arusha Region, Tanzania

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ABSTRACT

The paper explores livestock water use strategies that have been employed to cope with the problem of water shortage in Monduli District, Tanzania. The study employed a cross-sectional research design. Quantitative data were collected by using an interview schedule from 367 respondents who were randomly selected from Moita and Makuyuni Wards. Focus group discussions, key informant interviews, and observations were used to supplement the collected data. The Statistical Package for Social Sciences (SPSS) version 20 was used to analyse quantitative data, while qualitative data were analysed by using content analysis. The study findings show that livestock water scarcity and high-water supply charges caused pastoralists to come up with strategies for accessing water for livestock. These strategies include selling live livestock, engagement in off-farm income generation activities, water supply for livestock schedule, Charco dam rainwater harvesting technology, migration, small ruminant birth control and the use of temporary traditional dug well. Most of the strategies used play multiple roles since they not only enhance access to water for livestock but they play other beneficial roles. For example, selling livestock and birth control serve the problem of land degradation caused by overgrazing and also overcome the conflicts between farmers and pastoralists. It is therefore recommended that such strategies should be promoted for the development of livestock and agriculture sector in general. Other strategies used are traditional, for example, the use of traditional temporary wells, which do not allow pastoralists to access water throughout the year. This calls the need for local government and development partners to come up and promote improved and permanent structures like the Charco dam and other strategies that allow water accessibility throughout the year.

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INTRODUCTION

Around the globe, the existing literature has proven the capacity of various livestock especially camel, cattle, sheep, and goats to survive in water shortage-prone semi-arid areas (Amprako *et al.,* 2021; Verma & Khadka, 2016). Statistics show that countries with semi-arid climates experiencing water shortages have been leading in terms of livestock population, whereby Sudan ranks first, followed by Ethiopia, and then Tanzania comes third (URT, 2012). In Tanzania, livestock are concentrated in areas where water is scarce, particularly semi-arid areas (de Glanville *et al*., 2020; Maleko, 2022). However, studies confirm that the livestock water shortage is a problem that has not been resolved over a long period across various semi-arid areas (Hovden *et al.,* 2020; Campos & Studart, 2008). Furthermore, water and livestock policies in Africa ignored livestock water services development despite its contribution to household incomes in rural areas and the national economy in general (Mohamed, 2019). According to URT (2017), the livestock sub-sector contributes about 7.4% of the country's Gross Domestic Product (GDP). In addition, households receive collateral benefits from livestock products such as milk, meat, leather, manure fertilisers, animal traction, and riding as well as the sale of live livestock and milk, which provide households with incomes (Jaoji *et al.,* 2019).

In Tanzania, the livestock sector analyses conducted in 2016/2017 acknowledged the failure of previous governments' initiatives on providing livestock water supply services and suggested the establishment of a new agency to deal with livestock water supply services only (URT, 2017). This was due to the fact that the existing rural water supply agency, namely the Rural Water Supply and Sanitation Agency (RUWASA) had failed to provide livestock water supply services because it has mainly focused on water extraction and supply for domestic use. The livestock water supply shortage in Tanzania is further supported by Mahoo *et al. (*2015) and Richard (2019) who assert that there is a gap that exists between the government's policies, plans, and programs to address semi-arid areas' water shortage problems. It is chaotic in Tanzania as both livestock and pastoralists are suffering tremendously. In some areas, the livestock water supply shortage has resulted in conflicts (Saruni *et al.,* 2018: Kabote & Gudaga, 2018; Facius, 2008), lack of water use permits to access water (Kahimba & Niboye, 2019) and the unpredictable livestock water consumption provision (Muzzo & Provenza, 2018).

Various studies have been conducted in the areas related to livestock water supply services. These include a study on water scarcity resiliency (Ainab, 2018; Ahile *et al.,* 2015; Msambichaka & Onyango, 2019), livestock water productivity (Peden et al.,

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2009; Amole *et al.,* 2021; Ibidhi & Ben Salem, 2018), elements influencing mechanisms of access to resources (Ellis, 2016; Myers & Muhajir, 2015), water resources availability and livestock production (Heinke *et al.,* 2020; Niyonzima *et al*., 2014; Al-Khaza'leh *et al.,* 2020), the role of water in livestock (Wakchaure *et al.,* 2015; Doreau *et al*., 2012; Ahlberg *et al.,* 2019). However, studies that explore livestock water use strategies by pastoralists are limited. Therefore, the objective of this paper is to examine the livestock water use strategies by pastoralists in semi-arid areas taking into account the Monduli District in Arusha Region, Tanzania as a case study. Understanding the strategies used will assist the policy-makers and livestock stakeholders in designing water-use-related projects that will eventually improve the strategies employed by the pastoralists in Monduli and in other similar semi-arid areas.

Water use strategy is defined as an action performed by pastoralists to secure livestock water supply services to facilitate livestock production. These strategies may involve water supply for livestock rate during summer, the type of water sources used, variation in water among the livestock, and water supply-related limitations (Ibidhi *et al.,* 2018). In this study, water use strategies refer to activities carried out by pastoralists to access livestock water.

METHODOLOGY

Monduli District is one of the seven districts in the Arusha Region, which are Arusha Urban, Arusha Rural, Meru, Karatu, Monduli, Longido and Ngorongoro. Monduli District is situated at latitude 3° 20′ South and longitude 36° 15′ East. The district is characterised by climatic variations that include drought and unreliable rainfalls (Kimaro *et al.,* 2018) ranging between 200 mm and 600 mm (Kaswamila, 2009). The Monduli District was selected because it has a low land ecological zone with both arid and semi-arid climates where livestock keeping is the main economic activity (Kimaro *et al.,* 2018). The study was conducted in Makuyuni and Moita Wards which form part of the 20 wards in the district. The two wards were purposively selected because they are located in the low land ecological zone favourable for livestock activities. From the two wards, all seven villages were selected. The villages selected from the Makuyuni ward include Makuyuni, Naiti, and Mbuyuni. On the other hand, four villages selected from the Moita ward were Moita Kipoki, Moita Kiloriti, Moita Bwawani, and Kilimatinde.

The study used a cross-sectional research design, which according to Johnson (2010), allows the collection of data at one point in time. The design was also used because it allows the examination of relationships between variables (Thomas, 2021). Moreover, the design is appropriate because it is quick and can fit a large number of study units at a reasonable cost (Casley and Kumar, 1988). The study population was composed of pastoralists, which according to (Mohamed, 2019) are the people whose more than 50% of household income is derived from livestock keeping. The URT (2012) contends that the pastoralists' population in each selected village is as follows: Makuyuni 1159, Naiti 465, Mbuyuni 556, Moita Kipoki 470, Moita Kiloriti 533, Moita Bwawani 754 and Kilimatinde 453. Basing on the available population in each village, simple random sampling was used to select a total sample of 367 respondents computed by using the Yamane (1967) formula presented in equation (i).

Equation (i)

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

Where n = sample size, N is the population size = 4390, and e is the level of precision (sampling error) =5%.

From a sample of 367 respondents selected for an interview in each village, the respondents were selected proportionally by using Salkind (2010) formula presented in equation (ii). Table (1)

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summarises the number of respondents computed in each village.

Equation (ii)

$$n_b = \frac{N_h}{N} x\, n \qquad \text{(ii)}$$

Whereby n_b is the sample of the village, N_h is the population of the village, N is the total population of all seven villages and n is the total sample size for the study computed from all seven selected villages. Taking the example of Makuyuni village, the computation was as illustrated in equation (iii). The same procedure was used to calculate the sample size for each village.

$$n_b = \frac{1159}{4390} \times 367 = 96.89 \approx 97 \qquad \text{(iii)}$$

Table 1: Sample size determined in each village

Ward	Village	Sample size
Makuyuni	Makuyuni	97
	Mbuyuni	46
	Naiti	39
Moita	Moita Kipoki	39
	Moita Kiloriti	45
	Moita Bwawani	63
	Kilimatinde	38

A mixed research approach was used to collect primary data that enabled the researcher to collect both quantitative and qualitative data. Quantitative data were collected from the selected respondents (367 pastoralist household heads) by using an interview schedule. On the other hand, qualitative data were collected by using Focus Group Discussion (FGD), key informant interviews and field observation. A total of nine (9) Focus Group Discussions (FGD) were held, with four men FGD conducted in the Moita ward and three men FGD conducted in the Makuyuni ward. Basing on the fact that women speak less when they are mixed with men during the FGD (Stewart *et al.,* 2002), one FGD composed of women only was held in each ward, making a total of two female FGDs. Each FGD was composed of 6-10 pastoralists, which according to Mishra (2016) is an appropriate number for an FGD. Also, a total of 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 were interviewed using a checklist.

Secondary data were collected through a review of different documents relating to the study such as the Tanzania Water Policy of 2002, the National Agriculture Policy of 2013, the Tanzania Livestock Master Plan 2017/2018-2021/2022, the National Sample Census of Agriculture 2019/2020, and Tanzania Livestock Sector Analysis 2016/2017-2031/2032, just to mention few (URT, 2002, URT, 2013; URT, 2017; URT, 2021).

Quantitative data were analysed by using the Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics such as frequency counts and percentages were used to explore the number and percentage of water strategies employed by pastoralists. On the other hand, the qualitative data were analysed by using content analysis. The recorded interviews were converted into the form of a text and thereafter coded into themes and sub-themes, which were finally interpreted for discussion.

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RESULTS AND DISCUSSION

This section presents different strategies used by pastoralists to access water for livestock. These include the use of selling livestock to cover the water charges, water supply for livestock schedule, Charco dam rainwater harvesting, migration, small ruminant birth control (*Table 2*) and use of traditional temporary dug well. Each water strategy is separately explained to unveil its application by pastoralists in the study area.

Selling of Live Livestock to Cover the Livestock Water Supply Charges

According to Bahta (2020) and Gezie (2019), selling live livestock is one of the mechanisms of coping with livestock water supply shortages in semi-arid areas. This strategy involves converting livestock, especially cattle, sheep, donkeys, and goats, into funds that can assist the pastoralists in meeting the livestock water supply charges. The selling of livestock is also practised with a view to reducing the size of the herd, thus allowing pastoralists to keep a manageable number of livestock proportionate with the supply of water for livestock and other related costs.

Findings presented in *Table 2* show that selling live livestock was the main strategy practised by the majority of pastoralists (86.1%) in the study area. When comparing the two wards, the majority of pastoralists (95.1%) who practised livestock selling strategy were from the Makuyuni ward. It was reported during the FGD that the pastoralists sold livestock to get money since they had common pool water sources for livestock which required each pastoralist to pay for the water charges. It was further noted during the FGD that each pastoralist paid (TShs 10 – TShs. 50) per sheep or goat and TShs. 50 to 100 per cattle or donkey. This implies that the payment of water charges served as an incentive for pastoralists to find means of acquiring money including selling off their livestock. These findings are in line with what was reported by one of the key informants who is a traditional leader at Moita ward. He said:

> *"…Pastoralists sell cattle, goats, and sheep to pay for water charges. He added that water expenditures can be covered by selling up to two cattle each month for those with large herds size …".*

Table 2: Water use strategies for livestock used by pastoralists

Water use strategies	Moita Ward N=185				Makuyuni Ward N=182				Total N=367			
	Yes		No		Yes		No		Yes		No	
	n	%	n	%	N	%	n	%	n	%	n	%
Selling of livestock to pay for water charges	143	77.3	42	22.7	173	95.1	9	4.9	316	86.1	51	13.9
Water supply for livestock schedule												
Water supply for livestock one day and skipping the next day (Cattle, sheep, and goat)	140	75.7	45	24.3	137	75.3	45	24.7	277	75.5	90	24.5
Water supply two days per week (goat and sheep)	37	20	148	80	29	15.9	153	84.1	66	18	301	82.0
Charco dam rainwater harvesting	11	5.9	174	94.1	75	41.2	107	88.8	86	23.4	281	76.6
Migration	154	83.2	31	16.8	28	15.4	154	84.6	66	17.9	301	82.1
Small ruminant birth control	17	9.2	168	90.8	4	2.2	178	97.8	21	5.7	346	94.3

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Furthermore, the findings in *Table 2* show that 13.9% of the interviewed respondents did not sell live livestock to get water for livestock. It was informed during the FGD that they did not sell off their livestock because they owned less livestock than they needed. This finding is in line with Vetter and Bond (2012) who found out that the communal areas with few cattle opt not to sell their cattle because they have fewer cattle than they need and therefore they decided to engage themselves in other non-livestock activities to get money to cover water charges for livestock.

For those who did not sell their livestock, they indicated that they used other strategies that enabled them to get money like engagement in non-livestock activities such as selling crops, access to credit through Village Community Bank (VICOBA), employed workers (security guards), selling of livestock products, petty trade, retail shop, motorcycle transport business known as "*boda boda"*, remittance and selling of traditional herbs (*Table 3*). It was further reported during FGD in Mbuyuni village that Village Community Bank (VICOBA) was very beneficial in covering water charges for watering livestock during drought season. Additionally, it was claimed that males were able to acquire loans through their spouses who had access to loans from VICOBA with the agreement of repaying back during the wet season when rangeland is bountiful with pasture, there is enough water and a good livestock price.

This finding is supported by Joseph and Kaswamila (2017) who revealed that pastoralists in Longido District were engaged in non-livestock-keeping activities to obtain money for supporting water supply services for livestock and domestic use. Such activities include motorcycle transport business and engagement in petty trade activities.

Table 3: Other sources of money to cater for livestock water

Sources of money	Frequency = 51	Percentage
Selling of Crops	10	19.6
Access to credit through VICOBA	7	13.7
Employed workers (security guards)	6	11.8
Selling livestock products	6	11.8
Petty trade	5	9.8
Retail shop	4	7.8
Motorcycle transport business (boda boda)	4	7.8
Remittance	4	7.8
Selling traditional herbs	3	5.9

Water Supply for Livestock Schedules

In the study areas, pastoralists used two different livestock water supply schedules to access the water. This includes water supply for livestock one day and skip the next day, the strategy used to supply water for cattle, sheep, and goats. The other strategy is water supply for two days per week applied to goats and sheep. The results presented in *Table 2* show that most pastoralists (75.5%) used the strategy of supplying water for livestock (cattle, goats, and sheep) one day and skipped the following day. Other pastoralists (18%) used the strategy of supplying water for the livestock (goat and sheep only) two days per week. The difference in supplying water for the livestock intervals is that goats and sheep can survive prolonged periods of water shortage and they are able to trek far from water point sites as compared to cattle (Mataveia *et al.*, 2021). It was further noted during the interview with key informants that pastoralists used skipping watering arrangements to cope with the water

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scarcity and water charges and to arrange schedules for grazing livestock. A water committee member from Naiti village in Makuyuni Ward had this to say;

> *"…During drought seasons, the pastoralists supply water to their livestock one day and postpone the next day. He added that they did so to get an opportunity for grazing livestock, as pastures were located very far from water source…."*

The skipping schedule was noted with concern taking into consideration that livestock are supposed to be watered daily since water supply for livestock improves their survival and production. According to King (1979), cattle require 56.1 litres per day, goats require 5.4 litres per day and sheep require 5.2 litres per day. Wakchaure *et al.* (2015) add that daily watering of livestock is crucial since water forms about 50 to 70 % of an animal's live weight. In order to meet water demand the study conducted in Tunisia by Ibidhi and Ben Salem (2018) revealed that supplying water for the goats and sheep was applied three times a day during drought seasons due to the excessive temperatures.

Charco Dam Rainwater Harvesting Technology (CRWHT)

Charco dam rainwater harvesting is an important innovative strategy to ensure water supply for livestock in semi-arid areas. Charco dams refer to dams constructed to reduce water loss through evaporation by making deeper the water reservoirs and reducing their surface area (URT, 2020). Likewise, rainwater harvesting refers to the collection and storing of the naturally soft and pure rainfall that falls upon the roof and or land surfaces (URT, 2020). Therefore, Charco dam rainwater harvesting technology refers to a small earth dam that is used to harvest rainwater (Nissen-Petersen, 2006). It was reported during the focus group discussions in Makuyuni and Moita wards that in the study area, Charco dams were constructed by using local people's efforts combined with external support from World Vision Tanzania and local people's efforts alone.

The study findings indicated in Table 2 reveal that 41.2% of the pastoralists in Makuyuni ward used Charco dam rainwater harvesting technology as compared to Moita Ward, where only 5.9% of pastoralists used Charco dam. The smallest percentage of Charco dam adopters in the Moita ward is due to the fact that in the Moita ward, the pastoralists built Charco dams on their own without any support, while in the Makuyuni ward, they built with the support of the non-Government organisations, namely World Vision Tanzania (FGD in Moita Kiloriti village in Moita ward). The study findings are in line with Tumbo *et al.* (2010) and Manning et *al*. (2020) who revealed that pastoralists in the Same and Simanjiro Districts, Tanzania used Charco dams to access water supply for the livestock.

Migration of Livestock

Migration of livestock during drought seasons is another important strategy to ensure access to water supply for the livestock. In this study, migration of livestock refers to the movement of pastoralists with herds from one area to another in search of water supply for livestock. The findings indicated in Table 2 show that the majority (83.2%) of the respondents in the Moita ward used this strategy as compared to a few respondents (15.4%) in the Makuyuni ward. It was further reported during the Focus group discussions in Moita Kiloriti and Moita Bwawani villages in the Moita ward that pastoralists used this strategy to secure water supply for livestock, and it was a mechanism to avoid the negative ramifications of acute water scarcity such as high charges for supply of water for livestock, wastage of time due to long queuing and trekking long distance during day and night in searching for water. The findings are in line with what was reported during the key informant interviews with a traditional leader in Moita Kipoki village who was quoted saying:

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> *"... The cost of watering livestock is high due to water scarcity. As a result, some pastoralists, particularly those with large herds, migrate with their livestock to both Kiteto and Simanjiro Districts every year during the dry season."*

These findings are in line with Schrepfer and Caterina (2014) who contend that in Kenya, pastoralists migrate during drought season in search of water supply for their livestock. This implies that water scarcity and unaffordability for water charges for livestock serve as a root cause for pastoralists to migrate to other areas in search of affordable and accessible water supply for their livestock. However, migration cause problems for livestock, as contended by Pallas (1986) that walking distance of beyond 6-10 km/day for cattle, 3-5 km/day for goats, and 1-3 km for sheep affect their survival and production.

Small Ruminant Birth Control

Birth control is a mechanism that enables pastoralists to plan properly when livestock reproduction should take place, especially when their areas have inadequate water and pastures. Controlling livestock reproduction means fewer livestock are reproducing, resulting in less water demand and consumption as well as low water charges. It was informed during the focus group discussions at Moita Kipoki village in Moita Ward that birth control in the study area involved the control of reproduction to goats and sheep only. It was further reported during FGD in Moita Bwawani village that the approaches applied were separating male and female livestock to hinder mating during grazing and in the paddock. Another approach used was dressing male goats or sheep in a traditional pocket made of animal hide or plastic material to cover the loin of a male goat or sheep. In supporting the strategy of small ruminant birth control, a traditional leader at Moita Bwawani village said:

> *"... In the dry season, a female goat or sheep giving birth is a challenge as they are unable to walk long distances to drink water. As a result, we do not allow male goats or sheep to mate a female goat or sheep...."*

The findings are in line with Joseph and Kaswamila (2017) who contend that livestock reproduction control, particularly for goats, is employed to deal with water scarcity.

Use of Temporary Traditional Dug Well

Temporary traditional dug wells refer to simple hand-dug holes constructed along the river bed that allows people to fetch water for livestock and human consumption (Mwangi & Rutten, 2012). It was informed during the focus group discussions at Kilimatinde village in Moita ward that the traditional dug well famous known as "*Njoro*", is an important mechanism of ensuring the supply of water for domestic use and livestock. It was revealed that the community used the model of combining resources between four to five households to construct temporary traditional dug wells. It was further explained that in Kilimatinde, all pastoralists employed this strategy because the traditional temporary dug well was the only available water source for livestock and domestic use. This finding is similar to that of Mung'ong'o *et al.* (2019) who in their study in Kilindi and Kiteto Districts in Tanzania revealed that pastoralists used traditional dug wells strategy to access water for livestock.

CONCLUSION AND RECOMMENDATIONS

Water scarcity and high-water charges are among the main problems that affect pastoralists in Monduli District. To overcome these problems, pastoralists in the study area used various strategies like selling livestock and engaging in other income-generation activities to obtain funds for paying water charges. Other strategies used include water supply for livestock schedule, Charco dam rainwater harvesting, migration, and small ruminant birth control. Some strategies used to access water for livestock like dug wells are temporary and traditional which might not provide a

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permanent/sustainable solution to livestock water shortage in the study area. Some strategies like migration and skipping water supply schedules affect livestock survival and production. This calls the need for the government and other development partners to promote or come up with permanent solutions, including the construction of improved structures like Charco dam rainwater harvesting technologies that will ensure adequate and permanent water supply for livestock in order to enhance their productivity.

Other strategies like selling live livestock and birth control to small ruminants to obtain funds for accessing water for livestock do not only solve the problem of water shortage. These strategies also solve the problem of a large number of livestock kept by pastoralists that cause the problem of overgrazing, land degradation, deforestation as well as conflicts between pastoralists and farmers. This implies that such strategies should be promoted since they have multiple benefits. It is therefore recommended that livestock marketing including livestock selling centres should be improved to encourage pastoralists to sell their livestock and remain with a manageable size of herd.

It was also noted that some pastoralists engaged in off-farm income generation activities. These activities should also be encouraged since they serve as one way of diversifying their activities. Diversification of activities including engagement in petty trades might serve as one way of minimising migration by pastoralists and reducing the conflicts between farmers and pastoralists. Lastly, small ruminant birth control is not only a solution to water scarcity but also a mechanism that allows pastoralists to create a calendar that guides reproduction when the water supply for livestock is plentiful.

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