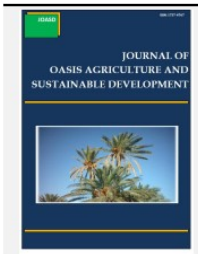

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Influence of water access for livestock on pastoralists household income in semi-arid areas of Monduli district in Tanzania

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Abstract

Access to water is arguably the most crucial, yet underappreciated determinant of household income for pastoralist households in semiarid regions. This study examined the influence of water access for livestock on pastoralists' household income in the semi-arid areas of Monduli District in Tanzania. The study employed a cross-sectional research design, in which primary data were collected using a semi-structured questionnaire from 367 randomly selected households. Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) version 20, whereby both descriptive statistics (frequencies and percentages) were determined. A multinomial logistic regression model was applied to examine the influence of water access to livestock on the household income of pastoralists. The findings indicate that household size (p=0.001) and levels of water access for livestock, namely medium (p=0.000) and high (p=0.006), influenced pastoralists' household income, while maintaining a low level of water access for livestock as the reference category. The study concluded that the higher the level of water access for livestock, the higher is the household income. This study recommends that the Government of Tanzania and the Monduli District Council establish programs to boost pastoralist income by improving communal access to livestock water sources.

1. INTRODUCTION

Pastoralism has long been a dominant livelihood in dryland regions, with herders relying on livestock mobility for grazing and access (Bostedt*et al*., 2023; Tamou, 2017; De Haan, 2016). In Africa, approximately one-third of the population, or 350 million people, rely on livestock farming for their food security and means of subsistence, accounting for between 30% and 80% of the agricultural Gross Domestic Product (AU-IBAR, 2016; Erdaw, 2023; Panel, 2020). Sub-Saharan Africa has around 200 million livestock owners, most of whom utilize rangelands (Mapfumo*et al*., 2021). Africa's semiarid and arid regions have a long history of livestock husbandry (Ngongo *et al*., 2022; Franke and Kotzé, 2022) which is intricately linked to the cultural, economic, and environmental dynamics of the continent (Abdou, 2019). For generations, livestock have been an essential component of African communities, serving vital functions in social interactions, trade, and subsistence. Furthermore, people living in rural areas, especially pastoralists, depend on livestock for their income (Catley and Ayele, 2021; Akouegnonhou and Demirbaş, 2021), physical assets such as land livestock among others (Tora et *al*., 2022).

North African countries, such as Morocco, Algeria, Libya, and Egypt, have significant pastoral populations (Rjili *et al*., 2023). Furthermore, livestock keeping in Northern Africa supports the rural population and has become a business among those endowed with water that supports the production of fodder (Brandolini *et al*., 2021). In addition, Ilu et al. (2016) stated that in West Africa, almost 50% of population keeps

livestock. For example, in West African nations like Burkina Faso, Niger, Senegal, and Mali, cattle production accounts for approximately 37% to 82% of the agricultural GDP (Molina-Flores et *al*., 2020). Approximately 20 million people are estimated to be the largest pastoral population in East Africa (Githae and Mutiga, 2021). Pastoral land is a major source of livestock production and exports for nations such as Kenya, Ethiopia, Somalia, and Sudan (Mtimet *et al*., 2020). Pastoralism directly contributes 15-50% of GDP in countries like Kenya and Ethiopia (Nyariki and Amwata, 2019). Despite the economic significance of livestock in Africa, water access for livestock has remained a challenge for many decades because of the scarcity of water resources, climate change, drought, changes in land use, and increases in the human population (Eeswaran *et al*., 2022; Musse, 2021). In addition, Achiba (2018) asserted that pastoralists' access to water is a key factor that supports people's livelihoods, especially increasing livestock productivity, employment, and diversification of their income sources.

In Tanzania, the shortage of water for livestock is a result of policies that were in place during the colonial era and after independence (Ntumva, 2022; Massoi, 2015). Examples of various legislation that affected water access for livestock in Tanzania include land ordinance 1923 by then Tanganyika took pastoralist land and established wild life reserves, modernization of livestock production systems through ranch and sedentary livestock keeping (Allegretti *et al*., 2016); villagelization program 1973-1983 (McCabe *et* al., 2020) and eviction of pastoralists from their areas endowed with water sources (Weldemichel, 2020). As a result, the implementation of such development policies in Tanzania opened opportunities for human development in other sectors, while at the same time jeopardizing water access for livestock in semi-arid areas.

In Tanzania despite the growing body of literature on this topic of water access for livestock and livelihood (Mfinanga *et al*., 2023; Malley *et al*., 2008; Ndesanjo and Asokan, 2023; Mwakalonge and Chingonikaya, 2023) yet the linkage between water access for livestock and pastoral household income has rarely been empirically examined, especially in Tanzania's semi-arid rangelands. Overall, this study examined the influence of water access for livestock on pastoralists' household income in semi-arid areas of the Monduli district in Tanzania, East Africa. The results of this study may be helpful in assisting policymakers, pastoralists, and non-governmental organizations such as World Vision Tanzania, PINGO Forum, Pastoral Women Council, Tanzania Natural Resource Forum, and others in recognizing the importance of water access in determining pastoralists' ability to support their households and in designing appropriate interventions to guarantee livestock water security. In addition, quantifying the economic value of water access can help prioritize interventions to enhance pastoral welfare in water-constrained semi-arid areas.

The research question that guided this study was as follows:

RQ1. What is the influence of water access for livestock on the household income of pastoralists in semi-arid areas?

H1. There was no statistically significant influence of water access for livestock on pastoralist household income in semi-arid areas.

2. MATERIAL AND METHODS

2.1. Theoretical Framework

This study was guided by DFID's Sustainable Livelihood Framework (SLF). The DFID (2011) framework (Fig. 1) views individuals as possessing some form of capital that can be utilized to achieve positive livelihood outcomes, particularly household income, increased well-being, reduced vulnerability, improved food security, and more sustainable use of natural resources. This study focused on pastoralists' household income as an important livelihood outcome. Livelihood assets are human, natural, physical, social, and financial. This study

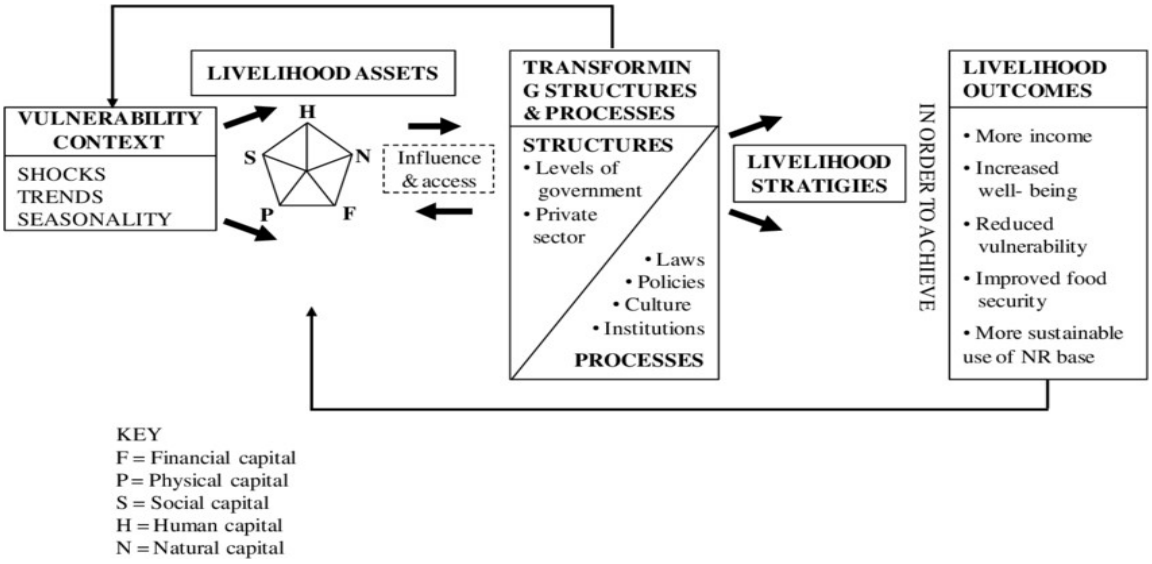

Fig. 1. Sustainable Livelihoods Framework by DFID (2000).

employed only three capitals, namely natural, human, and physical, because according to Lyatuu and Urassa (2015), SLF does not rank assets in terms of importance, but rather considers two important relationships between assets: first, the degree to which the acquisition of one asset facilitates the acquisition of another, and second, the degree to which particular assets can be substituted for another. This study assumed that the gain of human capital among pastoralists facilitated water access for livestock, which eventually caused pastoralists to engage in livestock keeping only, or combined livestock keeping and other non-livestock keeping activities to earn household income. The framework allows the assumption that pastoralist households with sufficient water supply would have better livestock production and, therefore, the possibility of increasing household income through participation in off-farm income and livestock keeping activities. Therefore, SLF was employed in this study because it is a framework that shows the variety of activities that pastoralist households often carry out in combination to make a living (Chambers, 1995). Additionally, Mwakalila (2011) asserts that water availability and livelihood assets are linked, which ultimately influences an individual's or household's production, specifically livestock keeping and off-farm activities, leading to the generation of household income. In addition, water access for livestock in this study was referred to as natural capital combined with human capital to influence livestock and non-livestock keeping activities, which finally determined pastoralists' household income.

2.2. Conceptual Framework

The conceptual framework of this study (Fig. 2) was used by modifying some elements of the DFID (2000) Sustainable Livelihood Framework Approach. This conceptual framework links the independent variables of water access to livestock, human capital factors, and the dependent variable of pastoralist household income. The following assumptions explain this relationship: Independent Variables include water access for livestock with five variables: affordability of water services by pastoralist households, multiple uses of water sources for livestock, livestock walking distance to the water point, time taken by livestock to reach the water point, drinking water, and type of water source. In addition, human capital, such as the age of the household head, marital status, formal education, and household size, are independent variables.

The cost of accessing water sources affects the extent to which pastoralists can access their herds. More affordable water sources for livestock allow larger herds to obtain water supply, which can contribute to higher

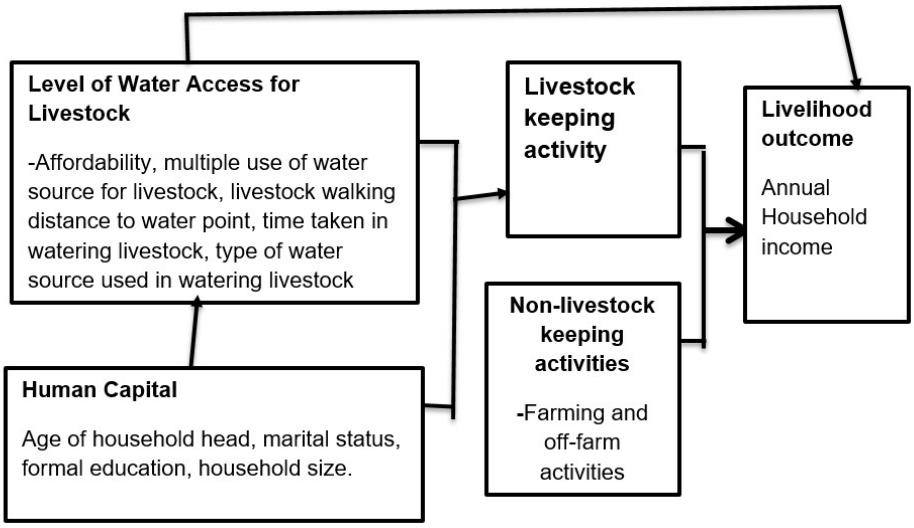

Fig. 2. Conceptual framework adapted from DFID (2000).

incomes. Similarly, water sources that can be used for both livestock and domestic/agricultural purposes (multiple uses of water sources) allow households to maximize productivity and income generation opportunities. Furthermore, shorter distances require less time and energy to walk from livestock sheds to water points, which allows for larger herds and more time to engage in other income-generating activities. Moreover, longer time spent seeking water for livestock each day reduces the time available for other tasks and income opportunities. Additionally, reliable permanent water sources, such as boreholes and seasonal rivers and dams, influence the size of herds that can be supported for income generation. Mwakalila (2011) suggests that the availability of water and household capital are connected to output, which includes activities related to both livestock and non-livestock keeping, as well as household income. As raising livestock is a major source of income for rural households, pastoralists' household income was the dependent variable in this study (FAO 2021). This leads to an increase in overall household income, in which a combination of livestock keeping and non-livestock is maintaining activities.

2.3. METHODOLOGY

2.3.1. The study area

The study was carried out in Monduli District, Arusha Region, which is among the areas leading to livestock production in Tanzania (URT, 2014). Approximately 20% of the GDP of the Arusha region is contributed by the livestock sector (URT, 2014). Makuyuni and Moita wards were purposively selected based on the criteria of livestock keeping being a prominent economic activity. In Makuyuni Ward, the villages of Mbuyuni, Naiti, and Makuyuni were selected, while the villages of Moita Bwawani, Moita Kilorit, Moita Kipok, and Kilimatinde were selected.

2.3.2. Research design, population and sampling procedures

This study employed a cross-sectional design, as defined by Wang and Cheng (2020), which involved collecting data on all variables at a single point in time. The population of this study was pastoralist households. A simple random sampling method was used to select the respondents. The sample for this study consisted of 367 pastoralist household heads and was determined using the formula presented by Yamane (1967) in equation (i).

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

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

sample size from each village was calculated based on the proportional sampling method of Salkind (2010), as presented in equation (ii).

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

Where n_b the sample size of the village, N_h= Total number of households in the village, N is the total household population, and n is the total sample size. Given a total population of N=4390, the computed sample size of each village is shown in Table 1.

Table 1. Sample size composition of each village in study area

Ward	Village	Number of	Sample
Moita	MoitaKipok	470	39
	MoitaKilorit	533	45
	MoitaBwawani	754	63
	Kilimatinde	453	38
Makuyuni	Naiti	465	39
	Mbuyuni	556	46
	Makuyuni	1159	97

2.3.3. Data collection

Quantitative data were collected using a semi-structured questionnaire for all household heads over the age of 18 years who participated in the field survey because they were more likely to have an impact on water access for livestock and key household income-generating activities, especially livestock keeping and off-farm activities. The information collected included socio-demographic characteristics of respondents and the levels of water supply for livestock by household and annual household income. Secondary data were acquired by conducting a thorough review of pertinent documents related to the study, such as the National Agriculture Policy of 2013, the Tanzania Livestock Master Plan 2017/2018–2021/2022, the National Water Policy 2002, and the Livestock Sector Development Strategy 2010.

2.3.4. Data analysis

The Statistical Package for Social Sciences version 20 assisted in the data analysis of inferential statistics, specifically the multinomial logistic regression model. Furthermore, the water supply for livestock was calculated using five indicators: multiple water use, affordability, livestock proximity to water sources, time spent on livestock water supply, and category of water sources for livestock. Water access for livestock dimensions and indicators is presented in Table 2.

2.4. Justification of the selected indicators of Water Access for Livestock Index Score is presented as follows

2.4.1. Multiple water uses

Indicators that consider multiple uses of water sources. It serves as a foundation for communities to monitor and manage water resources for various investments (Van Koppen *et al*., 2006). This dimension was selected because it has been tested in rural Sub-Saharan Africa to understand the benefits and costs of the application of single versus multiple uses of water in rural areas (Renwick *et al.,* 2006).

Table 2. Indicators for measurement of water access for livestock in semi-arid areas

Dimension	Indicator	How it was measured	Source
Water access for livestock	Affordability	≤ % of household income used in water charges.	Kayser (2013)
	Multiple water use	Utilizing water sources for livestock and various other purposes	Van Koppen (2006)
	Walking distance to water source	Distance covered by livestock to reach the water source	Pallas (1986)
	Time spent watering livestock	Time taken to provide water to livestock (from the homestead until they drink).	Thompson *et al*., (2003)
	Type of water source	Improved water source	WHO and UNICEF (2011)

Source: Adapted from Mfinanga et al. (2023)

2.4.2. Type of water sources

Improved and unimproved water sources were used as indicators to measure water service quality (WHO-UNICEF, 2010). Improved water refers to public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, or rainwater collection, and unimproved water refers to unprotected dug wells, unprotected springs, carts with small tanks, drums, surface water including rivers, dams, lakes, ponds, streams, canals, irrigation channels, and bottled water. This study focused on two types of water sources, namely improved and improved water sources used by pastoralist households to supply water for livestock, because they are among the indicators used to measure water access by households (WHO-UNICEF, 2010).

2.4.3. Distance to water source walked by livestock

Pallas (1986) contends that the standard to be walked by livestock to water sources that are less harmful is 6–10 km for cattle and 3-5 km for goats. Distance walked by livestock to a water source indicator was used because Hadush (2018) found that pastoralists' household income was negatively influenced by the distance their livestock walked to find water.

2.4.4. Time taken in watering livestock

Previous studies have documented time as an important indicator for measuring the level of water access by households (Masanyiwa, 2014; Thompson *et al*., 2003). In addition, Thompson et al. (2003) revealed that people in rural areas in East Africa spent three hours consuming improved water sources and five hours using unimproved water sources. Therefore, this indicator was selected because the time spent to reach the water point and collect water had ramifications on water availability in semi-arid rural areas, where water is scarce.

2.4.5. Affordability

This dimension was measured through a single indicator: the proportion of household income used to pay water supply charges. Affordability helps to determine the level of water services accessed by households. A household can afford water services if expenditure on water services does not exceed 3%-5% of household income (Wang *et al*., 2010).

Water access for livestock indicators was subjected to the summation formula by Vinti (2020) to compute the Water Access for Livestock Index Score (WALIS) in equation (iii).

$$WALIS = \sum_{i=1}^{n} xi \quad \text{(iii)}$$

Where:
WALIS=Water Access for Livestock Index Score
i=Indicator for water access (1=multiple uses of water, 2=type of water source, 3=distance walked by livestock to water source, 4= time spent to provide water for livestock, 5= affordability)
n=Total number of indicators i.e. 5
Xi=Score of the respondent on i^{th} indicator

The computation of water supply for the livestock index was based on a composite score of five indicators for each respondent, with a maximum score of 8 and a minimum score of 0 (Table 3). Respondents were then

Table 3. Interpretation of WALI scores

WALI score	Level of water access	Interpretation
Water access for livestock	Low	The household is incapable to fulfill water needs for livestock.
	Medium	On average the household is accessing water for livestock.
	High	The household is doing well in accessing water for livestock.

divided into three categories: low water access (0 to ≤3), medium water access (3 to <5), and high water access (scores ≥ 5).

The Statistical Package for Social Sciences (SPSS) computer application was used to analyse the quantitative data and examine the influence of water access for livestock on household income using a multinomial logistic regression model (Equation i). Before executing the regression model, a diagnostic test was conducted to assess the presence of multicollinearity among the independent (Xi) variables.

$$Y = \beta_0+\beta_1X_1+ \beta_2X_2+\ldots+\beta_nX_n+ \varepsilon, \text{ (iv)}$$

Where:

Y= Household income (Tshs)-dependent variable

B_1……βn = are regression coefficients.

β_0= Intercept.

X_1 …X_n are independent variables.

to water on the income of pastoralist households in the other ecological zones of Tanzania.

3. RESULTS & DISCUSSION

3.1. Multinomial logistic regression model results

These results confirm that the multicollinearity assumption in this study was upheld, which adds strength and validity to the findings. The Variance Inflation Factor (VIF) for all variables in the model meets the VIF stipulated by Pallant (2011). Hence, the independent variables had no multicollinearity problems. In addition, the Durbin-Watson test was used to test for autocorrelation. The regression analysis indicated that the independent variables in the model only accounted for 15.3% of the variations in household income, as denoted by the coefficient of multiple determinations (R^2) value of 0.153. This result was statistically significant at a probability level of P <0.05, as shown in Table 5. Furthermore, the results showed that the Durbin-Watson statistic is 1.767, which falls within the values of 1.5 < d < 2.5 (implying that there is no autocorrelation) (Kutner *et al.,* 2005). Hence, no autocorrelation was observed in the multiple linear regression data.

Multiple R=0.409, R Square=0.153, Durbin-Watson=1.767; the reference category is low water access for livestock.

Table 4. Description of variables applied in model

Variable	Description	Values
Dependent variables Household income	Income of the head of household	Tanzania shillings
Independent variables		
Age	Age of head of household	Years
Marital status	Marital status of head of household	0 Single , 1=Married
Education	Education level of head of household	1=Formal education, 0 Non-formal education
Household size	The size of household	Individuals
High water access for livestock	High level of water access for livestock by pastoralists household	Scores
Medium level of water access for livestock	High level of water access for livestock by pastoralists household	Scores
Low level of water access for livestock	High level of water access for livestock by pastoralists household	Scores

2.4.6. Methodology limitations

The study area was purposively selected, and data were gathered in one district in the semi-arid areas of Northern Tanzania. Of the seven agro-ecological zones found in Tanzania, including the coast, arid, semi-arid, plateau, southern and western highlands, and alluvial zones, this study was restricted to only one part of the semi-arid ecological zone (Mkonda *et al.,* 2018). Thus, it was not possible to extrapolate the results of this study to the impact of livestock access

Table 5. Influence of water access for livestock on household income.

			Standardized Coefficients	Beta	Sig p-value	Collinearity Statistics	
Variable	**β**	**Std. Error**	**Beta**			**Tolerance**	**VIF**
(Constant)	-3,192,000	8,488,000		-0.376	0.707		
Age	51,399	39,967	0.078	1.286	0.199	0.642	1.558
Marital status	1,773,000	8,138,000	0.011	0.218	0.828	0.978	1.023
Education	345,896	680,168	0.026	0.509	0.611	0.870	1.150
Household size	248,292	75,807	0.188	3.275	0.001*	0.706	1.416
Medium water access	3,245,000	1,172,000	0.167	2.768	0.006*	0.641	1.561
High water access	6,480,000	1,054,000	0.370	6.146	0.000*	0.645	1.549

From the regression analysis, the coefficient of multiple determinations (R2) was 0.153 (Table 5). This implies that 15.3% of the variations in the household income were explained by the independent variables in the model, which was significant at $p<0.05$ level of probability.

3.2. Age of the respondents

The results indicate that the beta coefficient (β) for age of respondents is Tanzanian shilling (TSh) 51,399 (Table 5) and a p value of 0.199, which is larger than the significance level of 5% ($p<0.05$). This implies that as age increased by one unit (year), household income increased by 51,399 TSh, but this increase was not statistically significant ($p=0.199$). This indicates that age is not a determinant of pastoralist household income. The analysis shows that neither the elderly head of the household nor the youth head of the household contributed significantly to household income. When this condition is associated with Sustainable Livelihood Framework by DFID (2000), it is evident that livestock keeping experience (presented in terms of age) has a positive impact on household income, although not significant since (p) value ($p=0.199$) was greater than the significance level of 5% (0.05). These findings imply that human capital is an important supplier of household income, although not significant. The findings of this study contradict those of previous studies by Omollo, (2018) and Getahun et al. (2022) who found that the age of the pastoralist head of the household has a positive and significant influence on household income. In Maasai society, household members play specific roles that contribute to household income. The elders in the households hold leadership and managerial positions, while the younger generation performs physically demanding tasks, such as herding livestock and ensuring they have access to water.

3.3. Marital status

The beta coefficient (β) for marital status is TSh. 1,773,000 and p value of 0.828 and had positively associated with household income at significance level of 5% ($p<0.05$)(Table 5). The analysis indicated that computed p value was greater than significance level of 5%; hence not statistically significant. This finding implies that the marital status of the household head is not statistically significant, although it is positively related to household income. This suggests that being single or married does not significantly impact pastoralists' household income. Therefore, whether a person is single or married does not affect household income and, therefore, does not significantly affect the purchasing power of households that enable households to finance water access for livestock in the study area. It is worth noting that pastoralists share their household income within an extended family network, which fosters a sense of unity and

cooperation among family members, regardless of their marital status. This finding provides valuable insights into the dynamics of pastoralist households and highlights the importance of family networks in accessing water for livestock. Interestingly, this finding contradicts that of Wanjiku (2017), who found that marital status had a significant influence on pastoralists' household incomes. When this is related to the Sustainable Livelihood Framework, it shows that human capital in terms of marital status (for example, being single and married) has a positive association with aggregate pastoralist household income, but is not significant.

3.4. Education level

The beta coefficient (β) for education of respondents was TSh 345,896 with p value of 0.611 and had positive association with household income but not significant at significance level of 5% ($p<0.05$) (Table 5). This indicates that, as the level of education increased by one unit, household income increased by TSh 345,896; however, this increase was not significant. The analysis indicated that increasing the level of education of the respondent did not add value significantly to pastoralist household income. On the other hand, these findings suggest that both educated heads of households and heads of households with informal education they did not significantly contributed to household income. These results differ from those reported by Kuria (2019) in the Samburu pastoral community in Kenya, who found that the level of education of the household head significantly influences household income levels.

3.5. Household size

In addition, the study results in Table 5 show that beta coefficient (β) for household size was TSh 248,292 with a (p) value of 0.001 and was positively significantly related to household income at significance level of 5% ($p<0.05$). This implies that, as household size increases by one unit (one member), household income increases by TSh 248,292. The analysis indicated that the number of people in households positively and significantly contributed to the household income of pastoralists. Livestock keeping is the backbone of pastoralism in dryland areas and requires a significant amount of labour. Households with more family members can have greater support in herding livestock too far off grazing lands and water sources, which can help increase herd size and household income (Jenet *et al*., 2016). These findings support the Sustainable Livelihood Framework, which affirms that human capital, once combined with other capital, such as water access for livestock, positively contributes to pastoralist household income.

3.6. Medium water access for livestock

The beta coefficient (β) for medium water access was TSh 3,245,000 with a (p) value of 0.006 and was positively significantly related to household income at significance level of 5 % ($p<0.05$). (Table 5). This analysis shows that the computed p value ($p=0.006$) was less than the significance level ($p<0.05$); hence, there was a positive association between medium water access for livestock and the generated household income of pastoralists in the study areas. In addition, since it was coded 1 for medium access of water for livestock and (o) for low, this implies that respondents with medium access to water for livestock had TSh 3,245,000 household incomes than those with low water access. The examination indicated that households with medium water access to livestock had a higher potential to engage in income-generating activities to increase household income. Similar findings by Balfour et al. (2020) in Kenya revealed that households with lower water insecurity had high financial capital. However, this study differs from previous studies in that it takes into account the aggregate household income, which was computed from selling livestock, crops, and farm products and selling livestock and farm products. Household income was computed from the cost of farming, livestock keeping, and income from off-farm activities.

3.7. High water access for livestock

In addition, the beta coefficient (β) for high water access was TSh 6,480,000 with a p-value of 0.000 and was significantly positively related to household income ($p<0.05$) (Table 5). This means that pastoralist households with high water access for livestock have a higher household income. In addition, this analysis indicates that high water access to livestock by pastoralist households contributes significantly to household income. In addition, since it was coded 1 for high and 0 for low, this suggests that pastoralists with high water access for livestock had TSh 6,480,000 household incomes compared to those with low levels of water access. This finding is supported by Cavatassi and Mallia (2018), who revealed that insufficient water access for livestock is the main factor limiting household income generated from the production of livestock farming in developing countries. This study findings supports the Sustainable Livelihood Framework where the availability of natural capital hereafter in this study water supply for livestock facilitated the diversification of livelihood activities to earn household income.

4. CONCLUSIONS

The study concluded that households with higher levels of water access for livestock experienced a significant increase in income compared to those with lower levels of water access for livestock. This finding suggests that improving water access for livestock is a viable strategy for pastoralists seeking to increase livestock production and enhance their household income. This study shows that improved access to water and higher livestock income can help pastoralists diversify their sources of income. This can be achieved through investments in water infrastructure, such as wells, boreholes, and water storage facilities, which should be prioritized in Tanzanian pastoralist communities. This could entail working together with NGOs, government agencies, and other stakeholders to increase access to water in the region. Additionally, the study concludes that household income among pastoralists is not dependent on typical socioeconomic characteristics, such as age, marital status, and education level.

The study recommends the following. First, the Government of Tanzania, in collaboration with the Monduli District Council, especially the agricultural livestock and fisheries division, should establish programs targeting pastoralists' income, especially on improving collective access to productive resources such as rangelands and water points, rather than focusing solely on individual characteristics. It can be implemented through the rehabilitation and construction of water sources, such as communal boreholes, shallow wells, earth pans, and charco dams in core grazing areas, in consultation with pastoralist communities. This will collectively enhance water access for livestock.

In addition, education programs should focus on building pastoralism skills through community-based approaches rather than segregating them based on individual levels of schooling. Finally, further research is required to better understand the economic role of different members of pastoralist communities in accessing water for livestock, beyond just the household head.

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