

WILLINGNESS TO PAY FOR SUSTAINABLE GRAZING MANAGEMENT PRACTICES UNDER PASTORAL REGIME IN TANA RIVER COUNTY, KENYA

A. I. Lutta[#], M.M. Nyangito and O.V. Wasonga

¹ University of Nairobi, Department of Land Resource Management and Agricultural Technology, P. O. Box 29053 00625, Kangemi, Nairobi, Kenya

ABSTRACT

Rangeland ecosystems are dynamic and complex socio-ecological systems that support extensive livestock production in Africa. However, productivity of arid and semi-arid rangelands currently exhibits a downward spiral trend, which is partly attributed to poor resource governance and in particular management of pasture and water in these areas. Attempts aimed at enhancing resilience of rangeland ecosystems and pastoral production systems should therefore give priority to promoting sustainable rangeland management practices. This study determined socio-economic factors influencing the willingness to pay for sustainable grazing management practices in Tana River County. The data were collected through household interviews, focus group discussions and key informant interviews. The study used contingent valuation method to determine the willingness of pastoralist households to pay for sustainable rangeland management practices. The results show that willingness to pay increased ($p \leq 0.05$) with membership in resource user associations, level of education, main source of livelihood, household income and marital status with regression coefficients of 1.38, 1.6, 3.71, 2.02 and 2.81, respectively. In an ecosystem where the grazing resource base had shrunk due to unsustainable grazing practices, pastoralists were willing to pay for maintenance of a sustainable grazing management practices that would guarantee adequate pastures and water. Membership in resource user associations, pastoral governance systems and the distribution of income among the households are therefore factors which policy and strategic actions should give priority to, in a bid to improve the welfare of pastoral communities.

Keywords: Rangeland management, pastoralism, Sustainable grazing

INTRODUCTION

Rangelands make about 40% of the globe (Zerga, 2015) and constitute approximately 69% of the world's agricultural land (Bolo *et al.*, 2019). They are important habitats for wild flora and fauna as well as for domestic livestock (Reid *et al.*, 2016). The dry lands are predominantly used for livestock production, mainly through pastoralism. Pastoralism is a low external input and subsistence system based primarily on livestock production. The system is grounded on strategic exploitation of resources that are non-uniformly distributed in space and time (Wasonga, 2013). The spatio-temporal variability in water and pasture availability, influences mobility and settlement patterns of pastoral communities leading to the development of pastoralism as the most suitable livelihood in the arid and semi-arid areas (Muricho *et al.*, 2017).

Pastoralists in Kenya are confronted with a variety of risks that constantly disrupt their livelihoods and devastate their main livestock assets (Lutta *et al.*, 2020). These risks, coupled with limited and increasingly ineffective risk management options, underlie vulnerability in pastoral systems. Some of the challenges facing pastoral communities include land tenure changes, diminishing grazing resource base, and frequent droughts which undermine pasture and livestock productivity (Huho *et al.*, 2011). Movement of livestock herds is a central component of land management in pastoral societies (Amoo, 2017). This movement has however been compromised due to declining access to rangeland resources occasioned by among others, loss of grazing land to agriculture, poor watering point management, conflicts and insecurity arising due to the breakdown of traditional institutions and social change necessitated by changing human aspirations and economic needs (Robinson and Berkes, 2011). These challenges undermine rangeland productivity and therefore the ability of pastoral communities to cope with the challenges of complex and dynamic ecosystems (Kamiri *et al.*, 2022).

[#]Corresponding author: lutaalpha@gmail.com

For a long time, pastoralists have used various adaptive and flexible risk management strategies and resilience enhancement mechanisms to maintain their lifestyle (Lutta *et al.*, 2019). Some of these strategies include: pasture deferral which involves grazing ban near water points during the wet season by having wet and dry season grazing reserves; maximizing stocking densities to ensure biomass threshold below which grazing is not allowed in order to avoid overgrazing; livestock species diversity which involves keeping mixed species of animals such as browsers and grazers to maximize the scarce resources; splitting of herds into satellite herds that feed far away from the homesteads and home-based herds which involve lactating animals and young ones that graze within homesteads; and livestock redistribution among friends and relatives as an insurance (Oba, 2012). Unfortunately, due to changes in policies, increase in human population and changing lifestyles, a number of these strategies are increasingly becoming constrained, thus affecting pastoral production systems (Lutta *et al.*, 2020).

Attempts aimed at enhancing resilience of the pastoral livelihoods and environments should therefore give priority to promoting sustainable rangeland management (Reid *et al.*, 2016), especially those that ensure equitable and sustainable access to pasture and water throughout the year (Muricho *et al.*, 2017). In Tana River County of Kenya, for example, communities have responded to recurrent droughts, associated perennial pasture scarcity, and increasing demand for forage and water by reviving and strengthening a communal system of governing their grazing patterns to help regulate sustainable use of grazing resources and ensure regeneration of the deteriorating land. The grazing management committee comprises opinion and religious leaders selected by the community who are guided by customary laws that preserves traditional laws and codes of conduct with amendments and additions based on the evolving environmental, social, and cultural context. Using the system, the communities have distinctly partitioned their grazing land into wet and dry season grazing units and drought grazing reserves. This zoning is designed to cater for pastoralists' needs in different seasons of the year and ensures that the resources are used sustainably. Additional water pans have also been constructed in the wet season grazing areas to ensure that animals do not return to the permanent water sources situated in the dry season grazing reserves before the right

time. To maintain the water pans and ensure adherence to the sustainable grazing patterns, each household pays some money agreed upon by the community (Lutta *et al.*, 2019). This study sought to determine socio-economic factors affecting the willingness to pay for maintaining sustainable grazing management practices in pastoral areas of Tana River County. This is important in development of appropriate incentives that ensure improved rangeland productivity and provide information that would help in identifying the preferred level of environmental conservation services and designing appropriate policies for sustainable rangeland use and management.

METHODOLOGY

Description of study area and population

The study was done in Tana River County located in north-eastern side of Kenya (Figure 1). The county is characterised by the spatial-temporal variability of water and rainfall. Seventy percent of the population relies on livestock production as their main source of livelihood (Kipchirchir, 2014). The dominant ethnic groups in the area are the Orma and Wardey, with extensive livestock production being their main source of livelihood—predominantly cattle and small ruminants, camels, and donkeys, and the Pokomo who do both livestock and crop farming along River Tana. The county is prone to droughts and extreme forage scarcity, making livestock production the most suitable economic activity in these areas (Lutta *et al.*, 2019).

Data collection

Multistage sampling procedure was used to determine the sampling frame in this study. Three sub-counties namely, Bura, Galole and Garsen inhabited by the agro-pastoralists and the nomadic pastoralists were purposively selected in the first stage of sampling. The second stage involved a systematic random sampling to select five locations from each sub-county giving a total of 15 locations from which sampling was done. This procedure was repeated in the third stage by narrowing down to two smaller administrative units (sub-locations) within each location using the systematic random sampling technique giving a total of 30 sub-locations.

A formula by Orme (1998) shown in Equation 1 was used to compute the appropriate sample size for the study, taking into consideration the projected number of

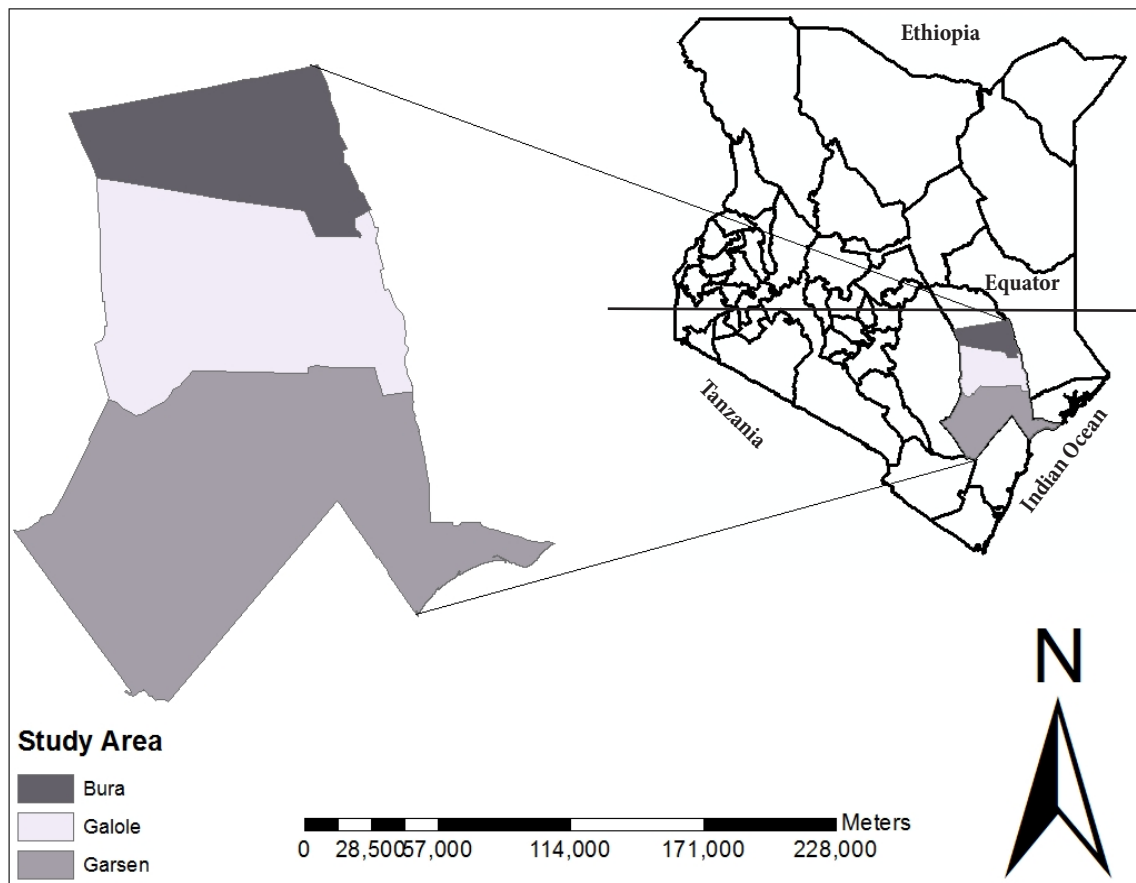


Figure 1: Map of Kenya showing Tana River County

households of the selected sub-locations.

$$n = 500 \times \left(\frac{L}{J \times T} \right) \dots\dots\dots (1)$$

Where n is the sample size; L is the largest number of levels for any of the attributes, J is the number of choice alternatives; and T is the number of choice situations in the design. In this study where L= 3, J =3 and T = 5, the sample size was 100 respondents per sub- county. Given the three sub-counties the total sample size was 300 respondents (100*3 sites). Information on the grazing management practices and the determinants of the willingness to pay for sustainable grazing management were collected through household surveys involving face-to-face interviews.

Data analysis

A multivariate binary logit model (Agresti, 1997) was used to establish the factors affecting Willingness to Pay (WTP) since the responses were categorical and dichotomous in nature. Logistic model is one of the widely used models where the response variable is dichotomous, taking 0-1 values. The WTP is a binary response of either yes or no and the outcome is a probability, which is expressed as Prob (Y = 1) when the answer is yes and as Prob (Y = 0) otherwise. The WTP variable is dependent on other variables of the respondent such as age, gender, level of education and income, source of livelihood, and resource use governance.

The probability of saying “YES” to a bid at different level of the independent variable is estimated as:

$$P_i = E (Y = 1 / X_i) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 X_i)}} \dots \dots \dots (2)$$

Where Y = 1 means the respondent is willing to pay, while X_i is a vector of explanatory variables, and e is the base of natural logarithm.

$$P_i = \frac{1}{1 + e^{-Z_i}} \dots \dots \dots (3)$$

Where Z_i = β₁ + β₂ X_i

Equation (3) represents a cumulative logistic distribution function. The P_i given in equation (3) gives the probability that the respondents are willing to pay while (1 - P_i), is the probability that all the households decide to pay as shown in equation 4.

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \dots \dots \dots (4)$$

Equation (4) can be simplified as:

$\frac{P_i}{1 - P_i}$ = is the odds ratio that the household is willing to pay grazing management. Hence the natural log of equation (5) can be expressed as follows:

$$L_i = \ln \left(\frac{P_i}{1 - P_i} \right) = Z_i = \beta_1 + \beta_2 X_i \dots \dots \dots (6)$$

Where L in equation 6, represents the log of odds ratios which is in linear form in X as well as in the parameters, therefore, the logit equation can be specified as shown in equation 7.

$$L_i = \left(\frac{P_i}{1 - P_i} \right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \epsilon_i \dots \dots \dots (7)$$

Where:

- X = is a vector of socio-economic factors influencing households' willingness to pay
- β= is a vector of coefficient to be estimated
- e= is the error term assumed to be normally distributed with a mean of zero and variance σ²

To determine factors influencing the WTP for improved grazing management practices, the presence of multicollinearity and heteroscedasticity in the independent variables were tested. For multicollinearity, a linear correlation coefficient which measures the direction of a linear relationship between two variables was used. To quantify the severity of multicollinearity, the Variance Inflation Factor (VIF) was used to measure how much the variance of the estimated regression coefficient is increased because of collinearity.

RESULTS

Households' socio-economic characteristics

The results show that livestock and livestock products were the main source of livelihoods for the communities accounting for 61.8% followed by mixed farming (35.5 %) and lastly formal employment (7%) (Table I). Most of the households (74%) were headed by males with only 26% headed by females. The results also indicate that more than half of the household heads had basic education with 56.1 % and 14.6% attaining primary and secondary levels of education respectively. Of the 300 household

heads, 75% were willing to pay for the sustainable grazing management practices.

TABLE I- SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS IN BURA, GALOLE AND GARSEN SUB-COUNTIES OF TANA-RIVER COUNTY (n=300)

Variable	Category	Proportion (%)
Gender	Male	74
	Female	26
Marital status	Single	5
	Married	87
	Separated/widow	8
Education level	None	28.9
	Primary	56.1
	Secondary	14.6
Source of Livelihood	Formal employment	2.3
	Livestock keeping only	61.8
	Farming and livestock	35.5
Income	< 10000	48
	>10000	52
Member of Resource User Association (RUA)	Yes	65
	Willing to Pay	Yes

Responses to pasture and water shortages

During the dry season when water and pasture is scarce, 20% of the respondents bought supplementary feeds for their livestock, 46.3% moved to other areas in search of pasture and water while 29.3% sold their livestock (Table II). A few households (2%) split the herds to spread the risks so that the weak and lactating ones remained close to the homesteads and the rest were moved to distant places.

TABLE II- RESPONSES TO PASTURE AND WATER SHORTAGES IN BURA, GALOLE AND GARSEN SUB-COUNTIES OF TANA-RIVER COUNTY (n=300)

Responses to feed shortages	Proportion (%)
Sell livestock	29.3
Migrate to other areas	46.3
Buy hay	20
Use leased pasture	1.0
Hire labour to access distant areas	1.3
Split herd to spread risks	2

Challenges faced by migrating pastoralists

Pastoralists who moved to distant places faced various

challenges (Table III). A majority (63.3%) reported that violent conflicts, raiding and clashes over land use continually undermined their livelihoods. These, according to focus group discussions, hindered delivery of essential services such as access to education, human and animal health care, adding to the plight of the poor pastoral communities. Transboundary epizootic disease transmission was also a major challenge that affected 15.9% of households that moved in search of water and pasture. Some weak animals (12.6%) died on their way due to long distances covered while 7.6% of animals were attacked by wildlife.

TABLE III - CHALLENGES FACED BY MIGRATING PASTORALISTS IN BURA, GALOLE AND GARSEN SUB-COUNTIES OF TANA-RIVER COUNTY (n=300)

Challenges faced when migrating with livestock		Proportion (%)
1.	Conflicts	63.3
2.	Disease outbreaks from animals of different areas	15.6
3.	Some animals die due to long distances	12.6
4.	Attacks from wildlife	7.3
5.	Unable to access markets	1.2

Factors influencing the WTP for improved grazing management practices

Table IV shows the VIF which have a mean of 1.2 that is lower than 5, hence no multicollinearity.

TABLE IV- RESULTS OF MULTICOLLINEARITY TEST ON THE INDEPENDENT VARIABLES FROM BURA, GALOLE AND GARSEN SUB-COUNTIES OF TANA-RIVER COUNTY

VARIABLE	VIF	1/VIF
Source of livelihood	1.41	0.70
Marital status	1.34	0.74
RUA membership	1.24	0.81
Buy supplementary feed	1.15	0.87
Education level	1.14	0.87
Gender	1.13	0.88
Level of income	1.10	0.90
Age	1.08	0.92
Mean	1.20	

The coefficient of determination (R^2) showed that 79% of the variation in the maximum WTP in the sample could be explained by independent variables and the model was significant ($p = 0.000$) with a log likelihood function of -38.18 (Table V). The level of significance of each variable was tested using the null hypothesis that these

TABLE VI - MARGINAL EFFECTS OF BINARY LOGIT MODEL AFTER LOGIT REGRESSION

Variable	Coefficient	S. E	Z	P-value
Buy feed	0.134	0.069	1.93	0.053*
Source of livelihood	0.361	0.107	3.37	0.001***
Group membership	0.157	0.089	1.77	0.077*
Level of income	0.197	0.058	3.41	0.001***
Level of education	0.164	0.075	2.19	0.028**
Age	0.0004	0.002	0.21	0.83
Gender	-0.062	0.062	-0.99	0.32
Marital status	0.406	0.131	3.08	0.002***

Statistical significance levels: ***1%, **5% and *10% respectively

explanatory variables had no effect on the maximum WTP. The source of livelihood, household income, access to extension information, land tenure, availability of active labour, membership in resource user association (RUA), education level attained by household head and marital status were the likely determinants (10% level) of the WTP for sustainable grazing management practices.

Development Goals (SDGs) with their recognition of increasing threats to current and future land productivity as well as provisioning of ecosystem services (UN, 2015). These threats include increasing demands for grazing land, food, energy and water, loss of soil fertility, conflicts over land accessibility and land use. They are exacerbated by unsustainable rangeland use, poor management

TABLE V- FACTORS AFFECTING WILLINGNESS TO PAY FOR SUSTAINABLE GRAZING MANAGEMENT IN BURA, GALOLE AND GARSEN SUB-COUNTIES OF TANA-RIVER COUNTY

Willingness to Pay	Coefficient	S. E	Wald	P value
Buy-feed	1.36	0.68	2.00	0.56
Source of livelihood	3.71	0.65	5.68	0.00***
RUA membership	1.38	0.64	2.16	0.03*
Level of income	2.02	0.43	4.69	0.00***
Level of education	1.60	0.64	2.48	0.013**
Age	0.005	0.023	0.21	0.83
Gender	-0.68	0.72	-0.94	0.34
Marital status	2.81	0.731	3.85	0.00***
Constant	-9.8	2.00	-4.91	0.00
N				300
Pseudo R ²				0.795
Log likelihood				38.17

Statistical significance levels: ***1%, **5% and *10% respectively. SE = standard error

The marginal effects of the membership in resource user association revealed that households in resource user associations had 15.7 times greater chances of paying for the improved grazing management practices than those who were not in any conservation group. Those who purchased livestock feeds were 13.4 times more willing to pay for improved grazing management practices while those with higher income and education levels were 19.7 and 16.4 times more likely to pay for the sustainable grazing management, respectively (Table VI).

DISCUSSION

Rangeland degradation is receiving the much-needed attention following the establishment of the Sustainable

practices, climate change and continuing high rates of land degradation (Lutta *et al.*, 2019). Rangeland degradation can be reversed by consequently applying sustainable grazing management practices whose benefits outweigh the cost by almost seven times (Nkonya *et al.*, 2011). Justification of investments in natural resource management depends on the nature and magnitude of social economic benefits the investment brings to society and individual. Willingness to pay (WTP) has been used as a proxy indicator for the incentives accruing from social benefits (Agutu *et al.*, 2021). Various socio-economic factors affect the WTP for sustainable grazing management practices in pastoral systems (Berhanu *et al.*, 2022). Membership in resource user associations, source of livelihood, household income, education levels

and marital status were highly significant in affecting the willingness of pastoralists to pay for sustainable grazing management practices.

The results show that source of livelihood has a positive and significant influence on the willingness to pay for sustainable grazing management practices. Those pastoralists whose only source of livelihood is livestock production are more willing to pay than those who have other alternatives as their primary source of livelihood such as farming. This is because the pastoralists whose main economic activity is livestock production derive more utilities from sustainable grazing management practices that would have more biomass and water for their animals across the seasons (Reid *et al.*, 2016; Muricho *et al.*, 2017), than those with other sources of livelihood.

Resource user associations also play a significant role in the sustainable management of natural resources in pastoral communities whose land is communally owned. This could explain why membership in resource user association was found to be positive and significant. The leadership of resource user groups are part of the traditional governance systems and are involved in decision making at the local level. In pastoral communities, leadership of the traditional governance systems are highly respected, and members are more convinced that they can ensure equitable access to the resources and therefore they are more willing to pay for the conservation of the resources (McKague and Oliver, 2009).

Leadership of the resource user groups plays an influential role in mediating conflicts and managing natural resources such as water and administering other functions through customary law. These functions are mainly informed by cultural practices and customary rules (Robinson and Berkes, 2011). Traditional systems of governance characterised most forms of administration and governance in the study areas of Tana River. The traditional systems of governance channel the desired stakeholder participation in a way that helps to address some of the chronic problems that constrain resource management such as low levels of awareness, poor land and water use practices, low levels of compliance with regulations and lack of proper monitoring (Muricho *et al.*, 2017).

According to Robinson and Berkes (2011), a multilevel participation where all levels of institutions are networked

may increase the adaptive capacity of communities and enhance their resilience to environmental changes. Traditional governance systems comprising of leadership of the resource user associations when strengthened, can therefore, ensure proper use of the range resources which enhances the confidence of the community in participating in natural resource management. According to McKague and Oliver (2012) social groups improve cooperation among pastoralists which enables them to pool their resources together and make proper decisions in the conservation of natural resources hence increasing their willingness to pay for management their resources.

The levels of income earned by a household significantly influenced the WTP for sustainable rangeland practices. Pastoralists who earned more income per month were more likely to pay for the grazing management practices than those who earned less. This could be due to the budget constraints where the pastoralists may not be willing to pay when the payment is beyond their budget set, with those having a higher income affording to pay with ease. Demand for a good is to do with consumer choices which are influenced by changes in benefits and costs, and this depends on income. This is however in contrast with the findings of Wattage and Mardle, (2008) who found that household income was not significant in explaining the WTP because of wide variations of income in a pastoral community; while other studies like Prasher *et al.* (2006) as well as Thang and Bennett (2007) found that household income positively influence the WTP for natural resources.

The level of education had a significant influence on the WTP for sustainable grazing management practices. Educated persons are assumed to have knowledge on the importance of natural resource conservation and their understanding of the significance of sustainable resource management enhances their WTP (Kisamba-Mugerwa, 2006). This is evident in the marginal effects of education in the model where those who had higher levels of education were more willing to pay for improved grazing than those with lower levels of education because they are more enlightened on the importance of resource use maintenance and conservation. These results are similar to the findings by Kisamba-Mugerwa (2006) which revealed that educated household heads were more likely to invest in rangeland improvements due to their understanding of the effects of resource degradation and its negative impact

on productivity of the rangelands.

Marital status also had a positive and significant influence on the WTP. Married household heads were more willing to pay for sustainable grazing management than those not married. This was expected especially in the pastoral communities where for any man to marry, he must have a certain number of livestock (Gurmu *et al.*, 2014). Therefore, most of the married couples have livestock which will require forage and water that the sustainable grazing management practices are more likely to give hence a positive utility. The married couples may also have extra needs such as taking care of their children, providing food for the families and paying school fees than those who are not married, which all has to come from livestock production (Gurmu *et al.*, 2014). The married couples whose main source of income comes from livestock and livestock related products have to ensure that the animals have enough pasture and water (Amoo, 2017); hence they are more likely to pay for sustainable grazing practices that will enhance the livestock production. Similarly, since they are married with a myriad of responsibilities, they may not be willing to travel for very long distances in search of pasture and water. They would rather prefer to stay around homesteads and not move very distant places in search of water and pasture. This explains why they are more willing to pay for sustainable grazing management practices.

CONCLUSIONS

The objective of the study was to determine socio-economic factors affecting the WTP for maintaining sustainable grazing management practices in pastoral areas. This is important in development of appropriate incentives that ensure improved rangeland productivity and provide information that would help in identifying the preferred level of environmental conservation services and designing appropriate policies for sustainable rangeland use and management. The findings of the study show that membership in resource user groups, income levels and source of livelihood had higher influence on the WTP for sustainable grazing management. Membership in resource user associations, traditional governance systems and the distribution of income among the households are therefore factors which policy and strategic actions should give priority to, in a bid to improve the welfare of pastoral communities. In an ecosystem where grazing

resource base is shrinking due to unsustainable grazing practices, pastoralists are willing to pay for maintenance of a sustainable grazing management practices that would guarantee adequate pastures and water.

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