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Research Article

Determinants of the adaptation mechanisms to the impacts of rangeland degradation: A case of Yabello district, southern Ethiopi

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Abstract

Over the decades, drought has occurred more frequently than previously documented in southern Ethiopia. Many projections of the causes and impacts of rangeland degradation on the pastoralists' livelihood have been reported. However, they were arguably too general to understand the magnitude of the impacts of rangeland degradation to suggest possible adaptation mechanisms in the pastoralists region of the country. A better understanding of the existing adaptation mechanisms and factors affecting pastoralists' choice is crucial for policies and programs that aim at promoting successful rangeland management in Ethiopia. The objective of this study was to assess possible adaptation mechanisms and to identify the factors that affect pastoralists' choice of adaptation mechanisms in Yabello district, southern Ethiopia. A total of 172 randomly selected households from two kebeles were interviewed using structured questionnaires. Multivariate probit regression and descriptive statistics were used for data analysis. The results showed that pastoralists' possessed their own adaptation mechanisms to cope up and prevail through the impacts of rangeland degradation. Herd diversification, buying of supplementary feed, destocking and hay making are among the common adaptation mechanisms of the area. Parameter estimates from the multivariate probit model revealed that the choice of adaptation mechanisms among pastoralists of Borana was significantly influenced by sex, age, family size, education livestock holding, access to weather forecast, access to credit service, and distance from the market center. Therefore, considering all these factors affecting pastoralists' choice of the adaptation mechanisms would help to develop more effective rangeland management. Furthermore, the finding of this research derived entry points for the policies aimed to work with the local communities' future research to cope-up with the impacts of rangeland degradation.
Keywords: Adaptation mechanisms, Borana, degradation, multivariate probit model,

Pastoralists, rangeland

1 Introduction

Rangelands are defined as uncultivated land that are suitable for browsing and grazing animals, which make up about 50 to 70% of the world's landmass with 50% of which is arid and semi- arid (Holechek, 2013). The rangelands of Ethiopia are located around the border line of the country and found below 1500 m a s l (Friedel et al. 2000). They are estimated to cover an area of 78 million hectare and are classified as arid and semiarid (Fenetahun et al. 2018). Rangelands provide several benefits, like forage for the livestock, protection and conservation of soil and water resources, provision of flora and fauna, and contribution to the attractiveness of the landscape (Carlier et al. 2009; Faraz et al. 2021).They provide a living for about six million Ethiopians, an estimated 10-12% of the country's total human population. Pastoralists keep about 40% of the country's total population of the cattle, half of the small ruminants and nearly all the dromedaries.

The rangeland of southern Ethiopia, including Borana rangeland is an important area of cattle production. They cover about 61 to 65% of the total area of the country and are characterized by high temperatures, low and high variables rainfall regimes, low density of vegetation cover and human population (Solomon et al. 2007).

The Borana rangeland is one of the pastoral areas that located in the southern part of the country, consisting of almost homogenous ethnic groups having the same culture and livestock- range management practices. It has been the center of widespread nomadic culture (Solomon et al. 2007). In recent decades, these lifestyles have come under enormous pressure due to rangeland degradation and fail to maintain the standard of living of a large sector of the pastoralists of the area (Tache and Oba, 2010). The major causes of rangeland degradation are overgrazing, recurrent drought, crop cultivation, bush encroachment, shortage of rainfall, inappropriate uses of land resources and soil erosion (Oba and Kotile, 2001; Kassahun Ameha et al. 2008; Mohammed Musa et al. 2016). The rangeland degradation resulting from those natural and man-made causes in the area leads to feed shortage for the cattle, death of livestock, food shortage for human and poverty. As a result, more than 80% of the livestock populations were died in Ethiopia (Kassahun Ameha et al. 2008). Consequently, the Borana communities have become food insecure and dependent on external food aid. Several studies have been conducted in the area; however, lessons learnt related pastoralists' perception on the rangeland degradation and its impacts on their livelihoods were far less documented for the future use (Tadesse Girma, 2001; Gemedo Dalle et al. 2006; Mekuria Wolde et al. 2007). Borana pastoralists have possessed indigenous adaptation mechanisms to cope up the impacts of degradation. The commonly adopted mechanisms in the area are haymaking, herd mobility, destocking, accumulating crop residue, providing supplementary feed and herd diversification. Although they developed indigenous adaptation mechanisms, the efforts are still low when compared with the impending calamity. Failure to incorporate the indigenous knowledge, skills, practices, goals and strategies of the pastoral communities, as well as lack of their involvement in the planning and implementation processes are the most important reasons for poor adaptability to variations in climatically conditions (Oba and Kotile, 2001; Angassa Ayana, 2002). Across Ethiopia, many people are experiencing the changing seasonal patterns of temperature and rainfall, which are expected to lower livestock production.

A better understanding of why pastoralists opt for certain coping mechanisms and identifying determining factors are the crucial for policies and programs that aim at promoting sustainable rangeland management. Several studies have been carried out about the adaptation mechanisms in different parts of Ethiopia. But it's difficult to generalize on the specific area. This is because the adaptation mechanisms are highly diverse and complex as they vary by community, social group, individuals, gender, age, season and time in history (Coulibaly, 2015). Thus, the key point is therefore, how do pastoralists in the area respond to the impact of rangeland degradation? Identifying potential adaptation measures thus helps in defining factors that influence the choice decisions of pastoralists in the study area. The ability to adapt to changing climate and other factors are determined by predictor variables, which are demographic, socioeconomic and institutional (Juana et al. 2013). However, experience has shown that nationally identified adaptations do not certainly translate into practice since adaptations are local and sector-specific. The fact that adaptation

choices vary contextually and spatially, thus, provide room for location and household level inquiry. A number of studies also identified specific variables; those may positively or negatively influence the particular adaptation choice to both natural and man-made changes and most of them focus on the wider East African region (Jones and Thornton, 2008). However, this paper focused on the specific adaptation mechanisms in Yabello District of southern Ethiopia where the changing climate and other factors put pressure on the areas. Results from this study will deliver empirical evidence on adaptation mechanisms there by helping to discern wherewithal to exploit the adaptation mechanisms sustainably. It also helps development practitioners to make an informed decision in their context.

2 Materials and Methods

2.1 Description of the study area

The study was conducted on the Yabello district, of Borana zone which is located about 600 km to the south of the capital city Addis Ababa. The Borana zone shares a boundary with Somali regional state in the East, SNNPR in the North and guji zone in the NE. The rangelands of Borana are located in the southern part of the Ethiopian lowlands and they cover a total land areas of 95,000 km^2 (Coppock, 1994). The area extends from 4.60^0 N to 4.90^0 N latitude 37.90^0 E 38.40^0 E longitudes (Figure1). The region is dominated by a semi-arid climate where the annual mean temperatures vary from19 to 24°C. The rainfall pattern in the area is bimodal with

the long rainy seasons between March and May and the short rainy seasons between September and November with an average annual rainfall ranging from 400 mm in the south to 600 mm in the north. The savannah communities containing mixtures of perennial herbaceous and woody vegetation are the dominant vegetation species in the region. Households on the area are highly dependent on livestock production as they are pastoralists and daily labor in different farming season.

2.2 Sampling design and Sample

Two rural pastoralist *kebeles* (the smallest administrative unit) namely Harewoyu and Utalo were selected randomly to represent pastoralists production system in the district. The sample size was determined using the formula (Yamane, 1967):

$$n = N/1 + N(e)^2 \tag{1}$$

Where n is the sample size, N is the population size, and e is the level of precision (with 7%).

Finally, 172 sample households (from a total of 1080 households of the two *kebeles*) were selected randomly following Probability Proportional to Size sampling procedure. Where n is the sample size; N is the total population and e is the level of precision (with 7%). The sample size taken to represent total population is the appropriate with regard to the sparsely distributed behavior of pastoralists' community in the study area.

2.3 Method of data collection

The primary data were collected from sample respondents, key informant interview (KII) and focus group discussion (FGD) through a structured and semi-structured questionnaire and the secondary data were collected from different journals and published documents to supplement the primary data.

2.4 Data analysis

The primary data collected from were analyzed by using computer STATA software. The analysis for household characteristics and their perception on the rangeland degradation impacts was undertaken by using appropriate tools, like descriptive statistics, frequency distribution or percentage. A five point Likert scale measure were used to measure the extent of perception of sample respondents on the impacts of degradation. The multivariate probit model was used to identify determining factors that affect pastoralists' choice of adaptation mechanisms for the impacts of rangeland degradation.

2.5 Empirical Model Specification

The multivariate probit model (MVP) is appropriate to simultaneously estimate the influence of the set of explanatory variables on each of the different practices, while allowing for the potential correlation between unobserved disturbances as well as the relationship between the adoptions of different practices (Ojo and Baiyegunhi, 2018). The study used MVP model characterized by a set of binary dependent variables Yij such that:

$$Y_{ij} = X_i\beta_i + u_i \tag{2}$$

$$Y_{ij} = \begin{cases} 1, & \text{if } Y_{ij} > 0 \\ 0, & \text{otherwise} \end{cases} \tag{3}$$

Where $j = 1, 2, \ldots, m$ denotes the type of adaptation mechanisms available; X_i is a vector of explanatory variables, β_i denotes the vector of parameters to be estimated, and u_i are random error terms distributed as multivariate normal distribution with zero mean and unitary variance.

It is assumed that a rational i^{th} household has a latent variable Y_{ij} which captures the unobserved preferences or demand associated with the j^{th} choice of adaptation mechanism.

The MVP analyses were aimed to identify key determinants of the choices of adaptation mechanisms based on households' decision. The empirical approach was successfully used by several previous studies. Greene, (2008); Nhemachena et al. (2014) have used the model to assess factors affecting the choices farmers make in the context of climate change adaptation strategies in the agricultural sector. For this study, it was found to be the appropriate model because pastoralists' use several adaptation strategies simultaneously. The estimated dependent variables were pastoralists' choice of adaptation mechanisms on the impacts of rangeland degradation given the explanatory variables. Four dummy dependent variables were selected for this study: herd diversification, buying of supplementary feed, herd destocking and haymaking.

2.6 Dependent and Independent Variables

The choices of these dependent variables in the equation were based on literature review and the suitability of each adaptation mechanisms for pastoralists in the study area. The dependent variables assume a value of 1 if individual apply specific adaptation mechanism and 0 otherwise. After testing for multicollinearity, only eleven explanatory variables were selected. Table 1 lists the summary of the explanatory variables their measurement and hypothesized effect on different dependent variables. Moreover, the model was tested for heteroskedasticity using the robust standard error procedure.

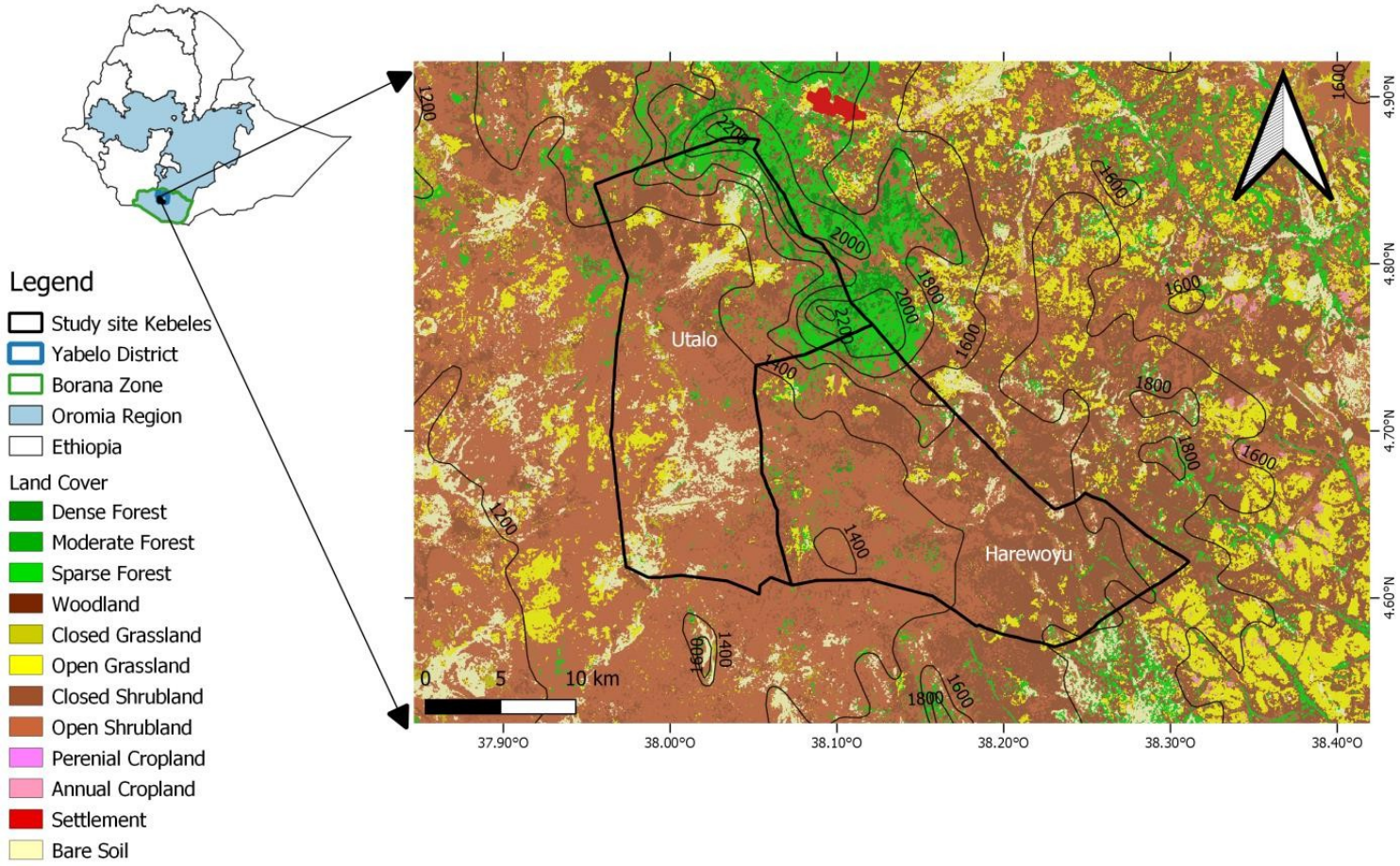

Figure 1: Map of the study area

3 Result and Discussion

3.1 Socio-economic /demographic/ institutional characteristics

Out of the total sample respondents about 90.7% was covered by male while the remaining 9.3% were females. About 80.23% of the respondents were illiterates (those who did not attend formal education), and only 19.77% can read and write (attend formal education). From the study sample respondents, there was no respondent who attained primary education and above. This shows that the households of the study area a little figure with compared to national level. With regard to the age of the respondents, the average age of the respondents was 45; with minimum age 22 and maximum of 88. From the total sample, majority of the respondents, about 88.37%were found within the productive age group and hence it is rational that they are engaged in different economic activities. The average family size of household Respondents was 6; with maximum house-hold of 12 and minimum size 1. The results of the survey revealed that the average livestock size of the respondents in the study area were 9 in TLU. Marital status of the respondents has a significant role in the resource utilization and management. Thus, it was investigated under the survey. Accordingly, results of the study showed that about 93.61% of the respondents were married 5.23% were widowed and the rest 1.16% were single and there was no divorced participant in terms of marital status in the household survey. The livelihood characteristics of a given society may determine the way on which they interact with their environment, thus, it was investigated under the study. Accordingly, livestock production is the most commonly practiced old age economic system. The result showed that, about 86.047% of the sample respondents stated that the major source of livelihood activities in the study area is livestock where crop cultivation and safety net program accounts only about 11.046% and 2.907% respectively.

3.2 Pastoralists perception on the causes and impacts of rangeland degradation

Respondents were asked about their perception towards rangeland degradation. According to the survey, 93.65% of the respondents from both *kebeles* perceived that rangeland resources are under its normal state. The finding of the study reveals that most of the households agreed that rangeland rehabilitation practices are important to minimize the rate of pasture degradation. This indicates that households had good perception towards the participation of rangeland resource conservation. The group discussion conducted with the pastoralists indicated that encroachment of the bush to the former

Table 1: Description of Independent Variables

Independent variables	Description	Types of variable	Expected sign
Sex	Sex of the respondent	Dummy variable	Positive/negative
Age	Age of the respondent	Continuous variable	Positive/negative
Marital	Marital status of the respondent	Categorical variable	Positive/negative
Total fam	Total family size of the respondent	Continuous variable	Positive/negative
Education	Education of the respondent	Dummy variable	Positive/negative
Major crops	Major livelihood activities of the respondent	Categorical variable	Positive/negative
Total land	Total cultivated land size of the respondents	Continuous variable	Negative/positive
TLU	Total livestock in tropical livestock unit	Continuous variable	Positive/negative
Credit	Access to credit service	Dummy variable	Positive/negative
Weather	Access to weather forecast	Dummy variable	Negative/positive
Market	Distance from market center	Continuous variable	Negative/positive

grassland has been the major cause of rangeland degradation and reduced both the quality and quantity of rangeland productivity.

The data collected through household survey revealed that Acacia tree species like *A. senegal*, *A. reficiens*, *A. drepanolobium* change and other species like *Tephrosia pentaphylla* (locally, named as sephansa, sigirso, chake and keessa ka'ii) are the major encroaching trees/ shrub species those are invading the rangelands. 87.8% of the respondents confirmed that the five most prevailing causes of rangeland degradation in the area are bush encroachment, climatic condition, overgrazing, population pressure, and poor policy.

From the total sample respondents, about 99.4% of interviewed pastoralists strongly agreed that feed shortage is the major and the first impacts of rangeland degradation while 57%, 47.9% and 45.3% of the respondents strongly agreed that livestock yield reduction (in terms of meat and milk), decline in crop products and the decline of rangeland productivity both in terms of quantity and quality are also the primary impacts of rangeland degradation respectively. On the other side, the result of weighted mean also showed that; feed shortage, livestock yield reduction, decline in the crop products, decline in the rangeland productivity and long distance travelled to feed animals are the five most common primary impacts of rangeland degradation on the study area (Table 2).

3.3 Descriptive statistics result of Pastoralists' adaptation mechanisms

The four most commonly used adaptation mechanisms listed above were involved in the analysis and summarized in figure 2 below.

3.4 Diversification

According to the result from the survey, 62.8% of sampled households use diversification as their adaptation mechanism choice and they ranked it as the second best option to reduce the impact of rangeland degradation on their livelihood. Diversification of herd composition is a key strategy that has enabled pastoralists to thrive in a harsh environment for centuries (Speranza, 2010). Herd diversification in favor camel and goats is the important strategy of pastoralist adaptive response to climate-induced shifts in rangeland ecosystems. In nature, Borana pastoralists predominantly practice a cattle- specialized pastoral system. A person with a few number of cattle in the Borana custom is considered as qolle (destitute) and "incomplete" because of the comprehensive social functions (Berhanu Wassie, and Fekadu Beyene 2015). The most important product in subsistence pastoralism is milk. The attractiveness of camel in pastoral households' animal species portfolio is that, camel breeds produce more milk than cows (Berhanu Wassie et al. 2007).

3.5 Supplementary feed

According to the results from the survey conducted on the two *kebeles* from Yabello district, 61.6% buy supplementary feed like floury and crop residue. This is because providing supplementary feed during the drought season is the other important means to cope up the impact of rangeland degradation. The average annual expenditure the pastoralists spent on purchasing supplementary feed was 2,160 ETB ($45.60) with a minimum value of 720 ETB ($15.2) and a maximum value of 4,320 ETB ($91.17) per year. More than half of pastoralists buy flour and rapeseed oil to feed animals in a harsh winter. Nowadays, buying supplementary feed has become a large financial burden for pastoralists' community. Many studies revealed that the proportion or the percentage of providing supplementary feed for the livestock depend on the individual pastoralist's financial capacity.

3.6 Destocking

In the study area, there is a changing behavioral pattern; some pastoralists are more commercially oriented, even though they have cultural and social attachments to their livestock. Also, in drought season, they prefer to sell part of their livestock instead of taking the risk of losing their animals. Some of them reported that the income generated from herd destocking is reinvested

Table 2: Pastoralists' perception on the impacts of rangeland degradation

No	Perception	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)	Total	Weighted mean	Rank
1	Decline in rangeland productivity	78 (45.3%)	94 (54.6%)	0	0	0	766	4.45	4
2	Feed shortage	171 (99.4%)	1 (0.6%)	0	0	0	859	4.99	1
3	Livestock yield reduction (meat & milk)	98 (57%)	74 (43%)	0	0	0	786	4.57	2
4	Decline in Crop products	81 (47%)	91 (53%)	0	0	0	769	4.47	3
5	Livestock price decline	11 (6.4%)	158 (91.9%)	0	3 (1.7%)	0	693	4.03	7
6	Death of livestock	6 (3.5%)	162 (94.2%)	0	4 (2.3%)	0	686	3.99	8
7	Damage from the bush on women	7 (4%)	165 (96%)	0	0	0	695	4.04	6
8	Long distance travelled	40 (23.3%)	132 (76.7%)	0	0	0	728	4.23	5
9	Migration of household	25 (14.5%)	121 (70.3%)	0	26 (15.1%)	0	661	3.84	9
10	Malnutrition	1 (0.6%)	51 (29.6%)	0	120 (69.8%)	0	449	2.61	10

in supplementing the remaining animals with concentrated feed and floury during the dry season. The result showed that about 51.2% use herd destocking as their best option to cope with the impacts of rangeland degradation on their livelihood. Herd destocking refers to selling some of their animals in order to keep a number of livestock that can be well managed.

3.7 Hay storage

The result showed that 63.95% of the total respondents have adopted hay making and use as their first choice of adaptation mechanism. Hay storage is a traditional means for pastoralists to cope with a harsh winter. Sufficient stocks of hay reduce livestock loss by death. One yak needed 30 kg of surplus fodder to ensure survival through the cold season in the township of Tawu in Sichuan. Even private enclosures for fodder production are not allowed in pastoralists' communities, they calculated stance by fencing the communal land for the double purpose of cereal cultivation and dry season hay-making.

3.8 Marginal success probability for each adaptation mechanisms

The marginal success probability for each adaptation mechanism is reported in Table 3. The likelihood of choosing destocking as an adaptation mechanism is relatively low (51.16%) as compared to the probability of selecting supplementary feed (61.6.0%), diversification (62.8%) and haymaking (63.95%). The joint probabilities of success or failure of adoption of the four adaptation mechanisms suggest that households are less likely to fail to jointly adopt all the adaptation mechanisms together. The likelihood of households' failure to jointly adopt all the adaptation mechanism is only 2% compared to their success to jointly adopt them 11.2%. Joint probability of success and failure to use all adaptation mechanisms together are reported in Table 4.

3.9 Factors affecting choice of adaptation mechanisms

Different factors determine choice of adaptation mechanism based on the pastoralists' interest to use. Demographic, socio-economic, and technical factors affect the choice of the adaptation mechanisms. Result showed that the choice of different adaptation mechanisms is significantly explained by age, gender, education, major livelihood activity, total family size, total herd size in TLU, access to credit services, access to weather forecast and market distance (Table 5).

The Wald test was used to test the model fits. The data is statistically significant at a 1% significance level, which implies that the subsets of coefficients are jointly significant and the independent variables included in the model are acceptable. Moreover, the likelihood ratio test in the model

$$\rho_{21} = \rho_{31} = \rho_{41} = \rho_{32} = \rho_{42} = \rho_{43} = 0$$

is significant at less than 1%. This indicates the goodness-of-fit of the model, implying that the decisions to choose these adaptation mechanism options are interdependent.

Coefficients from MVP regression designate the direction of the influence rather than the magnitude, so the interpretation commenced using marginal effects (Table 5). Some factor variables of the households (sex, age, educational status, total family size, and total number of livestock in TLU) had a significant influence ($P < 0.01$) on the household's choices of adaptation strategies, as discussed below.

Gender of the household head: Being a male household positively and significantly influenced the adaptation of herd diversification, buying of supplementary feed and haymaking practices and negatively and significantly affects adoption of herd destocking. So the marginal effect indicated those male households are 1.86 times more likely to adopt diversification, 2.09 times more likely to adopt buying of supplementary feed and 1.42 times more likely to adopt haymaking than female households to recruit the rangeland degradation effects. In the other side, female households are 1.48 times more likely to adopt herd destocking than male household heads. This can be due to the fact that women culturally have limited access to control critical resources (land, cash, and labor), which often undercuts their decision and ability to carry out large cost incurring activities. This finding is thus, consistent with (Kebede Wolka et al. 2014), affirming that males are more likely to access information on climate change and pleased to take risks than their counterparts.

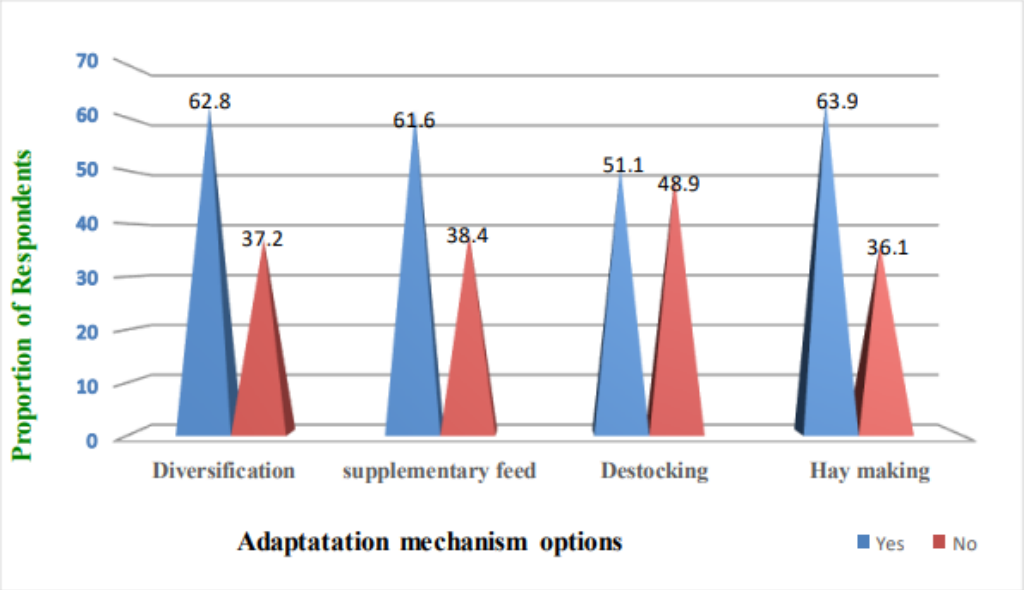

Figure 2: Adaptation mechanism options to cope up the impacts of rangeland degradation

Table 3:

Variable	n	Mean	Std. Dev.
Diversification	172	0.6283	0.4798
Supplementary feed	172	0.6163	0.4877
Herd destocking	172	0.5116	0.5013
Haymaking	172	0.6395	0.4863

Age of household: Age of the household head was significantly and positively influenced the choice of destocking by rural pastoralists, whereas, significantly and negatively influenced the choice of diversification and supplementary feed at (p-value=0.004) and (p=0.000) respectively. It is found that the probability of adjustment in pastoral practices of buying supplementary feed and herd diversification significantly decreases as age of the respondents' increases. This is good evidence that, the younger pastoral households have more capacity to buy supplementary feed as well as to use diversification strategy during the shock and climatic risks and older households may take their decision to choose better option to minimize any cost they incur regarding adaptation mechanism than the younger ones.

Educational status of the household head (educat): The result showed that, educational status of the respondent plays a vital role and has a negative and significant effect on herd destocking at less than 1% whereas, it has a positive and significant effect on buying supplementary feed, diversification and hay

making at less than 1% , 5% and 10% respectively. The result is in line with Addisu Solomon, et al. (2016), Gadédjisso, (2015) and Adeoti et al. (2016) that confirmed as the educational level of the household head increases, the level of understanding about adaptation strategies.

Family size of the household (totfam): Family size had a significant negative effect on pastoralists' adaptation choices. It has a negative and significant effect on buying of supplementary feed and haymaking at (p-value= 0.000) and at (p-value= .055) respectively. Moreover, it has a positive and significant effect on herd destocking at (p-value= 0.027). A unit increase in family size thus would result in a decline in the probability of using buying supplementary feed and haymaking by 44.92% and 12.78% respectively. This could be due to, the more the number of family size; the more the mouths to be fed, to fulfill the need of food for family members, everybody scarifies their money and time searching the food than buying supplementary feed to their livestock and hay making. Tazeze Aemero et al. (2012) proved the same finding for stating households with large families may be forced to divert part of their labor to other activities with an attempt to earn income and ease the consumption pressure imposed by a large family.

Total livestock holding (TLU): the households' livestock holding capacity is positively and significantly affects herd diversification (in favor of camels and goats), providing supplementary feed and haymaking, whereas; negatively and significantly affect herd destocking. Abraham Belay et al. (2017), revealed that owning large number of livestock in tropical livestock unit increases farmers" likelihood of adapting different mechanisms. The conversion factors used to estimate TLU is shown below in Annex Table 1.

Access to weather forecast (weather): Access to weather forecast is positively and significantly influences all adaptation mechanisms. The more access to forecast weather, the more to use different adap-

Table 4: Joint probability of success and failure to use all adaptation mechanisms

Variable	n	Mean	Std. Dev	Min	Max
tecjprls	172	0.1118	0.0754	1.60×10^{-7}	0.3008
tecjpros	172	0.0198	0.0256	5.79×10^{-9}	0.1746

Where tecjprls is joint probability of success
and tecjpros is joint probability of failure

Table 5: Parameter estimation of MVP in adaptation mechanism choices

Variables	Diversifications		Supplementary feed		Destocking		Hay making	
	Coef.	P¿—z—	Coef.	P¿—z—	Coef.	P¿—z—	Coef.	P¿—z—
Sex	1.8556	0.003	2.0875	0.000	-1.4807	0.008	1.4184	0.001
Age	-0.0234	0.017	-0.0411	0.000	0.0257	0.004	-0.0105	0.227
marital	0.4035	0.380	-0.5482	0.269	-0.1371	0.725	0.2505	0.541
education	0.7741	0.030	0.1561	10.00	-0.8709	0.003	0.5541	0.075
Total fam	-0.1134	0.139	-0.4492	0.000	0.1576	0.027	-0.1278	0.055
Major crop	0.4752	0.262	0.9097	0.036	-0.1748	0.637	0.8457	0.023
Total land	-0.3065	0.271	-0.3940	0.177	0.0199	0.938	-0.1415	0.583
TLU	0.2242	0.000	0.2545	0.000	-0.0757	0.024	0.1006	0.006
Credit	0.0234	0.217	0.0411	0.000	-0.1257	0.004	0.0105	0.227
Weather	1.0559	0.004	1.0875	0.006	1.0207	0.008	1.6184	0.000
Market	0.6541	0.100	-1.0121	0.002	-0.8709	0.103	0.5405	0.705
Cons	-3.0036	0.030	1.1173	0.416	0.5893		-1.8826	0.107

Log likelihood = -302.34694, No of obs = 172, Wald chi2 (32) = 112.18, Prob¿ chi2 = 0.000
Where, Coef: coefficient, Major: major livelihood activities, totland: total cultivated land size

tation mechanisms. Access to weather forecasts is important for pastoralists to be able to plan what to do in the future.

Access to Credit (credit): Access to credit service positively and significantly influence buying of supplementary feed, whereas, negatively and significantly influence destocking. Pattanayak et al. (2003); Deressa Temesgen et al. (2009) showed a positive relationship between the level of adaptation and the availability of credit. Availability of credit eases the cash constraints and allows pastoralists to buy different feed for their cattle as well as keep rearing their livestock rather than selling to solve households' food shortage problem.

Distance from the market (market): The result showed that distance to market center negatively and significantly affect pastoralists' decision to buy supplementary feed. Proximity to market is an important determinant of adaptation, presumably because the market serves as a means of exchanging different information with others (Maddison, 2007).

4 Conclusion

The Borana rangelands have been degrading due to the presence of various natural and man- made factors like recurrent drought, bush encroachment, overgrazing, over population, over utilization, inappropriate government intervention and poor rangeland management policy. The results showed that pastoralists' possessed their own adaptation mechanisms to cope up and prevail through the impacts of rangeland degradation. Herd diversification, buying of supplementary feed, destocking and hay making are among the common adaptation mechanisms to sustain their livelihoods on the study area. Choice of these adaptation mechanisms were significantly influenced by sex, age, educational level, family size, major livelihood activity, livestock holding (TLU), access to weather forecast, access to credit and distance from the market of the households. The marginal success probability of adapting herd destocking was lowest compared to other adaptation mechanisms practiced on the area. It also showed that the joint probability of using all adaptation strategies was 11% and the joint probability of failure to adopt all of the adaptation strategies was only 2%. This shows, pastoralists' were less likely to fail than succeed in adopting all choice sets jointly. The results of this study can be relevant for the development and sustainable management of rangelands in arid environments. It's recommended that strengthening the research and development intervention in rangeland improvement schemes in order to reverse and restore rangeland degradations in to sustainable use and full participation from all stakeholders is imperative. Moreover, to minimize the pressure on rangeland resources, various stakeholders should emphasize to expand adult education to enable them to select appropriate adaptation mechanisms.

Competing interests

The authors declare that they have no competing interests.

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Table 6: Conversion factors used to estimate TLU (Storck et al., 1991)

Livestock	Horse	Camel	Ox	Cow	Bull	Calf	Donkey	Sheep	Goat	Chick
Conversion factors	1.1	1.25	1.1	1	0.75	0.25	0.7	0.13	0.13	0.01