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Boran Pastoral Innovations in Response to Climate Change: A Case of Merti Division, Isiolo County, Kenya

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Abstract
Pastoralism is the main source of livelihood for Boran community inhabiting Northern Kenya. Over time, they have developed coping strategies aimed at minimising losses from aridity. Although the strategies may have served the community well in the past, they are presently perceived as inadequate in the light of climate change. This study investigated necessary adjustments in the strategies and innovations among the Boran in Merti Division of Isiolo County. Specific objectives are to investigate innovations by Boran pastoralist' in response to climate change, to find out the main drivers of innovation practices and to establish the relationships between herders' innovation practices, climate change and livelihood strategies Qualitative and quantitative approaches were applied. The target population was 400 from which a random sample of 80 herders was drawn. All the 6 local chiefs and 6 community leaders in the area were also interviewed. Data was collected using semi structured questionnaires and key Informant interviews. The resulting data was coded and statistically analyzed using the statistical package for a social scientist (SPSS). Then the results were analysed, discussed and presented in graphs, pie charts and tables. The results showed that there were main drivers of innovations among Boran pastoralists in Merti Division. They include prolonged droughts, conflicts and invasive species which are linked to climatic changes. There were also response strategies which were found to be improvement in their usual drought coping strategies while others are newly emerging strategies. The innovation practices include agreement between herders and ranchers, livelihood diversification, inter-community negotiations, change in mobility, among others. The study established that 53% of the pastoralists were aged over 40 years while 47% were aged below 40 years though there was no significant difference between the two groups (p=0.0921). On the period the respondents had worked as pastoralist, the results showed that majority (52%) had worked for more than 9 years while the rest had worked for less than 9 years as pastoralists. Further, the results of the study established that climate change was a key driver of herders led innovation practices. The study established that a unit deterioration of the climate change would lead to an increase in the herders led innovation practices by 4.5 units with this being significant at 5% level of significance (p=0.000). On the other hand, livelihood strategies were also to be significantly associated with herder led innovation with a p-value of 0.000. The study concluded that climate change has had an impact on Boran pastoralists' forcing them to improve their existing drought coping mechanisms and adopt newly emerging strategies. Some of the key recommendations are increasing participation of pastoralist in development of pastoral policies, reducing obstacles that hinder pastoral mobility and strengthening of security and peaceful existence in Northern Kenya in order to enhance adaptation to climate change.
Keywords: Climate Change, Boran, Pastoralism, Pastoral Innovations, Merti, Kenya

ABSTRACT
Pastoralism is the main source of livelihood for Boran community inhabiting Northern Kenya. Over time, they have developed coping strategies aimed at minimising losses from aridity. Although the strategies may have served the community well in the past, they are presently perceived as inadequate in the light of climate change. This study investigated necessary adjustments in the strategies and innovations among the Boran in Merti Division of Isiolo County. Specific objectives are to investigate innovations by Boran pastoralist' in response to climate change, to find out the main drivers of innovation practices and to establish the relationships between herders' innovation practices, climate change and livelihood strategies Qualitative and quantitative approaches were applied. The target population was 400 from which a random sample of 80 herders was drawn. All the 6 local chiefs and 6 community leaders in the area were also interviewed. Data was collected using semi structured questionnaires and key Informant interviews. The resulting data was coded and statistically analyzed using the statistical package for a social scientist (SPSS). Then the results were analysed, discussed and presented in graphs, pie charts and tables. The results showed that there were main drivers of innovations among Boran pastoralists in Merti Division. They include prolonged droughts, conflicts and invasive species which are linked to climatic changes. There were also response strategies which were found to be improvement in their usual drought coping strategies while others are newly emerging strategies. The innovation practices include agreement between herders and ranchers, livelihood diversification, inter-community negotiations, change in mobility, among others. The study established that 53% of the pastoralists were aged over 40 years while 47%

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1.0 INTRODUCTION

Pastoralism is a livestock production system that is based on extensive land use and often some form of herd mobility, which has been practiced in many regions of the world for centuries (WISP 2007). Pastoralism is globally important for the human populations it supports, the food and ecological services it provides, the economic contributions it makes to some of the world's poorest regions, and the long-standing civilizations it helps to maintain (Nori and Davies 2007). Unfortunately, threats and pressures associated with human population growth, economic development, land use changes, and climate change are challenging professionals and practitioners to sustain and protect these invaluable social, cultural, economic, and ecological assets worldwide (Nori and Davies 2007).

The climate of Africa is warmer than it was 100 years ago and model-based predictions of future green house gases (GHG) induced climate change for the continent clearly suggest that this warming will continue and, in most scenarios, accelerate (Hulme *et al*,2001). Observational records show that during the 20th century the continent of Africa has been warming at a rate of about 0.05°C per decade with slightly larger warming in the June–November seasons than in December–May (Hulme *et al*., 2001). By 2000, the five warmest years in Africa had all occurred since 1988, with 1988 and 1995 being the two warmest years (IPCC, 2007). This rate of warming is not dissimilar to that experienced globally, and the periods of most rapid warming the 1910s to 1930s and the post 1970s occur simultaneously in Africa and the rest of the world (IPCC, 2007).

Livestock production depends on natural resources, which in much of Africa primarily means pasture and water. Climate change therefore affects livestock production in a myriad ways, both directly through impacts on livestock performance, and indirectly through impacts on environment, society and economy. Impacts will be experienced on forage yields, livestock productivity, ecological processes and farm level profitability, possibly leading to modification of regional and national food production and incomes (WISP, 2010). The impact of climate change on livestock production in Africa is also greatly influenced by the vulnerability of African livestock keepers (WISP, 2010). Past studies reveal that farmers in developing countries are highly vulnerable to climate change (Rosenzweig and Parry, 1994; Mendelsohn et al., 2001; Kurukulasuriya *et al.,* 2006; Seo and Mendelsohn, 2008). Unlike the farmers in the rest of the world, they are vulnerable because they are already located in a hot climate zone and have limited capacity to cope with climate risk (Mendelsohn *et al.,* 2006)

In Kenya, over 60% of the national herd is held by pastoralists and it produces about 10 % of the Gross domestic product (GDP) and 50% of agricultural GDP (Huho *et al.,* 2011). In the Arid and Semi Arid lands (ASALS) of Kenya, pastoral economy accounts for 90% of employment opportunities and 95% of family incomes and livelihood security (Huho, *et al.,* 2009, USAID, 2010). In Northern Kenya, pastoralism is largely practised by the Boran, the Turkana, the Maasai, the Rendille, the Samburu, the Gabra, the Orma and the Pokot. Pastoralism in this region is nomadic in nature, where herders adapt to spatial-temporal variability in pasture and water availability through herd migration. Drought is by far the greatest cause of livestock mortality. Pastoralists in Northern Kenya keep different types of livestock which include cattle, goats, donkeys and camels. However the dominant stock varies from one ethnic community to the other depending on cultural values attached to specific livestock types and also due to climatic conditions (Huho *et al*, 2010).

Pastoralism is the main source of livelihood for communities in Northern Kenya. Pastoralists constitute 13.2 % of Kenya's estimated 39 million people (GoK, 2009), with livestock as their major source of livelihood and food security. The pastoralists contribute a significant share (approximately 70%) of the total marketed livestock in the country (Galvin *et al*., 2004). Pastoralists herd their livestock in the ASALS of the country where several extreme climatic events have occurred (Olukoye *et al*., 2004). Pastoralism is a dynamic system comprising of people, livestock, and natural resources such as vegetation, soil, water, temperature, wind, traditional system, and economic attributes such as markets. However, pastoralists' support system is prone to adverse effects of climatic variability and change. The notable droughts in the past three decades that impacted negatively in Northern Kenya include those in the years 1971,1975,1977,1980, 1983-1984, 1995-1996,1999-

2000 and 2004-2006. The extreme climatic events often result in a number of adverse impacts include loss of livestock, a major source of livelihood and food security especially among pastoralist communities in the region.

The increasing vulnerability of pastoralists' livelihoods to climate change is a pressing problem in Kenya's ASALs and ecosystem resulting from the interaction of ecological, socio-economic and socio-political factors. Northern Kenya represents a typical semi arid region within East Africa and adverse effects of climate change are likely to impact negatively on the livelihood support base as well as ecosystem structure and function. Innovations, which are new practices introduced by pastoralists themselves in response to climate change provide new ideas and practical experience to learn from. Alongside formal scientific and technological advancements, pastoralists are developing and testing new knowledge and practices to manage longstanding challenges and more recent pressures resulting from climatic changes.

2.0 RESEARCH METHODOLOGY

2.1 Study Area

The research area was Merti Division of Isiolo District. The area is about 220 kilometres north of Isiolo town and borders Marsabit to the North, Samburu District to the west, and Garbatula District to the east. The area is inhabited by Boran speaking people who are purely pastoralists. The economic activity practiced in the area is mainly livestock keeping. However, there are few businesses around the shopping centre. The population density was 15,771 (KNBS, 2009) and the area is a flat low lying plain characterized by scattered settlement of manyatta's composed of concentrated households. The area displays semi-arid climatic conditions with vegetation cover mostly found being acacia tree species, shrubs and grasslands. Temperature ranges between 12^0C to 28^o C and the area receives rainfall ranging between 150mm to 650mm annually which is erratic and unreliable (ALRMP, 2010). The altitude of Isiolo County lies between 200-300 metres above sea level. However, in some parts such as Merti plateau and other plains in Southern parts, altitude is as high as 1000 metres above sea level. The soils are mainly sandy which has low water holding capacity and saline (ALRMP, 2010). Borana pastoralism remains significantly attractive area of study partly because of its livestock resources, institutional peculiarity, and relative ecological potential.

2.2 Target Population

Target population in statistics is the specific population about which information is desired. Mugenda and Mugenda, (2003), explain that the target population should have some observable characteristics, to which the researcher intends to generalize the results of the study. The population size of Merti Division is 15,771 people. But for the purpose of this study, herders were the target population and they are 400 herders in Merti Division.

2.3 Sampling Procedure

Purposive sampling design was used to select herders in Merti Division. Purposive sampling method as noted by Srivastava et al., (1993) is a deliberate non-random method of sampling which aims at selecting a sample of people, settings or events with predetermined characteristics. In this study, the pre-determined characteristics are the pastoral characteristics. The rationale for using the purposive sampling was based on the fact that the pastoralists are believed to have similar characteristics in regard to the objectives of this study. There are 400 herders in Merti Division (ALRMP, 2010). A sample is a set of representative observations drawn from a population. For a sample size to be representative of the entire population, it needs to be sufficient and unbiased. According to Mugenda and Mugenda (2003), a sample size of between 10 and 30% is a good representation of the target population since it demonstrates the two characteristics of a sample i.e. unbiased and sufficient. To this effect, the researcher used 20% of the target population in this study which gives 80 herders. Purposive sampling was used to select 80 herders from the total 400 herders. Also interviewed were the 6 local chiefs and 6 community leaders as key informants as they were thought to have extra information which may not have been available from the pastoralists. The sample size of this study was therefore 92 herders in Merti Division.

2.4 Data Collection and Analysis

This study used a semi structured questionnaire and Key Informants Interviews to collect data. It was observed that questionnaires are very economical in terms of time, energy and finances. Similarly, it yields, quantitative data which is easy to collect and analyze. However, questionnaires deprive the participants an opportunity to express their feelings, attitude and behavior and hence Key Informants Interviews was used to collect qualitative data.

Quantitative data was collected through administering of questionnaires to individual herders who are part of the study sample while the qualitative data was collected through the Key Informants Interviews (KIIs). Eighty questionnaires were issued to the 80 herders sampled.

The collected data in this study were both quantitative and qualitative. The quantitative data was coded and entered into the Statistical Package for Social Science (SPSS) which was used to analyze the data. The SPSS

software was used since it was designed to analyze social statistics data. The researcher used both descriptive and inferential statistics to summarize the findings of the study. The descriptive statistics included the means, percentages and frequencies. The p-value used in this study was 5%. The study also used a multiple regression analysis in an effort to establish the relationship between herder-led innovations practices, livelihood strategies and climate change. Regression analysis is a statistical tool that is used to establish relationships between independent variables and dependent variables.

In analyzing qualitative variable, i.e. the open ended questions in the questionnaire and the data collected from the key informants, the study used content analysis.

The regression equation was;

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon}$$

Whereby Y = herder-led innovations practices
X_1 = livelihood strategies
X_2 = climate change
ε = Error term

3.0 RESULTS AND DISCUSSION

3.1 Demographic Characteristics

This section presents the results for the background information and characteristics which includes gender, age distribution, education level, and wealth in terms of livestock.

3.1.1 Gender Distribution

Result of the survey showed that 95% (N=79) of the interviewed pastoralists were male while 5% were female as shown in figure 4.1 below. This outcome can be attributed to the fact that most of the herders are normally male due to differentiated gender roles in that livestock herding in the rangelands is generally a male role while women participate in gathering of hay for calves and weaker animals kept around the homestead.

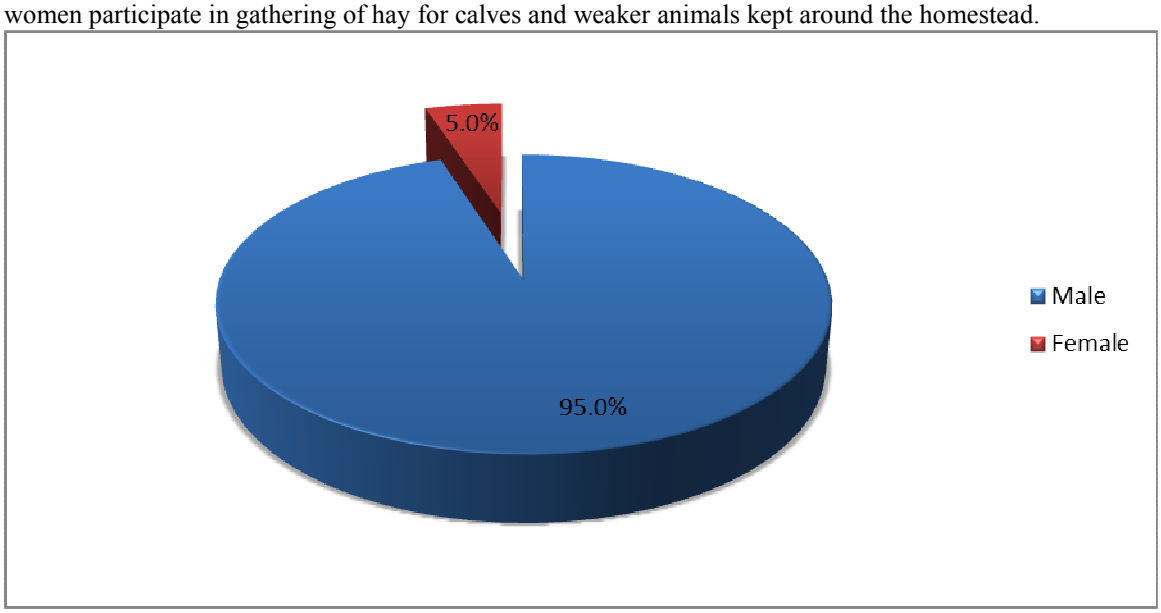

Figure 3.1: Gender Distribution of herders in Merti Division

3.1.2 Age Distribution

On the age distribution, the results showed that 34.2% (N=79) of the respondents interviewed were aged between 41 and 50 years, 26.6% were aged between 20 and 30 years, 20.3% were aged between 31 and 40 years while 19% were aged over 51 years. When combined, the results showed that 53% of the respondents were over 40 years of age though there was no significant difference with the group aged less than 40 years (p-value=0.0921). When compared with the total population age distribution, the results showed that there was no difference between the sample age distribution and the population age distribution (p=0.211). Figure 4.2 shows age distribution.

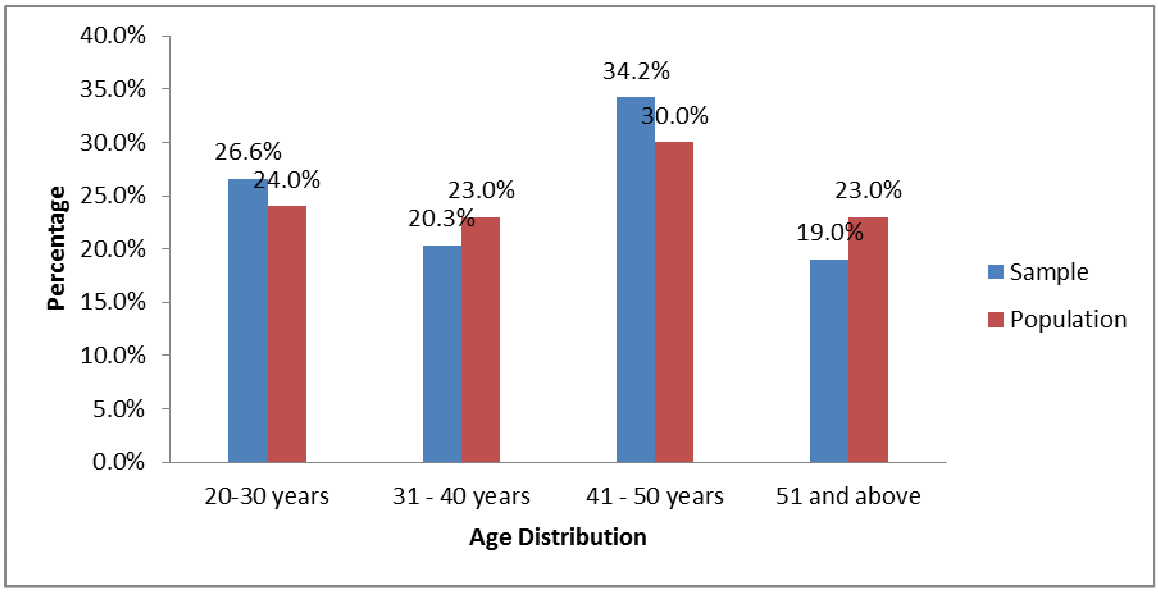

Figure 3.2: Age Distribution of herders in merti Division

3.1.3 Education Level

The figure 4.3 below shows the outcome of the survey on education level. 73.5% (N=79) of the pastoralist interviewed had no formal education while 20.3% reported that they had primary education. Only 6.2 % of the interviewed respondents had secondary education. This implies that according to the results of the survey the level of education was generally low among the Boran pastoralists.

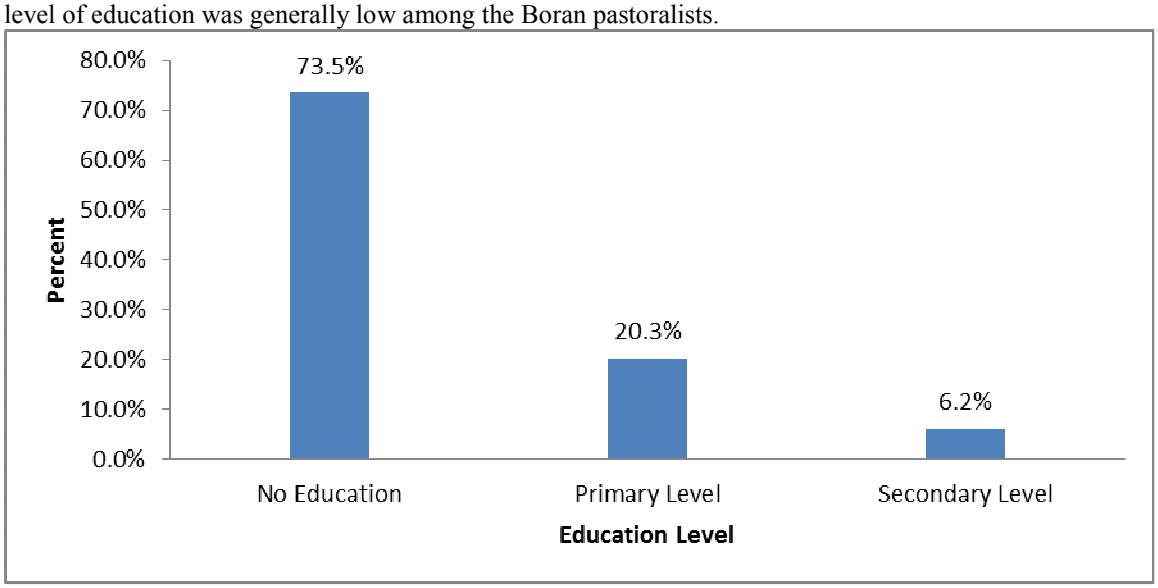

Figure 3.3: Education Level of herders in Merti Division

3.1.4 Period Worked as a Herder in Merti Division

On the period that the respondents had worked as herder, the results showed that 41.8% (N=79) of them had worked for over 12. Table 4.1. below shows 31.6% reported that they had worked as herder for between 3 and 9 years. In addition, 16.5% of the pastoralists reported that they had been pastoralists for less than 3 years while 10.1% reported that they had been pastoralists for between 9 and 12 years. According to the results, most (over 50%) of the pastoralists had worked as pastoralist for over 9 years. The majority of the respondents (41.8) therefore worked for over 12 years meaning they have experience to give an insight on changing climatic conditions. When compared between the two groups, the results established that there was a significant difference between the pastoralist who had worked for less than nine years and those who had worked for 9 and more years (p=0.002). This means that majority of the interviewed pastoralist had worked for more years.

Table 3.1: Period Worked as a Herder

Herding period	Frequency	Percentage
Over 12 years	33	41.80%
9 - 12 years	8	10.10%
3 - 9 years	25	31.60%
Less than 3 years	13	16.50%

3.1.5 Number of Livestock Owned by Pastoralist

Table 4.2 shows the distribution of wealth among the pastoralists in terms of animals owned. According to the research result, 42.3% (N=79) of the respondents reported that they had between 15 and 45 cattle, 32.4% had between 5 and 15, 12.7% had between 45 and 90 cattle. Over 55% of the respondents reported that they had over 15 cattle. On shoat owned by the pastoralists, over 50% reported that they had less than 15 sheep while over 60% of the pastoralist reported that they had less than 15 goats. On camels all the pastoralist reported that they had less than 5. This implies that majority of the pastoralist in Merti Division owned cattle followed by shoat. Camels were not popular in Merti, probably because of the strong historical attachment among the Boran community to cattle.

Table 3.2: Number of Livestock owned by Pastoralists

Livestock Owned	Less than 5	5 – 15	15 – 45	45 – 90	Above 90
Cattle	11.3%	32.4%	42.3%	12.7%	1.4%
Sheep	28.6%	30.2%	36.5%	3.2%	1.6%
Goats	20.8%	45.8%	30.6%	2.8%	Nil
Camels	100%	Nil	Nil	Nil	Nil

3.2 Main Drivers of Herders Innovation in Response to Climate Change

The respondents were asked to rank the extent to which environmental factors (land condition i.e. rainfall and vegetation and water access and availability) had negatively influenced pastoralism. Of the interviewed respondents, 74.7% agreed with the statement while 21.5% did strongly agreed with the statements. This result implies that all the respondents (96%) agreed that environmental factors had negatively influenced pastoralism in Merti. On deforestation, the respondents were asked whether deforestation due to settlement had led to desertification promoting emergence of alternative forms of subsistence; over 70% of the respondents agreed with the statement, 7.6% disagreed while 20.3% of them remained neutral. This implies that there was a general agreement by the majority of the respondents that deforestation had led to desertification promoting emergence of alternative forms of subsistence. In addition, over 80% of the respondents agreed that low and unpredictable rain continued to reduce vegetation cover while the rest either disagreed with the statement or remained neutral. This implies that the respondents felt that low and unpredictable rain continued to reduce vegetation cover.

The respondents were also asked whether sparse and erratic rains exacerbated lead to displacements. Over 90% of the respondents agreed with the above statement while the rest disagreed with the statement which implies that according to the result, there was a general agreement among the respondents that sparse and erratic rains lead to pastoral displacements and need for the pastoralists to innovate. On drought leading to loss of livestock due to lack of pasture and water creating dependency on relief aid and thus leading to pastoral innovation, over 90% of the responded approved the statement meaning that the drought had led to loss of livestock due to lack of pasture and water and thus creating dependency on relief aid and also leading to pastoral innovation. The researcher also asked the respondents their opinion towards degraded environment, inadequate water and changes from palatable to unpalatable grass. According to the results, 0ver 85% of the respondents agreed with statement meaning that degraded environment, inadequate water and changes from palatable and unpalatable grass and bushes had led to migration to far and wide areas and conflict between communities and thus forcing the pastoralist to innovate. On conflicts, majority (92%) of the respondents agreed that conflict was a driver of the herder-led innovation. Finally, over 67% of the respondents agreed that introduction of invasive species mainly *prosopis juliflora* was a major driver of herder-led innovations in response to changing climate. Table 4.3 shows the breakdown of the results.

Table 3.3: Main Drivers of Herders Innovation Response to Changing Climate

Main drivers of Innovations	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Environmental Factors	21.5%	74.7%	Nil	Nil	Nil
Deforestation	16.5%	55.7%	20.3%	7.6%	Nil
Low and Unpredictable Rain	15.2%	74.7%	7.6%	2.5%	Nil
Sparse and Erratic Rain	10.1%	81.0%	7.6%	1.3%	Nil
Drought	21.5%	69.6%	5.1%	3.8%	Nil
Degraded Environment	19.0%	67.1%	12.7%	1.3%	Nil
Invasive Species	5.1%	62.0%	21.5%	8.9%	2.5%
Conflict	21.3%	70.7%	6.0%	2.0%	Nil

3.3 Herders' Innovation Practices and Livelihood Strategies

This section presents the results of influence of innovation practices on livelihood and innovation practices present in Merti Division.

3.3.1 Innovation Practices that Influence Livelihood in Merti Division

The respondents were asked the extent to which they practice the following herders' innovation strategies thus influencing livelihood in Merti Division. According to the results as shown in table 4.4, majority 96% (N=79) of the respondents reported that they rated the statement "agreements between ranchers and farmers permitted limited grazing of cattle and sheep inside commercial ranches on a controlled basis" to a low extent. This implies that according to the respondents, the impact of the statement above on livelihood was minimal due to the fact that it involved moving of the livestock to Laikipia ranches which was a costly venture that can only be practiced by few pastoralist'. On the statement "herder's cooperation with small-holder farmers", majority (over 80%) of the respondents felt that its impact on livelihood was to a low extent probably due to absence of farms across the bigger stretch of the rangeland. The results of the survey also indicates that the extent of impact of "smaller and improved breeding stock and livelihood diversification" was great as reported by over 87% of the respondents. Reducing herd size has become an emerging strategy due to prolonged and frequent droughts.

On social contracts, majority (52%) of the respondents agreed that local agreements mainly for access of local resources e.g. pasture and water had influenced livelihood in Merti Division to a great extent. However, on cessation of breeding livestock, majority of the respondents reported that the extent to which it influenced on livelihood in Merti Division was low. The results of the survey showed that "pruning branches of trees near town and along rivers to feed weaker livestock at home and avoid moving them" was reported by the respondents that it influenced livelihood in Merti division by a great extent (over 90%). The village herds were fed using the patchy available forage close to villages. On moving stronger cows and sheep more widely, over 89% of the respondents reported that its influence on livelihood was great. Increment in the distance of mobility of livestock is attributable to scarcity and vegetation degradation across the Merti rangelands during prolonged droughts. In addition, the results of the survey showed that dipping and inoculating livestock to maintain health of stronger animals was found to have a great influence on livelihood in Merti. Concerning intensification of non-livestock tasks, such as burning charcoal, buying chickens and selling eggs, tending bee hives, casual work on horticulture farms and large ranches, and selling goats had a great impact on the livelihood in Merti according to over 98% of the respondents interviewed. Therefore livelihood diversification has become famous due to loss of livestock from droughts and threat to pastoralism as a livelihood option. Finally, herding splitting was found to have a great influence on livelihood in Merti according to all the respondents interviewed. The weaker and lactating livestock were kept as village herds and fed close to the village. This is practiced in light of climate change due to movement of stronger herds far and wide to look for pasture and water.

Table 3.4: Innovation Practices

Innovation Practices	Very Great Extent	Great Extent	Moderate Extent	Low Extent	No Extent at All
Agreement between Ranchers and Farmers	1.3%	1.3%	15.2%	25.3%	57.0%
Herders cooperation with small-holder farmers	19.0%	Nil	46.8%	30.4%	3.8%
Smaller and Improved Breeding Stock and Livelihood diversication	6.4%	83.3%	7.7%	2.3%	Nil
Social Contracts	2.5%	49.4%	22.8%	15.2%	10.2%
Cessation of Breeding Livestock	2.7%	23.0%	27.0%	40.5%	6.8%
Pruning Tree Branches to feed Weaker Livestock	17.7%	77.2%	3.8%	1.3%	Nil
Moving Stronger Cows and Sheep more Widely	17.7%	72.2%	10.1%	Nil	Nil
Dipping and Inoculating Livestock	3.8%	44.3%	40.5%	10.1%	1.3%
Intensification of Non-Livestock Tasks e.g trade,farming e.t.c	7.6%	91.1%	1.3%	Nil	Nil
Herd Splitting	12.7%	87.3%	Nil	Nil	Nil

3.4 Regression Analysis of the Relationships

This study used the multiple regression model to establish the relationship between herder-led innovations practices, livelihood strategies and climate change. The results of the regression analysis is displayed in Table 4.7.

3.4.1 Relationships between Herders Innovations, Livelihood Strategies and Climate Change

Table 3.5: Regression Analysis Output

Variable	Estimated Parameter	Standard Error	P-Value
Constant	1.31	0.12	0.213
Livelihood Strategies	3.11	0.43	0.000
Climate Change	4.51	0.49	0.000
Innovation Practices	1.98	0.11	0.120

According to the results in table 4.4, the constant of regression was found to be 1.31 (SD=0.12). This means that when all the other variables are held constant, the herder-led innovation practices will improve by 1.31 units though this was established to be insignificant at 0.05 level of significance (p=0.213). In addition, the results of the study showed that a unit increase in livelihood strategies will lead to an increase in the herder-led innovations practices by 3.11 units. This relationship was found to be significant at 0.05 level of significance. This means that improving the livelihood strategies by the pastoralist will lead to an increased herder-led innovation practices. The results of the study also showed that a unit increase in climate change will lead to increased herder-led innovations practices by 4.51 units. This was found to be significant at 0.05 level of significance. This implies that whenever the climate changes in the pastoralists' areas, the herder-led innovation practices improve.

3.5 Results from the Key Informant Interviews and Discussion

The above results among others were also supported by the key informants.

3.5.1 Main Drivers of Herder - led Innovations

The key informants suggested the following as the main drivers of innovation practices;

1) Prolonged Droughts

The frequent droughts in recent years has led to households not able to rebuild their assets including livestock leading to many Boran pastoralists becoming food insecure and poor. Respondents unanimously agreed that the main driver of innovations among Boran pastoralist is prolonged and frequent drought. They pointed out that droughts are more frequent and every two years there is a serious drought. The most recent being that one of year 2011. This has necessitated emergence of new drought coping practices and changing of normal practices to suit the severe drought situations.

2) Conflicts

Another challenge faced by Boran in Merti rangeland is persistent conflict between them and their Samburu neighbours. Conflict is prevalent in Kom rangeland which is at the boundary of the Boran and Samburu communities. The area operates as the last resort drought refuge for both the Boran community from Merti area

and Samburu community. The conflict normally is over pasture rights, water resources, boundaries, but also cattle rustling which is a cultural practice in some nomadic communities. In addition, conflicts between the two communities are also blamed on frequent droughts which makes the two communities to meet often in Kom rangelands in search of pasture. This conflict has led to tension in areas around Kom rangeland.

3) Invasive species

The study found out that there was a serious problem of an invasive species known as *Prosopis juliflora* (mathenge). It is an ever green thorny plant that locals said it was introduced in the area sometimes back as a reforestation effort. This plant is accused of reducing growth of grass and forage availability due to its ability to hinder other plant growth in its vicinity. Therefore the pastoralists are forced to travel far and wide to look for palatable pasture. In addition the pastoralists have limited technology for rehabilitating rangelands invaded by invasive species.

4) Low and unpredictable rains

Merti area experience bi-modal rainfall pattern i.e. long rains from April to June and short rains from mid October to December. In recent years, the residents had noted decrease in the amounts of rainfall and also uncertainty when rains were due.

5) Pasture Degradation

Most of the respondents pointed out that over time pasture have been changing from palatable to unpalatable state which they partly blame on climate change and emergence of varied weeds across Merti rangelands. This has led to a shift leading to reduction in the composition of highly nutritious grass species and rapid increase in the number of less palatable plants. Therefore in order to look for better pasture, Boran pastoralist' move their cattle more widely beyond the normal grazing areas.

6) Water shortages

Availability and access to water resources are crucial for pastoral livelihoods. Inadequacy of water was mentioned as one of the drivers of innovations among Boran pastoralists'. During extreme droughts most of the shallow wells and water pans gets dried up forcing pastoralist' to move their livestock to areas with boreholes. For example during prolonged droughts Pastoralists in Merti concentrate around Duma and Yamicha rangelands due to presence of boreholes. Water shortages mostly lead to inter communal negotiations for water access rights using elders.

3.5.2 Innovation Practices among the Boran Pastoralist in Merti Division

Key informants suggested the following as the Innovation Practices among the Boran pastoralist;

1) Agreement between herders and ranchers

This strategy is an emerging practice which was common among the few wealthy herders. During the prolonged drought in 2011, some few herders used trucks and took their livestock to Laikipia ranch owned by Agricultural Development Cooperation. There was agreement between herders and the ranch management that the livestock to be kept in the ranch during the drought period. The ranch provided pasture, water and veterinary services at a fee. Each cattle was charged 300 kshs per month. Then when the rain fell, the livestock were returned to Merti rangeland. Although only the well off can afford this arrangement, this approach was a success story because apart from cushioning the individual pastoralist against huge losses due to drought, it also led to improved health and body weights of the livestock. As a result the few livestock which were sold later fetched high prices in the market.

2) Inter-community negotiations

Due to prolonged droughts, the Boran elders visited their Samburu counter parts in order to negotiate grazing rights and conflict resolution mechanisms. For example in 2011, the Boran elders approached the Samburu elders to negotiate grazing rights so that Boran livestock could be allowed to graze in Samburu territory. A deal was reached and Boran community were allowed to graze their livestock in Samburu rangeland thus reducing livestock mortality due to drought.

3) Livelihood diversification

In order to reduce vulnerability to drought, many pastoralists' increased diversity of their livelihood strategies. Diversification reduces exposure to risks associated with a single activity and opens up opportunities for generating welfare. In Merti Division most pastoralist' engaged in petty trade to supplement pastoralism. For example Miraa trade in small centers' and having mobile shops. In addition they also engaged in crop farming along River Ewaso Nyiro, producing mostly vegetables (kales, cabbages, onions, carrots) which they sell in commercial centers' across Merti Division. Another activity they mentioned was engaging in employment both at local and distant town centres. Some of the pastoral drop outs travel to big towns and get employed where they then send remittances to their families back home. Others engage in casual labour locally. Of interest to note is emergence of fishing as an economic activity along Ewaso Nyiro River. Although most of the catch were transported to Isiolo town where there is presence of fish eating communities, some are consumed locally. Therefore it is noted that as climate changes leading to extreme and prolonged droughts, there is increased emergence of livelihood diversification which were not previously common.

4) Herd diversification

Diversification into different species of livestock was important in maintaining animals that feed on different species of plants thus ensuring maximum extraction from rangelands. In order to reduce shocks brought by extreme and prolonged drought exacerbated by recent climatic changes, keeping of goats, sheep and camels was common instead of the usual keeping of cattle alone. This is because goats and sheep are more drought tolerant and disease resistant as compared to cattle. Livestock diversification became one of the most universally adopted coping mechanisms in Merti Division.

5) Herd splitting

This involves splitting the herd in to groups and moving them in to different areas thus preventing overgrazing and maintaining the long term productivity of the range. Herd division was common practice during droughts. A practice known as warra (village herd) and fora (satellite herd). Warra herds were usually grazed near the homesteads and closer to permanent water point and included young and lactating animals. On the other hand, Fora herds, which included dry cows and male animals were grazed far away from the village. This dual herding system allowed uniform utilization of the rangeland and helped in minimizing feed and water shortage.

6) Change in mobility

As other nomadic communities, The Boran in Merti Division travel with their livestock in search of water and pasture across Merti rangelands. These seasonal movements are greatly aided by networks of watering points. Before the emergence of recent climate related changes, migration was limited to mainly dry and wet grazing areas, and traditional laws governed the use and access of these resources. Due to prolonged droughts observed in Merti area, there was change in how, where, when and for how long as far as movements are concerned. For example key informants pointed out that in extreme cases the Boran moved beyond borders and grazed their livestock in Samburu east District sometimes leading to ethnic tensions and cases of cattle rustling.

7) Improved water resource management.

The Boran people in Merti have for a long time adapted to rangeland with inadequate water. The recent climate changes have reduced further the water available for their livestock. Improved water resource management has therefore become essential in rangeland management. Most of the available boreholes and wells are traditionally managed. Rangeland users association came up with a strategy for managing boreholes which uses machines for pumping water. In consultation with all stakeholders, during wet season when natural dams and reservoirs are filled up by rain water, the rangeland user's association decided removal of pumping machines and keeping them safely at the offices of a local community based organization. The machines are only taken back to their respective boreholes during drought periods. This strategy has led to pasture regeneration in those areas so that it can be used as dry season grazing areas.

8) Destocking

Reducing herd sizes was common among the Boran occupying Merti Division. This enabled the pastoralists' to get financial gain and minimizing losses if the animal were to die. In addition income from livestock sales can be used to buy other urgent household goods hence acting as an emergency relief during drought. Among the Boran there is cultural prestige associated with large herd sizes but due to extreme and prolonged droughts attributable to climatic changes, reducing herd sizes was noted as an emerging practice among the Boran.

9) Increased participation in livestock markets

Some of the respondents pointed out that due to climate change, there is increasing participation of Boran pastoralist in livestock markets. They explained that young bulls of about three years are often sold and thus used as a liquid asset. The money got from the sales are used for buying household goods. Frequent droughts forced Boran pastoralists to sell some of their livestock although their preference is to build herd sizes.

10) Use of enclosures 'Kallo'

Locally known as 'Kallos' are enclosures reserved for lactating, young or sick animals so as to ensure these animals do not travel long distances travelled by the rest of the herd to look for water and pasture especially during dry season.

11) Feeding cattle on a root tuber called *Ipomea longituba Hall.f* (Convolvulaceae)

During severe drought conditions, respondents explained usage of a root tuber locally refered to as 'ruppis' which was used to feed livestock. This unique plant is said to provide food and water because of enormous water stored in the roots. The respondents acknowledged that this plant gave the livestock strength and resilience.

12) Information technology

Boran pastoralists' historically sent scouts to far areas to investigate availability of pasture and water resources so as to make informed decision on their migratory patterns. Currently mobile phones have become resourceful for many pastoralist because with phones important messages can be relayed. For example the availability of forage and water resources, cattle rustling cases, general conditions of animals can be easily communicated using phones rather than physical movement of people to relay important information. In addition mobile phones are used to inform on market conditions in far centre's thus enabling both livestock keepers and livestock traders to interact even using money transfer technologies (m-pesa) to do business.

13) Establishment of community information centre

There was establishment of Maarifa centre locally known as "Fulla bekh itargat", an idea which was born by rangeland users association in May 2009. Then after consultations, Drought management initiative project established the Maarifa centre in November 2009 in close collaboration with Merti Integrated Development Programme, a local CBO which hosts the centre and local communities. This was an innovation step because previously there was lack of infrastructure for information sharing in Merti area hence making communities without access to development information. In addition, the untapped innovative experiences can be exchanged between the communities and development agencies. The centre is now a hub for community documentation of local knowledge focusing on disaster management, indigenous early warning systems, livestock market information and environmental issues. The centre also gives alerts on drought and other impending disasters that increase human and livelihood vulnerabilities.

4.0 Conclusions

Climate change is indeed a major challenge for Boran pastoralist' in Merti Division. However, with provision of enabling environment, pastoralism can prove to be a sustainable and resilient livelihood even in the light of climate change. The Boran in Merti Division have noted the increase in the frequency of drought in the region. The frequent drought, indicator of climate variability has had an impact on the Boran pastoralist including loss of livestock, food insecurity, loss of livelihoods, vegetation degradation. The Boran recognizes the need to improve their coping mechanisms and look for new ways of adapting to climate change. Climate change is likely to bring new weather patterns that pastoralists are unfamiliar with and therefore the search for improved adaptation practices should continue. Exploring new strategies to counter new challenges brought by climate change can build on existing strategies.

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