EFFECTS OF CLIMATE CHANGE ON CATTLE RARING INCASE OF ADOLA REDE OROMIA REGION ETHIOPIA

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ACRONOMYS

AU-IBAR	African Union Inter-African Bureau for Animal Resources
ENSO	El Niño southern oscillation
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
GDP	Grosse Domestic Product
IFAD	International Fund for Agricultural Development
IK	Indigenous Knowledge
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-Governmental Organization
UN	United Nation
UNFCCC	United Nations Framework Convention on Climate Change
WCDP	Wisconsin Chronic Disease Program
WHO	World Health Organization

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1. INTRODUCTION

1.1 Background of Study

Most Africans depend on agriculture for their livelihoods, which is the backbone of national economies for almost all countries in Africa. The sector employs 70-90% of the total labor forces, supports about 50% of feed demands and 50% of the income of the households. Among the agricultural sub-sectors, livestock rearing supports the income and livelihood for about one-third of African populations and provides 30-50% of agricultural GDP **(AU-IBAR, 2016**). Livestock is the principal asset of the poor in most pastoral and agro-pastoral communities, though the sector is highly susceptible to extreme climatic events (Fereja, 2016). Climate extremes are having a significant impact on livestock productivity in Eastern and Western Africa. Increasing frequency and intensity of droughts; changes in water availability; increasing patterns of temperature and rainfall variability, all are profoundly threatening livelihoods of drought-prone areas, and the existence of arid and semi-arid remote regions (Palombi & Sessa, 2013; Ulrichs, Slater, & Costella, 2019). Climate change is threatening the productivity of agricultural land, by shortening growing periods and decreasing crop/pasture yields (UNFCCC, 2007).

In Ethiopia, climate variability and change has triggered frequent droughts, floods, heat waves, heavy rains, and strong winds (FDRE, 2007). The country is suffering from the impacts of climate change such as an increase in average surface temperature, changes in rainfall patterns, recurrent drought, El Niño southern oscillation (ENSO), floods and La Nina (Melees & Samuel, 2017; Melkamu, 2017). The country necessarily needs to switch to a new sustainable development strategy to cope with and adapt to the changing climatic condition (Anita, Dominic, & Neil, 2010; FDRE, 2011)

The climate variability alters plants' growth potential; deterioration of livestock feed resources 56 and livestock's physiological response. Increasing patterns of temperature and decreasing rainfall trends is a global phenomenon, pastoral and agro-pastoral communities who rely on natural resources for livestock production rigorously feel its adverse effects. Climate variability alters the niche of forage species and may modify animal feed resources. The rising surface temperature may increase fodder and pasture browse species' productivity while the productivity of grassland is severely declined (Thornton, Herero, & Erickson, 2011). Changes in grassland composition lead to inadequate grassland serving capacity and the areas left with browse feed resources (Fereja, 2016; Yilma, Haile, GuerneBleich, & Ababa, 2009

According to IPCC (2014), global surface temperature increases, rainfall patterns become uneven, and heat waves events are the potential consequences of the climate variability and changes. Effects of climate change will directly impact the livestock sector and rangeland resources, directly linked to pastoralists livelihoods and food security. The loss (death) of livestock has been observed by climate-driven impacts such as recurrent drought, which negatively impacts pastoralists' livelihood security. The pastoral and agro-pastoral communities are particularly vulnerable to climate variability and changes due to their livestock dependence for food and livelihood. For preparing people to face these challenges, decision-makers and policy planners need information on climate change. Pastoral and agro-pastoral communities in Ethiopia have become vulnerable to the effects of recurrent drought.

However, pastoralists have gradually developed mechanisms to survive in a risky environment. The communities lived in drought-prone regions, adapted to fragile environments, and sustainably conserved the natural resources. A comprehensive assessment of the pastoralists' perceptions on climate change and vulnerability, i.e., the degree to which livestock species is susceptible to climate variability and extremes, is needed to reduce its impacts and respond effectively. Pastoralists in the study area are rainfall dependent, and any variation in its pattern affects livestock productivity and survivability. Some livestock species are more vulnerable than others, depending on their resilience and adaptive capacity. Assessing community perception of climate change and livestock production potential under climatic stress is valuable in addressing livestock herder vulnerability to climate extremes. Therefore, this study examines the perception of the pastoral community on climate change and performance, resilience and adaptive capacity of livestock under climatic stress in southeastern Ethiopia.

Livestock system is one of the major sources of nutrition to the increasing population of the world. Human populations largely depend on animals and animal products like milk, meat, eggs, fibers, wool, and feather. Animals are also used for transport, draft and their manure.

Livestock production is adversely affected by various events of extreme climatic conditions. This study focuses in the effect of climate change on livestock production Human population is expected to increase from 7.2 to 9.6 billion by 2050 (UN, 2013). This represents a population increase of 33%, but as the global standard of living increases, demand for agricultural products will increase by about70% in the same period (FAO, 2009a). Meanwhile, total global cultivated land area has not changed since 1991 (O'Mara, 2012), reflecting increased productivity and intensification efforts.

Livestock products are an important agricultural commodity for global food security because they provide 17% of global kilocalorie consumption and 33% of global protein consumption (Rose grant et al., 2009).

The livestock sector contributes to the livelihoods of one billion of the poorest population in the world and employs close to 1.1 billion people (Hurst et al.2005). There is a growing demand for livestock products, and its rapid growth in developing countries has been deemed the ''livestock revolution" (Thornton, 2010; Wright et al., 2012). Worldwide milk production is expected to increase from 664 million tones (in 2006) to 1077 million tons (by 2050), and meat production will double from 258 to 455 million tones (Alexandrite's and Bruinsma, 2012). Livestock production is likely to be adversely affected by climate change, com-petition for land and water, and food security at a time when it is most needed (Thornton, 2010).

Gerber, 2010). At the same time, climate change will affect livestock production through Competition for natural resources, quantity and quality of feeds, livestock diseases, heat stress and biodiversity loss while the demand for livestock products is Climate change is expected to cause increase in weather-related disasters and extreme weather events, such as droughts, heat waves, storms, desertification, and increases in insect infestations (Khanal, 2010). Long-term changes in climate will affect the future of all animals including those in oceans, on farms, in forests, in wilderness areas, and in our homes (Khanal,2010).

Warmer and wetter weather (particularly warmer winters due to climate change) will increase the risk and occurrence of animal diseases, as certain species who serve as disease vectors, such as biting flies and ticks, are more likely to survive year-round. At higher temperature, numerous diseases display greater virulence. As a result of climate change the environment becomes favorable for the disease agent (bacteria, virus, etc.) and the host will become susceptible easily.

The epidemiological triad between agent, host and environment becomes imbalanced and -different diseases which were not present in -an ecological region may be seen, and certain existing parasitic diseases may also become more prevalent, or their geographical range may spread,if rainfall increases. Increased temperature may cause thermal stress in terrestrial and aquatic animals, leading to reduced growth, sub optimal behaviors, decrease productivity and reduced immune competence of the animals.

Higher temperatures tend to reduce animal feed intake and lower feed conversion rates (Rowlinson, 2008) and extra investment cost to keep animal warm or cool during climatic extremes is forecasted to increase. Unusual climatic changes and variability such as rising temperature, irregular monsoon, precipitation and erratic rainfall patterns have led to loss of large number livestock species ultimately affecting the income and food security of marginalized system, and emergence of unpalatable forage species in the rangeland and decrease the byproducts of agriculture and forage causing scarcity of fodder and forage for livestock.

Climate change has a major challenge to livestock production in the pastoral system through its impacts on forage production, water availability, disease risks and thermal stresses. Localized evidence from pastoral areas in southern and southeastern parts of Ethiopia (e.g. Borena and Shinile) highlights decreasing rainfall trends being a major cause of declining livestock production. Also stated that drought is the most crucial climatic variable that cause decline in pastoral livestock production. Other studies also reported that drought have frequently affected Guji - Borana pastoralists of southern Ethiopia, causing substantial livestock losses, declining agricultural production, and food insecurity.

On the other hand, pastoral communities have an indigenous knowledge about their environment and have been implementing various adaption strategies to cope with climate related risks and environmental stresses. Such adaption strategies have important cultural and religious dimensions and implications but their usability and effectiveness may remain limited because of values, processes and power relations in society. Studies have suggested that understanding local climate knowledge of communities can be valuable for decision-making processes.

According to Abate, traditional knowledge may provide new insights for improving existing scientific knowledge and a basis for designing appropriate research and development policies. Furthermore, the potential importance of local practices in enhancing socio- ecological resilience has been underestimated particularly in pastoral production system of Ethiopia including the Guji pastoral and agro-pastoral areas. In recent years, however, extreme climatic events (e.g. recurrent drought, and rainfall variability), attributed to food insecurity, poverty and exacerbate the existing vulnerability in the area.

1.2. Statement of the problem

Ethiopia is amongst the top countries in Africa that vulnerable to climate change. Directly or indirectly pastoralists dependent on the natural resources are being challenged by threats from climate change impacts, such as water scarcity, the changed trend of rainfall and drought pattern, increasing of desertification and bush encroachment in the range lands, expansions of human and livestock diseases and aggravated conflicts through competition for resources mainly through water and pasture scarcities.

However, the pastoral communities sustaining and surviving their life through their knowledge-based adaptation practices, but still most researchers' do not consider pastoralists' Indigenous Knowledge as a base for scientific knowledge in every aspect. Accordingly, the policies outlined in different countries were largely inadequate in addressing the pastoral communities' problems including their vulnerability reduction from the impacts of climate change.

Similarly, in Ethiopia, the government pastoral area policies are inadequate in the light of the frequent occurrence of droughts and climate change impacts in general. Southern Ethiopia, where Guji Zone is located, and some parts of Ethiopia's Somali region relied on their IK aimed at minimizing losses from climate change or facilitating recovery thereafter . Especially, the Guji pastoralists living in Sabba Boru district of Guji zone are affected by the brunt of climate change and live with a set of problems arising from it there. However, they were adapted to the impacts of climate change and reducing their vulnerability through their IK based weather forecasting, pond and well construction and management (water related practices), hay collection and storage for dry season, seasonal livestock mobility, participation on crop cultivation, livestock species diversification, livestock traditional health care systems. As a result, they are surviving in these very challenging environmental situations, in the area. So, studying the effects of climate change and adaptation strategies of pastoral communities is important, and this study is designed to addressing some of these gaps and to scale up its important role in autonomous adaptation in the local area.

1.3 Research Questions

1. What is the effect of climate change on cattle raring in Adola Rede Woreda?

1.4 Objectives of the Study

1.4.1 The general objective of study

The overall objective of this study is to assess the effects of climate change on cattle raring in study area.

1.4.2 The specific objectives of study.

- To examine the effects of climate change on livestock sector in the study area
- To Identifying pastoralists' adaptation strategies to climate change in the study area.

1.5. Scope and Limitations of the Study

The study will focuses on the issue of effect of climate change on cattle raring among farmers in study area, the study will conduct by taking samples from a District which will select purposively that could not allow making generalization about the whole Region and though farmers in the study area produce a variety of livestock, this study will focuses only on cattle and other livestock's are not included, and does not included Allocative and Economic efficiency of study. Only studies effect of climate change on cattle raring. The study will conduct using cross-sectional data. As cross sectional data reflects farmers' circumstances in a given year, specific climate of the year may affect the result as agriculture is weather dependent.

1.6 .Significance of the Study

As it recommend by Yin (2008), the case study approach is appropriate to make study in-depth. An effect of Climate change differs from region to region and hence it needs detail study to identify the effects and adaptation methods that fits with specific place. According to Admassie et al, (2008), in-depth studies on vulnerability and adaptation should continue. To this end a representative single-case study approach is appropriate. It could allow addressing a gap in the literature by examining one Woreda level initiative aimed at integrating adaptation strategies to climate change. The case study provides an example of a process that may also be useful in similar locations where changing climate is an issue and agriculture is prominent. Thus, this study would have significant contribution for the local and national government, NGOs or other bilateral donors in an effort to minimize the impact of climate change at local level through providing the necessary policy input. These include the local level adaptation strategies for climate change and factors that affect the farmer's decision to undertake adaptation. This is important particularly in assisting the government in assuring the food security which needs implementation of appropriate policy to adaptation for climate change. Hence, it is important to make study at the local level so as to identify the adaptation strategies that suit to the specific geographical area.

2. LITERATURE REVIEW

2.1. Theoretical Review

2.1.1 Impacts of Climate Change in Ethiopia

The living condition, housing condition, disease outbreaks, disease distribution, feeding style, clothing style, migration and conflict under social condition, income, food availability, food accessibility, consumption level, price of goods and services, livestock yield, livestock number and poverty under economic condition and forage quantity, forage quality, pastoral zone, water availability, water quality, loss of biodiversity, heat, flooding, and drought, are all present environmental conditions. The impacts of the changing climate are treated under three categories: social, economic and environmental impacts, because climate change has the potential to create a wide range of biophysical, social and economic impacts (Bordt and Smith,2008).

2.1.2 Impact of Climate Change on Animal Productivity in Ethiopia

According to Jones, R.N. (2000) climate change affects animal production by changing livestock feed-grain availability and price, livestock pastures and forage crop production and quality; distribution of livestock diseases and pests; and direct effects of weather and extreme events on animal health, growth and reproduction. The indirect effects of climate driven changes in animal performance result mainly from alterations in the nutritional environment. Due to climate variability, the community did not have an expected yield or products from their animals. In order to increase livestock's contribution to the livelihoods of developing communities requires improved understanding of livestock's multiple and complex roles.

2.1.3 Increased Temperature and Effects on Livestock Production

The productivity and performance of livestock will be affected by climate change. The significant implications of climate change on livestock production include reducing livestock growth, milk production, livestock genetic resources, water availability, disease, reproduction, quality of feed, and forage resources (Henry et al., 2012).

In addition, climate change will cause a reduction in body size, lower meat weight, and lessening of the fat thickness (Inbaraj et al., 2016). Thus, livestock production systems are vulnerable to climate change. There is no doubt that the vulnerability of livestock production will continue to increase, with negative consequences for rural communities, as losing livestock assets will result in poverty and jeopardize their livelihoods. One of the significant effects of climate change on cattle productivity and performance results from heat stress. Heat stress lowers the organic and inorganic milk components produced by dairy cows, causing substantial financial burdens on the farmers (Summer et al., 2019).

It affects meat production and animal health and reduces reproduction efficiency (Abdurehman & Ameha, 2018). Increased temperature due to climate change causes the environment in which the animal survives to become hot, which does not favor the optimum production levels. The hot climate impacts agricultural cattle and causes direct and indirect heat stress on livestock output. The direct impacts generally consist of effects caused by increased frequency and intensity of heatwaves due to rising temperatures. The immediate effect of heat stress causes alteration responsible for producing metabolic disturbances and oxidative stress in cattle's while indirect results of heat stress cause alteration in the availability of quality feedstuff and water for survival (Lacetera, 2019).

The reproduction efficiency of livestock is also highly vulnerable to climate change. Heat stress due to increased temperature harms livestock reproduction performance (Hansen, 2007). For example, hot conditions disrupt several reproductive processes, resulting in pronounced depression of conception rate (Wolfenson & Roth, 2019). In cows for example, increasing temperature and high heat radiation load can negatively impact the reproductive rhythm via the hypothalamic-hypophyseal-ovarian axis (Sheikh et al., 2017). In addition, during pregnancy, heat stress can slow down embryonic development, resulting in reduced fetal growth and subsequently small calf size (Samir, 2017). In some instances, heat stress in dairy livestock has caused early embryonic deaths (Samal, 2013). In bulls, the concentration of semen, the number of spermatozoa, and motile cells per ejaculation were found to have decreased in summer, often resulting from increased abnormal temperatures (Sheikh et al., 2017).

It was reported that their testis temperature reached around 2-6 degrees Celsius, lower than the average body temperature. Therefore, a correct ambient temperature range (5-15 degrees Celsius) is needed to produce better fertile and healthy spermatozoa (Zhou et al., 2020). If the testicular temperature increases above average, it can lead to infertility problems in bullocks

(Cardozo et al., 2006). Similarly, changes in seasonal environmental parameters can reduce the reproductive performance of males (Balic et al., 2012). Heat stress has also been noted to cause a significant reduction in conception and fertility rate per insemination of males, consequently reducing male fitness (Bhakat et al., 2014).

2.1.4 Impact of Climate Change on Mortality Rate in Livestock

Climate change reshapes the environment in which livestock graze. Due to increased temperature, heat-related mortality can increase in livestock (Thornton et al., 2008). For example, heat stroke, hyperthermia, heat syncope, heat cramps, and organ failure in animals are caused by increasing temperature (Lacetera, 2019). Changing precipitation and drought prone areas can also lead to increased loss of domestic livestock (IPCC, 2007). In addition, livestock diseases are likely to increase due to drought (IPCC, 2007).

Similarly, precipitation variations associated with drought can cause the untimely death of animals (Rojas-Downing et al., 2017). In areas where livestock is expansively grown, for instance, on rangelands, the impact of drought on rangeland productivity significantly impacts cattle population dynamics (Kanwal et al., 2020). Furthermore, changes in environmental variables such as warmth and humidity can induce heat stress, responsible for causing an increase in livestock mortality and contributing to lower birth rates (Howden et al., 2008). Additionally, such environmental variations can harm livestock by generating metabolic abnormalities, causing oxidative stress, and immunological suppression, all of which can lead to livestock illnesses and death (Lacetera, 2019).

2.1.5 Impact of Diseases and Parasites on Livestock

Due to Climate Change Livestock diseases and parasites are also crucial factors affecting livestock production and productivity. The negative consequences of climate change on livestock health and welfare result from changes in air temperature, precipitation, frequency, and magnitude of extreme weather events that affect livestock (Lacetera, 2019). Climate change may induce infectious diseases, and specifically, a higher temperature may increase the rate of development of pathogens (Baylis & Githeko, 2006).

On the other hand, changes in wind speed can alter the transmission of specific infections and vectors that can be deadly for livestock (Wittmann & Baylis, 2000). Additionally, pathogens and parasites that are sensitive to moist or dry environments may be affected by changing precipitation and flooding, increasing infestation and livestock mortality rates (Harvell et al., 2002). For example, McDermott et al. (2001), who researched African animal trypanosomiasis in cattle, concluded that climate change, particularly changes in precipitation, is linked with vector-borne diseases. The World Health Organization reported that climate change could indirectly influence the abundance and distribution of parasites or vectors that can affect the disease pattern and, in turn, affect livestock production (WHO, 1996). High temperature and change in rainfall patterns accelerate the spread of existing vector-borne diseases and macro parasites in livestock and introduce new diseases (FAO, 2007). For example, rising temperatures have previously resulted in new livestock diseases that affect animal health and welfare (Digambar, 2011).

Impact of Climate Change on Livestock Feed Resources Climate change is expected to amplify the vulnerability of livestock feed, mainly related to quality and quantity. Climatic characteristics such as temperature and rainfall patterns greatly influence pasture quality and quantity, thus affecting the food resource availability cycle of the livestock throughout the year (Fereja, 2016). A study by Tubiello et al. (2007) revealed that high temperatures caused by climate change were responsible for increasing lignification in plant tissues, decreasing their digestibility factor. Similarly, warming and drying climatic trends were found to negatively affect rangeland productivity by lowering forages' quantity and nutritional quality (Nardone et al., 2010).

In addition, Hidosa and Guyo (2017) concluded that climate change reduces rangelands' productivity and grazing capacity, causing higher levels of nutritional stress in livestock, thus affecting the farm's overall productivity. Consequently, adverse effects on the food resource of animals, resulting from changing climates, will further increase the gap between feed and fodder availability and the requirement of feed and fodder to livestock (Samir, 2017).

2.1.6 Impact of Climate Change on Water Availability for Livestock Production

Water supplies from rivers and rainfall are threatened by climate change. The impacts are related to reduce water availability for livestock production and increased drinking water demand in tropical and subtropical climates. The results are a loss in water availability and forage water content and quality due to extended exposure to high ambient temperatures or drought (Abdurehman & Ameha, 2018). Fibrous fodder can raise fermentative heat and the thermoregulatory demand for water in animals (Nardone et al., 2010). Animals exposed to hot environments drink 2-3 times more water than animals in thermo-neutral situations, putting them at risk, and changes in water pH can impact animal's metabolism, fertility, and digestion (Abdurehman & Ameha, 2018**).**

2.1.7 Impact of Climate Change on Livestock Genetic Resource

Livestock genetic resource is defined as genetic diversity found among or within animal species or breeds having economic or other socio-cultural values (Kantanen et al., 2015). Livestock's genetic resources play a crucial role in food security, nutrition, and livelihood and are critical components of sustainability, resilience, and adaptability in livestock production. However, livestock breeds and species are decreasing, affecting genetic biodiversity. For example, Thornton et al. (2009) highlighted that local breeds of livestock could become extinct due to climate change. In addition, climate change will enhance the growth and multiplication of new pests and diseases that will affect the livestock, particularly the local and indigenous breeds that are already highly susceptible.

Likewise, Thomas et al. (2004) reported that climate change could eliminate 15 to 37% of all species globally, causing food insecurity, malnutrition, and livelihood problems among those who heavily depend on animals for survival. More specifically, a change in temperature by 2 to 3 degrees Celsius may result in 20 to 30% of biodiversity loss of livestock (IPCC, 2014). Additionally, climate-induced extreme weather events such as droughts, flooding, and hurricanes will also affect many animal species and breeds. Such events can also completely wipe out all the breed population concentration locally, such as within a limited geographical area, affecting the local breeding program (FAO, 2015)

2.2. Empirical Review

2.2.1 Adaptations or Coping Mechanisms to climate change Impacts

According to the UNDP Climate Change Profile for Ethiopia, the mean annual temperature in Ethiopia has increased by 1.3°C between 1960 and 2006, at an average rate of 0.28°C per decade. The temperature increase has been most rapid from July to September (0.32°C per decade). It is reported that the average number of hot days per year has increased by 73 (an additional 20% of days) and the number of hot nights has increased by 137 (an additional 37.5% of nights) between 1960 and 2006. The rate of increase is seen most strongly in June, July and August. Over the same period, the average number of cold days and nights decreased by 21 (5.8% of days) and 41 (11.2% of nights), respectively. These reductions have mainly occurred in the months of September to November (McSweeneyet al.(2009)

According to Deressa and Hassan (2009) studies that have investigated the impacts of climate change in the context of Ethiopia using a Ricardian approach, find that the climate variables have a significant impact on net crop revenue per hectare of farmers under Ethiopian conditions. They also find that, whereas marginally increasing seasonal precipitation during the spring would significantly increase net crop revenue per hectare, marginally increasing seasonal temperature during summer and winter would significantly reduce net crop revenue per hectare.

Adaptation to climate change: Adgeret al . (2007) defines adaptation to climate change as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation can be described by different scholars based on level/scope, time and management plan.

According to Burton et al (2002), the term “adaptation measures” covers eight categories: bearing losses (doing nothing), sharing losses, modifying the threat and thus preventing effects, changing use, changing location, accessing new research based technologies, disseminating knowledge through education to change behavior, and restoration. Others have classified the different forms of adaptation as anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC, 2001 cited in Yohannes and Mebratu, 2009) . Adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to drought (WCDP, 2004; IPCC, 2007b).

Adaptability refers to the degree to which adjustments are possible in practices, processes or structures of systems to projected or actual drought. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions (Watson et al., 1996, quoted in Smit et al., 2000). Smit et al. (2000) also discuss various typologies and distinctions related to the process of adaptation which appear in the literature. For example, according to some of the typologies considered, adaptation can be planned or spontaneous; passive, reactive or anticipatory, etc. From their point of view, it may be that planned, anticipatory adaptations that are undertaken by governments or NGOs as a policy initiative (as opposed to those that are autonomous and/or mainly reactive) are those that require the most attention. Furthermore, it is important to assess not only the "best" adaptation options, but also what adaptations are likely in various settings.

According to the WCDP, adaptation "has the potential to reduce adverse impacts of climate change, but will incur costs and will not prevent all damages." Furthermore, it is argued that human and natural systems will, to some extent, adapt autonomously and that planned adaptation can supplement autonomous adaptation. However, "options and incentives are greater for adaptation of human systems than for adaptation to protect natural systems" (WCDP, 2004:4). The propensity of systems (e.g., socio-economic systems) to adapt is influenced by certain system characteristics that have been called "determinants of adaptation" in the literature. These include terms such as "sensitivity," "vulnerability," "resilience," "susceptibility" and "adaptive capacity," among others. The occurrences as well as the nature of adaptations are influenced by these. As Smit et al. (2000) point out; there is some overlap in the concepts captured in these terms. The same authors argue that sensitivity, vulnerability and adaptability capture the broad concepts. Definitions of terms that describe system characteristics that are relevant for adaptation include the following:

Vulnerability: degree to which a system is susceptible to injury, damage or harm Impact potential: degree, to which a system is susceptible to drought,

Resilience: degree to which a system rebounds, recoups or recovers from a stimulus Responsiveness: degree to which a system reacts to stimulus

Adaptive capacity: the potential or capability of a system to adapt to (to alter to better suit) drought crisis,

Adaptability: the ability, competency or capacity of a system to adapt to (to alter to better suit) drought disaster.

Building on some of this literature, and on its previous work, the most recent definitions adopted by the WCDP (2004) and IPCC (2001, 2007b cited in Mirjam, 2008) are the following:

Sensitivity: the degree to which a system is affected, either adversely or beneficially, by climate-related shocks such as drought.

Adaptive capacity: the ability of a system to adjust to drought and to moderate potential damages, or to cope with the consequences.

Agrawal (2008), classified the basic coping strategies in the context of environmental risks to livelihoods into five analytical categories of adaptation responses and their combinations: mobility, which helps address risks across space, storage (time), diversification (asset classes), communal pooling (across households), and market exchange – which can substitute for the above four classes of risk mitigation when households and communities have access to markets. Mobility -is perhaps the most common and seemingly natural responses to environmental risks. It pools risks across space, and is especially successful in combination with clear information about the spatial and temporal distribution of precipitation.

Storage -as an adaptation practice to address risks, storage is relevant to individual farmers and communities, and to address food as well as water scarcities. Indeed, in light of the significant losses of food and other perishable commodities all over the developing world, improvements in storage technologies and institutions have immense potential to improve rural livelihoods. Diversification- pools risks across assets and resources of households and collectives. Highly varied in form, it can occur in relation to productive and non-productive assets, consumption strategies, and employment opportunities. It is reliable to the extent benefit flows from assets are subject to uncorrelated risks (Behnke et al., 1993; Ellis; 2000; Sandford, 1983). Diversifying households typically give up some returns in exchange for the greater security provided by diversification.

Communal pooling-refers to adaptation responses involving joint ownership of assets and resources; sharing of wealth, labor, or incomes from particular activities across households, or mobilization and use of resources that are held collectively during times of scarcity. It pools risks across households. It is most effective when the benefits from assets owned by different households and livelihoods benefit streams are uncorrelated. When a group is affected in a similar manner by adverse climate hazards – e.g., floods or drought, communal pooling is less likely to be an effective response**.**

Market Exchange -is perhaps the most versatile of adaptation responses. Indeed, markets and exchanges are a characteristic of almost all human groups, and are a mechanism not just for adaptation to environmental risks but also critical for specialization, trade, and welfare gains that result from specialization and trade at multiple scales. Market exchange-based adaptation practices can substitute for the first four when rural poor have access to markets. But they are likely to do so mainly when there are well developed institutions to facilitate market access.

While sale of poultry and livestock, informal trade and casual employment are coping strategies common to most areas of eastern Africa, the exact combination of activities in which a household engages depends both on the options available locally and the labor availability, education, skills, and access to capital of the household or individuals within it. In addition to resource access, strong local links between and within social groups and local knowledge of environmental processes are important for coping and adapting (Eriksen et al., 2008).

2.2.2 Livestock Adaptation Strategies to Climate Change Smallholder livestock

Farmers in the past have adapted to various ecological and climatic change impacts by building on their knowledge of the environment for rearing livestock (Myeki & Bahta, 2021). However, increasing population, urbanization, environmental degradation, and increased consumption of animals for foods have rendered the effectiveness of the coping mechanisms (Sidahmed et al., 2008). Moreover, the speed at which environmental-related changes occur due to global warming will likely outpace our adaptation strategies. Nevertheless, adaptation is one of the strategies that could reduce the impacts of climate change and can also be used to address the emerging risks associated with global warming. Several experts have identified the following adaptation techniques to increase adaptation in livestock production (Rischkowsky et al., 2008; Barrett et al., 2008; Kitalyi et al., 2008; Henry et al., 2012; Tiruneh & Tegene, 2018; Bernabucci, 2019).

Farmers can modify and enhance their current livestock production practices through the following methods.

Intensification and diversification of pasture management: The intensification and diversification of the pasture system will also increase grazing pressure and intensity (Cardoso et al., 2020). One way to achieve this is by planting drought-tolerant shrubs such as A triplex and Acacia species because they are essential for rehabilitating rangeland. The shrubs can also be utilized as an ingredient in feed blocks (Estell et al., 2012). Similarly, tree forages have shown potential to increase the growth performance of livestock, and so have pasture grass cultivars that are drought tolerant (Cyriac et al., 2018). Farmers can also develop low-cost feed blocks made from agro-industrial by-products such as tomato pulp, molasses, crude olive cake, sesame cake, citrus pulp, sunflower cake, and mulberry leaves (Yang et al., 2021).

Livestock management system: This is possible by providing farmers with efficient and cheap adaptation practices over expensive adaptation technologies, such as providing shade and water to the livestock to reduce heat stress from high temperatures. Livestock caretakers can also reduce or split the livestock herds into small manageable groups, allowing for smaller group movements of livestock into different areas for grazing purposes, ensuring the long-term productivity of rangeland. Flock management intervention can be adopted by farmers as well, as this will allow finding other suitable ways to feed the livestock, for example, during heavy droughts. Mobilizing livestock from drought-prone areas to areas that receive reasonable precipitation can act as a vital pastoralist adaptation to counter the challenges of spatial and temporal variations in rainfall. The introduction of localized and straightforward water irrigation for better management of water resources for livestock can also be implemented, for example, through the development of rainwater harvesting infrastructure and storage facilities (Sonder et al., 2003; Hilali et al., 2010).

Nutritional management in livestock: When the temperature increases, feed intake by the livestock tend to decrease. Farmers can therefore graze their livestock during the night. Night grazing will partially fulfill the nutritional requirement, but the livestock will still exercise for normal physiological functions. To counter reduced feed intake, farmers can level up the concentration of vitamins and minerals to enhance the livestock's health. In addition, a highly digestible high energy ratio is an effective feed formulation for livestock in summer because it aids in controlling their body temperature. In the form of livestock exercise on the hottest days, the walking time could also be reduced, because livestock walking, often in herds, allows the generation of heat loads. The farmers could take the feed to the livestock preventing long walking distances of the livestock to the piled feed locations.

Breeding and acclimatization strategies: To counter heat stress problems due to climate change, it is crucial to breed indigenous or local livestock breeds. These breeds naturally have been found to have high heat tolerance capabilities and are adapted to the harsh realities of the environment. Farmers should improve local species through cross-breeding with heat and disease tolerant genotypes to allow better acclimatization of breeds. Farmers should also identify and strengthen local breeds that have adapted to local climatic stressors through reproduction technologies such as embryo transfer technology to increase reproduction efficiency in livestock. To increase livestock fertility during periods of heat stress, farmers should be trained to use supplementary hormones such as progesterone and improve heat synchronization in females through GnRH to improve fertility effectiveness. Livestock genetic resource management should be integrated into climate change adaptation planning at the production level to preserve local and exotic genetics.

Capacity building for livestock farmers: is integral to improving livestock keepers' capacity to understand and overcome climate change risk to livestock production by increasing their awareness about global climate change and its impacts. Furthermore, livestock producers should be trained with agro ecological approaches, methodologies, technologies, and practices to produce and conserve pasture, reducing malnutrition and mortality issues. In addition, it is vital to increase farmers' capacity to improve the management, productivity, revenue, and long-term stability of their livestock systems. This could be achieved by continuously enhancing their inventiveness, strategies, procedures, practices, and performance. (VI) Early warning system is a data-gathering system that helps monitor and provide timely information on climate-related stress. The installation and implementation of early warning systems will give a strengthened rational approach to risk management and improve the prospect of sustainable livestock production through better disaster preparedness plans. In turn, this will increase the resilience capacity of livestock producers and maximize their ability to cope with external shocks and reduce their vulnerability to adversities resulting from extreme drought.

2.2.3 Livestock Mitigation Strategies to Climate Change

The selection and implementation of mitigation measures for livestock production, as a response to the impacts of climate change, should consider measures that are easy to implement and cost-effective to increase the capacity of local actors, particularly the smallholder livestock farmers. Livestock production systems, which are susceptible to climate change, contribute to global warming. This is because livestock themselves produce greenhouse gases, such as Methane and Nitrous oxide, majorly associated with livestock waste (Dourmad et al., 2008). The mitigation of greenhouse gas emissions and livestock waste can be achieved through possible mitigation options.

Feeding management: There are various feed additives that reduce methane emissions. These include ionospheres, antibiotics, halogenated compounds, and propionate precursors (Indira & Srividya, 2012). Feeding livestock with a higher concentration of concentrate in livestock diet can reduce methane emissions as a percentage of total energy intake (Singhal & Mohini, 2002; Sejian, 2013). Livestock farmers can also feed additives such as monensin to reduce methane emission by 21% (de Souza et al., 2021). In addition, livestock farmers can provide feed with higher efficiency and digestibility rate because it helps reduce greenhouse gas emissions (IFAD, 2009).

Better waste management: involves improving livestock waste management and disposal through various mechanisms such as covered storage to reduce GHG emissions. Disposal improvement of farmyard manure can be used for biogas production to reduce methane emissions from waste (Sejian, 2013). Manure mitigation should use low-tech measures such as covering and cooling manure lagoons during storage and alternative approaches such as appropriate manure application, handling, and storage for manure dispersion (Weiske et al., 2006). Another alternative for waste management is to change the overall bedding materials for the animals, which could affect the pH and soluble carbon and nitrogen levels in the manure, thus reducing the emission of methane (Sejian, 2013).

Grazing management: Proper pasture management through rotational grazing would be cost-effective to mitigate GHG emissions from feed crop production (IFAD, 2009). Expressly, rotational grazing should be incorporated, as multiple smaller fields referred to as paddocks, for livestock rotation. Farmers can adjust stocking numbers and grazing duration by subdividing pastures, rotating animals, and managing their nitrogen excreta dispersion and pasture re-growth. This will also allow for the uniform distribution of urine around the paddock, potentially lowering nitrous oxide emissions (Eckard et al., 2010). Sward damage and soil compaction during wet weather can also be reduced by keeping the animals off-paddock. Excreta deposition during wet weather will also minimize nitrous oxide emissions and nitrogen leaching into the atmosphere (Luo et al., 2010).

Lowering livestock and consumption: Lowering the production and consumption of milk and meat in areas of a high standard of living can be a short-term response to GHG emissions (IFAD, 2009). A decrease in demand would mean a decrease in livestock to produce the necessary consumer items. Both industry and the government, on the other hand, want to keep output at a maximum to fulfil food demands; therefore, it is vital to use cost-effective techniques to make each livestock more productive.

Fertilizer management: In increasing livestock feed crop production, synthesized fertilizers are used, contributing to nitrous oxide in the atmosphere. Farmers can increase nitrogen use efficiency or use organic fertilizers to overcome this problem. In addition, using enhanced fertilizers and combining the plantation of legumes with pasture may decrease GHG emissions in production (Dickie et al., 2014).

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

Adola Rede Woreda is found at 475km from Addis Ababa. The absolute location of the district is between 5o44'10"N- 6o12'38"N and 38o45'10"E - 39o12'37"E. It shares boundary with Girja in North-East direction, Anna Sorra in North-West direction, Oddo Shakiso in Southern direction and Wadara in South-East direction. It has a total area of about 1401km2. Most part of the topography of this Woreda is characterized by ups and down. Moreover, it has land surface with an elevation ranging from 1500 meters in the Southern portion to over 2000 meters in the North-Western part. Like in many parts of Ethiopia, the farming system in Adola Rede is still traditional with oxen and yolk (animal's power), and labor as the major means of production during land preparation, planting and harvesting as well as post-harvest process. Rain-fed agriculture is a common practice for many farm households in this Woreda. However, a semi-nomadic economic activity is also practiced as a means of livelihood by some of its residents. This Woreda has 28 rural kebeles and two urban kebeles with population number of 149735 in year 2008. The farmers of this Woreda produce both in meher and belg seasons. They produce cereals such as teff, wheat, barley and maize, pulses such as haricot bean, and others such as fruits and vegetables. Overall, wheat, maize and teff are the major crops cultivate by the farmers in this study area. They also engaged in the production of coffee as means of livelihood. Moreover, this Woreda has a potential for livestock production which is witnessed by farmers ownership large number of livestock.

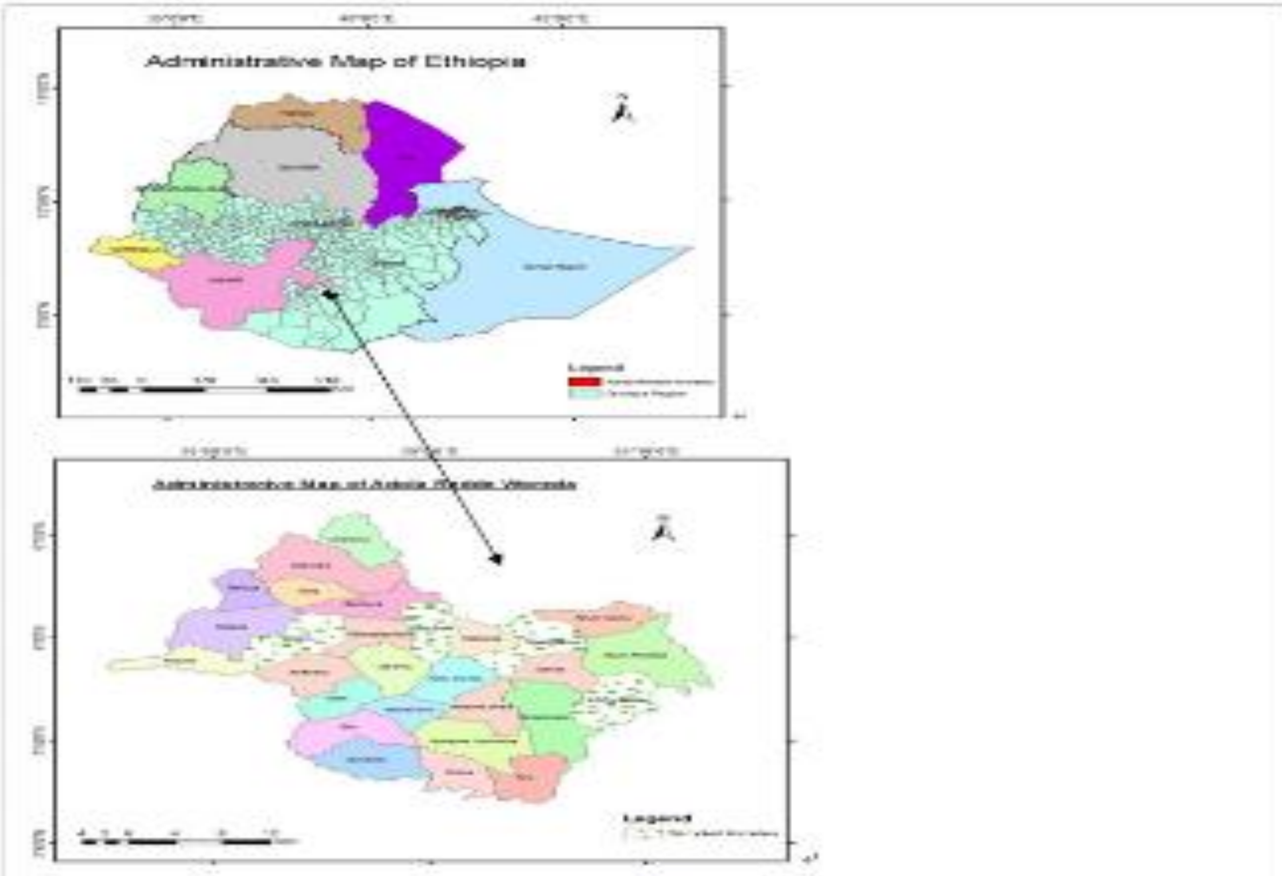

Figure 3.1 map of the study area

3.2. Data types and sources

This study was conducted in Adola Rede district to study effects of climate change on raring of cattle. The study was focused on effects of climate change on raring of cattle. To undertake this study we were used the primary and secondary data. The primary data were collected from the smallholder farmers of the Adola Rede district using a survey questionnaire and semi interview schedule with key informant groups. The survey questionnaire were prepared in English and translated to local language (Afan Oromo) so as to get accurate information from the households since this language is used by the majority of the resident in this district.

Sample size and sampling methods

Adola Rede district has 33 rural kebeles and two urban kebeles. It has three agro-ecological zones namely: dega,woina dega and kola. In this study, samples of 100 smallholder households were taken from Adola Rede district smallholder farmers. In order to select these respondents a two-stage sampling approach was employed. First, three Kebeles was selected out of 33 rural Kebeles in the district purposively based on agro-ecological zones and the intensity of the impact of the climate change and variability. Second, using systematic sampling method households were selected from each of randomly selected kebeles proportionally. In this case the lists of the households were collected from the kebele administrator's or development agent officials of each kebele first. In systematic sampling method by using random numbers to pick up the unit with which to start, an element of randomness is usually introduced. The sample size for the study was determined by Yamane (1967).

Where, n = total sample size, N = total target population and

N=149735

e = margin of error = 10% for social science

Therefore, n = 149735/1+ (149735*0.01) =99.93

Therefore it becomes approximately 100 total respondents.

Table: 3.1. Purposively selected kebeles for study, number of households and sample size

No.	Name of kebeles	Agro-climatic zone	Household size	Sample size
1	Dilallessa	kolla	913	44
2	Boke	woina dega	380	18
3	Maleka	dega	800	38
Total			2093	100

Source: Adola Rede Woreda Administration, (2013/14)

3.3. Methods of data analysis

After data collection descriptive method of data analysis was employed to analyze data.

Descriptive analysis

This method was employed to summarize and analyze the effect of climate change on cattle raring small holders. We were used Descriptive statistics such as mean, standard deviation, percentage and frequencies to analyze the effect of climate change on cattle raring of the sample farmers, by using SPSS version 16 software.

4. RESULTS AND DISCUSSION

This chapter deals with the presentation of results and discussion. It is divided into four parts. The first part presents the background of the respondents, the second part presents climate change and variability trends, the third part describes the Effects of climate change on pastoralism and agro pastoral systems; the fourth part adaptation strategies among pastoralists and agro pastoralists and determinants of adaptation strategies. Under chapter five summary, conclusion and Recommendation were presented.

4.1 Demographic Characteristics of the Respondents

The investigator found it is important to establish the gender proportions of the respondents. As presented in table 1, 76 % of the respondents were men while 24 % of the respondents were women. This gender distribution has a lot of implications in understanding the perception of men and women and the nature of strategies used to cope with adverse climate changes between male and female members of the pastoralists and agro pastoralists households. As shown in the table 3, 82% of the households are married and 18% households are not married.

Concerning the educational status of sampled household's, the survey results indicates 34% of the total samples have no education, 36% of the sampled households were in their primary education ,24 % were at secondary school and 6% of the total Sampled households were in Graduate. The age of the household's heads is categorized as young, adult and old age populations. Regarding age compositions of the respondents 43% of the household's fall under the age category of 15-24 years(young age) followed by % are in age 25-64 years (youth age) and 17% are in the age group of >65years (elder).

Table 1: Demographic Characteristics of Respondents

Variables		Frequency	Percent (%)
Sex	Male	76	76
	Female	24	24
	Total	100	100
Age	Young age	43	43
	Adult age	40	40

	Old age Total	17 100	17 100
Marital status	Married Not married Total	82 18 100	82 18 100
Educational level	No education Primary school Secondary school Graduate Total	34 36 24 6 100	34 36 24 6 100

Source: own survey, 2023

As showed in table 2, Pastoralism was reported to be the main occupation with 65 % (n=65) of the respondents depend on on it. About 30% (n= 30) are agro pastoralists and 5 % of the study area communities were involved in other business like goods trade.

Table 2: Socio-economic activity

Activity	Frequency	Percentage
Pastoralism	65	65
Agro pastoralism	30	30
Other business	5	5
Total	100	100

Source: own survey,

The participant respondents showed that rainfall and temperature in study area has been decreasing and increasing, respectively, thus negatively affecting the production and management of crop and livestock in the study area. Crop failure and livestock mortality is common problem in the study area due to shortage of rainfall and severe drought. Pastoral livelihood and livestock production which is more correlated with rangeland productivities. In the other ways this rangeland has been affected seriously by the climate change in the lowlands which induces the frequent recurrence of drought that lead to livestock mortality. Pastoralists and agro-pastoralists in Adola Rede area indicated that climate change had its effect on their production systems through various mechanisms. As indicated in table (3) about 27.86% of the sample respondents replied feed shortage is the main effect of climate change followed by shortage of water (22%), increased mortality (20%), reduced crop and livestock productivity (17.04%) and increased disease prevalence (13.11%), respectively. Similarly, as prioritized by respondents during the group discussion, the five major effects of climate change on crop and livestock production ranked by pastoralists and agro-pastoralists were; feed shortage, shortage of water, reduced productivity, increased mortality and increased diseases prevalence in their order of importance.

Table 3: Perceived effects of climate change on crop and livestock production.

No	Perceived effects of climate change by pastoralist and agro-pastoralists.	Respondents	
		Number	Percentage
1	Feed shortage	85	27.86
2	Shortage of water	67	22
3	Reduced crop and livestock productivity	52	17.04
4	Increased mortality	61	20
5	Increased disease prevalence	40	13.11
	Total	305	100

Source: own Survey,

In table 4, In the case of agro pastoral communities, this study found that mixed crop-livestock farming 82(43.16 %) was dominantly supporting their livelihood bases. Similarly, agro-pastoral communities were employed Crop diversification as the second adaptation and about 48(25.25%) perceived fodder production as adaptation strategy and non-farming activity and changing cropping calendar were employed as inferior strategy to other adaptation option

Table 4: Climate change adaptation strategies by agro pastoral farmers

No	Adaptation choice	Frequency	Percent (%)
1	Crop diversification	48	25.25
2	fodder production	36	18.95
3	Changing cropping calendar	9	4.74

4	Mixed crop-livestock farming	82	43.16
5	Non-farming activity	15	7.9
	Total	190	100

Source: own Survey,

In table 5, About 88(73.94%) of the pastoral communities responded that diversifying their livestock to that can tolerate the changing climate (drought-tolerant species), 16(12.6%) of respondents indicated that the growing strain of climate-induced difficulties have pressed them to increase their mobility in terms of distance and frequency. Mobility is a survival and resource management strategy commonly 48 practiced by herder societies for efficient use of meagre and scattered rangeland resources for sustainable livelihoods in the face of climate fluctuations in the study area. Mobility is a good practical instance of locally adapted strategies in dry land areas (Martin et al., 2014).

About 28 (9 %) of households reported they have privately fenced communal rangelands for fodder production. Since private enclosures for fodder production are not allowed, the most convenient way to have one is through a calculated stance in pastoral household decision by fencing the communal land for the double purpose of cereal cultivation and dry season hay-making. Non-farming activities and herd destocking were the least adaptation strategies used by the pastoralists (Feyera 2021).

Table 5: Climate change adaptation strategies by agro pastoral farmers

No	Adaptation Choice	Frequency	Percent (%)
1	Purchasing and providing supplementary feed	10	8.4
2	Diversification of Livestock species/types	88	73.94
3	Herd mobility/Migration	15	12.6
4	Herd Destocking	6	5.04
	Total	119	100

Source: own Survey,

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APPENDIXES I

Questionnaire for Households

Date _______________
No. ________________

A. GENERAL INFORMATION AND HOUSEHOLD COMPOSITION

1. Kebele name _____________

2. Household number___________________

3. Respondent name__________________

4. Respondent number________

5. Age of respondent_______

6. Sex of respondent [ ] 1=Male [ ] 2=Female

7. Ethnic group: [ ] 1= SNNP [ ] 2= Amhara [ ] 3 = Tigere [ ] 4 =Oromo [ ] 5=other

8. Religion: [ ] 1=Ethiopian Orthodox ; [ ]2=Protestant; [ ]3=Catholic; [ ]4=Muslim; [ ]5=Others

9. Household head [ ] 1=Male; [ ] 2=Female

10. Marital status

    [ ] 1=Single [ ] 2=Married [ ] 3=Divorced/separated

    [ ] 4=Widowed [ ] 5= spouse left for job

11. Age of the household head________

12. Current size of the household

    [ ] 1= <10 years; Male =_____, Female = ________

    [ ] 2= 11-14 years; Male =_____, Female =_____

    [ ] 3= 15-49 years; Male =_____, Female= ____

    [ ] 4= 50-65 years; Male =_____, Female =____

    [ ] 5= > 65 years; Male =_____, Female =_____

Summary

Total number of members in the Household____________

No. of active/working members of the household ________

No. of dependents_______

B. EDUCATIONAL BACKGROUND

13. Can you read and write? [ ] 0=No [ ] 1=somewhat [ ] 2= Yes

14. How many years of formal education have you completed? (For the head)

[ ] 1=None [ ] 2=primary [ ]3=secondary

[ ] 4=tertiary (college and above)

4.1[ ] Diploma 4.2[ ] Degree

15. Did you receive any vocational training? [ ] 1= yes; [ ] 2=No

16. If yes, specify the subject of training ____________________

17. Education level of members in the household

[ ] 1=None; Number _______; Male______; Female_______

[ ] 2=primary; Number _______ Male______; Female_______

[ ] 3 =secondary; Number _______ Male______; Female_______

[ ] 4=tertiary (college and above) [ ] Diploma [ ] Degree;

Number _______ Male______; Female_______

C. OCCUPATION

18. What is your main occupation?

[ ] 1=Farming only [ ] crop production [ ] animal husbandry

[ ] 2=Farming+ non-farm business (specify in proportions)_________

[ ] 5=other specify

AppendixII

Questionnaires

1. Name of the household head ____________________________Sex ________ Age __________

2. Marital status   Married........ Not married .... other specify..............

3. What is your educational level? 1. No education...... 2. Primary school ...   3. Secondary School
.....4. Graduate ......
4. Do you have children? Yes/no If yes, how many ....
5. How do you make your life? Livestock rearing, Livestock rearing and cultivation Other/specify/____
___
6 do you or your family members have another source of livelihood other than agriculture? Yes/No, if
yes specify____________________
7. Do you own land? .... If yes how much? .....
8. How many livestock do you own?
9. How do you characterize the weather of this area in terms of its temperature and precipitation? Is there any change? If yes, how?
10. Have you ever faced any climate related impact in your life time? If yes, what type of climatic
shock?
11. What are the major effects of climate change on livestock and crop production?
a. Decreased productivity …….   c. Feed shortage………..
b. Increased mortality……….   d. Prevalence of disease…………
e. Water shortage………..

12. If the answer to Q11 is yes, did it affect your cattle or/and crop? Yes/No, if yes how much?

____

13. In recent years (within five years), were there any changes in the production of your livestock? Yes……… No……….

14. If yes, what was the trend? A. Increase……… B. Decrease………..

15. In your opinion, have there been changes in rainfall rates in recent years?

Yes……. No……

16. If yes, what changes did you observe? A. Increase B. Decrease

17. Do you think there is any relationship between changes in the production of your crop and livestock and the climatic variable of rainfall? Yes No Explain your answer (in terms of the relationship) ....

18. Do you think there is any relationship between changes in the production of your crop and livestock and the climatic variable of temperature? Yes No

Explain your answer..

19. How did you adapt or what did you do to cope with the situation?

20. Which type of climatic shock is your main concern?

21. What livestock types and number do you own?

A. Goats …….. C. Donkeys……....

D. Sheep……. D. Cattle ………….

E. Camel…….

22. What are the major adaptation strategies in agro pastoral communities?

A. mixed crop-livestock farming yes…… No……..

B. providing supplementary feed Yes …… No…….

C. Fodder production Yes …… No…….

D. Changing cropping calendar Yes …….. No…….

E. Non-farming activity Yes ……. No……

F. Crop diversification Yes …….. No…....

23. What is the major adaptation strategies employed in your area (Only for pastoralists)?

G. Diversification Livestock types Yes…… No……

H. Herd mobility/Migration yes……. No…….

I. Destocking Yes………. No………

J. Non- farming yes……….. No…………

24. What are the major determinants that hinder your adaptation strategies?

1. Poverty Yes……. No ………

2. Information on Climate Yes …….. No………

3. Land Scarcity Yes……….. No……

4.TrainingServices Yes…… No……

5.CreditAccess Yes……… No………

6.Age Yes…… No………

7.Gender Yes…… No…….

8. Level of Education Yes …… No……