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Research Application Summary

Climate change and smallholder livestock production: Impacts and adaptation Strategies in Ethiopia

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Abstract

Ethiopia is one of the countries most affected by climate change since its economy mainly relies on agriculture. In Ethiopia agriculture is characterized by subsistence farming, virtually rain-fed, dominated by cereal crop, cattle and goat production. The Ethiopia Government is implementing a “Climate-Resilient Green Economy” policy and “Growth and Transformation Plan-II” programme to minimize the negative effects of climate change on the national economy. However, the livestock sector is still threatened by climate variability and change through recurrent drought, floods and heat stresses. Thus, this paper reviews what would be the most prominent climate variability and related risks for smallholder livestock farmers, how they are experiencing and adapting to those risks and factors limiting effective utilizing of adaptation strategies. In the country, the average annual temperature has been increasing at about 0.2°C per decade since 1980 whereas precipitation remains constant but declining. The average numbers of “hot” nights and “hot” days have increased by 37.5% and 20% between 1960 and 2003, respectively. In projection analysis, temperature will increase in the range of 0.9- 1.1°C by 2030 whereas rainfall will decline by 25.5 mm/year. The frequency of hot-days and hot-nights will also substantially increase by about 15–29% by 2060. This climate variability has created risky situation in form of unreliable and heavy rainfall, lightning, strong winds, frost, heat waves, droughts, floods and landslides. These affect livestock production and productivity through increased heat stress, reduced feed intake and conversion rate, reduced feed availability, aggravated transmission of animal diseases, increased water scarcity, decreased biodiversity and changing agricultural practices. Thus, climate change is contributing a lot to food shortages and seasonal hunger among livestock keepers. In turn, these are ecological, social and economic impacts at household and national levels. Therefore, there is a need to minimize these negative effects and maintain livestock sector as the mainstay of the national economy and smallholders’ livelihood. So, efforts should be made by government and non-government bodies to promote adoption of existing adaption strategies, designing and implementing others.

Key words: Adaptation, climate change, devastating risk, Ethiopia, livestock production

Résumé

L’Éthiopie est l’un des pays les plus touchés par les changements climatiques du fait de son économie reposant principalement sur l’agriculture. L’agriculture est caractérisée par une agriculture de

subsistance pratiquement pluviale, dominée par la production de céréales, de bétail et de chèvres. Le gouvernement éthiopien met en œuvre une politique «d'économie verte résiliente au climat» et un programme «Plan de croissance et de transformation II» visant à réduire au minimum les effets négatifs du changement climatique sur l'économie nationale. Cependant, le secteur de l'élevage est toujours menacé par les variabilités et changements climatiques dus aux sécheresses, inondations et stress thermiques récurrents. Ainsi, le présent document cherche à examiner la variabilité climatique la plus importante et les risques pour les petits éleveurs, les conditions de vie et d'adaptation à ces risques et les facteurs qui limitent l'utilisation effective des stratégies d'adaptation. La température annuelle moyenne augmente d'environ 0,20 ° C par décennie depuis 1980, alors que les précipitations restent constantes avec une probable diminution. Le nombre moyen de nuits et de journées «chaudes» a augmenté de 37,5% et 20% entre 1960 et 2003, respectivement. Dans l'analyse des projections, la température augmentera de 0,9 à 1,10 ° C d'ici 2030 tandis que les précipitations diminueront de 25,5 mm / an. La fréquence des jours et nuits chaudes augmentera également sensiblement de 15 à 29% d'ici 2060. Cette variabilité climatique a créé une situation à risque sous forme de précipitations peu fiables et abondantes, de lumière, de vents violents, de givre, de vagues de chaleur, de sécheresses, d'inondations et glissements de terrain. Ces facteurs affectent la production et la productivité du bétail en raison d'un stress thermique accru, d'une consommation alimentaire et d'un taux de conservation réduits, d'une disponibilité alimentaire réduite, d'une transmission des pathologies animales, de la pénurie en eau, d'une biodiversité réduite et de pratiques agricoles en mutation. Ainsi, le changement climatique contribue aux pénuries alimentaires et à une famine saisonnière des éleveurs. Ces impacts sont écologiques, sociaux et économiques au niveau des ménages et au niveau national. Il est donc nécessaire de minimiser ces effets négatifs et de maintenir le secteur de l'élevage en tant que pilier de l'économie nationale et du gagne-pain des petits exploitants. Les organismes gouvernementaux et non gouvernementaux devraient donc s'efforcer de promouvoir l'adoption des stratégies d'adaptation existantes, ainsi que la conception et la mise en œuvre d'autres stratégies.

Mots clés: Adaptation, changement climatique, risque dévastateur, production animale

Introduction

In Eastern Africa, Ethiopia is one of the most affected countries with climate change, especially on agricultural productivity and food farming security because its economy mainly relies on agriculture which is characterized by subsistence, virtually rain-fed, dominated by cereal crop, cattle and goat production (Evangelista *et al.*, 2013). The country is also getting warmer by 0.37°C in every ten years since the 1990s (Emerta Asaminew, 2013) and drier by 15–20% in precipitation since the mid-1970s (Chris Funk *et al.*, 2012). Even in the future, the mean annual temperature in the country is projected to increase by 0.44°C and 0.84°C by 2030 and 2050, respectively, and the amount and seasonal distribution of precipitation are anticipated to be highly erratic and difficult to predict (USAID, 2015). The climate changes have already resulted in increased occurrence and coverage of climatic extreme events which in turn, have caused crop failures, livestock death, food shortages and devastating famines in the country.

Under the changing climatic scenarios, efforts are needed to reduce and/or curb the devastating effects of climate change on national economy through designing and implementing plausible adaptation and mitigation strategies (Seibert *et al.*, 2015). Thus, Ethiopia's government has put in place "Climate-Resilient Green Economy" and Growth and Transformation Plan-II as a development policy and strategy to bring climate resilience and sustainable development in the country (Belay

and Getaneh, 2016). However, the sector is still threatened under the effect of climate variability and change through recurrent drought, floods and heat stresses. As a result, livestock farmers also incur extra costs for their animal production and marketing which results in less returns like low income generation, food and nutrition insecurity and reduce role in social and cultural values in many part of the country. In order to design appropriate climate policy and strategies, a deep understanding of the decision processes related to mitigation and adaptation behaviour is indispensable (Osberghaus, 2013). Therefore, understanding the effects of climate change and the coexisting adaptation strategies would help strengthen and/or design location specific adaptation strategies for the changing climate. The main objective of this paper is to review the previous studies to know the nature of climate variability, possible climatic risks, impacts of climate change on livestock production and their adaptation strategies; and identify the most hindering factors from effectively utilizing the existing adaptation strategies in Ethiopia.

Climate change and variability in Ethiopia. In Ethiopia climate change manifests in many ways. These include increasing frequencies of extreme climatic events like droughts, floods and above average daily minimum and maximum temperature and number of hot nights and hot days (Enete, 2014; USAID, 2016). The country has experienced both dry and wet years over the last five decades. In the country, trend analysis of climate variability studies show that average annual rainfall has remained more or less constant while the average annual temperature has got warmer and warmer in every year (Alemu Eshetu Fentaw, 2011; Chris Funk *et al.*, 2012). As indicted in Keller's (2009) report, the average annual temperature in Ethiopia increased at about 0.2°C per decade and its annual minimum temperatures increased at 0.4°C per decade whereas precipitation remained fairly stable over the last 50 years. Mengistu *et al.* (2014) also reported that in the upper Blue Nile River Basin of Ethiopia, the mean annual maximum temperature showed warming trend by 0.1°C per decade for the period 1981–2010, whereas the annual rainfall trend showed increased trends with no statistically significant change. Other studies also reported that, in the country, average number of “hot” nights and “hot” days increased by 37.5% and 20% between 1960 and 2003, respectively (USAID, 2016).

Projection analysis from different studies showed that precipitation is decreasing from an annual average of 2.04 mm/day (1961-1990) to 1.97 mm/day (2070-2099), for a cumulative decline in rainfall of 25.5 mm/year, whereas the mean annual temperature will increase in the range of 0.9 -1.1°C by 2030, in the range of 1.7 - 2.1°C by 2050 and in the range of 2.7- 3.4 °C by 2080 compared to the 1961-1990 normal (NAPA, 2007). The frequency of hot-days and hot-nights will also substantially increase by about 15–29% by 2060 (USAID, 2016). Furthermore, the incidents of climatic extreme events like droughts and floods are projected to increase in the coming decades (Keller, 2009). Though the country get warmer indiscriminately, the temperature rise is more pronounced in the dry and hot spots of the country, which are located in the northern, northeastern, and eastern parts of the country (Emerta, 2013).

Climate related devastating risks in Ethiopia. Climate variability is already imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and disasters (Alemu, 2011). These are mainly caused by recurrent climate related hazards; namely unreliable and heavy rainfall, lightning, strong winds, frost, heat waves, droughts, floods and landslides (NAPA, 2007; Emerta, 2013; Michelle Winthrop, 2018). As a result, according to the Index for Risk Management (INFORM) country risk profiles for 2018, Ethiopia ranks as the 16th most risk prone country, the 39th in terms of hazard and exposure, the 11th in terms of vulnerability and the 27th in terms of lack of

coping capacity from 191 countries (Michelle, 2018).

However, it is important to note that the level and extent of exposure to those hazardous risks are not the same all over the country because of various reasons. For example, in Oromiya region Guduru district, late rain, droughts and animal disease and pests outbreak were the major devastative risks (Keller, 2009) whereas in Southern Tigray region, drought, flood and water-logging were the common environmental shocks for many rural communities (Gebre Hadgu and Kindie Tesfaye, 2015). In general, increase in the inter-annual variability of precipitation in combination with warming of the country, the likelihood of drought and flash flood occurrence have become prominent devastative risks in many part of the country (Keller, 2009). The harsh effects of climate change are expected to have maximum impact on lowland areas, i.e., pastoral communities engaged in extensive livestock production systems because the areas are largely dry and exposed to flooding during extreme precipitation in the highlands (Emerta, 2013; Temesgen and Aleme, 2014).

In Southern Ethiopia, recurrent droughts, flash floods, diseases, and pests are the major prevalent climate related risks for pastoralists (Aklilu and Desalegn, 2013). A similar study also revealed that unpredictability of the rainfall, less volume of annual rainfall as well as seasonality of rainfall, duration of rainy season, and recurrent drought and heat stress are the major climatic related risk for pastoralists in southern Ethiopia (Bekele *et al.*, 2014). A study in Afar region, which is located in the North eastern part of Ethiopia, reported that the major climatic devastative risks are rainfall variability, human and animal diseases, resource degradation, flooding and strong wind (Gebreyes *et al.*, 2017). Areas in the Afar Region along the Awash River, in the Somali Region along the Wabi Shebele River and in the Gambela Region along the Baro-Akobo River, in the Southern Region along the Omo-Gibe River, Bahirdar Zuria and Fogera areas along the Abbay River in the Amhara Region are prone to seasonal river floods (NAPA, 2007). Because of significant dependence on the agricultural sector for production, employment, and export revenues, Ethiopia is seriously threatened by climate change, which contributes to frequent drought, flooding, and rising average temperatures (Emerta, 2013).

Livestock production and climate change in Ethiopia. The livestock sub-sector plays a significant role in the Ethiopian economy at both the national and household levels (Asfaw, 2011). Tens of millions of pastoralists and agro-pastoralists highly depend on livestock production for their daily survival and extra income and food security (Gerber *et al.*, 2013). Livestock contributes 11 % of national GDP and 24% of agricultural GDP and is also source of revenue for 60–70% of the population of the country (Helina, 2012). Besides, livestock provide food like meat and milk, and non-food items like draft power, manure, and transportation, input for crop production, and fuel for cooking. They also act as a store of wealth and determine social status within the community (Benin, 2003; Degnet, 2004; Asfaw, 2011; Temesgen and Aleme, 2014). Thus, livestock play an important role in improving food security and alleviating poverty in the country (Benin, 2003). The country has three livestock production systems namely highland crop-livestock mixed farming system, lowland pastoral and agro-pastoral production system with a different social, cultural and economic functions (Selamawi, 2016). Generally, livestock production in the country is virtually smallholder rain-fed production system with low-input and low-output characteristic. These conditions make the country's livestock production and economy predisposed to climate variability and climate change (Temesgen and Aleme, 2014; Amsalu, 2016).

Changing temperature and precipitation have a great influence on increasing magnitude of climate change effects in the country's livestock production because its livestock production system is highly dependent on rainfall, particularly on the amount and seasonal distribution and the seasonal surrounding temperature (Evangelista *et al.*, 2013). These variability lead to reducing soil moisture, water availability, and increasing the incidence and distribution of animal diseases and pathogens (Amsalu, 2016). In addition, the variability also affect livestock feed availability, growth and reproduction of the animals, forage crops quality and quantity; and income and prices (NAPA, 2007; Yohannes, 2016). Thus, climate change has brought a far reaching negative consequences on the rural poor livestock producers and makes them more vulnerable to its adverse effects and weaken their adaptive capacities (Keller, 2009; Chibinga, 2013; Temesgen and Aleme, 2014).

Effects of climate change on livestock production in Ethiopia. In Ethiopia, for the last three decades the livestock sector could not contribute its maximum potential of benefits to both household welfare and the nation's economy development due to various factors. Among others, climate change is one of the most prominent threat factors for livestock development in the county because the sector is very sensitive to climatic variability and related factors (Temesgen and Aleme, 2014). As different studies on climate change in the country revealed, the sector was affected directly through increasing ambient temperature and humidity which create stress and discomfort for the animals (Antle, 2009; Enete, 2014). This higher temperature tends to reduce animal feed intake, lower feed conversion rates, create physiological disorder and reduces immunity to disease and pests (Keller, 2009; Yalew, 2016).

Indirectly, climate change has affected the livestock sector through adversely affecting the availability and quality of animal feed and grazing pasture, aggravating the transmission and geographical distribution of animal diseases and pathogens; increasing water scarcity, decreasing biodiversity and changing agricultural practices (Aklilu, 2013; Chibinga, 2013; Enete, 2014; Getu, 2015). The climate change effects on livestock production cascaded into reduced livestock production and productivity, reduced growth performance, failed conception rates, increased mortality and morbidity of the animals (Antle, 2009; Keller, 2009; Kimaro and Chibinga, 2013). For example, decrease in precipitation has multiple effects on water availability for forage and pasture development, and cause reduced supply of drinking water for both animals and people, especially in the north, northeastern, and eastern lowlands of the country (Emerta, 2013). Study in Guduru district, Oromiya region, showed that problems of livestock productivity reduction, water shortage, income reduction from agriculture and food insecurity/famines were attributed to the effects of climate change and variability for many rural livestock farmers (Keller, 2009).

Due to climate extreme events like drought and floods, fodder biomass and livestock population considerably dropped in many part of the Ethiopia. The recurrent droughts affected significantly the growth of palatable grass species and fodder development in pasture and forest fodder areas which resulted in shortage of animal feed in quality as well as in quantity. These recurrent droughts had also an effect in drying wetlands, pasture land, water resources, streams and decreasing availability of drinking water for livestock (Bekele, 2017). For instance, in arid and semi -arid regions of the country, droughts and high temperature were the major causes for the rapid disappearance of traditional water sources for people and livestock (Michelle, 2018). As a result, in southern Ethiopia, the number of cattle population dropped by 37% after the drought between 1983 and 1985 (Kefyalew Alemayehu, 2012) and also in 2010/2011 drought caused substantial decline in the cattle herd sizes due to increased mortality and forced off-take (Megersa *et al.*, 2014). In the same region, more than 15,600 animals were also lost due to flooding in 2006 (Open University, 2016). In addition, more than

2700 heads of cattle and 760 traditional silos were washed away in South Omo and about 10,000 livestock were encircled by river floods in Afar (NAPA, 2007). Livestock keepers in Yabelo and Borana Zones experienced a severe reduction of assets with average reduction of 80% in livestock holdings from their peak holdings over the past ten years mainly by climate change (Temesgeb *et al.*, 2014). Additionally a decline in the number of livestock species namely cattle, goats, sheep and donkey kept by pastoralists in Moyale and Dillo areas was recorded in which most of the animals were reported to have died during severe droughts, which occurred in 2005 and 2008 (Zelalem and Aynalem, 2009). Another study in north eastern Ethiopia, in Afar region, reported that pastoralist and agro-pastoralists have been subjected to frequent droughts (especially, the drought years of the mid-1970s and 1980s) and floods which cause rangeland degradation and shortage of pasture. This resulted in a drastic reduction in individual assets, such as the number of cattle, sheep, goats and camels (Gebreyes *et al.*, 2017).

Moreover, these negative effects of climate change had also extended to export marketing of livestock and livestock products, affecting the quality and quantities of exported animals and their products and not being able to meet the preferences and demands of international markets (Temesgen and Aleme, 2014), nor satisfying the local demand for livestock products (Asfaw Negassa, 2011). According to FAO (2004), Ethiopia does not show significant increase in exporting live animal and animal products to international markets rather there has been a decline over the years. For example, in 1980 the net trade of live animal was 4,543 million US\$ whereas in 2000 the net trade significantly declined to 1,183 million US\$. In the 1980's the net trade to livestock products was 49,737 US\$ while in 2000 the net trade of livestock product declined to 16,399 US\$.

Climate change, thus, contributed a lot in bringing food shortages and seasonal hunger among livestock keepers by reducing the volume of livestock production and by collapsing livestock prices as a result of disposing emaciated animals to the market (Ouma *et al.*, 2011; Evangelista *et al.*, 2013). Finally, it also triggered chronic poverty, food insecurity and has a long lasting effect on the livelihood of rural community (Keller, 2009). Hence, climate change is expected to have adverse ecological, social and economic impacts at household level as well as at national level (NAPA, 2007).

Adaptation to climate change by livestock producers in Ethiopia. Adaptation might be proactive or reactive. Proactive adaptation is an adaptation that takes place to anticipate climate change occurrence; whereas reactive adaptation refers to an adaptation that takes place in response to already observed climate stimuli (Nathnael, 2017). So, farmers should be able to adapt with the changed climate either proactively or reactively in order to reduce its negative effects and to ensure food security and protect their livelihoods (Mohammed, 2013; Abid *et al.*, 2016; Singh *et al.*, 2016; Ali and Erenstein, 2017). That is why individuals and societies have adapted to climate change over the course of human history and will continue to adapt with changing climate (Adger, 2010). Adaptation to climate change is a two-step process which requires that farmers perceive climate change in the first step and respond to changes in the second step through adaptation (Deressa, 2010). Adaptation may take various forms such as autonomous (private/collective) and/or planned (public sector) adaptation (Nathnael and Hanna, 2017). Some types of adaptation were undertaken by individuals in response to threats to the climate, often triggered by individual extreme events whereas, others were undertaken by governments on behalf of society, sometimes in anticipation of change but, again, often in response to individual events (Adger, 2010).

Different studies revealed that in Ethiopia, pastoralists and agro-pastoralist applied various kinds of adaptation mechanisms to minimize the effects of climate change in their livestock production and livelihoods. For example, in lowland areas like Afar, Southern and some part of Oromiya regions, pastoralists used temporal migration to less-affected areas to escape from the effect of severe droughts. They also switched from rearing cattle and sheep to camel and goat, which withstand stress to adapt to the changing climate (Gebreyes *et al.*, 2017). In some cases, they sell off their animals (though at low price) in anticipation of climate extreme events (Zelalem and Aynalem, 2009; Singh *et al.*, 2016).

In highland parts of the country, livestock farmers also used different adaptation strategies such as selling their animals, diversifying species, entrust animals to other herders, migrated to good pasture places and temporal migration to urban areas and some time outside the country to get money and support their families (Getu, 2015). According to Fikeremaryam *et al.* (2016), marketing live animals during shock, home feeding, using crossbreds and provision of shade to their animals during extreme weather events, hot and cold season were the major adaptations strategies that were often used by sheep and goat farmers in central and south Tigray region. Other study in Guduru, Oromiya region reported that the major adaptation mechanisms to climate changes were preservation of crop residues and development of improved forage to address animal feed shortage; constructed water harvesting infrastructures, like water collecting from roof, well digging and ponds, to address water shortage and income diversification through livestock, bees and poultry to address reduction in incomes (Keller, 2009).

Government of Ethiopia attempted to develop and implement different programmes to create and/or strengthen climate change adaptation strategies for stable national economic development in general and livestock development in particular. Some of the programmes promoted improved animal breeds by reducing the herd size of less genetic potential breeds, improved fodder crops and pasture management; use of different improved animal feed conservation practices, agro-forestry system to plant multipurpose trees that could be used to produce feed, and soil and waters conservation practices. In addition, government worked on creating awareness to livestock farmers and pastoralists about natural resource management, conservation and rational use environmental protection and developing drinking water sources for human and animals in pastoral areas (NAPA, 2007).

Government also provide early warning, safety net programmes, natural resource management based adaptation mechanisms, and weather index insurance mechanisms (Nathnael and Hanna, 2017). Beyond adaption, the state played a great role in promoting various mitigation strategies by improving animal productivity through breeding (reduce GHGE by 6 Mt CO₂e per year by 2030), feedlots practice by smallholder farmers, improving feed and feeding management, diversification toward lower emitting animal species like small ruminants (*ibid*). This allows for environmental conservation and rehabilitation, sustainable production, benefit from the global carbon market, and achieving the green growth strategy.

Barriers to livestock farmers in climate change adaptation. Even though different adaptation mechanisms were used among many Ethiopian livestock herders, the types of adaptation mechanisms varied from place to place and from individual to individual. The effectiveness of these adaptation strategies to climate change variability depends on the social acceptability of options for adaptation, the institutional constraints on adaptation, and the place of adaptation in the wider landscape of economic development and social evolution (Adger, 2010; Deressa, 2010). In addition, they can also be affected by wealth, infrastructure, access and control of resources, information, culture, law, education, etc

(Bryan *et al.*, 2009). Lack of climate information/awareness and technical knowledge, shortage of labor and land, low potential for irrigation, lack of financial capacity, lack of suitable livestock species (i.e. drought resistant), inadequate training and farmer capacity and lack of understanding of adaptation process also played a great role in affecting the choose of effective climate change adaptation strategies for herders in many parts of Ethiopia (Nathnael and Hanna, 2017).

As indicated in the study of Deressa (2010), educational status of household head, family size, gender, livestock ownership, access to extension and credit services, and access to weather information were the major hindering factors for livestock farmers from adapting to the changing climate in the upper Nile basin of Ethiopia. Similar findings were reported in Tigray region where education, age and sex of household head, farm income, extension service, credit service and climate information and agro-ecological settings where the farmers are living were the major factors which determined the decision behavior of livestock farmers to adapt with the changing climate (Gebre Hadgu and Kindie Tesfaye, 2015). In addition, farming experiences, number of households in a village, and distance to market *also* affected the smallholder sheep and goat farmers from utilizing the available adaptation strategies in southern and central Tigray region (Fikeremaryam Birara and Melaku Berhe, 2016). Other study in Central Rift Valley and Upper Nile basin of Ethiopia showed that low level of education, lack of awareness on improved technologies, shortage of land, lack of access to information through mass media, shortage of farm implements and poor potential for irrigation and financial constraints and insufficient family labor were the major factors that could affect livestock herders' decision making behavior (Deressa, 2010; Belay *et al.*, 2017).

Conclusion

Climate of Ethiopia is so variable and manifested in many ways. Its average annual temperature is constantly increasing whereas its precipitation remains relatively constant but unpredictable. As a result, unreliable rainfall, strong winds, heat waves, droughts, floods and landslides have become the most devastative climate related risks in the country. These climatic devastative risks has adversely affected the livestock sector in many ways. Climate change affected the sector directly through creating heat stress, reducing animal feed intake and feed conversion rate, create physiological disorder and reduce immunity. Indirectly, climate change has affected the sector by reducing the quality and quantity of animal feed, aggravating transmission. These diseases, increase water scarcity, and decreasing biodiversity. These in turn, lead to reduced livestock production and productivity and trigger chronic poverty, food insecurity and has a long lasting effect on the livelihood of rural communities and the wider economy at large.

Both private (individual/community) and public adaptation (State) strategies have been applied to minimize the effect of climate change on livestock production in the country. Herders use temporal migration, shift herd composition, sell live animals, change feeding practices, using improved breeds, conserve animal feed for future use and construct water harvesting infrastructure as the major adaptation strategies in both lowland and highland livestock communities. However, livestock herders have not effectively utilized these adaptation strategies due to various factors, including the individual's status of wealth, age, education, capacity in accessing resources, extension and credit, lack of weather information and limited income. In addition, agro-ecological settings of the individual, farming experience and distance to the market have also affected the ability of the livestock producers to utilize the available adaptation options. Therefore, to minimize climate variability and its impacts on livestock production in Ethiopia, government and non-government

bodies should understand location specific adaptation strategies and develop plausible location specific adaptation strategies.

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