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Review Article – Agriculture

Impacts of climate change on livestock production and productivity and different adaptation strategies in Ethiopia

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Abstract

This review work was conducted to explore the likely impacts of climate change on livestock production and productivity and different adaptation strategies in Ethiopia. National average temperature has increased by 1^0 c since the 1960s. Most of the livestock owners in the country perceive there is a climate change impacts on Livestock production and productivity. The major effects of climate change on livestock production include feed shortage, shortage of water, livestock genetic resources loss, reduced productivity, and decreased mature weight and/or longer time to reach mature weight in their order of importance. Higher temperatures resulting from climate change may increase the rate of development of certain pathogens or parasites that have one or more life cycle stages outside their animal host. Furthermore, the spatial distribution and availability of pasture and water are highly dependent on the pattern and availability of rainfall. Shortage of feed and water contribute to reduced productivity and reproductive performance of livestock. This includes slow growth rate of animals, loss of body condition, reduced milk production and poor reproductive performance in mature animals. Draught oxen that are emaciated and in poor body condition cannot provide adequate draught power for plowing, and thus affects crop cultivation. Bush encroachment as well as population pressure lead to diminishing availability of good pasture and hence to a decline in the total number of animals. Different adaptation options are followed by Livestock owners, such as Conservation of feed, out-migration of some household members to earn additional income, destocking, settlement and intensification of livestock production, undertaking supplementary income generating activities and awareness creation on the factors affecting climate change.

Keywords: Climate change, Livestock, Production, Impact, Adaptation

Introduction

Ethiopia is home to Africa's largest livestock population, and it is the continent's top livestock producer and exporter. Although domestic demand for animal products in Ethiopia is increasing driven by the urban middle and upper-classes export potential is the key force encouraging expansion and intensification of livestock production (MacDonald and Simon, 2011). The recent livestock population of Ethiopia estimates that the country has about 57.83 million cattle, 28.89 million sheep, 29.70 million goats, 2.08 million horses,7 .88 million donkeys, 60.51 million poultry, 5.92 million beehive, 0.41 million mules and about 1.23 million camels CSA(2016). They are an important component of nearly all farming systems in Ethiopia and provide draught power, milk, meat, manure, hides, skins and other products (Funk *et al.*, 2012). Ethiopia has a diversified climate, which has different size and diversity of major agro-ecological zones render it suitable for the support of large numbers and classes of livestock (Funk *et al.*, 2012).

However, the country has suffered from climatic variability and extremes (Alebachew and Woldeamlak, 2011). Consequence of the long-term climate related to changes in precipitation patterns, rainfall variability, and temperature has increased the frequency of droughts and floods (World Bank, 2010). Among factors which influence livestock production are climate, and location are undoubtedly the most significant. In fact, climatology characteristics such as ambient temperature and rainfall patterns have great influence on pasture and food resources availability cycle throughout the year among animal populations. The rain pattern during the year strongly influences livestock production systems through pasture development and disease and parasites outbreaks, therefore influencing animal production systems, productivity. Tropical and Mediterranean climates are characterized by the existence of a season of varied duration, when rainfall is scanty or non-prevalent.

Such season is termed dry season in the tropics and summer in Mediterranean climates. During rainy season pastures are available in higher quantities and show good nutritional quality whereas dry season's pastures have poor nutritional quality with high fiber and low protein contents, which often results in declining the animal production (Kiros Abebe, 2017). Therefore, this review work was conducted to explore the impacts of climate change on livestock production and productivity and different adaptation strategies in Ethiopia.

Climatic feature

Ethiopia is located between 3°N - 15°N and 33°E - 48°E. Ethiopia's climate is typically tropical in the south-eastern and north-eastern lowland regions, but much cooler in the highland regions of the country. Mean annual temperatures are around 15-20 °C in high altitude regions, whilst 25-30°C in the lowlands. National average temperature has increased by 1^0C since the 1960s (FDRE, 2015). The number of hot days and nights in a year is increasing overtime. On the other

hand, the observed trend of mean annual rainfall is not clear (World Bank, 2016).

Despite the inter-seasonal and inter-annual rainfall variability, nationally rainfall remained more or less constant in the second half of the twentieth century (FDRE, 2015). In line with the meteorological evidences is that many farmers across Ethiopia perceive that increasing temperature, decreasing and erratic rainfall in their villages in the past twenty to thirty years (Hadgu *et al*., 2014). Regional projections of climate models indicate a substantial rise in mean temperatures in Ethiopia over the 21st century and an increase in rainfall variability, with a rising frequency of both extreme flooding and droughts due to global warming (Robinson *et al.,* 2013).

Livestock owners' perception on the effects of Climate Change

Most of pastoralists and agro-pastoralists, which lives in Aba'ala, district of Afar Regional State of north-eastern Ethiopia, perceived that repeated frequencies of drought occurrences due to climatic change. They explained that prolonged drought was their major challenge that largely damaged the natural resources, and finally followed by lack of feed and water for people and animals (Berhe *et al.,* 2016). Masih *et al.* (2014) also noted that drought severely harms the ecosystem and worsens considerably human crisis. Most of Pastoralists and agro-pastoralists live in Aba'ala, district of Afar Regional State of north-eastern Ethiopia, confirmed that the effects of climate change, which widely destroyed crop farming twice or more times within a five years' period. During drought period, almost all of the peoples reported that lack of animal feed as their critical challenge. In this area majority of the respondents sensitized the effects of climate change in terms of rainfall variability, temperature change, untimely raining and flooding, scarcity of water, shortage of food for human and drying of streams and other water sources (Berhe *et al.,* 2016). On the other hand, farmers; which lives Southern and Central Tigray Zones, most of the peoples perceived that climate change is indeed occurring. Among climate change indicators, temperature and rainfall were considered as parameters for the analysis. The responses from respondents in relation to changes in temperature and rainfall across three agro-ecological zones are depicted, respectively.

Most of the respondents acknowledged that there is rise in temperature and decline in rainfall amount over the last 10 years (Birara *et al*., 2016).Similar expressions of awareness by farmers about climate change have been reported in studies conducted Borana lowlands; the large majority of respondents in the study area believed to have experienced climate change. Study participants indicated that they perceived changes in temperature and rainfall, expressed mainly in terms of patterns in weather experienced; higher temperatures, below normal rainfalls and short rainy seasons, higher frequency and intensity of extreme weather events (Debela *et al*., 2015). According to Kefyalew Alemayehu1 and Addis Getu, (2016), about 92.2, 78 and 83.3 percent respondents in Farta, Gondar Zuria and Bahir Dar Zuria districts respectively said that there is a change in amount of rainfall distribution during the main rainy seasons due to climate change. About 84.5 percent of respondent in the three districts believe that climate change made variation in rainfall distribution.

Effect of climate change on livestock production and productivity

Climate change is expected to result in fall in productivity, Livestock productivity may be lower that by 50% in 2050s compared to without climate change scenario. Agricultural GDP with climate change may be lower by 3% to 30% than without climate change agricultural GDP in 2050. Climate change may increase the number of people looking for food aid by 30% (World Bank, 2010), increase drought expenses by 72% in 2050s (FDRE, 2015). Increasing temperatures and decreasing rainfall reduce yields of rangelands and contribute to their degradation. Higher temperatures tend to reduce animal feed intake and lower feed conversion rates (Rowlinson, 2008). Pastoralists in Borana area indicated that climate change had its effect on their livelihoods through various mechanisms (Table 1). As prioritized by pastoralists, the four major effects of climate change on livestock production include feed shortage, shortage of water, reduced productivity, and decreased mature weight and/or longer time to reach mature weight in their order of importance. An attempt was made to illustrate the effect of climate change on livestock flock dynamics and productivity, considering two reference years: 2009 and 2002 - the most recent fairly good year remembered by most of the pastoralists (Zelalem *et al*., 2009).

Table1. Major effects of climate on livestock production ranked by pastoralists in Borana area, Ethiopia

Major effects	Rank
Feed shortage	1st
Shortage of water	2nd
Reduced productivity	2nd
Decreased mature weight and/or longer time to reach mature weight	4th
More conflict	4th
Increased disease prevalence	6th
Increased mortality	7th

Sources: Zelalem *et al*., 2009. *Effects of climate change on livestock production and livelihood of pastoralists in selected pastoral areas of Borana, Ethiopia.*

The spatial distribution and availability of pasture and water are highly dependent on the pattern and availability of rainfall (Aklilu *et al*., 2013). Changes in the patterns of rainfall and ranges of temperature affect feed availability, grazing ranges, feed quality, weed, pest and disease incidence (Coffey, 2008). Thus, changes in climatic factors such as temperature, precipitation and the frequency and severity of extreme events like droughts directly affected livestock yields. The harsh effect of climate change is expected to have maximum impact on vulnerable pastoral communities engaged in extensive livestock production systems in dry-lands (Saidu and Omedo, 2010). According to ONRS (2011), climate change and variability in Ethiopia poses particular risks to poor farmers and pastoralists who have an immediate daily dependence on climate sensitive livelihoods and natural resources. In addition to the physiological effects of higher temperatures on individual animals, loss of animals as a result of droughts and floods, or disease epidemics related to climate change may thus increase. Indirect effects may be felt via ecosystem changes that alter the distribution of animal diseases or the supply of feed.

Similarly, report of ANRS (2010) described that; all pastoral regions in Ethiopia are highly prone to the adverse impacts of climate change, while the problem is more

prevalent in the North Eastern lowlands of the country. The afar region is home to pastoral and agro-pastoral people who largely depend on livestock production for their livelihood but due to climate variability the people exposing to the risks of several climate related disasters. Kassaye (2010) reported that livestock production in already marginal ecosystems in Ethiopia is severely affected by climate change induced disasters. On the same way, Stark *et al*. (2011) reported that in some regions, invasive species linked by pastoralists to both restrictions on bush burning and climate change are severely reducing or eliminating viable grazing areas. Trends indicative of climate change, such as increasingly recurrent drought, floods, erratic rainfall patterns, and high temperatures are adding significantly to these stresses. The effect of climate change on the range lands in Moyale and Dillo areas is also remarkable. In many of the cases, the range land is changed into bare termite mount (Zelalem *et al*., 2009). Climate change will have far-reaching consequences for dairy and meat production, especially in vulnerable parts of the world where it is vital for nutrition and livelihoods (WSPA, 2012). Recurrent droughts, flash floods, diseases, and pests are among the prevalent disaster risks related to climate change in the area. Pastoral communities are the major victims of these disaster risks (Aklilu *et al*., 2013). A study conducted in Yabelo, Borana Zone in southern Ethiopia indicated that households have experienced a severe reduction in their assets, with an average reduction of 80% in livestock holdings from their peak holdings over the past ten years mainly by climate change (Stark *et al*., 2011). Additional study indicated that the decline in the number of livestock species namely cattle, goats, sheep and donkey kept by pastoralists of Moyale and Dillo areas was remarkable in which most of the animals were reported to have died during severe droughts, which occurred in 2005 and 2008 (Zelalem *et al*., 2009).

Again, the decreases in number of livestock in Arba Minch district is directly or indirectly interlinked and related to climate change (Iqubal, 2013). Livestock health problems exacerbated by climate change such as the high prevalence of Trypanosomiasis in the lowlands are among the challenges that affect livestock fertility (Habtamu, 2012). Thus, it is agreed that livestock productivity is highly affected by climate change. Livestock productivity is affected most severely under the Ethiopia dry scenario, in which the ratio between future and baseline productivity falls to a low value of approximately 0.70 in the moisture reliable humid lowland zone, or a 30% decline in productivity. Under each scenario, there is a downward trend in productivity over the 2001 to 2050 period (Robinson *et al*., 2013). Generally, Shortage of feed and water contribute to reduced productivity and reproductive performance of livestock. This includes slow growth rate of animals, loss of body condition, reduced milk production and poor reproductive performance in mature animals. Draught oxen that are emaciated and in poor body condition cannot provide adequate draught power for plowing, and thus affects crop cultivation (Woldeamlak *et al*., 2015).

Effects of climate change on Livestock feed resources

Climate directly affects the quality and quantity of the forage that can be produced in a given area. In general, semi-arid areas are predicted to experience lower rainfall as a consequence of climate change. The length of the growing period is expected to decrease in many parts of the tropics, and this may be accompanied by greater variability in rainfall patterns with more frequent droughts (Thornton *et al*., 2009). This is likely to increase the risk that animals will suffer lengthy periods of nutritional stress. In addition, animals may be required to walk longer distances in search of feed and have to cope with less frequent watering. The movement of animal populations out of drought-affected areas can lead to problems of overgrazing in neighboring areas and to problems with diseases and parasites as animals' crowd together or move into areas where unfamiliar diseases are endemic. Conflict over access to grazing land and water is another potential hazard. On the other hand, high temperatures tend to increase lignifications of plant tissues and hence decrease the digestibility of forage. It is also predicted that climate change will induce a shift from C3 to C4 grasses. C4 plants are more efficient in terms of photosynthesis and water use than C3 plants. Both types coexist in the tropics, but react differently to increases in temperature and carbon dioxide levels. In addition to various changes in ecosystem function, a shift from C3 to C4 grasses has direct implications for forage supply. C3 forage plants generally have higher nutritive value, but yield less, while C4 plants contain large amounts of low-quality dry matter and have a higher carbon–nitrogen ratio (Morgan *et al*., 2007). The effect of climate change on the range lands is remarkable. In many of the cases, the range land is changed into bare termite mount. In situations where some plants are seen, the general indication is that there is encroachment of unpalatable bushes. The pastoralists indicated that invasive and poisonous plant species are dominant in the area. The major invasive woody species is Acacia drepanolobium (Zelalem *et al*., 2009). On the other study reported by Woldeamlak *et al*., (2015); apart from increased temperatures, prolonged dry seasons and frequent droughts, bush encroachers and alien invasive species1 are causing significant reduction in availability of livestock feed. Invasive species such as *Prosopis juliflora, Parthenium hysterophorus, Lantana camara and Opuntia ficus-indica* have expanded in rangelands of the pastoral districts of Teltele and Filtu. The bush encroachers are threatening the livelihoods of Borana and Somali pastoralists and the ecosystems. *Acacia drepanolobium, A. mellifera, A. bussi, A. bresvispica, and A. senegal* were among the major encroaching species in both sites.

Finally, climate change have an effects on livestock production is changing the animal feed resources. Indirect effects on feed resources can have a significant impact on livestock productivity, carrying capacity of rangelands, buffering ability of ecosystems and their sustainability, prices of Stover and grains, trade in feeds, changes in feeding options, greenhouse gas emissions and grazing management. Changes on the primary productivity of crops, forages and rangelands are probably the most visible effect of climate change on feed resources for animals. Thus, it also causes changes in species composition in rangelands and some managed grasslands that are an important determinant of livestock productivity (Zelalem *et al*., 2009).

Effects of climate change on Water resources

In Ethiopia, decreasing water levels in rivers and low levels of water accumulation in community ponds have been observed in recent years. Critical water shortage was observed particularly in the lowland districts such as Loka Abaya. Ponds are drying up quickly after the end of the rains during the dry season due to increased evaporation resulting from increased temperature (Woldeamlak *et al*., 2015).

Similarly, the Borana pastoralists indicated that they face a critical water shortage due to climate change. They indicated that there is critical shortage of rainfall (unreliable, less intensity and duration), and hence ponds do not fill to their capacity and dry out fast, streams and rivers disappeared and boreholes dried out (Zelalem *et al*., 2009).

Effects of climate change on Livestock genetic resources

Ethiopia showed that rainfall variability greatly influenced herd dynamics under the communal and ranch management in terms of herd die-offs and lower birth rates, which also considerably affected milk production for household consumption. Droughts of the 1980s and 1990s caused 49% herd losses under the communal land use, while 57% of the cattle mortality under ranch management was attributed to droughts of the 1990s (Abdeta, 2011). There are various reasons for the genetic erosion of the Borana cattle. The most severe ones are ecological reasons such as bush encroachment and recurrent droughts, reasons related to the herd management, and civil reasons. Bush encroachment as well as population pressure lead to diminishing availability of good pasture and hence to a decline in the total number of cattle and particularly in Borana cattle(Zelalem *et al*., 2009). There are also emergency interventions involving restocking to the drought affected communities. After frequent droughts, the loss of Borana cattle is often compensated by other breeds that are readily available or cheaper. These include the smaller Guji cattle or Small East African Zebus in general which are often bought for restocking whole Borana herds lost due to droughts. This exercise will have adverse effect on the available genetic pool in the area (Zelalem *et al*., 2009). The trends of livestock breed distribution pattern varied from year to year and from agro-ecology to agro-ecology (move towards the highland). It was noted especially that the number of cattle and equines are decreasing as the number of goats population responds positively to the change (Kefyalew Alemayehu and Addis Getu, 2016).

Effects of climate change on Animal health

Higher temperatures and greater humidity generally increase the rate of development of parasites and pathogens that spend part of their life cycle outside the host. Changes to wind can affect the spread of pathogens. Flooding that follows extreme climate events provides suitable conditions for many water-borne pathogens. Drought and desiccation are inimical to most pathogens (Grace *et al*., 2015). Climate stress (heat, inadequate food and water) can also lower host immunity (Grace *et al*., 2015). Climate change may bring about substantial shifts in disease distribution, and outbreaks of severe disease could occur in previously unexposed animal populations (possibly with the breakdown of endemic stability) (Thornton *et al*., 2009). According to Woldeamlak *et al*., (2015), increased incidence of diseases during the long dry season, when animals are in poor condition due to inadequate feed supply and increased heat stress as a result of the increased temperature. Similar study reported by Zelalem *et al*., (2009) foot and mouth disease, black leg and CBPP were identified as the major three diseases in cattle, whereas, CCPP, Coenurus cerebralis and general septicemia cause a serious damage to the sheep and goat population in Borane area. Emergence of new diseases is one of the major problems mentioned by the community. They believe that diseases to which they are not used are occurring in the area and claiming lives of many livestock. This is associated to increased susceptibility of livestock to diseases aggravated by shortage of feed (Zelalem *et al*., 2009).

Effects of climate change on Land use and livelihood systems changes

As temperature increases and rainfall decreases and becomes more variable, the niches for different crops and grassland species change. For example, transitions from one crop to another, or between crops and rangelands, can occur. In Borana, a clear shift in the livelihood was observed. In Medo, there used to be a crop production activity together with livestock rising. However, because of lack of rain water and increased temperature, crop production is abandoned and people have now become pastoralists. There are cases where pastoral livelihood is also challenged and people have moved to petty trade and other activities. It is generally noted that there is increased dependence on food aid (safety net program) (Zelalem *et al*., 2009). One of the traditional climate change induced disasters was mobility to less affected areas. As was noted from the study in almost all the areas, this was challenged and the mobility has decreased dramatically. The decrease in mobility of pastoral societies in the study area was related mainly to two reasons: first, competition from the limited resource have led to frequent conflicts in the area and it has become difficult to freely move in the area; and second it is noted that the whole area is affected and it is hardly possible to find reasonably good areas in the study area. Therefore, mobility as a mitigation strategy is now challenged in the area. These land-use and system changes can lead to a change in the ability of pastoralists to manage feed deficits. These two effects can have substantial effects on animal productivity and on the maintenance of livestock assets (Zelalem *et al*., 2009).

Adaptation/Mitigation of climate change through different mechanisms

Mitigation of climate change through indigenous cattle breeds

Ethiopia is considered a center of diversity for animal genetic resources in general and to cattle in particular. Indigenous cattle breeds in Ethiopia are a valuable source of genetic material because of their adaptation to harsh climatic conditions, their ability to better utilize the limited and poor quality feed resources and their tolerance to a range of diseases found in these regions. Despite the significant contribution of cattle to the country, little attention is given to identify, characterize and conserve the diversity of the various classes of livestock (Zewdu, 2010). According to Kerstin and John (2004), the Borana cattle in northern Kenya and southern Ethiopia have unique traits that make them suitable for the harsh environment in the lowlands and have ever been part of the pastoralists' identity. Almost all the traditional and cultural rites of the pastoralists in these areas revolve around the Borana cattle, which are also the main source of their income. According to them, another important reason for conservation of the local breeds is the multiple use of their various traits in uncertain situations, for instance, in the case of climate change, catastrophes, loss of resistance due to changing environment, protection failures (Tsetse controlling) etc. Equally important is the fact that the preserved breeds might possess qualities that are not yet

known but which could be of some use in the future.

Coping and adaptation strategies through livestock production

In the history of the Afar community, natural pasture has continued serving as the dominant source of feed for their cattle. But later, the influx of migrated people from highland areas along with the indigenous Afar began settling in specific villages during the 1960s (Tsegaye *et al*., 2013). It was since this period cropping was introduced in Aba'ala. Owing to repeated droughts over series of years, rural farmers realized that storing animal feed such as straws and hay would paramount essential to save the lives of their livestock. As shown in Table 2, farmers in Aba'ala Woreda (district) harvested hay and straw across the five years (2011 to 2015) (Berhe *et al., 2016*).

In Table 2, the least harvest of hay and straw during 2015 may be because of the severe drought currently Ethiopia is facing. In this period, crop growers, agro-pastoral and semi-pastoral communities in Aba'ala district did not produce any crop. Despite the harsh drought in 2015, cattle owners purchased much less hay and straw than they purchased in the preceding years. This might be because of the reason that purchase of animal feed for whole is costly and unaffordable to the locals, thereby, households opt to move their livestock to eastern Afar in search of feed during drought times (Berhe *et al., 2016*).

Table 2: Adaptation to climatic change through cattle feeding

Year	Year Amount Produced in kg		Amount Purchased in kg		
	Hay	Straw	Hay	straw	Formula feed
2011	214.69	1020.57	0	42.08	13.48
2012	166.39	986.83	0	12.78	7.76
2013	211.34	787.57	76.68	398.55	197.26
2014	242.87	826.58	196.75	681.01	374.85
2015	10.06	762.27	103.64	174.90	157.54

Sources: Berhe *et al., 2016. Effects of adaptation to climate change on income of cattle owners in the pastoral and agro-pastoral communities of Northern Ethiopia.*

On the other study reported by Woldeamlak *et al*., (2015), smallholder farmers across Ethiopia have made adjustments in livestock production in response to climate variability and climate change that include: Increased use of crop residues as animal feed; Diversification of animal feeds by including Kinchib (Euphorbia tirucalli) for goats and camels, cactus (Ficus carica) for camels, elephant grass and even using prosopis and parthenium weeds as ingredients for livestock feed; Changing herd composition by reducing cattle herd size while increasing the number of camels and goats in their herds. Camels and goats have better feeding habits, and the shorter life cycle of goats is good for marketing mainly in the lowland pastoral areas; Asset rebuilding after droughts through the traditional mutual support system— locally referred to as Busa Gonofa particularly in Borana area; Migration of people to other areas in search of alternative sources of livelihood.

Other measures and practices with potential for enhancing adaptive capacity of communities in pastoral areas were: Reducing livestock numbers to match carrying capacity of grazing lands through increased commercial off-take rates; Forage development such as elephant grass and fodder trees (e.g. Leucaena and Sesbania); Building on existing traditional mutual support systems and organizing communities into savings and credit associations; Supporting inter-regional state collaboration in development and management of natural resources; Strengthening traditional conflict resolution mechanisms; Supporting cultivation of cactus in Afar to be used as feed; and Developing alternative livelihood sources, especially for the younger generation (Woldeamlak *et al*., 2015).

Future directions to minimize risk of climate change on livestock production

The Growth and Transformation Plan, The current five-year national development plan, known as the Growth and Transformation Plan (GTP), aims to accelerate agricultural growth and builds on the solid performance of the previous five-year plan; the Plan to Accelerate Sustained Development to End Poverty (PASDEP). Given that smallholder agriculture is the major source of agricultural growth, increasing the productivity and production of smallholder agriculture is the main thrust of GTP through: Scaling-up best practices of leading and innovative farmers; improving natural resources management focusing on improving water utilization and expansion of irrigation; and encouraging farmers to shift from low to high value agricultural products, with complementary investments in market and infrastructure development (Woldeamlak *et al*., 2015).

GTP identifies three main agro-ecological zones, namely, adequate moisture areas, moisture deficit areas, and pastoral areas. Strategic areas of intervention have been identified for each of these zones. In areas with adequate moisture, GTP focuses on scaling-up best production and marketing practices to increase productivity by supplying agricultural inputs. Priority areas of focus include soil fertility management using organic and inorganic fertilizers, improved rain fed agronomic methods, irrigation and improved water use efficiency, production and distribution of seeds, natural resource conservation, livestock and forage development, and strengthening the research-extension-farmer linkages. In moisture deficit areas, the focus will be on soil and water conservation, and watershed management. Particular areas of intervention include underground and surface water utilization, development of small ruminants, poultry and apiculture, and productive safety net initiatives to support food security of vulnerable households. Lastly, in pastoral areas, the focus will be on livestock development, specifically water for people and livestock, forage development, irrigation, and improving livestock marketing systems (Woldeamlak *et al*., 2015).

The GTP recognizes that climate change presents a threat as well as an opportunity for Ethiopia. Under the 'Environment and Climate change' sub-section, the GTP recognizes the role that environmental management plays in sustainable development and clearly declares the government's commitment to building a green economy' and ongoing implementation of environmental policies and laws of the country. In order to build a climate-resilient economy and facilitate the move towards a carbon-neutral economy, the GTP declares that Ethiopia will pursue both appropriate climate change adaptation and mitigation measures. Although Ethiopia's contribution to GHG emissions is minimal, the GTP recognizes that, Ethiopia is

among the most vulnerable countries which will be hardest hit by the impacts of climate change (Woldeamlak *et al*., 2015). Annually, Ethiopia loses 2 to 6% of its annual production due to climate change (MoFED, 2010). Unless appropriate adaptation measures are put in place, the impacts of climate change will be manifested more in the loss of agricultural production. Apart from the adaptation measures, the plan recommends embarking on aggressive economic expansion and development in the areas of renewable energy resources, building climate change mitigation capacity and implementation of environmental management practices. In general, it can be argued that the GTP considers issues of climate change adaptation. However, effective integration of climate change issues in any future sector development policy instruments as suggested in the GTP is yet to be realized.

LMP Lowland pastoral and agro-pastoral feed strategies: To increase improved forage and processed feed for lowland pastoral/agro-pastoral system.

- Herd management skills of pastoralists need to be strengthened through training.
- All stakeholders need to promote ecologically sound water point development and distribution.
- To promote herd mobility as a strategy to utilize temporal and spatial variability in the availability of forage.

To promote bush clearing/thinning, and the use of controlled burning as a range management technique to increase production of good quality forage (Barry *et al*., 2015).

Conclusion

Climate change is caused an increment of weather-related disasters and extreme weather events, such as droughts, heat waves, storms, desertification and increases in insect infestations. All climate change related hazards and their related disasters have a negative impact on animals. Livestock owners had a perception on climate change and they express its effect in different way and they also prioritize the related effects of climate change on livestock production and productivity include feed shortage, shortage of water, livestock genetic resources loss, reduced productivity, and decreased mature weight and/or longer time to reach mature weight in their order of importance. Livestock can be affected in two ways by climate change: the quality and amount of forage from grasslands may be affected and there may be a direct effect on livestock due to higher temperatures. Despite, the importance of livestock to poor people and the magnitude of the changes are likely to be failed livestock systems.

In this review explored that the intersection impact of climate change and livestock production is a relatively neglected area. Little is known about the interactions of climate and increasing climate variability with other drivers of change in livestock systems and development trends. Shortage of feed and water contribute to reduced productivity and reproductive performance of livestock. This includes slow growth rate of animals, loss of body condition, reduced milk production and poor reproductive performance in mature animals. Draught oxen that are emaciated and in poor body condition cannot provide adequate draught power for plowing, and thus affects crop cultivation. Effective adaptation and adoption of new technologies, which contribute both to mitigation and the long term viability of farming, will require investments and planning efforts capacity of individual farms.

In order to continue, livestock industries need to anticipate these changes, be prepared for uncertainty and develop adaption strategies now. Some governments are more active than others in addressing climate change issues. For climate adaption to occur people need to be aware that climate change is real what the practical impacts will be and how it will affect businesses. The country GTP considers issues of climate change adaptation and nationally appropriate mitigation actions. However, effective integration of climate change issues in any future sector development policy instruments as suggested in the GTP is yet to be realized.

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