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# Current Status of Climate Change Impact on Production and Reproductive Performance of Beef Cattle in Ethiopia: A Review

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**Abstract**
This review was initiated to assess the current status of climate change impact on production and reproductive performance of beef Cattle under Ethiopian condition. Climate is one of the determining factors for production and reproduction in farm animals throughout the world. Its effect is higher in cattle than in other ruminants. Beef can be affected by heat stress, particularly in feedlot situations or when grazing fescue-infected pastures. Climate change affects both male and female reproductive performance of beef cattle by altering their physiological process. In contrast of this, beef cattle are the most contributors for climate change causes than other farm animal. Therefore, to enhance production and reproductive performance of beef cattle, specialized beef production strategies should be strengthen, integrating beef cattle production system with natural conservation strategies and climate change should be part of educational curriculum(from elementary to higher education).
**Keywords**: Beef Cattle, Climate Change, Reproduction, Production

## 1. INTRODUCTION

Climate is one of the determining factors for production and reproduction in farm animals throughout the world (Balamurugan *et al*., 2017). In Ethiopia, increased frequencies of extreme events such as drought and flooding which attributed to climate change undermine the rural livelihood systems (Aklilu *et al*., 2013; Temesgen *et al*., 2014). The economic contribution of the livestock sub-sector in Ethiopia is about 12% of the total and 33% of agricultural Gross Domestic Product (GDP) and provides livelihood for 65% of the population (Ayele *et al*., 2003; Harko, 2015).

The estimated cattle population of the country is 57.83 million heads, of the total population of the cattle, 55.38 % of them are female and the remaining 44.62 % are male cattle and majority (63.75%) of them, found under 10 years of age and 499,841(0.86%) were slaughtered in 2016(CSA, 2016). Despite the largest cattle population productive and reproductive performance is very low. Productivity implies some relationship between inputs and outputs whereas production is merely an output function (Shiferaw, 2014; Damitie *et al*., 2015). For instance, the country was severing from high livestock mortality is, which estimated variously at 8–10% for cattle and 14% for small stock (Negassa and Jabbar 2008; Sintayehu *et al*., 2013). Drought occurrences cause massive cattle losses every 5 to 6 years on the Borana Plateau (Desta and Coppock, 2002; Bekele, 2015). In the same area, according to Bekele (2015) report, the drought had dwindled cattle numbers by causing heavy mortalities (26%) and escalating early sales (18.9%).

Livestock are adversely affected by the detrimental effects of extreme weather. Climatic extremes and seasonal fluctuations in herbage quantity and quality will affect the well-being of livestock, and will lead to declines in production and reproduction efficiency (Sejian, 2013; Balamurugan *et al*., 2017). Livestock generally expend more energy and increase their voluntary feed intake in order to maintain their core temperature, resulting in lower feed efficiency (NRC, 1981).

The effects of heat stress are higher in cattle than in other ruminants due to their higher metabolic rate, and poorly developed water retention in the kidney and gut (Bernabucci *et al*., 2010). Gaughan *et al*. (2009) reported that fat cattle with a lot of hair and dark coat are very sensitive to heat. Cattle can, within limits, adapt to environmental challenges to minimize adverse consequences. Beef cattle can particularly be vulnerable to extreme environmental conditions and to rapid changes therein (Bernabucci *et al*., 2010). Similarly, Mitlöhner *et al*. (2002) stated that beef cattle can be affected by heat stress, particularly in feedlot situations or when grazing fescue-infected pastures (Caldwell *et al*., 2013), but several factors mitigate against large effects on reproduction in beef cattle. At temperatures above $25^0$C feed in- take dropped (Hahn, 1999; Scholtz *et al*., 2013). However according to Hahn, (1999) report, in beef cattle the threshold temperature above which dry matter intake is adversely affected is 30°C with a relative humidity of below 80%, and if the relative humidity is above 80% the threshold temperature drops to $27^0$C. Ambient temperature has the largest direct effect on beef cattle. Normal comfort zone is between 4 and 24°C. In temperature rises above this, it is important that cattle that are adapted to these higher temperatures are used. High temperatures decrease in feed intake in order to reduce digestive heat production, reduce grazing time (animals do not graze in hot midday hours) and sweating and water intake increases (Scholtz, 2014).

Therefore, the objective of this paper is:

- ✓ to review the current status of climate change impact on production and reproductive performance of beef cattle

## 2. OVERVIEW OF BEEF CATTLE AND CLIMATE CHANGE

### 2.1. Current Status of Climate Change and Beef Cattle

Global climate change is primarily caused by greenhouse gas (GHG) emissions that result in warming of the atmosphere (IPCC, 2013; Jas-Downing *et al*., 2017). Global warming has a great impact on the reproductive activity of cattle. Global warming has risen the surface temperature about 0.7°C since the early 20$^{th}$ century. It is anticipated that the temperature rise will be 1.8-4°C by 2100 (IPCC, 2016, Dash *et al*., 2016). Climate change is real and becoming worse and most vulnerable people will be affected. The International Fund for Agricultural Development (IFAD) acknowledges climate change as one of the factors affecting rural poverty and challenged to address. While climate change is a global phenomenon, its negative impacts are more severely felt by poor people in developing countries who rely heavily on the natural resource base for their livelihoods. Agriculture and livestock keeping are amongst the climate-sensitive sectors (IPCC, 2007; Addis, 2014).

Heat stress is known to alter the physiology of livestock, reducing male and female reproduction and production, and increasing mortality (Hoffmann, 2010; Maria, 2012). Heat Stress induced production losses for beef cattle are not as severe as those experienced by the dairy industry. It is not entirely clear why growing cattle tolerate higher THI conditions and exhibit a greater heat-strain threshold than lactating dairy cows, but likely possibilities may include(a) increased surface area–to-mass ratio, (b) reduced rumen heat production (because of the mostly grain diet), and (c) reduced overall metabolic heat production (on a bodyweight basis (Morrison, R.S. 1983; Mader *et al*., 2007; Lance and Robert, 2012).

In contrast, the livestock sector contributes 14.5% of global GHG emissions (Gerber *et al*., 2013; Rojas-Downing *et al*., 2017), and thus may increase land degradation, air and water pollution, and declines in biodiversity (Bellarby *et al*., 2013; Reynolds *et al*., 2010;Steinfeld *et al*., 2006; Thornton and Gerber, 2010; Rojas-Downing *et al*., 2017). Generally, according to Scholtz (2014) beef production both contributes to climate change and suffers from the consequences. Global warming has twofold implications for the beef industry (food security). 1. Continuous increase in ambient temperature has direct and indirect effects on the animal and 2. Responsibility of the beef cattle industry to limit the release of greenhouse gases (GHG) or the carbon footprint, in order to ensure future sustainability.

### 2.2. Impact of Climate Change on Beef Cattle Production

Animal production is affected by climate in four major ways: 1) changes in livestock feed-grain availability and price; 2) livestock pastures and forage crop production and quality; 3) distribution of livestock diseases, disease vectors and parasites; and 4) direct effect of weather and extreme events on animal health, growth and reproduction (Smit *et al*.,1996; Herrero *et al*., 2008; Scholtz *et al.,* 2010)

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 expected to increase by 100% by mid of the 21$^{st}$ century (Garnett, 2009; Rojas-Downing *et al*., 2017). The effects of climate change can be direct or indirect. The direct effects of climate change include higher temperatures and changing rainfall patterns, which could be translated into the increased spread of existing vector-borne diseases and macro-parasites, accompanied by the emergence and circulation of new diseases. The indirect effects are attributable to changes in feed resources associated with the carrying capacity of rangelands, the buffering abilities of ecosystems, intensified desertification processes, increased scarcity of water resources and decreased grain production. Other indirect effects are linked to the expected shortage of feed arising from the increasingly competitive demands of food, feed and fuel production, and land use systems (Calvosa *et al.,* 2009; Damitie, 2015).

#### 2.2.1. Feed Resources

Climate change affects livestock production by altering the quantity and quality of feed available for animals. Climate change is expected to change the species composition (and hence biodiversity and genetic resources) of grasslands as well as affect the digestibility and nutritional quality of forage (Thornton *et al*., 2009). One of the most significant effects of climate change on livestock production is changing the animal feed resources.

#### 2.2.2. Water

The response of increased temperature on water demand by livestock is well-known. For Bos Indicus, water intake increases from about 3 kg per kg DM intake at 10 °C ambient temperature, to 5 kg at 30°C, and to about 10 kg at 35°C (NRC, 1981; Adisu, 2014). For Bos Taurus, intake at the same three temperatures is about 3, 8 and 14 kg/kg DM intake. Some of this water intake comes from forage and forage water content itself will depend on climate-related factors: forage water content may vary from close to 0–80%, depending on species and weather conditions (Masike, 2007; Adisu, 2014). The same source indicated that groundwater will be more important in the future in the face of climate change.

**2.2.3. Biodiversity**

According to Ehrenfeld (2005) as cited by Kiros (2017) the loss of genetic and cultural diversity in agriculture is as a result of the forces of globalization. On the other hand Sere *et al*. (2008) reported that animal and plant genetic resources are the ultimate nonrenewable resource; once gone, they are gone for good. Similarly, FAO (2007) and CGRFA (2007) indicated that about 20% of animal genetic resource breeds are now classified as at risk and that almost one breed per month is becoming extinct. Much of this genetic erosion is attributed to global livestock production practices and the increasing marginalization of traditional production systems and associated local breeds. The drivers of these changes in developing countries depend on the system (Seré *et al*., 2008; Adisu, 2014)

Among the different sources of animal protein, beef is the most nutrient dense on a per calorie basis, sup plying several of the essential vitamins and minerals with a relatively low caloric intake per serving (McAfee *et al*. 2010). In the case of meat production, beef cattle with high weights, thick coats, and darker colors are more vulnerable to warming (Nardone *et al*., 2010; Jas-Downing *et al.,* 2017). Global warming may reduce body size, carcass weight, and fat thickness in ruminants (Mitloehner *et al*., 2001; Nardone, 2000; Jas-Downing *et al.,* 2017). One of the major causes of decreased production in the dairy and beef industry is heat stress (Nardone *et al*., 2010) and significant economic losses have been related to this.

**2.3. Impact of Climate Change on Beef Cattle Reproduction**

Diskin, and Kenny(2014) pointed out the generally agreed reproductive targets for a beef cow herd: (1) 365 days calving-to-calving interval, (2) <5% cows culled annually as barren, (3) >95% of cows calving to wean a calf, (4) Heifers calving at 24 months of age, (5) Compact calving with 80% of cows calved in 42 days, (6) Replacement rate 16 to 18%, (7) Sustained genetic improvement of the cow herd for economically important traits relating to reproduction, calving ability and calf weaning weight, (8) Close alignment of calving date with onset of pasture availability in the spring. There are four key benchmarks that must be achieved in a timely fashion in order to meet the above targets. These are: (1) occurrence and timing of puberty in heifers, (2) resumption of oestrous cycles post-calving, (3) Expression and detection of oestrus if artificial insemination (AI) is used; and (4) Breeding and the establishment of pregnancy. Reproduction is a complex composite trait influenced by numerous components including age at puberty, ovulation rate, estrus, fertilization, embryo implantation, pregnancy, parturition, lactation, and mothering ability (Snowder, 2007; Zishiri, 2011).

**2.3.1. Impact of Heat Stress on female reproductive performance**

**2.3.1.1. Fertility**

Infertility is the main problem that influences reproduction in both native and crossbred cows and heifers in Ethiopia (Duguma *et al.,* 2012). Productivity of the livestock population in Ethiopia has been hampered by the low fertility of the breeding herd (Payne and Wilson, 1999; Yoseph, 2007). A period of high-temperature results to increase secretion of endometrial PGF-2α, there by threatening pregnancy maintenance leads to infertility (Bilby *et al*., 2008; Ramendra *et al.,* 2016). A high level of prostaglandin F2 **α** (PGF2 **α**) inhibited implantation, altered embryo development and induced luteal regression (Stocco, 1998; Takahash, 2012). Plasma follicle-stimulating hormone (FSH) surge increases and inhibin concentrations decrease during heat stress leading to variation in follicular dynamics and depression of follicular dominance that could be associated with low fertility of cattle during the summer and autumn (Roth *et al*.,2000; Ramendra *et al.,*2016). On the other hand, heat stress decreases fertility by diminishing quality of oocytes and embryos through direct and indirect effects. (Lacerda and Loureiro 2015; Damitie, 2016).

**2.3.1.2. Conception/Pregnancy Rate**

The major impact of HS on reproduction involves delaying a return to gestation due to decreased submission rate and low conception / pregnancy rates (Nardone *et al*., 2010; Wakayo *et al*., 2014/15). Conception rates drop from about 40 to 60% in cooler months to 10-20% or lower in summer, depending on the severity of the thermal stress (Cavestany *et al*., 1985; Damitie, 2016). In terms of temperature, heat stress starts at 25ºC (Bitman *et al.*, 1984; Maria, 2012) in contrast, conception rate decreases from 31ºC (García-Ispierto *et al.*, 2007), declining 6.9–12.8% for each 0.5°C increase in uterine temperature (Gwazdauskas *et al.* 1973; Maria, 2012).

High temperatures increase the number of pregnancy losses that rise from 2.1 to 12.3% for cows that become pregnant during the warm period which contrasts clearly with the cold period. It seems that cool environment preserves gestation, probably as a reflection of cow well-being (Garcia-Ispierto *et al.*, 2006; Maria, 2012).

**2.3.1.3. Oestrus**

Heat stress reduces the length and intensity of estrus besides increases incidence of anestrous and silent heat in farm animals (Kadokawa *et al*., 2012; Singh M *et al*., 2013.; Singhal *et al*., 1984; Ramendra *et al.,* 2016). Length of the estrus cycle is reduced. One possible reason for the reduced estrus behaviour and extended estrus cycle in summer is a reduction in concentrations of estradiol-17b (Wilson *et al*., 1998; Sejian *et al*., 2016). Similarly, it blocks estradiol-induced sexual behavior (Hein and Allrich, 1992; Damitie, 2016). On the other hand it has the ability to influence the onset of estrus (Sejian *et al*. 2011; Naqvi *et al*., 2012). Heat stressed animals (tropical and subtropical regions) also experience an increased incidence of anoestrus and silent ovulation (De Rensis and Scaramuzzi, 2003; Walsh *et al*., 2011). According to Singh *et al*. (2013) heat stress increases adrenocorticotropic hormone and cortisol secretion.

**2.3.1.4. Embryo and Ovarian Development**

Embryo development begins on day 0, or the day of standing oestrus (Table 1.). This is the day the female is receptive to the male. Ovulation occurs on day 1 or about 30 hours after the first standing mount. After fertilization, the first cell division occurs on day 2 and by day 3 the embryo has reached the 8 cell stage. Between days 7-8, the zygote migrates into the uterine horn, and two distinct parts of the embryo can be observed: the inner cell mass which will form the foetus and the trophoblast which will form the placenta. On day 15 to 17, the embryo sends a signal (Farin et Farin, 1990; Mann et al., 2001) as a messenger for pregnancy initiation. The embryo starts attachment in the uterus on day 19, with a fully bound by day 42

Heat stress affects embryonic development long before the embryo is formed because it disrupts the process of oogenesis. This consequence of heat stress is indicated by observations that competence of oocytes to be fertilized and/or develop to the blastocyst stage is lower in summer than in winter. This is true both following insemination of cows *in vivo* (Sartori *et al*., 2002; Hansen, 2013). Similarly, Samal (2013) stated that embryo quality and growth is often reduced during heat stress. Thermal stress also alters the ability of embryos to develop into blastocysts. It causes early embryonic development, increased risk of early embryonic deaths and decreased foetal growth. There are effects of heat stress on the ovary and these effects may influence the ability of cows to become pregnant. The sensitivity of oocytes and embryos to heat stress are due to insufficient production of heat shock protein (HSP) and as glutathione (Edwards and Hansen, 1996; Alves *et al*., 2013). Similarly, Ealy *et al.* (1993) demonstrated that the most sensitive period after fertilization occurs until the second 93 days, because, from this moment, the embryo begins to acquire resistance against high temperatures.

**2.3.2. Impact of Heat Stress on male reproductive performance**

Bull's fertility is equally or more important for fertilization of oocyte to produce a good, viable and genetically potential conceptus. It is well known that bull testes must be 2-6°C cooler than core body temperature for fertile sperm to be produced. Therefore, increased testicular temperature results from thermal stress could changes in seminal and biochemical parameters leads to infertility problems in bulls (Ramendra *et al.*, 2016). In bulls, bovine testicular temperature must not exceed 33–34.5°C for normal spermatogenesis (Wildeus *et al.,* 1983; Barth and Bowman, 1994; Takahash, 2012**)**. Similarly, in males; high temperatures have negative effects on libido and sperm quality leading to sub-fertility, temporary or permanent sterility (Setchell, 1998a; Lue *et al.*, 1999; Yaeram *et al*, 2006; Tusell *et al.*, 2011; Maria, 2012). Elevated body temperature during periods of high ambient temperature leads to testicular degeneration and reduction in percentage of normal and fertile spermatozoa in the ejaculate (Marai *et al.*, 2002; Marai *et al.*, 2008).

Damage to spermatozoa can occur due to the production of free radicals; however, no one knows the time required for the production of free radicals increase (Monterroso *et al*., 1995). Male fertility is highly important economically both in naturally and artificially bred livestock herds. Fewer males compared to females are usually employed in breeding livestock herds making male fertility of critical importance in the reproductive performance of livestock. Male fertility is a function of the quality of semen (Gholami *et al*., 2010; Elile *et al*., 2014).

**2.4. Impact of Nutritional Stress on Reproduction**

Poor nutritional status directly influences the fertility in cattle especially those maintained on grazing in the subtropical/tropical areas (Bó *et al*., 2003). Fertility requires adequate nutrition and energy reserves. Starvation, wasting and obesity are associated with reproductive system abnormalities and infertility. It is evident that the energy balance plays a significant role in reproductive function and fertility. This effect of nutrition and/or energy reserves on reproductive function has long been suspected to be mediated by metabolic signal(s) that link adipose stores with neuroendocrine function (Goumenou *et al*., 2003; El-Khadrawy *et al*., 2011; Saime and Meltem, 2014). Energy deprivation reduces the frequency of pulses of luteinizing hormone (LH); thereby impairing follicle maturation and ovulation. Furthermore, under nutrition inhibits estrous behavior by reducing responsiveness of the central nervous system to estradiol by reducing the estrogen receptor α content in the brain (Hileman *et al*., 1999; José Eduardo, 2008).

Body condition score (BCS) is an indicator of the nutritional status of the cow and exerts a marked influence on fertility (Randel, 1990). Generally, it is reported that poor reproductive performance is associated with poor body condition. The study conducted in Ethiopia by Destalem (2015) revealed that, cows with BCS of 4 showed higher conception rate (41.51%) and lower NSC (2.40) than BCS of 3 and 5. Similarly, Conception rates directly correlate with BCS as the effect conception rate directly correlated with BCS. As the effect of nongenetic factors such as season, year, feed resources, and management are some of the factors influencing the trait of conception rate. In the Boran cows of Southern Ethiopia lower conception is generally observed during the dry season when the BCS are usually lower (Azage, 1989; Debir, 2016).

Negative energy balance is a common finding in high yielders during early lactation because of inadequate consumption of feed to meet the nutrient requirements for high levels of milk production. Energy stores in body tissues are mobilized and weight losses occur. This negative energy balance positively affects the reproductive status of the animal because of the longer interval to first ovulation (Nishany *et al.,* 2013; Rooh, 2013). Sudden reductions in dry matter intake (DMI) around the time of AI adversely affected embryo survival in heifer dam. When energy intake was reduced from twice maintenance to 0.8 times maintenance for 2 weeks immediately after AI, embryo survival rate in heifers was consistently less than 40%. When heifers were provided with either a constant level of feed intake or changed from a lower- to a higher-level feed intake, embryo survival was 65–71%.(Dunne *et al*. 1999; Mondal *et al* ., 2015).

Nutrition affects the quantity of oocytes that ovulate, in addition to, the quality of oocytes. The level of nutrition (energy content) an animal receives has the potential to influence their oocytes' developmental competence, and subsequent embryo viability in a direct and⁄or indirect way. The effect of nutrition on oocyte quality is dependent on the body condition of the animal (Adamiak *et al*., 2005; Mondal *et al*., 2015).

**2.5. Contribution of Beef Cattle to Climate Change**

The livestock sector contributes 14.5% of global GHG emissions (Gerber *et al*., 2013; Jas-Downing *et al*., 2017), and thus may increase land degradation, air and water pollution, and declines in biodiversity (Bellarby *et al*., 2013; Reynolds *et al*., 2010; Steinfeld *et al*., 2006 ; Thornton and Gerber, 2010; Jas-Downing *et al*., 2017). On the other hand Gerber et al. (2013) reported that the primary livestock GHG emissions are $CO_2$, $CH_4$, and $N_2O$. $CH_4$ contributes the most to anthropogenic GHG emissions (44%), followed by $N_2O$ (29%) and $CO_2$ (27%). According to Gerber et al. (2013) report globally, livestock contribute 44% of anthropogenic $CH_4$, 53% of anthropogenic $N_2O$ and 5% of anthropogenic $CO_2$ emissions. Higher concentrations of these gases can be explained by lower efficiency and productivity of livestock system due to excess loss of nutrients, energy, and organic matter.

Contributions according to commodity were: beef cattle contribute the most with 41% of the sector's emission, followed by dairy cattle (20%), swine (9%), buffalo (8%), poultry (8%), and small ruminant (6%) (Gerber *et al*., 2013; Jas-Downing *et al*., 2017). Pelletier *et al*. (2010) found an increase of 30% in total GHG emissions from cattle finished on pasture compared to cattle in a confined system. "A kilogram of beef is responsible for more greenhouse gas emissions and other pollution than driving for 3 hours while leaving all the lights on back home (New Scientist, 2007).

**2.6. Mitigation Strategies to Combat Climate Change**

There are two central ideas for dealing with climate change, namely, mitigation and adaptation. Mitigation is a response strategy to global climate change, and can be explained as measures that reduce the amount of emissions (abatement) or enhance the absorption capacity of greenhouse gases (sequestration). Adaptation to climate change is an adjustment made to human, ecological or physical system in response to vulnerability (Adger *et al*., 2007; Adebanjo, 2013). On the other hand Rosegrant *et al*., (2008) revealed that climate change adaptation through the modification or improvement of agricultural practices will be imperative to continue meeting the growing food demands of modern society

Mitigation strategies were management practices (stocking rate, level and type of feed supplementation), forage types, genetic selection for improved feed efficiency, and feed additives aimed at decreasing methane emissions. Perhaps one of the most successful ways to minimize the environmental impact is to increase productivity and thus decrease the GHG emissions per unit of animal protein produced (Hristov *et al*., 2013b; Nicolas DiLorenzo *et al*., 2014). Electrolyte balance in beef cows and feedlot cattle, but without the effect of climate (Ross *et al*., 1994; Hersom *et al*., 2010).

The main strategies for reducing GHG emissions involve: improving productive and reproductive indexes (reducing age on slaughter, age at first calving and calving interval); reducing the quantity of replacement animals; increasing the longevity of reproductive cows; improving the genetic merit of both animals and forage plants; utilizing additives and supplements; improving food conversion efficiency; optimizing the supply of good quality water; improving management of both animals and pasture; enhancing animal health (control of parasites, diseases and vaccines); and looking to improve animal well-being (Boadi *et al*., 2004; Hegarty *et al*., 2007; Beauchemin *et al*., 2008; Perdok and Newbold, 2009; Berndt, 2010; Smith *et al*., 2011). Studies show that the first step in the attempt to reduce the effect of cattle production on global warming is to increase productivity by supplying better quality food.

All the livestock practice such as genetics, nutrition, reproduction, health and dietary supplements and proper feeding (include grazing) management are that result in the improved feed efficiency. Improved feeding management mainly the composition of feed has some effect on the enteric fermentation and emission of CH4from the rumen or the hindgut (Dourmad, *et al*., 2008).

## 3. SUMMARY AND CONCLUSION

### 3.1. Summary

Climate is one of the determining factors for production and reproduction in farm animals throughout the world. Its effect is higher in cattle than in other ruminants. Beef cattle can particularly be vulnerable to extreme environmental conditions and to rapid changes therein. It can be affected by heat stress, particularly in feedlot situations or when grazing fescue-infected pastures. Climate change affect beef cattle through direct and indirect ways. It affects both male and female reproductive performance of beef cattle by altering their physiological process. Of the total contribution of livestock to climate change, beef cattle are the most contributor farm animal. Mitigation strategies to enhance production and reproductive performance of beef cattle are improving productive and reproductive indexes (reducing age on slaughter, age at first calving and calving interval), increasing the longevity of reproductive cows; improving the genetic merit, improving quality and type of feed and provide ventilation, water, and shading.

### 3.2. Conclusion and Recommendation

Beef cattle both contributing and affected by climate change. Therefore, in order to tackle the impact of climate and improving production and reproductive performance of beef cattle the following recommendations were forwarded for the future attention.

- Specialized beef production strategies should strengthen
- Awareness creation should be given for beef producers on economic impact of climate change on beef cattle and contribution of beef cattle for climate change by concerned expertise and organizations
- Integrating beef cattle production system with natural conservation strategies in order to get sufficient feed, water and shade is prioritized by concerned bodies
- Climate change should be part of educational curriculum(from elementary to higher education)

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