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The Climate Change Impacts on Livestock Production: A Review

Kassahun Desalegn

Department of Animal Sciences, College of Agriculture and Veterinary Medicine,
Jimma University, Box 307, Ethiopia

Abstract: This review was conducted to assess the effect of climate change on livestock production. The climate change especially global warming may highly influence production performance of farm animals throughout the world. Among the environmental variable that affect animals heat stress seems to be the intriguing factor making animal production challenging in many geographical locations in the world. All animals have a range of ambient environmental temperature termed as thermo neutral zone and temperature above or below this thermo neutral range of the animal create stress condition in animals. A thermal environment is a major factor that affects milk production in dairy cow especially on animals of high genetic merit. Milk yield decline by 0.2kgper unit increase thermal humidity index(THI) when it exceeded 72.The increase in milk yield increase sensitivity of animals to thermal stress and decline the threshold temperature at which milk losses occur. the mid lactating dairy cows were the most heat sensitive compared to their early and late lactating counterparts. In addition mid lactating dairy cows showed a higher decline in milk production (-38%) when the animals were exposed to heat. Animals can adapt the hot environment, however the response mechanism are helpful for survival but are detrimental to productive and reproductive performances. Reproduction is normally luxurious phenomenon and appropriate when the animal is in right homeostasis. Heat stress due to high ambient temperature accompanied with excess humidity cause infertility in most of the farm species and adverse effect on reproductive performance of farm animals. Changes in rainfall and temperature regimes may affect both the distribution and abundance of disease causing vectors, as can changes in the frequency of extreme events. Higher temperature resulting from climate change may increase the rate of development of certain pathogen or parasites that have one or more life cycle stages outside their animal host. This may shorten generation times and possible increase the total number of generations per year leading to higher pathogen or parasite population size.

Key words: Reproductive · Health · Feed · Water

INTRODUCTION

The livestock sector has a significant contribution to the community as well as the national economy of several countries. Livestock are a vital fraction of many farming systems in the world, through provision of milk, meat, draught power, hides, skins, manure and other products [1]. However the livestock production has been suffered by climatic change hazards such as drought, floods, heavy rains, high temperature, strong winds and frost [2]. Sustainability of livestock production system is threatened by climatic change due reinforcing the stressors such as heat stress, drought and flood events that have led to loss of livestock productivity potential. As a result of the long term climate related changes in temperature, precipitation pattern and rainfall variability has increased the frequency drought and flood [2, 3]. Climate change problems are much more severely felt by poor people who rely heavily on the natural resource base for their livelihoods [4, 5]. Particularly the pastoral communities are the most susceptible communities [6, 5].

Uncertainty is the most problematic aspect of climate change and a high limiting factor in the prediction and assessment of its effect. At best the range of high and low extremes with defined probability distribution can be predicted [7].

Corresponding Author: Kassahun Desalegn, Department of Animal Sciences, College of Agriculture and Veterinary Medicine, Jimma University, Box 307, Ethiopia.

This report [8] stated an approach to address the challenges of climate change in Africa which depends on the close engagement with climate variability. They suggested that addressing climate on one time scale may be the best way to approach the institutional and informational gaps that limit progress at another, longer time scale. These pillars from two key constraints; the relative scarcity of climate scientists and shortage of climate data in Africa. Adaptation to climate changes requires change to and behavioral modification. There is an urgent need to consider developing collaborative learning process to support the adaptation of agriculture and food systems to better cope with the effects of climate change [9].

Agriculture is the back bone of most African countries economy[10]. The agricultural sector is the largest domestic producer across the continent and employs about 70% to 90% of the total labor force [11]. Moreover this sector supplies up to 50% of household food demand and up to 50% of their income. In addition most of the income generated by livestock rearing such as dairy cattle, beef cattle, sheep, goat and chickens. In most rural communities livestock is the only asset of the poor. But it is highly susceptible to climate variability extremes [11-14]. The effect of climate change is anticipated to heighten the susceptibility of livestock system and reinforce the existing factors that are affecting livestock production systems [15] therefore the objective of this review is to review the climate change impacts on livestock production.

Effects of Climate Change on Livestock Production: The climate change especially global warming may highly influence production performance of farm animals throughout the world. Among the environmental variable that affect animals heat stress seems to be the intriguing factor making animal production challenging in many geographical locations in the world [16]. But new knowledge about animal response to the environment continues to be developed, managing animals to decrease impact of climate remains the challenge [17].

Animal stress level due to rise temperature has been worked out using temperature humidity index (THI) in India [18]. All animals have a range of ambient environmental temperature termed as thermo neutral zone and temperature above or below this thermo neutral range of the animal create stress condition in animals. Climate change scenario constructed in India revealed that temperature rise about 4°cis likely to increase uncomfortable days (THI> 80) from existing 40 days (10.9%) to 104 days (28.5%). This change in THI has a negative impact on the livestock production both directly and indirectly. Dhakal *et al*., [19] reported that climate change had negative impact on milk production, lactation length and infertility in Nepal.

Effect of Climate Change on Milk Production: Increase in number of stress day (THI more than 80) and their frequency will affect the yield and production of cattle and buffaloes [18].A thermal environment is a major factor that affects milk production in dairy cow especially on animals of high genetic merit. Milk yield decline by 0.2kgper unit increase THI when it exceeded 72 [20].Maust *et al*. [21] reported the variation in milk (9%) in milk fat (13%) feed intake (5%) and rectal temperature due to THI were attributable to weather condition. The degree of milk yield reduction observed in heat stressed cows is dependent in several factors that interact with high air temperature. The milk yield loss seems positively related with milk yield of cows [22].

The increase in milk yield increase sensitivity of animals to thermal stress and decline the threshold temperature at which milk losses occur [23]. According to Berman, [23] and Nardone *et al.* [24] when high milk producing cattle were kept in hot climatic zone, metabolic heat production was intensified that resulted in an increment of respiratory rate, consequently reduce milk production. Molee*et al.,* [25] reported that Holstein crossed with local tropical and subtropical breeds perform better than the pure Holstein bred and were also resistance to heat stress. Purwanto *et al*. [26] reported that when non-lactating cow lower milk yielding (18.5kg/day) or high yielding cows (31.6kg/day) were compared, low and high yielding cows produced 27 and 48% of more heat than non-lactating cows despite of low body weight (752, 624 and597 kg for non-lactating, low and high producers respectively.

The stage of lactation is also an important factor affecting dairy cows' response to heat. Johnson *et al.* [27] observed that the mid lactating dairy cows were the most heat sensitive compared to their early and late lactating counterparts. In addition mid lactating dairy cows showed a higher decline in milk production (-38%) when the animals were exposed to heat. Upadhyay *et al*. [18] found that the degree of reduction in milk yield were less at mid lactation stage than either late or early and reduction in yield varies from 10 to 30% in the first lactation and 5 to 20 % the second and third lactation in Murrah buffaloes.

The minor importance of small ruminants in milk production in the world, lower selection for high productivity in these species and their supposed higher adaptability to hot environment, explain the fact that less attention has been given to the effects of heat stress to these species. Milk production traits in ewes seem to a higher negative correlation with the direct values of temperature or relative humidity than THI. The value of THI, above which ewes start to suffer from heat stress, seems to be quite different among breeds of sheep. Solar radiation seems to have a lesser effect on milk yield but a greater effect on casein, fat and clot firmness in the milk of Comssina ewes [28]. High air temperature even affects goats, reducing milk yield and the composition of milk components. In particular if lactating goats are deprived of water during the hot season they activate an efficient mechanism for reducing water loss in urine, milk and by evaporation to maintain milk production for a longer time [29].

Effects of Climate Change on Animal Reproduction: Animals can adapt the hot environment, however the response mechanism are helpful for survival but are detrimental to productive and reproductive performances. Reproduction is normally luxurious phenomenon and appropriate when the animal is in right homeostasis. Heat stress due to high ambient temperature accompanied with excess humidity cause infertility in most of the farm species and adverse effect on reproductive performance of farm animals. Most of the buffaloes exhibit sexual activities during cooler part of the year when the THI generally remains <72 [30].

A temperature rise of more than 2°c in unabated buffaloes may cause negative impacts due low or desynchronized endocrine activities particularly pineal hypothalamo-hypophysealgonado axis altering the respective hormone functions [30], where as in case of cattle, the effect of heat stress on infertility appear to carry in autumn even though the cows are no longer exposed to heat stress [31]. Gwazduaskas *et al.* [32] reported that an increase in uterine temperature of 0.5°cabove average is associated with a decline in conception rate of 12.8%. low temperature and THI in during night in summer provide an opportunity to buffaloes to dissipate heat during night hours compared to day hours. This might be the reason that buffaloes experienced less stress during hot dry season compared with hot humid season [30]. During heat stress motor activity and other manifestation of stress are reduced [33] and the incidence of anestrus and silent ovulation is increased [34].

Reproductive processes in male animal are very sensitive to disruption by hyperthermia with the most pronounced consequences being reduced quantity and quality of sperm production and decline fertility. There were no significant effect of ambient temperature and humidity on sperm production and semen quality [35]. However, Taylor *et al.,* [36] demonstrated that extreme temperatures (-24 to -19°cand 27 to 32°c) had only small effects on sperm production. Sperm production (ejaculate volume, sperm concentration and total sperm number) and percentage of normal sperm cells decrease in hot season in boss indicus bulls in Africa. Collier et al 1982 [35] reported that dairy cows experiencing heat stress during late gestation had calves with low birth weight and reduced milk production than cows not exposed to heat stress. Scrotal circumference, testicular consistency, tone size and weight are decrease in hot summer in the sub tropics than the same breeds of buffaloes reared under temperate environmental condition [26].

Effects of Climate Change on Feed and Fodder Availability: Climate change affects livestock production by altering the quantity and quality of feed available for animals. Climate change is anticipated to change species composition (and hence biodiversity and genetic resource) of grass land as well as affect digestibility and nutritional quality of forage [9]. Drought and extreme rainfall variability can trigger periods of sever feed scarcity, especially in dry land areas, with devastating effects on livestock population.

Change in primary product of crops, forages and rangelands are probably the most visible effect of climate change on feed resource availability for livestock, a change in the quantity of grains, stovers and rangelands available for dry season feeding [13].

Changes in species composition in range lands and some managed grass lands will have significant impact on the types of animal species that can graze them and may alter the dietary patterns of the community depending on them[13]. The quality of plant material may be altered (from c3 to c4) by increased temperature and will reduce the digestibility and the rates of degradability of species, which will lead to reduce nutrient availability for animals [13].

Effects of Climate Change on Water Resources: The impact of climate change is not only the water resource but also at the same time affect availability of feed resources particularly for the pastoral community who depend mostly on rainfall. Some African countries are already experiencing water stress as a result of insufficient and unreliable rainfall. The IPCC [4] stated that the overall net impact of climate change on water resources and fresh water ecosystem is negative due to diminished quantity and availability of available water. Droughts are more likely to become widespread, while increases in heavy rainfall events would produce more flooding [12]

Climate change and variability have the potential to impact negatively on water availability and access to and demand for water in most countries, but particularly in Africa [4]. There is a large degree of uncertainty about future impacts of climate change on water resources than climate variability [37]. The scarcity of water due to climate change has affected two important variables that influence livestock production which are rainfall and temperature. Lack of water resources and rise frequency of drought in some countries will lead to just a loss of livestock resources. Population growth, economic development and climate change impacts the global water availability in the future. In the present food production and environmental trends continue into the future, they will lead to crises in many parts of the world [38The response of increased temperature on water demand by livestock is well known. For boss indices water intake increases from about 3kg/kg dry matter intake at 10°c ambient temperature to 5kg/kg DM at 35°c. For bos Taurus intake at the similar temperature were about 3, 8 and 14kg/kgDM intake. Some of this water intake comes from forage and forage water content itself depends on climate related factors; forage water content may vary from close 0 to 80% depending on species and weather condition [38].

Effects of Climate Change on Livestock Health: Global climate change alters ecological construction which causes both the geographical and phonological shifts [39].these shifts affect the efficiency and transmission pattern of the pathogen and increases their spectrum in the host [40]. The increased spectrum of pathogen increases the disease susceptibility of the livestock and thus supports the pathogenicity of the causative agent. The livestock systems are susceptible to changes in severity and distribution livestock disease and parasite as potential consequences. Incidence of external parasite (43.3%) was first ranked as the problem in the warm temperate [19].

Changes in rainfall and temperature regimes may affect both the distribution and abundance of disease causing vectors, as can changes in the frequency of extreme events [9].the hot humid weather condition was found to aggravate the infestation of cattle ticks such as *Boophilusmicroplus, Haemaphysalisbispinosa and Hyalommaanatolicum* [41, 42].

Higher temperature resulting from climate change may increase the rate of development of certain pathogen or parasites that have one or more life cycle stages outside their animal host. This may shorten generation times and possible increase the total number of generations per year leading to higher pathogen or parasite population size [43]. Certain tick borne disease of livestock in Africa such as *Anaplasmosis, Babesiosis* and *Cowdriosis* show a degree of endemic stability [44].

Effect of Climate Change on Biodiversity: Climate change may continue alarmingly [45]; cheap energy and other resources, including fresh water will diminish and disappear at an accelerating rate; agricultural and farm communities will deteriorate further while we loss more genetic diversity among crops and farm animals; biodiversity will decline faster as terrestrial and aquatic ecosystem are damaged; harmful exotic species will become ever more numerous. FAO, [11] report on animal genetic resources indicates that 20% of reported breed are now classified as at risk and that almost one breed per month is becoming extinct. For developing regions, the proportion mammalian species at risk is lower (7 to 10%) but 60 to 70% of mammals are classified as being of unknown risk status.

CONCLUSION

The climate change has negative impact on livestock production in different ways (reproductive and productive performance, health, genetic etc.) worldwide, as it has been stated by several researchers. Therefore, it needs an immediate action of finding strategies which enables livestock to adapt climate change. If the climates change continues as the present it will have devastating effect on livestock and communities who overwhelmingly depend on livestock, like pastoralists.

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