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Review on impact of climate change on livestock health and productivity

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Abstract

Climate change and extreme weather events affect plants and animals and the direct impact of anthropogenic climate change has been documented extensively over the past years. Throughout the world. National average temperature has increased by 1°C since the 1960s. Most of the livestock owners in the country perceive there is a climate change impact on Livestock production and health. The major impact of climate change on livestock production include: Feed shortage, shortage of water, losses of livestock genetic resources, reduced productivity, and decreased mature weight or longer time to reach mature weight. Again, which may cause loss of body condition, reduced milk production and poor reproductive performance in mature animals. Drought oxen that will be emaciated and cannot provide adequate drought power for plowing thus hinder crop cultivation. Furthermore, the spatial distribution and availability of pasture and water are highly dependent on the pattern and availability of rainfall. Thus, shortage of feed and water contribute to reduced productivity and reproductive performance of livestock. 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. Moreover, it is found climate change will affects livestock health through several pathways, which are effects on pathogens, effects on hosts, effects on vectors, such as changes in rainfall and temperature regimes can affect both the distribution and the abundance of disease vectors, and effects on epidemiology such; as altered transmission rates between hosts. Climate change will have far-reaching consequences on production and health of especially, in vulnerable parts of the world where it is vital for nutrition and livelihood. This review is conducted to explore the likely impacts of climate change on livestock health and productivity.

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Introduction

The Intergovernmental Panel on Climate Change: Defines climate change as the change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period [1]. Climate change effects include among other things i.e. sea level rise, changes in the intensity, timing and spatial distribution of precipitation, changes in temperature and the frequency, intensity and duration of extreme climate events such as droughts, floods, and tropical storms[2].

Domestic animals represent the only means of subsistence for hundreds of millions of families worldwide.

It is estimated that among one billion people, 700 million of whom live in poverty, depend on their animals for food, income, traction and transport [3]. Livestock sector is a rapidly growing agricultural sector, sharing 33% agricultural GDP and driven by population growth, urbanization and increasing incomes in developing countries [4,5]. Demand for all livestock products is expected to double in sub-Saharan Africa and South Asia by 2050 [6].

On the other hand, changes in climate over the last 30 years, reduced global agricultural production in the range of 1-5% per decade [6]. Climate is one of factors with the potential to alter disease states and is expected to exert an overwhelming negative effect on humans and animals health, it poses serious social upheaval, population displacement, economic hardships and environmental degradation [7]. Furthermore, climate change now is the accepted facts, affecting all ecosystems and will go on if left uncontrolled [4,8].

Climate change influences the emergence and proliferation of disease hosts, vectors, and pathogens and their breeding, development and disease transmission. Consequently, it affects distributions, host-parasite relationships, and its assemblages to new areas. Climate change is likely to affect the health of animals greatly, both directly and indirectly [4,7]. The direct effects of climate on animal disease are likely to be more pronounced for vector- borne diseases, soil associated, water or flood associated, rodent associated, or air temperature/humidity associated and sensitive to climate [4,9].

Indirect impacts follow more complex pathway, especially those deriving from the attempt of animals to adapt to thermal environment or from the influence of climate on microbial populations, distribution of vector-borne diseases and host resistance to the distribution of vector-borne diseases and food-borne diseases [4,8]. Furthermore, climatic changes can influence livestock health through a number of factors, including the range and abundance of vectors, wildlife reservoirs and the survival of pathogens in the environment [4,7] Heat stress results from the animal's inability to dissipate sufficient heat to maintain homoeothermic [10].

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. This may shorten generation times and increase the total number of generations per year, causing higher pathogen or parasite population sizes [4,11]. Increase in temperature results in the spatial distribution and intensity of existing pests and diseases that in turn affect livestock productivity or may cause death of livestock [4,12].

According to [13] the developmental stage of vectors such as ticks and flies are often heavily dependent on temperature and transmit most diseases. Cattle, goats, horses and sheep are also vulnerable to an extensive range of nematode worm infections, most of which have their development stages influenced by climatic conditions. Understanding of the relation between climate change and livestock disease is critical for better management of animal health problems with its potential impact on productivity.

However, Current knowledge on the relationship between climate change effects on animal health and productivity is lacking, particularly in Africa despite livestock agriculture being economically important. Therefore, one of the objectives of this paper is to give an overview on the effects of climate changes on livestock health as well as its impact on productivity.

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 [14]. They are an important component of nearly all farming systems in Ethiopia and provide draught power, milk, meat, manure, hides, skins and other products [15]. Ethiopia has a diversified climate, which has different size and diversity of major agro-ecological zones, rendering it suitable for the support of large numbers and classes of livestock [15].

Ethiopia is the home of the largest livestock population in Africa, and it is the continent's top livestock producer and exporter. Domestic demand for animal products in Ethiopia is increasingly driven by the urban middle and upper classes; export potential is the key force encouraging expansion and intensification of livestock production [16].

However, the country has been severed from climatic variability and extremes. Consequence of the long-term climate related to changes in precipitation patterns, rainfall variability, and temperature has increased the frequency of droughts and floods [17]. Thus among factors which influence livestock production are climate, and location are undoubtedly the most significant.

In fact, climatological characteristics such as ambient temperature and rainfall patterns have great influence on pasture and food resources availability cycle throughout the year among animal populations. This means 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 animal production [18].

Literature review

Climate change and animal diseases linkage

The distribution of infectious diseases (human, animal and plant), the timing and intensity of disease outbreaks are often linked to climate. Climate change may affect livestock diseases through several pathways both direct and indirect. The direct effects of climate on animal diseases, pronounced for diseases that are: vector-borne, soil associated, water or flood associated, rodent associated, air temperature/humidity associated and diseases sensitive to climate. These direct effects by weather and climate may be spatial, with climate affecting distribution, or indirect effects by weather may be spatial temporal, with affecting the timing of an outbreak or relate to the intensity of an outbreak [9].

Moreover Indirect effect of climate changes on health is changes in livestock production systems: less cattle, more small ruminants and camels [19,20] should be used.

Climate change may have an impact on different cardinal physiological reactions [21], reported that there is significant effect due to the change of the micro climatological components on various cardinal physiological reactions i.e., rectal temperature, respiration rate and pulse rate of growing calves in different months. Thus, climate would be the possible reason for COVID 19 re-emergences today as well. Its diagnosis should consider these physiological changes due to climate change rather than going to mass vaccinations.

Global climate change alters ecological construction, which causes both the geographical and phonological shifts [22]. These shifts may affect the efficiency and transmission pattern of the pathogen and increase their spectrum in the hosts [23]. The increased spectrum of pathogens increases the disease susceptibility of the animal and thus, supports the pathogenicity of the causative agent. Therefore, livestock systems are susceptible to changes in severity and distribution of livestock diseases.

Incidence of external parasites (43.3%) first ranked, as the problem in the warm temperate. Vector-borne diseases are especially sensitive to climate change, especially Changes in rainfall and temperature regimes may affect both the distribution and the abundance of disease vectors [24]. Arthropod vectors tend to be more active at higher temperatures, thus they feed more regularly to sustain the increases in their metabolic functions, enhancing chances of transmission of infections between hosts.

Small changes in vector characteristics can produce substantial changes in disease [9]. There is a link between climate and epidemiological conditions of disease agents. Temperature, precipitation, humidity and other climatic factors known to affect the reproduction, development, behavior and population dynamics of the helminthes, arthropod vectors and the pathogen they carry. Climate change influences the emergence, proliferation of disease hosts or vectors, pathogens and their breeding, development and disease transmission [7].

The OIE Scientific Commission has concluded that climate changes are likely to be an important factor in determining the spread of some diseases, especially those that are vector-borne. The two most mentioned emerging and re-emerging cattle diseases in a recent OIE survey are catarrhal fever (bluetongue) and rift valley fever (RVF) [25]. The global distribution of bluetongue virus infection changed drastically in recent years and climate change may be partly responsible for this profound change in the global distribution of the bluetongue virus. Studies have demonstrated that the vector of the diseases affected by temperature and have indicated a possible role of humidity and precipitation.

Climate change and livestock health

Climate change may have significant impacts on the emergence, spread and distribution of livestock diseases. For example, the distribution of vector-borne diseases of animals such as; Rift Valley Fever, African Horse Sickness and Bluetongue, vary considerably with seasonal and longer-term climatic variations. Climate change may affect infectious diseases of livestock in several ways; effects on pathogens, such as higher temperatures affecting the rate of development of pathogens or parasites, effects on hosts, such as shifts in disease distribution that may affect susceptible animal populations, effects on vectors, such as changes in rainfall and temperature regimes that can affect both the distribution and the abundance of disease vectors and effects on epidemiology, such as altered transmission rates between hosts [26].

While there is no consensus that a warmer world is necessarily a more disease-ridden world, disease risks may be increasing for a variety of other reasons, such as the increasing complexity and scale of market chains and the inevitable intensification of production systems in particular places [27].

Climate change and vectors

Vectors are intermediate hosts and they carry and transmit pathogens to living organisms, which become hosts.

There may be several impacts of climate change on the vectors of disease (midges, flies, ticks, mosquitoes and tsetse are all important vectors of livestock disease in the tropics) [28]. The geographical locations and population changes of insect vectors are closely associated with the patterns and changes of climate. Thus, climate change may cause changes in range, period, and intensity of infectious diseases through its impacts on disease vectors [29]. Changes in rainfall and temperature regimes may affect both the distribution and the abundance of disease vectors**.** Theability of some insect vectors to become or remain infected with viruses (such as bluetongue) varies with temperature [28,30].

Changes in rainfall and temperature regimes may affect both the distribution and the abundance of disease [31]. Arthropod vectors tend to be more active at higher temperatures; they therefore feed more regularly to sustain the increase in their metabolic functions, enhancing chances of infections being transmitted between hosts [31].

Arthropod vectors are cold-blooded and thus sensitive to climatic factors, like; Temperature, precipitation, humidity and other climatic factors that influence the survival, production, development, behavior and population dynamics of the arthropod vectors.

Subsequently climate factors influence habitat suitability, distribution, abundance; intensity and temporal pattern of vector activity (particularly biting rates) throughout the year [4]. It might affect disease vectors by several processes. First, temperature and moisture frequently impose limits on their distribution. Often, low temperatures are limiting because of high winter mortality and a relatively slow rate of population recovery and by contrast, high temperatures are limiting because they involve excessive moisture loss [7]. Climate change influences the emergence and proliferation of disease hosts or vectors and pathogens and their breeding, development and disease transmission [4].

Climate change and pathogens

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 [4,9]. 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 [9]. Increased the rate of development due higher temperatures may shorten generation times and, possibly, increase the total number of generations per year, leading to higher pathogen/ parasite population sizes [4,32]. Conversely, some pathogens are sensitive to high temperatures and their survival may decrease with climate warming.

Pathogens and parasites that are sensitive to moist or dry conditions may be affected by changes to precipitation, soil moisture and the frequency of loads [32]. Changes to winds could also affect the spread of certain pathogens and vectors [33].

Arthropod vectors tend to require warm weather so the infection season of arthropod-borne diseases may extend. Some pathogens/parasites and many vectors experience significant mortality during cold winter conditions; warmer winters may increase the likelihood of successful overwintering [30]. Extreme weather events, like flooding, can carry a risk of Cryptosporidium parasites or entero-haemorrhagic Escherichia coli emerging as diffuse pollution in a run-off from agricultural land. This poses an obvious threat to other livestock and is also a zoonotic risk to humans, through contamination of water supplies Future challenges in the control of parasitic zoonoses, including those related to climate change; deserve increasing attention alongside production-limiting diseases [30].

Impact of climate change on disease epidemiology

In developed countries, farmed animal mortality is generally low, due to good control of diseases. In developing countries, however, livestock have yet to see an epidemiological transition, and enormous numbers die annually, many from preventable disease [9].

In medical education, epidemiology is often depicted as a triangle that shows the relationship between microbes, its host and the environment. While it can be argued that this classical description is simplistic, it does highlight the importance of the environment (or the ecosystem), without which there would not be the right conditions for diseases to develop and spread [34]. Climate change may alter transmission rates between hosts not only by affecting the survival of the pathogen, parasite, or intermediate vector but also by other means [28]. Future patterns of international trade, local animal transportation, and farm size are factors that will be driven in part by climate change, and may affect disease transmission [28]. Examples of this type of analysis are done for several diseases of livestock in developing countries. It is believed that the possible climate change impacts on the distribution of the brown-ear tick, Rhipicephalusappendiculatus, the primary vector of East Coast Fever (ECF), a disease that affects both grazing and mixed systems in eastern and southern Africa. The majorfactor affecting infectious disease emergence is ecological changes, more specifically, climate change as an example, Rift Valley fever [35].

By the 2050s, suitable habitat is projected to have largely disappeared from the southeastern part of its existing range (Southeastern Zimbabwe and southern Mozambique), although its range may expand in western and central parts of southern Africa [36]. In another study that looked at possible impacts of climate change on a major disease of livestock in African livestock systems, is cattle Trypanosomiasis [37] investigated due to climate-driven changes in habitat suitability for the tsetse fly vector. There are no prior reasons for expecting that climate change will necessarily lead to increases in disease risk in general, and in general a multitude of interacting factors determine infection risk and exposure of livestock to that risk [38]. It noted that new studies are focusing on the spread of animal diseases and pests from low to mid-latitudes due to warming [28]. Some models project that bluetongue, which mostly affects sheep and occasionally goat and deer, will spread from the tropics to mid-latitudes [28].

Climate change effects on livestock disease suffer intrinsic problems of predictability than livestock productivity. This is due in part to the nature of diseases. It is noted that climate change-driven alterations to livestock husbandry in Africa, if they occur, could have many indirect and unpredictable impacts on infectious animal disease in the continent. It is observed that combinations of drought followed by high rainfall have led to widespread outbreaks of diseases such as RVF and bluetongue in East Africa and of African horse sickness in the Republic of South Africa [26]. Outbreaks of certain vector-borne diseases will become more common in parts of Africa; we are very limited when it comes to predicting when and where these are likely to occur. In addition to this noted that there has been a tendency to oversimplify the mechanisms by which climate change may affect disease transmission [39]. In general, there are many factors operating, thus considerable work needed on disease dynamics and how these may adapt to a changing climate. These things make impact assessment of livestock diseases in developing countries particularly challenging [39].

Impact of climate change on disease incidence

Increased milk somatic cell counts and a high incidence of clinical mastitis in dairy cattle occur during hot summer month [21]. Reduction of thermal stress by air conditioning or shade management resulted in a lower frequency of clinical mastitis in cows than those exposed to their natural environments. Higher incidence of clinical mastitis in dairy animals during hot and humid weather, due to increased heat stress and greater fly population associated with hot and hot-humid conditions [40,21]. Hot–humid weather conditions were found to aggravate the infestation of cattle ticks like, Boophilusmicroplus, Haemaphysalisbispinosa and Hyalommaanatolicum which act as vector for various protozoan diseases [41,21].

Impact of climate change on hosts

Some livestock will be exposed to new pathogens and vectors as their range increases and impacts can be severe. Climate stress (heat, inadequate food and water) can also lower immunity [31]. Peoples' behavior may change as the result of climate change and this may affect how they keep animals, which in turn may affect the exposure or vulnerability of animals to pathogens or vectors. Thus, some livestock will be exposed to new pathogens and vectors as their range increases and impacts can be severe. Climate stress (heat, inadequate food and water) can also lower host immunity [9]. Mammalian cellular immunity can be suppressed following heightened exposure to ultraviolet B radiation, which is an expected outcome of stratospheric ozone depletion [28,26]. Therefore, greenhouse-gas emissions that affect ozone could have an impact on certain animal diseases, which are not well studied such as livestock production or its health especially, in Ethiopia. A more important effect may be on genetic resistance to disease.While animals often have evolved genetic resistance to diseases to which they are commonly exposed, they may be highly susceptible to ''new" diseases [28]. This animal can lose its potential diseases resistances due climates variations and could harbor new diseases (re-emerging diseases).

Climate change may bring about substantial shifts in disease distribution, and outbreaks of severe disease that could occur in previously unexposed animal populations by breakdown of endemic stability [28,26].

Impact of climate change on livestock production

Impact of climate on livestock feed resources

The most important effects of climate change on livestock production is changing the animal feed resources [42,43] cited drought and delay in the onset of rain led to poor regeneration of grass, water shortage and heat stress on livestock. Again, drought and delay of rainfall led to increased mortality of livestock, vulnerability to diseases and physical deterioration due to long distance travel for water and pastures [42,44] reported that because of severe drought, there was a direct impact on the growth of palatable grass species, regeneration of fodder species in pasture and forest fodder. Because of less rainfall leading to a shortage in diversity and quality of livestock fodder. This has led to a decrease in livestock population, which further will affect production of milk, milk products and meat.

Out of all the factors influencing livestock production, 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 [10]. Climate change will have far-reaching consequences for animal production, especially in vulnerable parts of the world where it is vital for nutrition and livelihood [10].

The direct effects of air temperature, humidity and wind speed capable of influencing growth rate, milk production, wool production and reproduction have been reported by [45,46,10].

The drought also affected livestock by drying wetlands, pastureland, water resources, streams and decreasing availability of drinking water for livestock. Changes in temperature, rainfall regime and CO_2 levels will affect grassland productivity and species composition and dynamics, resulting in changes in animal diets and possibly reduced nutrient availability for animals [44].

Effects of climate change on water resources

Bekele De Wit Stankiewicz, et al., [42,47] calculated that decreases in perennial drainage would significantly affect present surface water access across 25 percent of Africa by the end of this century [21]. Morton, 2007 et al., Believed that climate change mostly affected developing countries, in particular among populations referred to as subsistence or smallholder farmers. Furthermore, small farm sizes, low technology and low capitalization are likely to increase the vulnerability of livestock production in developing countries [42]. Water supplies from rivers, lakes and rainfall are being threatened by climate change, which reduces water availability for livestock production [42,47].

Effects of climate on milk production

Livestock and climate change have a close relationship. The spatial distribution and availability of pasture and water are highly dependent on the pattern and availability of rainfall [48,42]. Changes in the patterns of rainfall and ranges of temperature affect feed availability, grazing ranges, feed quality, weed, and pest and disease incidence. Thus, changes in climatic factors such as temperature, precipitation and the frequency and severity of extreme events like droughts directly affected livestock yields [49,42]. The rise in temperature between 2 to 3° cover the entire country together with increased humidity resulting from climate change is likely to aggravate the heat stress in dairy animals resulting in reduced growth and milk production [50].

Climatic factors or seasonal changes greatly influence the behavior of animals due to neuro-endocrine response to climatic elements, consequently affecting production and health of animals [51,52]. Climate change is a major threat to the viability and sustainability of livestock production systems in many regions of the world. High production animals are subjected to greater influence by climatic factors, particularly those raised under tropical conditions, due to high air temperatures and relative humidity [53,54,42]. [55,42] et al., have argued that high temperatures may reduce feed intake, lower milk production, lead to energy deficits that may lower cow fertility, fitness and longevity. Modeling work by [56] using the Cornell Net Carbohydrate and Protein System model suggested that the maintenance energy requirements of a dairy cow weighing of 635 kg yielding 36 kg of milk per day may be increased by 22% at 32°C compared with the energy requirements at 16°C. For the same temperature increase, predicted dry matter intake decreased by 18% and milk decreased by 32% [57].

Climate impact on egg and meat production in poultry

The thermoregulation characteristics of poultry differ to some extent from those of mammals due to their high rate of metabolism associated with more intensive heat production and low heat dissipation capacity caused by their feathers and lack of sweat glands [21]. Above 30°C, the feed and energy intake declines to such an extent that birds are no longer able to compensate for it, production declines rapidly and the rate of mortality increases. Several studies reported that high ambient temperatures decrease the digestibility of nutrients in poultry, which might be due to reduced activity of trypsin, chymotrypsin, and amylas [21]. Consequently, the lower and by most insufficient nutrient supply limits egg production, egg mass and shell quality of egg in layers, and lower the growth rate in broilers [58].

Effects of climate change on livestock reproduction

Reproductive functions of livestock are vulnerable to climate changes and both females and males are affected adversely [42]. Heat stress also negatively affects reproductive function [58,42]. The climate change scenario due to rise in temperature and higher intensity of radiant heat load will affect reproductive rhythm via hypothalamo-hypophyseal–ovarian axis [42]. The main factor regulating ovarian activity is GnRH from hypothalamus and the gonadotropins, that is, FSH and LH from anterior pituitary gland [59,42]. It is reported that the length and intensity of estrous period decrease, therefore less conception rate occurs. Therefore, heat stress may reduce the fertility of dairy cows in summer by poor expression of behavioral signs of estrus due to a reduced estradiol secretion from the dominant follicle. In these situations, the calving interval becomes longer [21].

Therefore, lifetime production of dairy animals comes down. At the same time heat stress during pregnancy slows the growth of the fetus, due to decreased blood supply to the uterus, which causes placental insufficiency to provide maternal nutrients, so leads to decreased fetal growth and calf size [21]. Even there is early embryonic death in cows exposed to heat stress. Heat stress also leads to reduced seminal volume and sperm concentration [21]. It is reported that ejaculate volume, concentration of spermatozoa and sperm motility in bulls are lower in summer than in winter season [60,21].

Conclusions and recommendation

Climate change has a negative effect on livestock health and productivity in many aspects. It may influence livestock health through many factors including: the range and abundance of vectors and wildlife reservoirs, the survival of pathogens in the environment. It can exacerbate disease in livestock and some diseases are especially sensitive to climate change. Indeed a better understanding of the effect of climate change on animal health is crucial and good for recommendations on how to lessen its potential impact. Unfortunately, the determinants of resilience and adaptation that already reduce this impact is poorly understood.

Livestock have important roles in providing income, food, security and psychosocial benefits for over a billion poor households. Animal disease is the single greatest threat to livestock assets, a major risk to human health, and a huge source of risk as new diseases emerge every four months. Of the animal diseases of most relevance to vulnerable agricultural systems, the majority are climate sensitive. There is little information on the possible changes in distribution and impact under climate change scenarios, but for two of three well-studied diseases changes in disease dynamics will have serious additional impacts under climate change scenarios. Fortunately, there are a range of 'no-regret' adaptation options that can reduce the burden of disease present and future.

For example, adaptive capacity could be increased in the broader context of developing appropriate policy measures and institutional support to help the livestock owners to cope with all livestock health problems. In fact, the development of an effective and sustainable animal health service, with associated surveillance and emergency preparedness systems and sustainable animal disease control and prevention program, is the most important and most needed adaptive strategy. This will safeguard livestock populations from the threats of climate change and climate variability. Again, the very complex issue of impacts of climate change on livestock production and productivity.

Climate change could affect animal production and well-being, especially because of increases in air temperature. However, the knowledge of animal responses to heat stress during the hot months in several areas of the world, as well as during extreme heat events, may be used to evaluate the impacts of global change. However, farmers are not quite aware about the impacts global warming can produce in their operation, because the natural pastures on which, majorities of the livestock owners rely on, for feeding their animals are deteriorating in quality and the amount of fodder available. In addition to that, water sources available are not reliable, as they sometimes dry up due to high temperatures and shortage of rainfall. Livestock has been lost due to excessive heat, shortage of water, feed and unknown diseases.

Therefore, the following recommendations are forwarded for future action. The awareness of livestock owners and professionals on climate change must be raised through training. The choice of representative climate stations for livestock enterprises particularly, in the arid and semi-arid regions must be considered. The recordation of additional inputs to pasture and livestock production, especially in climatically favorable zones must be applied.

Successful adaptations may be shown as a better way of coping with the negative consequences of climate change and associated drivers of disease. Future need assessments should have to be made regarding climate change impact, then its incorporation into curriculum by the concerned policy maker for veterinarian, animal production and related professionals.

Adaptation related to livestock productivity

Adaptation by housing and managing mental intervention**:** Adaptation with reference to climate change is referred to asadjustment or preparation of natural, human or livestock systems to new or changing environments which moderates harm or uses beneficial opportunities. Adaptation can reduce the current risks of climate change impacts and can be used for addressing emerging risks.To increase milk productivity Dairy cattle production in hot climates may be improved in two ways:

a) By adapting the animal to the climate through selection, breeding and acclimatization.

b) By adapting the climate to the animal by providing protective structures and cooling devices.

The first way poses a biological problem, the second a technical problem. For the solution of both these problems it is important to know the qualitative and quantitative responses of the animal to various degrees of heat stress. Promoting indigenous breeds for rearing as these are more heat tolerant than cross-bred and exotic breeds. It was observed that adverse effects of heat stress such as reduction [21].

Livestock management, in reality, is the manipulation of the animal environment to promote the most efficient production of meat, milk and wool. A better understanding of climatological stress and adaptations will greatly enhance managerial capabilities [61, 20]. Shade for livestock is considered essential to minimize loss in milk production and reproductive efficiency. Shades can improve animal comfort and productivity and should be designed to maximize ventilation and protection from the solar load. It is reported that well designed shade would reduce heat load on animals around 30-40%. The design and management of shade for dairy cattle vary in different areas and climates. A shade space of 60 square feet per animal is considered adequate. The larger space allotments provide more open area for ventilation, which is a critical factor in hot, humid climate [62,21]., observed in a study that orientation of cattle.

shed has a significant effect on microclimate of shed and milk yield of crossbred cowsin the coastal region. Cattle shades should be designed and orientated in such a way that the animals are exposed to a large proportion of the cool sky. Elimination of direct solar radiation is essential, since the radiated heat load imposed on an animal by the midday sun is several times greater than the metabolic heat generated by the animal. So reduction of indirect radiation to a minimum is needed to be achieved. This is achieved by the absence of objects, such as nearby buildings, heavy wooden fences etc, which absorb heat and radiate it onto the animals. False ceiling with low cost materials in the shed was proved in a study to reduce heat stress in cattle and buffalo [62,21].

Adaptation by nutritional intervention

a. Take feed to cows, rather than cows to feed in hot weather. Walking to feed increases a cow's heat load, so reduce their walking during the hottest time of the day.

b. Allow cattle grazing at night time in hot weather. So, night grazing may be practiced for 2-3hr to fulfill nutrient requirements partially and have sufficient exercise for normal physiological function.

c. Highly digestible high-energy rations are an effective form of summer diet to help animals to control body temperature by reduction of excess heat. Providing cool drinking water and a low fiber diet renders comfort to the animals [63,21].

d. Bypass fat was proved in a study to reduce heat stress in cattle and buffalo around 18-20% [64,21].

e. Increase the concentration of minerals and vitamins in the diet to compensate for the reduction in feed intake, particularly sodium, potassium, magnesium and niacin levels in the diet. Supplementing cows with 1.5-1.6% DM of potassium and 0.5-0.6% DM of sodium will potentially improve milk yield in heat-stressed cows. Include magnesium at 0.35-0.4% DM to help to avoid metabolic problems (grass tetany) when feeding higher amounts of potassium. Including niacin (6g/cow/day) may also be beneficial. It has been reported to reduce skin temperature and increase milk yield [65,21].

f. Improvement in milk yield has also been reported by feeding 150-200g/cow/day of sodium bicarbonate during hot weather to help buffer the rumen.

g. The use of antioxidants such as Vit. E, Vit. A and selenium helps in reducing the impact of heat stress by oxidant balance, resulting in improved reproductive efficiency and animal health [66].

Adaptation by reproductive intervention

a) Progesterone supplementation during early pregnancy has proven beneficial in some studies. Supplementation of exogenous progesterone during summer heat stress has the potential to improve fertility.

b) [67,21] et al., reported that heat synchronization with GnRH and PGF2α also improves fertility. iii. The use of embryo transfer technology (ETT) should be considered a potential strategy for minimizing the negative effects of heat stress on bovine reproduction [68].

Adaptation related climate sensitive livestock diseases

Responses to improve the control of climate sensitive livestock diseases are:

No-regret' options: which enhance community resilience, alleviate poverty and address global inequality [30]. These are sensible development and public health interventions. For example, trypanosomosis and ECF are two of the most serious and most climate sensitive animal pests.

Improve surveillance and response capacity: Accurate information on its presence, level, and impacts and the costs for controlling disease is needed to plan disease control. Disease surveillance is an information-based activity that involves collection and analysis of information on disease occurrence [31]. Well-functioning surveillance systems and timely responses may reduce the cost of outbreaks by 95% [69,31].

Forecasting and prediction of disease: Satellite data are increasingly being used to aid disease prediction especially for those diseases that occur in epidemics such as RVF, malaria, etc [31]. Prediction however needs to be grounded on disease transmission patterns; therefore, a good understanding about the disease and its epidemiology is important. Satellite data have also been found to overestimate rainfall in dry areas and underestimate it in the highlands [70,31].

Improve animal health service delivery: The last several decades have seen interest in better linking human, animal and environmental health, an approach called "One Health" and Ecohealth.

Support eradication and control of priority diseases: Some control technologies with potential to improve control of climate sensitive disease include:

- Multivalent vaccines that can confer immunity to multiple diseases
- Thermo-tolerant vaccines that do not require a cold-chain
- Breeding for disease livestock breeds since they withstand multiple diseases
- Insecticides (e.g. pyrethroids) which are effective against several multiple vectors

Improve the resilience of livestock systems: Livestock can play a greater role in adaptation to climate change and variability. In fact livestock husbandry is regarded as a form of adaptation compared to crop agriculture because livestock are mobile and so can be moved to areas with available feed and water [31]. Changes that could be instituted to help livestock farmers adapt better include:

- Diversification of livestock and livelihoods
- Integrating livestock farming with agriculture.
- Identifying and improving breeds that are better adapted to the environment and disease.
- Adopting farming practices that limit greenhouse gas emissions e.g. better management of manure, replacing fertilizers with biological/nitrogen fixing legumes, soil conservation tillage, etc.

Consider the implications of climate change responses on disease: Land use changes that are implemented in response to climate change and variability can be sources of ecosystem disservices, which result in more animal (and human disease). These changes may result in loss of biodiversity (and hence the risk of more disease), nutrient runoff, sedimentation of waterways, greenhouse gas emissions, and pesticide poisoning of humans and other non-target species [31]. Understanding potential changes and monitoring their occurrence will allow preventive or remedial actions.

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References

1. IPCC. Climate Change 2007: Impacts, Adaptation and Vulnerability. In: Parry ML, Canziani, OF, Palutikof JP, van der Linden PJ, Hanson CE. (Eds.), Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK. 2007.
2. Nkonde MS, Luyengo PO, Manyatsi AM, Luyengo PO. The Impact of Climate Change on Livestock Production in Swaziland : The case of Mpolonjeni Area Development Programme. 2014: 2: 1-15.
3. Oyhantçabal W, Vitale E, Lagarmilla P. Climate change and links to animal diseases and animal production. Conf.OIE, 2010; 179-186.
4. Abdela N, Jilo K. Impact of Climate Change on Livestock Health: A Review', Global Veterinaria.2016.
5. Thornton PK. Livestock production : recent trends, future prospects. 2853-2867.
6. Bekele S. Impacts of Climate Change on Livestock Production : A Review. 2017; 7: 53-59.
7. ESAP (Ethiopian Society of Animal Production), 2009. Climate change, livestock and people: Challenges, opportunities, and the way forward. ZelalemYilma and Aynalem Haile (Eds). Proceedings of the 17th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, September 24 to 26, 2009. ESAP, Addis Ababa 300 pp
8. Yatoo MI, Kumar P, Dimri U, Sharma MC. Effects of climate change on animal health and diseases. International Journal of Livestock Research. 2012; 2: 15-24.
9. Grace D, Bett B, Lindahl J, Robinson T. Climate and livestock disease: assessing the vulnerability of agricultural systems to livestock pests under climate change scenarios. CCAFS Working Paper. 2015.
10. Getachew Bekele Fereja. The Impacts of Climate Change on Livestock Production and Productivities in Developing Countries : a Review. International Journal of Research Granthaalayah. 4: 181-187.
11. Chauhan DS, Ghosh N. Impact of Climate Change on Livestock Production: A Review. Journal of Animal Research. 2014; 4: 223.
12. Musemwa L, Muchenje V, Mushunje A, Zhou L. The impact of climate change on livestock production amongst the resource-poor farmers of third world countries: a review. Asian Journal of Agriculture and Rural Development. 2012; 2: 621.
13. ECARD (European Commission Agriculture and Rural Development) "Climate change: the challenges for agriculture",. European Commission Directorate-General for Agriculture and Rural Development, 2008.
14. CSA. Agricultural Sample Survey. Report on Livestock and livestock characteristics (Private peasant holdings). Statistical Bulletin. 2016; 2: 194.
15. Funk C, Rowland J, Eilerts G, Emebet K, Nigist B, et al. A climate trend analysis of Ethiopia. USGS Numbered Series 2012; 3053.
16. MacDonald M, Simon J. Climate, food security, & growth Ethiopia's complex relationship with livestock. Policy Brief 3. Brighter Green. 2011.
17. World Bank. The social dimensions of adaptation to climate change in Ethiopia. Development and climate change discussion paper 14. Washington, DC. USA. 2010.
18. AbebeKiros. Effect of Climate Change on Nutritional Supply to Livestock Production. Acad Res J AgriSci Res. 2017; 5: 98-106.
19. Lancelot R. What impact of climate change on animal health ?. 2015.
20. Seo SN, Mendelsohn R. Climate change impacts and adaptations on animal husbandry in Africa. Agricultural Economics. 2008; 38: 1-15.
21. Das S. Impact of Climate Change on Livestock, Various Adaptive and Mitigative Measures for Sustainable Livestock Production. 2017; 49: 534-536.
22. Slenning BD. Global climate change and implications for disease emergence. Veterinary Pathology. 2010; 47: 28-33.
23. Brooks DR, Hoberg EP. How will global climate change affect parasite host assemblages? Trends in Parasitology. 2007; 23: 571-574.
24. Dhakal CK, Regmi PP, Dhakal IP, Khanal B, Bhatta UK, Barsila SR et al. Perception, Impact and Adaptation to Climate Change: An Analysis of Livestock System in Nepal. J. Anim Sci Adv. 2013; 3: 462-471.
25. OIE Report of the Meeting of the OIE Scientific Commission for Animal Diseases. 2008.
26. Baylis M, Githeko AK. The effects of climate change on infectious diseases of animals. Report for the Foresight Project on Detection of Infectious Diseases, Department of Trade and Industry, UK Government. 2006: 35.
27. Randolph SE. Dynamics of tick-borne disease systems: minor role of recent climate change. Revue Scientifique et Technique. Office International desEpizooties. 2008; 27: 367-381.
28. Thornton PK, van de Steeg J, An Maria Omer Notenbaert, Herrero M. The impacts of climate change on livestock and livestock systems in developing countries : A review of what we know and what we need to know. Agricultural Systems. 2009; 101: 113-127.
29. Wu X, Lu Y, Zhou S,Chen L, Xu B. Impact of climate change on human infectious diseases: Empirical evidence and human adaptation. Environment International. 2016; 86: 14-23.
30. Wittmann EJ, Baylis M. Climate change: Effects on Culicoides-transmitted viruses and implications for the UK. The Veterinary Journal. 2000; 160: 107-117.
31. Agriculture T. Climate and Livestock Disease : assessing the vulnerability of agricultural systems to livestock pests under climate change scenarios Summary for policymakers. 2014.
32. Kimaro EG, Chibinga OC. Potential impact of climate change on livestock production and health in East Africa: A review. Livestock Res. Rural Development. 2013; 25: 116.
33. Harvell CD, Mitchell CE, Ward JR, Altizer S, Dobson AP, et al. Climate warming and disease risks for terrestrial and marine biota. Science. 2002; 296: 2158-2162.

34. Ca SB. Climate change and animal diseases : making the case for adaptation. Anim Health Res Rev. 2012; 13: 209-222.

35. Rabozzi G, Bonizzi L, Crespi E, Somaruga C, Sokooti M, et al. Emerging Zoonoses : the "One Health Approach". Safety and Health at Work. 2012; 3: 77-83.

36. Rogers DJ. Changes in disease vector distributions. In: Hulme, M. (Ed.), Climate Change and Southern Africa: An Exploration of Some Potential Impacts and Implications in the SADC Region. Climatic Research Unit, University of East Anglia, Norwich. 1996; 49-55.

37. Thornton PK, Jones PG, Owiyo TM, Kruska RL, Herrero M, et al. Mapping Climate Vulnerability and Poverty in Africa. Report to the Department for International Development, ILRI, Nairobi, Kenya. 2006.

38. Randolph SE. Dynamics of tick-borne disease systems: minor role of recent climate change. Revue Scientifique et Technique. Rev Sci Tech. 2008; 27: 367-381.

39. Kovats RS, Campbell-Lendrum DH, McMichael AJ, Woodward A, Cox JS, et al. Early effects of climate change: do they include changes in vector-borne disease?. Philos Trans R Soc Lond B Biol Sci. 356; 1058-1068.

40. Singh KB, Nauriyal DC, Oberoi MS, Baxi KK. Studies on occurrence of clinical mastitis in relation to climatic factors. Indian J Dairy Sci. 1996; 49: 534-536.

41. Kumar S, Prasad KD, Deb AR. Seasonal prevalence of different ectoparasites infecting cattle and buffaloes. BAU J Res. 2004; 16: 159-163.

42. Bekele S. Impacts of Climate Change on Livestock Production : A Review. 2017; 7: 53-59.

43. Abate FS. Climate Change Impact on Livelihood, Vulnerability and Coping Mechanisms in West-Arsi Zone, Ethiopia. 2009.

44. Digambar DS. Impact of Climate Change on Livelihood and Biodiversity inRural Communities (A case study of Siddhi Ganesh and Nepane Community Forestry User Groups of Sindhupalchowk District of Nepal). 2011.

45. Houghton JT, Ding Y, Griggs DJ, Noguer M, van der Linden PJ, et al. Climate Change 2001: the scientific basis contribution of working group I to the third assessment report of the intergovernmental panel on climate change (IPCC). Cambridge, MA: Cambridge University Press. 2001.

46. Rust JM, Rust T. Climate change and livestock production: A review with emphasis on Africa. South African Journal of Animal Science. 2013; 43.

47. De Wit M, Stankiewicz J. Changes in surface water supply across Africa with predicted climate change. Science. 2006; 311: 1917-1921.

48. Aklilu A, Desalegn W, Mesfin K, Negash T. Climate change impacts on Pastoral Women in Ethiopia: Some evidence from the Southern lowlands. PHE Ethiopia Consortium.2013; 1-6.

49. Adams R, McCarl B, Segerson K, Rosenzweig C, Bryant K, et al. The economic effects of climate change on US agriculture", in Mendelsohn, R. and Neumann, J. (Ed.), The Impact of Climate Change on the United States Economy, Cambridge University Press, Cambridge, UK. 1999.

50. Das S. Impact of Climate Change on Livestock , Various Adaptive and Mitigative Measures for Sustainable Livestock Production. 2017; 1-7.

51. Sejian V, Maurya VP, Naqvi SMK. Adaptive capability as indicated by endocrine and biochemical responses of Malpura ewes subjected to combined stresses (thermal and nutritional) under semi-arid tropical environments. Int J Biometeorol. 2010; 54: 653-661.

52. Baumgard LH, Rhoads RP, Rhoads ML, Gabler NK, Ross JW, et al. Impact of Climate Change on Livestock Production. In: Environmental Stress and Amelioration in Livestock Production, Germany. 2012; 4: 13-68.

53. Gaughan JB, Mader TL, Holt SM, Lisle A. A new heat load index for feedlot cattle. Journal of Animal Science. 2008; 86: 226-234.

54. Martello LS, Junior HS, Silva SL, Balieiro JCC. Alternative body sites for heat stress measurement in milking cows under tropical conditions and their relationship to the thermal discomfort of the animals. Int J Biometeorol.2010; 54: 647-652.

55. Parsons DJ, Armstron AC, Turnpenny JR, Matthews AM, Cooper K, et al. Integrated models of livestock systems for climate change studies. Global Change Biology. 2001; 7: 93-112.

56. Chase LE. Climate change impacts on dairy cattle. Fact Sheet, Climate Change and Agriculture: Promoting Practical and Profitable Responses. 2006.

57. Thornton P, Herrero M. Climate Change, Vulnerability, and Livestock Keepers: Challenges for Poverty Alleviation. In: Livestock and Global Climate Change Conference Proceeding, May 2008, Tunisia. 2008.

58. Amundson JL, Mader TL, Rasby RJ, Hu QS. Environmental effects on pregnancy rate in beef cattle. Journal of Animal Science. 2006; 84: 3415-3420.

59. Madan ML, Prakash BS. Reproductive endocrinology and biotechnology applications among buffaloes. In: Reproduction in Domestic Ruminants VI, (Nottingham University Press) Nottingham, United Kingdom. 2007; 261-281.

60. Samal L. Heat Stress in Dairy Cows - Reproductive Problems and Control Measures. Int J Livest Res. 2013; 3: 14-23.

61. Stott GH. What is animal stress and how is it measured? J AnimSci. 1981; 52: 150-153.

62. Das SK, Karunakaran M, Barbuddhe SB, Singh NP. Effect of Orientation, Ventilation, Floor Space Allowance and Cooling Arrangement on Milk Yield and Microclimate of Dairy Shed in Goa. J Anim Res. 2015; 5: 231-235.

63. Beede DK, Collier RJ. Potential nutritional strategies for intensively managed cattle during thermal stress. J AnimSci. 1986; 62: 543- 554

64. Terada F. Milk production in hot and humid environments. In: Proceedings of the 8th AAAP Animal Science Congress. 1996; 1: 414-421.

65. West JW. Effects of Heat-Stress on Production in Dairy Cattle. J Dairy Sci. 2003; 86: 2131-2144.

66. Sejian V, Singh AK, Sahoo A, Naqvi SMK. Effect of mineral mixture and antioxidant supplementation on growth, reproductive performance and adaptive capability of Malpura ewes subjected to heat stress. J AnimPhysiolAnimNutr (Berl). 2014; 98: 72-83.

67. Friedman E, Voet H, Reznikov D, Dagoni I, Roth Z. Induction of successive follicular waves by gonadotropin-releasing hormone and prostaglandin F2α to improve fertility of high producing cows during the summer and autumn. J Dairy Sci. 2011; 94: 2393-2404.

68. Baruselli PS, Ferreira RM, Sales JN, Gimenes LU, SáFilho MF, et al. Timed embryo transfer programs for management of donor and recipient cattle. J Theriogenology. 2011; 76: 1583-1593.

69. Grace D. The business case for One Health Onderstepoort. J Vet Res. 2014; 81: 6.

70. Dinku T, Chidzambwa S, Ceccato P, Connor SJ, Ropelewski CF. Validation of high-resolution satellite rainfall products over complex terrain. Int J Remote Sens. 2008: 4097-4110.