Climate Change Scenario on Livestock Agriculture

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Abstract: Climate change has a serious effect on the economy of livestock production as it affects the feed-grain availability, quality and price, livestock behaviour in terms of grazing ability, feed intake, utilization and conversion rate; pastures and forage crop availability and quality; livestock diseases, pests and parasites; processing, handling and storage of feeds and livestock products; and the production and reproduction parameters. Measures to reduce the effects of climate change on livestock such as physical modifications of the animal environment viz-á-viz shade provision, ventilation, wetting and water sprinkling; genetic manipulation of less sensitive breeds; improved nutritional management schemes viz-á-viz supply of good quality feed and water, feed with less digestion heat; improved electronic systems and innovative measures as well as multiple or integrated schemes to reduce the effect of climate change on the thermal comfort of livestock are also discussed.
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Key words: climate, radiation conditions, heat stress, livestock, innovation measures.

Introduction

Climate is a combination of elements that include temperature, humidity, air movement, radiation conditions of barometric pressure. It is the primary determinant factor of agricultural productivity with respect to livestock production. According to Bello (2010), climate is the synthesis of weather over a given area or location over a period of a least 30years. Leonard (2005) explained that climate is the end product of the workings of the climate systems consisting of the biosphere, the lithosphere, the hydrosphere, the cryosphere and the biosphere interacting together and powered by solar radiation. According to Ayoade (2004), climate refers to the characteristic condition of the atmosphere deduced from repeated observation over a long period. Climate includes more than the average weather conditions over a given area, but includes conditions of departures from average (i.e variability) extreme conditions and the probabilities of frequencies of occurrences of given weather conditions. It is these departures or variabilities around the average or normal conditions that make climate a dynamic phenomenon. The threat climate change poses to human existence is enormous. Africa is said to be most vulnerable to the effects of climate change (Obasi, 2002). Climate change is projected to impact broadly across ecosystem, societies, pressure on human livelihoods, food supplies, including livestock production. Cline (2007) explained that climate change is projected to have significant impacts on conditions affecting agriculture, including temperature, precipitation and glacial run-off. These conditions determine the carrying capacity of the biosphere to produce enough food for human population and domesticated animals.

The climate system is an open system that is in dynamic equilibrium or steady state over a given period. If this steady state is disturbed as a result of significant changes in one or more of the components making up the system or the amount of solar energy powering the system, the climate system will move over time to a new state of equilibrium to produce a new climate state. When this occurs, a change of climate is said to have happened. The occurrence of climate change could be natural or human activity that interferes with the ozone layer. It is natural through emission of carbon dioxide to the atmosphere by volcanoes or nitrous oxide through microbial action, nitrogenous fertilizer or human activity through, in the soil burning of biomass, fossil, fuels forest, and the operation of equipment that release large amount of carbon dioxide to the atmosphere.

In effect, climate change affects livestock production in diverse ways such as; (a) on feed-grain availability, quality and price; (b) on livestock behaviour as regards grazing ability, feed intake and utilization; (c) on pastures and forage crop availability and quality; (d) on the distribution or spread of livestock diseases, pests and parasites; (e) on the processing, handling and storage of livestock feeds and products; and (f) on the production and reproduction performance. In all these diverse ways, climate change impact serious economic and socio-economic consequences on livestock production world wide.

Impacts of climate change on feed-grain availability, quality and prices.

The impact of climate change on livestock

feed-grain availability, quality and prices is observed during the severe heat episodes when grains fell short of supply and the available ones were of poor quality, leading to increase in their prices even with poor quality. The wind storms of 1992, 1995, 1999, and 2002 in United States were so catastrophic, resulting in reduced production of grains with attendant low livestock production (Adams *et al.,* 1990). Research suggests that climate change would affect the quality and quantity of grain produced when the surge is greater to the point of being detrimental to the growth, survival and yield of grains (Topp & Doyle, 1996a; Adams *et al*., 1990). Favourable climate in term of adequate temperature, moderate and optimal rainfall, and adequate sunshine favour good grain yield, thereby ensuring adequate and steady supply of good grain quality with reasonable prices while bad or inclement climate bring reduction in the yield of grains with attendant low quality which push the price up, with subsequent reduction in livestock production (Eckert, *et al.,* 1995). The direct consequences of extreme high temperature in livestock include listlessness, abnormal behaviour, restlessness, reduced production and reduced conception rate (Baker & Viglizzo,1998; Hahn, 1999).

Impact of climate change on livestock behaviour

The potential impacts of climate change on the behaviour of livestock can be determined using defined relationship between climate change and voluntary feed intake, response to heat stress and climatologically data. It is noted that ingestion of feed is directly related to heat production hence any change in voluntary feed intake and/or energy density of the diet will alter/affect the amount of heat produced by the animal (Hahn *et al.,* 2000; Hatfield, 2008). When the ambient temperature is very high, feed intake will reduce while water consumption by livestock will increase. Feed consumption and rumination may practically cease in some livestock as ambient temperature rise above 40^0C. Increasing humidity at ambient temperature above 23.9^0C depresses feed intake in cattle while increase radiation stress also has the same effect on some breed of cattle like *Bos taurus* but not on *Bos indicus* type (Hahn *et al.,* 2000). Climate also has an effect on the grazing behaviour of animals. The length of daytime grazing of cattle varies according to climate stress, the breed of cattle and quantity and quality of pasture available. At very hot weather, cattle graze less and consume more water, and there is decrease in feed efficiency (Hahn *et al.,* 2000). As water is not a nutrient, though dietary essential, energy supplied by excess consumption of feeds high in water is low, hence too much consumption of water at the expense of low feed intake reduces the energy supplied to the animal (Hahn, 1999; Hahn *et al.,* 2000). Intake of digestible nutrients is most often the limiting factor in livestock production. From any diet supplied, animal will first utilize the diet for maintenance needs, followed by production either in term of meat, milk or egg, and then excess left will be converted for reproduction purpose. There is always a range of thermal conditions within which animals are able to maintain a relatively stable temperature by means of physiological and behavioural means.

Impact of climate change on pastures and forage crop availability and quality.

The effects of climate change in livestock performance result from the alterations in the nutritional composition of pasture, grasses and forage crops used for feeding animal. Alterations in the chemical composition of the forage crops and pastures result to the poor quality of the forage crops with resultant decrease in animal performance and production (Adams *et al*., 1999; Hatfield, 2000). At very high temperatures, pastures and forage crops become dried and lignified, reducing their acceptability and palatability. Also, extreme temperatures either high or cold will not favour the yield of pastures and forage crops. Plants require sun to photosynthesize hence, very cold climate or low sunshine will reduce the photosynthetic ability of the forage crops thereby reducing their yield, while excessive sunshine or very high temperatures will cause the bleaching of the chlorophyll; a green pigment required for photosynthesis to take place. Hence, extreme temperatures are not desirable for good yield of pasture crops. The impact of climate change on pastures and forage crops may include deterioration of pasture quality towards poorer quality, thereby making the pasture being rejected by the animal.

The availability of pasture and forage crops, their quantity and quality are climate dependant. In developing countries, typical of Nigeria, pastoralism is still peasantry, using the traditional methods, where animals are fed through free range. If the climate is unfavourable, the animal will suffer. Animals have optimum climatic condition in terms of temperature and humidity, for maximum growth and development. The productive capacity of animals is reduced by high temperature, particularly in the tropics (Ayoyi, 2000). Dairy cows produce less milk under high temperature, cattle graze more in shade location than in the open sun, poultry produce large eggs in winter and in high latitude than summer or low latitude and fertility increases with increasing daylight, and goats are seriously upset when it is raining. In effect, climate changes affect the survivability and sustainability of pastoralism.

Impacts of climate change on the distribution and spread of livestock diseases, pests and parasites.

Climatic variations as it affects vectors, pathogens,

pests and parasites are important in either curtailing or proliferating the distribution and spread of diseases, pests and parasites of livestock. Some pathogens, pests and parasites are able to multiply more at very high temperature while some undergo dormancy only to break their dormancy when the environment becomes favourable for its existence and attack. In some, high ambient temperature and humidity provide favourable breeding environment for internal and external parasites, fungi and disease vectors. Climates are also important in keeping many livestock diseases at bay (Stem, *et al.,* 1989). Incidences of diseases such as bovine respiratory disease, chronic respiratory disease are known to be increasing at high temperatures (Stem *et al.,* 1989), although, causes for the increase of these diseases can be attributed to other non-environmentally related factors. Stem *et al.,* (1989), describe the potential of how climate change could affect parasites, pathogens, diseases, and insect vectors of livestock. Warming and changes in rainfall distribution may lead to changes in spatial and temporally distribution of diseases sensitive to moisture such as anthrax, blackleg, hemorrhagic septicaemia and vector-borne disease (Stem *et al.,* 1989). Alterations of temperature and precipitation regimes may result in a spread of disease, pests and parasites into near regions, or produce an increase in the incidence of disease, which in turn would reduce animal productivity and performance, and possibly heighten the rate of mortality (Baker & Viglizzo, 1998). For example, the winter of 1996-97 caused hardship for cattle producers because of greater than normal snowfall and wind velocity, with some feedlot reporting losses in excess of 1,000 heads. During that winter, up to 50 percent of the newborn calves were lost and more than 100,000 heads of cattle died (Baker & Viglizzo, 1998). The effect of tsetse fly attack on cattle is attributable to the influence of climate, particularly when the condition is too humid. More than half of the land area of Nigeria is infested by tsetse fly which is a vector of trypanosomosis disease, which accounts for serious economic loss of Nigerian cattle, especially the non-indigenous breeds. Also, long exposure of animals to cold causes frost bite.

Impacts of climate change on processing, preservation and storage of livestock feeds and products.

Tropical climate favour rapid deterioration of stored animal products, thus increasing processing and handling costs. If one should take initial estimate of feed before storage to calculate the quantity of feed or feeding ingredient, one may likely over estimate, because after storage the feeds or produce might have lost certain amount of moisture. This situation may even be more at higher temperature, because the rate of moisture evaporation from the produce would be greater. Conversely, at very low temperature, produce or feeds stored may become dampened, because moisture in the surrounding environment would be absorbed by the produce, making it to grow mould thereby reducing its quality. At very high temperature, the rate of oxidation will be very high making the feed to lose some fatty acids as a result of oxidative destruction. Also at low temperature, the feeds will go through rancidity making it objectionable to farm animals.

The primary purpose of preservation is to prevent spoilage. Spoilage occurs from the action of bacteria, mould and yeasts. Basically, preservation methods are designed to make conditions unfavorable for putrefying organisms to grow. Such conditions could be extreme heat or cold, deprivation of water and oxygen. Some disease organisms are known to survive and proliferate more at higher temperature e.g *Bacillus anthracis,* as the pathogen can survive at very high temperature.

Preserved forages such as silage and hay require optimum conditions for their processing and preservation. Intense heat often denatures the feed during the ensiling process while cold weather increases the rate of oxidative rancidity resulting from the growth of mould.

Impacts of climate change on livestock production and reproduction performance.

The risk potential associated with livestock production systems due to global warming can be characterized by levels of vulnerability as influenced by animal performance and environmental parameters (Hahn, 1999). When performance level and environmental influences create a low level of vulnerability, there is little risk. However, if performance levels increase and environmental factors are unfavourable, the animal is at great risk and the level of vulnerability increases, pushing the animal to drop in production level with high risk of losing the animal to death as a result of other complications. Inherent genetic characteristics or management scenarios that limit the animals' ability to cope with the environmental factors further put the animal at risk. Hahn *et al* (2001) estimated the effects of climate change on swine growth rate and milk production during summer as well as other periods during the year. In the East-central United States, per animal milk production was found to decline 388kg (less 22 percent) for July through April production cycle, and 219kg (less 2.2 percent) for October through July production cycle as a result of global warming. Swine

growth rate in this same region was found to decline 26 percent during the summer months, but increased nearly 12 percent during the winter months as a result of global warming. Warmer temperatures are estimated to have suppressing effect on livestock appetite which leads to lower weight gain (Adams *et al.,* 1998). He also observed that under a 5.0^0C increase temperature, livestock yield will fall by 10% for cow/calf and dairy cow.

The direct effect of climate change involves heat exchange between the animal and the surrounding environments that are related to radiation, temperature, humidity and wind speed. In many areas of the world, lack of the ability of animals to dissipate heat makes the animals to suffer heat stress especially during the hot season. Heat stress has a lot of detrimental effects on animals with significant effects on feed intake, feed digestibility and feed conversion, milk production (Johnson 1987; Valtorta *et al.,* 1996b), beef/meat production (Ingram & Mount, 1975), wool production and other products (Johnson 1987; Valtorta & Maciel, 1998). A production area in which global climate change may have negative effects that are not offset by positive summer effects is conception rates, particularly in instances when the breeding season primarily occurs in the spring and summer months (Valtorta & Maciel, 1998). Hahn (1985) observed that conception rates in dairy cows were reduced 4.6 percent for each unit change when the Temperature Humidity Index (THI) reaches above 70^0C. Also in the report by Hatfield (2008), a decrease in pregnancy rates of *Bos taurus* cattle of 3.2 percent for each increase in average THI above 70^0C, and a decrease of 3.5 percent for each increase in average temperature above 23.4^0C were observed from beef cows in a range or pasture management system. In another study by Johnson (1987), he reported that of the environment variables studied, minimum temperatures had the greatest influence on the percent of cows getting pregnant. Under global climate change conditions, these responses from the production and reproduction parameters could be extended to other areas around the world.

Measures to reduce the effect of climate change on livestock performance and production.

Increases in air/ambient temperature reduce livestock performance and production especially during the hot season with partial offset during the cold season. Different animals use different physiological and behavioural mechanisms to counteract the effect of heat stress. Rabbit on its own use three behavioral and physiological mechanisms to counteract unfavorable conditions in its environment; (a) the rabbits can stretch out to help it lose heat if it is too hot; (b) it can breathe faster and increase blood supply to the ear when it is hot; and (c) it can curl up to keep warm if it is too cold. These readjustments, generally referred to as adaptations, may be favorable or unfavorable to economic interests of humans, but are essential for survival of the animal. Current management systems especially for ruminants do not provide adequate succour to alleviate the effects of adverse weather conditions. Since climate change result in an increase heat stress, all measures to help animals cope with, or at least, alleviate the impacts could be put in place to mitigate the impacts. Five basic management strategies could be employed to help reduce the effect of heat on the thermal comfort of farm animals. Such measures are; (a) physical modifications of the animal environment; (b) genetic manipulation of less sensitive breeds; (c) improved nutritional management schemes; (d) improved electronic systems/innovative measures; and (e) integrated or multiple schemes.

Physical modifications of the animal environment.

The various environmental modifications to reduce the effect of solar radiation include; (a) provision of sunshades either natural; through the planting of shade trees, (Hahn, 1985) or artificially by making use of low heat absorbing materials and with high efficiency when it is painted white and the underside insulated. Shades are effective in reducing the effect of solar radiation in diary cow (Valtorta *et al.,* 1996b, 1997 & 2002); (b) provision of adequate ventilation to allow good air circulation within the animal environment. The use of electric fans can be of good help to increase air movement; (c) wetting or sprinkling; direct sprinkling of water on animal body is more beneficial in arid region but less in the humid region; (d) sprinkling and ventilation, evaporative cooling by direct wetting/sprinkling in conjunction with mechanical ventilation. The single use of a sprinkling and fan system for 30 minutes before milking has proved to be useful to relief dairy cows with heat stress (Valtorta *et al.,* 2002; Hatfield, 2008). Cooling by evaporation can be increased by reducing the dew point temperature in the animal environment.

Genetic manipulation of less sensitive breeds.

This can be achieved by first recognizing the adaptive ability of the animals and applying proactive appropriate counter measures. Animals can also be bred during the cooler month of the year so that the vulnerable ones such as the pregnant and lactating mothers and the young ones would experience less of heat stress.

Improved nutritional management schemes.

Nutrition has a significant effect on the health and well being of livestock. The ability of an animal to resist diseases, pests, and parasites attack is a measure of the nutritional status and good quality feed and feeding. Animals in hot weather should be provided adequate quantity and quality of cool water. Also low fibre diet which is more readily digestible and has less heat of digestion should be supplied.

Improved electronic systems and innovative measures.

Innovations in electronic system capabilities will undoubtedly continue to be exploited for the betterment of livestock environments with improved economic utilization of environmental measures and mitigation strategies. The use of air conditioner in poultry house has helped increase feed and water intake with attendant increase in egg and meat production. There is much potential for application of improved sensors, expert systems and electronic stockman ship in livestock management and production (Hatfield, 2008).

Integrated or multiple schemes.

The importance of obtaining integrated or multiple measures to reduce heat stress are becoming more apparent. Although, inclusion and weighting of multiple factors (such as endocrine function, immune function, health status, vocalizations) is not an easy task to develop integrated stress measures (Hatfield 2008). Going into multiple schemes in reducing heat stress may not be economical or adapted by local farmers as it involves some technical competences.

Conclusion and Summary

Climate has serious impact on livestock viz-á-viz feed-grain availability, quality and price; feed intake, utilization and efficiency; pastures and forage crops availability and quality; distribution and spread of livestock diseases, pests and parasites; processing, handling and storage of livestock feeds and products; and the production and reproduction performance of livestock. In all these ways, climate change impact serious economic and socio-economic consequences on livestock production worldwide. The direct effect of climate change involves heat exchange between the animal and the surrounding environment which could affect grazing behavior (particularly in ruminants), feed intake, feed digestibility and efficiency of feed utilization which can be measured in terms of growth, beef and milk production, egg and, or production, reproduction efficiency both in males and females. The indirect effect could be on quantity and quality of feed available, incidence and distribution of diseases, pests, and parasites and the storage and handling of animal products. Different measures such as physical modifications of the animal environment such as provision of sunshades, adequate ventilation, wetting or sprinkling, combination of wetting and ventilation; genetic manipulation of less sensitive breeds, improved nutritional management, improved electronic systems and innovative measures, and multiple schemes can be employed to help reduce the effect of climate change on the thermal comfort and performance of livestock.

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