Changing climate: impact on livestock’s economic traits

Livestock plays a major role in the agricultural sector of developing nations with 40% contribution towards agricultural GDP. Global demand for foods of animal origin is growing and it is apparent that the livestock sector will need to expand (FAO, 2009). Health, production, and reproduction traits are the major economic concerns of livestock rearing. Livestock gets adversely affected by the detrimental effects of extreme weather. Climatic extremes and seasonal fluctuations in herbage quantity and quality will affect the well-being of livestock and will lead to declines in production and reproduction efficiency (Sejian, 2013).

Climate change has been emerging out as a major threat to the sustainability of livestock systems globally. Although, animal agriculture is itself a major contributor to climate change, responsible for 18% of greenhouse gas (GHG) emissions (9% CO2, 37% methane and 65% N2O) (FAO report, "Livestock long shadow: environmental issues and options", 2006). Livestock systems based on grazing and the mixed farming systems (most prevalent in India) are expected to be more affected by climate change than an industrialized system [Thome et al, 2007] (1). These issues may lead to a greater increase in intensive production practices at the expense of medium and long-term environmental and animal welfare friendly extensive production methods. This may be attributed to direct effects of high temperature and solar radiation on animals and the negative effect of erratic rainfall pattern and frequent droughts which affect crops and pasture growth. Climate elements include air temperature, humidity, wind velocity, solar radiation, and other factors. Heat is the major constraint in tropical and subtropical climatic conditions which negatively affects the production and reproduction of livestock species. The heat stress causes a chain reaction of physiological, behavioral and anatomical changes leading to a reduction in growth, productive and reproductive functions. In addition, there is a decrease in activity, increase in respiration, body temperature increased peripheral blood flow and alterations in endocrine functions. Fundamentally, the animal production is affected by climate change in four ways, a) Through changes in livestock feed-grain availability and price; b) Impacts on livestock pastures and forage crop production and quality; c) Changes in the distribution of livestock diseases and pests; and d) Direct effects of weather on animal health, growth, and reproduction [Smit et al, 1996]

Direct effects of climate change on livestock

The most significant direct impact of climate change on livestock production comes from the heat stress. Heat stress results in a significant financial burden to livestock producers through a decrease in milk component and milk production, meat production, reproductive efficiency, and

animal health.

Indirect effects of climate change on livestock

Most of the production losses are incurred via indirect impacts of climate change largely through reductions or non-availability of feed and water resources. In the coming decades; crops and forage plants will continue to be subjected to warmer temperatures, elevated carbon dioxide, as well as wildly fluctuating water availability due to changing precipitation patterns. Climate change can adversely affect productivity, species composition, and quality with potential impacts not only on forage production but also on other ecological roles of grasslands (Giridhar and Samireddypalle, 2015). Climate change has ill effects on the quality, quantity, and reliability of forage production, as well as on the large-scale rangeland vegetation patterns. Changes in temperature and weather may also affect the quality, quantity, and distribution of rainfall, snowmelt, river flow, and groundwater. Due to the wide fluctuations in the distribution of rainfall in growing season in several regions of the world, the forage production will be greatly impacted. With the likely emerging scenarios that are already evident from the impact of the climate change effects, the livestock production systems are likely to face more of negative than the positive impact. Climate change influences the water demand, availability, and quality. Climate change can result in a higher intensity precipitation that leads to greater peak run-offs and less groundwater recharge. Longer dry periods may reduce groundwater recharge, reduce river flow and ultimately affect water availability, agriculture, and drinking water supply. The deprivation of water affects animal physiological homeostasis leading to loss of body weight, low reproductive rates and a decreased resistance to diseases (Naqvi et al., 2015). In addition, emerging diseases including vector-borne diseases that may arise as a result of climate change will result in severe economic losses.

Challenges associated with changing the climate on livestock production system

Livestock production system is expected to be exposed to many challenges due to climate change in India. They are listed as follows:

A. Challenges associated with the direct effects of changing the climate and its alleviation

The direct effect of climate change through raised temperature, humidity, and solar radiation may alter the physiology of livestock, reducing production and reproductive efficiency of both male and female and altered morbidity and mortality rates. Heat stress suppresses appetite and feeds intake; however, the animal's water requirements get increased. In general, the high-output breeds especially crossbreds, which provide the sizable amount of Indian production, are more vulnerable to heat stress as compared to the indigenous one. Also, as people are lured by

immediate money making methods, indiscriminate crossbreeding is adding to the concern, however, this approach is not sustainable.

Options for alleviating heat stress include adjusting animals' diets to minimize diet-induced thermogenesis (low fibre and low protein) or by increasing nutrient concentration in the feed to compensate for lower intake; taking measures to protect the animals from excessive heat load (shading/improving ventilation by using fans) or enhance heat loss from their bodies (Sprinklers/misters); or genetic selection for heat tolerance or bringing in types of animals that already have good heat tolerance [Renaudeau et al., 2010]. All these options require some degree of initial investment, some require access to relatively advanced technologies, and all except simple shading require the ongoing input of water and/or power. The practicality of implementing cooling measures depends on the type of production system. They can most easily be applied in systems where the animals are confined and where the necessary inputs can be afforded and easily accessed. In extensive grazing systems, it is difficult to do more than provide some shade for the animals and possibly places for them to wallow.

B. Challenges associated with the effects of diseases and parasites

The geographical and seasonal distributions of many infectious diseases, particularly vector-borne, as well as those of many parasites and pests of various kinds are affected by climate. Pathogens, vectors, and intermediate and final hosts can all be affected both directly by the climate (e.g. temperature and humidity) and by the effects of climate on other aspects of their habitats (e.g. vegetation). If the climate changes, hosts and pathogens may be brought together in new locations and contexts, bringing new threats to animal (and in some cases human) health and new challenges for livestock management and policy. However, it is difficult to segregate out epidemiological changes that can be attributed unambiguously to climate change. Climate is characterized not merely by averages, but also by short-term fluctuations, seasonal oscillations, sudden discontinuities, and long-term variations, all of which can influence disease distribution and impacts.

Future perspectives

Responding to the challenges of global warming necessitates a paradigm shift in the practice of agriculture and in the role of livestock within farming systems. Science and technology are lacking in thematic issues, including those related to climatic adaptation, dissemination of new understandings in rangeland ecology (matching stocking rates with pasture production, adjusting herd and water point management to altered seasonal and spatial patterns of forage production, managing diet quality, more effective use of silage, pasture seeding and rotation, fire management to control woody thickening and using more suitable livestock breeds or species), and a holistic understanding of pastoral management (migratory pastoralist activities

and a wide range of bio-security activities to monitor and manage the spread of pests, weeds, and diseases). Integrating grain crops with pasture plants and livestock could result in a more diversified system that will be more resilient to higher temperatures, elevated carbon dioxide levels, uncertain precipitation changes and other dramatic effects resulting from the global climate change. The key thematic issues for effectively managing environment stress and livestock production include (Sejian et al., 2015b):

- development of early warning system;
- research to understand interactions among multiple stressors; development of simulation models;
- development of strategies to improve water-use efficiency and conservation for diversified production system;
- exploitation of the genetic potential of native breeds;
- research on the development of suitable breeding programmes and nutritional interventions.