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Impact of climate change on livestock sector

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Abstract
Globally sector of livestock is changing rapidly in response to globalization and increasing demand for quality foods of animal origin. Livestock performance is best when environmental factors are optimum which is difficult to achieve due its variable nature. Type and magnitude of stress due to physical environment depends on climatic factors of a particular area, animal adaptability, breed characteristics and managemental interventions by humans to minimize the losses. Climate change threatens livestock productivity as well as the sustainability of agricultural crops and vegetation, accessibility to water, animal growth and milk production, livestock illnesses, reproduction, and biodiversity. Methane emissions from enteric digestion and manure management account for the majority of contribution of livestock to climate change. Multidisciplinary strategies that prioritize animal nutrition, housing and health care are needed to lessen the negative impacts of environmental stress on livestock.

Keywords: Livestock sector, climate change, animal adaptability

Introduction

Indian climate may be broadly defined as tropical monsoon type which comprises 4 main seasons ‘winter’ (January-February), ‘hot-summer’ (March-May), ‘rainy south-western monsoon’ (June-September) and ‘north eastern monsoon’ (October-December). Specific variations are seen in higher altitude regions like Kashmir valley which has typical temperate climate and Ladakh, which have a typical cold-arid desert climate. The National Agricultural Research Project (NARP) and the Thornthwait moisture and heat indices are used to categorize the Indian climate.

Globally, numerous facets of the biological, environmental, and sociopolitical domains are impacted by the complex global problem of climate change. It is a worldwide threat that has started to strain several industries. The rising global temperature, unpredictable seasonal variations and a rise in the occurrence of extreme weather events including heat waves, droughts, floods and precipitations, all of which are associated with climate change, are posing significant difficulties for the production of crops and livestock. In human history, this is first time recorded, the amount of CO_2 in the atmosphere on a daily basis exceeded 400 parts per million in 2013.

In addition to other factors like pressure and humidity levels in the surrounding environment, long-haul temperature and precipitation trends are used to characterize climate change. Additionally, among the most well-known domestic and worldwide repercussions of climate change are the unpredictable weather patterns, the melting of global ice sheets, and the resulting heightened sea level rise. There are two types of dangers associated with climate change: transitional and physical (Carney, 2015) [19].

Physical hazards are mostly associated with adverse effects on business operations, society, and the supply chain resulting from weather-related catastrophes and climate change (Tankov & Tantet, 2019) [20]. On the other hand, transformational risks include all possible outcomes that align with a path towards a low-carbon economy, as well as any related implications for fossil fuels and the businesses that depend on them (Curtin *et al*., 2019) [21].

According to the Intergovernmental Panel on Climate Change (IPCC), the average global surface temperature will rise by 0.2 ºC every ten years and by 2100, it is expected to have increased by 1.8 ºC to 4 ºC (IPCC, 2007) [10].

The water cycle may be impacted generally in the twenty-first century due to global warming. The IPCC estimates that the average global temperature has risen by 0.85 ºC since 1880.
Twenty to thirty percent of species of plants and animals are predicted to be in danger of going extinct if temperatures rise by 1.5 to 2.5 degrees Celsius. Approximately 70% of India's livestock is owned by laborers without land and small and marginal farmers.

A) Impacts of Climate Change on Agriculture

Climate change can affect agriculture through their direct and indirect effects on the crops, soils, livestock and pests.

- Crops using the C_3 photosynthetic pathway benefit from increased atmospheric CO_2 because it fertilizes them and encourages growth and productivity.
- Raising the temperature can shorten crop life, boost crop respiration rates, change the process of photosynthesis, and have an impact on the survival and dispersion of insect populations.
- An increase in the frequency and length of extreme weather events that have a negative impact on agricultural productivity, such as heat waves, cyclones, floods, and droughts.
- A decrease in production in the areas that receive rain because to a rise in crop water requirements and modifications to the monsoon season's rainfall patterns.
- A decrease in the quality of coffee, tea, aromatic and medicinal plants, fruits, and vegetables.
- Changes in agricultural pests and illnesses due to increased host sensitivity, faster pathogen transmission, and increased production of pathogens and vectors.
- Increased warmth, rising sea levels, unpredictable rainfall, and a rise in the frequency and intensity of natural disasters pose a threat to agricultural biodiversity.
- If temperatures rise by 2.5 to 4.9 degrees Celsius in India, rice yields will decrease by 32-40% and wheat yields by 41-52%.
- The Indian Agricultural Research Institute (IARI) found that every 1 ºC increase in temperature affects wheat productivity by 4-5 million tonnes, with major effects on the rabi crops.

B) Impacts of Climate Change on Livestock

Climate change may pose a risk to livestock output, depending on animal performance and vulnerability as well as environmental factors. Animals become more vulnerable as their performance levels rise (body weight gain, milk and egg production). Given that 70% of India's livestock is owned by small-marginal farmers, the country's livestock production would be particularly vulnerable to climate change.

a) Effect of Climate on Animal Production

Animal health, growth, and reproduction are directly impacted by severe weather and extreme climate conditions; indirect effects include changes in feed quality and quantity, cost, and incidence frequency, as well as changes in the distribution patterns of livestock diseases and pests. Climate change primarily affects growth rate, feed intake, reproduction efficiency, and the production of milk, eggs, and wool. The heat stress caused by climate change has the largest direct influence on cattle productivity.
Heat stress has an adverse effect on an ability of animal to consume feed, develop, produce milk, eggs, wool, reproduce, and maintain good health, all of which indirectly lower animal productivity. High temperatures have an impact on enteric methane emission as well; under extreme heat stress, methane output increased per unit dry matter intake (Yadav *et al*., 2012) [18]. The amount of milk produced is clearly declining, and the quality of the milk is also impacted, with reduced levels of fat, SNF, lactose, and higher levels of stearic and palmitic acids. In addition to inhibiting humoral and immunological responses in chickens, heat stress compromises the immune system.
On the other hand, dry matter intake and voluntary feed intake are elevated during cold stress, as is metabolic rate. Cold stress reduces digestibility and causes nutrients to be diverted from the body in order to produce heat. The immunological condition of the animal is impacted by stress brought on by both heat and cold.

b) Effect of Climate on Animal Growth

Elevated ambient temperature has a detrimental effect on livestock growth, as it reduces feed intake and increases energy expenditure to fend off stress. The need of animal for maintenance results in increased stress from the heat and cold. Due to feed nutrient diversion for heat generation during cold stress and decreased feed intake during heat stress, there is a reduction in daily weight gain. Because heat stress increases the breakdown of proteins for energy and reduces their digestibility, there is a lower retention of nitrogen. Sweat further lowers the ability of growing animal to retain nitrogen by removing nitrogen from its body.

c) Effect of Climate on Milk, Meat and Egg Production

In general, under heat stress, feed intake, milk output, daily weight growth, egg production, egg shell thickness, etc. decline while maintenance requirements rise. In high yielders, heat stress has a major impact on milk yield. Heat stress on the composition of milk results in reduced total milk proteins, altered fatty acid concentration, reduced the amount of fatty acids in the fat of the milk, slightly reduced lactose, and lower SNF. Heat stress has indirect effects on yield of milk that are mediated by decreased thyrotrophic hormone and milk composition through altered substrate supply of components utilized in milk synthesis, increased adrenaline, and decreased aldosterone hormone.
Reduced feed intake, subpar growth performance, decreased carcass weight, low muscle protein and pH, decreased muscle glycogen content, and increased drip losses all have an impact on meat output, particularly in the case of chicken.
High temperatures and humidity have a negative impact on egg production, as evidenced by their impacts on clutch size, egg size, hen mortality, hormonal imbalances, egg shell quality, and the rate at which chickens gain body weight.

d) Effect of Climate on Wool Production

Significant climatic variations have a negative impact on sheep's wool growth, which is contingent upon various factors such as physiological state, breed, diet, sex, and shearing. Since sheep are seasonal breeders, their physiology is greatly impacted by the length of time they spend in light or dark. This has an impact on the amount of wool they produce, as seen by the fact that wool grows more during the summer and less during the winter.

e) Effect of Climate on Animal Reproduction

Animal reproductive efficiency is negatively impacted by heat stress. Female animals under stress from heat often show silent heat, and dairy cattle conception rates can decrease by 20–27% throughout the summer.

Heat-related weather has a direct impact on animal fertility, while diet, fodder, and disease susceptibility have an indirect effect. Heat stress causes changes in hormone levels, including GnRH, LH, FSH, and oestradiol, which in turn impacts sexual behaviour and delays puberty. The gestation period and the features of the newborns at birth may be impacted by exposure to heat stress during the second or third trimester of pregnancy. In male spermatogenesis was impacted by heat stress, which also decreased sperm quality and quantity, morphology, and acrosomal integrity, as well as decreased hatchability and fertility.

f) Effect of Climate on Animal Health

Diseases like anthrax, haemorrhagic septicaemia, ovine chlamydiosis, caprine arthritis, equine infectious anaemia, equine influenza, Marek's disease, and bovine viral diarrhoea may become more or less prevalent over time as a result of climate change. Incidence of bacterial, viral, and parasitic infections will change in tandem with an increase in the frequency of extreme weather events such as droughts and floods. An important issue is the spread of infectious illnesses in flood-affected communities. An epidemic of this kind will worsen the state of the ecosystem around the animals, which will have an impact on their health and productivity. Global climate change will lead to an increase in the frequency of climatic extremes such as floods, droughts, cyclones, and so on. As a result, there will be more animal illness outbreaks and higher rates of morbidity and mortality, which will ultimately result in fewer animals overall and less livestock produced.

Mitigation and Adaptation Strategies of Climate Changes

The global society has focused on lowering CO_2 emissions by endorsing climate change adaptation and mitigation strategies. Mitigation attempts to reduce emissions of heat-trapping greenhouse emissions and stabilize their levels in the atmosphere by either improving the sinks that absorb and store them or reducing their sources. The ultimate objective of mitigation is to normalize emission levels of greenhouse gases so that ecosystems can naturally adjust to climate change and proceed with sustainable economic development.

1. Livestock Housing and Management Systems

Examples of adaptations, such as changing production and management systems, include diversifying livestock animals and crops, integrating livestock systems with forestry and crop production, and modifying the timing and locations of agricultural operations (IFAD, 2010) [9].

1.1. Feeding Management

- Enhancing feeding procedures as a means of adaptation may tangentially increase animal production efficiency (Havlík *et al*., 2013) [7].
- Relocating crops and cattle could increase nitrogen and moisture retention while reducing soil erosion (Kurukulasuriya and Rosenthal, 2003) [11].
- The advantage of vitamin E supplementation in cold-weather breastfeeding buffaloes (Lallawmkimi *et al*., 2013) [12].
- Enhancing growth performance and immunity, chromium supplementation has a positive impact during heat stress (Kumar *et al.*, 2013) [22].

1.2 Shelter Management

In tropical and subtropical climates, animal shelters should be designed to minimize heat load from the surrounding environment. A cooler microenvironment for the animal depends on a number of factors, including the design, height, and orientation of the shelter, the roofing material chosen, and the appropriate amount of ventilation. For rural impoverished farmers unable to purchase costly adaptation equipment, effective and economical adaptation techniques include ventilation, sprinkling, and shading to lessen heat stress.

1.3 Health Management

Elevated temperatures and humidity promote the survival and procreation of insects such as flies, ticks, fleas, and mosquitoes, hence increasing the incidence of diseases carried by vectors. Thus, it is important to take preventative measures, such as routinely cleaning and disinfecting animal sheds, reducing water logging, caulking gaps and crevices, and improving ventilation and sunlight exposure in animal sheds.

2. Breeding Strategies

Breeding strategy modifications can assist animals become more resilient to illnesses and heat stress, as well as enhance their growth and reproduction (Henry *et al*., 2012, Rowlinson, 2008) [8, 14]. Animals that have been genetically modified to withstand severe environments will produce more. Compared to exotic and crossbred cattle, zebu cattle can withstand higher temperatures (Aggarwal and Upadhyay, 1997) [1]. In order to identify and comprehend the roles of genes and molecules involved in thermostability and thermo-sensitivity (e.g., Heat Shock Protein especially HSP 70), proteomics and genome analysis techniques have recently been applied.

3. The Perception and Adaptive capacity of farmers

Information regarding farmers' opinions of mitigation and adaptation strategies should be gathered. A different method of gathering data on farmer views that has been applied to studies on mitigation and adaptation is qualitative, which involves understanding individual and group opinions through group discussions at workshops or open-ended survey questions (Barnes *et al*., 2008) [2].

Mitigation Strategies

Carbon sequestration, better nutrition to lessen enteric fermentation, better manure management, and more effective fertilizer use are a few technological alternatives for reducing the impact of cattle on climate change (Steinfeld *et al*., 2006, Thornton and Gerber, 2010, UNFCCC, 2008) [15-17].

Carbon Sequestration

Reduced rates of deforestation, reversing deforestation by replanting (Carvalho *et al*., 2004) [4], focusing on higher-yielding crops with better varieties adapted to climate change, and better land and water management are some ways to achieve carbon sequestration (Steinfeld *et al*., 2006) [15].

1. Enteric Fermentation

Methane emissions can be minimized by methods including bettering animal diet and genetics (US-EPA, 1999). Enteric fermentation is one cause of these emissions.

2. Manure Management

The storage and anaerobic treatment processes account for the majority of methane emissions from manure management. Despite the fact that manure spread on pasture might result in nitrous oxide emissions, the dispersion of manure makes it frequently challenging to implement mitigation strategies (Dickie *et al.*, 2014) [6].

3. Fertilizer Management
Nitrous oxide emissions are increased when fertilizer is applied to crops used as animal feed (Bouwman, 1996) [3].

Thus, mitigation techniques like applying technologically advanced fertilizers, increasing nitrogen use efficiency, plant breeding and genetic modification, using organic fertilizers (Denef *et al.*, 2011) [5], combining legumes with grasses in pasture areas, regular soil testing, and using plant breeding and genetic modifications may all help lower the production of greenhouse gases in the feed industry (Dickie *et al.*, 2014) [6].

Conclusion
It is important to implement effective and appropriate management strategies based on the breed and agroclimatic conditions. Furthermore, the nutritional value of livestock products, which are a major source of calories, proteins, and vital micronutrients for the world, will be impacted by climate change. It is not sustainable to increase or maintain existing output levels in an increasingly hostile climate. Thematic challenges such as climate adaptation, the creation of sustainable models, and the transfer of new knowledge to farmers are areas where science and technology fall short.

Policies, mitigation strategies, and livestock production adaptation are essential to safeguarding livestock productivity from climate change. Improved animal diet and genetics are crucial for mitigating the greenhouse gas emissions associated with livestock production, as enteric fermentation is a primary source of these emissions. Significant modifications to agricultural practices and production technologies may be necessary for adaptation and mitigation, which could have an impact on animal productivity under the lowest possible stress level.

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