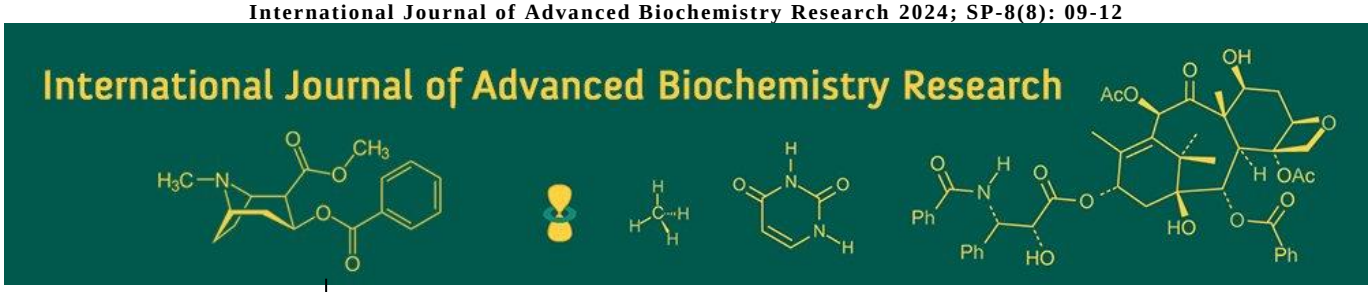

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Climate change and its impact on livestock and poultry population

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Abstract
Climate change is a long term shift in the Earth's average temperature and weather conditions. Temperature is having a crucial impact on the environment because any fluctuation in this parameter is a cardinal signal of the disturbances in regional or local environment. This altering climate is impacting poultry and livestock industry to a great extent. Physiological parameters of the livestock as well as poultry population are altered by this escalating temperature of the globe. This in turn is affecting growth, productivity and overall health of the animal and birds. This review throws insight into the effect of climate change on overall health and productivity of the animals and birds.

Keywords: Climate change, poultry, livestock, physiology, growth

Introduction
Each day our internet is flooded with news on global warming and climate change. Climate change is a long term shift in the Earth's average temperature and weather conditions. Accelerated global temperature is driven by human activities, resulting in more intense heat waves, progressive shrinkage of glaciers and polar ice caps, rising sea levels, disruption of cyclic weather pattern, escalating number of freak natural disasters and other ill effects. Rising heat waves and oceanic temperature posses a constant challenge to lives on earth. These climate crises are distorting the global atmospheric circulation system as well as oceanic buffering system which are considered as the regulator of the Earth's climate.

Temperature is having a crucial impact on the environment because any fluctuation in this parameter is a cardinal signal of the disturbances in regional or local environment. Rising temperature means more extreme weather events. Myriad of these impacts have already sprung up which cover rise in the sea level due to glaciers' retreat, decline in Arctic ice, ocean acidification, more heat waves, longer warm seasons and shorter cold seasons, increased chance of tropical cyclones, cloud bursts and other weather events. The oceans are also warming since they engulf the major portion of heat. According to Fifth Assessment Report, published by IPCC (Intergovernmental panel on Climate Change) in 2013 oceans have imbibed above and beyond 90% of the surplus heat in the climate system since 1970. These sequels of climate change and global warming are menace to food security, health, environment and sustainable development.

As per the World Meteorological Organization (WMO), there is 40% likelihood that the annual average temperature could rise 1.5 degree Celsius beyond the pre industrial level in one or more of the next five years. All pointing that we are looming inexorably nearer to the lower margin of the Paris agreement of 2015 on climate change (international treaty on climate change that quests to curb global warming to below 2, preferably to1.5 degree Celsius compared to pre industrial level). And this is an alarm to all the member countries to slash down their greenhouse gas emission to attain carbon neutrality. UN weather agency has put a "red alert" on global warming, citing record-breaking swelling in greenhouse gases, land and water temperatures and shrinkage of glaciers and sea ice caps. As per World Meteorological Organization (WMO), that there is anticipation that 2024 will be another record-hot year and warned that inadequate efforts have been made by the world's agencies to reverse the trend.

In India, these climate change-associated weather events have exhibited an ascending trend in occurrence. As per the report of Council of Environment, Energy and Water (CEEW), over and beyond 75% of Indian districts are hotspots for cyclones, droughts, incessant and erratic rainfalls that culminate in floods and other extreme weather events. The episodes of occurrence of cyclones in these areas have doubled since 2005, the report added. The seas around India are warming and this has triggered the incidence of cyclones in the Indian sub continent. Though cyclones are more frequent in Bay of Bengal, this temperature related climate changes are fomenting stronger cyclones in the Arabian Sea as well.

Impacts of climate change are multifarious affecting every form of life on Earth. This temperature spike can put biodiversity in peril. Climate change has affected a number of species at large. In Arctic, shorter duration of sea ice coverage has endangered polar bear's habitat and existence. In North America, vagaries of climate have shrunken plankton's population, the principle food for the North Atlantic right whales and thus influencing their survival. Another sequel of warmer sea surface is coral bleaching (whitening of corals caused due to disassociation of coral from zooxanthellae, a symbiotic photosynthetic alga). Zooxanthellae provide nutrients to the coral; ergo their loss can impact coral growth and survival. It is projected that Australia's Great Barrier can dissipate up to 95 percent of its living coral by 2050 owing to fluctuations in ocean temperature and chemistry. These impacts of climate changes can be perceived across every nook and corner of the globe. These impacts of climate change can be seen among the livestock and poultry population thus affecting the economy of the farmers and world as a whole.

Effects of heat stress in livestock are reduced feed intake, growth performance, milk yield, increased sweating rate, panting, rectal temperature, respiratory rate, and water intake (Sejian *et al.*, 2012) [3]. Apart from these there are also changes in haematological parameters, electrolytes, metabolites, increased mortality and morbidity and reduced immune function (Sejian *et al.*, 2010) [4]. Physiological mechanisms sets in gesture once animal were subjected to stress, which helps to maintain homeostasis and physical equilibrium within them (Farooq *et al.*, 2010) [1]. Physiological responses can be classified into short term changes and long term changes. Short term changes are often caused by acute stressors, e.g. a heat wave while long-term changes may be due to chronic stressors. Acute stressors may also lead to permanent changes in gene expression pattern (Gaughan *et al.*, 2012) [2].

Fig 1: Depiction of dried up natural vegetation leading to fodder constraints

Impact on livestock

Reproductive Health

Heat and nutrition stress are the two major environmental factors impacting productivity and reproductive health of the livestock population (Sejian *et al.*, 2010) [5].

Fertility Decline: The physiology of livestock is considerably influenced by climate change, which impinges their welfare, production, and health. Escalating temperatures can have a pernicious impact on reproductive health, eventually reducing conception rates and increasing the rates of embryonic death.

Events coupled with climate change in cattle

Thermoregulation

It is a process through which our body tries to retain its core internal temperature. Increased environmental temperature beyond a certain level may lead to the failure of this mechanism, which in turn may lead to heat stroke in animals and death of animal.

Heat Stress

High temperatures cause hardship for animals in regulation of their body temperature, which may lead to heat stress which is manifested by sweating, panting, and an elevated respiratory rate etc.

Heat Acclimatization

With a view to extended heat, livestock may adapt to behavioural, physiological, and skin thickness modifications over a period of time.

Metabolic Modifications

Energy Balance: Heat stress dwindle intake of feed and alters the metabolic rates, which results in loss of body weight and productivity. This alteration can affect the process by which nutrients are absorbed and digested by the body thus affecting overall growth and health of the animal.

Immune Function

Immuno suppression: Animals that undergo heat stress for a prolonged period of time may develop impaired immunological function and hence become more susceptible to diseases. The prevalence and distribution of infectious diseases have shown an increasing trend owing to climate change and its related activities and in turn is affecting the general health of livestock population.

Behavioural Changes

Feeding and Drinking

During the hottest period of the day, animals prefer to consume less feed and drink more water. This changing habit may lead to loss of body weight and general health of the animal. This in turn affects the productivity of the animals and incurs economic loss to the farmers in special and society as a whole.

Resting and Activity

With an aim to keep its body cool, animals may hide in shade and may take naps for a longer duration of time.

Production Traits

Milk Yield

Owing to the reduction in consumption of feed and metabolic alteration that occurs due to heat stress, milk yield of the animal decreases and its composition changes.

Meat Quality
Due to the physiological alteration brought on by the heat stress the composition of the muscle and its tenderness alters thus degrading the quality of meat available for the consumers.

Physiological alterations brought on by rising temperature
Cardiovascular Function
Increased Heart Rate
Due to escalating temperature, livestock population may exhibit increased rate of the heart beat and blood flow through it. These alterations are coupled with elevated blood pressure and thus affect the physiology of cardiovascular system at large.

Several other biochemical alterations brought on by climate change are increased oxidative stress
Increased temperature and heat stress may lead to the production of more reactive oxygen species which damages cells and tissues and impedes multitudes of physiological functions carried by these organs.

Altered immune function
Climate change and its related events produce discomfort for the animals and suppress the immune system rendering the animals more susceptible to infections.

Changes in nutrient metabolism
Escalating temperature may lead to decrease consumption of feed and water by the animal. This in turn will affect its capacity to utilise energy, synthesise proteins, and absorb nutrients. These alterations will result in low milk output, altered body composition, decreased growth rates etc.

Shifts in gut microbiota
Climate change can alter the composition and diversity of microflora present in the gastro intestinal tract of livestock population. These microflora play a vital role in digestion and absorption of nutrient and hence maintain the overall health of the animals. Any alteration in microbial populations can alter nutrient gut health of animals.

Increased water and electrolyte requirements
Heat stress causes sweating and panting in animals leading to more amount of water and electrolyte loss from the body. This causes dehydration and electrolyte imbalances, thus affecting the physiological functions and overall productivity of the animals.

How it affects poultry
Some of the primary physiological changes observed in poultry due to climate change
Thermoregulation
It is a process through which our body tries to retain its core internal temperature. Increased environmental temperature beyond a certain level may lead to the failure of this mechanism, which in turn may lead to heat stroke in poultry and death of the birds.

Heat Stress
Elevated temperature may cause them to pant, decreases feed intake which in turn causes loss of body weight which is followed by sluggish growth rates.

Feather Moult
With an aim to survive the escalating temperature, birds frequently moult their feather which affects their production as well as their energy balance.

Metabolic Changes: Altered Metabolism
Heat stress alters the normal metabolic process that takes place inside their body. It increases the basal metabolic rate and enhances the glucose metabolism process. During this hottest period, birds divert its concentration from feeding and breeds and try to maintain its homeostasis.

Electrolyte Imbalance
Elevated temperature cause the birds to pant which in turns leads to more electrolyte loss from the body thus affecting the normal physiological functions that takes place within the body.

Reproductive Performance
Reduced Egg Production
Increased temperature reduces the rate of egg production and quality resulting in formation of eggs with thin shells and poor hatchability rates.

Hormonal Changes
Increased temperature can cause disruption of the endocrine function and the hormone produced resulting in increased cases of reproductive disorders.

Immune Function
Immunosuppression
Heat stress can lead to suppression of the immune system rendering birds more vulnerable to infectious diseases. This may be accompanied by vaccination failure due to diminished capacity of the birds to respond to vaccine and produce effective immune responses. This will further increase the burden of emerging and life threatening infectious diseases.

Respiratory Function
Increased Respiratory Rate
To cope up with the escalating temperature poultry increases its respiratory rate which may further result in respiratory alkalosis and compromise oxygen exchange efficiency.

Susceptibility to Respiratory Diseases
Escalating temperature coupled with poor ventilation and give rise to respiratory disorder as well as it facilitates the dissemination of infectious disease within the flock of birds.

Behavioural Changes
Reduced Activity
During the period of this hottest period the working efficiency of the birds reduces and it become more inactive thus affecting the overall growth and development of the bird.

Altered Feeding and Drinking Patterns
Heat stress leads to reduced consumption of feed and water among birds thus reducing its body weight, altering its nutrients absorption pattern and disrupting the overall health and productivity of the birds.

Oxidative Stress

Increased Free Radicals

Escalating temperature may result in production of more free radicals and reactive oxygen species will cause oxidative damage to tissues and cells.

Antioxidant Depletion

Heat stress causes depletion of antioxidants at higher pace rendering birds more vulnerable to oxidative damage and related diseases.

Nutritional Requirements

Adjusted Nutrient Intake

Alteration in temperature can modify the nutritional requirement of birds. It may need higher amount of vitamin and minerals such as Vit C, vit E, selenium etc to beat heat stress.

Here are some additional biochemical changes that can occur in poultry due to climate change

Oxidative stress

Heat stress causes oxidative stress in poultry thus leading to the production of more reactive oxygen species (ROS), which disrupt the cellular components like lipids, proteins, and DNA etc. Antioxidant defence mechanisms of the birds may get activated to overcome the damages brought on by oxidative stress.

Energy metabolism

Climate change and its related events induces stressors can lead to disruption of the energy metabolism impacting process like glycolysis, oxidative phosphorylation, and lipid metabolism. In order to cope up with situation birds may exhibit alteration in nutrient utilization and energy expenditure mechanisms.

Nutrient absorption and utilization

Environmental temperature can impact both availability of nutrients and effectiveness of its absorption and utilisation by the body. Alteration of temperature and humidity can change physiological process of the digestive system and the dietary requirements of the birds thus affecting the bioavailability of essential nutrients.

Gut microbiota

Climate change and its associated change stressor can alter the delicate balance of gut microflora which results in dysbiosis and production of altered metabolites. This affects the immunological responses, absorption of nutrients and overall health of the birds.

Conclusion

Due to alteration of environmental parameter, livestock and poultry industry is facing lots of noteworthy challenges. This can be addressed by proactive management techniques, which covers enhanced nutrition, housing with well ventilation facilities, illness prevention and monitoring, and genetic selection for stressor resistance. To ensure long term sustainability of livestock and poultry industry efforts should be made to minimise the pernicious effects of climate change on animal health, welfare, and production by implementing comprehensive plans on climate change. This has highlighted the need for all concerned authorities to pay heed to climate adaptations to slacken the unprecedented pace of climate change. The member countries of WMO should enhance their early warning systems with an eye to dwindle the pernicious impacts of extreme events. Further impacts of climate change would hinge on the degree to which several nations implement various preventive measures to tackle climate crisis. Albeit, to achieve this ambitious goal, ample climate finance from developed nations is a mandate. Today the world is failing to limit global warming to 1.5 degree Celsius above pre industrial level. Hence, it is the high time for all the nations to staunchly adhere to their commitments pertaining to the Paris Agreement on Climate Change signed in 2015, as expeditious actions can put a cap to the catastrophe outcome of climate change.

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