

*Review Paper*

**EFFECT AND ADAPTATION OF CLIMATE CHANGE ON FODDER  
AND LIVESTOCK MANGEMENT**

**Dr. Birendra Kumar and Ashisan Tuti**

Department of Agronomy, Ranchi Agricultural College  
Birsa Agricultural University, Kanke, Ranchi, Jharkhand-834006  
E-mail: kbirendra1973@gmail.com

The natural history of the earth has witnessed many changes in the atmosphere and biosphere over last millions of years. These changes were slow in the past but now the pace of change is quite rapid and remarkably influenced by human activities. The climate change is one of them, which is influenced by natural factors such as continental drift, volcanoes, and earth's tilt and ocean currents. Concern about climate change has been growing for the last two decades. Climate variability and change are not new phenomena, but the scale of climate change in recent decades is unprecedented. This accelerated climate change is driven largely by emission of greenhouse gases mostly resulting from use of fossil fuels (IPCC, 2007). Weather and climate are the key factors that affect the life of flora and fauna on the earth. Agriculture, animal husbandry and fisheries are highly dependent on weather and climate change for producing food and by-products necessary to sustain human life and therefore changing climate could have a significant role for maintaining food security. Human factor in climate change is the industrial activities. Droughts, floods, tornadoes, hurricanes, temperature peaks and heat waves have caused material losses and human suffering.

The climate change directly or indirectly influences the production of different crops including forage, horticulture, vegetables, forest, livestock as well as fisheries and to keep the pace with food requirement of ever-growing population. The climate has changed with ecosystems and species coming and going, rapid climate change affects ecosystems and species ability to adapt and so biodiversity loss increases. From human perspective, the rapid climate change and accelerating biodiversity loss risks human security e.g. major change in food chain upon which we depend, water sources may change, recede or disappear, medicines and other resources. We rely on may be harder to obtain as the plants and flora may reduce or disappear.

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The changes observed in the regional climate have already affected many of the physical and biological systems and there are indications that social and economic systems have also been affected. In India, the climate and weather are dominated by the largest seasonal mode of precipitation in the world, due to the summer monsoon circulation. Over and above this seasonal mode, the precipitation variability has predominant inter-annual and intra-seasonal components, giving rise to extremes in seasonal anomalies resulting in large-scale droughts and floods and short-period precipitation extremes in the form of heavy rainstorms or prolonged breaks on the synoptic scale. Further, the Indian climate is also marked by cold waves during winter in the north and heat waves during the pre-monsoon season over most parts of the country. Tropical cyclones, affecting the coastal regions through heavy rainfall, high wind speeds and storm surges, often leave behind widespread destruction and loss of life, and constitute a major natural disaster associated with climatic extremes. These extremes have visible impact on human activities and therefore deserve to receive greater attention by all sections of the society to mitigate this threat. The observed changes in India's climate reveal that an increase of  $0.4^{\circ}\text{C}$  in surface air temperatures over the past century (1901-2000) has been noticed in India as against the globally observed increase of  $0.76^{\circ}\text{C}$ . However, there is no significant long term trend in monsoon rainfall or floods in the summer monsoon season at all India level. The total frequency of cyclonic storms forming over Bay of Bengal has also remained almost constant over 1887-1997. It is projected that, by the end of 21st century, rainfall in India may increase by 15-40 % with high regional variability. Warming may be more pronounced over land areas with northern India experiencing maximum increase. The warming could be relatively greater in winter and post-monsoon seasons. The annual mean temperature could increase by  $3^{\circ}\text{C}$  to  $6^{\circ}\text{C}$  over the century. The rise in sea level in the north Indian Ocean has been observed to be in the range of 1.06 -1.75 millimeters per year in the past century. There is a threat of coastal inundation in some of the low lying coastal areas. On the other hand, the glaciers show a mixed behavior. While some of them are receding, some of them are growing. As the glaciers retreat, they become more fragmented and the smaller glaciers are more sensitive to global warming. While some of the glacial recession could be a part of natural cyclic process, the accelerated melting experienced by some of the glaciers as a result of the earth's warming may affect future water availability.

India is a tropical country, though certain parts of the country have temperate or sub-temperate climatic conditions. The various agro- climatic zones clearly reflect the diversity of weather and climatic conditions as also of the water bodies which are found there. The three

seasons in India viz. summer, rainy and winter have their bearing on almost all the aspects of life, including crops animal husbandry. The ultimately temperature, rains, humidity, droughts and floods influence crops as well as animal including fishery production.

**Climate change and Indian agriculture:** India is the most affected country due to climate change. Changes in raining pattern, delayed monsoon, melting of Himalayas, flooding of rivers as in Bihar and in other northern part of India almost every year, tsunamis and cyclones are all natural calamities resulting out of climate change and global warming brought on indirectly by human beings. The effects of global warming on the Indian subcontinent vary from the submergence of low-lying islands and coastal lands to the melting of glaciers in the Indian Himalayas, threatening the volumetric flow rate of many of the most important rivers of India and South Asia. In India, such effects are projected to impact millions of lives. As a result of ongoing climate change, the climate of India has become increasingly volatile over the past several decades; this trend is expected to continue. Elevated carbon dioxide emissions from industries, factories, vehicles etc. have contributed to the greenhouse effect, causing warmer weather that lasted long after the atmospheric shroud of dust and aerosols had cleared. Unrestricted use of fossil fuels emits carbon dioxide, which the natural sinks in the bio-chemical cycle cannot fully absorb due to the inadequate existence of sinks like forests and oceans. This increases the concentration of carbon dioxide in the atmosphere, causing a greenhouse effect, leading to global warming (Sheth, 2008). Further climatic changes 20 million years ago, long after India had crashed into the Laurasian landmass, were severe enough to cause the extinction of many endemic Indian forms. The formation of the Himalayas resulted in blockage of frigid Central Asian air, preventing it from reaching India; this made its climate significantly warmer and more tropical in character than it would otherwise have been (The Hindu, 2010). These changes in the climate of Indian subcontinent also influence the productivity of various crops. Due to climate change temperature increase by 0.5°C has lead to decrease of 0.45 tonnes of wheat per hectare and decrease of 25 to 30 per cent sugarcane yield per hectare (The Hindu, 2010).

**Plant responses to climate change:** The direct effects of climate change on individual plants and plant communities may occur in the absence of pathogens, but may also bring about changes in plants that will affect their interactions with pathogens (Garett et al, 2006). Climate change causes following changes in the plant.

- Change in population genetic structure of plant species
- Change in abundance of particular plant species

- Certain species may succumb to diseases and show symptoms like wilting, leaf burn, leaf folding, abscission and affect susceptibility to pathogen.
- Problem in maintaining traditional land races/varieties
- Loss of biodiversity
- Shorter useful life of resistance genes- Climate change will modify host physiology and resistance, and alter the stages and rates of the development of pathogens. Studies carried out by Eastburn (2010) on soybean showed that elevated CO<sub>2</sub> and O<sub>3</sub> induced changes in the soybean canopy density and leaf age. Lake and Wade (2009) found in Arabidopsis more stomata on resistant varieties and fewer on susceptible varieties and resistant varieties become more susceptible to powdery mildew
- Need for development of cultivars with wider adaptation.

#### **Effect of climate on fodder**

Fodder is also a crop/plant having different diversification and capable to fight with slight effect of climate change. However, fodder as naturally grown varied with flora and fauna prevailed in particular region. While, cultivable cereals fodder, legumes, roughes, perennial grasses and tress required different climatic situation, thus it has immense variation in growth as well as yielding ability of quality green fodder. Constituent and quality of green fodder changed with variation in climate. Further, animal health as well as quality of animal products also influenced with the same.

#### **Effect of climate on Livestock**

The major effects of climate change for livestock sector are reduction in grazing area, fodder crisis due to less growth and green fodder yield (GFY) and decrease in production of milk, egg and meat. All these will lead to loss in rural household income, unemployment and supply of dietary nutrition. Climate affect animals in four ways: (a) the impact of 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) the direct effects of weather and extreme events on animal health, growth and reproduction. Some studies have been under taken in developed countries, less so in Africa, Asia and South America and there is uncertainty on how climate changes will impact animal production on a global. In animal husbandry sector loss of habitat, change in habitat conditions, disease outbreak and obstacle in reproduction and reduced production.

### **Adaptations to climate change**

The people of developing countries have adapted over generations to the risk of floods, droughts and cyclones. However, impacts of climate change means the present approaches and traditional methods of adapting to climatic changes need to be re-assessed. Introduction of climate-resilient fodder crops and climate-resilient live stock breeds. Shallow pump could supply water to restore natural grass and pasture lands where major livestock are raised. It is important to assess the vulnerability of economically important breeds. For example, Black Bengal goat is considered as short term animal crop in Bangladesh. It is famous for its breed characteristics such as quality of meat and skin, highly prolific and disease resistance. This breed is also considered as poverty reduction tool. Consequently, it can be considered as flagship species too. This breed also got recognition in Jharkhand.

Studies and research on fodder and livestock is limited. This is even more evident in the livestock sector. Literature on climate change impacts and adaptation options need to be enhanced. The government should allow grants for research and incentives for development of technology and knowledge on establishment of infrastructure like poly hose, irrigation facility, proper accommodations for cattle, moisture conservation practice and other practice that may minimized the economic loss from the climate change. Introduction of climate resilient fodder crops, storing and conservation of feeds and fodder, stock breeds, development of low cost weather controlled housing for livestock, strengthening animal disease surveillance facilities *etc.* should also be keep in consideration. Some of the strategies adopted by the farmer's communities to cope with or minimize the negative impacts of climate change and climate variability include:

1. **Storing food grains for use during the dry season and droughts.** Many households, particularly those producing sorghum and maize as rain fed crops keep and save which can be utilized during prolonged dry period.
2. **Relocation of livestock to areas where better pastures are available.** Earlier this was an effective measure to save livestock from loss due to droughts as well as flood, however, free grazing rangelands have been shrinking rapidly in recent decades due to land enclosures and the utility of this strategy is fading fast
3. **Sharing own resources with other farmers.** Farmers should be sentimentally reached and motivated to spare their resources to the needy. Animal domesticating farmers, agro-pastoral and pastoral communities are well known for their culture of sharing resources in times of hardship with the more disadvantaged and vulnerable households. Shared

resources include fodder and pasture, drinking water, and food for human consumption. In general, this culture is deep-rooted in rural peoples of Jharkhand.

4. **Storing crop stalks and conserved the fodder through Hay and silage making,** particularly sorghum and maize Stover, after grain harvest for livestock feeding during the dry season. Hay and silage can be successfully being prepared from perennial as well as annual legume found abundant which can be utilized during favorable condition.

5. **Diversifying cultivated crop plants.** Crop diversification has improved in recent years in the chottanagpur as well as Santhal area. During the last few years, farmers have been increasingly growing cowpea, and sesame in addition to their major rain fed crops and perennial grasses. Natural grassland should be developed having all kind of fodder.

6. **Reducing livestock number and/or changing herd composition.** In the face of declining grazing resources, and disappearing free communal lands, many households are keeping smaller herd sizes or are keeping fewer cattle and more sheep and goats. Cattle, because of their poor tolerance to drought, inability to browse trees and shrubs, and higher demand for drinking water compared to poultry, goats and sheep are less favored by most households.

7. **Water harvesting.** Many households have constructed small water ponds, the base and sides covered with plastic sheets, around homesteads to harvest runoff water. This simple, low cost technique of water harvesting has been found to be very beneficial to agro-pastoral communities saving them time spent fetching for water in distant places. Cemented open underground water reservoirs, are fairly common in the agro-pastoral and pastoral areas but are much more expensive than the more recent plastic-covered ponds. While the latter is affordable to almost all households, the former can be constructed only by the relatively wealthier members of a village.

8. **Selection of suitable fodder crops and cultivar for cultivation.** It is also important aspect to mitigate the loss of unfavorable situation. As different types of fodder have different characteristics which keep in consideration for selection of varieties and crops. Suitability of different fodder in Jharkhand situation are listed as under.

Sl	Situation	Crops can be taken for cultivation
1.	Water lodged	Para grass, Dallies grass
2.	Dry tolerant	Sudan grass, Signal grass, Sadabahar, Bajra
3.	Shade condition	Cango single, Guinea grass, Para grass
4.	Less water/hot situation	Anjan grass,
5.	Wet soil	Dhaincha, guar, H.N, Guinea grass
6.	Acid soil	Deenanath grass, stylo, lupin, turnip
7.	Saline soil	Sorghum, Oat,Guar
8.	Desert /unfertile soil	Stylo,Single grass,Deenanath,
9.	Degraded soil	Siratro, Anjan grass, Marvell grass
10.	Erosion prone area	Brazilian lucern, Deenanath

### Conclusion

The role of fodder and livestock sub-sector is very crucial for the economic development and sustainable dairy development in Jharkhand. Balance diet is essential for cattle as well as human. Feeds, fodder, concentrate, mineral mixture and other feed supplements is essential for balance nutrition of cattle and similarly, Livestock provide daily dietary protein, calcium fat and other milk products requirements of the people thus playing an important role in the nutrition and overall health of the population. Any reduction in production in this sector will result in a loss in rural household income as well as health slandered and an increase in unemployment in the rural areas. Climate change is seen as a major threat to the survival of many species, ecosystems and the financial sustainability of fodder- livestock production systems. Like human beings, livestock and animal feeds/ concentrate may suffer due to natural disasters, higher temperatures, salinity intrusions and floods. In changing climate scenarios, fodder production may decrease and mortality rates in animal (not only due to malnutrition but also due to change in habitat) may rise, which may threaten the viability of the livestock production in future. The government also needs to focus on research and development of new technologies to reduce the impacts of climate change on fodder and livestock sector. The crop lands, pastures and forests that occupy 60 percent of the Earth's surface are progressively being exposed to threats from increased climatic variability and, in

the longer run, to climate change. Abnormal changes in air temperature and rainfall and resulting increases in frequency and intensity of drought and flood events have long-term implications for the viability of these ecosystems. As climatic patterns change, so also do the spatial distribution of agro-ecological zones, habitats, distribution patterns of plant diseases and pests, and water harvesting and proper circulation/irrigation patterns, which can have significant impacts on dairy production.

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