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Editorial

Resilience of livestock production under varying climates

SOHAN VIR SINGH[1] and SURENDER SINGH[2]

[1]Editor, Journal of Agrometeorology and Principal Scientist, ICAR-National Dairy Research Institute, Karnal, India
**Corresponding author's email: sohanvir2011@gmail.com*
[2]Managing Editor, Journal of Agrometeorology and Principal Scientist, CCS Haryana Agricultural University, Hisar, India
**Corresponding author's email: surendersd@yahoo.com*

The livestock sector is a pillar of the global food system and a contributor to poverty reduction, food security and agricultural development and contributes to the livelihoods of one billion of the poorest population in the world and employs close to 1.1 billion people. In India, the sector contributes 4.1 per cent to the GDP and 25.6 per cent to total Agriculture GDP. There is a growing demand for livestock products, and its rapid growth in developing countries has been deemed the 'livestock revolution'. Worldwide milk production is expected to increase from 664 million tonnes (in 2006) to 1077 million tonnes (by 2050), and meat production will double from 258 to 455 million tonnes. Livestock production is likely to be adversely affected by climate change, competition for land and water, and food security at a time when it is most needed.

Global climate change is primarily caused by greenhouse gas ( ) emissions that result in warming of the atmosphere. Presently, the livestock sector emits an estimated 7.1 GT of CO_2-equivalent per year, representing 14.5 per cent of human-induced greenhouse gas (GHG) emissions and thus may increase land degradation, air and water pollution, and declines in biodiversity. Methane emission from the enteric fermentation of ruminant livestock is a main source of greenhouse gas (GHG) emission and a major concern for global warming. Ruminant livestock can produce 250 to 500 liters of methane per day. This level of production results in estimates of the contribution by cattle to global warming that may occur in the next 50 to 100 years to be around 2 per cent. Many factors *viz*., level of feed intake, type of carbohydrate in the diet, feed processing, addition of lipids or ionophores to the diet, and alterations in the ruminal microflora influence methane emissions from the ruminant livestock. Manipulation of these factors can reduce methane emissions from cattle. Further, increasing the efficiency of livestock supply chains is key to limiting the growth of GHG emissions in the future. Increasing incomes, changing diets, and population growth have led to increased demand and made the livestock sector one of the fastest growing agricultural sub-sectors in middle- and low-income countries. At the same time, climate change will affect livestock production through competition for natural resources, quantity and quality of feeds, livestock diseases, heat stress and biodiversity loss while the demand for livestock products is expected to increase by 100 per cent by mid of the 21st century. Therefore, the challenge is to maintain a balance between productivity, household food security, and environmental preservation.

The impending impacts on livestock include changes in production and quality of feed crop and forage, water availability, animal growth and milk production, diseases, reproduction and biodiversity. These impacts are primarily due to an increase in temperature and atmospheric carbon dioxide (CO_2) concentration, precipitation variation, and a combination of these factors. Temperature affects most of the critical factors for livestock production *viz.*, water availability, animal production, reproduction and health. Forage quantity and quality are affected by a combination of increases in temperature, CO_2 and precipitation variation. Livestock diseases are mainly affected by an increase in temperature and precipitation variation. Besides these critical factors, livestock may be prone to heat stress due to higher environmental Temperature-Humidity Index (THI), solar radiation and lower wind speed in summer season. All animals have a thermal comfort zone, which is a range of ambient environmental temperatures that are beneficial

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to physiological functions. During the day, livestock keep a body temperature within a range of ±0.5°C. When temperature increases more than the upper critical temperature of the range (varies by species type), the animals begin to suffer heat stress. Heat stress on livestock is dependent on temperature, humidity, species, genetic potential, life stage, and nutritional status. Livestock in higher latitudes will be more affected by the increase of temperatures than livestock located in lower latitudes, because livestock in lower latitudes are usually better adapted to high temperatures and droughts. Heat stress decreases forage intake, milk production, the efficiency of feed conversion, and performance. Warm and humid conditions cause heat stress, which affects behavior and metabolic variations on livestock or even mortality.

Adaptation and mitigation can make significant impacts for achieving resilience of sustainable livestock productivity to varying climates if they become part of national and regional policies. The key adaptation and mitigation strategies involve:

- *Ruminant methane control* – dietary management or use of growth promotants can reduce methane output per unit of product. More research and developmental efforts need to be undertaken for rumen manipulation, alteration of rumen fermentation, modification of rumen microbial biodiversity by various means. Selective breeding for livestock that emit less methane, produce more milk for longer period during the year may be explored. Vaccine against methane producing bacteria need to be developed so as to contain its emission.
- *Livestock production and management systems* – through diversification of livestock animals and crops, integration of livestock systems with forestry and crop production, and changing the timing and locations of farm operations
- *Agroforestry* – by establishing trees alongside crops and pastures in a mix as a land management approach
- *Breeding strategies* – to increase animals tolerance to heat stress and diseases and improve their reproduction and growth development
- *Farmers' perception and adaptive capacity* - to recognize the problem and adopt climate change adaptation and mitigation measures for sustainable and resilient livestock production
- *Carbon sequestration* - through decreasing deforestation rates, reversing of deforestation by replanting, targeting for higher-yielding crops with better climate change adapted varieties, and improvement of land and water management
- *Manure management* - involving shortening storage duration, improving timing and application of manure, used of anaerobic digesters, covering the storage, using a solids separator, and changing the animal diets
- *Fertilizer management* – for reducing nitrous oxide emissions through increasing nitrogen use efficiency, plant breeding and genetic modifications, using organic fertilizers, regular soil testing, using technologically advanced fertilizers, and combining legumes with grasses in pasture areas may decrease GHG emissions in feed production
- *Shifting human dietary trends* - by reducing meat consumption and returning to a more vegetarian diet may significantly reduce GHG emissions

The better adaptation and mitigation options can help to curtail the effects of climate change on livestock performance. To reduce the poverty and promote sustainable development through livestock production, favorable policies and action oriented research are urgently required to address the pertinent issue. For effective adaptation and mitigation measures to address climate change and livestock production, these measures should be scaled up through policy. For example, understanding farmers' perceptions and including them in policy development can improve food security and environmental conservation by promoting widespread practice adoption. In addition, a comprehensive view of costs, time, and effort required from the producer needs to be included to the policy framework to maintain sustainable and resilient production systems ensuring food security and livelihood.