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Climate Smart Livestock Production

Dr. Ajit Kumar[1] and Tania Roy[2]

[1]PhD Scholar, Department of Livestock Production Management, WBUAFS, Kolkata

[2]School of Agricultural Sciences, JIS University, Kolkata

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Abstract

Climatic change in terms of increased ambient temperature, altered rainfall and modifications in precipitation forms, heat waves, heat stress, droughts, floods and erratic changes in seasonal patterns are emerging challenges for crop and livestock production. Indirect effects of altered climate are being observed through reduced yields and quality of feeds and fodder, possible increased incidences of diseases and competition for the available resources. Though the negative impacts of environmental change may be a global concern, our country India where almost 70 per cent of livestock are owned by small and marginal farmers and landless labourers is at high risk. Minimizing the impact of global climate change is thus essential to achieve sustainable development and poverty eradication. Implementation of policies and formulations of strategies for improved adaptation pathways for livestock production towards the changing climatic scenario will promote sustainable livestock farming and poverty eradication.

Keywords: Livestock, Global climate change, Sustainable livestock farming

Definition:

A climate-smart livestock approach is a comprehensive approach that works towards sustainable livestock production systems that fully support, as much as possible:

- Climate change adaptation and mitigation activities
- Food security
- Sustainable incomes
- Animal welfare
- Reduce the environmental impact

Introduction

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Climate is the long-term average of weather, typically averaged over 30 years. More rigorously, it denotes the mean and variability of meteorological variables over a time spanning from months to millions of years. Anthropogenic activities are one of the chief causes of climate change. The most imminent climatic changes in recent times are the increase in the atmospheric temperatures due to increased levels of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), ozone (O_3), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs) because of the increasing concentration of those greenhouse gases, there is much concern about the future change in our climate and direct or indirect effect on agriculture.

Global climate change has a considerable impact on the environment and therefore the natural resources on which the livestock sector depends. Climate change may be a serious threat to the livestock sector. Increased ambient temperature, erratic shifts in rainfall distribution and increased incidences of life-threatening weather events like heat waves, floods, drought etc. are expected to aggravate the negative impact of climate change on the production and reproduction performances of livestock. These adverse impacts will be the direct result of increased heat stress and reduced water availability, competition for the available resources, increased incidences of diseases (FAO, 2009; Thornton and Gerber, 2010).

The carbon dioxide (CO_2) concentration was in the steady-state at 280 ppm till the preindustrial period (1850). It is rising since then at the rate of 1.5 to 1.8 ppm per year. The concentration of CO_2 is likely to be doubled by the end of the 21st century. Open top chambers and FACE technology are currently being used for the study of the response of crop plants to elevated CO_2. Results from such studies have shown an increase in plant photosynthetic rate and crop yield.

The impacts of temperature change on livestock are extensive. The most serious impacts are expected to be in grazing systems because of their high dependency on climate and limited adaptation opportunities. The consequences are anticipated to be most severe in arid and semi-arid grazing systems at low latitudes, where higher temperature and lower rainfall are likely to cut back yields and increased land degradation. Climate change is a very fast-growing problem within the world. However, it's more alarming in India as over two-third of the population of farmers are small-scale farmers and it is difficult for them to cope up with

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the changing climatic condition which needs adaptation and mitigations strategies. Financial constraint is one of the foremost backward forces pulling the farmers deep down. Throughout 1901-2010 in India, overall rainfall has been reduced. But there has been an increase in the extreme rainfall in certain parts of central India and lots of other areas. Of most concern within the anthropogenic factors are CO_2 emissions from fossil fuel combustion and industrial processes, which together contributed 78% of total GHG emissions increase from 1970 to 2010.

The FAO has defined climate-smart agriculture as one that "sustainably increases productivity, enhances resilience (adaptation), reduces/removes greenhouse gases (mitigation) and enhances achievement of national food security and development goals". Livestock production covers two-thirds (34 Mkm^2) of the world´s agricultural land (49 Mkm^2) for production of animal feed (grazed pastures 80%, and feed crop 20%), while a section (3.5 Mkm^2) of the crop area (15.2 Mkm^2) used for animal feed (FAO, 2006).

Temperature change potentially affects the quality and availability of feed and fodder and will cause fast degradation of grassland and successively cause more drought or flood along with disease incidences because of warmer temperatures. In Indian conditions, the stress of livestock production in adverse climatic conditions can be negotiated by adopting several strategies, such as genetic improvement of animals, balanced diet, better herd management to improve output, including better herd health management with less dependence on antibiotics, better management of grassland (e.g. sowing improved varieties of pasture, rotational grazing) etc. (Gerber *et al.*, 2013).

- In India substantial work has been done in the last decade aimed at understanding the nature and magnitude of change in yield of different crops due to possible climatic change. The objective of this presentation is to discuss the present scenario of the Indian condition and the status of the impact of climate change on Indian agriculture and livestock.

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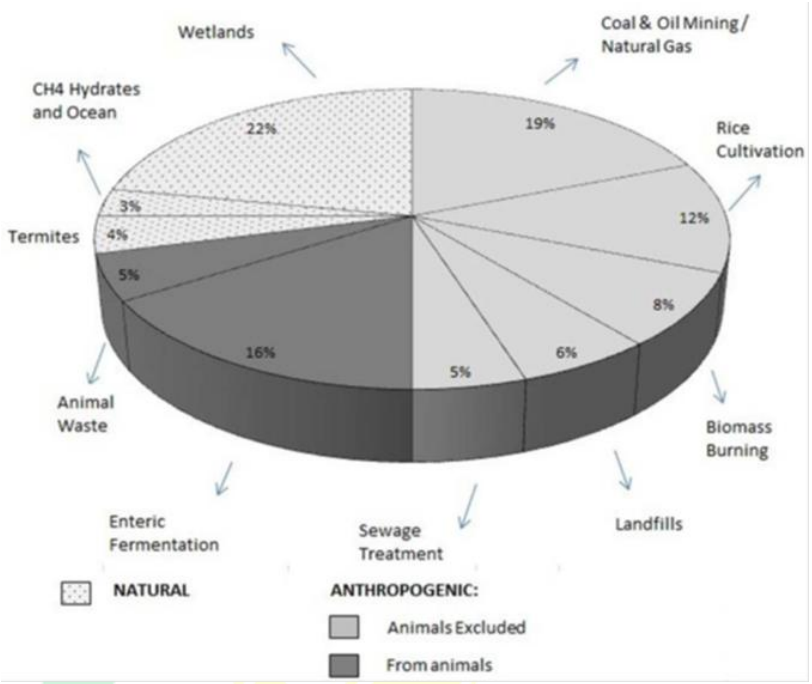

Fig.1. Sources of anthropogenic methane production

Global Warming

Global warming is the long-term heating of the earth's climate system observed since the pre-Industrial period due to human activities, primarily due to fuel burning, which increases heat-trapping greenhouse emission levels in the earth's atmosphere. Since the pre-industrial period, human activities are estimated to possess increased Earth's global average temperature by about 1-degree centigrade. Global warming occurs when CO_2 and other air pollutants and greenhouse gases collect within the atmosphere and absorb sunlight and radiation that have bounced off the earth's surface. Melting glaciers, early snowmelt and severe droughts will cause more dramatic water shortages and increase the danger of wildfires. Rising sea levels will cause coastal flooding on the eastern seaboard. Forests, farms, and cities will face troublesome new pests, heat waves, heavy downpours, and increased flooding. All those factors will damage or destroy agriculture and fisheries. Disruption of habitats like coral reefs and alpine meadows could drive many plants and animal species to extinction.

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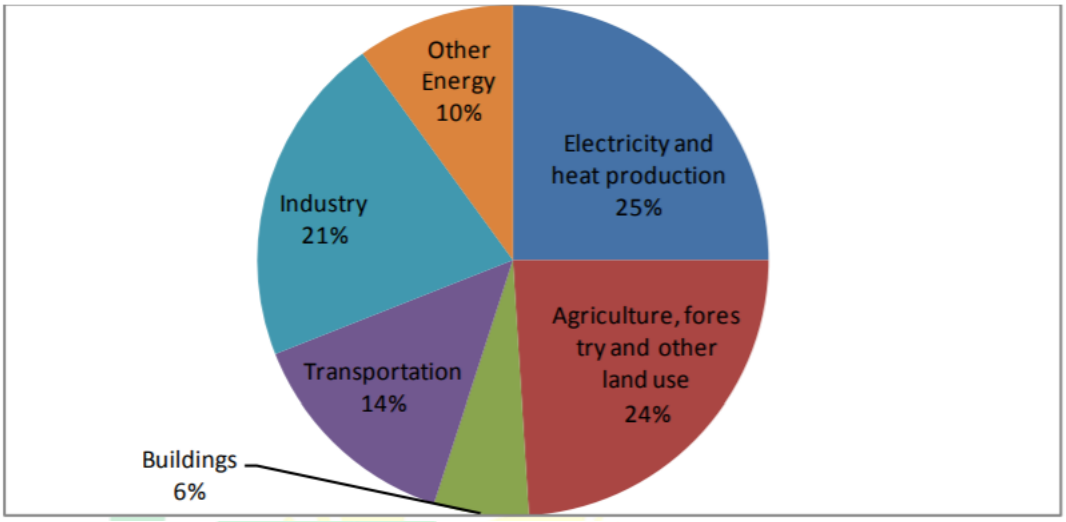

Fig.2. Global gas emission by different sectors

Climate Change in Indian Context

The first Assessment of climate change over the Indian region has been published by the Ministry of Earth Sciences (MoES). It is India's first-ever national forecast on the impact of global warming on the subcontinent in the coming century. The highlights of the findings are discussed below.

1. Temperature:

1. In a worst-case scenario, the average surface air temperature over India could rise by up to 4.4°C by the end of the century as compared to the period between 1976 and 2005.

2. The worst-case scenario is defined by the Representative Concentration Pathway (RCP) 8.5 that calculates a radiative forcing of 8.5 watts per square meter due to the rising greenhouse gas (GHG) emission in the atmosphere.

3. Radiative forcing or climate forcing is the difference between sunlight energy absorbed by the Earth (including its atmosphere) and the energy that it radiates back into space.

4. Under an intermediate scenario of RCP 4.5, the country's average temperature could rise by up to 2.4°C.

5. By 2100, the frequency of warm days and warm nights might also increase by 55% and 70% respectively, as compared to the period 1976-2005 under the RCP 8.5 scenario.

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6. The incidence of heat waves over the country could also increase by three to four times. Their duration of occurrence might also increase which was already witnessed by the country in 2019

7. Between 1900 and 2018, the average temperature of India rose by 0.7°C.

8. This temperature rise has been largely attributed to global warming due to GHG emissions and land use and land cover changes.

2. Rainfall:

1. Another significant highlight of the assessment is the projected variability in the rainfall, especially during the monsoon season which brings 70% of the rainfall received by India and is one of the primary drivers of its rural agrarian economy.

2. Monsoon rainfall could change by an average of 14% by 2100 which could go as high as 22.5%. It is not mentioned if this change will be an increase or decrease but still represents variability.

3. Overall rainfall during the monsoon season has decreased by 6% between 1950 and 2015.

4. In the past few decades, there has been an increased frequency of dry spells during the monsoon season that has increased by 27% in 1981 to 2011, as compared to 1951-1980.

Impact of Climate Change on Livestock Production

The approximate thermal comfort zone for optimum performance of adult cattle is reported to be 5-15oC. Climate change represents a feedback loop in which livestock production both contributes to the problem and suffers from the consequences. The impact of global warming and the continued, uncontrolled release of greenhouse gasses (GHG) has two-fold implications for the livestock industry, and consequently food security. Firstly, the continuous increase in ambient temperature is predicted to have a direct effect on the animal, as well as on food and nutrition security, due to changes associated with temperature itself, relative humidity, rainfall distribution in time and space, altered disease distribution, changes in the ecosystem and biome composition. Secondly, the responsibility of livestock production is to limit the release of greenhouse gases (GHG) or the carbon footprint, to ensure future sustainability. This can be done by implementing new or adapted climate-smart production systems, the use of known and new technologies to turn waste into assets, and by promoting sustainable human diets with low environmental impacts. The following elements, which are related to livestock production and climate change: (1) restoring the value of

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grasslands/rangelands, (2) pastoral risk management and decision support systems, (3) improved production efficiency, (4) global warming and sustainable livestock production, (5) the disentanglement between food and nutritional needs, focusing on nutrient-rich core foods, (6) GHG from livestock and carbon sequestration, and (7) water and waste management.

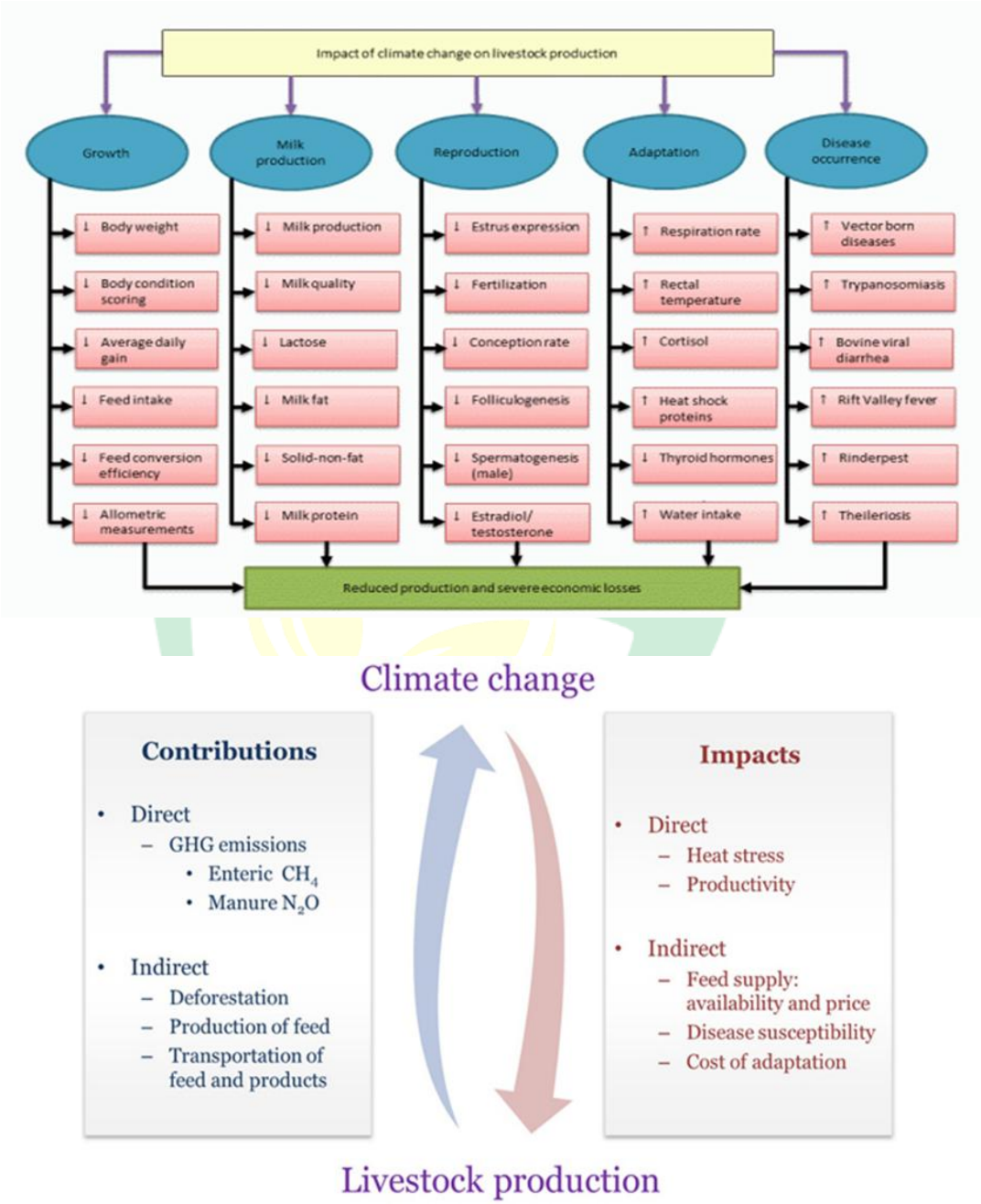

Fig.3. Impact of climate change on Livestock Production

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An increase in ambient temperature alters heat exchange between animals and the environment and harms feed intake, growth, milk production, egg, wool production, reproduction and health of the animals. Productive animals are more vulnerable to heat stress and a further rise in temperature due to climate change will have aggravated the impact. The methane emission per unit of dry matter intake reduced under moderate heat stress and increased under severe heat stress. In India average stress hours, i.e. hours above THI 72, during hot months of the year are likely to increase. This will lead to decreased milk, meat and egg production. The reproductive performance of female and male animals is affected by climatic heat directly as well as indirectly through feed and fodder and proneness to diseases. Abrupt rise or fall in environmental temperature above critical level reduces the conception rates. Compared to other species of domestic animals, poultry is more sensitive to high ambient temperatures as they do not have sweat glands, have a higher basal metabolic rate per unit body weight and body is covered with feathers. To mitigate the heat stress condition in bird's additional expenditures will be done by use of air cooler or sprinklers on the roof.

Climate change will put extra pressure on farmers due to heatwaves, drought, and cyclones. These natural calamities will damage fodder production in India. Increase frequencies of extreme weather conditions will make the grasslands more prone to drought and flood. Crop production will be damaged due to sudden or lack of rainfall. The crops produced in these scenarios will have a low nutritional quality than that of standard fodder. Lack or abundance of water will also affect fodder productivity. Even if the green fodder is available from other regions, that will cost high leading to increased cost of production. These factors will put extra pressure on animals to meet the energy and protein requirements, which may lead to reduced productivity. In India there is a shortage of feed and fodder availability by 40 % dry fodder, 36 % green fodder and 52% concentrate on a dry matter basis, which is a prime constraint for full genetic potential expression.

Climate-smart livestock:

Improving efficiency of the use of resources:

Efficiency in the use of natural resources is measured by the ratio between the use of natural resources as input to the production system and the output from production. Higher yields per hectare, higher water productivity, higher feed efficiency, improved management of manure and fertilizers and reduced losses along the food chain should be achieved by efficient use of

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the resources. Improving the feed conversion efficiency in animal production systems is a basic strategy for improvising the environmental sustainability of the livestock sector. A large volume of food is wasted even before it reaches the consumer, which should be checked for improving efficiency.

Building resilience:

Long term strategies by the farmers that inhibit huge loss due to lack of productivity is a vital arena of the adaptation strategies. These strategies can include system changes (e.g. alteration in the set of commodities produced or the change from extensive to mixed systems) or the implementation of new technology that is currently unavailable. There may be long lag times between the identification of a problem and the formulation of readily available and applicable technology. Research conducted today needs to fit the environment 20-30 years ahead. These systemic changes will lead to slow buffering of the adverse effect of climate change on animals.

Feeding management:

Farmers need to minimize the heat loss from the body, which is a waste of energy. A lot of energy is wasted during the utilization of poor-quality forages, straws, crop residues etc. and a proportionately higher amount of heat per unit feed intake is produced. This extra heat also is to be lost from the body to maintain thermal balance. Similarly, the particle size of fodder affects the amount of heat produced per unit weight of dry matter consumed. So economic feed processing techniques such as wetting of grasses, cropping and chopping of green, grinding, pelleting, use of urea-molasses will reduce the energy loss in the digestion and decrease the heat loss for maintenance of body temperature. Use of available green fodder during summer or efficient use of non-conventional feed resources or newer feed resources will help to negotiate the fodder scarcity produced due to adverse climatic conditions.

Breeding Management:

· Identifying climatic stress-tolerant species and breeds that are most adaptable/suitable for each bioclimatic zone in consultation with livestock owners. Use of molecular genetic markers for high tolerance to environmental stress as well as production ability in the animal selection program.

• Encouragement of farmers by providing incentives for active participation in improvement program of prioritized breeds in the form of artificial insemination services at farmer's door

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without charge, health coverage, animal insurance at nominal charges and institutional credit at zero per cent interest for procurement of animals of prioritized breeds.

• Establishment of mother bull farms of prioritized breeds of cattle and buffalo in major climatic zones.

• Training of rural women and youth in improved feeding technologies and reproductive management.

• Establishment of regional demonstration units for climate-resilient livestock production systems and technologies with government support.

Housing Management:

Good housing with proper design, height, and orientation and with good open space for ventilation and comfortable space per animal will provide a cooler microenvironment inside the house.

Heat ameliorative measures:

• During periods of high temperatures, farmers should use water to bring down the inside temperature within the animal shelters and increase the evaporative heat loss from the animal body.

• use of fans inside the animal house is very efficient but more expensive.

• Use of sprinklers and plantations around the animal houses can give thermal comfort to the animals.

• Allowing animals to graze during the cooler part of the day.

• Provision of clean cool water for drinking inside the animal house.

• The animals in the arid zone are allowed to graze in the fields during the day and are exposed to more heat stress because of scarce feed and fodder. The provision of community shelters in these areas will alleviate heat stress in these animals by allowing them to take rest during peak hot hours.

Building shelters at flood and cyclone-prone areas:

The coastal low-lying areas are very much prone to rise in sea level and cyclonic storms. Hence, it is very crucial to build well-planned structures to protect these low-lying areas. The provision of suitable shelters in flood and cyclone-prone areas can check the morbidity and mortality of animals in these areas.

Weather forecasting and early warning system:

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Weather forecasting and early warning of bad weather are very crucial to allow the farmers to take necessary preventive measures to protect the animals from bad weather conditions like severe heatwaves, cold waves, heavy precipitation and thunderstorm, cyclone, flood and disease outbreaks.

The Government of India launched National Action Plan on Climate Change (NAPCC) on 30th June 2008 outlining eight National Missions on climate change. These include:

1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Mission on Sustainable Habitat
4. National Water Mission
5. National Mission for Sustaining the Himalayan Eco-system
6. National Mission for a Green India
7. National Mission for Sustainable Agriculture
8. National Mission on Strategic Knowledge for Climate Change

Conclusion

Climate change has become a global problem today. Erratic weather conditions increased the frequency of extreme weather events like cyclones, floods, heatwaves, and shifts in rainfall etc. harm animal's reproductive and production efficiency. Increased air temperature disturbs heat exchange between animals and the environment that in turn imparts negative effects on dry matter intake, growth, and milk production, egg, wool production, and conception rate, the oestrous and overall health of the animals. The climatic stress on livestock production can be reduced by developing a climate-smart livestock production system. Formulation and adoption of several direct and indirect heat stress mitigation strategies like improvement of the genetic potential of the animals, the introduction of marker-assisted selection for heat tolerance in selection programs will help to combat heat stress. Improving diets, construction of scientifically designed animal houses, plantation around shed, setting up of weather forecasting systems for earlier alarming of farmers about bad weathers will help in mitigating the negative effects of changing climate.

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