

Livestock Rearers Under Climate Change: A Review of its Impact and Adaptation Strategies in India

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Abstract: Livestock sector plays a significant role in socio-economic development of rural households dependent on livestock for income. The impact of climate change on livestock production and health is adverse in majority of agro-climatic regions, thereby making poor livestock owners most vulnerable to climate change. This paper reviews studies related to climate change impact on livestock rearers in different states or different agro-climatic regions. It explores the adverse effects of climate change faced or perceived by livestock farmers and various measures practised by them to cope with climate change effects. The paper also proposes future research directions that might help in addressing the climate change issues affecting livestock rearers livelihood and document localised adaptation strategies. Various policy recommendations stated in the paper aim to strengthen adaptive capacity of livestock farmers. The conclusion emphasizes the need for immediate actions to protect livelihood of the livestock farmers from ill effects of climate change.

Keywords: Climate change, livestock rearers, livelihood, adaptation strategies

I. INTRODUCTION

India is home to 535.78 million livestock as per the 20th livestock census showing a significant 4.6 per cent growth rate over 19th livestock census. Livestock sector share of total gross value added at current basic prices accounted for 5.7 percent during the financial year 2021-22. This sector provides a major source of income to landless, small and marginal farmers. Livestock rearing is one of the most climate sensitive economic sector, thereby making it vulnerable to the effects of climate change. Climate change has become the major threat to the livelihood of the livestock rearers. Anthropogenic activities led to approximately 1.0 °C of global warming above pre-industrial levels, ranging between 0.8 °C to 1.2 °C and it is expected to reach 1.5 °C between 2030 and 2052 [1]. The rising temperature causes adverse effects in form of heat stress on productive and reproductive performance of livestock by reducing feed intake, general activity, growth, milk production, wool production and conception rates [2]. The shortage of feed and fodder due to climate change have a severe influence on livestock production [3]. Higher temperatures induce more lignin formation in plant tissues which reduces the digestibility and rates of degradation of fodder and crop residues in the ruminants, thereby lead to reduced nutrient availability for animals followed by drop in livestock production [4]. Besides these effects, the temperature rise and changes in precipitation cause changes in spatial or temporal distribution and frequency of incidence of diseases resulting in livestock mortality. The livestock mortality also occur due to heavy floods and drought like condition. Farmers dependent on livestock rearing as their major source of livelihood might suffer from chronic poverty if they lose livestock in frequently occurring droughts and floods. Commercial dairy farmers have better access to financial resources and technology to minimize the impact of climatic variabilities as compared to small scale dairy farmers, tribal livestock rearers or nomadic herders. Therefore, such rearers with limited adaptive resources are most vulnerable to climate change. This paper reviews literature regarding adverse climate change impacts on livestock rearers and adaptation strategies followed to cope up with climate change effects. The paper is divided into several sections: Section II gives an overview of the data source and methodology, Section III discusses the studies based on climate change impact on livestock rearers and adaptation strategies followed to counter

these impacts in various agro-climatic regions or states, Section IV presents the study's conclusions, Section V explores policy recommendations, and finally, Section VI outlines directions for future research.

II. METHODOLOGY

This study primarily focuses on a qualitative systematic review of literature related to climate change effects faced or perceived by livestock rearers and coping mechanism followed by them against climate change. The objective is to understand the localised impact of climate change on livestock rearers of different agro-climatic regions or states. The literature for this study has been gathered from various sources, including published scientific journals, online articles, and websites of organizations and institutions. The collected literature has been organized based on two criteria that align with the study objectives:

- Literature that discusses impact of climate change on livestock rearers
- Literature that specifically explores different adaptation strategies adopted by livestock rearers to adapt to climate change effects.
- After a thorough review of the selected literature, a compilation being done of the challenges brought up by climate change on the livestock rearers and the adaptive measures practised to combat these climate-induced effects.

A. Climate Change Impact on Livestock Rearers and Adaptation in Different Regions

Climate Change Impact on Livestock Rearers and Adaptation in Western Himalayan Region

[5] conducted a study in Una and Sirmaur districts of Himanchal Pradesh for examining the impact of climate change on tribal livestock rearers and the coping strategies adopted by them. Both the districts, situated in low hill and sub mountainous region of Western Himalaya, are prone to flood and come under high flood risk zone of Himachal Pradesh. Due to climate change, the tribal livestock rearers experienced various challenges in rearing livestock. The degraded pastureland reduced the availability of fodder for livestock. Increased insect pest infestation affected animals health. Prolonged dry season became cause of increased frequency of drought. The excess rain fall led to huge loss of crop and livestock. The respondents reported variation in rainfall and change in mean temperature which affected their livestock production. The long distance to major accessible road and large family size were becoming the hurdle to combat climate change effects.

To cope up with the ill effects of climate change on livestock, the tribal livestock rearers adopted some adaptive strategies that were part of their indigenous traditional knowledge. Transhumance was followed to ensure availability of adequate amount of fodder for animals. The water scarcity caused constipation in animals, so tribal farmers gave fresh raw milk to the animals. The frequent change in temperature adversely affected reproductive health of pregnant animals. For the problem of retained placenta, a liquid prepared from water, bark of Simbal tree and Jaggery which facilitate the animal to expel its placenta. Prolapse disease treatment was done by washing reproductive organs with rum or alcohol, which has antiseptic effect. The prevalent disease was repeat breeding for which farmers fed Kachnar (*Bauhinia variegata*) leaves to such animals.

B. Climate Change Impact on Dairy Farmers and Adaptation in Western Ghat Region

[6] identified the adverse effects perceived by dairy farmers due to climate variability and change in Western Ghats region and compiled some innovative adaptation strategies followed by them in response to climate change. The study was conducted in three states namely Kerala (Wayanad), Karnataka (Shimoga) and Maharashtra (Ratnagiri). The frequent landslides caused by prolonged and intense rainfall or more particularly a combination of the two led to loss of livestock and property. Already more than 29 cases of landslides were reported in Wayanad. Such extreme climatic conditions made the livelihood of dairy farmers of Wayanad districts highly vulnerable. There was regular occurrence of heat wave and moderate occurrence of drought, flood and cyclone in Ratnagiri district in general. The drought reduced the availability of fodder for the livestock. Some dairy farmers in Ratnagiri reported low milk production and production losses. Due to low infrastructural facility, they are vulnerable to extreme climate conditions.

On the aspect of adaptation strategies followed by dairy farmers to adapt to climate change, the study revealed that dairy farmers in Western Ghat region are increasingly sensitive of location-specific technology on demand which is

important for reducing climatic risks and adaptation to future climate. In Maharashtra, Pennisetum purpureum, also known as Napier grass, elephant grass or Uganda grass was being fed to cattle by the farmers of drought hit districts. The water and nutrient requirements of this grass is low; therefore, it can be grown in uncultivated lands. Elephant grass being a high yielding fodder used as a major livestock feed in smallholder dairy production systems. To overcome green fodder and dry fodder scarcity and diseases due to climate change, dairy farmers in Palakkamoola village of Kerala replaced recommended dose of concentrates, green and dry fodders with a mixture of Brewery spent grain waste (6kg), maize bran (2kg), maize fine (2kg) and thippi waste (2kg) to overcome scarcity of fodder due to climate change and indigestion due to high temperature issues. A farmer of Shimoga district in Karnataka did innovative changes in cow shed by adding second layer after the main roof and arranged bamboo sticks to absorb excess heat. He followed strategic nutrient supplementation by increasing the level of dietary fat by feeding a diet of crushed oilseeds (sunflower seed, canola seed or flaxseed) or dried corn distillers grain as it reduced the energy lost as methane by up to twenty percent. Due to climate vagaries, disease cycle will become unpredictable and sporadic outbreaks might occur and the most viable strategy adopted by some farmers to counter this effect was to retain more of the adapted indigenous livestock.

C. Climate Change Impact on Livestock Dependents and Adaptation in Middle Gangetic Plains

[7] assessed climate change impact on livestock dependents and documented followed adaptation strategies in parts of Bihar which come under middle gangetic plains region. Bihar has faced various disasters whether it be floods, earthquakes, cyclone, heat wave, cold wave or drought. Drought occurrence in Bihar became quite common. The shortage or failure in monsoon rainfall led to decline in feed, fodder and drinking water availability for the animals, causing serious problem to cattle-rearing farmers. This study selected three districts namely Gaya (non-drought prone), Samastipur (moderately drought prone) and Bhagalpur (severely drought prone). Majority of the livestock dependents of severely drought prone district perceived that heat stress highly affect the productive and reproductive performance of livestock as compared to moderately drought prone and non-drought prone district where perceived impact of heat stress on livestock performance was moderate. Due to reduced availability of fodder in drought prone districts, livestock suffered from malnutrition which resulted in reduced productivity.

During drought, the lack of feed and fodder led to reduced feed intake of livestock which resulted in decrease in livestock productivity. Livestock dependents provided extra crop residues, extra concentrates, minerals, supplementation and feed additives, changed feeding schedule and grazing time during climate adversities. Vitamins and zinc helped in reducing negative impact of heat stress and in enhancement of milk quality. If the paddy crop failed due to uneven distribution of monsoon, then the immature paddy crop was used to feed animals. Majority of livestock dependents from non-drought prone and severely drought prone districts favoured rearing buffalo as the buffaloes are more tolerant to stress conditions and inadequate fodder resources. Due to prolonged scarcity of fodder resources, livestock dependents of severely drought prone district used to remove unproductive animals from the herd. Sick animals were treated by keeping animals in cool place, giving cold water bath and providing fan.

D. Climate Change Impact on Livestock Rearers and Adaptation in Eastern Coastal Region

East coast is more vulnerable than the west coast with respect to the frequency of occurrence of extreme climatic events. Livestock rearers of coastal region are always in fear as every year there are tropical cyclone, flood, extremely heavy rainfall, drought etc. [8],[9] conducted a study to examine awareness and perception of livestock rearers in response to climate change effects on livestock at household level and examined various coping measures followed by livestock rearers in Odisha and West Bengal of eastern coastal region. A climate change awareness scale was constructed to study effects of climate change perceived by 480 livestock rearers households i.e. 240 household each from both the states. The results showed that livestock rearers of West Bengal were more aware about climate change than livestock rearers of Odisha. The livestock rearers perceived that heat stress was negatively affecting the fertility of livestock and increase in temperature and humidity caused declined milk production of dairy bovine. Heat stress also caused reduced feed intake of the livestock.

Various adaptation strategies were adopted by the livestock-rearers of the coastal region to cope up with climate change effects. During heat stress, farmers used to offer more green grasses, fodder, concentrate etc to their animal for

maintaining productivity and body weight of the animal. In order to minimize the risk of huge monetary loss and to get relief from fodder scarcity, livestock rearers of West Bengal shifted to small ruminants like sheep (specially Garole breed) and goat (specially Black Bengal goat) from the large ruminant specially cattle. Wide occurrence of death of livestock during extreme climatic events like cyclone, flood, drought etc., made commercial livestock rearers of coastal region to insure their livestock with insurance company for some monetary benefits from accidental death of their livestock.

E. Climate Change Impact on Yak Rearers and Adaptation in Eastern Himalayan Region

Yak rearing is a common source of livelihood of herders living in high altitude where commercial agriculture is difficult due to unsuitable climatic condition.[10] studied climate change effects on pastoral yak rearers and reported certain adaptation strategies followed by yak herders in North Sikkim. The warming affected the flora distribution in high altitudes, causing fodder shortage for the livestock species. The respondents reported reduction in grazing area and poor pasture quality as compared to scenario two decades ago. Moreover, the seasonal shift of snowfall events and frequent avalanches, led to migration of wild animals to lower elevations which enhanced depredation of yak of herders. Climate change led to changes in migration pattern as the timing and route for seasonal migration of yak herders is decided based on snowfall, temperature and forage availability. The respondents believed that the increased rate of yak deaths from liver disease was due to heightened temperature. Some pregnant female yaks death occurred during summers and herders thought it occurred because pregnant yaks couldn't withstand warm climate. As an adaptation strategy against changing climate scenario, yak herders followed transhumance pastoralism in which they used to fix their dates of movement according to Tibetan lunar calendar and managed the pastureland resources by rotational grazing practices. Thereby, making it suitable for yaks to adjust and adapt to the seasonal variation and better utilization of seasonal pasture at different altitudes.

F. Climate Change Effect on Dairy Farmers and Adaptation in North Eastern Himalayan Region

[11] assessed the effect of climate change on dairy farmers in the north eastern Himalayan region of India. A random sample of 240 farm households from Assam and Nagaland were interviewed for the study. Through the respondents, it was found that drought caused change in livestock compositions, total animals per household got reduced and milk production declined. The fodder collection took longer than before due to reduced natural fodder resources and pasture. A significant number of dairy farmers reported the decline in milk yield from heat stress, less availability of green fodder and deterioration of grazing land. They further expressed decrease in milch animals' body weight during low rainfall or drought like condition than the normal periods due to scarcity of green fodder. To cope with these climate change induced effects, no adaptation strategy was identified in the study area. About 90 percent of respondents didn't know about the livestock insurance programme. Some of the respondents showed their inclination towards scientific animal health management as mitigating option in the area.

Other related findings from different states are shown below in Table I.

TABLE I:

Some other relevant studies on impact of climate change and various adaptation strategies adopted by livestock rearers

S.No.	Author	Study area	Climate change induced effects	Adaptation Strategies
1.	Dhanajirao Shrimant Patil (2013)	Maharashtra	Decline in wool quality and quantity in sheep	Reduced flock size
			Increased incidence of disease	Sheep insurance
2.	Luxom et al. (2022)	North Sikkim	Unpredictable events of heavy snowfall and short spells of heavy rainfall, negatively affected the local vegetation utilized for grazing purposes.	Continuation of rotational grazing regime
3.	Pushpendra Yadav (2022)	Karnal district of Haryana	Digestive problem in hot weather	Change in feeding time (early morning and late evening)

			Decrease feed intake in hot humid climate	Feeding specific mineral mixture
			Increase of endoparasite in humid climate	Deworming of dairy animals
4.	Shantharaju et al. (2024)	Karnataka	Alteration of nutritional value in plants/grasses and feed issues	Cultivating drought tolerant variety grasses
5.	Kuchimanchi et al. (2021)	Telangana	Decrease in vegetation in common property resources	Grazing on leased land Purchase fodder from markets and other farmer
6.	Ahmed et al. (2023)	Jammuand Kashmir	Decrease in the pasture in the area and early drying of grassland	Change in Seasonal Migration
7.	Kant et al. (2015)	Rajasthan	Repeat breeding	Provision of goodquality bull
8.	Venkatasubramanian and Ramnarain (2018)	Gujarat	Poor quality and less fodder availability during longer lean periods	Shifting from rearing dairy cattle to goats
9.	Yadav et al. (2022)	Uttar Pradesh	Heat stress symptoms like rise in body temperature, more open-mouth panting with a reduction in feed intake in cattle and buffaloes	Extra bath to cattle and buffaloes
10.	Uma et al. (2017)	Namakkal districtof Tamil Nadu	Reduced conception rate	Cooling of animals after insemination

Table I depicts that heat stress effects on livestock like reduced feed intake, drop in fertility rate and digestive problems were major climate change effects perceived by livestock rearers of different states. Poor quantity and quality of fodder was indirect effect of climate change on livestock production. Adaptation strategies followed to mitigate these effects were simple and not technology based which included alteration in feeding schedule, feeding extra mineral concentrate and extra bathing provided to animals. For fodder shortage problem, most of farmers either purchased fodder from market or other farmers while some farmers were cultivating drought tolerant fodder varieties. Highlanders made changes in their seasonal migration to ensure availability of pasture for their livestock grazing.

IV. CONCLUSION

The melting glaciers, unpredictable rainfall, rising temperatures, stronger and more frequent climate extremes giving all signs of a changing climate. These variability in climatic patterns and its impact on livestock rearers is clearly visible. The anticipated climate change effect on livestock production poses a big concern to livelihood stability of livestock farmers. The animals of poor livestock owners are more vulnerable to climate change due to low adaptive capacity which might result in chronic poverty. Therefore, managing the effects of climate change is very important to achieve sustainable development and equity. With the increasing human population and demand for livestock food products, there is a need to make livestock farming more climate resilient. Appropriate adaptation and mitigation strategies like change in feeding schedule, change in grazing time, livestock insurance etc., suitable for particular region should be followed to strengthen the livelihood security of livestock rearers and promoting their sustainable development amidst climate change effects.

V. POLICY RECOMMENDATION

The highly vulnerable livestock farmers will be the major sufferers of climate change effects owing to high exposure to extreme climatic conditions and low adaptive capacity. The exposure reduction can be done through strategic planning,

development and practices. The government should strengthen the adaptive capacity of livestock rearers through training programs or workshops on climate change, dissemination of innovative cost effective technologies and promoting farmer to farmer extension system. Some policy recommendations accordingly are:

- Organizing climate change awareness workshop for farmers to make them aware about the adverse effects of climate change on livestock and demonstration of adaptive strategies that can be used by them to mitigate these effects.
- Promoting community-based adaptation strategies, where collective action help in resilience-building.
- Besides already available district wise agriculture contingency plan, there should be separate contingency planning for vulnerable locations of the district.
- To overcome feed and fodder shortage, establishment of fodder and seed banks with public private partnership.
- Proper breeding policy for various livestock species.
- As majority of farmers have little access to credit and micro-finance, government should implement farm credit policies for promoting climate-smart livestock initiatives.
- Encouraging farmers for livestock insurance to mitigate mortality risk due to occurrence of extreme climatic events.
- Research on developing innovative and cost effective adaptation strategy should be guided by demands from livestock farmers to limit the negative effects of climate change

VI. DIRECTION FOR FUTURE RESEARCH

The findings of the various studies open the gateway to the horizon of new research endeavours. Some of the possible future research direction is summarized below:

- Research focusing on documentation of indigenous technical knowledge used by livestock rearers to cope up with climate change is notably scarce. Therefore, more studies need to be conducted in this domain.
- Research on cost effective adaptive strategies tailored to local conditions is essential.
- The majority of studies were limited to examine the adaptation strategies followed by the livestock rearers. Therefore, future research could investigate the constraints faced by livestock rearers while adopting the coping mechanisms against climate change.
- Socio-economic studies should be conducted to establish a clear idea of the broader impacts of climate change on livestock-dependent households regarding income, food security, and migration patterns.
- District level mapping of livestock rearers' vulnerability to climate change.
- Research on gender wise impact of climate change should be done to comprehend the relative distribution of resources, constraints and power between gender. Such research work will help to develop more effective climate policies by addressing the needs of women and men separately.
- Study on impacts of several national and state-level climate action programmes and policies should be taken up by academic institutions and need-based changes be made based on the findings of these impact studies.
- The reason behind low adaptive capacity of most of the livestock farmers is costly adaptation strategy. Hence, studies related to estimating cost on adaptation and economics can be very useful for up-scaling adaptation options to larger regions.

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