Indian J Dairy Sci 78(4): 364-369
https://doi.org/10.33785/IJDS.2025.v78i04.010

RESEARCH ARTICLE

Adaptation strategies to climate change followed by the Murrah Buffalo farmers of Haryana

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Received: 24 August 2024 / Accepted: 12 December 2024 / Published online: 23 August 2025

Abstract: Air temperature, humidity, wind velocity and solar radiation are the main climate variables that affect buffalo production in tropical climate. Adaptation is the adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or mitigates negative effects. The Adaptation strategies are an imperative requisite in the current scenario to decrease the negative impacts of climate change in order to maintain sustainable production. Therefore, the present study was undertaken to assess the adaptation strategies followed by the Murrah buffalo farmers to cope with the changing climatic conditions. The current study was carried out in Hisar, Jind and Rohtak districts of Haryana. From each district two blocks were selected randomly and from each block 4 villages were selected randomly, thus 24 villages from the 6 blocks. From each village 15 farmers were selected randomly constituting a total sample size of 360 respondents. Primary data was collected from respondents through a well-structured interview schedule. Feeding during cooler parts of the day, use of concentrates for animal feed, providing chopped fodder, providing fresh and clean drinking water, wallowing/bathing, regular vaccination, shed hygiene, sowing improved varieties of crops and change in crop calendar were the most common followed adaptation strategies by the Murrah farmers to cope with the changing climatic conditions and minimize adverse impacts of climate change on their crop-livestock farming.

Keywords: Climate Change, Adaptation, Crop, Murrah, Haryana

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Introduction

Global warming is likely to impact the productivity of buffaloes due to their sensitivity to temperature changes. India's average temperature has risen by around 0.7°C during 1901–2018 and by the end of the 21st century, average temperature is projected to rise by approximately 4.4°C relative to the recent past (1976–2005 average). Summer monsoon precipitation (June to September) over India has declined by around 6% from 1951 to 2015 and more frequent dry spells (27% higher during 1981–2011) and more intense wet spells during the summer monsoon season (Krishnan et al. 2020). India has experienced more than 2 droughts per decade, on average and the area affected by drought has also increased by 1.3% per decade over the period 1951–2016 (Krishnan et al. 2020). Air temperature, humidity, wind velocity and solar radiation are the main climate variables that affect buffalo production in tropical climate. The negative impact of temperature rise on total milk production for India has been estimated about more than 15 MT in 2050 (Upadhyay et al. 2013). Climate change is likely to aggravate the heat stress in dairy animals, adversely affecting their productive and reproductive performance, incidence of diseases, feed, fodder and water availability (Sirohi and Michaelowa, 2007). As a result, dairy farming in India is highly vulnerable to weather and climate risks, and swift adaptation strategies are necessary to strengthen the resilient capacity of farming systems and maintain sustainable production in the face of climate change risks. The changing weather patterns could eventually result in lower crop yields and more weeds and pests. Changes in rainfall patterns also raise the chance of short-term crop loss, which will eventually result in a decrease in production (Thapliyal and Kulshrestha, 1991; Srivastava et al. 1992). Terminal heat stress is expected to have a negative effect on wheat, whereas rice will be impacted by both temperature and water availability (Swaminathan, 2002). Wheat production in India will decrease by 4-6 million tonnes for every 1°C increase in temperature. Irrigated rice yields are expected to drop by up to 23% in areas where more rain is expected (Aggarwal, 2009). The Haryana state has about 113 Murrah buffalo per square kilometer (highest population density of Murrah buffalo among all the states). It has earned the distinction of being the home of the world famous Murrah buffalo. In the present changing climatic scenario, Rao et al. (2016) assess the climate change vulnerability using 38 indicators and classified 162 districts covering Indo-Gangetic plains. The study result revealed that out of 22 districts in Haryana, 15 districts came in the range of medium to high vulnerability towards climate change. Given the importance of buffalo-based cropping systems in Haryana and the fact that they are better able to cope with climate change than crops, understanding the adaptation strategies followed at farm level will help to assess the degree to which the sector still needs to adapt in order to cope with the anticipated changes. Thus, the present study was designed to assess the climate change adaptation strategies followed by Murrah buffalo farmers of Haryana to cope with the changing climatic conditions.

Methodology

The study was carried out in Haryana's purposefully chosen districts of Hisar, Jind, and Rohtak. Two blocks were chosen at random from each district. Thus, the current study included six blocks: Agroha and Barwala in Hisar district, Pillukhera and Safindo in Jind district, and Meham and Rohtak in Rohtak district. Subsequently, four villages were chosen at random from each selected block, thus a total of 24 villages from 6 blocks. Following that, 15 farmers from each village who have been rearing Murrah buffaloes for at least 10 years and have a minimum herd size of 04 Murrah buffalo were chosen at random. As a result, the current study's overall sample size was 360. A personal interview with observation method was followed with the help of pre-tested structure interview schedule which was prepared according to the objectives of the study. The respondents were contacted at their door steps and/or grazing ground /livestock farm and/or field of crop production. The primary data was collected at the time of interview and the purpose of the study was explained to the respondents. Only one respondent was interviewed at a time. Respondents were asked whether they adopted any measures to cope with the negative impact of climate change and responses were recorded on a two-point continuum, viz. adoption and non-adoption with the scores of 1 and 0 on a prelisted adaptation strategies for the region. Adaptation index score of the respondents on different adaptation strategies was calculated using the formula:

$$\text{Adaptation index score} = \frac{\text{sum of the obtained score}}{\text{maximum obtained score}}$$

Adaptation index score of each sub component having different adaptation strategies was calculated using the formula:

$$\text{Adaptation index score of each subcomponent} = \frac{\text{sum of the adaptation index score of all the statements of the subcomponent}}{\text{Total number of adaptation strategies under each subcomponet}}$$

Results and Discussion

A. Adaptation strategies followed in animal feed and fodder

Almost cent percent of the farmers were preserving wheat and paddy straw fodder in the form of piling up with an index score of 1.00 as displayed in the Table 1. Majority of them stored crop residues/straw in the open areas unprotected which is being exposed to weather vagaries, i.e., hot sun, snow, wind, rain etc causing wastage of fodder, reducing its nutritional value, short shelf life and also making straw unpalatable to animals. Only few respondents stored the wheat and paddy husk/bran in a proper enclosed area like shed/room. None of them was preparing silage from the fodder which is available surplus during winter and monsoon season to meet the fodder scarcity in the summer and lean periods. Similar results were found in a study conducted on fodder and feed availability for livestock in Haryana (Roy et al. 2020)

The Table 1 clearly depicts that almost cent percent of the respondents was feeding concentrate feed to their animals with an index score of 1.00. The most commonly used feeds include *Kal, Ghehu Dhalia* (Broken pieces of wheat), *chana ka churi* (chickpea flour), *maiti* (fenugreek), bajra, soyabean, maize apart from oil cakes. These concentrate feeds in the range of 2-5 kg were mostly boiled along with oil seed cakes and were fed two times daily to the animals. Though recommendation is 2 kg concentrate per litre of milk produced, only negligible were following this proportion. A study by Pankaj et al. (2013) has recommended feeding of concentrate mixture (18% DCP and 70% TDN) prepared with locally available feed ingredients for animals to compensate for less roughage intake due to thermal stress to maintain energy balance and when no green fodder is available, the addition of vitamin supplement in concentrate mixture helps in mitigating heat stress.

As shown in Table 1, almost cent percent of the respondents were following the feeding schedule at cooler parts of the day with an index score of 1.00. The feeding schedule followed by farmers at the field level was

Early morning: 2 times feeding- 1st feeding of grass/fodder at 4 a.m.-5 a.m. and 2nd feeding of concentrate (including oil cakes) at 6 a.m.-7 a.m.
Late evening: 2 times feeding- 1st feeding of grass/fodder at 4pm-5pm and 2nd feeding of concentrate (including oil cakes) at 5 p.m.-7 p.m. Pankaj et al. (2013) in their study have also recommended this practice of feeding during cooler parts of the

day as a nutritional adjustment strategy to ameliorate the heat stress. Due to the already heavy thermal loads on the animal and extreme humid temperatures during the day time, animal will reduce its feed intake especially roughages. So, feeding during cooler parts of the day enables the animals to consume almost 80% of their total dry matter intake.

B. Adaptation strategies followed in management practices

Hot humid conditions create an excessive headload on the buffaloes which are highly sensitive to heat and are difficult to dissipate the excess heat. Heat stress will affect both reproductive and production potential of the animals, so implementing proper management practices at the farm can help to minimize some of the negative effects of heat stress.

Increased water consumption is a major response to thermal stress. Cent percent of the respondents were providing fresh and clean drinking water round the clock to the animals as displayed in the Table 2. Drinking water was supplied to animals on an average of 3-5 times a day. Dairy cows in general need roughly 3-4 liters of water per liter of milk produced. Cold drinking water in rumen further increases feed intake by 24%. Drinking water has distinct effect on animal comfort by direct cooling in the reticule-rumen (Bianca, 1964), and by helping as the chief vehicle for heat transfer and dissipation through sweating and panting. Therefore, facility has to be made for supply of incessant clean, fresh and cool water to the animals.

It is evident from the Table 2 that all farmers adopted wallowing/bathing of animals during summer with an index score of 1.00. Most of the study villages have village level ponds (*thalaap*) where the animals were taken for wallowing for 2-4 times in a day, usually early morning, before noon and late in the evening. Buffaloes, due to their black skin and far less number of sweat glands than cows, particularly like to wallow in water for easing of heat stress (Aggarwal and Singh, 2008). Results depicted in the Table 2 reveal that changing micro climate in the shed/stall was adopted nearly by cent percent except few marginal/small dairy farmers with an index score of 0.91. Respondents were using mostly the fan or cooler during almost entire summer except on the days/hours when there is temperature drop due to rain. Air movement is an important factor in the relief of heat stress, fans can be installed if natural airflow is not sufficient, forced ventilation by fans is a very effective method for lowering the temperature (Debbarma et al. 2022, Parkes et al. 2022).

C. Adaptation strategies followed in animal health and disease

Table 1: Adaptation strategies followed by respondents in animal feed and fodder (n=360)

Sl. No.	Statements	Index score	Rank
1	Using improved/multicut varieties of fodder crops	0.79	IV
2	Preserving fodder in the form of hay, silage, storing crop residues/straw	1.00	I
3	Use of unconventional resources as feed: The existing waste products like vegetable waste, fruit pulp waste, cakes after ousting oil etc.	0.87	III
4	Using concentrates to maintain productivity and body weight of animal	1.00	I
5	Minerals and feed additives: Providing minerals like K, Na, Mg etc. and feed additives like vitamin supplements, mineral mixture etc. to reduce heat stress, maintain productivity and health	0.41	V
6	Change in feeding schedule: providing ration during cooler parts of day i.e., early morning and late evening	1.00	I
7	Providing chopped fodder to avoid wastage	0.92	II

Table 2: Adaptation strategies followed by respondents in management practices (n=360)

Sl. No.	Statements	Index score	Rank
1	Changing micro climate in shed/stall: Use of fans/sprinkler/mist during summer	0.91	II
2	Planting trees to provide shade, protect from direct sunlight and hot winds	0.80	III
3	Providing clean and fresh drinking water at frequent intervals during summer	1.00	I
4	Cooling ponds/wallowing/bathing during summer	1.00	I
5	Use of bedding materials and covering windows or open spaces during winter	0.91	II
6	Use of gunny bags as curtains hanged on the sides of shelter and frequent sprinkling of water on gunny bags	0.086	IV

Though with the strong veterinary infrastructure of Haryana at village level and yearly free vaccination drive for Foot-and-Mouth disease (FMD) and Haemorrhagic Septicemia (HS) at the farmers doorstep, around two third of farmers have adapted vaccination in their herd with an index score of 0.66 as show in the Table 3. Upon discussion with respondents, key informants and veterinarians revealed that vaccination is very low for the animals in pregnancy which is around 40-50 percent. The vaccination rate for the animals in milk is around 50 percent, reason being reduction in milk yield for 15-20 days after vaccination so animals which are at peak yield are not vaccinated and also animals at late milking stage after 7-8 months which are giving already less milk will also be reduced due to vaccination. Calves are vaccinated more than 90 percent and so are heifers which are vaccinated in the range of 80-90 percent. Respondents who have vaccinated reported that there is almost no case of any major diseases in their cattle after vaccination and the delay or no vaccination further increase disease incidence in the herd. Study conducted Madhya Pradesh and Assam in Kanha and Bandhavgarh region of Madhya Pradesh; and Kaziranga region of Assam had also found that the majority of respondents in all three regions were aware of FMD, HS and Black quarter (BQ). Further 51%, 50%, and 31% of respondents (from Kanha, Bandhavgarh and Kaziranga respectively) reported vaccination of their livestock was well below any threshold for effective population level disease control (Hopker et al. 2021). Low level of knowledge regarding vaccinations regading the same diseases was found in a study in Cambodia (Young et al. 2017).

It is clear from the Table 3 that deworming was adopted even by less percentage of farmers with an index score of 0.42. Further discussions with respondents revealed that most of the farmers were not even aware of it and few have not considered its significance in animal growth and development. Deworming is considerably adopted more in the calves than any other category of animal and almost not adopted in pregnant animals. Farmer have also told that they go for deworming only when the animal is weak, not eating feed and fodder properly. Fenbendazole and albendazole are the tablet names recalled by farmers they were using. Deworming is practiced at varying rates i.e., calf dewormed after 15 days of birth and if noticed any further signs again deworming at every 30 days for calf up to 2 years of age; yearly twice deworming after 2 years of age; few are following yearly 3-4 times deworming. Summer monsoon is the season where famers felt calf become weak due to worms so deworming is done mostly during this period. A study by Chander et al. (2015) concluded that there was lack of awareness and poor adoption of deworming due to various constraints faced by farmers in deworming their

Table 3: Adaptation strategies followed by respondents in animal health and disease (n=360)

Sl. No.	Statements	Index score	Rank
1	Regular vaccination for disease prevention	0.66	I
2	Deworming of animals at optimum intervals	0.42	II
3	Fogging with herbs like neem leaves to prevent vectors like mosquitoes, flies etc.	0.27	III

Table 4: Adaptation strategies followed by respondents in animal housing/shelter (N=360)

Sl. No.	Statements	Index score	Rank
1	Use of rubber mats for animals	0.60	III
2	Proper disposal of dung, urine, drainage facility and hygiene maintenance in animal shed etc.	0.72	I
3	Use of mosquito nets around shelter and better aeration and proper ventilation facilities in the shed	0.69	II

Table 5: Adaptation strategies followed by respondents in major crops (n=360)

Sl. No.	Statements	Index score	Rank
1	Change in crop calendar: change in sowing time, irrigation schedule, harvesting time	0.49	II
2	Crop diversification	0.02	V
3	Sowing of improved crop varieties/seeds	0.89	I
4	Preventing straw burning	0.26	III
5	Balanced and timely application of fertilizers	0.14	IV

livestock herd. Even animals in Barishal district of Bangladesh were reared without the practice of deworming showning lack of awareness towards it (Sayed et al. 2022).

D. Adaptation strategies followed in animal housing/shelter

Table 4 shows that proper disposal of dung, urine, drainage facilities and cattle shed hygiene maintenance were maintained by respondents in the study region with an index score of 0.72. Use of rubber mats by most of them enabled easy removal of cow dung and slight downward slope of cattle shed surface with cow mat enabled easy flow of urine without stagnation/absorption straight to the gutter/channel provided at the rear end of shed. The hygiene maintenance was very poor in case of those who did hot have cattle shed or proper well-planned shed. Also the places where cow mat was not used, the animals used to rest on undulated soil surface having moisture, cattle waste of dung and urine etc. which caused stress and increased the chances of infection to the herd.

The use of mosquito nets around shelter and better aeration and proper ventilation facilities in the shed was adopted by the respondents with an index score of 0.69 as revealed from the Table 4. Most of the respondents have their cattle sheds attached to their homes or very nearby homes which is hindering the animals from having fresh and open-air atmosphere which might create additional stress during humid summers. Most of the cattle sheds did not have windows, open areas to the shed except at the one side of entrance. Few of them have planted trees surrounding the shed for ventilation. Forced ventilation using fan and or cooler was also provided by the respondents during summers. Cattle sheds were also covered with fixed mosquitoes' nets for control of flies, mosquitoes etc.

It can be observed from the Table 4 that around three fifth of them were using the rubber mats for the animals in their cattle sheds with an index score of 0.60. When asked for the reasons of adopting cow mats, farmers expressed that due to heavy weight of Murrah buffalo these rubber mats provide non slippery surface thereby reducing injuries to their feet and knees, easy to clean and disinfect as it will not absorb any liquid or other dust, relieves stress on the animals providing better comfortable surface while resting of animal. Similar findings were highlighted by Ji et al. (2020) and Galán et al. (2018).

E. Adaptation strategies followed in major crops

The results displayed in the below Table 5 indicate that majority of the farmers adopted the improved varieties in the study region with an index score of 0.89. The improved crop varieties as reported by farmers were WH-711, WH-912, HD- 2967, C-306, HD-3086, DBW-187, DBW-222, WH-1184 in wheat crop and PR-1121, Basmati HBC-19, Basmati-30, PR-114, PR-111, CR dhan-408, Pusa Basmati -1509, Pusa Basmati-1718 in paddy crop. Release of suitable varieties from time to time by universities and research institutes, high land holding sizes, availability of water and awareness levels, besides the timely supply of quality seeds to the farmers at the right place and at reasonable prices by the Haryana Seed Development Corporation (HSDC) and Haryana Seed Certification Agency might be the reasons for this. Results are in line with the findings of Singh (1989) and Chauhan and Chamola (2002).

An efficient adaptation strategy to prevent agricultural yield loss and reduced water use in a changing climate may involve adjusting crop calendars. Table 5 reveals that therespondents in the study areas practiced the change in crop calendar over the years with an index score of 0.49, due to changing climatic conditions. Similar findings were reported by Wang et al. (2022) in their study in Indo-Gangetic plain of India and Bangladesh. The results showed that crop calendar modification has tremendous potential to reverse yield loss caused by temperature rise and reduced water requirement by utilising monsoon precipitation, despite the short time gap between harvest of kharif crops and (trans-) planting of rabi crops. The study also noted a growing trend toward early planting rabi wheat to reduce heat stress during the reproductive stage and earlier planting of kharif rice to take advantage of monsoon precipitation which prevent kharif rice from suffering from cold stress during anthesis and enable earlier wheat sowing.

Conclusions

Adaptation strategies in the midst of climate change to reduce the negative impacts of climate change are the need of the hour to maintain sustainable production. Feeding during cooler parts of the day, use of concentrates for animal feed, providing chopped fodder, providing fresh and clean drinking water, wallowing/ bathing, regular vaccination, shed hygiene and sowing improved varieties of crops are the mostly followed adaptation strategies by the farmers in the study region to cope with the changing climatic scenarios. Successful adaptation strategies that reduce the risks associated with climate change, or vulnerability to climate change impacts, to a predetermined level, without compromising economic, social, or environmental sustainability needs to be identified and upscaled on a priority basis to build the resilient capacity of dairy farmers. Regular training and awareness programmes for the farming community may have significant effect on improving the adoption levels of the climate resilient dairy farming practices.

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