Effect of microclimatological changes on dairy cattle production under the coastal climate of Goa

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ABSTRACT
It was observed that in Deoni and Cross bred cow daily change of relative humidity, maximum temperature and minimum temperatures had significant (P < 0.01) effect on daily milk yield of cow. It was inferred that the effect was more pronounced on cross bred cows than that of Deoni and Sahiwal cows. Between the two indigenous cows effect of micro climatological changes was more pronounced on Deoni breed than Sahiwal breed of cow. It was also observed that overall daily milk yield was reduced by 1 g (P > 0.05), 6 g (P > 0.05), 22 g (P > 0.05) and 78 g (P < 0.01) per unit increase of air temperature, relative humidity, temperature humidity index and maximum temperature respectively while data were analyzed as a whole considering all the cows of all the breeds together. Economic losses resulting from temperature-induced reductions in production may justify mitigation of these temperature increases through changes in management practices such as installation of sprinklers in sheds, evaporative cooling of barns, feeding and nutritional strategies, and/or selection of more heat-tolerant animals. So, risk management, by considering perceived thermal challenges, then assessing the potential consequences and acting accordingly, will reduce the impact of such challenges.

Key words: Breeds, Cattle, Milk production, Microclimate.

INTRODUCTION
Livestock is an integral part of agriculture in India more particularly in this state as most of the people due to multifarious reasons depend on the animals for their economic support. Climate change poses formidable challenge to the development of livestock sector in India. The rise in temperature between 2 to 3°C over the entire country together with increased humidity resulting from climate change is likely to aggravate the heat stress in dairy animals and non ruminants affecting the milk yield and growth of animal. Due to rapid growth of human population, demand for milk and meat is increasing day by day. India possesses second largest number of cattle (16% of world population) and largest number of buffaloes (57% of world population) in the world.

It is reported sporadically in different countries of the world including India that climate change has adverse effect on livestock productivity, particularly on milk production and growth which is reflected in meat production indirectly. At a temperature of 29°C and 40% relative humidity the milk yield of Holstein, Jersey and Brown Swiss cows was 97, 93, and 98% of normal, but when relative humidity increased to 90%, yields were 69, 75, and 83% of normal (Bianca, 1965). St-Pierre et al. (2003) estimated a total economic annual loss incurred by the US farm animals due to heat stress at between 1.69 and 2.36 billion US dollars. About 58% of this occurs in the dairy industry, 20% in the beef industry, 15% in pigs and the remaining 7% in the poultry industry. Quantification of these potential impacts of climate on livestock production allows producers to gain better understanding of the magnitude of the changes in production levels and potential indicators of livestock response, on which to base management actions. Economic losses resulting from temperature-induced reductions in production may justify mitigation of these temperature increases through changes in management practices such as installation of sprinklers in sheds, evaporative cooling of barns, feeding and nutritional strategies, and/or selection of more heat-tolerant animals. So, the object of this study is to quantify the effect of micro climatological changes on milk production of dairy cattle in hot and humid climatological condition of Goa.

MATERIALS AND METHODS
Five lactating animals of each of the Sahiwal, Deoni and Crossbred of Jersey and Red Sindhi of 3-4 th lactation were taken from institute farm for this study. Study was continued for a period of one year. Cows were kept in RCC semi open house with East – West orientation. Standard feeding and management practices were followed. Kadwa kutty was fed as dry fodder @ 5-6 kg / cow / day. Hybrid napier CO3 variety fodder was fed @ 7 - 8 kg / head / day. Concentrate mash feed was provided @ 6-7 kg / cow / day.

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Composition of feed was maize crust 40%, rice bran 25%, Cotton seed cake 18%, groundnut cake 15%, mineral and vitamin mixture 1.5% and common salt 0.5%. Regular deworming was done twice a year before and after rainy season. Routine immunization was done against HS, BQ and FMD. Regular data on milk yield of individual cow were recorded twice daily at 7:00 am in the morning and 4:00 pm in the evening. Daily meteorological parameters were recorded in the morning at 9:00 am as per standard method (IMD, 1994). Relative humidity was calculated from standard psychometric table. Temperature humidity Index (THI) was calculated as per West (1994). Experiment was carried out in RBD for a period of one year. Data were analyzed statistically as per Snedecor and Cochran (1994) using SPSS package version 10.1. Multiple regression analysis and one way analysis of variance was carried out.

**RESULTS AND DISCUSSION**

Multiple regression analysis revealed that none the microclimatalogical components had significant effect on daily milk yield, weekly average milk yield and monthly average milk yield in Sahiwal cows. However, in Deoni and Cross bred cow daily change of relative humidity (RH), maximum temperature (T maximum) and minimum temperatures (T minimum), had significant (P < 0.01) effect on daily milk yield of cow. It was found that milk yield in Deoni cow was decreased by 1 g (P > 0.05), 9 g (P < 0.01), 42 g (P > 0.05) and 70 g (P < 0.01) per unit increase of air temperature (AT), relative humidity (RH), temperature humidity index (THI) and maximum temperature (T maximum). Similarly in crossbred cows daily change of relative humidity, maximum and minimum temperature had significant influence on the daily milk yield. It was found that milk yield in crossbred cows was reduced by 1 g (P > 0.05), 44 g (P < 0.01), 65 g (P > 0.05) and 234 g (P < 0.01) per unit increase of AT, RH, THI and T maximum respectively (Table 2).

Negative correlation between milk yield of Sahiwal, crossbred cows and THI was reported by Singh and Upadhyay (2009). They reported that milk yield was reduced by 0.43 l/it/day cow in crossbred cows and 0.16 l/it/day cow in Sahiwal cows per unit increase of THI. So our present findings corroborates with their findings. Ravagnolo et al (2000) also reported similar finding who informed that daily milk yield was reduced by 0.2 kg per unit increase of THI above 72. Shinde et al (1990); Kulkarni et al (1998) and Mandal et al (2002a) also reported that milk yield of crossbred cows were negatively correlated with THI and the average daily milk yield of crossbred cows in the hot humid eastern part of the country were significantly reduced by even rise of minimum temperature. Kohli et al (2014) also reported that in high yielding crossbred cows there was a significant decrease of milk yield when THI was above 80.

So, it was inferred that the effect was more pronounced on cross bred cows than that of Deoni and Sahiwal cows. Between the two indigenous cows effect of microclimatalogical changes was more pronounced on Deoni breed than Sahiwal breed of cow. It was also observed that overall daily milk yield was reduced by 1 g (P > 0.05), 6 g (P > 0.05), 22 g (P > 0.05) and 78 g (P < 0.01) per unit increase of AT, RH, THI and T maximum respectively while data were analyzed as a whole considering all the cows of all the breeds together (Table 1).

Weekly change of average air temperature, average RH, average THI, average maximum and minimum temperature had no significant effect on weekly average milk yield of cows in any breed. It was observed that overall weekly average milk yield was reduced by 49 g (P > 0.05), 121 g (P > 0.05) and 213 g (P > 0.05) per unit increase of RH, THI and T maximum respectively (Table 2).

Similarly monthly change of average air temperature, average relative humidity, average temperature humidity index, average maximum and minimum temperature had no significant (P > 0.05) effect on monthly

| Table 1: Effect of microclimatalogical changes on daily milk yield of cows |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| $Y_1 = 4.94 - 0.001 x + 0.008 x_2 - 0.012 x_3 + 0.045 x_4 - 0.024 x_5$ |
| $Y_2 = 5.01 - 0.001 x - 0.009 x_2 - 0.042 x_3 - 0.070 x_4 + 0.124 x_5$ |
| $Y_3 = 13.47 - 0.0001 x - 0.044 x_2 - 0.065 x_3 - 0.234 x_4 + 0.360 x_5$ |
| $Y_4 = 9.18 - 0.001 x - 0.006 x_2 - 0.022 x_3 - 0.078 x_4 + 0.005 x_5$ |

Where $Y_1$ = Daily Milk Yield in Sahiwal cows, $Y_2$ = Daily Milk Yield in Deoni cows, $Y_3$ = Daily Milk Yield in Cross bred cows, $Y_4$ = Overall Daily Milk Yield in cows, $x_1$ = Daily Air Temperature, $x_2$ = Daily Relative Humidity, $x_3$ = Daily Temperature Humidity Index, $x_4$ = Daily Maximum Temperature, $x_5$ = Daily Minimum Temperature.

| Table 2: Effect of microclimatalogical changes on weekly milk yield of cows |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| $Y_1 = 1.97 + 0.722 x_1 + 0.024 x_2 + 0.064 x_3 - 0.373 x_4 - 0.494 x_5$ |
| $Y_2 = 5.59 + 0.151 x_1 + 0.022 x_2 - 0.075 x_3 + 0.178 x_4 + 0.090 x_5$ |
| $Y_3 = 26.28 + 0.362 x_1 - 0.095 x_2 - 0.186 x_3 - 0.527 x_4 + 0.361 x_5$ |
| $Y_4 = 17.39 + 0.079 x_1 - 0.049 x_2 - 0.121 x_3 - 0.213 x_4 + 0.218 x_5$ |

Where $Y_1$ = Weekly Average Milk Yield in Sahiwal cows, $Y_2$ = Weekly Average Milk Yield in Deoni cows, $Y_3$ = Weekly Average Milk Yield in Cross bred cows, $Y_4$ = Overall Weekly Average Milk Yield in cows, $x_1$ = Weekly Average Air Temperature, $x_2$ = Weekly Average Relative Humidity, $x_3$ = Weekly Average Temperature Humidity Index, $x_4$ = Weekly Average Maximum Temperature, $x_5$ = Weekly Average Minimum Temperature.
average milk yield of cow in any of the breed. However, monthly average milk yield of cow was reduced by 1.002 l, 1.136 l and 1.769 l in Sahiwal. Deoni and Crossbred cow per unit increase of monthly average air temperature respectively. Monthly average milk yield of cow was reduced 18 ml, 29 ml and 80 ml in Sahiwal. Deoni and Crossbred cow per unit increase of monthly average relative humidity respectively. Monthly average milk yield of cow was reduced by 127 ml, 235 ml and 492 ml in Sahiwal. Deoni and Crossbred cow per unit increase of monthly average temperature humidity index (THI) respectively. So, the effect of monthly average change of air temperature, relative humidity and temperature humidity index was more pronounced on crossbred cows than indigenous cows and between two indigenous cows effect was more pronounced on Deoni breed than Sahiwal breed of cow. It indicated highest adaptability of Sahiwal cow under the existing housing, management and environmental condition. Overall monthly average milk yield was reduced by 1.839 l (P > 0.05), 20 ml (P > 0.05) and 185 ml (P > 0.05) per unit increase of monthly average air temperature, monthly average RH and monthly average THI respectively (Table 3).

It was also observed that there was significant (P < 0.05) effect of season on average milk yield of cow in all the breeds due to significant variation of temperature, maximum temperature, minimum temperature, relative humidity and temperature humidity index between the seasons. It was seen that in Deoni and crossbred cow average daily milk yield was highest in rainy season, whereas in Sahiwal cow maximum yield was observed in winter season (Table 4). Significantly (P < 0.05) lower milk yield was found in summer season than that in rainy and winter season in crossbred cow. Similarly, significantly (P < 0.05) lower milk yield was found in summer season than that in winter season in Sahiwal and crossbred cows.

In cattle shed of our institute in the year 2010, highest air temperature was observed in May i.e. 30.46 °C with an average value of 27.64 °C. Highest THI (86.56) and highest minimum temperature (28.25 °C) were also found in May. Overall mean value of THI and minimum temperature in the year 2010 were recorded to be 79.38 and 24.56 °C respectively. Maximum relative humidity was observed in July (91.41 %) with an average value of 82.17%. Highest maximum temperature was observed in March (32.97 °C) with an average value of 30.79 °C. ANOVA of microenvironmental parameters indicated significant differences between the months.

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Table 3: Effect of microclimatological changes on monthly milk yield of cows

<table>
<thead>
<tr>
<th>Breed</th>
<th>Winter (1)</th>
<th>Summer (2)</th>
<th>Rainy (3)</th>
<th>Overall Mean</th>
<th>F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sahiwal</td>
<td>5.51 ± 0.10 (338)</td>
<td>5.02 ± 0.07 (449)</td>
<td>5.39 ± 0.12 (612)</td>
<td>5.30 ± 0.06 (1399)</td>
<td>5.28 *</td>
</tr>
<tr>
<td>Deoni</td>
<td>1.63 ± 0.04 (214)</td>
<td>1.91 ± 0.09 (86)</td>
<td>1.96 ± 0.06 (122)</td>
<td>1.78 ± 0.03 (422)</td>
<td>13.45 **</td>
</tr>
<tr>
<td>Crossbred</td>
<td>5.96 ± 0.11 (522)</td>
<td>4.89 ± 0.06 (776)</td>
<td>6.18 ± 0.09 (1040)</td>
<td>5.70 ± 0.05 (2338)</td>
<td>62.76 **</td>
</tr>
</tbody>
</table>

Table 4: Average daily milk yield of different breeds of cows in different seasons

REFERENCES


