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Effect of Orientation, Ventilation, Floor Space Allowance and Cooling Arrangement on Milk Yield and Microclimate of Dairy Shed in Goa

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ABSTRACT

Ten farmers consisting of large, medium, small and marginal from each of six talukas ie Pernem, Bicholim and Ponda taluka of North Goa district; Salcete, Canacona and Sanguem talukas of South Goa district in total sixty farmers were considered based on cattle population for this study. Farmers were interviewed for collecting information on housing and production aspect of dairy cattle. Subsequently farmers were grouped according to type of dairy house. Data on microenvironment of cattle shed and milk yield of cows were recorded on daily basis. Data analysis revealed that the orientation, ventilation, floor space provision and cooling arrangement had a significant effect on average daily milk yield and microenvironment of dairy shed. Significantly higher milk yield and lesser heat stress were observed in east – west orientation, good ventilation and standard floor space of minimum 5 m^2 per cattle. Further cooling arrangement in cattle shed had a highly significant ($P < 0.01$) effect on average daily milk yield and microenvironmental parameters revealing that if false ceiling is made inside cattle shed besides manual and mechanical cooling animals would feel more comfort resulting in higher milk production.

Keywords: Cooling, dairy cattle, floor space, milk yield, orientation, ventilation

Livestock is an integral part of agriculture in India more particularly in the state of Goa as most of the people due to multifarious reasons depend up on the animals for their economic support. Livestock contributes around 6 % to National GDP and 25 - 26 % to Agricultural GDP. As per basic animal husbandry statistics (2012), total cattle population in India is 199 million; total buffalo population is 105 million with total bovine population of 304 million. Animal husbandry and agriculture are not competitive rather complementary to each other.

Dairy housing systems have significant impact on the dairy production, overall health and longevity of dairy cattle. Housing systems have been transformed from pasture-based systems to indoor housing systems with limited outdoor access. Housing management, in reality, is the manipulation of the animal environment to promote the most efficient production of meat, milk and wool. A better understanding of micro climate of shed will greatly enhance managerial capabilities. Several management practices are available to ameliorate heat stress, each with positive and negative properties.

Housing provides the most potential control over micro-climatological parameters; however, it comes at a relatively high initial investment cost per head. In present times, the main focus is on cow comfort, which will increase the milk production and eliminate many animal health problems. The most common measure taken by the Japanese farmers to reduce the temperature effect on dairy farms was to improve the building construction (Nomiyama *et al.,* 1981), since it is proved beyond doubt that high temperature and high humidity is deleterious to milk production (Lurdi, 1982). Thiagarajan and Thomas (1990)

also found that proper housing helped in reducing the extremes of different climatic stressors such as maximum and minimum air temperatures. Shades can improve animal comfort and productivity and should be designed properly to reduce heat stress. Good housing systems are those that are well designed for ease of management and maintenance at all times. So, this study was undertaken with the objective to develop suitable housing system in order to enhance the comfort and productivity of dairy cattle under the agro climatic condition of Goa.

MATERIALS AND METHODS

Sixty farmers spread over six talukas of Goa, namely Pernem, Bicholim and Ponda taluka of North Goa district; Salcete, Canacona and Sanguem talukas of South Goa district, were considered for the present study based on cattle population.

Ten farmers consisting of very large, large, medium, small and marginal from each taluka were considered randomly and interviewed for collecting information on dairy production system such as system of management, type of cattle shed, orientation of shed, ventilation system, height of roof, roofing material, floor material, drainage system, floor space provision, cooling system, breed of animal, feeding status and health status of animal etc. Afterwards twenty four farmers were selected randomly considering four from each taluka. Two types of orientation of shed ie east - west and north - south were considered for the study. Likewise, two types of shed ventilation were studied i.e. good ventilation which was characterized by proper height of shed & facility of cross ventilation and poor ventilation which was characterized by low height of shed & lack of cross ventilation. Moreover two types of shed were considered one with standard floor space of minimum 5 m^2 per cattle and another having lesser than 5 m^2 floor space per cattle. Further, the cooling arrangement in the cattle shed were of four types, manual cooling only (A), mechanical cooling only (B), manual cooling and arrangement of false ceiling (C), manual cooling, mechanical cooling and arrangement of false ceiling (D).

Digital hygrometer, dry bulb – wet bulb and maximum – minimum thermometer were installed in sheds and farmers were trained for recording the data. Data on microclimate was recorded regularly in the morning as per Indian Meteorological Department (1994). Temperature Humidity Index (THI) was calculated as per West (1994). Relative humidity was calculated as per standard psychrometric table. Data on daily milk yield of cows were recorded twice daily as per standard procedure. Each farmer's house was visited regularly for monitoring production, reproduction, health aspect of animal and data recording. Data were analyzed statistically as per Snedecor and Cochran (1994) using SPSS package to find the effect of housing on milk production and microenvironment of dairy shed.

RESULTS AND DISCUSSION

Effect of Orientation on milk yield and microclimate of dairy shed

The orientation of cattle shed had a significant ($P < 0.05$) effect on average daily milk yield, air temperature and relative humidity, while a highly significant effect ($P < 0.01$) on average daily temperature humidity index was observed (Table - 1). Average daily milk yield was significantly higher in the cattle shed having east – west orientation (9.720 ± 0.093 kg) than the cattle of north - south orientation shed (9.470 ± 0.085 kg). The results obtained could be attributed to the reason that east – west orientation reduces the direct entry of solar radiation inside the shed which ultimately helps to keep the shed cool and provide maximum comfort to the animal resulting in higher milk production. Alignment of the long-axis in an east-west direction achieves the maximum amount of shade under the structure and is the preferred orientation for confined animals (Bianca, 1964). Buffington and Collier (1983) have also mentioned that the preferred orientation is east-west for hot climates, i.e. the long axis of the building runs in an east-west direction with shed height of 3.65 m and shading efficiency not lower than 85%. Samer (2010) also advocated that shade structure should be oriented east - west where the largest area of the structure should face the prevailing summer winds to allow better aeration.

Effect of ventilation on milk yield and microclimate of dairy shed

Data analysis revealed that ventilation of cattle shed had a highly significant ($P < 0.01$) effect on average daily milk yield, while significant effect ($P < 0.05$) on air

temperature, relative humidity and temperature humidity index was recorded (Table - 2). It was observed that significantly higher milk yield (9.896 ± 0.090 kg), lower air temperature (27.62 ± 0.13 ^{0}C) and relative humidity (79.43 ± 0.35 %) were observed in cattle shed having good ventilation compared to the shed with poor ventilation. In conformity to present findings Meenakshisundaram *et al* (2009) reported that in poor type of house where ventilation was poor relative humidity was found to be significantly higher than that of good type of cattle house where ventilation was good. Good ventilation causes minimal interference with convective and evaporative heat loss from the animals, thus allowing natural air movement to carry heat and moisture away from the surface of the animals. Ventilation of shed depends on height, width and slope of the roof (Bianca, 1964).

Table 1. Effect of orientation on milk yield and microclimate of dairy shed Parameters East-West Orientation North-South Orientation F Value

Parameters	East-West Orientation	North-South Orientation	F Value
Av. daily milk yield (Kg)	9.720 ^{a} ± 0.093	9.470 ^{b} ± 0.085	9.56 *
Av. daily air temperature (°C) 27.81 ^{b} ± 0.12	28.05 ^{a} ± 0.10	7.12 *	
Av. daily relative humidity (%)	77.15 ^{b} ± 0.60	79.42 ^{a} ± 0.36	8.97*
Av. daily THI 77.72 ^{b} ± 0.31	79.02 ^{a} ± 0.16	21.94 **	

Means having different superscripts in a row differ significantly (P < 0.05), *P < 0.05, **P < 0.01

Table 2: Effect of ventilation on milk yield and microclimate of dairy shed

Parameters	Good Ventilation	Poor Ventilation	F Value
Av. daily milk yield (Kg)	9.896 ^{a} ± 0.090	8.445 ^{b} ± 0.081	125.727 **
Av. daily air temperature (°C)	27.62 ^{b} ± 0.13	27.93 ^{a} ± 0.09	5.023*
Av. daily relative humidity (%)	79.43 ^{b} ± 0.35	80.70 ^{a} ± 0.44	6.786 *
Av. daily THI	79.12 ^{a} ± 0.18	78.05 ^{b} ± 0.19	4.251*

Means having different superscripts in a row differ significantly (P < 0.05), *=> P < 0.05, ** => P < 0.01

Effect of floor space on milk yield and microclimate of dairy shed

The floor space provision inside cattle shed revealed that it had highly significant (P < 0.01) effect on average daily milk yield, air temperature, relative humidity and temperature humidity index (Table 3). It was observed that average daily milk yield (9.736 ± 0.085 kg) was significantly higher in the cattle shed where standard floor space of minimum 5 m^2 per cattle was maintained. Meenakshisundaram *et al* (2009) reported that in poor type of cattle house where floor space provision was 2.61 m^2 per cow, relative humidity was found to be significantly higher than that of good type of cattle house having floor space of 3.84 m^2 per cow. In France, even under the temperate conditions, Brouillet and Raguet (1990) suggested a floor space allowance of 6 m^2 per cow. The restriction of floor area adversely affected the behavior of cows (Stergarrdoe *et al*., 1986).

Table 3: Effect of floor space on milk yield and microclimate of dairy shed Parameters Standard Floor Space Poor Floor Space F Value

Parameters	Good Ventilation	Poor Ventilation	F Value
Av. daily milk yield (Kg)	9.736 ^{a} ± 0.085	8.184 ^{b} ± 0.090	65.897 **
Av. daily air temperature (°C)	28.07 ^{a} ± 0.12	27.23 ^{b} ± 0.11	15.261 **
Av. daily relative humidity (%)	79.88 ^{b} ± 0.37	81.09 ^{a} ± 0.43	7.681 **
Av. daily THI	79.49 ^{a} ± 0.20	78.43 ^{b} ± 0.17	6.294 **

Means having different superscripts in a row differ significantly (P < 0.05), ** => P < 0.01

Effect of cooling arrangement on milk yield and microclimate of dairy shed

Table 4. Effect of cooling on milk yield and microclimate of dairy shed Parameters A B C D F Value

Parameters	A	B	C	D	F Value
Av. daily milk yield (Kg)	9.570 ^{b} ± 0.077	9.070 ^{c} ± 0.132	9.265 ^{bc} ± 0.069	10.692 ^{a} ± 0.033	7.554 **
Av. daily air temperature (°C)	28.30 ^{a} ± 0.11	27.35 ^{b} ± 0.12	28.26 ^{a} ± 0.10	26.61 ^{c} ± 0.08	8.790 **
Av. daily relative humidity (%)	78.65 ^{c} ± 0.42	79.50 ^{c} ± 0.52	85.02 ^{b} ± 0.32	90.43 ^{a} ± 0.38	25.639 **
Av. daily THI	79.90 ^{ab} ± 0.22	78.53 ^{c} ± 0.24	80.77 ^{a} ± 0.16	76.62 ^{d} ± 0.14	21.157 **

Means having different superscripts in a row differ significantly ($P < 0.05$), ** => $P < 0.01$

Figure 1. Cattle shed having false ceiling of arecanut stems besides fitted electric fan

Cooling arrangement in cattle house had highly significant ($P < 0.01$) effect on average daily milk yield and all the microenvironmental parameters (Table 4). It was observed that average daily milk yield (10.692 ± 0.033 kg) was highest while air temperature (26.61 ± 0.08 ^{0}C) and temperature humidity index (76.62 ± 0.14) were lowest in the cattle shed where false ceiling was done by arecanut stem besides manual and mechanical cooling by electric fans (Fig. – 1). However relative humidity was lowest in the shed where only manual cooling was arranged. Suriyasathaporn *et al* (2006) reported that the use of electric fan in cattle shed operated during the day time increased milk production of cows during the first period of lactation. Therefore if false ceiling is made inside cattle shed besides manual and mechanical cooling, cows would feel more comfort resulting in higher milk yield.

CONCLUSION

So, it was inferred that semi open house with east – west orientation, good ventilation and having standard floor space of 5 m ^{2} per cattle was found to be suitable for high milk production and less heat stress on cattle. False ceiling inside cattle house besides manual and mechanical cooling would render more comfort to the animals, resulting in higher milk production.

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