HOUSING DESIGNS AND ITS IMPACT ON MICRO CLIMATE OF CATTLE SHEDS IN CHENNAI CITY*

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Abstract

A study on housing designs and its effect on microenvironment were carried out in 17 randomly selected cattle sheds (owned by private milkmen) of Chennai city and its suburbs. The cow houses were classified as poor and good types based on score and values. The mean values were 46.00 and 67.71 per cent for poor and good types respectively. The poor type cow houses were located in the crowded areas of the city, with high rise walls and poor ventilation with a floor space allowance of 2.61 m² per cow. The good type cow houses located in less crowded areas of the city and suburbs and had optimum floor space allowance of 3.84 m² per cow. The mean air temperature and relative humidity inside the poor type houses remained significantly (P<0.01) higher than outside both in morning and evening whereas in the good type houses they remained the same. The air velocity inside poor type houses remained significantly (P<0.01) lower both in mornings and evenings than good type houses, though the air velocity outside both the housing types remained the same. The air velocity showed a significant (P<0.01) negative correlation with relative humidity indicating that the built up of humidity in poor type houses was due to poor ventilation.

Key words : *Housing designs, microenvironment, cattle sheds*

The micro-environment is affected to a considerable extent by the meteorological factors of the external environment, the type of construction of animal house, the management practices and the animals housed in time. Knowledge on housing design is essential in understanding the problems of animal comfort. Little information is available on the micro-climate in different types of animal sheds. Some of the work reported in this aspect is confined to animal houses in organised farms and not on farmer's field level. Hence an attempt is made in this work to study the housing designs and its effect on the micro-environment of cattle sheds in Chennai city.

Materials and Methods

The study was conducted in the cowsheds owned by private milkmen in Chennai city and its suburbs. Seventeen farms were randomly selected out of which 12 were within city, three in suburban areas and two in rural areas. All the cowsheds were individually examined, judged and scored using score card method. They were classified as good and poor for scores >50 and <50 respectively. Climatic variables *viz.*, air temperature and air velocity (Anemotherm air meter) and relative humidity (Whirling Psychrometer) were, recorded at weekly intervals both in the morning (7.00 AM) and evening (2.00 PM) in the selected farms. The data obtained were statistically analysed (Snedecor and Cochran, 1967).

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Table 1. Scores of cattle sheds

Cow house No.	Location per cent	Score values	Classification per cow m²	Floor space
1	Choolai	49	Poor	3.32
2	Choolai	48	Poor	1.97
3	Choolai	43	Poor	2.78
5	Mint	41	Poor	2.42
6	Mint	43	Poor	3.37
7	Broadway	49	Poor	1.93
8	Broadway	46	Poor	2.62
9	Broadway	49	Poor	2.30
10	Broadway	49	Poor	2.66
12	Nungabakkam	43	Poor	2.73
Mean		**46.99**		**2.61**
4	Mint	58	Good	2.59
11	Ningambakkam	84	Good	5.07
13	Kilpauk	59	Good	3.38
14	Kilpuak	57	Good	2.57
15	Tambaram	66	Good	2.5
16	Guduvanchery	70	Good	4.93
17	Thailavaram	80	Good	5.88
Mean		**67.71**		**3.84**

Results and Discussion

It was seen that 12 out of 17 cow houses selected for the study fell under the category of poor housing design (Table 1). They were mainly located in the crowded areas of the city. In these locations, the cow owners did not seem to pay much attention to proper housing of their cows. The mean floor space allowance given in these poor housing designs was only 2.61 m² per cow which was much below the standard requirements. In a large scale sample survey conducted in the ICDP areas of Maharashtra State in 1970, Raut (1982) could find that the floor space allowance given to the milch cows had a definite bearing on their milk production. He recommended a floor area of 4.37 m² per cow, an ideal design, and a score of 17 out of 20 to be necessary. Stergarrdoe *et al.* (1986) stated that restriction of floor area adversely affected the behaviour of cows. In France, even under the temperate conditions, Brouillet and Raguet (1990) suggested a floor space allowance of 6 m² per cow.

It was also seen that only one cow house fell under the category of good design within the crowded city limits. The rest of the farms were located either in less crowded areas like Kilpauk or in the suburbs and rural areas. The mean score given to this group of houses was 67.71 per cent which was only a little less than the optimum. The cow houses that have scored above 70 per cent were called as ideal housing with open sides all around with reasonably high roof to suit the needs of the cows under the stressful tropical climate. The optimum floor space allowance given under the classification of good housing design was 3.84 m².

The mean air temperature (Table 2) inside the poor type of housing was significantly ($P<0.01$) higher than that of outside air, both at 7.00 AM and at 2.00 PM. The mean air temperature inside the good type of house was higher than that of the outside environment and this difference was not found to be statistically significant. This indicated that the poor type of housing design greatly influenced the temperature of the ambient air to a great extent, resulting in built up of unwanted temperature in the vicinity of the housed animals putting them to stress. In a study conducted at IVRI, Izatnagar (Khub Singh *et al.*, 1977) comparing the micro-environment, it was found that the mean daily temperature and the mean minimum temperature in closed type of sheds was significantly higher ($P<0.01$) than that of the macro-environment.

Table 2. Means (± SE of air temperature °C recorded in the cow houses.

Cow House No.	Poor Type				Cow House No.	Good Type			
	Inside the cow house		Outside the cow house			Inside the cow house		Outside the cow house	
	7 am	2 pm	7 am	2 am		7 am	2 pm	7 am	2 pm
1	25.58 ± 0.43	30.17 ± 0.38	24.67 ± 0.42	24.67 ± 0.42	4	25.17 ± 0.32	29.29 ± 0.43	24.88 ± 0.33	28.85 ± 0.43
2	25.47± 0.43	30.08 ± 0.39	24.67 ± 0.43	29.02 ± 0.40	11	23.94 ± 0.42	29.35 ± 0.42	23.94 ± 0.42	29.00 ± 0.39
3	25.35 ± 0.41	29.64 ± 0.39	24.70 ± 0.40	28.76 ± 0.38	13	2.41 ± 0.40	29.61 ± 0.40	25.08 ± 0.43	29.17 ± 0.41
5	25.82 ± 0.30	30.17 ± 0.46	24.88 ± 0.30	29.08 ± 0.47	14	25.58 ± 0.40	30.02 ± 0.39	24.82 ± 0.43	30.11± 0.57
6	25.61 ± 0.34	29.94 ± 0.44	24.97 ± 0.30	29.11 ± 0.47	15	25.32 ± 0.25	31.02 ± 0.42	24.82 ± 0.27	30.11 ± 0.57
7	25.73 ± 0.36	30.73 ± 0.34	24.88 ± 0.33	29.52 ± 0.36	16	25.79 ± 0.23	29.76 ±0.36	25.79 ± 0.23	29.70 ± 0.36
8	26.05 ± 0.33	30.67 ± 0.39	25.11 ± 0.33	29.26 ± 0.39	17	26.14 ± 0.16	29.50 ± 0.39	26.14 ± 0.16	29.50 ± 0.39
9	25.7 ± 0.34	29.41 ± 0.40	24.79± 0.39	29.02 ± 0.41	Mean	25.53	29.79	25.10	29.35
10	25.41 ± 0.38	30.11 ± 0.37	24.76 ± 0.39	28.97 ± 0.42					
12	25.58 ± 0.38	30.61 ± 0.42	24.79 ± 0.42	24.79 ± 0.42					
Mean	25.63	30.20	24.82	24.82					

Table 2a. Analysis of air temperature between the poor and good type of housing

Sources of variation	df	Ms	F value
Between inside and outside			
a. Poor type of housing			
7 am	1	3.26	108.66**
2 pm	1	5.82	64.66**
b. Good type of housing			
7 am	1	0.186	0.37
2 pm	1	0.66	2.44
Between poor and good type of housing			
7 am inside the cow house	1	0.35	1.66
7 am outside the cow house	1	0.32	1.52
2 pm inside the cow house	1	0.69	3.28
2 am outside the cow house	1	0.21	1.90

** Significant at one per cent level (P<0.01)

It is concluded that open type sheds has many advantages over the closed type in the tropical North Indian climate of Izatnagar. 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 in maximum and minimum air temperatures. Even though gross differences were noticed both in the air temperature recorded inside and outside, between the poor type and good type

Table 3. Means (± SE) of relative humidity per cent recorded in the cow houses.

	Poor Type					Good Type			
Cow House No.	Inside the cow house		Outside the cow house		Cow House No.	Inside the cow house		Outside the cow house	
	7 am	2 pm	7 am	2 am		7 am	2 pm	7 am	2 pm
1	80.41± 1.309	67.76 ± 0.94	79.17± 1.42	65.17 ± 0.94	4	79.41± 1.90	68.29 ± 1.33	79.52 ± 1.83	66.88 ± 1.15
2	79.41± 1.57	68.29 ± 0.81	78.35 ± 1.66	65.47 ± 0.94	11	83.23 ± 0.96	65.29 ± 1.40	83.29 ± 1.00	64.88 ± 1.37
3	79.94 ± 1.41	69.27 ± 1.02	78.47 ± 1.48	65.75 ± 0.81	13	78.47 ± 1.81	67.00 ± 1.66	78.11 ± 1.92	65.29 ± 1.68
5	81.05 ± 1.22	69.05 ± 1.4	77.82 ± 1.48	65.82 ± 1.32	14	79.70 ± 1.95	68.64 ± 1.48	78.11 ± 1.92	65.94 ± 1.57
6	80.00 ± 1.13	68.94 ± 1.38	79.47 ± 1.20	67.35 ± 1.36	15	81.05 ± 1.03	67.64 ± 1.85	80.00 ± 1.13	66.23 ± 1.94
7	80.58 ± 1.41	69.1 ± 1.15	79.17 ± 1.5	66.64 ± 1.23	16	77.23 ± 1.19	65.76 ± 1.30	77.00 ± 1.16	65.29 ± 1.30
8	81.64 ± 1.41	70.11 ± 1.13	78.47 ± 1.53	66.35 ± 1.17	17	75.64 ± 0.97	65.76 ± 1.43	75.88 ± 0.88	69.35 ± 1.55
9	80.35 ± 1.121	70.23 ± 1.26	78.70 ± 1.46	67.17 ± 1.25	Mean	79.24	66.91	78.80	65.69
10	80.64 ± 1.32	68.82 ± 1.33	78.88 ± 1.57	67.47 ± 1.25					
12	81.23 ± 1.26	67.64 ± 1.47	79.88 ± 1.47	64.05 ± 1.48					
Mean	80.52	68.74	78.83	66.12					

Table 3a. Analysis of relative humidity between the poor and good type of housing

	Sources of variation	df	Ms	F value
A.	Between inside & Outside the house			
	a. Poor type of housing			
	7 am	1	14.22	35.55**
	2 pm	1	34.24	32.60**
	b. Good type of housing			
	7 am	1	0.69	0.112
	2 pm	1	5.18	4.58
B.	Between poor and good type of housing			
	7 am inside the cow house	1	6.72	2.46
	7 am outside the cow house	1	0.07	0.0037
	2 pm inside the cow house	1	13.79	10.85**
	2 am outside the cow house	1	0.76	0.85

** Significant at one per cent level (P<0.01)

of houses, with the poor type remaining at a higher range, this difference was not found to be statistically significant.

The relative humidity (Table 3) inside the poor type of housing was significantly (P<0.01) higher than that of outside environment both at 7.00 AM and at 2.00 PM. The relative humidity inside the good type of housing was higher than that of outside environment and this difference was not found to be significant statistically. This indicated that poor type of housing design greatly influenced

Table 4. Means (± SE) of the air velocity m/sec recorded in the cow houses

	Poor Type					Good Type			
Cow House No.	Inside the cow house		Outside the cow house		Cow House No.	Inside the cow house		Outside the cow house	
	7 am	2 pm	7 am	2 am		7 am	2 pm	7 am	2 pm
1	0.050 ± 0	0.067 ± 0.008	0.160 ± 0.014	0.400 ± 0.266	4	0.110 ± 0.031	0.230 ± 0.031	0.190 ± 0.019	0.450 ± 0.06
2	0.050 ± 0	0.060 ± 0.004	0.160 ± 0.014	0.390 ± 0.014	11	0.070 ± 0.008	0.230 ± 0.02	0.087 ± 0.001	0.300 ± 0.024
3	0.058 ± 0.003	0.120 ± 0.16	0.230 ± 0.026	0.500 ± 0.032	13	0.120 ± 0.012	0.260 ± 0.02	0.210 ± 0.02	0.420 ± 0.02
5	0.051 ± 0	0.050 ± 0	0.240 ± 0.029	0.330 ± 0.0210	14	0.060 ± 0.008	0.127 ± 0.016	0.210 ± 0.002	0.420 ± 0.02
6	0.052 ± 0.0001	0.060 ± 0.002	0.220 ± 0.027	370 ± 0.024	15	0.070 ± 0.01	0.150 ± 0.020	0.160 ± 0.016	0.3 ± 0.030
7	0.050 ± 0	0.060 ± 0.0005	0.170 ± 0.024	0.340 ± 0.03	16	0.290 ± 0.025	0.420 ± 0.020	0.310 ± 0.025	0.440 ± 0.02
8	0.050 ± 0	0.060 ± 0.007	0.210 ± 0.03	0.410 ± 0.03	17	0.580 ± 0.07	0.940 ± 0.090	0.600 ± 0.070	0.970 ± 0.090
9	0.050 ± 0	0.850 ± 0.009	0.240 ± 0.025	0.420 ± 0.027	Mean	0.180	0.330	0.250	0.460
10	0.057 ± 0003	0.097 ± 0.014	0.230 ± 0.02	0.440 ± 0.02					
12	0.050 ± 0	0.060 ± 0.009	0.155 ± 0.014	0.350 ± 0.029					
Mean	0.051	0.070	0.201	0.390					

Table 4a. Analysis of air velocity between the poor and good type of housing

	Sources of variation	df	Ms	F value
A.	Between inside and Outside the house			
	a. Poor type of housing			
	7 am	1	0.11	200**
	2 pm	1	0.52	400**
	b. Good type of housing			
	7 am	1	0.016	0.53
	2 pm	1	0.06	1
B.	Between poor and good type of housing			
	7 am inside the cow house	1	0.074	5.28*
	7 am outside the cow house	1	0.01	0.83
	2 pm inside the cow house	1	0.28	8.75**
	2 am outside the cow house	1	0.024	1.09

*Significant at five per cent level (P<0.05)
** Significant at one per cent (P<0.01)

the relative humidity of the ambient air to a great extent, resulting in the built up of moisture inside the animal house adding stress to the already overheated micro-environment. Under good type of housing design, due to better ventilation there was proper exchange of outside air with the air inside the animal house. Khubsingh *et al.* (1988) studied the micro-environment in three types of animal sheds *viz.*, closed facing west, closed facing east and open, in relation to macro-environment. They found that the closed type shed aggravated and prolonged the heat stress of housed animals in comparison to open type shed, by increasing the overall temperature -humidity complex.

The relative humidity inside and outside the poor type of houses was at a higher range than that of good type of housing at 7.00 AM, the difference being not statistically significant. Similarly the relative humidity inside poor type of housing was at a higher range than that of good type of housing at 2.00 PM, the difference being highly significant ($P<0.01$) reiterating the earlier findings that poor housing structure interfered with elimination of moisture produced by the heat stressed animals through perspiration and evaporation.

The air velocity inside the poor type of housing was significantly lower ($P<0.01$) than that of outside both at 7.00 AM and at 2.00 PM (Table 4). The air velocity inside good type of housing was lower than that of outside environment, the difference being not significant statistically. This indicated that poor type of housing design considerably cut down the air flow, thus depriving the housed animals from the beneficial effects of the good wind velocity. In a study conducted at West Java by Gatenby *et al.* (1987), to measure the wind speeds in sheep and goat houses, it was found that houses with platforms and many open walls had higher internal wind speeds than enclosed sheds. The air velocity inside the poor type of housing was significantly lower than that of inside of good type of housing at 7.00 AM and at 2.00 PM. The air velocity outside the poor type of housing was lower than that of outside of good type of housing, the difference being not significant statistically.

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