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## Evaluation of Climatic Control Units Sufficiency for Water Buffalo Barns in Thrace Region with Regard to Animal Welfare

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**Abstract** This research was carried out to evaluate the sufficiency of existing ventilation and lighting systems of the water buffalo barns in Thrace region of Turkey with regard to animal welfare. As a result of this research, it was found that 61.3% of the barns had a ventilation chimneys, total cross-sectional areas of the ventilation chimneys varied among the barns and ranged from 0.25 to 5.2 m<sup>2</sup>. Based on animal welfare, this value should be between 0.45 and 11.8 m<sup>2</sup> according to barn capacity. The window areas for natural lighting had great difference among the barns and the percentages of window area depending on barn floor area were calculated between 0.66 and 4.80%. When the region's climatic characteristics and animal welfare are taken into consideration, this value should be at least 7.5% of the barn floor area. 94 % of the barns had artificial lighting but the artificial lighting values per unit floor area (1 m<sup>2</sup>) were found between 0.2 - 2.3 W. This value should be in the range of 4-6 W / m<sup>2</sup>.

**Keywords** Water buffalo farms, barn, ventilation, lighting, animal welfare

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### Introduction

The main objective in commercial animal breeding is to obtain the highest economical efficiency. This may be possible with sufficient feeding, proper genotype and balanced environment conditions of animal barns [1]. Planning and construction of barns should be taken care because housed animals are expensive and obtained products are closely related to human health. Despite the genetics and physiological characteristics of water buffaloes are different from other cattle in our country, they are considered in the same category. Thus, there have not been enough scientific studies on the control of climate environment in water buffalo barns.

One of the most important factors in effective utilization of the genotypic potential is to maintain optimal indoor climatic environmental conditions. The outdoor thermal conditions are generally incompatible with optimum thermal conditions for farm animals. In order to provide proper thermal conditions for animal welfare, some environmental variables such as temperature and humidity should be controlled.

It is possible to keep temperature and humidity at desired values for different seasons with well-planned ventilation systems for water buffalo barns. In order to enable effective ventilation systems, the air inlet and outlet openings which can provide air exchange within the structure and have a certain height difference between them, must be well planned. On the other hand, artificial and natural lighting systems should be sufficient in terms of animal health and hygienic conditions. This study was conducted in order to investigate sufficiency of the climatic control units for the water buffalo barns located in Thrace part of Turkey.

### Material and Method

The research was conducted at 31 different administrations of Istanbul Water Buffalo Breeders Association located in Arnavutköy where is a district of Istanbul in the European part of Turkey. The study area



geographically located 41° 12' northern latitude and 28 ° 44' east longitude and at 119 m altitude [2]. The research has been carried out in two stages as field and office works. The data obtained from the ventilation and lighting systems were evaluated in terms of animal welfare by comparing with the literature information.

## Results and Discussion

### 1. Investigation of Ventilation Systems Sufficiency

Farm animals emit heat, water vapour and various gases into the barn. The excessive heat humidity, bad smell and gases must be thrown out of the barn without reaching critical level for animals. For this reason, natural or mechanical ventilation systems should be designed considering to the technical principles. Table 1 showed the current situation of the ventilation systems of investigated water buffalo barns and the values required for animal welfare.

**Table 1:** Current situation of the ventilation systems in the investigated barns

Barn Number	Amount of Water Buffalo	Barn Floor Area (m <sup>2</sup> )	Current Ventilation Systems			Required Ventilation Systems for Animal Welfare	
			Number of Chimney	Dimensions of Chimney (cm)	Total Cross-Section Area of Chimney (m <sup>2</sup> )	Number of Chimney (min.)	Total Cross-Section Area of Chimney (m <sup>2</sup> )
1	71	82.13	2	50x50	0.50	4	3.55
2	45	78.56	-	-	-	3	2.25
3	19	24.00	-	-	-	1	0.95
4	82	123.90	1	50x50	0.25	5	4.10
5	75	214.88	2	50x100	1.00	4	3.75
6	125	266.00	2	80x120	1.92	7	6.25
7	47	67.55	1	50x60	0.30	3	2.35
8	91	134.64	3	35x35	0.37	5	4.55
9	59	72.60	-	-	-	3	2.95
10	236	152.10	1	100x220	2.20	12	11.8
11	163	230.00	2	70x70	0.98	9	8.15
12	72	117.12	-	-	-	4	3.60
13	114	206.36	-	-	-	6	5.70
14	79	86.25	-	-	-	4	3.95
15	147	161.54	3	50x60	0.90	8	7.35
16	123	205.00	1	70x100	0.70	7	6.15
17	9	54.60	-	-	-	1	0.45
18	85	103.87	2	130x200	5.20	5	4.25
19	102	108.5	2	60x80	0.96	6	5.10
20	52	70.68	-	-	-	3	2.60
21	47	113.28	-	-	-	3	2.35
22	55	106.92	2	35x35	0.25	3	2.75
23	72	87.00	2	40x50	0.40	4	3.60
24	19	139.30	-	-	-	1	0.95
25	24	78.39	1	50x50	0.25	2	1.20
26	44	117.60	5	60x60	1.80	3	2.20
27	32	100.00	-	-	-	2	1.60
28	28	65.28	2	60x60	0.72	2	1.40
29	31	105.00	6	40x50	1.2	2	1.55
30	51	63.00	-	-	-	3	2.55
31	50	92.80	1	60x70	0.42	3	2.50

When Table 1 was examined, it was seen that ventilation systems were not sufficient in all barns and 38.7% of barns did not have ventilation chimneys. Based on barn capacity, total number of chimneys should be in the



range of 1-12 to provide the condition of minimum one chimney per 100 m<sup>2</sup> floor area. Also, the cross-section areas should be between 0.45 and 11.8 m<sup>2</sup>.

Ventilation systems should be able to change the indoor air temperature at least 4-6 times per a hour in the winter months and 10-15 times per a hour in the summer months [3]. Breeze or draft should not be occurred in the ventilated barn conditions.

Openings left under windows, transom-windows, continuous openings left under eaves, individual air inlet holes and large-scale ventilation panels can be used as air inlet openings.

When transom-windows are used as air inlet opening, placement height of windows must be at least 150-160 cm above level of barn floor based on withers height in order to minimize negative effect of cold air during winter months [4].

In natural ventilation, the air outlet openings can be in the forms of ventilation chimneys placed at a certain distance on the roof, or continuous openings along the roof. Considering the climate of the region, it may be advisable to plan the air outlets as continuous openings for efficient ventilation in the water buffalo barns. The ridge should not be narrower than 15 cm. As a general measure, 1.5-2 cm ridge space should be left for each one meter of barn floor width. Lantern type roofs can be suggested to improve the efficiency of ventilation and also prevent the rain water in the water buffalo barns [5].

The values given in Table 2 can be taken as a basis for planning air outlet openings of the lantern type roofs.

**Table 2:** The suggested air outlet opening of lantern type roofs according to barn floor width

Barn Floor Width (m)	W (cm)	W/2 (cm)	2W (cm)
7	15	7.5	30
9	18	9	36
12	24	12	48
15	30	15	60
18	36	18	72
21	42	21	84

## 2. Investigation of Lighting Systems Sufficiency

Lighting is an important in terms of climatic environment of barns, animal welfare and hygienic conditions. Table 3 showed the current situations of natural lighting windows in the investigated barns and the values required for animal welfare.

**Table 3:** Current situation of the ventilation systems in the investigated barns

Barn Number	Amount of Water Buffalo	Barn Floor Area (m <sup>2</sup> )	Current Natural Lighting Windows			Required Window Areas for Animal Welfare		
			Number of Window	Dimensions of Window	Window Area to Barn Floor Area Ratios (%)	Window Area to Barn Floor Area Ratios (%)	Window Area (m <sup>2</sup> )	
1	71	82.13	5	40x120	2.92	7.50	6.16	
2	45	78.56	7	50x90	4.01	7.50	5.89	
3	19	24.00	1	50x50	1.04	7.50	1.80	
4	82	123.90	7	40x80	1.81	7.50	9.29	
5	75	214.88	6	70x70	1.37	7.50	16.11	
6	125	266.00	14	40x70	1.47	7.50	19.95	
7	47	67.55	4	60x60	2.13	7.50	5.06	
8	91	134.64	11	45x55	2.02	7.50	10.09	
9	59	72.60	4	30x40	0.66	7.50	5.44	
10	236	152.10	9	60x100	3.55	7.50	11.40	
11	163	230.00	7	70x80	1.70	7.50	17.25	
12	72	117.12	9	70x90	4.84	7.50	8.78	
13	114	206.36	9	50x60	0.71	7.50	15.47	



14	79	86.25	2	60x60	0.83	7.50	6.46
15	147	161.54	9	60x80	2.67	7.50	12.11
16	123	205.00	10	60x60	1.76	7.50	15.37
17	9	54.60	2	50x75	1.37	7.50	4.09
18	85	103.87	5	70x80	2.70	7.50	7.79
19	102	108.5	5	60x70	1.94	7.50	8.13
20	52	70.68	3	60x70	1.78	7.50	5.30
21	47	113.28	5	60x80	2.12	7.50	8.49
22	55	106.92	7	40x110	2.88	7.50	8.01
23	72	87.00	6	70x100	4.83	7.50	6.52
24	19	139.30	9	60x80	3.10	7.50	10.44
25	24	78.39	5	60x60	2.30	7.50	5.87
26	44	117.60	5	50x80	1.70	7.50	8.82
27	32	100.00	9	50x50	2.25	7.50	7.50
28	28	65.28	4	60x60	2.21	7.50	4.89
29	31	105.00	4	40x50	0.76	7.50	7.87
30	51	63.00	3	50x70	1.67	7.50	4.72
31	50	92.80	8	50x60	2.59	7.50	6.96

The window area to barn floor area ratios were calculated between 0.66 and 4.84 % in the barns. The recommended value is 5-7.5 % for temperate zones [6]. Accordingly, natural lighting was insufficient in the all barns. On the other hand, 94% of barns have artificial lighting. But, the artificial lighting values were calculated between 0.2-2.3 W for 1 m<sup>2</sup> floor area and these values showed that no barn had sufficient artificial lighting. This value should be in the range of 4-6 W / m<sup>2</sup> [7].

### Result and Suggestions

Increasing of animal yields within proper economic conditions is possible with high efficiency breeding, well-feeding and well-designed barn based on climatic, structural and social-environment conditions.

For this reason, consideration of the following will be beneficial for animal welfare in designation process of new planned water buffalo barns;

- In order to maximize utilization of natural light, the long axes of the barns must be in the east-west direction. However, if there are two stall rows or more in the tie-stall barns, they are should be located in the north-south direction.
- Lantern type roof for natural ventilation system in the closed barn will be useful for control of the climatic environment.
- The difference in height between the air inlet and outlet openings should not be less than 1.5 m.
- For natural lighting, 5-7.5% of the floor area of the barn should be planned and 4-6% W/m<sup>2</sup> should be considered for artificial lighting.

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