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The Effect of Climatic Condition on Area Preference of Animals in Dairy Cattle Houses[#]

Selda UZAL[*], Nuh UGURLU

Selcuk University, Faculty of Agriculture, Department of Farm Structures and Irrigation, Konya, Turkey

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Abstract: Realizing design of appropriate structure for cow comfort is important to increase animal production. This study was carried out to determine shelter area choice of cows for loose housing and free stall housing between 2006-2008 in Konya. Behaviour of animals was investigated in two dairy cattle companies which have loose and free stall livestock buildings. It has taken 80 days (1920 h) totally, 40 days per company. Forty days were decided to represent 4 seasons (10 days per season). Behaviour of cows was observed by recording during 24 hours of a day with video cameras mounted at suitable places in investigated parts. Seasonal time budget and shelter field choice of cows was determined for each shelter company. As a result of the observations, it was determined that climate is an important factor for area preference of cows. It was observed that cows usually preferred barn facilities which had low air flow in cold climatic conditions, high air flow in hot climatic conditions.

***Key words**: Cattle Behaviour, Dairy Livestock Building, Time Budget, Area Usage of Cattle.*

Introduction

Consuming animal production which has ample protein is important for well nutrition of people. Consumption of animal production shows the development level of a country in today's world. Milk consumption of a person was 85 L/year in European Countries, and 25 L/year in Turkey (Anonymous, 2005a).

The most important parameter in dairy farming is annual milk production of an animal. Mean milk production was 8.9 tons/animal in U.S.A., 5.9 tons/animal in European Countries (Anonymous, 2006a), 2.6 tons/animal in Turkey (Anonymous, 2006b). Although dairy cattle amount of Turkey is 20 % of European Countries and milk production is 7 %. This situation shows that milk production per cow is low in Turkey. Inappropriate environmental conditions, malnutrition, and genetic factors are main reasons of this.

The most important factors to improve animal production are genetics, nutrition, and environmental conditions. Environmental conditions are quite important for animal production. Ekmekyapar (1991) expressed that genetics and environmental conditions were important and affected animal production by a ratio of 30 % and 70 % respectively. Although genetics and improvement are usually studied for animal breeding, environmental conditions are considered less important. Environmental conditions include all external factors which affect breeding and productivity of animals (Ekmekyapar, 1991). It is known that desired animal production cannot be reached in inappropriate conditions in spite of good genetic merit.

Environmental conditions consist of structural, climatic, and social environment for cows. Structural environment consists of dry, clean, soft, and enough sized shelter areas in which animals spend their daily time without stress. Climatic environment represents climatic conditions of the area in which animals take shelter. Social environment represents groups of animals formed according to social properties of them and group size. Webster (1994) expressed

[*]*Corresponding: E-mail: seldauzal@selcuk.edu.tr, Tel: +90 332 2232852, Fax:+90 332 241 01 08*

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convenient temperature values between 10 and 20 °C for dairy cattle. Gebremedhin and Wu (2001) emphasized that high air flow is decrease temperature tolerance of animals by increasing heat losses by means of convection and evaporation from animal skin especially in the bedding area of getting dirty and wet. Air flow should not be above 0.2-0.3 m/s not to unfavourably affect animals especially in low temperature levels (Mutaf & Sonmez, 1984).

Productivity is inversely proportional to stress. Because animals spend a part of their energy to overcome stress, productivity decreases with increment of stress (Ugurlu, 2006). Increasing number of studies related to designing convenient structure for animal behaviour especially in developed countries show that importance of the subject is understood. In this study, barn area preference were determined by observing seasonal climatic values (temperature, relative humidity and air flow) in loose and freestall dairy house in Konya.

Materials and Method

This study was conducted in loose dairy barn (Besman Company) and freestall dairy barns (Ozcan Seker Company) in Konya. 70 cows, totally 140 animals has taken sheltered in loose barn. In barn facilities, resting area stocking density , courtyard area stocking density, feed alley width were 7.50-10.70 m^2/animal, 19.70-28.10 m^2/animal, 1.25-1.79 m/animal, 1.5 m, respectively. Freestall barn has had 70 dairy cattle, totally 150 animals. In this barn, stall width, stall length, feeding length, courtyard area stocking density, centre drive-through alley width were 1.15 m, 2.30 m, 0.82-1.00 m/animal, 16.40-20.00 m^2/animal, 4.40 m.

Digital temperature-humidity meter were utilized to determine climatic data in the companies (temperature measurement range: -40 ºC, +100 ºC, resolution: 0.03ºC, precision: ±0.3 ºC; relative humidity measurement range: 0-100 % RH, resolution: 0.4 %, precision: ±3 %). Measurement values were recorded at 7 different points in loose barn, and 9 different points in freestall barn. Temperature and relative humidity measurements were carried out in 3 main groups in both companies. These were outside area, resting area, and courtyard area. Air flow meters were used to measure air flow in different parts of the barns (measurement range: 0-15 m/s, resolution: 0.01 m/s, precision: ±0.1).

Live view system was set in both barns to observe behaviour of animals. The system has consisted of 8 digital, colourful, and day/night vision cameras (1/3" Sony HQ1 colour CCD sensor, 752 (H)x582 (V) pixel, minimum light sensitivity) and 1 portable, 8 channels recording device (15" LCD display, 8 sensor inputs, 500 GB memory). 4 cameras were mounted in each barn. Totally 8 cameras were used in both companies. Because there was only one recording device, it was mounted at each company in observation period.

Behaviour observation was carried out to determine area preference of cows according to seasonal effects and barn type. Firstly behaviours were specified to observe animals. Animal behaviours are response of whole body to specific alert or reaction type to its around. (Inal, 2006).

In this study, samples with 1/3 ratio were observed by utilizing studies of Mitlohner *et al*. (2001), Martin and Bateson (1993), Yurtman *et al*. (2002), Bogner (1984), Savas and Samli (2000), Olgun and Celik (1997). Recording was carried out during 24 hours of a day by continuous recording method. Totally 48 animals were observed during 4 seasons in both dairy barns. Ten days was determined for each season by utilizing studies of Frazzi and Calegari (2003) and Hernández and Calmenáres (2006). Because observations of each barn was separately and alternately, continuous camera recording were conducted during 80 days totally. 3 days average behaviour of cows was taken into consideration to determine area preference of animals.

Results and Discussion

Climatic properties and area usage densities in loose dairy barn

Velocity and prevailing direction of wind were measured in observation periods and these are shown on barn plan in each season. Prevailing directions of wind are north, northeast, and

northwest in Konya (Ugurlu, 1998). Air flow values were determined in different parts of barn for both companies in observation periods. The effect of wind distribution in barn facilities on barn area usage of cows was observed and discussed in this section. Area usage densities of animals in different seasons are shown by drawing fine parallel lines upon barn plan. Hatched areas represent 60-80 % higher usage density regions than the other areas. Air flows, dry floor, sunny and shady areas quite affect area preference of animals. However, air flow is more important parameter influencing area usage while the effects of other conditions are lessening.
Measured temperature and humidity values in loose barn in autumn are given in Table 1 and air flow values and area usage densities of animals are given in Figure 1. Air flow values were measured between 0 and 0.6 m/s in resting area in this season. In contrast to this, they were measured between 2.5 and 3.0 m/s in courtyard area. Temperatures are between -2 and +14 ºC in autumn It is a chilly climatic environment for cows so that it was observed that cows preferred barn parts with light windy area. Appropriate air flow values were explained between 0.2-0.4 m/s by Mutaf and Sonmez (1984). It was observed that cows preferred sunny barn areas with low air flow in this season.

Table 1. Climatic properties for loose barn in autumn observation period

Climatic Properties		Barn Areas		
		Outside Area	Resting Area	Courtyard Area
Temperature (^{o}C)	Average temp.	4.1	5.6	4.4
	Average low temp.	-2.6	-0.8	-2.2
	Average high temp.	12.2	13.7	12.4
Relative Humidity (%)	Average RH.	75	75	77
	Average low RH.	46	48	47
	Average high RH.	93	90	96

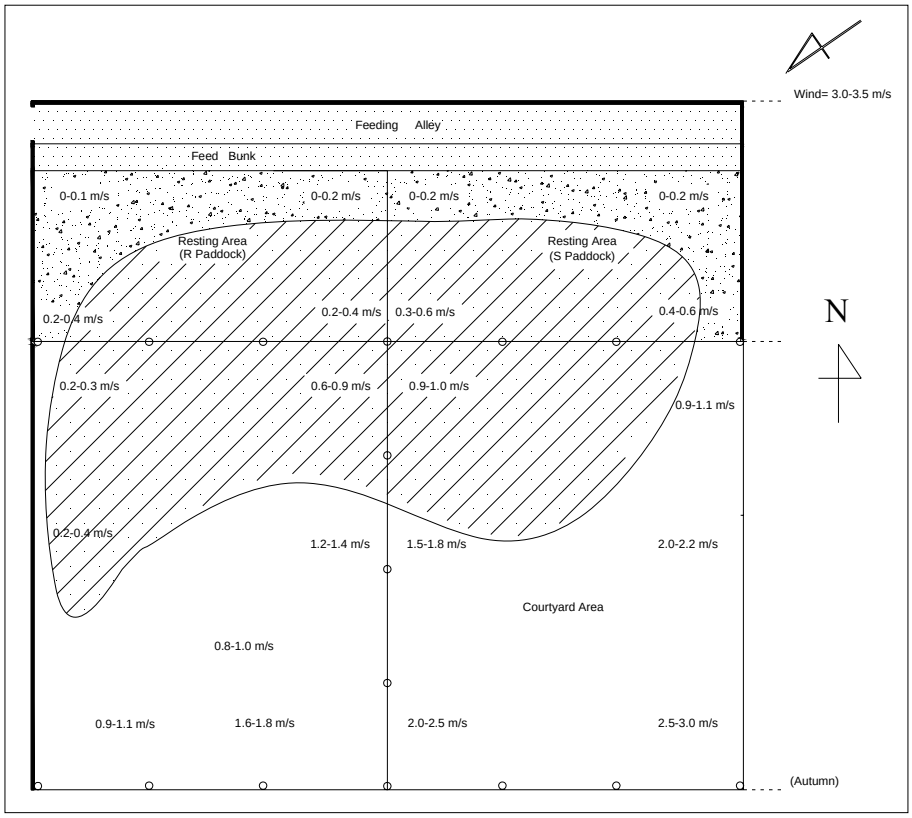

Figure 1. Air flow and barn area usage densities for loose barn in autumn observation period

Measured temperature and humidity values in loose barn in winter are given in Table 2 and air flow values and area usage densities of animals are given in Figure 2. When Wind speed even reached 4-5 m/s, calm areas were observed in shelter resting area. Because temperatures were low (between -10.7 and -0.2 ºC) in winter, it was observed that cows preferred calm barn areas. Animals preferred calm areas with low air flow at low temperatures to decline heat losses from their body by using of convection.

Table 2. Climatic properties for loose barn in winter observation period

Climatic Properties		Barn Areas		
		Outside Area	Resting Area	Courtyard Area
Temperature (^{o}C)	Average temp.	-6.3	-4.2	-5.9
	Average low temp.	-10.7	-8.7	-10.2
	Average high temp.	-2.0	-0.2	-1.9
Relative Humidity (%)	Average RH.	100	87	95
	Average low RH	87	75	86
	Average high RH	100	94	100

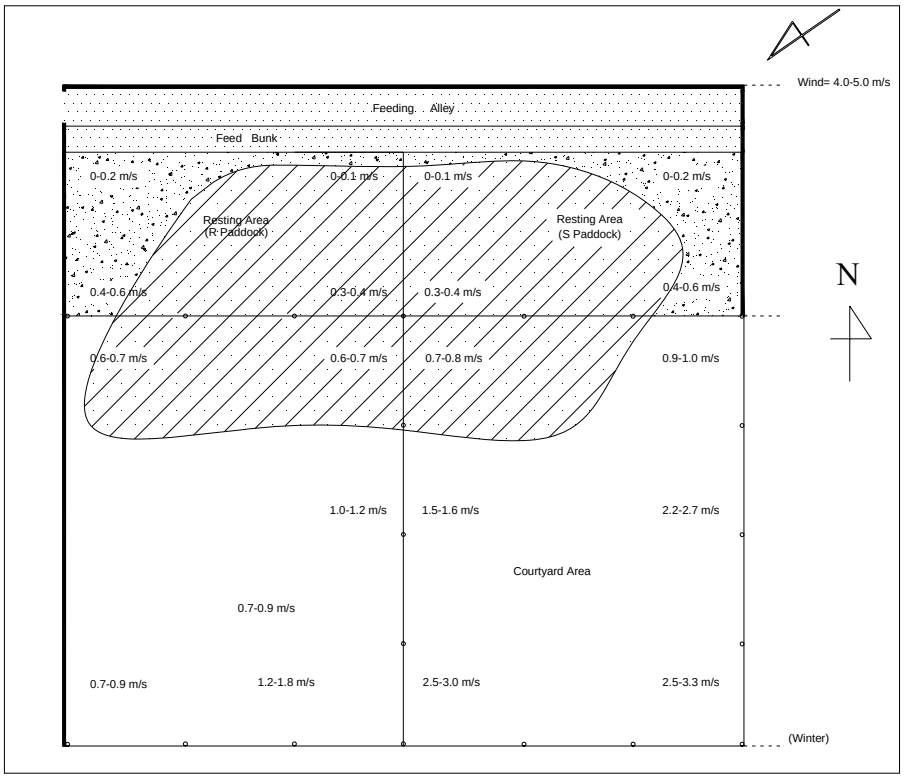

Figure 2. Air flow and barn area usage densities for loose barn in winter observation period

Temperature and humidity values in loose barn in spring are given in Table 3 and air flow values and area usage densities of animals are given in Figure 3. Wind velocity was measured between 0 and 0.6 m/s in resting area in this season. It was measured between 0.2 and 2.0 m/s in courtyard area and lower air flow found values (<1 m/s) in nearest to resting area. Cows preferred parts with light windy area in paddock while temperature values were arising in spring. Lower air flow, dry and soft floor in courtyard was became comfortable resting area for dairy cow that represented in Figure 2 with hatched.

Table 3. Climatic properties for loose barn in spring observation period

Climatic Properties		Barn Areas		
		Outside Area	Resting Area	Courtyard Area
Temperature (°C)	Average temp.	18.0	19.3	18.4
	Average low temp.	10.4	11.7	10.9
	Average high temp.	25.3	27.9	25.7
Relative Humidity (%)	Average rh.	52	49	50
	Average low rh	27	25	26
	Average high rh	83	76	78

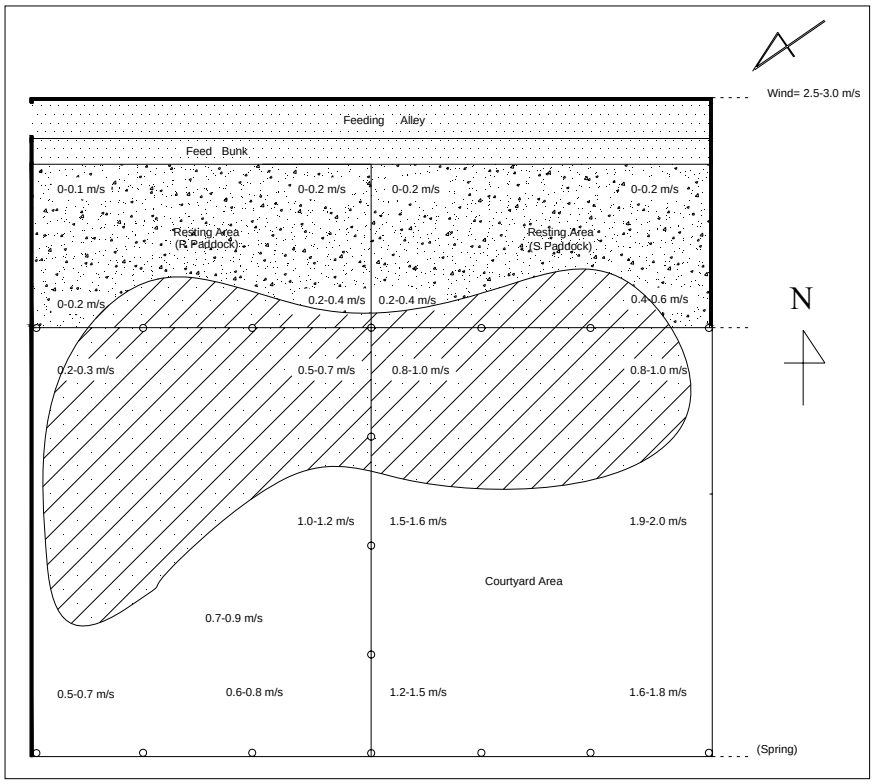

Figure 3. Air flow and barn area usage densities for loose barn in spring observation period

Measured temperature and relative humidity values in loose barn in summer are given in Table 4 and distribution of air flow values with respect to different parts of barn and area usage densities of animals are given in Figure 4. Wind velocity was measured between 0 and 0.4 m/s in resting area in loose barn. Air flow was measured between 0.3 and 2.3 m/s in courtyard parts of nearest the shelter resting area, Wind speed was measured between 3.0 and 4.8 m/s south part of courtyard area. Because resting area was shady in daily time in summer, cows have preferred resting area. In contrast to this, they have preferred hatched region in Figure 4, when the sun has gone down and during the night. It was determined that because temperatures were high in summer, cows used higher windy areas to supply body heat balance and to get cool.

Table 4. Climatic properties for loose barn in summer observation period

Climatic Properties		Barn Areas		
		Outside Area	Resting Area	Courtyard Area
Temperature (°C)	Average temp.	24.9	26.5	25.6
	Average low temp.	17.2	18.1	17.4
	Average high temp.	31.6	36.3	33.1
Relative Humidity (%)	Average RH.	36	35	34
	Average low RH	18	17	17
	Average high RH	61	60	59

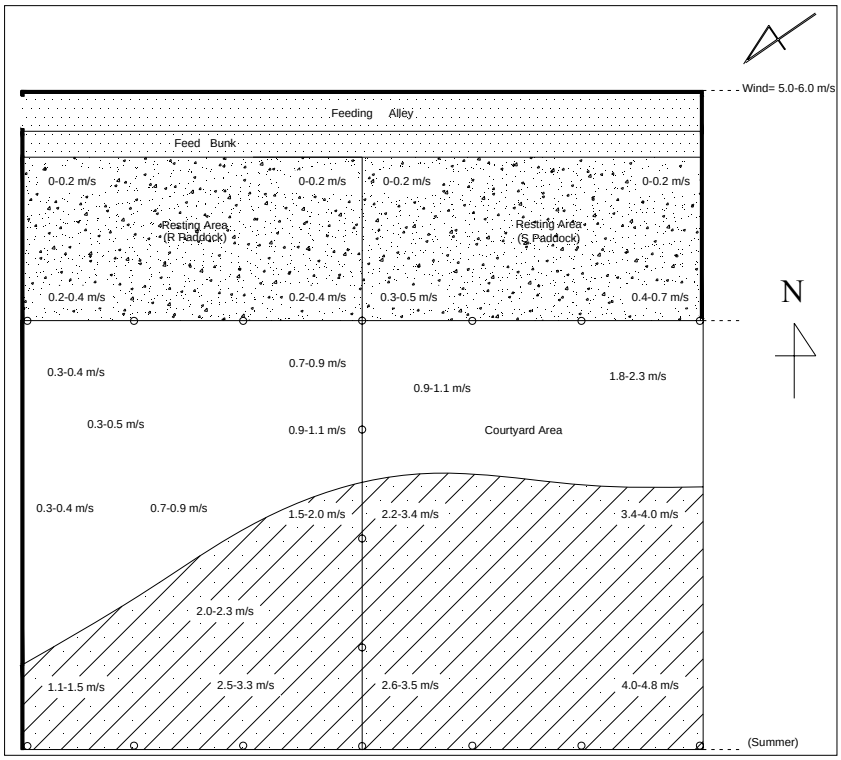

Figure 4. Air flow and barn area usage densities for loose barn in summer observation period

Climatic properties and area usage densities in dairy freestall barn

Temperature and relative humidity values in freestall barn in observation periods are given in Table 5 - Table 8. Measured prevailing direction of wind and air flow values are shown on barn plan in Figure5 – Figure 8.

Table 5. Climatic properties for freestall barn in autumn observation period

Climatic Properties		Barn Areas		
		Outside Area	Closed Area	Courtyard Area
Temperature (^oC)	Average temp.	9.3	11.2	9.4
	Average low temp.	5.6	7.5	5.7
	Average high temp.	13.7	15.3	13.9
Relative Humidity (%)	Average RH	86	83	87
	Average low RH	68	65	69
	Average high RH	96	90	98

It was observed that prevailing wind direction was usually from north in autumn. Wind velocity was measured between 0.2 and 0.3 m/s in closed area of barn when doors were even open. Wind speed was measured between 0.2-1.8 m/s in courtyard area. Air flow was decreased in parts of nearest the barn wall of courtyard area, the highest velocity was seen in outside parts of lot, and average velocities were shown in middle region (Figure 5). Because average temperature values were between 4 and 12 ^oC, it was observed that cows preferred slow air flow lot area in near by barn wall. Hatched region in Figure 5 shows courtyard area which was intensively used by cows in autumn.

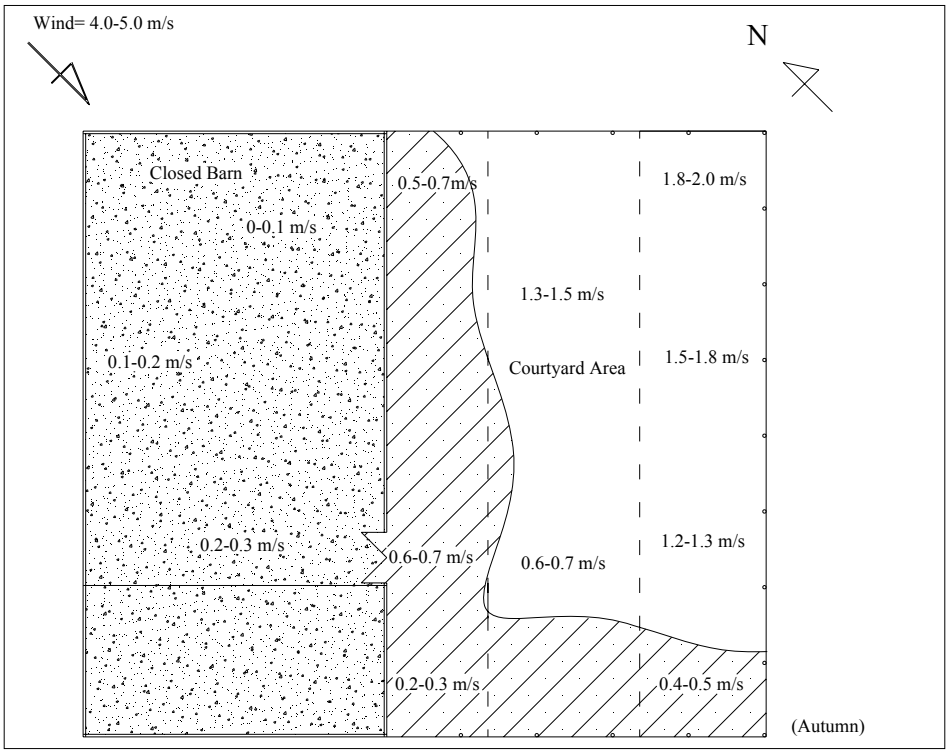

Figure 5. Air flow and barn area usage densities for freestall barn in autumn observation period

Temperature and relative humidity values in freestall barn in winter are given in Table 6 and air flow values are given in Figure 6. It was observed that prevailing direction of wind was north, northeast, and northwest in winter. Air flow was measured between 0.1 and 0.2 m/s in closed area. In contrast to this, air flow was measured between 0.3 and 0.6 m/s in parts of nearest to barn wall, 2-4 m/s in middle region of courtyard and 4-6 m/s outside parts of courtyard in paddock. Cows were permitted to go to courtyard area only in daily time and have preferred hatched area with low air flow shown in Figure 6 in this season.

Table 6. Climatic properties for freestall barn in winter observation period

Climatic Properties		Barn Areas		
		Outside Area	Closed Area	Courtyard Area
Temperature (^{o}C)	Average temp.	1.2	6.3	1.3
	Average low temp.	-3.5	3.0	-3.3
	Average high temp.	6.1	9.9	6.3
Relative Humidity (%)	Average RH.	99	85	93
	Average low RH	78	69	78
	Average high RH	104	95	101

Measured temperature and relative humidity values in different areas of freestall barn in spring are given in Table 7 and air flow values are given in Figure 7. Air flow was measured between 0.1- 0.4 m/s in closed area in this season. Air flow values were varying between 0.1-2.0 m/s in courtyard area. Average temperatures were between 10 and 12 ºC in this season and it was nearly optimum level for cows. It was observed that cows intensively used hatched parts with medium air flow area.

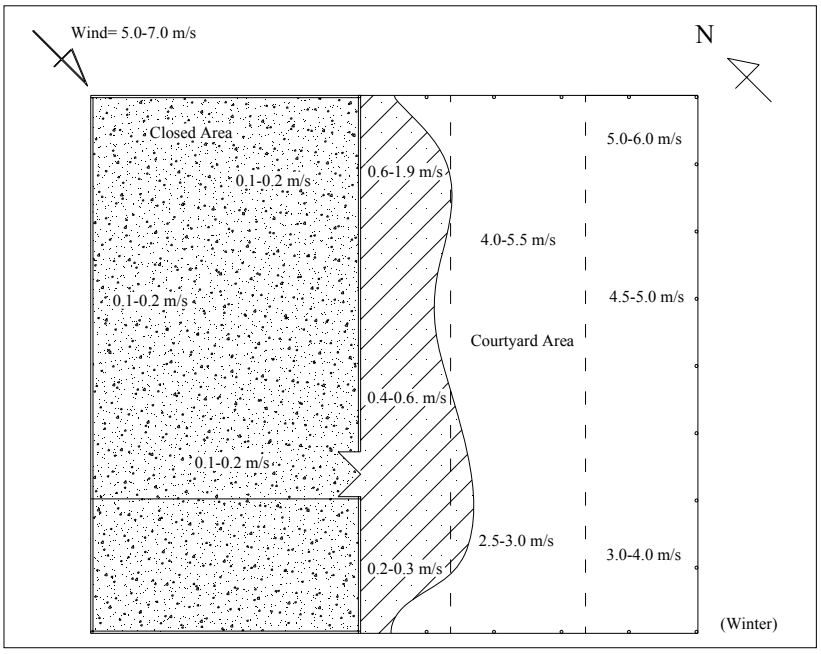

Figure 6. Air flow and barn area usage densities for freestall barn in winter observation period

Table 7. Climatic Properties for freestall barn in spring observation period

Climatic Properties		Barn Areas		
		Outside Area	Closed Area	Courtyard Area
Temperature (^{o}C)	Average temp.	10.4	12.5	10.7
	Average low temp.	1.6	4.2	1.7
	Average high temp.	17.7	20.5	18.2
Relative Humidity (%)	Average RH.	50	51	52
	Average low RH	23	24	25
	average high RH	84	84	84

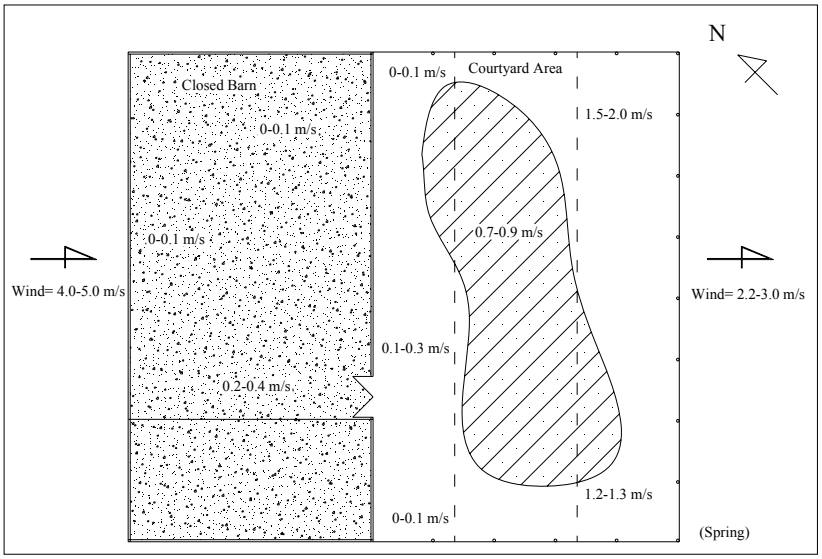

Figure 7. Air flow and barn area usage densities for freestall barn in spring observation period

Climatic properties and area usage densities of animals in summer are given in Table 8 and Figure 8. Air flow values were between 0 and 3.0 m/s in courtyard area. It was between 2.0 and 2.5 m/s in outside parts of courtyard. Because it was hot in this season (27-36 ºC), it was observed that cows preferred parts with high air flow to get cool. It was observed that cows intensively used hatched region of paddock area in this season.

Table 8. Climatic properties for freestall barn in summer observation period

Climatic Properties		Barn Areas		
		Outside Area	Closed Area	Courtyard Area
Temperature (°C)	Average temp.	26.9	28.2	27.1
	Average low temp.	16.3	18.5	16.2
	Average high temp.	35.5	37.8	36.3
Relative Humidity (%)	Average RH.	28	29	29
	Average low RH	12	13	12
	Average high RH	53	54	55

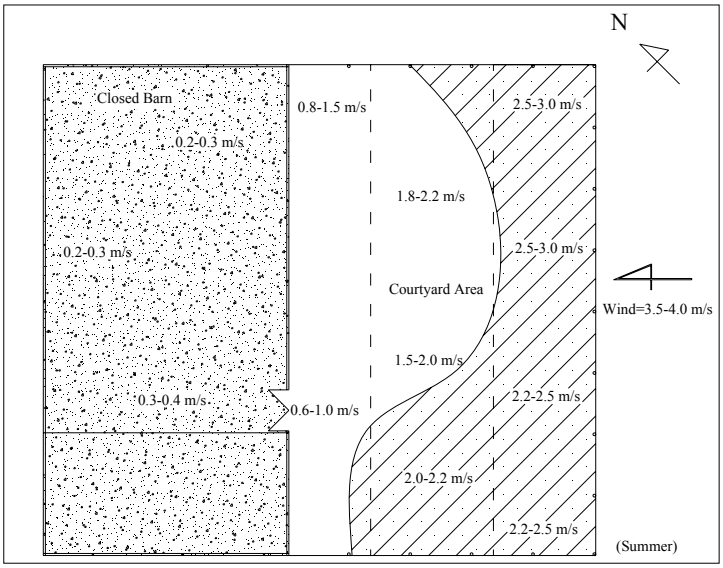

Figure 8. Air flow and barn area usage densities for freestall barn in summer observation period

Conclusion

As a conclusion, there is an important relation between air flow and barn area preference of cows. Animals preferred areas with low air flow at low temperatures to supply their heat balance by declining their heat losses by means of convection. They preferred areas with high air flow at high temperatures to body heat balance by increasing heat emission. It was concluded that designing alternative barn areas to be used in different seasons was very important, while planning livestock buildings.

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