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The Dairy Cattle Behaviors and Time Budget and Barn Area Usage in Freestall Housing

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Abstract: The design of appropriate housing for cow comfort is important to increase animal production. This study was carried out to determine annual time budget and shelter area usage of cows between 2006 and 2008 in Konya-Turkey. Behavior of animals (n = 24) and barn area usage of dairy cattle was investigated freestall dairy housings. Behavior of cows was observed by recording during 24 h of a day with video cameras mounted at suitable places in barn parts. The animals behaviors related to barn area choice were investigated and seasonal variation of dairy cattle housing area usage observed during to 10 days for each season. Annually average barn area usage of dairy cattle were determined as 3.33 h cubicle, 12.22 h courtyard, 1.30 h scraped alley, 6.09 h feeding, 1.06 h watering and milking area in freestall housing. The effect of season on the time budget activity of dairy cattle was important. Lying behaviors of dairy cattle decreased from 50.9% (summer) to 40.5% (winter). Dairy cattle spent their time about >50% in open area as courtyard. The annually time budget of dairy cattle were found as 45.4% lying, 13.7% standing, 25.4% feeding, 1.7% drinking, 9.9% walking, 2.6% milking and 1.3% other behaviors in the research. The present study showed that well design of courtyard, resting and feeding areas very important for animal production and welfare as well as cattle management.

Key words: Cattle behavior, freestall housing, area usage of cattle, time budget, lying behavior, feeding behavior

INTRODUCTION

The 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^{-1} in European Countries and 25 L year^{-1} in Turkey (Anonymous, 2005).

The most important parameter in dairy farming is annual milk production of an animal. Mean milk production was 8.9 tons animal^{-1} in USA, 5.9 tons animal^{-1} in European Countries (Anonymous, 2006a) 2.6 tons animal^{-1} in Turkey and 3.1 tons animal^{-1} in Konya (Anonymous, 2006b). Although dairy cattle amount of Turkey is 20% of European Countries, milk production is 7% of that. This situation shows that milk production per cow is low in Turkey. Poor environmental conditions, malnutrition and genetic factors are main causes low milk production (Uzal and Ugurlu, 2008).

Environmental conditions consist of structural, climatic and social factors for cows. Structural environment is constitute to dry, clean, soft and enough sized shelter areas in which animals spend their daily time without stress. Climatic environment is 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 convenient temperature values between 10 and 20°C for dairy cattle. Gebremedhin and Wu (2001) emphasized that high air flow decreased temperature tolerance by increasing heat losses carried out by means of convection and evaporation from animal skin especially in the conditions of getting dirty and wet.

Animal productivity decreases in high stress factors in housing condition. Animal spends a part of their energy to overcome stress. The effects of these factors can be alleviating to design of comfortable barn areas in planning of animal houses (Ugurlu and Uzal, 2007). Design new housing model will be possible by observation of animals' behavior reaction in any area and relation between animal behavior and areas. Therefore, the lying behaviour of dairy cows attracts a lot of research interest. Changes in the behavioral activity of farm animals are widely used as welfare indicators (Muller and Schrader, 2003) and to investigate animal production parameters (Phillips and Rind, 2001). The duration and frequency of lying bouts are behavioral indicators of cow comfort (Haley *et al*., 2000).

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Blowey (1994) found that dairy cows spend 45% of 24 h lying and with respect to different housing systems their lying behavior changed between values 46-50%. Grant and Albright (2000) determined time budget of dairy cows in feeding behavior 3-5 h day^{-1}, lying behavior 12-14 h day^{-1}, social behavior 2-3 h day^{-1}, rumination 7-10 h day^{-1}, drinking 0.5 h day^{-1} and outside the stall (milking, walking, grooming) 2.5-3.5 h day^{-1}. The development of alternative housing systems for dairy cattle becomes more and more important. However, low cost alternatives that offer potential benefits with regard to cow comfort are currently under investigation worldwide (O'Driscoll *et al*., 2008a, b; Tucker *et al*., 2007; Barberg *et al*., 2007).

The research was planned for developing of criteria to design new dairy cattle barns which are suitable for animal behavior and high production performance and welfare. Shelter area preferences of cattle were observed in different season by climate values (temperature, relative humidity) and time budget of animals were found in freestall housing in Konya-Turkey. The developing of correct building structure models were aimed by analyzing animal behaviors in the research.

MATERIALS AND METHODS

The study was conducted in freestall dairy barn sheltered 150 in Konya-Turkey between 2006 and 2008. In barn facilities, stall width, stall length, feeding length, courtyard area stocking density, feed alley width were 1.15, 2.30, 0.8 m animal^{-1}, 16.40 m^2 animal^{-1}, 4.40 m, respectively.

Digital temperature-humiditymeter were utilized to determine climatic data in the barn (temperature measurement range: -40°C, +100°C, resolution: 0.03°C, precision: ±0.3°C; relative humidity measurement range: 0-100% rh, resolution: 0.4%, precision: ±3%). Measurement values were recorded at 9 different points in freestall barn. Temperature and relative humidity measurements were carried out in 3 main groups in the building. These were outside area, resting area and courtyard area. The live view system was set in experimental barn for observation of animal behaviors. The system consist of digital, colorful and day/night vision cameras (1/3" Sony HQ1 color CCD sensor, 752 (H) ×582 (V) pixel, minimum light sensitivity) and 1 portable, 8 channels recording device (15" LCD display, 8 sensor

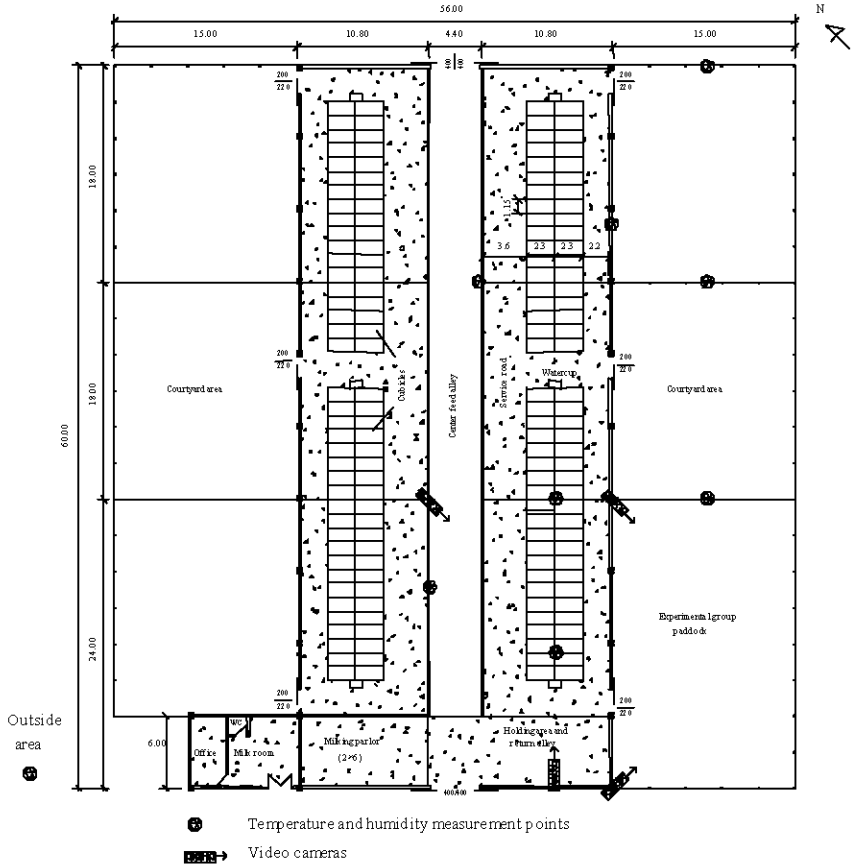

Fig. 1: The view plan of the experimental freestall housing system and positions of measurement points (m)

inputs, 500 GB memory). Four cameras were mounted outside and inside areas of barn. The view plan of experimental building and measurement devices location was shown in Fig. 1.

In this study, 6 dairy cattle were selected in 1/3 ratio of experimental group and observation data was enrolled during 24 h by continuous sampling method by Mitlohner *et al.* (2001), Martin and Bateson (1993), Yurtman *et al.* (2002), Bogner (1984), Antov *et al.* (1991). O'Driscoll *et al.* (2008c, 2009) and Mitlohner *et al.* (2001) explain that 5 min intervals ise adequate to obtain an accurate representation of bovine standing and lying behavior over a 24 h period. Martin and Bateson (1993) was reported that the start and end time of the observed behavior, duration and frequency to be measured should be used for the continuous observation method in behavioral observations. In this research, it was used continuous recording method in order to examine dairy cattle daily activite (lying, standing, feeding, drinking, walking, milking and social behavior). Totally, 24 animals were observed during all year in freestall dairy barn, which experimental pen have 18-22 dairy cattle. The selected dairy cattle freely move in their pens with other animals in test group. The dairy cattle behavior was observed >1920 h by video recordings in experimental pen of dairy cattle housing. To guarantee identification of dairy cattle, each of them was marked at least one day before the start of the video recordings with patterns by using yellow, green and red paints. Ten days was selected for each season with totally 40 days as recommended by of Frazzi and Calegari (2003), Wagner-Storch and Palmer (2003), Hayasaka *et al.* (2002), Stefanowska *et al.* (2002a, b), Mitlohner *et al.* (2001) and Hernandez and Calmenares (2006).

RESULTS AND DISCUSSION

The climatic data were given as average of daily minimum or maximum measurements in observation periods. Max., Min. and average temperatures were 13.9, 5.7 and 9.4°C in autumn and measured 6.3, -3.3 and 1.3°C in winter and found 18.2, 1.7 and 10.7°C in spring and determined 36.3, 16.2 and 27.1°C for summer, respectively in courtyard. The Max. and Min. temperatures of closed barn were higher than courtyard and increasing of temperatures were measured about 2, 5, 3 and 2°C for autumn, winter, spring and summer, respectively. The average relative humidity were found as 83% (autumn), 85% (winter), 51% (spring) and 29% (summer). By analyzing climatic properties of freestall housing system, temperature and humidity of outside and courtyard area in all season were very close. In general, temperature value of closed area was found higher than courtyard area in all season.

The time budget activity (lying, standing, feeding, drinking, walking, other behavior and milking) of dairy cattle was given in Fig. 2 for different season in freestall dairy housing system. The result of behavioral studies in barn the total annually time budget of animals were found as 45.4% lying, 25.4% feeding, 13.7% standing, 9.9% walking, 1.7% drinking, 2.6% milking, 1.3% other behaviors. As a result, for successful dairy housed system, barn areas must be well designed that is conform for animal behaviors.

The time budget differences of animals in seasons were found significant. Lying behaviors were 50.9% for spring and decreased to 40.5% for winter. Also, it was observed that lying behaviors were 48% for summer and 42.5% for autumn. The cattle reduced lying time and increased standing and feeding time in winter. The most important reason of time budget variation is wet and too dirty courtyard areas. Since, the animals limited their lying behaviors under undesired ground conditions. Lying time is very important for milk production and animal welfare. Adequate lying times are essential to the well being of the dairy cow and indeed dairy cow comfort is often measured in terms of time spent lying (Overton *et al.*, 2002). These cows also stood for prolonged periods, which resulted in lying times that were well below the normal 12-13 h day^{-1} (Jensen *et al.*, 2005; Munksgaard *et al.*, 2005). Blowey (1994) and O'Driscoll *et al.* (2009) explain that observed 11-12 h day^{-1} for lying time. Lying time was suggested as 12 h day^{-1} by Wolf (2000). Dairy cattle are reaching high production performance in 14 h day^{-1} laying behavior (Grant, 2004).

Feeding behavior were the longest in autumn (30.8%) and the decreased to 22.1% in spring. The main reason was that in autumn for the number of animal decreased in group and feeding length increased from 0.8-1.0 m $animal^{-1}$. Besides cows feed in a competitive condition except for autumn in freestall barn. That is why in this period feeding duration is higher than other seasons. Adequate access to feed is a high priority for dairy cows as illustrated by the aggressive interactions and displacements that occur when feed bunk space is limited (Huzzey *et al.*, 2006). In fact, increasing the space per cow at the feed bunk from 0.5-1.0 m reduced the occurrence of aggressive behaviours by 57% (DeVries *et al.*, 2004). The lack of an increase in displacements immediately after all milkings with greater stocking densities conflicts with previous research that found increased aggressive interactions when feed bunk space was restricted and cows were observed for 24 h

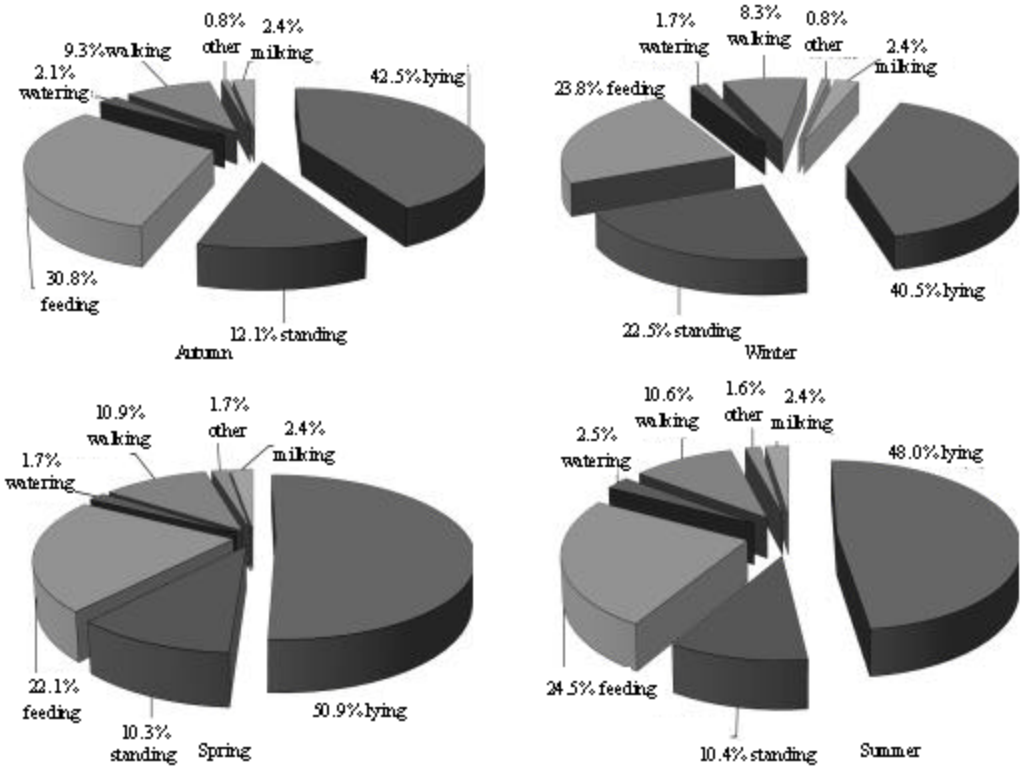

Fig. 2: Distribution of dairy cattle time budget in freestall housing for season

(Fregonesi and Leaver, 2002; DeVries *et al*., 2004; Huzzey *et al*., 2006). Huzzey *et al*. (2006) found that average number of durations that a cow was displaced from the feed bunk throughout the day increased with greater stocking density. DeVries *et al*. (2004) noted an increase in displacements from the feed bunk during the 90 min peak feeding duration as stocking density increased. It was observed that since in summer months animals mostly prefer closed barn under shadow, their feeding duration increased a bit more. The condition of building area (size, quality), climatic values and social environment were effective in behavioral durations of cows. West (2001) states that the main factors affecting the emergence of heat stress in dairy cows are environmental conditions, lactation periods, exercise, race, color, productivity level and feed consumption. McGuire *et al*. (1991) emphasize that in dairy cows when the temperature rises to 26°C, their dry feed consumption decreases and in 30°C feed consumption decreases to 90% compared to optimum temperature, in 32°C to 75%, in 40°C to 67%. Due to high temperature, feed consumption in cows decreases (Goings, 2003).

Walking behaviors were observed that in spring (10.9%) and summer (10.6%) was high duration as in autumn (8.3%) and winter (9.3%) was low duration. It was seen that in housing system walking behaviors increased in summer months. The main reason was that due to heat stress animals got away from comfortable housing conditions thus, their behavioral durations decreased and repetitions, back and front movements increased. During winter due to snow and low temperature animals preferred to stand close to each other in lying area and they do not moved much. In spring and autumn since climatic conditions are favorable cows prefer lying instead of walking. It was observed that as 0.8-1.7% for other behaviors and as 2.4% for milking in all season.

Seasonal area usages of dairy cattle in different parts of freestall barn are shown in Fig. 3. The courtyard area usages of dairy cattle were high in spring (16.60 h day^{-1}) and summer (14.77 h day^{-1}) and in autumn (11.00 h day^{-1}). It was observed that courtyard area usages were low 6.26 h day^{-1} in winter. Dairy cattle commonly preferred courtyard (open area) according to the other barn parts in all season except winter. Because barn doors were closed and courtyard was mud and dirty in winter, freestall usage of animals raised to 7.44 h from 0.76 h. The feeding time is removal of day time, cows preferred open area about 70% total activity period. This shows that dairy cattle did not prefer using freestall. Average freestall usage of animals was 1.95 h day^{-1} except for winter. The longest period of stall alley usage (3.6 h day^{-1}) was observed in winter. Dairy cattle unwilling preferred stall alley instead of freestall in winter. The use of stall alley was observed 0.62 h day^{-1} except for winter. Dairy cattle spent quite part

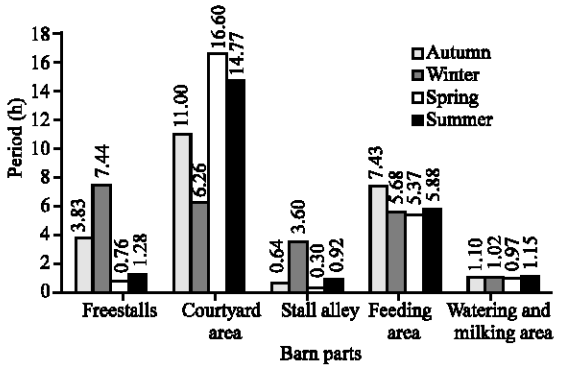

Fig. 3: The relation of area usage periods of dairy cattle and barn parts with seasons

of their time at feeding area (5.37-7.43 h day^{-1}). These results show that dairy cattle did not preferred use of freestall and stall alley. It is very important to give an attention in design barns for animal comfort. Cows spent varying proportions of time in the different functional areas (activity area 10-20%, feeding area 30-40%, lying area 40-60%), which are typical for loose housing system (Krohn *et al*., 1992; Munksgaard *et al*., 2005; Neisen *et al*., 2009).

Annual average area usages of dairy cattle were found as 3.33 h day^{-1} freestall, 12.22 h day^{-1} courtyard, 1.30 h day^{-1} stall alley, 6.09 h day^{-1} feeding and 1.06 h day^{-1} watering and milking area. Dairy cattle spent most of their time at courtyard, when climatic and outside area conditions were suitable. If courtyard have been more suitable in winter and autumn (dry ground and draught free) and summer (shaded area), its use of animal will increase. Dairy cattle spent second great part of their time at feeding area (6.09 h). Dairy cattle spent about 76% their time in courtyard and feeding area of freestall barn. Therefore, the design of courtyard and feeding area is very important to for increasing of animal production and welfare.

An average high temperature was 15.3°C at closed area of the barn and was 13.9°C at courtyard. Average low temperatures were 7.5 and 5.7°C, respectively in same season. In winter, the averaged low temperature was measured as 3°C at closed area of the barn and averaged high temperature was nearly 10°C. Temperature difference between closed area and courtyard was between 1-2°C in summer. Courtyard was found colder.

CONCLUSION

The observation studies shown that lying and feeding behaviors of animals were include of 76% day time. As a result, it was shown that dairy cattle usually preferred open areas. The animals usually spent their time in courtyard, although use of freestall. The design of new housing models must be a comfortable lying, courtyard and feeding area for increasing animal production and welfare.

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