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Research Article

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Evaluation of Structural Properties of Barns of Tekirdağ Province Cattle Breeders Association in terms of Animal Welfare

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Abstract This research was carried out in order to determine the conformity of the structural features of the barns, which belong to the Tekirdag Province Breeder and Cattle Breeders' Association, where breeding heifers are made, with the TS 5689/T1 numbered 'Cattle Barns Construction Rules' standard published by the Turkish Standards Institute, in terms of animal welfare and propose solutions to the problems encountered. The research area is located in the Thrace part of Turkey. As a result of the research, it was determined that the selection and positioning of the barn site was correct. However, it was determined that the ventilation systems in the barn were not planned properly and the internal volume per animal was more than necessary. This situation increases the cost of the building and makes it difficult to control the climatic environment at optimum levels. In order to provide the desired benefit from the barns, systems that will protect the animals from the negative effects of external environmental conditions and provide economy in time and labor should be built with a functional planning.

Keywords Heifer breeding, structural features, animal welfare

Introduction

The increasing world population and the nutritional need of people with qualified nutrients make it necessary to increase the production amount and quality of animal nutrients, which have an important place in basic food sources. Studies in this direction are gaining importance in our country as well as in the world.

Although Turkey is almost at the same level as developed countries in terms of livestock, the share of animal production in national income remains at very low levels. This result shows that some measures should be taken to increase animal production, which has an important place in human nutrition and the country's economy. Animal production can only be increased to the level of developed countries by including effective livestock policies and all kinds of research and development studies that increase productivity. In order to increase animal production, it is essential to improve and optimize the environmental conditions in living and sheltering environments, as well as increasing the yield potential of animals with feeding and genetic improvements [1].

The main purpose in animal breeding for commercial purposes is to obtain the highest and most economical yield against a certain expense. This can be possible if the environmental conditions in the barn are kept at an appropriate level together with adequate feeding and appropriate genotype [2].

In agricultural enterprises, barns have an important place in the buildings in the business center. Especially in enterprises whose main occupation is animal husbandry, the importance of animal barns is increasing. Barns are among the structures that need to be carefully planned because the animals housed in them are expensive and the products obtained are closely related to human health. In order to provide the expected benefit from barns, they must be planned, designed and builtin accordance with technical principles. This research was carried out

in order to determine the conformity of the structural features of the barns, which belong to the Tekirdag Province Breeder and Cattle Breeders' Association, where breeding heifers are made, with the TS 5689/T1 numbered 'Cattle Barns Construction Rules' standard published by the Turkish Standards Institute, in terms of animal welfare and propose solutions to the problems encountered.

Material and Method

The research was carried out in a cattle farm affiliated to the Cattle Breeders' Association in Malkara district of Tekirdağ province in the Thrace part of Turkey. The enterprise was established on 56 decares of land and has a closed area of 4500 m^2. The livestock establishment has 2 free-stall barns, each with a capacity of 250 heads. It was chosen as the material because the business in question sets an example for the local farmer. Malkara district, where the enterprise is located, is located at 40.54° north latitude and 26.52° east longitude, and its altitude is 250 m [3]. The semi-continental climate is dominant in the region. According to multi-year meteorological observation data, the annual average temperature is 13.2 °C, the annual average precipitation is 678.8 mm, the annual average humidity is 70%, the annual average wind speed is 3 m/s and the maximum wind speed is 29.6 m/s [4].

The research was carried out in two phases, field studies and office studies. In field studies, subjects such as site selection, positioning, material arrangements, building elements, ventilation systems, floor arrangement and waste management were determined by on-site measurements and observations. In the office studies, the compliance of the data obtained with the TS 5689/T1 Cattle Barns Construction Rules standard published by the Turkish Standards Institute was investigated and the problems encountered were determined and solutions were proposed [6].

Results and Discussion

In animal production structures, both the physiological activities of animals and animal wastes that occur in enterprises can create some problems in terms of environment and human health. In the same way, factors such as noise and noise originating from settlements can create negative stress on farm animals. Agricultural enterprises where animal production is carried out should be at a distance of at least 500 m and an average of 1000 m from the settlements. It should also be located far enough away from industrial areas, crowded, dusty main roads and excessively noisy areas [6;7]. It should be at least 300 m from lakes and similar water sources, at least 100 m from irrigation and drainage channels, and at least 30 m from sanitary installations that provide water. The selected terrain should preferably be flat or sloping to the south [5;8]. Considering the aforementioned TS 5689/T1 standard and literature information, the location of the barns in the enterprise is appropriate in terms of environmental health and animal welfare. The distance of the enterprise to the nearest settlement is 2000 m and the distance to the nearest highway is 700 m. There is no sound and noise pollution in the enterprise. The general view of the barns in the enterprise is given in Figure 1.

Figure 1: General view of research barns

Steel construction was used in the carrier systems in the barns, sandwich panels on the walls and 0.5 mm trapezoidal sheets on the roof. The use of steel material in carrier systems is suitable as it is highly resistant to incoming and future loads. The use of sandwich panels on the walls can provide effective natural ventilation in the barn by opening in hot weather. However, considering the climatic conditions of the region and especially the maximum wind speed of 29.6 m/s, the movement of the panel walls with the effect of the wind may create noise pollution in the barn. This noise pollution can have a negative impact on animal welfare. As stated in the TS 5689/T1 standard, it would be more appropriate to use bricks as wall material in the barns [5]. The general view of the panel walls used in the barn is given in Figure 2.

Figure 2: Panel wall systems used in the barns

On the other hand, the use of 0.5 mm trapezoidal sheet as a covering material will cause overheating of the barn air, especially in summer and transition seasons, and will create heat stress in the animals housed in the barn. For this reason, it would be a better choice to use insulated trapezoidal sheet as a covering material. As a matter of fact, the owners of the enterprises stated that the temperature in the barn is a big problem, especially in the summer months, the feed consumption decreases and the breeding heifers cannot show the desired development. In order to reduce the heat stress, some structural measures such as a fogging system should be taken together with an effective mechanical ventilation.

The barn floor is arranged in 4 rows as free-stall. The dimensions of the barns are 54.4 m in length, 32 m in width, 3 m in sidewall height and 7 m in ridge height. Roof slope angle is 14°. Based on the topographic structure of the place where it was established, its positioning was done correctly. Accordingly, the long axis of the barn was placed in the northeast-southwest direction. In the TS 5689/T1 standard, when free-stall barns are arranged in two or more rows, it is recommended to position them in the south-north direction in order for the animals to benefit from natural light to the maximum extent [5]. Therefore, considering the topographic structure of the land, it is appropriate to place it in the southwest-northeast direction.

Figure 3: General view of the free-stalls

Based on the climatic conditions of the region, it was appropriate to arrange the base of the barn in a free-stall system. The layout design is suitable for the free movement of animals within the barn. In other words, it allows the animal to move freely in the feeder, waterer and bed area whenever it wants. However, free-stall dimensions are sized based on adult culture breeds. The general view of the free-stalls in the barns is given in Figure 3.

Currently, the free-stall length is 210 cm and the width is 120 cm. The live weights of the breeding heifers ranged between 300-450 kg. Based on the live weights and morphometric characteristics of the heifers, the free-stall dimensions are more than necessary. This situation has led to an increase in the cost of construction. In free-stall barns, the varying free-stall dimensions depending on the live weight are given in Table 1.

Table 1: Required free-stall dimensions of cattle depending on body weight [5;6]

Live weight (kg)	Stall length (cm)	Stall width (cm)	Dividing height (cm)
135-180	120-130	70	70-85
180-270	150-170	80	85-90
270-360	170-180	90	90-95
360-450	180-200	100	95-100
450-500	200-210	110	100-110
500-600	210-230	120	110-115
600-725	230-245	125	115-120

Inside the barn, each heifer is falling an internal volume of approximately 35 m^3 and a floor area of 5.7 m^2. In the TS 5689/T1 standard, 18-21 m^3 internal volume and 4.5-7.5 m^2 floor area are recommended for each head of cattle (454 kg live weight) in closed free-stall barns under optimum conditions. Based on these values, in the current situation, each heifer is falling too much internal volume. Excess interior volume in the barn will increase the cost of the building and will make it difficult to meet the climatic environmental conditions at optimum levels in terms of animal welfare, especially in winter. On the other hand, the amount of floor area per animal is among the recommended values in the literature. The width of the manure stripping channels is 260 cm and this value is sufficient. The service road continues from one end to the other at the middle point parallel to the long axis of the barn. Its width is 480 cm. Feeding of animals is done on the service road. In the barns paddocks are built for the animals and each animal is falling an area of approximately 6 m^2. Although this value is sufficient, it is recommended to be 9-10 m^2 under optimum conditions [9].

Natural ventilation systems are applied in the barns. However, the use of windows as air inlet and outlet openings, the placement of windows as continuous openings on the barn walls, and the absence of covering material on the windows make it difficult to control the ventilation. On the other hand, the fact that the panel walls are not fully closed and air leaks from the openings in these areas affect the control of the ventilation amount negatively, creating a breeze inside the barn and causing the animals to be exposed to harmful air currents. In the barn, it will be possible to provide more controlled ventilation by covering the windows with glass and fixing them well on the panel walls. In addition, the arrangement of the air outlet openings left on the roof as given in Figure 4 will increase the ventilation efficiency [10;11].

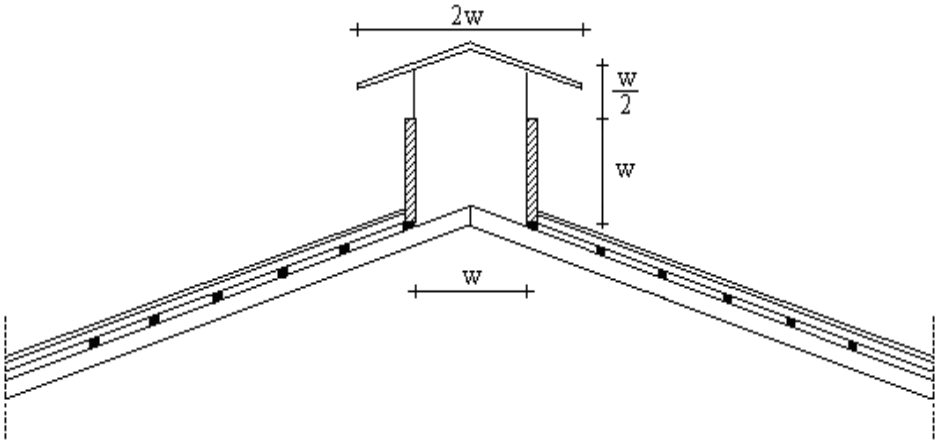

Figure 4: Cross-sectional view of the lantern type air outlet opening

Depending on the base width of the barn, the air outlet opening dimensions to be left in the ridge can be arranged according to the values given in Table 2 [5;6].

Table 2: Dimensions of the lantern type air outlet opening

Barn base width (m)	W (cm)	W/2 (cm)	2W (cm)
15	30	15	60
18	36	18	72
21	42	21	84
24	48	24	96
27	54	27	108
30	60	30	120
33	66	33	132

Lighting is as essential to animal health as water and air. In addition, lighting is essential for carrying out work inside the barn and creating hygiene and health conditions. The windows left for natural lighting in the barns where the research was carried out were placed on both long axis walls of the barns at a height of 240 cm from the bottom of the barn and 60 cm in width as a continuous band. Based on the wither heights of the heifers, the placement height of the windows is appropriate. The ratio of the windows to the barn base area is 13%. This ratio is in the range of 10-15% recommended for temperate and warm regions in the standard numbered TS 4654 [12]. There is an artificial lighting system in the barn. Illumination power is 2 W/m^2. This value is between the 1-4 W/m^2 limit values foreseen for heifers in the TS 4654 standard.

The pollution caused by animal wastes in enterprises or settlements is not a point-based pollution as in industrial and urban pollution sources, but a pollution spread over wider areas. The wastes generated in the barns where the research was conducted are stored in a way that does not harm the environment. The general view of the animal waste warehouse is given in Figure 5.

Figure 5: General view of the animal waste warehouse

Cattle produce approximately 8% of their live weight in wet manure in a day [6;10]. If the necessary precautions are not taken, animal wastes can create major environmental problems, especially in large-capacity livestock enterprises. In this context, it is important to adopt and implement the principle of 'zero waste' in livestock enterprises in waste management.

Conclusion

The barns examined were built in a free-stall system, and the location selection and positioning of the shelters is appropriate. Considering the environmental demands and behavior patterns of animals, research barns are suitable for breeding heifer breeding. However, keeping the internal volume of the barn too high and the internal volume per animal being much higher than the value recommended in the TS 5689/T1 standard increased the cost of the building. On the other hand, improper planning of air inlet and outlet opening areas in natural ventilation systems makes it difficult to control the climatic environment at optimum levels, especially in winter. As a result, barns are animal production structures built to protect animals from the negative effects of external

environmental conditions, to create a suitable production environment, to provide economy from time and labor with a functional planning. Therefore, animal production structures should be designed in accordance with the morphometric characteristics of animals, keeping animal welfare in the foreground.

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