# Chapter 4

# Investigation Of The Structural Features Of Dairy Cattle Facilities In Bursa Region

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## ABSTRACT

## INTRODUCTION

When the increasing population rates in the world are evaluated, the reality of how important nutrition and food sources are. Although animal products, which are among these food sources, have an important place in human nutrition, the amount of animal food per capita in Turkey remains at low levels compared to other OECD member countries.

While the production of milk and dairy products, which are necessary at every stage of human life, was 624,285 tons and 8,67 kg per person in 2010 in Turkey, it reached 1.195.940 tons in 2022 and realized as 14,23 kg per person (TUIK, 2022). Despite this increase, while the average milk consumption in European Union countries was 5,.8 kg/year in 2019, this rate is only 18,1 kg/year in Turkey. Likewise, when we look at the cheese consumption in 2019, the average cheese consumption in European Union countries is 19,1 kg/year, while this rate is quite low with 8 kg/year in Turkey (Anonymous, 2020). According to TUIK data for 2021, the total number of cattle in Turkey is 17,850,543 heads.

Animal husbandry is of great importance in the agricultural sector. With the increase in population, the demand for products such as meat and milk, which are important for human nutrition, is increasing. This increasing demand and need can be met by productive animal husbandry in modern enterprises and facilities, the structures of which are regularly planned and optimized in terms of environmental conditions.

When shelter and environmental conditions are mentioned, climatic, structural and social factors are understood (Mutaf and Sönmez, 1984). Climatic factors are ambient temperature and relative humidity, air velocity, various gases and dusts. Structural and social factors are resting places and stops, feeders, transition points, drinkers, walking areas, group sizes, and building elements depending on the shelter floor arrangement (McFarland, 2000; Rodenburg, 2003). Shelters require proper planning to protect animals from climatic environmental conditions and to provide an environment suitable for animal welfare and wishes. Shelter temperature and relative humidity values should be in accordance with animal requests. Otherwise, the health of the animals will be adversely affected and the desired yield will not be achieved. (Yüksel and Şişman, 2015).

Shelters are planned in order to eliminate the negative effects of environmental conditions for animals and to provide efficiency in production by creating a welfare environment. In the selection of shelter; Soil structure, topographic features of the land, location to the road, accessibility to water and electricity, location of other structures in the enterprise and the way they are arranged (or usefulness of the structures) should be taken into consideration. Base arrangement and technology use should be provided to increase the work

efficiency of the employees in the shelter. Appropriate development areas should be left for the shelter to be enlarged by considering future developments. The shelter should be placed in such a way as to allow integration with other structures in the operation center. It is expected that the construction of the barns is simple, air inlet and outlet openings are sufficient, comfortable and suitable for versatile use (Ekmekyapar, 2001; Arıcı et al, 2014).

Different barn models are applied in dairy cattle breeding in Turkey and in the world. The majority of small-capacity and traditional production methods use the barn type with closed and tied stalls. The possibilities of such enterprises to expand their capacity and implement innovations are very limited. These shelters are very difficult to operate. Feed distribution, manure cleaning, milking and maintenance are time consuming and tiring. Since animals are constantly connected, it is very difficult for them to fulfill their natural behaviors, that is, to ensure animal welfare. In addition, an unsuitable working environment for the caregiver reduces productivity. The free-open (semi-open) barn model, designed in accordance with the natural behavior of dairy cattle, allows animals to move freely. This type of barn is arranged according to the climatic conditions of the region and is applied in such a way that the east and south facades are open or completely open. Resting areas are freely provided for animals, and walking areas and mangers are arranged outside the barn. This building model, which was designed by taking into consideration the cost of the building and animal welfare, also has various disadvantages. First of all, there is a constant use of litter in the resting place, especially in winter. Since at least one side of the barn is open, yield losses can be seen as regional winds directly affect the animals. Therefore, we may encounter effects that restrict the widespread use of this barn model (Arıcı et al., 2014).

The ambient temperature of the shelter should be located within the limits called the Comfort Zone, where the animals perform their productivity in the best way and provide their comfort. In the researches, it has been determined that the optimum temperature value for dairy cattle is between 4 and 21 ºC. At temperatures above this value, heat stress occurs depending on the height in air humidity. In particular, Temperature-Humidity Indicators are used to determine the effects of temperature and humidity on dairy cattle (Armstrong and Welchert, 1994). In order to minimize the decrease in efficiency caused by heat stress, it is recommended to provide good ventilation in the shelter by natural means, to use mechanical fans to increase air circulation, and to cool by sprinkling (Armstrong, 1994). This efficiency can be increased with the insulation to be provided in the building elements (Bickert et all., 2000).

One of the climatic environmental conditions in dairy cattle barns is relative humidity. Relative humidity has a significant effect on animals and its negative effects become more evident with temperature. Since high relative humidity and temperature stress the animals, especially in summer, it leads to a decrease in feed consumption and decreases milk yield. For this reason, the most suitable environmental conditions for dairy cattle can be provided at temperatures of 10-15 ºC and relative humidity of 70-80% (Balaban and Şen, 1988). Likewise, the combined negative effects of high temperature and relative humidity and high solar radiation are more common. As a result, yield losses occur as feed requests and feed consumption decrease (Mutaf and Sönmez, 1984).

In the welfare and productivity of animals, good air quality must be ensured in the barn environment. There should be good ventilation in it. In animal shelters, ventilation is carried out in order to provide the oxygen requirement of animals, to remove various harmful gases and microorganisms, to provide heat and water vapor balance (Noton, 1982). For this purpose, dairy cattle barns can be named as closed and open systems and as cold, adjustable and warm barns according to their insulation properties (House and Rodenburg, 1994).

Marmara region is one of the regions where dairy cattle breeding is intense. Likewise, the basic production structure of many enterprises in Bursa and its districts is based on dairy cattle breeding. However, the majority of enterprises have traditional production methods and structural problems that make production and efficiency difficult in many ways. In this study, the structural problems of dairy cattle enterprises in the settlements in Bursa Province, Nilüfer District, Karacaoba Neighborhood were examined. The problems for the newly established businesses in the region were analyzed on-site and solutions were developed.

## MATERIAL AND METHOD

The research was carried out in dairy cattle farms located in Karacaoba Neighborhood, located within the borders of Nilüfer district of Bursa province. The region is located in the northeast of Uluabat Lake. The boundaries of the neighborhood are 2,3 km in east-west direction and 4,6 km in north-south direction. The entire area is 7,141,493 m2. In the study, businesses within the borders of Karacaoba Neighborhood were examined (Figure 1).

According to 2019 data in Nilüfer district, it has been determined that there are 12836 cattle, 3791 of which are milked cows. With a milk yield of 9.53 kg/day per animal, total milk production was 13,013.53 tons/year. In Turkey, the total number of cattle is 17,850,543 heads, according to the 2021 TUIK data. Bursa's annual average temperature is 14.6 degrees, annual average precipitation is 709.5

mm, and average humidity is 73.16%. The annual average wind speed in the region is 15 km/h and the prevailing wind breeze is in the north-northeast direction. Bursa's annual average temperature value is 14.2 degrees, annual average precipitation is 674 mm, humidity average is 69%, although the prevailing wind direction is northeast, it varies and the annual average is 12,08 km/hour (Anonymous 2022).




**Figure 1.** View of the Research Area

Due to the lack of statistical data on the financial values, agricultural incomes and land sizes of dairy cattle breeding enterprises in the research region, 15 randomly selected enterprises were chosen as research material, taking into account their size and location in the selection of enterprises. In this election, businesses are classified as small, medium and large scale.

The data on the business structures determined as research material were provided with measurements, sketches, surveys, data obtained from the relevant municipality and photographs taken (field and drone photos). All structures and structural elements of the dairy farms in the farm yard were measured with laser meters and sketches were drawn in computer-aided programs (CAD) at the scale of the situation. Structural features of the shelter and other structures are presented with views, sections and photographs. The structural characteristics of the examined enterprises were evaluated by filling in the questionnaire forms prepared for the buildings according to the results of one-to-one interviews with the owners, employees and veterinarians.

**RESULTS**

The average dairy cattle capacities of the 15 enterprises examined in the research vary between 10 and 180 heads. Animal capacities may vary depending on the structural size of the enterprise, the financial possibilities of the owners of the enterprise, and livestock and economic developments. Although most of the surveyed businesses are family businesses, there are businesses with employees. The majority of the surveyed enterprises are over the age of 15, and only one enterprise has been established in the last 5 years. Again, the ones other than the last established enterprise were not built in line with any project. It has been observed that the businesses are mostly done with traditional methods. Project enterprises were built without any support from any institution or organization.

Most of the enterprises produce especially fodder crops to meet their roughage needs, and purchase the missing part from outside, and use this mostly by supplementing it with their own feed. Small-scale enterprises, especially in the north of the study area, far from the settlement, cultivate forage crops near the enterprise, so that they can reduce their feed costs, whose costs are about 2 times compared to the previous year at the date of the examination.

Briquettes and bricks were used as the wall material of the animal shelters in the enterprises, and it was determined that 2 enterprises were made of wood material. In 3 buildings, it was determined that the shelter was covered with sheet metal panels instead of the wall (Figure 2).



**Figure 2.** Shelter side wall material preference (sheet material)

It was observed that wood was used in the bearing elements of the old buildings, steel was used in 6 enterprises, and reinforced concrete was used in the new and large-scale structures. Plaster-paint or any coating and heat insulation

materials were not used in the examples where brick was used on the side walls of the barn structures (Figure 3). This not only reduces the life of the building but also affects the animal welfare due to the fact that the structure is exposed to thermal changes in summer and winter.

The barn roofs are covered with insulated sandwich panel material in 2 shelters and with uninsulated tile, corrugated and single layer sheet material in the others (Figure 4). The uninsulated roofs cause heat losses in winter, while in summer it can lead to overheating of the shelter.



**Figure 3.** A view from the shelter exterior



**Figure 4.** An example of a shelter roof covering

Natural ventilation system is applied in all of the barns. The inadequacy of the air inlet and outlet openings required for natural ventilation cannot provide the desired air exchange. Only two of the barns examined have ventilation openings

on the side walls and in the ridge above the roof. In the vast majority of them, ridge ventilation was not provided and air inlet openings were not left on the side walls, and the doors were found sufficient to be used for this purpose. In the barns where the free barn system is used, one surface is kept completely open.

The ventilation system plays an important role in ensuring animal and employee health in the shelter interior. With ventilation, the accumulation of harmful gases caused by animal respiration and feces in the shelter is prevented, and it becomes possible to maintain the indoor temperature and humidity balance. When a suitable environment is provided for the animals, an increase in feed consumption can be achieved and this situation will directly reflect on the animal yield. High temperature causes stress in dairy cattle and reduces productivity. For this reason, it is important to choose the cold barn type, which is designed by arranging the air inlet and outlet openings by leaving continuous openings in the side wall and ridge, in accordance with the characteristics of the region, in the shelter planning, in which maximum ventilation in summer and minimum ventilation in winter can be made. (Olgun, 1989; Arıcı et al., 2014).

The barns of the examined enterprises were built in 3 different types. 3 barns with free stalls, 3 with tie stalls and the other 9 barns are planned as free barns, which were built recently and evaluated among large-capacity enterprises. Although the business structures, which have been in use for about 20 years, were designed in a tied system at first, most of them were converted to a free system by removing the fastening mechanisms. Here, the producers stated that they took the developments in the region into account or made changes in their structures with the warning of the experts. However, in the observations and measurements, it has been observed that the areas reserved for animals are insufficient (the area allocated per animal is between 2.5-3 m2), therefore the animals may experience stress in the shelter. In some barns, it was observed that there were quite large areas due to the low number of animals. It is stated that in this type of shelters, an area of 5-7 m2 per animal should be allocated at the resting place (Arıcı et al., 2014). In addition, as seen in Figure 2, the side wall height of the barn is 2.3 m, which is quite insufficient considering the climatic conditions of the region, which can affect the indoor air volume and thus the air quality. Yüksel and Şişman, 2015, suggest the sidewall height as 2.55 m in temperate regions.

It is seen that large-capacity enterprises are planned as free-stall barn type. It has been determined that these enterprises were built without benefiting from any support, and they benefited from the personal efforts of the business owners and the plans of the businesses they saw in the environment. It can be said that they have a clear advantage over the traditional businesses. The most important indicators are that the level of mechanization in the shelter is better than in other

enterprises. Feed distribution, manure cleaning and milking automation are developed. Herd management and feed ration are carried out in a planned manner. Animal needs are given priority. Animals are raised by constantly consuming the feed given in their shelters and keeping them under control. Since the floor arrangement of traditional farms does not leave enough space for animals, it is insufficient to provide the desired environmental conditions. In the barn, the feeders are not arranged properly, the drinkers cannot provide water to the animals continuously in some enterprises (Figure 5).




**Figure 5.** In-house drinkers

Appropriate space has not been allocated for maternity chambers and newborn animals. This may result in injury or even death of newborn animals. In addition, most of the farms do not have a calf compartment and the animals are raised collectively.

In most of the 67% of the enterprises, there is no fertilizer and feed storage structure. Manure, most of which is shoveled by hand, is transferred out of the barn, where it is collected for a certain period of time and transported to the fields (Figure 6).



**Figure 6.** An example from the outdoor manure storage area

Significant pollution has been observed in this process. The level of flies, insects and odor has the potential to harm the environment and animals. It has been observed that even in large enterprises, there are insufficient fertilizer warehouses or significant problems are encountered due to planning errors. Similarly, feed storage structures either do not exist or are not of sufficient size and feature. Silage is mostly stored horizontally above the ground. It has been observed that it is also stored in trailers in some enterprises. Concrete silos are only available in businesses that have been built recently. Poor storage can lead to large feed losses.

In most of the structures, serious corrosion has been observed in steel carriers, roofing materials and even reinforced concrete parts. In the building example, the deformation of the steel roofs is at an advanced stage and it has been determined that the structure and the living things in it have reached such dimensions that they can be damaged, and the owner has stated that he will make repairs in these areas (Figure 7).



**Figure 7.** Example of corrosion in structural elements

Finally, many businesses are located in the neighborhood residential area. This causes businesses to be stuck in limited and small areas, not suitable for correct planning and mechanization, and completely limited growth opportunities in the future. At the same time, these businesses, which are located in the residential area, disturb the people living in the houses in terms of smell and pollution (Figure 8).



**Figure 8.** Businesses intertwined with residential areas

## CONCLUSION

In the study, the structural features and problems of dairy cattle farms located in Bursa Province Nilüfer District Karacaoba Neighborhood were tried to be determined. Although it is seen that the enterprises over 20 years old and built with traditional methods in the study area have many problems, it is seen that the region has a very important potential for dairy cattle breeding due to its advantages such as its past habits, proximity to metropolitan cities, and the presence of many dairy processing facilities. It is possible that the problems encountered in the enterprises can be improved with the renovation works. However, the renewal of the enterprises developed in the traditional settlement order and the increase in their capacities limit the desired arrangements due to the inadequacy of the courtyard areas. However, it would be more appropriate to establish new businesses with the relocation of businesses outside the existing settlement center.

In the study, the majority of existing enterprises are insufficient to provide animal productivity. The most important indicators of this are that barn systems suitable for animal welfare are not used. Since the dimensions of the majority of the shelters are not suitable for animal demands and adequate ventilation is not created, the air quality of the shelter affects the animal productivity. The most

important indicator of animals' adoption of their environment is their adaptation to the weather conditions in their environment.

Barns are planned in order to provide suitable environmental conditions for animals, to increase animal productivity by improving health conditions, to create a suitable environment for workers and to extend the life of the building by preventing damage to building elements (Olgun, 1989). Dairy cattle are more productive in comfortable environments. In order to ensure the positive development of the behavior of animals during feeding, movement and rest, barns should be clean and dry and protect animals from variable weather conditions (Holmes and Graves, 1994).

In order to ensure animal welfare, the environmental conditions in the shelter should be controlled according to animal requests. In this context, subjects such as temperature, relative humidity, air flow, chemical composition of the air, illumination, and noise should be carefully considered (Yaganoglu, 1988; McFarland, 1994).

The most important indicators that determine the profitability of a business are the investment cost and operating expenses. With the barn design that can be arranged in accordance with the regional conditions, the operating investment cost can be reduced. For example, semi-open barn systems not only provide good ventilation, but also reduce construction costs due to less material use and lightweight construction. Tie-stall barns increase the construction cost per animal. Şimşek and Yaslıoğlu, 2006, determined that greenhouse type shelters will be built at 57% lower cost compared to closed system shelters. As a result of the effective use of mechanization processes in the barn, which increase work efficiency, in reducing the operating costs, especially since it will facilitate feed distribution, manure cleaning and milking, it will be possible to get a return on the investment made beforehand.

Barns should be designed in a way that will meet animal demands and natural behaviors, taking into account the choice of location and future developments, with minimum use of labor and low cost, and it should be ensured that the problems that may be encountered in the future are at a minimum level. Otherwise, it should be noted that it will be very difficult and costly to arrange the mistakes to be made. For this reason, dairy cattle business structures should be designed by taking into account the opinions and suggestions of experts.

In dairy cattle breeding, the environmental conditions of the animals have an important effect on the productivity of the animals along with the desire and welfare of the animals. The shelter environment must first have good air quality. For this, attention should be paid to the planning of structural features, from building insulation to sizing the ventilation system. Considering the age and

characteristics of the animals, a suitable barn floor arrangement should be made that will enable the animals to find a comfortable environment.

The wishes of the employees should never be ignored, and the use of automation and herd management systems that will ensure work efficiency should be supported. Low cost and easy installation of the planned barns should be provided to meet the animal and employee demands. In summary, the following suggestions can be made to eliminate the problems observed in the research area;

- Measures should be taken to prevent environmental and water pollution,
- The contribution of the young population to production should be increased,
- Systems for low-cost building design should be evaluated,
- Shelters that increase the welfare of animals and workers should be developed,
- Producers should benefit from appropriate business support,
- Feed storage and fertilizer warehouses should be established,
- Producers should be provided with information about new production techniques,
- Product sales prices should be increased while input costs are reduced,
- Producers should be provided to increase their quality production and sales opportunities in an organized manner,
- Efforts should be made to reduce feed production costs.

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