Structural Analysis of Dairy Cattle Barns in Ilgın and Their Effects on Environmental Pollution

Ejder Demir and Selda Uzal Seyfi

Abstract—**Global warming is one of the most important environmental problems. Gases originating from dairy farms have an important place in world greenhouse gas production. In order to minimize the environmental impact of harmful gases originating from milk production, dairy cattle barns must be constructed in accordance with the planning principles. In addition, it is possible to increase the quantity and quality of the milk, which has an indispensable place in human nutrition, as the barns are constructed in accordance with the animal welfare, as well as the limit level of the harmful gas in the barn. This can be done in two steps. First, it is necessary to investigate the suitability of existing livestock building for animal breeding and to propose solutions by identifying problems. In the second stage, the newly established livestock buildings are designed which is appropriate for animal welfare. This study was carried out in 2017-2018 in order to examine the structural characteristics of dairy cattle barns in the Ilgın district of Konya in Turkey and to determine its suitability for animal welfare and the effects on the environment. In the study, 20 shelters with the ability to represent dairy cattle houses in the region were investigated. The shelters examined in the study were determined by purposeful sampling method. In the study, face-to-face surveys were conducted to determine the characteristics of dairy farms and barns. Measurement, observation and photographing were carried out in order to examine the structural features of the shelters in more detail. As a result of the study, it was determined that about 50% of the dairy cattle barns were built in the last ten years and 25% were built before 1990. it was determined that while the owners of the shelters designed the shelter projects with his own thought in 70% of the shelters surveyed, they designed projects with support of an expert in only 30%. In the majority of the farms surveyed, no measures against environmental pollution were observed. The elimination of the deficiencies of the shelters in the research area will be very useful in terms of animal welfare, production performance and environmental pollution.**

Index Terms—**Dairy cattle houses, dairy farms, structural analysis, environmental pollution, Konya.**

I. Introduction

The most negative effect of animal production on the environment is the source of a number of infectious disease agents. The propagation ways of these factors on the environment are direct pulses and indirect pulses. The pits where are stored wastes which are removed from barns and poultry poses create a great danger as a source of disease for humans and animals.

It is seen that some disease agents originating from animals can survive for about 1 week to 3 years in nature and that pollution to be formed in the environment has not lost its activity for a very long time and continues its life as a microorganism [1].

Inside of the shelter is created temperature, humidity, air flow and various gases, odors and dusts, slaughtering products arising from cutting and processing applied to dead animals constitute the external environment.

Other auxiliary structures which outside of shelter in court of the dairy farm (slaughterhouse, fertilizer, feed depot, etc.) have been created an agricultural operation together with animal shelter, environmental pollution arises as a result of the operations applied in these areas. For this reason, it is necessary to remove the harmful wastes that cause environmental pollution, which adversely affect human and animal health, both within and outside the agricultural structure. If this is not possible, it should be kept below the tolerance values which will not harm the environment [2], [3].

Livestock produces a large of amount of fertilizer depending on the capacity of the dairy farms. Fertilizer operation is one of the main problems in many businesses and there is not much emphasis on processes such as cleaning, removing, storing and applying fertilizer. Solid and liquid fertilizers in barns are collected or thrown in an unplanned way. Exception of the Black Sea region of Turkey's territory 65 % organic deficiency is known [4]. When we consider the lack of organic matter of 65% in our soil, the evaluation of organic fertilization in this way causes the national wealth to be wasted and great environmental problems. Farming has been developed in the countries, has been recorded a lot of progresses at the point of fertilizer operation and management in the countries [5].

During history, animal raising has played an important role in the social and economic achievement of societies. Livestock has been a branch of agricultural activities; the population has been interested in farming deal with both livestock and land while obtaining various products.

As the culture level of the societies increased, there has been also an improvement in livestock breeding, and it has been recorded an increase in animal products from various species. Livestock has contributed to the economies of all countries at varying rates. Although Türkiye has an important place in terms of the numbers of animal, the production of animal products is low. Animal breeding in Türkiye holds an important place in terms of being in feeding the growing population and industrial raw materials. Although animal breeding has developed rapidly in our country, it has not reached the desired level. Türkiye has a great potential in terms of livestock with a variety of climates and pastures. Animal breeding is an indispensable sector in economic and

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The authors are with Selcuk University, Faculty of Agriculture, Dept. of Farm Structure and Irrigation, Konya, Turkey (e-mail: edemir@gmail.com, seldauzal@selcuk.edu.tr).

social terms due to the activities it has created in agriculture [6], [7].

Animal houses provides suitable and stress-free areas for viable and so this is one of the most important factors affecting the productivity of animals and an economic operation. This is possible to create stress-free shelter areas according to the preferences of animals [8] (Uğurlu and Uzal 2002).

Yağanoğlu [9] reported that minimizing the effects of environmental conditions on animals and keeping them at economic boundaries would only be possible by developing appropriate solution proposals by investigating existing shelters in different climatic and environmental conditions.

There are 15.943.537 total cattle in turkey in 2017 [4]. The cattle in Konya is 890,545,345 [4]. Konya is ranked first in terms of number of cattle in Turkey. At the same time it is ranked first in terms of 1,200,055 (tons) milk production in Turkey (nearly 18.8 million tons) [4]. Konya - Ilgın has an important share about 41,000 bovine animals among Konya Districts. It is taken parted in research because of these potentials.

Global warming is one of the most important environmental problems. Gases originating from dairy farms have an important place in world greenhouse gas production. In order to minimize the environmental impact of harmful gases originating from milk production, dairy cattle barns must be constructed in accordance with the planning principles. In addition, it is possible to increase the quantity and quality of the milk, which has an indispensable place in human nutrition, as the barns are constructed in accordance with the animal welfare, as well as the limit level of the harmful gas in the barn. This can be done in two steps. First, it is necessary to investigate the suitability of existing livestock building for animal breeding and to propose solutions by identifying problems. In the second stage, the newly established livestock buildings are designed which is appropriate for animal welfare.

The aim of this study was to determine the structural properties of dairy cattle barns and the effects of them on environmental pollution in the Konya, ranks first in milk production in Turkey, Ilgın that has a significant potential. In this study, the structural properties of dairy cattle barns, appropriateness of animal breeding and animal welfare, the effects of dairy cattle breeding on environmental pollution were investigated and the solution proposal was tried to be developed.

II. Material and Methods

This study was carried out in 2017-2018 in order to examine the structural characteristics of dairy cattle barns in the Ilgın district of Konya in Turkey and to determine its suitability for animal welfare and the effects on the environment. In the study, 20 shelters with the ability to represent dairy cattle houses in the region were investigated. The shelters examined in the study were determined by purposeful sampling method. In the study, face-to-face surveys were conducted to determine the characteristics of dairy farms and barns. Measurement, observation and photographing were carried out in order to examine the structural features of the shelters in more detail.

The important part of investigated dairy farms consists of livestock buildings with loose and freestall barn planning system. In the selected dairy farms, a questionnaire including a structural properties of the dairy farms, land use, labor force utilization, level of technology usage, where the shelter project was procured, transportation conditions and problems, manure management and requirements were prepared and a survey study was conducted.

The suitability of examined the dairy cattle barns in the study in accordance with the planning principles, animal behavior and welfare and their effects on environmental pollution was evaluated by using the studies of Olgun [10], Uzal Seyfi [11], [12], Uzal [13], Ekmekyapar [14], Blowey [15], Webster [16] and Balaban and Şen [17].

III. Results and Discussion

A. General Characteristics of the Dairy Farms

The distribution of the investigated dairy farms in this study according to their location is determined according to the density of the dairy cattle farms in the research area and given in Table 1. Distribution of the dairy farms according to their positions is as follows; Ilgın center 20%, Ağlar neighborhood 20%, Zaferiye neighborhood 10%, Uçarı neighborhood 10%, Gedikören neighborhood 15% and Orhaniye neighborhood 25% (Table I).

TABLE I: The Distribution of the Investigated Dairy Farms in This Study According to Their Location

Location of Dairy Farms	Number of Dairy Farms	Percentage, %
Ilgın(centre)	4	20
Orhaniye	5	25
Ağlar	4	20
Zaferiye	2	10
Uçarı	2	10
Gedikören	3	15
Total	20	100

It is found that 70% of the investigated dairy farms have loose housings, 15% were freestall system and 15% were farmed in tie-stall shelters. The fact that a significant portion of the dairy farms (85%) are planned in loose housing and free-stall housing systems that is more appropriate for animal welfare is a positive development in terms of increasing animal production and eliminating the adverse effects of environmental conditions on livings. Öztürk [18] reported that 92% of the shelter systems used in the dairy farms were loose housing systems and 8% were freestall housing systems. Uğurlu and Uzal [19] emphasize the appropriateness of loose and freestall houses to ensure that animals are housed in environments that are close to their natural surroundings and that animals benefit more from fresh air and sunlight to reduce the stress effect on animals.

The average capacity of the investigated dairy farm with tie-stall houses in the study is 20 heads and above while it is over 70 heads in the dairy farm with loose and freestall houses. In this study, only the characteristics of loose and freestall houses have been examined since it is a more suitable

planning system for animal welfare.

B. The Structure Properties of Dairy Cattle Barns

In this study, when the investigated dairy cattle barns are evaluated according to their animal capacities; 20-40 heads of 30% of dairy farms, 41-60 heads of 20%, 61-80 heads of 20%, 81-100 heads of 15% and 101 heads and over. Nearly 70% of the examined dairy farm in this study are over 60 heads.

TABLE II: DISTRIBUTION OF THE INVESTIGATED DAIRY BARNS ACCORDING TO ANIMAL CAPACITIES

Number of animals	Number of dairy barns	Percentage, %
20-40	6	30
41-60	4	20
61-80	4	20
81-100	3	15
101 and above	3	15
Total	20	100

In the study, the examined dairy cattle barns are evaluated in 6 groups according to their establishment dates. It is as follows; shelters prior to foundation year 1990 1st group, 1990-1995 2nd group, 1996-2000 3rd group, 2001-2005 dates 4th group, 2006-2010 dates 5th group, shelters after 2010 6th group (Table III). It has been determined that 60% of the examined shelters in the study were established after 2000. It has been determined that 25% of the shelters are before 1990 year of establishment. Nearly 50% of the shelters are found to have been established within the last 10 years.

TABLE III: DISTRIBUTION OF THE INVESTIGATED DAIRY CATTLE BARNS ACCORDING TO FOUNDATION YEAR

The group of barns	Foundation years	Percentage, %
1st group	<1990	25
2nd group	1990-1995	5
3rd group	1996-2000	10
4th group	2001-2005	10
5th group	2006-2010	20
6th group	2010<	30
Total	20	100

It has been determined that 70% of the shelters surveyed in the study have built their own sheltered and inspired shelters and 30% have received technical support and assistance from private firms. In the purchase of technical support, it was determined that the standard projects prepared by the companies to which the milking unit was awarded were used. Kayar [20] found that 42.4% of the livestock houses owners had made inspections in the sample dairy farm before the start of the construction of the shelter and that they got information from the owners, 33.3% of them had done the shelter and auxiliary facilities with their own experiences, 6% 1 of them visited and used their own farms, 3% of them benefited from the projects in the Provincial Directorate of Agriculture and 3% of them stated that they had made shelter and auxiliary facilities by consulting with technical staff.

Material Types and Dimensions of Building Elements of Dairy Cattle Barns

The floor areas required for animals has a very important place in terms of animal welfare and production performance. The stocking density of the resting areas are calculated as 3.51-3.80 m^2 per animal in 15% of the examined dairy cattle barns, 5.01-6.50 m^2 per animal in 20%, and higher than 6.50 m^2 per animal in 50% of them (Table IV). Olgun [10] and Ekmekyapar [14] reported that it would be more appropriate to plan the stocking density of the resting area as 5-7 m^2 per animal, and Uzal [13] reported as 6-10 m^2 per animal for resting area in terms of animal welfare and increasing animal production. In this study, approximately 50% of the examined shelters were appropriately planned for the literature reports.

TABLE IV: DISTRIBUTION OF THE INVESTIGATED DAIRY CATTLE BARNS ACCORDING TO STOCKING DENSITY OF RESTING AREA

The stocking density of resting area	Number of dairy barns	Percentage, %
< 3.5 m^2 per animal	0	0
3.51-3.80 m^2 per animal	3	15
3.81-5.00 m^2 per animal	3	15
5.01-6.50 m^2 per animal	4	20
6.50 m^2 per animal <	10	50
Total	20	100

In this study, the stocking density of courtyard areas is calculated as 4.80-6.90 m^2 per animal in 15% of the shelters, 7.00-8.90 m^2 per animal in 35% and the higher than 9.00 m^2 per animal in 50% of the shelters (Table V). Olgun [10] and Ekmekyapar [14] were reported that it would be more appropriate to plan the stocking density of the courtyard area should be at least as much as the resting area. Preferably, however, it is more convenient to leave an area twice as large. The courtyard stocking density should be separated for soil-based courtyard areas as 30 m^2 per animal for dairy cows and 20 m^2 per animal for young cattle [10]. In terms of animal welfare, it is more appropriate to leave the courtyard area as a soft natural ground and 15-25 m^2 per animal [13]. Increasing the courtyard area per animal in a significant portion of the examined barns would be beneficial in increasing animal production.

TABLE V: DISTRIBUTION OF THE INVESTIGATED DAIRY CATTLE BARNS ACCORDING TO STOCKING DENSITY OF COURTYARD AREA

The stocking density of courtyard area	Number of dairy barns	Percentage, %
<4.00 m^2 per animal	0	0
4.00-4.90 m^2 per animal	1	5
5.00-6.90 m^2 per animal	2	10
7.00-8.90 m^2 per animal	7	35
9.00 m^2 per animal <	10	50
Total	20	100

The floor, walls and foundations of dairy cattle barns have a significant share in stability. The resting areas of the examined shelters; 10-20% of the shelters have a height of 11-20 cm, 15% of them are 21-30 cm and 25% of them are 31-40 cm higher than the ground of courtyard area. However, in the 50% of the shelters, the resting area is at the same level with the ground of courtyard area. It has been determined that the floor of resting area is constructed as concrete in the whole of the loose houses. The floor of courtyard areas is constructed as cobblestone in 60% of them while compacted soil in 20% of them.

The basic width of the studied shelters is 40-60 cm and the basic depths are around 80-150 cm. Okuroğlu and Delibaş [21] suggest that the depth of the base frosts in cold regions should

be 80-130 cm. This shows that the existing bases are at a sufficient depth.

The shelter walls were made of mud brick at 5% of the barn, brick at 50% of them and brick at 45% of them. No stonewall was found in any of the dairy cattle barns. In only 10% of the shelters, the shelter is made of briquettes and bricks made of concrete or stonewall with a height of about 50-100 cm from the wall.

In the studied houses, 25% wood and 75% steel constructions were used as roof frame. 60% of the examined shelters were built as cradle roofs and 40% were constructed as porch roofs. As roofing material, 15% of shelters are eternit (eternit on 5 cm thick board), 15% are tile (10 cm reed coat, 5 cm mud straw mixture, tile on), 65% insulation and roofing were not used) and 5% had sandwich panels. 65% of the shelters examined did not use insulating material.

Door widths are less than 90 cm in 20%, 90-120 cm in 20%, and 120 cm in 70% in 10% of the shelters where the research is carried out. The door heights of the loose houses were measured 195 cm above the shelters. 20% of the shelter doors are made of wood and 80% of the barns are made of niobium steel. It is recommended that the width of the door is 120 cm and the height of the door is 200 cm, where the animals can freely enter and exit the barriers where the existing material and feed entrance are by hand [14]. It can be said that the door sizes of almost all of the examined loose houses are sufficient.

The window of investigated dairy cattle barn are wood in 25% of the shelters, and 75% of them preferred iron windows. Of the barn windows, 45% are 51-100 cm and 55% are 101-150 cm. The height of the windows, 55% is 31-90 cm, 45% is 91-120 cm. In the examined shelters, the elevation from the shelter floor of the windows was found to be 95-150 cm in 40% of the shelters and around 150 - 190 cm in 60% of the shelters. Balaban and Sen [17] suggest that the window width and height should be 100 cm or more in a shelter with 20 heads in order to enlighten the shelter and to ensure good visibility.

Uğurlu and Uzal [19] report that animals should be housed in environments that are close to their natural environment in order to reduce the stress effect on the animals and emphasize that the breadth of the open area must be as large as possible for animals to benefit more from fresh air and sunlight and is observed an improvement in this area . The dairy farms should follow the technology and account the animal population and the shelters should be designed according to these data.

IV. Conclusion

As a result of the study, it was determined that about 50% of the dairy cattle barns were built in the last ten years and 25% were built before 1990. it was determined that while the owners of the shelters designed the shelter projects with his own thought in 70% of the shelters surveyed, they designed projects with support of an expert in only 30%. In the majority of the farms surveyed, no measures against environmental pollution were observed. The elimination of the deficiencies of the shelters in the research area will be very useful in terms of animal welfare, production performance and environmental pollution.

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Selda Uzal Seyfi was born in Samsun, Turkey in 1980. He received the B.Sc. degree in Dept. of Farm Structures and Irrigation from Ondokuz Mayıs University and the M.Sc. and Ph.D. degree in Dept. of Farm Structures and Irrigation from Selcuk University in Turkey in 2001, 2004, and 2008, respectively.

From 2001 to 2014, she had been a research assistant at Dept. of Farm Structures and Irrigation, Selçuk University, Konya, Turkey. She has been Assoc. Prof. Dr. since 2014 at the same department. Her research interests include animal behaviour, farm structures and dairy farms.