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DETERMINATION OF STRUCTURAL CHARACTERISTICS OF LARGE-SCALE DAIRY FARMS: EXAMPLE OF YOZGAT PROVINCE

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Abstract: This research was carried out to determine the status of dairy cattle farms in Yozgat province, which has significant potential in animal husbandry, to evaluate the positive and negative aspects of the existing barns, and to put forward suggestions for solving the problems. The research was completed by conducting observation and physical measurement studies in 28 dairy cattle farms with more than 50 milking animals, which we classified as large-scale, with the data obtained through questionnaires. Most dairy farms were established in the last ten years and received investment and grant support from various public institutions. It has been observed that the criteria suitable for animal welfare, especially in ventilation and building materials, are not followed by avoiding investment costs in farms established with equity capital. In the dairy farms established by receiving grants and investment support, it was observed that the stables were built in conditions suitable for animal welfare. Still, the herd management system was not established, and the records were not kept healthy because the farm owners and employees of the farms were insufficient in dairy cattle breeding knowledge, which would increase the costs. Although the majority of the examined enterprises did not have structural and technical problems, the absence of a birth partition in 21.43%, an individual calf pen in 25%, a ventilation shaft in 3.57%, and a manure pit slope in 28.57% was seen as an obstacle for these dairy farms to be modern enterprises. It is recommended that the economic sustainability of dairy cattle farms, which is a long-term investment branch, does not only depend on having sufficient equipment in terms of structural features but also on farm owners and employees should have sufficient knowledge and infrastructure on dairy cattle breeding and training should be provided to the relevant people.

Keywords: Large-scale dairy farms, Barn, Dairy cattle, Yozgat

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1. Introduction

The way to create a livestock sector that can compete with the world in milk and meat production is through intensive livestock breeding. According to the farm's milk or meat production purpose, it is necessary to raise animals of qualified breeds with quality feeds in a modern way under hygienic care feeding conditions. In intensive animal breeding, which is done by providing the environmental conditions needed by animals with good genetic characteristics and feeding them with quality feed sources to obtain higher yields, the animals' shelters are planned as tie-stall, loose, or free-stall barns (Kara and Eroğlu, 2015). Türkiye needs to make structural changes in modern animal husbandry to compete with the world, especially the EU. One of the first problems to be solved in this area is the size of the barn. The scale of cattle farms in Türkiye is relatively small compared to other countries. While it is 32.20 heads per farm in the EU, this average is around 4.50 in Türkiye (Kara and Eroğlu, 2018). According to TUIK data for 2021, our country's total number of cattle is 18,036,117 heads, of which 17,850,543 are cattle. 49.44% of our bovine stock is culture breed, 42.81% is crossbreed, and 7.76% is domestic breed. With 20,782,374 tons of milk obtained from 6,580,753 cows milked, approximately 91% of the total milk production is cow's milk, and the average milk yield is 3,158 kg (TUIK, 2021).

Environmental conditions within a shelter play a crucial role in ensuring the well-being of animals. Factors such as ventilation, lighting, temperature, and relative humidity must be carefully considered when constructing shelters, as these factors collectively form what is known as the shelter climate. It is essential to consider the natural behavioral characteristics of animals, including their movements, rest patterns, rumination, and feeding and drinking habits, while also adhering to the principle of achieving maximum benefits at minimum costs during shelter construction. Furthermore, the construction of shelters should incorporate modern features that prioritize animal welfare, consider the dimensions required for the animals, account for their behavior, and adhere to biosecurity guidelines (Uğur, 2014; Mundan et al., 2018).

Production planning in dairy cattle farms; It is the effective use of optimum inputs and operating capacity while determining which production level the farm will achieve optimum profit according to opportunities and targets in a certain period. For successful animal production, dairy farms can focus on increasing milk per animal unit rather than increasing the number of animals and milk. In general, a single herd size will not be economical under all conditions everywhere. According to Göncü and Görgülü (2011), considering intensive operating conditions and cost factors, at least 80 milking capacity should be the starting point, and 176 head milking capacity should be taken into account as the average economic herd size.

2. Materials and Methods

The study examined shelters with over 50 cattle in Yozgat province and the data related to these shelters as the primary material. As a result of the field studies carried out in the study area and the evaluation of the data received from public institutions, the study was carried out in 28 dairy cattle farms that were selected by random sampling method from 43 dairy cattle farms with 50 heads and more dairy cattle and allowed surveys and examinations. Information on the locations of the farms and the number of animals are given in Table 1, and the distribution of the number of animals by age and breed is given in Table 2. 28 farms with and without accessible mattresses; evaluated in terms of farms structure and animal welfare and examined as a modern (qualified) dairy farms. With the data obtained from the dairy cattle farms through face-to-face interviews and surveys between September 01 and December 20, 2022, the collected dairy farms' information was processed by making observations and physical measurements in the barns. The structural and technical characteristics of dairy farms discussed in the study were evaluated. In the study, the numerical values (N) and percentage (%) frequencies of the data obtained from the dairy cattle farms included in the research were presented by calculating.

Table 1. Locations of farms and number of dairy cattle

District	Village	Number of dairy cattle	District	Village	Number of dairy cattle
Akdağmadeni	Oluközü	106	Sarıkaya	Karahallı	120
Boğazlayan	Yenipazar	215		Tepe Dogan	133
Çandır	Büyükkışla	133		Karayakup	165
	Büyükkışla	50		Arpalık	100
Kadışehri	Merkez	100		Yukarı Sarıkaya	78
Merkez	Araplı Çiftliği	80	Şefaatli	Kuzayca	255
	Yazıpınar	84		Kuzayca	80
	Köseyusuflu	50		Kuzayca	60
	Bebek	130	Yenifakılı	Merkez	61
	Kızıltepe	120		Merkez	91
	Kızıltepe	100		Eskioren	115
	Türkmen	80		Fehimli	54
Saraykent	Altınsu	140	Yerköy	Merkez	200
	Ozankasabası	50		Sarıyaprak	185

Table 2. Distribution of cattle by ages and breeds

Current status	Number (Head)	%	Breeds	Number (Head)	%
Milked Cows	1006	32	Holstein	855	27
Dry	554	18	Brown Swiss	290	9
Pregnant Heifer	443	14	Simmental	1914	62
Heifer	368	12	Domestic	30	1
Calf	764	24	Crossbreed	46	1
Total	3135	100	Total	3135	100

3. Results and Discussion

The operating ages of the modern dairy cattle farms studied in the research area vary between 1 and 25 years as of their establishment years widely. 15 farms between 1-5 years (53.57%), 6 farms between 6-10 years (21.43%), 3 farms between 11-15 years (10.71%), 2 farms between 16-20 years (7.14%), and 2 breeders have been operating for 21-25 years (7.14%) (Figure 1). The fact that most dairy farms were established in the last 10 years shows that they benefit from farm investments, grants, and support projects from public resources.

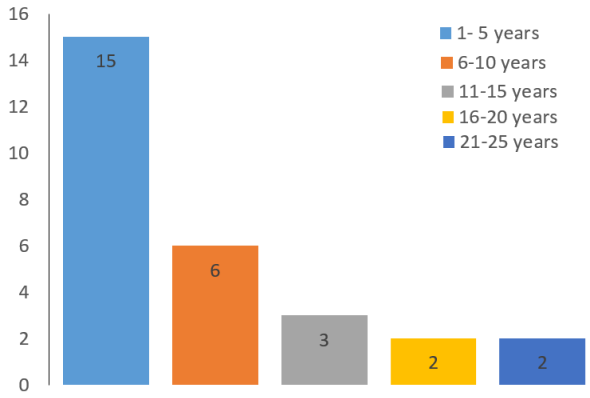

Figure 1. Age of dairy farms by year of establishment.

Of the modern barns examined within the scope of the study, 92.85% (26 farms) are free tie-stall, and 7.15% (2 farms) are tie-stall systems. While the ratio of dairy cattle farms with a free stall system was 89.29% (25 farms), the percentage of dairy cattle barns with tied stall system was 10.71% (3 farms). The common type of tie-stall barn is preferred due to climatic conditions. Mundan et al. (2018) in their study in Şanlıurfa, it was determined that 17.5% of the barns were tie-stall, 82.5% of them were tie-stall type, and free-stall barn system was used in all of them. Their study in Özsağlıcak and Yanar (2022) found that 95.0% of their research had tie-stall barns, 4.8% had free tie-stall barns, and 0.3% had loose barns. 50.6% stated that stone (22.7%), adobe (12.6%), brick (11.6%), pumice (2.2%), and wood (0.3%) were used. Approximately 90% of the modern dairy farms examined within the scope of various studies are free stalls, and it has been reported that animals move freely in such barns and use their rest periods more effectively, and accordingly, the disease levels are lower than the others (Rushen and Pasille, 1999; Öcal, 2020).

In 89.29% (25 farms) of the surveyed dairy cattle barns, there is bedding material; in 3 barns (10.71%), there is insufficient or no substrate material. The employees have stated that the animals are cleaner in the establishments where bedding is used at the stalls, and the disease rates are lower than in the ones that do not use bedding in those establishments. While the base of the shelter is concrete in 27 farms (96.43%), the ground is soil in 2 farms (3.57%). It has been observed that the type of project boards are complied with in the farms built with the support received in public institutions. In contrast, quality materials are not chosen in farms constructed with their resources, especially in ventilation and building materials, avoiding investment costs. Information on the shelter floor, barn width dimensions, wall material, wall thickness, and barn short-side directions are given in Table 3.

While the walls were plastered and clean in 96.43% of the farms (27), it was observed that there was no plaster on the walls in 1 barn (3.57%). While 22 barns (78.57%) have sufficient electricity systems and night lighting is available, it is noted that electricity and energy systems are insufficient, and there is no night lighting in 6 barns (21.43%). This situation can be associated with the distances of the farms to the city networks and their access to the energy lines in terms of their location.

Table 3. Ground, wall, and axis characteristics of shelters

Bedding material	n	%
Rubber	24	85.71
Partially Rubber	1	3.57
Soil + Concrete	2	7.14
Concrete	1	3.57
Wall Material		
Stone	2	7.14
Briquette	7	25.00
Brick	3	10.71
Curtain Concrete	16	57.14
Wall Thickness		
10 cm	2	7.14
20 cm	13	46.43
25 cm	9	32.14
30 cm	3	10.71
50 cm	1	3.57
Barn Width Dimensions		
7m* 20 m-24 m	3	10.71
8m* 38 m-40 m	2	7.14
10 m * 50 m	5	17.86
15 m* 50 m-65 m-66 m	3	10.71
16 m* 67 m-70 m-78 m	4	14.29
25 m* 78 m-82 m-100 m	6	21.43
28 m* 100 m	2	7.14
30 m * 120 m	1	3.57
40 m * 130m	1	3.57
50m * 200 m	1	3.57
Short Side (Shelter Entrance Direction)		
East	7	25.00
South	8	28.57
South West	1	3.57
West	5	17.86
East West	3	10.71
South North	1	3.57
North	3	10.71

When the ventilation conditions were examined, it was seen that there was a ventilation shaft, and the ventilation was sufficient in 25 barns (89.29%), while in 3 barns (10.71%), the required amount of ventilation shafts was not found or the capacity was insufficient. The construction of the roof and the choice of roof materials are also factors that directly affect the ventilation and the environmental conditions inside the shelter. With improperly selected material and faulty roof design, the environmental conditions, especially the temperature and humidity values, will change and become unsuitable for the housed animal. In most barns in Türkiye, the barn wall height is kept short, and the principle of avoiding construction and heating costs has been adopted, but this has brought ventilation problems. Increasing window

areas and effective ventilation are important for improving efficiency, health, and well-being (Öcal, 2020). Other data regarding the chimney and window conditions that determine the ventilation conditions of the farms are given in Table 4.

Table 4. Details on ventilation conditions in shelters

Number of Chimneys	n	%
Along the length	20	71.43
2 pieces	2	7.14
4 pieces	2	7.14
8 pieces	2	7.14
10 pieces	1	3.57
No chimney	1	3.57
Chimney Height		
3 m	2	7.14
4-6 m	10	35.71
6.5-7.5 m	7	25.00
8-10 m	8	28.57
No chimney	1	3.57
Number of windows		
2-10	7	25.00
12-24	6	21.43
30-48	5	17.86
52-80	3	10.71
Along the length	7	25.00
Window opening Direction		
From top to bottom	23	82.14
To the right or left	5	17.86
Barn Height		
3-5.5 m	8	28.58
6-7.5 m	11	39.28
8-10 m	9	32.14
Side Wall Height		
2-4 m	17	60.71
4.5-6 m	7	25
7-14 m	4	14.29
Roofing Materials		
Sheet (Galvanized, isogloss, corrugated, stone, tile top)	13	46.43
Panel material	8	28.57
Roof tile	2	7.14
Wood-tile	2	7.14
Polycarbonate material	1	3.57
Steel material	1	3.57
Styrofoam material	1	3.57

The height of the barn is 6-7.5 m in 39% of the farms, the height of the side wall is 2-4 m in about 61%, 53% of the age of establishment is within 1-5 years, and most of them are plastered, concrete-based, side walls. It has been observed that the walls are made of curtain concrete from one end to the other as a ventilation shaft. The height of the windows from the ground in the barns is between 1.60 m and 3.00 m. Ensuring sufficient window space and chimney space is important for optimum ventilation. It is possible to say that the modern dairy farms we examined are better equipped in terms of structural features compared to traditional family farms. Concrete floors in shelters are the most preferred floor type due to their easy cleaning and longevity, but increasing complaints of animal foot problems can be counted as one of the adverse effects of this flooring type (Manninen et al., 2002). The use of grilled floors in shelters has decreased due to problems with estrus detection, increased foot diseases, and adverse effects on animal welfare. It has been suggested that the ground be designed as a rough structure with different geometries (Haley et al. 2000). It has been recommended that the materials to be used for this design should be used with 12 mm depth, 12-19 mm width, and 9-10 cm spacing. It has been reported that the quality of the ground concrete is also essential (Ondarza, 2003). Foot and udder problems in dairy cattle are among the most important health problems. Failure to prevent these problems causes lameness, yield reductions, and economic losses in the long run (Vermunt and Greenough, 1996).

Animal drinking water and its shape are also among shelters' main planning criteria for breeding and hygiene. While the animal's drinking water frequency is related to its health and productivity characteristics, the drinking conditions are of great importance in terms of comfort and hygiene. In 92.86% of the surveyed holdings (26 farms), animals can freely access water without restrictions or routines. In the remaining 2 farms (7.14%), the animals' drinking water frequency was determined to be 2 times daily.

Among the issues related to planning, yield, and hygiene conditions in shelters are the status and adequacy of special compartments for animals reared in the shelter. The presence of sections suitable for the living conditions of the animals in the shelters, a separate infirmary, and a walking area where the animals can roam freely will also positively affect productivity, animal welfare, and hygiene conditions. These data regarding the shelters in the study area are reported in Table 5.

Among the dairy cattle farms studied in the study area are calf huts, infirmaries, maternity chambers, and walking areas in all farms built with the project. The study observed that the calf compartment was used at the rate of 75%, and accordingly, the areas allocated to the calves were sufficient for group compartments.

Delebe (2022), in his study in Şanlıurfa province, stated that the rate of those who keep each calf in a separate compartment is 4.96%, and the rate of those who keep them freely as a group in a particular place is 95.03%. In the study conducted by Özsağlıcak and Yanar (2022), in the province of Erzincan, 60.3% of the holdings had calves in a separate group section in the same barn, 11.7% in the same barn with the mother, 15.9% in the same barn in individual calf sections and 12% in the same barn. They reported that they were reared in individual calf huts in separate buildings. Kaygısız et al. (2022), in their study in the Andırın district of Kahramanmaraş province, it was observed that in 82% of

the farms, the calves were housed in the same barn with the adult cattle, in 18% of the calves were housed in separate compartments from the adult cattle. Straw and sawdust were used as litter material in the calf compartments in all of the farms. Öcal (2020), in his study on dairy cattle farms in Ankara, reported that the ratio of the birth chamber is 100%, and the infirmary rate is 80% in the dairy cattle farms he examined.

Table 5. Conditions of individual compartments, promenades, and infirmaries in shelters

Birth Partition	n	%
Exist	22	78.57
None	6	21.43
Number of Birth Division		
None	6	21.43
1	18	64.29
2	4	14.29
Birth Partition Area		
None	6	21.43
12-20 m^2	10	35.71
21-40 m^2	9	32.14
41-50 m^2	3	10.71
Individual Calf Pen		
Exist	21	75.00
None	7	25.00
Number of Individual Calf Pens		
None	7	25.00
15-20	11	39.29
25-30	8	28.57
35-40	2	7.14
Cow Alley	N	%
0-2 m^2	4	14.29
160 m^2	1	3.57
350-360 m^2	2	7.14
500-800 m^2	8	28.57
840-1200 m^2	7	25.00
1300-2000 m^2	6	21.43
Sickroom		
Exist	21	75.00
None	7	25.00

Feeder and stall planning is also among the important design criteria in shelters. These criteria directly affect the productivity and welfare conditions of the animal. During the project, mangers and stalls suitable for the type of animal to be raised should be planned; Controls at feeders and stalls should be done regularly. In 21 dairy farms with stalls, the length of the stall is between 150-200 cm, and the width is between 105-143 cm. Details regarding the feeding and stall system and feeder information of the surveyed establishments are given in Table 6.

When the barn equipment and its structural features are examined, it has been observed that most farms have free stalls, their mangers are close to the ground level, and fed with feed mixers twice a day.

Table 6. Barn equipment and structural features

Feeding system	n	%
Feed bunk+feed alley	23	82.14
Classic feed bunk+feed alley	3	10.71
Classic feed bunk	2	7.14
Width of feed bunk		
Headlock width	23	82.14
45-49 cm	1	3.57
51-60 cm	2	7.14
70-75 cm	2	7.14
Length of feed bunk		
Along the feed alley	23	82.14
15-18 cm	2	7.14
35-50 cm	2	7.14
86 cm	1	3.57
Feed bunk front wall height		
10-30 cm	23	82.14
50-60 cm	3	10.71
70 cm	2	7.14
Feed alley length		
None	3	10.71
16-24 m	4	14.29
38-50 m	6	21.43
65-70 m	5	17.86
78-97 m	5	17.86
100-130 m	5	17.86
Feed alley width		
0 cm	3	10.71
60-100 cm	5	17.86
150-350 cm	8	28.57
400-500 cm	8	28.57
550-600 cm	3	10.71
700 cm	1	3.57
Feeding area location		
In the rest area	27	96.43
In the cow alley	1	3.57
Total number of stalls		
Non-stalls	7	25.00
60-80 stalls	7	25.00
100-120 stalls	9	32.14
140-240 stalls	5	17.86
Height of stalls above ground		
Non-stalls	7	25.00
0-5 cm	1	3.57
10-18 cm	8	28.57
19-25 cm	11	39.28
26-30 cm	1	3.57

All the results regarding the characteristics of manure storage in the researched farms are given in Table 7.

It was determined that 71.43% of the barns examined in the study had manure pits, and the same rate of manure cleaning was done using manure scrapers (20 barns-71.43%). For manure cleaning, 1 barn (3.57%) stated that they scraped manure with a tractor shovel, and 7 barns (25%) noted that the workforce was used for manure cleaning. As cattle manure use, farms used manure as soil fertilizer on their own fields (20 farms-

71.43%); (8 farms-28.57%) sold manure to other farms in the soil.

Table 7. Characteristics of manure pits and storage in the farms

Manure pit slope	n	%
No manure pit	8	28.57
%1	6	21.43
%2	8	28.57
%3	3	10.71
%5	2	7.14
%10	1	3.57
Manure emptied time		
No manure pit	8	28.57
Every 1-2 months	5	17.86
Every 2-3 months	7	25.00
3 > months	8	28.57
Width of manure pit		
No manure pit	8	28.57
2.8-3.5 m	4	14.29
4-5 m	4	14.29
6-7 m	7	25.00
8-10 m	4	14.29
13 m	1	3.57
Length of manure pit		
No manure pit	8	28.57
4-5 m	3	10.71
6-7 m	3	10.71
8-10 m	7	25.00
12 m	1	3.57
15-18 m	2	7.14
20-26 m	2	7.14
30 m	2	7.14
Height of manure pit		
no manure pit	8	28.57
2.5-3.5 m	6	21.43
4-5.5 m	13	46.43
10 m	1	3.57
Manure pit base material		
No manure pit	8	28.57
Concrete	18	64.29
Soil	2	7.14

Soyer (2014), in his study in Aydın, reported that 10.4% of dairy cattle farms use manure scrapers, 89.7% do not have an impermeable manure pit, and 87.4% of the farms use manure on their land. In their study in Özsağlıcak and Yanar (2022) also determined that the workforce did manure removal in the barns at 97.5%, automatic mechanical scrapers at 1.5%, and tractors at 1.0%. Yüzbaşıoğlu (2022) reported that 56% of the dairy farms he examined in the province of Tokat did not have a manure storage area. The results of the study were found to be compatible with the literature on this subject.

It has been observed that barns with manure discharge the manure in periods ranging from 1 month to 3 months. Even if these periods seem sufficient for the effective and systematic use of manure, there are risk conditions such as disruption of these processes, increases in the number of manures, or overflow of manure with precipitation. It is a remarkable result that none of the 28 farms examined did not have a drainage system. 96.43% (27 farms) of the holdings, and thus the manures are built on sloping lands. The remaining 1 farm (3.57%) was established on flat ground.

The farms are on sloping lands, and the drainage systems are insufficient; it causes concern that the wastes generated will pollute the water resources and the natural environment by surface flow and deep infiltration in the slope direction. In addition, city mains water is used as a water source in only 6 farms (21.43%), and groundwater is used in the remaining 22 farms (78.57%). This situation highlights the farm's lack of drainage systems and the necessity to question manure storage conditions' adequacy more seriously. The location where the livestock farms and the manures are established is also important. Especially in cases where drainage systems are inadequate and manure storage conditions differ, this importance increases with the risks of runoff and leakage. In this context, the distances of manures to water sources, milking units, and settlements were determined and given in Figure 2, Figure 3, and Figure 4, respectively.

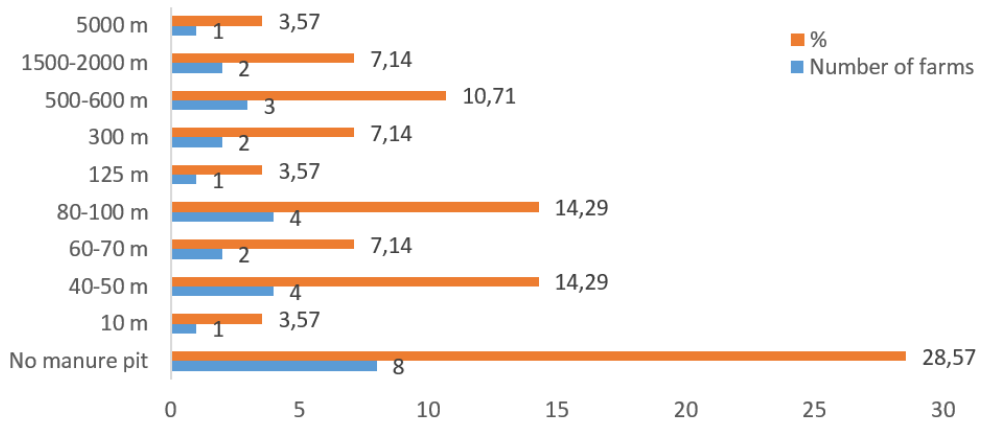

Figure 2. Distances between manure pits and water sources.

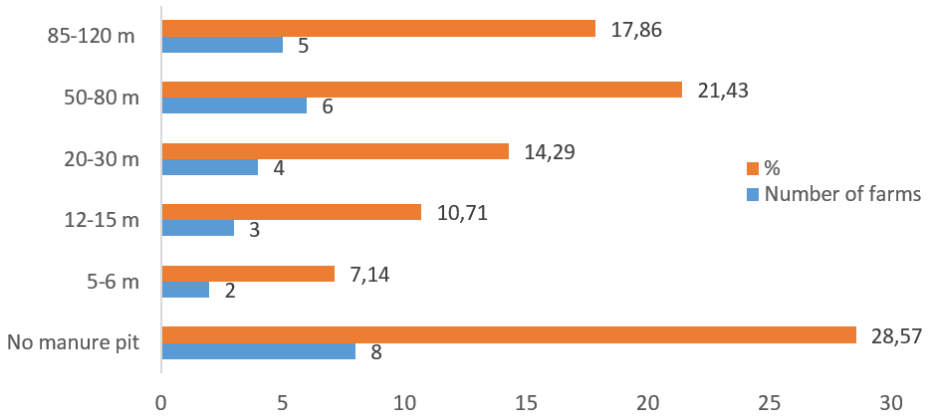

Figure 3. Distances between manure pits and milking units.

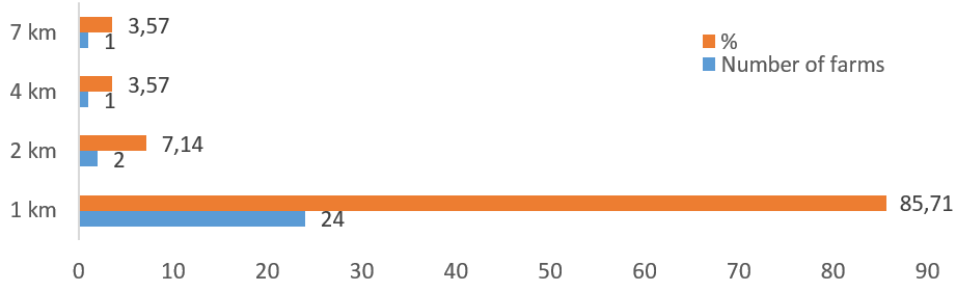

Figure 4. Distances between manure pits and settlements.

In our country, no attention is paid to the disposal, storage, and use of manure by distribution in the field. Liquid manure issues can become an important problem in farms that do not have agricultural land. It should be considered that manures may harm health if they leak into groundwater. Another critical issue is that manure cleaning must be done regularly in the shelter. Manure should be able to be transported out of the shelter with minimal labor and the use of machinery and equipment. If it is known that the daily manure production of dairy cattle weighing approximately 600 kg is 0.05 m^3 or 50 kg, it will be clear how important storage is. For efficient and healthy production, it would be appropriate to take the manure out of the shelter at certain daily intervals (Kırbıyık, 2022).

4. Conclusion

We can show that the studies based on sustainable animal husbandry and animal welfare are still insufficient among the many reasons why the desired efficiency levels cannot be achieved despite the increase in the number of intensification and large-capacity farms thanks to various incentives and grants in dairy cattle breeding in our country. In large capacity barns, which we can classify as modern farms in Yozgat, in farms established by receiving grants from institutions such as TKDK (Agriculture and Rural Development Support Institution), KOP (Konya Plain Project Regional Development Administration), and the Ministry of Agriculture and Forestry, stables are built under conditions suitable for animal welfare. Dairy barns should be designed to accommodate the behavioral needs of animals and produce high-quality products. Moreover, it is necessary to develop new models that consider each region's specific climatic conditions and structural characteristics. As a result, it has been observed that livestock activities in the Yozgat province, which are prevalent, have undergone significant transformations in recent years, transitioning towards modern facilities. To enhance profitability and achieve better milk quality, it may be advisable to encourage the conversion of small-scale enterprises into larger ones. Still, the farm owner and employees are insufficient in these project-based farms because they will increase costs. It was observed that the herd management system was not established, and the records were not kept properly. Making investments without long-term planning of production costs and profit and loss accounts in dairy farms threatens the sustainability of farms. Dairy cattle farming is a long-term line of business, and it isn't easy to convert the investments made for this activity into other investments once the action has started. There is no short-term planning flexibility in dairy farms. Making profitable and sustainable livestock farming is impossible by investing only in barns. It is recommended that relevant farm owners and employees be trained in dairy cattle breeding.

Author Contributions

The percentage of the author(s) contributions is presented below. All authors reviewed and approved the final version of the manuscript.

	O.E.	M.E.C.
C	100	
D		100
S	50	50
DCP	100	
DAI		100
L	50	50
W	50	50
CR	25	75
SR	75	25

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to. The survey study was approved by the Ethics Committee of Yozgat Bozok University (protocol code: 32/14 and date: April 20, 2022).

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