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O 33. STRUCTURAL ANALYSE of GREENHOUSE SHEEP BARN for SHEEP BREEDING in KONYA#

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ABSTRACT: Development of alternative barns designs; It has a very important place in terms of ensuring animal welfare and increasing efficiency and quality in animal production. Greenhouse sheep barns have become more preferred in recent years due to their ease of installation and economy, as well as animal welfare. Konya Region has an important place in sheep breeding in Türkiye. This study was conducted in Konya between 2022 and 2023 to examine the structural features of Greenhouse sheep barns, which have found widespread use in recent years. In the research, 25 Greenhouse sheep barns with different features suitable for the research purpose, built in the Konya Region with the support of the KOP administration (KOP Regional Development Administration, Ministry of Development), were examined. Purposive sampling method was used in the selection of the barns examined in the research. The structural adequacy and animal welfare suitability of the examined greenhouse sheep barns were investigated. In the study, it was determined that all of the barns were of steel construction and a four-layer membrane (air-permeable polyevins lining, moisture-absorbing isofelt felt, foil-coated bisofol with air bubbles in the middle, polyester-coated outer tarpaulin) cover was used. It was determined that the average floor area of the greenhouse sheep barns examined was 206 m² and the average animal population was 161. It was determined that the stocking density in the sheep barns was 1.28 m²/animal. The ratio of the total area of ventilation windows to the floor area is on average 2.1%. It was determined that gates with a width of 2.4 m and a length of 2.9 m were used in the sheep barns examined. User satisfaction in the farms has been determined to be 88% due to features such as greenhouse sheep barns, speed of construction and ease of transport. It was determined that the reason why problems were experienced in 12% of the examined farms was due to the high frequency of stocking in the barn and the inadequate use of ventilation openings.

Keywords: Greenhouse sheep barn, Average settlement density, Four-layer membrane

1. INTRODUCTION

Konya is one of the provinces located in the Central Anatolia Region and has a say in Türkiye's agricultural production. Small livestock farming is a breeding method suitable for the climatic conditions of the region. The main aim of sheep farms is to increase the number of healthy lambs per parent sheep by minimizing losses. The main source of income for sheep breeders in our country is butchery and breeding lamb sales (Anonymous, 2019a). Factors such as the fact that natural resources, especially meadows and pastures, are more suitable for sheep and goats, and people's nutritional habits, lead to small animal breeding (Kaymakçı and Sönmez, 1996). Animals spread on pastures and pastures for 7-8 months of the year. In other months when the climate is harsh, they are taken to sheep barns. In addition to conventional sheep barns, greenhouse sheep barns are also used as barn. Due to the anatomical and physiological characteristics of sheep and their ability to adapt to climatic conditions, expectations for the development of alternative barns that are cheap, facilitate production conditions and meet the demands of the sheep are increasing. In line with these expectations, plastic-covered greenhouse-type barns have been developed (Onuk, 2015).

This research was carried out in order to determine the structural characteristics of greenhouse sheep barn livestock farming farms in the central districts of Konya Province, to identify their competence status, problems and to develop solution suggestions. In addition, the study tried to determine the animal welfare and structural adequacy of greenhouse sheep barns built in the Konya Region, especially with the support of KOP (Konya Plain Project Regional Development Administration).

2. MATERIAL AND METHOD

This research was conducted in 25 greenhouse sheep barns in sheep farming farms located in the central districts of Konya Province in 2022-2023. Purposive sampling method was used to determine the sheep farming farms examined. 25 greenhouse sheep farming farms with different capacities and different structural features, which are representative of the Konya Region, were selected as research material.

Research; The study was carried out in three stages: identification of the farms, determination of the characteristics of the farm and the characteristics of the structures and facilities in the farm through field work, and evaluation of the study results.

In the first stage, experts working in official organizations in the region (District Directorates of Agriculture, KOP) were interviewed and an inventory of greenhouse sheep barns was prepared. Among these farms, farm that could represent the region with different characteristics in terms of planning principles suitable for the purpose of the research were determined. Of the 25 farms examined in the study, 13 are located in Meram District, 8 in Karatay District and 4 in Selçuklu District. In the second stage of the study; farm characteristics (location of the farm, establishment date, farm capacity, land availability…), sheep barns features (barn type, planning system, barn capacity, barn dimensions, structural features, material features…) and manure management (manure removal method, mechanization used). Information regarding the situation…) was obtained. The information contained in the surveys prepared for this purpose; The data were obtained through face-to-face interviews, measurement, observation and photography by visiting farms.

In the research, the data obtained from the field studies were classified and in the light of literature reports (Olgun, 2011; Okuroğlu and Yağanoğlu, 1998; Uzal and Aslan, 2015; Uzal and Karaçay, 2017; Kaymakçı and Sönmez, 1996; Ekmekyapar, 1997; Balaban and Şen, 1988). has been evaluated. Sheep farming farms, greenhouse sheep barns and the structures and facilities in the farm were evaluated in terms of animal welfare and planning principles.

3. CONCLUSION AND DISCUSSION

3.1. General Features of Greenhouse Sheep Sheep Farms

The distribution of greenhouse sheep farming farms examined in the research according to the central districts of Konya is given in Table 3A. 52% of the examined farms are located in Meram, 32% in Karatay and 16% in Selçuklu district. Since there are more farms in Meram District, more than 50% of the fares examined in the research were selected from Meram District.

Table 3.A Distribution of Greenhouse Type Sheep Farms Examined in the Research by Districts

District Name	Number of Farm	% Percentage
Karatay	8	32,0%
Meram	13	52,0%
Selçuklu	4	16,0%
Total	**25**	**100,0%**

The distribution of greenhouse sheep farms examined in the study according to their distance from the settlement is given in Table 3.B. The distances of the examined farms to the settlement center vary between 50-4,500 m, and it was determined that 44% of the farms were less than 1000 m to the settlement center. The sheepfold location should be at least 1 km away from residential areas, protected from winter winds, exposed to constant sunlight and close to pasture (Olgun and Çelik, 1999). It was determined that 56% of the farms examined in the research were more than 1 km away from the settlement center, and their locations are shown on the map in Figure 3.A.

Table 3.B Distribution of Greenhouse Type Sheep Farms Examined in the Research According to Their Distance from Settlements

Distance to Settlement (m)	Number of Farm	% Percentage
< 1000	11	44,0%
1.000- 2.000	10	40,0%
2.001- 3.000	3	12,0%
3.001- 4.000	0	0,0%
> 4.001	1	4,0%
Total	**25**	**100,0%**

Figure 3.A Locations of Greenhouse Sheep Farms Examined in the Research

Most of the greenhouse sheep barn farms examined in the research were built in 2019. The increase in greenhouse sheep barn farms over time can be seen in Table 3.C.

Table 3.C Distribution of Greenhouse Sheep Farms Examined in the Research According to the Year of Construction

Year of Construction	Number of Farm	% Percentage
2017	1	4,0%
2018	2	8,0%
2019	16	64,0%
2020	6	24,0%
Total	**25**	**100,0%**

The land ownership status of the greenhouse sheep barns examined in the research was examined and it was understood that 64% of the land was privately owned. The examined farm number 11 was established in a place not registered in the land registry. The distribution is given in Table 3.D.

Table 3.D Distribution of Greenhouse Sheep Farms Examined in the Research According to Land Ownership Status

Land Ownership Status	Number of Farm	% Percentage
State Land Rent	3	12,0%
Pasture	5	20,0%
Privately owned	16	64,0%
Non-Registered Place	1	4,0%
Total	**25**	**100,0%**

In 20% of the greenhouse sheep farming farms examined in the research, no cultivation is carried out for feed production purposes, and feed is purchased entirely from outside. The distribution of farms according to their cultivation status is given in Table 3.E. Planting for animal feeding is very important for the continuity of farm.

Table 3.E Land Cultivation Status of Greenhouse Type Sheep Farms Examined in the Research

Area Cultivated for Feed per Animal (da/animal)	Number of Farm	% Percentage
-	5	20,0%
< 0.2	11	44,0%
0.2-0.4	8	32,0%
> 0.4	1	4,0%
Total	**25**	**100,0%**

3.2. Features of Greenhouse Sheep Barns

The lengths of the greenhouse sheep barns examined in the research are planned to be multiples of 2 m, since the distance between the two trusses is 2 m. Depending on the number of animals, the length of the sheepfold can be increased or decreased as desired.

Table 3.F Distribution of Greenhouse Sheep Barns Examined in the Research According to Their Lengths

Lenght of Greenhouse Sheep Barn (m)	Number of Barns	% Percentage
16	3	12,0%
18	4	16,0%
24	4	16,0%
30	8	32,0%
34	6	24,0%
Total	**25**	**100,0%**

The width of the greenhouse sheep barns examined in the research was measured as 8 m in all of them. Since all the barns were built by the same administration, they were built to a standard size.

Table 3.G Distribution of Greenhouse Sheep Barns Examined in the Research According to Their Widths

Width of Greenhouse Sheep Barn (m)	Number of Barns	% Percentage
< 9.00	25	100,0%
9.00-12.00	0	100,0%
> 12.00	0	100,0%
Total	**25**	**100,0%**

The width of sheep barns generally varies between 9-12 meters (Olgun, M. 2011). In the light of these data, it was seen that the widths of the sheep barns were close to the limits of the literature information.

The floor area of greenhouse sheep barns and the animal stocking density determined according to the number of animals are important criteria in terms of animal welfare. The in-barn stocking frequency of the greenhouse sheep barns examined in the research is classified according to Olgun (2011) and is given in Table 3.H.

Table 3.H Distribution of Greenhouse Sheep Barns Examined in the Research According to the Density of Stocking in the Barns

Density of Stocking in the Barns (m²/animal)	Number of Barns	% Percentage
<0.80	0	0,0%
0.81-1.20	11	44,0%
1.21-1.50	4	16,0%
1.51-1.80	6	24,0%
>1.80	4	16,0%
Total	**25**	**100,0%**

According to Olgun (2011), 0.80-1.20 m² of resting area is required for sheep, 1.20-1.50 m² for sheep with one lamb, and 1.50-1.80 m² for sheep with two lambs. Koçak (2020) in his study measured 2.00 animals per m² in cattle farms and 1.47 animals per m² in sheep farms. According to Anonymous (2019a), planning should be done so that the floor area in the barns is 2 m² per adult sheep, 1.4 m² per yearling (6-12 months old) and 0.7 m² per lamb. It was understood that in 44% of the greenhouse sheep barns examined, the density of in-barn stocking was below the average value, and in 40% it was above the average value. In terms of animal welfare, the density of stocking can be reached to average values by reducing the number of animals in these barns or increasing the length of the barn.

The greenhouse sheep barns examined in the research were built with a Gothic roof system. The ridge height in the greenhouse sheep barns examined was 3.90 m; The side wall height decreases to 1.60 m.

Table 3.I Distribution of Greenhouse Sheep Barns Examined in the Research According to Ridge Heights

Ridge Height (m)	Number of Barns	% Percentage
2.40-2.50	0	0,0%
2.51-2.75	0	0,0%
2.76-3.00	0	0,0%
>3.01	25	100,0%
Total	**25**	**84,0%**

Table 3.J Distribution of Greenhouse Sheep Barns Examined in the Study According to Side Wall Heights

Side Wall Height (m)	Number of Barns	% Percentage
<1.20	0	0,0%
1.21-2.00	25	100,0%
>2.00	0	0,0%
Toplam	**25**	**100,0%**

In closed barns, the height between the top level of manure and the ceiling or roof beam should not be less than 185-100 cm. In closed barns, the barn height can be 2.40–2.50 m in cold regions, 2.5–2.75 m in warm regions, and 2.75–3 m in hot regions (Yüksel and Şişman 2003). The height of sheep barns should not be less than 200 cm between the upper manure level and the lower roof beam. In cold regions, it may be between 240-250 cm, in warm regions between 250-275 cm, and in hot regions between 275-300 cm. In barns where the number of animals is high, it is made over 300 cm and can go up to 400 cm (Olgun, 2011). The height of the sheep barns is compatible with the values given for the cold region in the literature. The values given in the literature are for masonry type barns and are expected to be higher for greenhouse type barns. The higher the ridge, the higher the volume inside the barn.

In agricultural buildings, doors are made single-winged, double-winged or sliding, depending on their functions. The wing widths of single or double-winged doors are generally 90–100 cm and their height is 190–200 cm. These can be opened inwards or outwards depending on the situation (Ekmekyapar 1997). There are 2 gates in all of the barns examined; They are 2.90 m long and 2.40 m wide double-winged doors opening outwards. It is built in dimensions suitable for tractor and equipment entry into the sheepfold.

The number of windows in the greenhouse sheep barns examined in the research is between 6 and 16, and they are 45x55 cm or 45x90 cm in size. The windows are 1.2 m above the ground. The floor area ratio of the total area of the window is below 1%.

Table 3.K Distribution of Window Area According to the Ratio of the Floor Area in the Greenhouse Sheep Barns Examined in the Research

Ratio of Window Area to Floor Area	Number of Barns	% Percentage
< 0.010	25	100,0%
0.01-0.015	0	0,0%
> 0.015	0	0,0%
Total	**25**	**100,0%**

According to Anonymous (2019a), windows; although its area varies depending on the region, it should be 10-15% of the floor area and allow plenty of light. Air drafts that occur in the barn cause stress in the animals as they will suddenly lower their body temperature. The height of the windows from the floor is required to be between 1.20 and 1.70 m in animal barns (Ekmekyapar, 1997). In the greenhouse barns examined, the ratio of window area to floor area was found to be below the literature information. The height of the windows from the ground is lower. Since the floor area ratio of the total window area does not reach 10% in any farm, adequate light penetration cannot be provided. The height of the windows from the ground is 30 cm higher, which will reduce the risk of animals being caught in drafts.

In the greenhouse sheep barns examined in the research, the ventilation chimney consists of a 30 cm diameter and 50 cm long cylindrical pipe in the middle of the roof. There are a number of ventilation chimneys ranging from 8 to 16. The effective ventilation chimney height, that is, the top of the ventilation chimney, is 4.30 m above the ground. The ratios of the ventilation chimney area to the floor area in the greenhouse sheep barns examined in the research are classified and shown in Table 3.L.

Table 3.L Distribution of Ventilation Chimney Area According to the Ratio of the Floor Area in the Greenhouse Sheep Barns Examined in the Research

Ventilation Chimney Area to Floor Area (%)	Number of Barns	% Percentage
< 0.50	21	84,00%
>0.50	4	16,00%
Total	**25**	**100,00%**

Şişman et all (2009), ventilation chimney cross-sectional area should be at least 0.25 m² and maximum 1.00 m², 0.50 m² ventilation chimney should be calculated for every 100 m² floor area, effective ventilation chimney height should be greater than 4.0 m. According to Anonymous (2019a), ventilation chimneys should be raised at least 50 cm above the roof ridge to ensure adequate ventilation in the barn. For natural ventilation, the ventilation chimney area should be 1.0-2.0 cm² for 1 m² of barn floor area. 84% of the barns examined It has been observed that the ratio of the area of the ventilation chimney to the floor area explained by Şişman et all (2009) is below the ratio. The number of ventilation chimneys and cross-sectional area should be increased. The effective ventilation chimney height is above the specified value.

The part of a building that remains below the ground surface and forms its infrastructure is called the foundation. It is the structural element that collects, carries and transmits the dead and live loads of the foundation structure to the ground (Yüksel and Şişman 2003). According to Anonymous (2019a), the portable barn skeleton section is made with a scissor system. The main carriers are fixed to the concrete floor with steel dowels.

In the greenhouse sheep barns examined in the research, except for farm no. 7, carrier elements were placed under the leveled ground in the excavated place at a height of 25-30 cm and filled with soil and fixed to the ground. Since the wind load was high in farm no. 7, a continuous concrete foundation of 30 cm width and 50 cm height was built on both sides along the sheepfold and the carrier element was connected to this foundation.

One of the most expensive building elements in the sheepfold to build and maintain is the roof. The roof protects the structure against external factors such as snow, rain and wind and also provides an aesthetic appearance to the structure (Ekmekyapar 1997). Covering material is one of the most important building materials of greenhouse sheep barns. In the greenhouse sheep barns examined in the research, there are 4 layers of material: air permeable polyevins lining on the first floor, isofelt felt with moisture absorption feature on the second layer, bisofol with foil on both sides and air bubble in the middle on the third layer, and polyester coated outer tarpaulin on the fourth layer. Deformation was observed in the cover material in farm no. 13 among the barns; No significant deformation was observed in the cover material in the other barns.

In the greenhouse sheep barns examined in the research, the average feeder length per barn was 28.4 m; The feeder length per animal was found to be 0.20 m/animal. The barns were classified by calculating the feeder lengths per animal for each barn and are given in Table 3.M.

Table 3.M Distribution of Greenhouse Sheep Barns Examined in the Study According to Feeding Lengths

Feeding Lengths (m/animal)	Number of Farm	% Percentage
< 0.20	15	60,00%
0.20-0.30	6	24,00%
0.31-0.45	4	16,00%
>0.45	0	0,00%
Total	**25**	**100,0%**

Required feeding length for each animal in feedlots; It is between 20-30 cm for lambs and 30-45 cm for sheep (Olgun, 2011). Required feeding length for each animal in feedlots; It is calculated as 18 cm for suckling lambs, 20 cm for weaned lambs, 30 cm for one-year-old lambs, 35-45 cm for ewes, 60 cm for those in the birth barns and 80 cm for breeding rams (Alkan 1972). According to Anonymous (2019a), the feeding length should be 40-50 cm per sheep and 20-30 cm per lamb. It was understood that the feeding length of the barns examined was below the range determined for sheep in 60% of the barns, as stated by Olgun (2011). Animals getting stuck in feeders while eating and feeding will reduce animal welfare and increase competition.

Of the greenhouse sheep barns examined in the research, 15 have waterers and 10 do not.

Table 3.N Distribution of Water Supply Types in the Greenhouse Sheep Barns Examined in the Research

Water Supply Types	Number of Farm	% Percentage
Fountain	9	36,0%
Well	8	32,0%
Water network	7	28,0%
Water Network+Well	1	4,0%
Total	**25**	**100,0%**

If the water needs of the sheep will be met in the barn, it is most appropriate to use automatic waterers. Automatic waterers are arranged as one for 40-50 sheep (Balaban and Şen, 1988). In 15 barns with drinkers, a value of 0.02 m drinker/animal was reached.

Artificial lighting in the greenhouse sheep barns examined in the research is provided by lamps and projectors connected to the electrical network, solar powered projectors and flashlights.

Table 3.O Distribution of Lighting Types in the Greenhouse Sheep Barns Examined in the Research

Lighting Type	Number of Farm	% Percentage
Lamps and projectors	12	48,0%
Solar powered projectors	1	4,0%
Flashlights	12	48,0%
Total	**25**	**100,0%**

13 of the greenhouse sheep barns examined in the research are illuminated by one or more lamps from the nearby line or from the solar energy panel. In the other 12 sheepfolds, the need for illumination at night is provided by flashlights. It has been understood that in sheepfolds where natural lighting is insufficient due to the small window area, it should be supplemented with artificial lighting.

3.3. Manure Management in the Farms Examined in the Research

Manure management of the greenhouse sheep barns examined in the research is done with a scraper attached to the back of the tractor or by manually throwing it into the tractor trailer entering the barn.

Table 3.P Manure Management in Greenhouse Sheep Barns Examined in the Research

Cleaning method	Number of Farm	Frequency (month^{-1})	% Percentage
Manually throwing it into the tractor trailer	7	0.33	28,0%
Manually throwing it into the tractor trailer	6	0.66	24,0%
Manually throwing it into the tractor trailer	4	1	16,0%
With scraper mounted on tractor	8	1	32,0%
Total	**25**	**0.73**	**100,0%**

Anonymous (2019a) manure yards; although it varies depending on the productivity period, sheep produce 4-5% of their average live weight per kg of wet manure per day. Manures that serve as a breeding ground for lice, fleas and houseflies should be kept away from the barns. In 32% of the barns examined, manure cleaning is carried out once a month because stripping with a tractor is easier, while in 68%, manual loading onto the tractor trailer is done less frequently because it requires manpower.

As a result, user satisfaction in the greenhouse sheep barn sheep farming farms examined in the research is at the level of 88%. The problem of sweating inside the barn in winter was expressed as dissatisfaction in farms 11 and 13; it was observed that a part of the barn was reserved as a feed store and the ventilation openings there were closed. It was understood that the problems experienced in 2 farms were due to the high density of placement in the barn and the inadequate use of ventilation openings. The reason why the frequency of barn placement in the farm numbered 11 was lower is that the operator reduced the number of animals after the problems he experience.

The frequency of in-barn placement, which is low in 44% of the greenhouse sheep barns examined in the research, should be increased. The dimensions of the doors are planned appropriately in terms of mechanization and allow easy entry and exit to the sheepfold. Since the window area of all barns is below average values, natural lighting cannot be provided adequately. It is recommended to increase the number and area of windows and use more artificial lighting. It has been observed that it would be more appropriate in terms of planning to increase the number and cross-sectional area of ventilation chimneys in barns where the ratio of ventilation area to floor area is below the average. The effective ventilation chimney height is planned appropriately. In order to be economical, it is recommended to build a foundation, especially in regions where the wind speed is high, as not building a foundation structure increases the risk of the sheepfold tipping over against the wind load. The covering material is a well-chosen material, especially in terms of protection from excessive sun and heat insulation. Since in 60% of the barns, the length of the feeder per animal is below the feeder length range determined for the sheep, it is thought that if the number of feeders is increased so that the animals can be more comfortable while feeding, the welfare level will increase. Delayed cleaning of manure prevents lice, fleas, etc. It would be appropriate to clean manure more frequently, as pests cause discomfort and diseases to animals and employees. It has been understood that if the feed tanks must be inside the barn in the farms, it is necessary to separate the animals from where they are located so that they cannot reach the tanks. Otherwise, it is thought that the animals may die as a result of overeating. Electrical energy is drawn from the grid in most farms; It is recommended to develop more applications to benefit from natural resources, especially solar energy, for efficient use of energy.

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