*Available online www.jsaer.com*

***Journal of Scientific and Engineering Research*, 2021, 8(12):68-73**

**Research Article**

**ISSN: 2394-2630**
**CODEN(USA): JSERBR**

# A Study on the Determination of Technical Principles in the Planning of Water Buffalo Barn Systems in Turkey

**Israfil KOCAMAN**

Tekirdag Namik Kemal University Agricultural Faculty Biosystems Engineering Department, TR-59030 Tekirdag Turkey
Corresponding author: e-posta: ikocaman@nku.edu.tr

**Abstract** This research was carried out in order to determine the structural characteristics of traditional water buffalo barns and to determine the technical principles for planning modern water buffalo barn systems in the Thrace part of Turkey, which is a pilot region in terms of water buffalo breeding. The research covers all water buffalo enterprises in the region. According to the data obtained, more than 80% of the water buffalo businesses are located in or near the settlements.95% of the water buffalo barns in the holdings do not have a technical project and were built as closed type tie-stall barns according to traditional methods. The data obtained as a result of the research were evaluated in the light of the literature, and the technical principles for the planning of water buffalo barn systems for the conditions of Turkey were revealed.

**Keywords** Water buffalo, Barn systems, Technical principles

## Introduction

In agricultural enterprises, barns have an important place in the buildings in the enterprise center.Especially in enterprises whose main occupation is animal husbandry, the importance of animal barns is increasing. Barns are among the structures that need to be carefully planned, since the animals housed in them are expensive and the product obtained is closely related to human health.

In the design of animal barns, the fact that sufficient information is not collected, necessary preliminary studies are not carried out and especially the necessary importance is not given to animal-environment relations prevents the realization of the desired goal.

In order to provide the expected benefit from barns, they must be planned, designed and built in accordance with technical principles. For this, three main factors should be considered in the construction of barns. These; It is to provide optimum climatic, structural and social environmental conditions in the shelters for animals, to keep the cost of the barn at the lowest level considering the service life of the shelter, to minimize the waste of time, energy losses and the need for labor [1].

In order for livestock enterprises to be successful, the above-mentioned factors must be well analyzed and brought together. In order to provide suitable environmental conditions in barns, very expensive barns should not be built, rather the appropriate type of barn should be chosen in a way that will eliminate the negative effects of climatic conditions on animals within economic limits [2].

Planning of barns requires considering the environmental conditions that affect the planning and changing according to the regions, together with the construction techniques. The ability of barns to provide the desired functions in Turkish conditions will be possible with the preparation of plans suitable for different climatic conditions. Studies have shown that most of the barns are planned in a closed and tied-stall system, and the principles regarding the control of environmental conditions during the design of the barns are not sufficiently

followed. Although there are very different climatic regions in Turkey, it is seen that the same type of barns are built even in regions that show great differences from each other, similar building materials are used, the building elements are sized in the same way, and the dimensions of the building elements are generally overestimated [3].

There are almost no studies on the technical principles for the planning of buffalo barns in Turkey. This study was carried out in order to inform our farmers dealing with water buffalo breeding, about the technical principles that should be taken into account in the planning of water buffalo barns.

## Material and Method

The research was carried out in the water buffalo enterprises selected as the pilot region and located in the Thrace part of Turkey. Geographically, the research area is located between 41° 12' north latitude and 28° 44' east longitude, and its height above sea level is 119 m. According to the meteorological data for many years, the annual average temperature is 13 ºC, the annual average precipitation is 808.3 mm, the annual average humidity is 76% and the annual average wind speed is 4.7 m/s [4].

The research was carried out in three stages: selection of enterprises, field studies and office studies. In the field studies, a survey study was conducted in order to obtain detailed information about the selected enterprises. In addition, detailed data about the structural features and spatial locations of the barns were obtained by making on-site measurements and observations. In the office studies, the data obtained as a result of the field studies were evaluated with the literature information, necessary comments were made and suggestions were made for practice.

## Results and Discussion

### *Analyzing the current situation of water buffalo barns*

In animal production structures, both the physiological activities of animals and animal wastes that occur in enterprises can create some problems in terms of environment and human health. Likewise, factors such as noise originating from residential units can create negative stress on farm animals. Polycultural agriculture is practiced throughout the surveyed enterprises. While the ratio of enterprises engaged in only water buffalo breeding is 16%, the ratio of enterprises engaged in both plant production and water buffalo breeding is 84%.Milk production comes to the fore in buffalo breeding.

In terms of the number of buffaloes, the enterprises are generally in the form of small and medium-sized enterprises, and this rate is 97% in the surveyed enterprises. More than 80% of the businesses are located in or near settlements. Only 7% of the enterprises are established at a distance of 500-1000 m from the settlements. In order to minimize the problems that may arise in terms of human, environmental and animal health, it is important to consider some principles in the selection of the barn location. Agricultural enterprises where animal production is carried out should be at a distance of at least 500 m and an average of 1000 m from the settlements. It should also be located far enough away from industrial areas, crowded, dusty main roads and excessively noisy areas [5]. It should be at least 300 m from lakes and similar water sources, at least 100 m from irrigation and drainage channels, and at least 30 m from sanitary installations that provide water [6]. The ground of the place where the shelter will be built should not be close to the ground water, the drainage should be good and the chosen place should not receive continuous and excessive wind. The selected terrain should preferably be flat or sloping to the south. Areas that will be flooded and flat valley floors should not be preferred. The location chosen for the shelters should be large enough to meet the requirements and be capable of responding to possible developments. It should also be at a distance of at least 40 m from other structures in enterprises. The barns should be close to main roads, water and electricity sources in agricultural enterprises. A place should be chosen to minimize the possible dust and odor transport from the barns to the prevailing winds and settlements. In our country, genetic structure and breeding studies are mostly focused on in animal husbandry and structural and climatic environmental conditions in barns are put in the background. The same is true for the water buffalo barns where the research was conducted. In the survey study conducted with one-on-one interviews with the breeders, they stated that the water buffalo barns did not have a technical project and they were built entirely according to traditional methods. In all of the establishments, the barns were built as closed tie-stall systems,

with 58% located in the east-west direction and 42% in the north-south direction. It is recommended to position the single-row barns in the east-west direction, and the two or more-row barns in the north-south direction so that the animals can benefit from natural light to the maximum extent and in a balanced way [7;8]. On the other hand, considering the climatic conditions of the region, animal welfare and the morphometric characteristics of the water buffaloes, the most suitable barn model that can be suggested for the region is free or free-stall barn. In terms of animal welfare, issues such as floor arrangement, sizing of building elements, arrangement of ventilation systems and waste management are very important in closed type barns. The internal volume, resting and walking area amounts per animal in barns are different from each other in all enterprises. The barn interior volume per buffalo varies between 4.5-17.5 $m^3$. In ideal conditions, the internal volume per animal should be at least between 15-18 $m^3$ in order to increase the efficiency of ventilation in the barns, to provide adequate fresh air for the animals and to have a suitable gas balance [9]. Considering all the elements such as feeding way, manger, standing platform, urinary canal and service way in the barn floor arrangement, the area required per animal should be between 4-6 $m^2$ at least [10].In the barns studied, this value is between 2-4 $m^2$, which is quite insufficient in terms of animal welfare. At least 5-6 $m^2$, preferably 8-12 $m^2$ area should be calculated per adult buffalo in the paddock area [11]. The excursion area allocated per buffalo in the mentioned barns is between 1-10 $m^2$.

Natural ventilation is widely used as a ventilation system in the barns. However, 38% of the barns do not have ventilation shafts and windows are used as air inlet and outlet openings. Implementation of lantern-type natural ventilation system in barns will facilitate the control of the climatic environment. For this purpose, at least 1.5 cm clearance should be left in the ridge for 1 m of the width of the barn [8].

The window areas left for lighting in the barns studied take a value between 0.7-4.5%. The recommended value for temperate regions under optimum conditions is in the range of 5-7.5% [9]. Accordingly, natural lighting is insufficient in all of the barns. On the other hand, 94% of the barns have artificial lighting. However, the artificial lighting value per 1 $m^2$ of the barn floor area is between 0.2-2.3 Watts and is not sufficient. This value should be in the range of 4-6 $W/m^2$ [8].

***Determination of technical principles for planning different types of water buffalo barn systems***

The main purpose of making a barn in a livestock enterprise is to protect animals from adverse environmental conditions and to obtain optimum efficiency from them with minimum input. While deciding on the type of shelter in the enterprises, the environmental demands of the animals as well as the costs of both the construction and operation phases should be taken into consideration.

Different types of barns can be built depending on factors such as the size of the enterprise, the availability of land, the degree of mechanization envisaged. Water buffalo barn systems can be grouped into three groups as tied-stall, free-stall and completely free.

***a. Free system water buffalo barns***

These barns are generally closed to cold winds on three sides, especially on the south or east side, which is open for the animals to benefit from the fresh air to the maximum extent, and is covered with a suitable roof. The free system consists of barns, resting place, paddock area, special sections, feed storage, milking place and milk storage room. Animals have the opportunity to roam freely in the barn and paddock area. Compared to other types of barns, the construction cost is very low. The biggest disadvantage is the need for a separate milking unit and milk room.

The resting place is the place where the litter material is laid on the compacted earth ground, where the animals usually rest by lying down and are covered with a porch or a gable roof. When calculating the required area for each water buffalo at the resting place, an area of 5 $m^2$ is needed, based on 500 kg live weight. The ground level of the resting area is usually 20-30 cm higher than the promenade due to drainage conditions.

The paddock area is built in front of the open side of the resting place to allow the animals to get fresh air and roam. An area of 10 $m^2$ is needed for a buffalo weighing 500 kg in a paddock area. A 2% slope should be given to the paddock area to be outward from the buildings. In addition, the area around the area should be protected with fences. Generally, feeding and irrigation applications are also carried out in the paddock area. It is

important to place the mangers along the fences and to make the feeding from the service road outside the paddock area in order not to disturb the animals. The width of the feeder should be 60-70 cm for single-sided ones and 90-120 cm for double-sided ones, and a feeder length of 60 cm should be calculated for each adult buffalo [12]. It is appropriate for the mangers to be 20-30 cm high from the ground and 60-70 cm at the top [13]. The front of the mangers should be sloped outwards and covered with 2.5-3 m wide concrete or cobblestone. A canopy roof should be built over the mangers to protect the animals from bad weather conditions in winter and harmful sun rays in summer. Float drinkers can be used for watering animals. When using this type of drinker, one drinker for 25 animals can be considered.

A milking parlor is a place where more than one buffalo can be milked at the same time. The milking parlor can be planned in different ways depending on the operating capacity and economic conditions. Due to hygienic conditions, the window area in the milking area should not be less than 10% of the floor area. The milk room, on the other hand, is the place where milk is stored for a certain period of time, processed, and cleaning of tools and containers. For the milk room, an area of 3x3 $m^2$ is sufficient for small and medium-sized enterprises. If the milk production exceeds 200 liters, an area of 4x4 $m^2$ should be reserved for the milk island. In addition, it would be appropriate to add an area of 4 $m^2$ for every 100 liters of increase in milk production [14].

***b. Tied-stall system water buffalo barns***

In cold regions, tied-stall system barns can be built to protect water buffalo from adverse climatic environmental conditions and to ensure that they make maximum use of the feed provided. In tied-stall barns, animals' resting, feeding, watering and milking are done in the stalls reserved for them. These system barns can be built either as a single row or as a double row, based on the number of water buffaloes. When the number of animals is maximum 10, it should be done in a single row. If the number of animals is more than 10 and it is planned to expand the business in the future, it should be done in two rows. In order for the animals to benefit from natural light to the maximum extent, the long axes of the single-row barns should be positioned in the east-west direction, taking into account the prevailing winds and topographic structure. Two or more rows of barns, on the other hand, would be more suitable to be positioned in the south-north direction. When arranging the base of the barn, the stalls should be placed with the buffaloes facing out. In this way, the milking of the animals and the cleaning work in the barn can be done faster.

In the tied-stall system, the stalls consist of the feeder path, the feeder, the standing platform, the urinary canal, and the service road. The width of the feeder path should be between 90-120 cm in case the feed is distributed by human power and between 240-300 cm in the case of distribution from a trailer pulled by a feeding machine or tractor [15]. The width of the feeder should be 60-80 cm, and the front height of the manger should be 17.5-20 cm. The feeder floor can be made at the same level as the barn floor or 5-7.5 cm higher than the barn floor [7]. The stall length and width should be calculated based on the live weight of the buffalo. Accordingly, for a water buffalo with a live weight of 500 kg, the standing platform should be 170-180 cm in length and 110-120 cm in width. In addition, 1-2% slope should be given to the base of the standing platform. It is appropriate to make it so that the width of the urinary canal is 40-45 cm, the depth is 30-40 cm, and the base slope is 1-2%.The width of the service road can be made between 120-150 cm in single-row barns and 200-300 cm in double-row barns, depending on the equipment used in the cleaning of the barn [16].

Special compartments should be planned for buffalo cub, bulls and pregnant buffaloes in tied-stall system barns.1.5 $m^2$ for 0-3month oldbuffalo cub, 1.8 $m^2$ for 3-6 month old buffalo cub, 2.5 $m^2$ for 6-12 month old buffalo cub, 10-12 $m^2$ for bulls and pregnant buffaloes should be allocated in special compartments [12].Partitions should be separated from each other by curtain walls. The height of these walls can be 110-120 cm in the parts where the malaks are sheltered, and 125-150 cm in the pregnant buffalo compartments. The partition walls reserved for the bull should be at a height not to see the female buffaloes. For this, a height of 160-170 cm is suitable.

***c. Free-stall system water buffalo barns***

It is a type of the barn developed to combine the beneficial aspects of tied-stall and free system barns.A special stall is planned for each water buffalo at the barn. Free-stall system barns can be fully closed or partially open.A

promenade can also be planned in front of the south or east side of the barn to allow for detailed cleaning of the barn or to ensure that the water buffaloes get maximum benefit from natural light in the open air.

The stalls should be wide enough for animal comfort. However, it should not be wide enough for the buffaloes to turn around and leave their manure inside the stall. The length of the stall should be so long that the water buffaloes can lie down without any injury and make their manure outside the stall. As in other barn types, in this system, the water buffalo surface area calculated based on live weight should be taken as a basis in determining the area requirement of buffaloes. Accordingly, it is appropriate for water buffalo with a live weight of 500 kg to have a stall area of 2.5 $m^2$, a stall length of 220 cm and a stall width of 115 cm. The height of the stalls from the base of the barn should be 20-30 cm. Materials such as straw and sawdust can be used as bedding material at the stalls. However, since the supply, storage and use of these materials causes a waste of labor and time, it is more appropriate to use bedding material made of rubber, which has recently been widely used in modern enterprises.

An area of 5 $m^2$ should be calculated for each adult buffalo in the barn as a walking area. It is appropriate that the base of the walking area is concrete or grid-based so that cleaning can be done easily. In case a paddock area is planned other than the barn, the required space requirement should be 10 $m^2$ for each water buffalo. The width of the feeder should be 60-70 cm for single-sided ones and 90-120 cm for double-sided ones, and a feeder length of 60 cm should be calculated for each adult buffalo [12]. Float drinkers can be used for watering animals. When this type of drinker is used, one drinker can be calculated for 25 animals.

In free-stall system barns special compartments should be at the values given in tied-stall system barns. In the planning of the milking parlor and milk room, the principles given in the free system barns are valid.

**Conclusion**

Increasing animal productivity within economic limits; In addition to obtaining high-yielding breeds, it is possible to build barns where animals can be fed well and climatic, structural and social environmental conditions can be kept within optimal limits. For this reason, considering the above-mentioned technical principles in the improvement of existing barns and the construction of new barns will be beneficial in terms of environmental health and animal welfare.

**References**

[1]. Anonymous (2006). Animal Barns-Building Rules. TSE-5244, Turkish Standards Institute, Ankara.
[2]. Anonymous (1996). Semi-Open and Closed Free System Dairy Cattle. Ziraat Bank Publications, Publication No: 16, Ankara.
[3]. Kocaman, I. (1998). A Research on the Investigation of the Physical Status of the Tied-Stall Dairy Cattle Barns and Environmental Conditions InInanlı and Turkgeldi Livestock Farming Administration. (PhD Thesis), Trakya University Institute of Science and Technology, Edirne.
[4]. Anonymous (2015). Istanbul Province Meteorological data. State Meteorology General Directorate, Ankara.
[5]. Kocaman, I., Konukcu F. and Ozturk, G. (2011). Measures to Protect Environmental Problems Caused by Animal Wastes in Rural Settlement Areas a Case Study from Western Turkey. Journal of Animal and Veterinary Advances 10(12), 1536-1542
[6]. Anonymous (1987). Animal Barns-Manure Construction Rules. TSE-5244, Turkish Standards Institute, Ankara.
[7]. Balaban, A. and Sen, E. (1988). Agricultural Structures. Ankara University Faculty of Agriculture. Publications, No: 721, Ankara.
[8]. Olgun, M. (2009). Agricultural Structures. Ankara University Faculty of Agriculture Publications, Ankara.
[9]. Ekmekyapar, T. (1991). Regulation of Environmental Conditions in Animal Shelters. Ataturk University Faculty of Agriculture Publications, Erzurum.
[10]. Kocaman, I., Kurc H.C. (2013). Planning of Water Buffalo BarnSystems. Journal of Istanbul Buffalo Breeders' Association, 1(1), 13-17.
[11]. Bhoite, D. P. (2009). Loose Housing Cattle–Buffalo Shed Desing. http://www.kvkbaramati.com.

[12]. Soysal, M. I. (2009). Production of Buffalo and Its Products. Namık Kemal University Department of Animal Science Publications, Tekirdag.
[13]. Okuroglu, M. and Yaganoğlu, A.V. (1993). Kulturtechnics. Atatürk University Faculty of Agriculture Lecture Publications No: 157, Erzurum.
[14]. Alkan, Z. (1973). Technical Fundamentals of Stable Planning. Ataturk University Faculty of Agriculture. Publications, No: 189, Erzurum.
[15]. Maton, A., Daelemans, J. and Lambrecht, J. (1985). Housing of Animals. Elsevier Science Publishers B.V., Netherlands.
[16]. Wathes, C.H. and Charles, D.R. (1994). Livestock Housing. Animal Science and Engineering Division Silsoe Research Institute, UK.