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The Objectives Of Technological Parameters For Dairy Goats Keeping In Stable-Housing Period.

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ABSTRACT

The paper reveals the data on determining the optimal area norms for keeping dairy goats in accordance with behavioral reactions at group keeping. The research used the technique of the objective assessment of technological parameters. The assessment of individual characteristics of animal behavior involved the time study of animal behavior, the study of rank subordination of small ruminants, the determining of speed of feed eating, the records of motion activity of goats. The observations of the animal behavior used the method of time-based recording of an animal location in the pens and the determining of the linear distances between them. For this purpose special scaled record cards were used, and the pens were divided into conditional squares. Observations after the group behavioral animal reactions allowed making a conclusion that the dairy goats have a definite hierarchical structure of the population. Leader-animals and outsider-animals were identified in all groups. Calculations of the area per one animal in a limited space were based on the carried research. The calculations considered the area of the animal in the projection of the floor and half of the individual distance between the animals in each of four directions, which made one individual distance in length and one in width. The optimal floor area for all-season group loose keeping of dairy goats is 1.5m^2 per head. In the case of pasture-stabling keeping or the use of a barn yard, the floor area must be at least 1.3m^2. A decrease inthese indicators leads to a reduction in individual distances between animals, an increase in their motion activity and rank collisions. Individual distances are maintained by animals in the "standing" position, as rank collisions between animals may be only in this case. The floor area required for keeping animals of different age-and-sex groups is 3.0 per begetter goat; replacement male goat – 1.7, ewe – 1.5; replacement female goat – 1,2; male kid of 7–8 months – 0,4; female kid of 7–8 months – 0,4; male kid of 0–10 days – 0.1; female kid of 0–10 days –0,1m^2. A further decrease in this indicator leads to a sharp spike in rank fights, which indicates an insufficient feed cribs for dairy goats.

Keywords: dairy goats, housing conditions, technological parameters, floor area, feed cribs.

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INTRODUCTION

Determining the optimal area for dairy goats keeping is of great importance for designing and construction of new and reconstruction of existing livestock farms. Until recently, the methodological approach in determining these indicators has been based on measuring the animal bodies of different age-and-sex groups. As a result of our studies based on behavioral reactions in conditions of animal group housing we used methods of an objective assessment of technological parameters at dairy goats keeping. The assessment of the individual characteristics of animal behavior involved the time study of animal behavior, the study of rank subordination of small ruminants, the determination of the speed of feed eating, the recording of the motion activity of goats [1].

Dairy goat breeding considers loose housing with unchangeable deep litter, which is related to the specific herd behavior of goats, high motion activity, and peculiarities of their behavior. To achieve a high level of milk production, it is necessary to create comfortable conditions for goats keeping. It is important to ensure sufficient space between animals considering a rank hierarchy in the group. Animals of a low rank should have a possibility to avoid collisions with goats of a higher rank. A ranking subordination was clarified in the experimental group of animals to determine the optimum area norms for dairy goats keeping. When forming a group of animals, rank collisions occur between them. As a result, the leaders and outsiders of the group are revealed. In our studies we divided the animals into three groups: dominant, subordinate and neutral, labeling them as "leaders", "neutral" and "outsiders." These animals were revealed as a result of monitoring them and recording winners in rank collisions [2, 3, 4, 5, 6, 7, 8, 9].

The observations of the animal behavior used the method of time-based recording of the animal location in the pens and the determining the linear distances between them.

For this purpose special scaled record cards were used, and the pens were divided into conditional squares.

EXPERIMENTAL PROCEDURE

To conduct studies on determining the area norms for a dairy goat at loose housing, three groups of ewes were formed, in which the rank hierarchy had been previously determined. The animals were kept in three pens with different floor areas. In formation of groups the rank hierarchy was considered, thus, leaders, outsiders and neural were included in each group.

The floor area per head in the I group was 1.7m^2, which is 40% higher than the normative value, the II group had 1.2m^2, which corresponded to the recommended norm, the III group had 0.8m^2, which was below the norm by 33 %. The test duration was 10 days, 6 days had recordings.

Ethological indicators of animals were studied in determining the norms of the floor area. During the 1–3 days after the formation of experimental groups, a hierarchical relationship between animals was studied by recording double contacts (collisions) at artificial reduction of the floor area. During the record periods the motion activity and individual distances between animals were studied. The motion activity of the females was determined with a pedometer on three animals from each group considering their rank position. The records of the number of motion acts were carried out at record days three times a day (in the morning, afternoon and evening at the same time). The pedometers were placed in cases and fastened with straps on the animal's body behind the front legs.

Individual distances between animals were studied with the method of observing the location of animals in the pens during the waking period 6 times a day with an interval of 2–3 hours, considering the distances between them. The location of goats in the pens was recorded on a specially designed card, where a pen with coordinate lines was schematically represented in a scale of 1:20 (Fig. 1). For observer's convenience the perimeter of the pen (on panel equipment and wall) was marked with a line painted at intervals of 50cm.

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	A	B	C	D	E	F
1						
2		L5				
3				E7		
4		S8				
5						
6						

Figure 1: The record card for recording the location and state of the animal

The location of animals with their number and state was put schematically on the record card; it was marked with letters (L–lying, S–standing, E–eating).

In accordance with this data, the individual distances between animals at a given time were calculated.

AREA NORMS FOR GOAT KEEPING

Observing the group behavioral animal reactions allowed making a conclusion that the dairy goats have a definite hierarchical structure of the population. Leader-animals and outsider-animals were identified in all groups.

The individual distances between "leaders", "neutral" and "outsiders" are presented in Table 1.

Table 1: Individual distances between dairy female goats in dependence with the floor area in pens, m

Animal rank	I group (1,7m^2 per head)			II group (1,2m^2 per head)			III group (0,8m^2 per head)		
	Ileader	II	III	Ileader	II	III	Ileader	II	III
I (leader)	–	1,00±0,62	1,40±0,61	–	0,98±0,59	1,04±0,63	–	0,97±0,56	0,74±0,43
II (neutral)	–	1,25±0,81	1,34±0,85	–	1,04±0,69	1,07±0,69	–	0,95±0,67	0,79±0,59
III (outsider)	–	–	0,74±0,71	–	–	1,00±0,78	–	–	0,66±0,64
On the average in group	1,15±0,73			1,03±0,67			0,82±0,58		

The analysis of Table 1 shows that the average individual distances between animals, which are limited by a particular room, depend on the floor area per animal. In the first group this distance is more by 10.5 and 28.7% compared to the second and third ones. It should be noted that individual distances between animals are reduced to a lesser extent than the floor area per animal. So, the floor area in the second group is less by 29.6%, and in the third group – by 58.8% compared to the floor area in the first group.

The longest individual distances in the first group are marked between the "leaders" and "outsiders". With a decrease of the floor area, these distances are reduced in the second group by 25.7% and in the third group by 47.1% compared to the animals in the first group. The individual distances between the "leaders" and "neutral" in the first group are less than between the "leaders" and "outsiders" by 28.6%. At the same time, there is no significant reduction in the distance between the "leaders" and "neutral" when the floor area is reduced; and the difference is 2.0 and 3.0%, respectively in the second and third groups.

As a result, the third group has the individual distances between the "leaders" and "outsiders" less than between the "leaders" and "neutral" by 23.7%. This can be explained by the fact that the "neutral" animals manage to maintain individual distances with the "leaders" by crowding out the "outsiders" who are forced to reduce individual distances with the "leaders".

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The individual distances between two "neutral" female goats are reduced in groups with a smaller floor area by 16.8% in the second group and 24.0% in the third group compared to animals from the first one. Thus, as the floor area decreases, the individual distance between two "neutral" animals reduces more than between the neutral" animal and the "leader." The individual distance between the "neutral" animal and the "outsider" in the second group is less by 20.1%, and in the third – by 41.0% compared to the animals in the first group. The individual distance between the "outsiders" in the second group increases by 35.1%, and in the third group it decreases by 10.8% compared to the similar animals in the first group (Fig. 2).

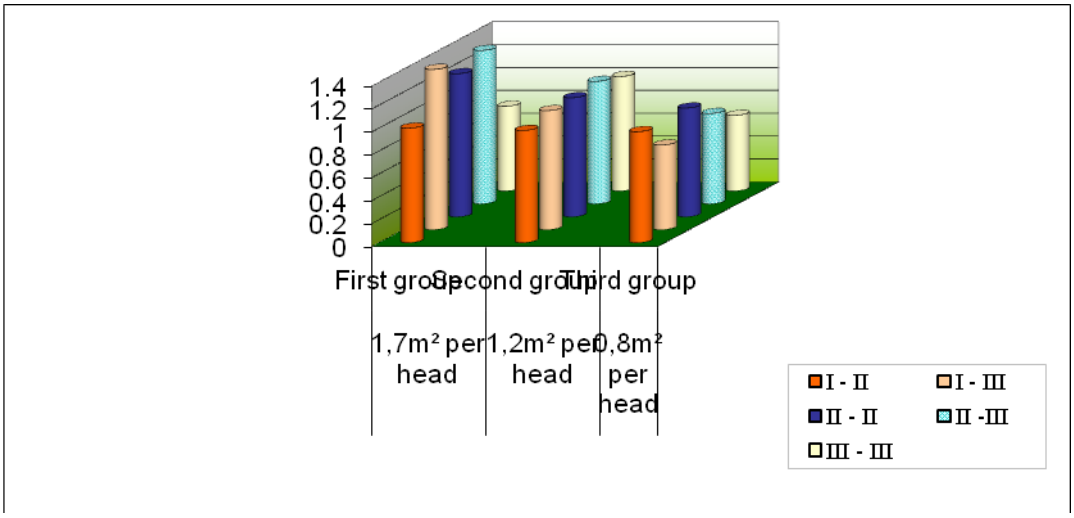

Figure 2: The individual distances between goats of different hierarchical status: I – "leaders", II – "neutral", III – "outsiders" depending on the floor area in pens

Thus, the individual distances between animals are about 1.0m, and only with a significant reduction in the floor area in a limited room space, the individual distances are reduced – primarily due to the animals of a lower hierarchical rank, which are forced to reduce the individual distances, first of all, with the leaders and be in uncomfortable conditions.

The motion activity of animals is also an important aspect considering behavioral reactions in conditions of limited area of housing (Table 2).

Table 2: Motion activity of goats, depending on the pen sizes for housing (m / day)

Animal rank	First group (1,7m² per head)	Second group (1,2m² per head)	Third group (0,8m² per head)	On the average
I "leader"	400,7±124,5	331,8±132,1	324,8±74,2	352,5±111,6
II "neutral"	203,3±65,6	397,4±121,4	324,1±105,9	308,2±104,8
III "outsider"	384,0±157,4	447,3±112,0	556,4±139,4	462,6±128,4
On the average in group	329,4±109,57	392,2±57,97	401,8±133,9	

The analysis of Table 2 shows that the motion activity of animals increases with decrease of the floor area. Thus, the average activity of animals in the first group was less by 19.1 and 22.0% than in the second and third groups respectively. The comparison of the motion activity of animals of different hierarchical ranks showed that the most active goats are "outsiders", which have a higher indicator in comparison with the "leaders" and "neutral" animals by 23.8 and 33.4% respectively.

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It should be noted that the "leader"-goats had the greatest motion activity in the first group, which is with the maximum floor area, and the lowest motion activity in the third group with the minimal floor area. The difference in motion activity of the "leaders" in the second and third groups in comparison with the first group was 17.2 and 18.9%, respectively.

The motion activity of the "neutral" animals in the second and third groups increased by 95.5 and 59.4%, respectively, compared to the goats in the first group. The motion activity of the "outsiders" in the second and third groups increased by 16.5 and 44.9%, respectively, compared to the animals in the first group (Fig. 3).

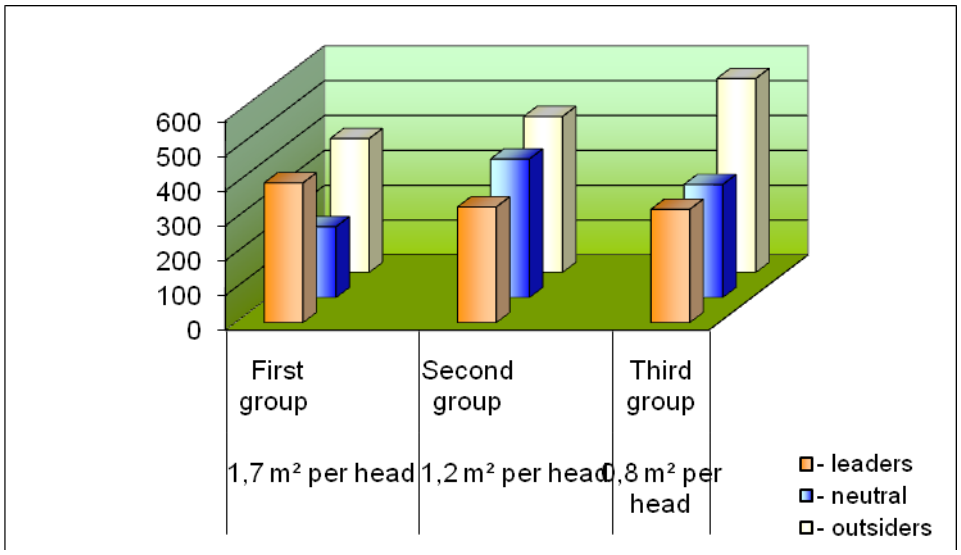

Figure 3: The motion activity of goats of different hierarchical status depending on the floor area in pens

The identified regularities can be explained by the fact that the "leaders" in the first group have the opportunity to maintain the greatest possible distances with other animals, which requires constant movement for defending their comfortable position. Reduction of the floor area makes it physically impossible to increase distances between animals, thus, the motion activity of the "leaders" decreases.

The motion activity of the "neutral" animals is the greatest in the second group that is connected with the need to defend a comfortable distance between two "neutral" animals or the "neutral" animal and the "outsider". The motion activity of the "neutral" animals in the third group, as well as "leader" animals, decreases in comparison with the animals from the second group, as it becomes physically impossible to defend free space.

The highest motion activity of the "outsider" animals in the third group is related to the necessity of constant avoidance of collisions with animals of higher hierarchical ranks. Therefore, these goats are in the most unfavorable housing conditions with the least floor area.

Calculations of the area occupied by one animal in a limited room space were based on the carried research. The calculations took into account the area of the animal in the projection of the floor and half of the individual distance between the animals in each of four directions, which made one individual distance in length and one in width. The individual distances are maintained by animals in the "standing" position, as rank collisions between animals may be only in this case.

If we take the "standing" position for calculating the floor area occupied by one animal, then for simplicity of calculations the animal projection on the floor can be represented as a rectangle in which the length is equal to the sum of two body dimensions: the oblique length of the trunk and the length of the head, and the width is the widest part of a body, width of the chest. However, in a case of group housing, the "standing" position is characteristic for all animals simultaneously only during the feed distribution or manipulations by a person (milking, veterinary procedures, etc.). Usually about 30–50% of animals are lying

down during the day, and at night this indicator reaches 100%. In the "lying" position, the individual distances between animals are significantly reduced, because, as a rule, goats rest along walls and react less to decrease of the distance with other animals. Considering this fact, the formula for calculating the floor area per animal can be represented as:

$$S_a=k \times (l_o+l_h+l_d) \times (W_{ch}+l_d), \quad (1)$$

as S_a – the floor area per animal;

k – the correction factor at group animal housing in the "standing" position;
l_o – the oblique length of the body;
l_h – the length of the head;
l_d – individual distance between animals;
W_{ch} – width of the chest

We calculate the floor area for keeping one animal with substituting in the formula the average parameters of body measurements and the value of individual distance between the goats and taking the correction factor of 0.6, which corresponds to 60% of animals which are in the "standing" position:

$S_a= 0,6 \times (0,84 + 0,24 + 1,00) \times (0,22 + 1,00) = 1,5\ m^2$.

The reported value is optimal for all-season in-door breeding of goats in pens with deep litter. For animals keeping in barn yards or pasture-stabling keeping, the floor area can be reduced, as the animals rest more and in 50% of cases they are lying. It to put the coefficient of 0.5, we get the optimal floor area with consideration of the above mentioned factors.

$S_a= 0,5 \times (0,84 + 0,24 + 1,00) \times (0,22 + 1,00) = 1,3\ m^2$.

After the conducted research it is possible to make a conclusion that the optimum floor area for all-season loose group keeping dairy goats is $1.5m^2$ per head. In the case of pasture-stabling or the use of a walking yard, the floor area in the room must be at least $1.3m^2$. Reduction of these values leads to a reduction in individual distances between animals, an increase in their motor activity and rank collisions.

Determining The Area For Housing Of Goats Of Various Age-And-Sex Groups

The industrial dairy goat breeding can involve various organizational forms for farms, which influence the herd structure and the movement of sex-and-age groups. The basis of the industrial farm is dairy goats, which have a share of 60 to 80% in the herd, and in some cases it can be up to 100%. Thus, the constructions for keeping dairy goats occupy the main place at the farm.

The number of begetters and replacement goats at the farm does not exceed 1–2% of the total number of animals. Replacement goats occupy 20–25% in the herd structure, and kids of the current year of birth, as a rule, do not stay long at the farm and, if possible, they are sold at 2–4 months of age. Nevertheless, all these age-and-sex groups need living space, and accordingly it is necessary to calculate the optimal requirements in the floor area.

To calculate the floor area for keeping different age-and-sex groups, the formula (1) was used, that was approved in calculating the floor area for dairy goats. The values of individual distances for begetters and replacement goats older than 1.5 years old, as well as replacement goats older than 1.5 years old are calculated by the method of ethological observations after goats described above.

Kids from birth up to 1.5 years old do not show great activity in keeping individual distances. During this period of life, cognitive and playful factors prevail in animals. High motion activity, constant playing collisions, common rest in one group, pressing against each other, result in significant reduction of individual distances.

When calculating the correction factor for group keeping of animals in the "standing" position for begetters, we consider the fact that they are kept either individually in pens or in small groups of 2 to 10 heads. As goats manifest the same behavior, in the fact they often stand, or lay, the factor was 1.

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The young stock of dairy goats, the factor varies with the growth and development, as after the birth of the goat most of the time lay, pressed against each other, and after that the typical behavior is characteristic for kids (they play, take food or rest). The results of the calculations are in Table 3.

Table 3: Calculations of the floor area in pens for keeping goats of different age-and-sex groups

Age and sex group	Oblique length of the body, m (l_o)	Length of the head, m (l_h)	Width of the chest, m (W_{ch})	Individual distance (l_d)	Factor at group keeping (k)	Area floor per animal, m^2
Begetter goat	0,95	0,25	0,27	1,05	1	3,0
Replacement male goat	0,76	0,17	0,23	0,90	0,8	1,7
Ewe	0,84	0,24	0,22	1,00	0,6	1,5
Replacement female goats	0,72	0,17	0,21	0,70	0,8	1,2
Male kids 7–8 months	0,64	0,15	0,19	0,30	0,8	0,4
Female kids 7–8 months	0,63	0,14	0,19	0,30	0,8	0,4
Male kids 0–10 days	0,3	0,09	0,07	0,20	0,5	0,1
Female kids 0–10 days	0,29	0,09	0,07	0,20	0,5	0,1

Thus, the suggested method for calculating the floor area for keeping dairy goats is based on an objective assessment of the exterior characteristics and biological characteristics of animals (group behavior) and can be recommended for animal husbandry practice.

DETERMINING THE OPTIMUM FEED CRIB

An important moment in group keeping of goats is determining the optimal feed crib for one animal. It is necessary to determine the width of the feed crib per animal for correct feeding. We investigated the process of eating feed from feed cribs equipped with feeding places, considering behavior of goats and their rank hierarchy. The duration of the study was 20 days. The experiment had 5 periods of 4 days each. In each subsequent period the width of the feed crib was decreased in comparison to the previous one. The feeding places were reduced from 18 to 10 with the same number of animals, which corresponded to a decrease in the width of food cribs from 0.26 to 0.14m per animal. For initial calculations of the width of the feeding place, the main parameters of body measurements were considered. Thus, goats older than 3 years old have the average chest width of 21.5cm with lim 17–27cm, the forehead width is 13.5cm with lim 12–15cm. The optimal width of a feeding place was calculated after the experiment.

The behavioral reactions of animals were studied during the experiment. For the convenience each animal was given an individual number. Observations after animals (their approach to feed cribs with hay) were carried out during hay feeding from 7:00 to 7:30 – every 5 minutes; from 7:30 to 8:30 – every 15 minutes; from 8:30 to 12:00 – every 30 minutes; from 12:00 to 16:00 – every hour; from 16:00 to 16:30 – every 5 minutes; from 16:30 to 17:30 – every 15 minutes; from 17:30 to 21:30 – every 30 minutes; from 21:30 to 7:00 – every 3 hours.

Simultaneously with observations of animal approaches to feed cribs, cases of aggressive behavior of goats in the fight for the feeding place (clashes, jumps, displacement) were recorded.

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The analysis of the data showed that the intensity of the use of food places at a limited number of them and, correspondingly, the feed cribs increased (Fig. 4).

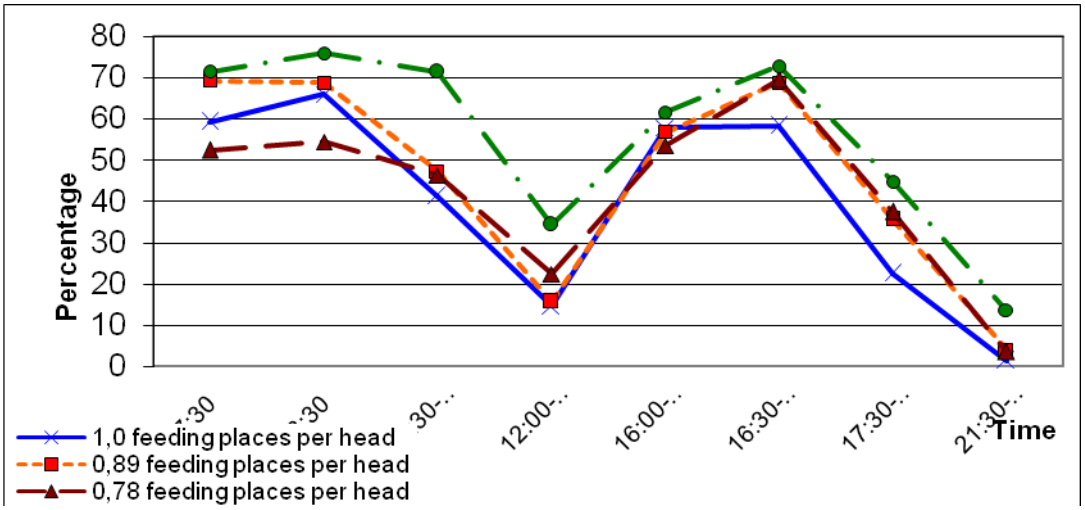

Figure 4: Intensity of use off eeding places at their various quantity

During the feeding at 7:00–7:30 and 16:00–16:30, the capacity of the feeding places with 1.0 feed cribs (0.26cm) per head is by 3.8–19.8 abs.% lower compared to 67% of feeding places (0,67 feeding places and 0.14m per head). At the same time, in time intervals between feeding at 8:30–12:00 and 17:30–21:30, the difference in intensity of the use of feeding places increased and was 10.1–30.2 abs.%.

This can be explained by the fact that while limiting free access to feeding, animals are forced to wait for their turn according to the hierarchical behavioral subordination between them. This conclusion is confirmed by an increase in the number of collisions between goats to identify leadership between animals as the number of feeding places and the feed cribs decreases (Table 4).

Table 4: Number of collisions between goats to detect rank distances

Record time	Number of collisions with availability of feed places per head:				
	1,0 (0,26 m)	0,89 (0,23 m)	0,78 (0,20 m)	0,67 (0,14 m)	On the average
7:00–7:30	10	19	23	43	23,8
7:30–8:30	13	31	16	36	24,0
8:30–12:00	8	15	9	22	13,5
12:00–16:00	2	2	3	2	4,5
16:00–16:30	15	26	38	40	29,8
16:30–17:30	7	23	26	28	21,0
17:30–21:30	0	9	9	20	9,5
Generally during the full day	55	125	124	191	

The analysis of Table 4 shows that the greatest number of collisions occurs during the feeding and during the first hour after it. On the average, 21.0–29.8 cases were recorded. In the intervals between feedings, this indicator was at the lowest level and was 4.5–13.5 cases.

At the same time, as the number of feeding places and, accordingly, the feed cribs decreased the number of "collisions" between the goats increased. The difference between the extreme variants (1.0 and 0.67 feeding places or 0.26 and 0.14 m) was 3.5 times. Even a decrease in the feed cribs by 3 cm (0.89) in the feeding place increased the number of collisions by 2.3 times. The increase in the number of rank fights between dairy goats forces a stressful situation, which is of a permanent technological nature, which can result in a decrease of milk productivity during lactation.

On the results of the studies, it can be concluded that the minimum necessary feed cribs the group keeping of dairy goats should be 0.25–0.26m per head. A further decrease in this indicator results in sharp spike in rank fights, which indicates insufficiency of feed cribs for dairy goats.

SUMMARY

1. The optimal floor area for all-season group loose keeping of dairy goats is 1.5 m^2 per head. At pasture-stable keeping or with the use of a barn yard the floor area in pens should be not less than 1,3m^2. Decrease in these indicators results in reduction of individual distances between animals, and in increase of their action activity and rank collisions.
2. The floor area required for keeping one begetter goat was 3.0; replacement male goat – 1.7, ewe – 1.5; replacement female goat – 1,2; male kid of 7–8 months – 0,4; female kid of 7–8 months – 0,4; male kid of 0–10 days – 0.1; female kid of 0–10 days – 0,1 m^2.
3. The minimum necessary feed cribs for group keeping of dairy goats should be considered 0.25–0.26m per head.

CONCLUSION

Thus, the average individual distances between animals in the limited pen space depend on the floor area per animal and they decrease to a lesser extent than the floor area per animal.

The dairy goats have a definite hierarchical structure of the population: leader-animals and outsider-animals have been identified in all groups. The optimal floor area for all-season group loose keeping of dairy goats is 1.5 m^2 per head, for pasture-stabling keeping or the use of a barn yard, the floor area in the pen must be at least 1.3m^2.A decrease in these indicators leads to a reduction in individual distances between animals, an increase in their motion activity and rank collisions. Individual distances are maintained by animals in the "standing" position, since only in this case there are rank collisions between animals.

Conflict Of Interests: The authors confirm that the presented data do not contain a conflict of interest.

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