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Original Contribution

ETHOLOGICAL EVALUATION OF LARGE MEASURED BUILDING FOR DAIRY COWS REARED IN INDIVIDUAL CUBICLES

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ABSTRACT

The aim of this study was to make ethological evaluation of four areas of biological needs of animals, which are loose locomotion, social contacts, resting place and conditions and lack of indications of discomfort, and to evaluate a completely new technological solution for Bulgaria; a project carried out in a large farm building for 500 dairy cows in the Town of Tvarditsa. The study showed that the building had provided the necessary conditions for free locomotion and free choice of all behavioral activities, which had led to effective use of premises of areas more than 92 per cent. Furthermore, a stable hierarchy in the groups and a lack of conflicts were recorded. It can also be seen that there were good conditions for rest and animal welfare. Therefore no symptoms of discomfort were noticed. The technology is given the highest grade of 4-grade scale, which means that it is highly satisfactory in all biological needs of animals and it is beneficial and effective as well.

Key Words: Behaviour; Housing systems; Animal welfare; Lying behaviour; Comfort; Locomotion

INTRODUCTION

Significant reorganization of dairy processing industry structure has recently started in Bulgaria This is the result of achievement of two goals: Bulgarian producers, through introduction of new technological solutions and, in accordance with Stockbreeding Law and European requirements, are struggling to survive in a highly competitive marketplace and they also seek to find their place among the promoted and well-known dairy brands on the integrated market.

In the developed countries in Europe and America there is a tendency towards loose breeding of dairy cows in individual cubicles and reduction in tied-up breeding. Semi-open buildings with light constructions fenced with walls and roofs and are widely used. The number of cows, breeding in premises is increasing as well as their number in a group. It is owing to some economic reasons such as higher productivity, automated and mechanized processing and lower value of one place for cow (mainly due to the light construction). The main goal is to create convenience and comforts of breeding cattle by new modern technologies, which results in making a good use of their genetic potential (1, 2, 3, 4).

Expectations of a fast return of the investments often fail due to a lack of knowledge or non-compliance with cows' genetic requirements. This is the main motive of carrying out research like this –to outline the boundaries of sensible compromise, where economic interest of people and biological one of the machine producing milk- cows- have met. Such research has become very popular in the last 10 years because in a lot of countries the price of milk in the supermarkets is far lower than the price of water. The number of people who are able to spend more money on high-quality food (including better conditions for breeding animals) has been increasing gradually. Moreover, more countries aim at providing the so-called five opportunities of free choice, approved by British Council of Domestic Animals Welfare in 1979 (5, 6). Only one of these possibilities refers to animals' freedom to choose how to behave, other four are for things leading to discomfort (hunger, stress, diseases, undernourishment, etc.). While detailed studies of the conditions for broiler chicks and pigs are often done and regulated to high extent, there is a clear need for further research on cattle breeding environmental conditions because the subject has not been fully researched before. Such work and some law initiations have started in the last 15-20

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years (7, 8, 9, 10).

The aim of this research is to explore 4 different areas of satisfaction of biological requirements for raising animals: freedom at locomotion; social contacts, conditions for having a rest and available symptoms of discomfort and then to make ethological evaluation of the building, according to a completely new technological solution for our country, which is carried out in the town of Tvarditsa. The recent research shows to what extent the different areas of the building have been used in accordance with their purpose. It was also made to determine whether the efficiency of technological project was in line with the authors' expectations.

All manifestations of discomfort, aggression and abnormal behaviour activities are clearly stated in order to make analyses of their cause.

MATERIAL AND METHODS

The research was conducted in a dairy farm with the following specific features:

Type of building- fully open like a shelter, large measured building for 500 cows. This is one of the most innovative and high-level technological solutions for building construction for breeding cattle ever designed and built in Bulgaria up to now.

The Number of Cows in a Group – over 120 dairy cows, which has a big influence on their social behaviour.

Provided area for an animal – considerably bigger area than the required one, according to Bulgarian regulations, which is expected to provide much more comfort and have positive effect on their rest and motor skills and activity. Some measurements of the technological elements are: a feed line width (5.2 m), an aisle between the individual cubicles (3 m at required minimum of 1.80 – 2 m), feeding platform (4 m at required minimum of 2.80 – 3 m), individual cubicles length (2.5 - 2.7 m at required min of 2.20 - 2.40 m), etc.

Type of Milking Parlour - a higher class milking parlour is introduced (Type Parallel – 2x12) with a lounge, where enough place is provided for all dairy cows to stay. One more new piece of technology is an electromechanical device to herd on the cows, which makes the movement of the animals towards the milking boxes easier. In addition, it aims to improve their milking reflex and their behaviour during the time of milking.

Feeding – ad libitum. It suggests extreme satisfaction of animals' biological requirements. However, it is prompted by lack of possibility to provide required regulated feeding in doses. Fodder is given at stripes on the edge of the central feeding line by a trailer-blender (there are no mangers).

Cleaning up dung – dung is removed through the four technological lines, set in motion by two installations along the building, which lead to the centre where the dung falls into a sewer and afterwards it is pushed out into an open concrete lagoon by a pump.

Regulation of microclimate - the two longitudinal walls of the building are replaced by automatically rising curtains. To prevent the animals from overheating and sun radiation during the summer and to improve the natural air ventilation, the height of the building is increased at the eaves and the ridge.

Cows of each group have the possibility to have a rest into individual cubicles in three rows along the walls and located on the both sides of feeding line.

Figure 1 and **Figure 2** represent six basic areas, differentiated by the technological project. Ethological studies have been made basically in the first three areas, where it is investigated which behavioural activity is predominant and, regarding it, has been found the extent of the use of these areas. For the purpose of this research, we separated areas A and B into smaller sub areas noted down as A1 – outer individual cubicles, A2 – first inner individual cubicles, A3 – second inner individual cubicles, B1 – outer path (aisle) and B2 – passages (see **Figure 1**).

Experimental Animals

The behaviour of the three most common and basic cows' breeds in our country has been studied – Bulgarian Black Pied, Bulgarian Brown and Bulgarian Simmental. Cows were housed in groups of 120 animals and 10 cows of each group were taken, applying the method of random choice and regarding the reliable indexes of equality in their breed, age and physiological condition.

Ethological Methods

Ethological observations were made within last 24 hours and were held within two seasons – summer and autumn. For the purpose of our research, the method of direct, non-stop 24-hour monitoring of the group was adopted. The reading registrations were done at interval of 15 min, aimed at achieving necessary authenticity and reliability of the

results (possible deviation of less than 5%). The main objects of our observation were: feeding behaviour, moving and rest behaviour, represented by their activities – feeding, ruminating, moving and resting, being in a completely calm and relaxed state. Behavioural stereotypes have been recorded: acts of discomfort, abnormal forms of behaviour, communications and positions for maintaining the hierarchy.

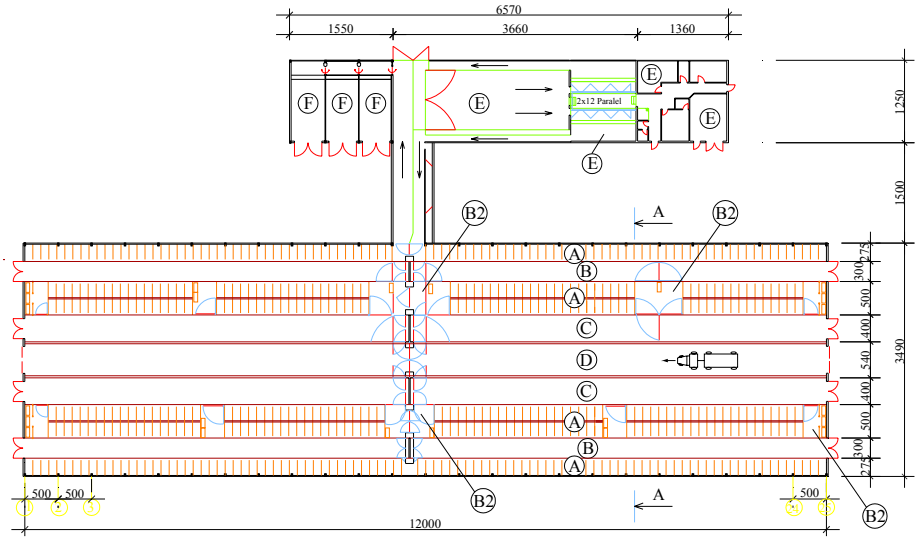

Figure 1. *Distribution plan of the building area for 500 cows – the Town of Tvarditsa: A - area of rest, B - area of movement, C - area of movement and feeding (incl. feeding platform), D - area of fodder distribution, E – milking area, F - maternity ward*

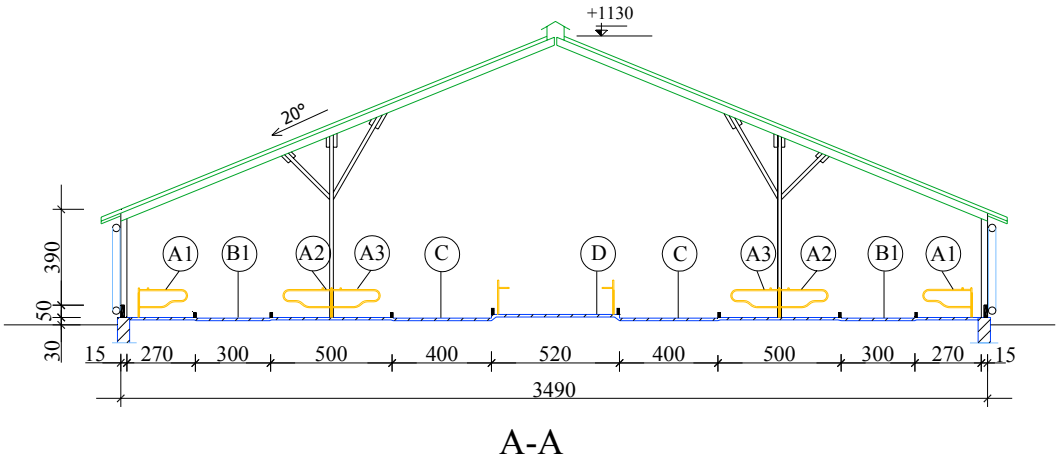

Figure 2. *Cross section of the building for 500 cows in the Town of Tvarditsa*

The results of the observation gave us a base for evaluating the conditions of the farm from ethological point of view as well as the extent of biological requirements satisfaction. Four-grade scale was used for our evaluation as we did in our previous studies and it occurred to be much more efficient than scales used by other scientists (7, 11, 12, 13).

According to this scale the maximum Good grade is given for the environmental conditions, fully corresponding to biological requirements of the animals – the base for comparison were the indexes of FA for loose breeding (out to pasture) and lack of discomfort. Satisfactory grade is given when some insignificant deviations from the standards of FA and behaviour stereotypes are noticed, causing discomfort in more than 5 per

cent of the animals. Unsatisfactory was the grade of technology, in which basic characteristics of feeding behaviour and rest were disturbed. Moreover there were constant conflicts, high sound and tactile sensitivity and unwelcome behavioural stereotype in not more than 30 per cent of the cows. For example, ruminating in standing position predominated over the ruminating in lying state, feeding was accompanied by long-lasting conflicts, more than 30 per cent of the animals relaxed on places not intended for resting places- concrete aisles, passages etc. Bad grade is obtained when the basic requirements for humane treatment to animals are not fulfilled and drastic deviation from zoo hygienic norms. Having such bad grade, the farm cannot sell its production and a lot of sanctions are imposed. The farm is under very strict control until all the faults are repaired.

Four spheres of biological requirements satisfaction of animals are observed:

- Freedom of locomotion;
- Fodder receiving conditions;
- Rest conditions;
- Available symptoms of discomfort.

Mathematical methods

Average values of functional activities (FA) of the research are determined with the help of adapted mathematical model. Arguments for its use are stated in our previous editions (10, 14). An index of the respective FA is calculated by the following formula, with the set purpose of comparing the results with other similar studies:

$$iFA = \Delta t / t,$$

Where:

iFA – Index of a respective FA

Δt – Sum of registered periods in which the respective FA is displayed (min)

t – Total duration of research (min).

Table 1. *Indicators of macro- and microclimate*

Season	***Temperature °C***		***Relative humidity (%)***		***Air velocity (м/s)***	
	out	*in*	*out*	*in*	*out*	*in*
Summer daily average	24,1	20,4	56,5	59,5	1,928	0,419
Min ÷ Max	18,5÷29,7	18,9÷22,0	43÷70	48÷71	1,38÷3,04	0,300÷0,497
Autumn daily average	12,2	17,6	71,0	59	2,435	1,108
Min - Max	11,1÷13,1	16,8÷18,0	46÷96	55÷63	1,035÷4,000	0,697÷1,388

RESULTS AND DISCUSSION

In both observations of cows' behaviour held in summer and autumn, we have ascertained that used technology guarantee temperature comfort for breeding animals. The temperature outside does not affect the temperature inside the building and its measurement varies from 16, 1 °C to 22, 5 °C. Regarding measures of humidity and air velocity (**Table 1**), we can estimate that designers' efforts of creating favourable environment for breeding animals have succeeded. It is confirmed by data for using different areas of premises as well- no abnormal behavioural reactions are recorded in unusual areas such as standing near the gates, lying on the concrete paths, lying near the watering place in summer or irregular use of individual cubicles (**Table 2** and **Table 3**).

Figure 3 illustrates changing patterns of index of basic behavioural activities of the dairy cows, recorded during our research. It can be seen that ruminating and resting (lying) have the biggest share of all. The activity of standing is regarded as a transition to rest, thus the combination of standing and lying makes the seasonal differences less. The index of feeding has the same stable values (about 0,200) with the three breeds under the research.

The seasonal influence on the behavioural activities was insignificant. The main factor for this is relatively stable features of microclimate, as well as favourable conditions provided in the housing system, which will be further discussed in details.

In the research we focused our attention on 4 areas: individual cubicles, outer path, passages and feeding platform, where we registered and recorded behavioural activities. **Table 2** represents data for the index of basic functional activities (iFA), from where it can be seen that individual cubicles are used to the highest extent while passages to the lowest one. To make picture clearer, **Table 3** shows that insignificant part of time for rest and ruminating (less than 2 %) is spent outside the individual cubicles. Feeding platform is used

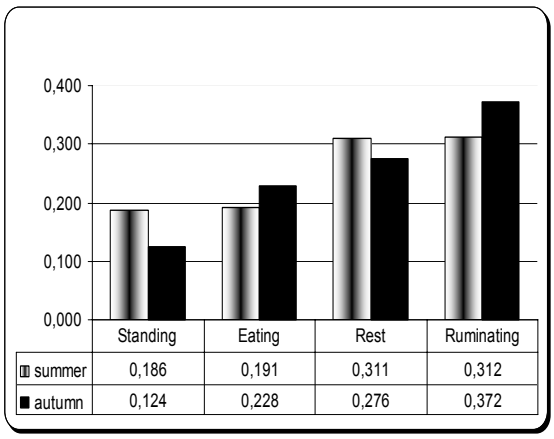

Figure 3. *Indexes of basic Functional Activities (iFA)*

to the greatest extent (100%), which must be a result of lack of other sources of food. At the same time, because of its width (4 m) the platform is a preferred place for standing and ruminating. Outer path and passages are used for movements (their basic function) and for standing and ruminating as well. FA registered on the outer path are three times more than ones in the passages (see **Table 2**).

Data in **Table 3** shows extremely large extent of use of the areas preferably designed by the constructors, almost 100% for area A, area C and passages (area B).

The results of area B1 are caused by mixing of 2 components – in addition to its basic function as an area of movement, the outer path occurs to be a preferred place for standing and ruminating, not depending on the season. Total measures of efficiency indicators are approximately 93%, which is an excellent result for the designers once again.

Such high values have never been recorded either in the scientific literature or in our previous experiments. In addition to favourable effect of an animal satisfaction with room (space), we established the positive effect of other technological elements, which can manipulate animals' behaviour and eliminate the possibility of unwelcome FA such as: lying and ruminating on the concrete paths or in the passages.

There is a subtle influence of the season on the use of individual cubicles - total index of registered and recorded FA is with similar values – less than 4% difference. It is established a preference to outer individual cubicles during the summer and the opposite tendency during the autumn (see **Table.4**). It is considered that the main cause is the higher temperature outside, because the temperature differences inside the building are insignificant, as well as longer day that affecting biorhythms and dynamic stereotype of cows.

Basic behavioural activities registered and recorded in the individual cubicles are lying and ruminating in lying position. There are recorded differences in use of the individual cubicles for rest according to the season: a preference for outer individual cubicles in the summer is noticed in comparison with the winter when the preferences are equal. Ruminating in lying position has opposite tendencies in these seasons- the preference for inner individual cubicles is established, affected by lower temperature outside (see **Table 5**).

Table 2. *Use of different areas of the building during summer and autumn (iFA)*

Season	***Individual cubicles*** *(area A)*	***Outer path*** *(area B_1)*	***Passages*** *(area B_2)*	***Feeding platform*** *(area C)*
Summer	0,558	0,117	0,033	0,308
Autumn	0,580	0,064	0,026	0,292

Table 3*. Efficiency of use of different areas of the building, according to their function - relative part of total time for Functional Activity (%)*

Season	***Individual cubicles*** *(area A)*	***Outer path*** *(area B_1)*	***Passages*** *(area B_2)*	***Feeding platform*** *(area C)*
Summer	98,20	93,82	99,97	100,00
Autumn	99,46	92,78	99,98	100,00

Table 4. *Efficiency of use of individual cubicles, according to the season and their location*

Season	***Total (iFA)***	***Outer cubicle (iFA)***	***First inner cubicle (iFA)***	***Second inner cubicle (iFA)***
Summer	0,558	0,284	0,131	0,144
Autumn	0,580	0,179	0,188	0,213

Table 5. *Basic behavior activities, shown and registered in the individual cubicles*

Functional activity	***Season***	***% of FA****	***Outer cubicle (iFA)***	***1st inner cubicle (iFA)***	***2nd inner cubicle (iFA)***
Lying	Summer	97,00	0,130	0,082	0,090
	Autumn	99,30	0,090	0,091	0,093
Lying and Ruminating	Summer	99,40	0,153	0,049	0,054
	Autumn	99,62	0,089	0,097	0,121

**relative part of total time for Functional Activity (FA)*

Table 6. *Basic behavioural activities, displayed and registered on the paths (aisles)*

Functional activity	***Season***	***% of FA****	***Outer path (iFA)***	***Feeding platform (iFA)***
Standing	Summer	82,57	0,069	0,085
	Autumn	80,38	0,033	0,067
Standing and Ruminating	Summer	99,28	0,038	0,015
	Autumn	97,56	0,030	0,032

**relative part of total time for Functional Activity (FA)*

There are 2 paths in the building: outside path 3m wide – between the individual cubicles and inside path, 4 m in width, between the individual cubicles and central feeding line, which is also used as a feeding platform. Owing to their enough width, these aisles (paths) are preferred place for standing- over 80% of total activity. It is noticed a preference for inner aisle during both seasons, which may be due to its bigger size and its closeness to the fodder.

Seasonal effect on FA is specified – during the summer cows are standing approximately 19% of 24 hours. While during the autumn the per cent is lower- 10%. The outer path is used almost twice as a result of identical causes for the use of individual cubicles (See **Table 6**). The animals are ruminating in standing position about 6% of 24 hours and are using the path between the individual cubicles. There is no seasonal influence noticed (see **Table 6)**.

The relative part of ruminating in standing position from the total time of ruminating is a basic indicator of discomfort with the ruminating animals, especially with cows - 40% is considered as a crucial borderline. In our experiments ruminating in standing position is about 20% (20.71% - in the summer and 20,54% in the autumn) which is indirect index for favourable raising of animals conditions according to their biological requirements, especially individual cubicles and feeding.

Searching for behavioural activities, characterizing the state of discomfort, we were able to specify the types of FA and the duration of their passages. We have ascertained the fact that Functional Activities are used mainly for standing – about 18% and very rarely for ruminating in standing position (some single cases). The influence of season or breed was not noticed.

It is necessary to distinguish two technological elements, which have favourable effect on the behaviour of the animals. First is that the adjacent installed device, which removes the dung on the 4-technological lines, switches on every 45 min. This creates conditioned reflex in animals,

because they have to move to let the technological lines pass and at the same time this forms the negative reflex- the cows don't lie in the concrete paths. During the experiments we recorded one breakdown of one of the lines of the device for 6 hours and only one animal lay on the path for a very short period – 6 minutes. Another good technological solution is the location of the watering places in the passages. Cows' frequent visits make impossible the long period of standing, ruminating or lying there.

Owing to the fact that we have not found any increasing sound sensitivity, or conflicts, and any signs of unwanted behavioural stereotypes (with one exception- some limp animals- the object of other research), we conclude that conditions of raising animals are favourable and satisfy to a great extent biological requirements of the animals.

CONCLUSION

Using 4-grade scale for evaluating, based on 4 spheres of biological requirements satisfaction, freedom for movement, social contacts, conditions for rest and available symptoms of discomfort we can come to the following conclusion:

Technological solution for breeding dairy cows used in the Town of Tvarditsa has achieved a high degree (*good grade*) of biological requirements satisfaction, due to:

- Provided possibilities for loose movement and free choice of all behavioural activities lead to over 90 % efficiency in use of the areas of the building, according to their function,
- The solid hierarchy is built in the groups which results in lack of conflicts,
- Provided time and place for rest and ruminating,
- Lack of any symptoms of discomfort.

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