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ANALYSIS OF THE MICROCLIMATE CONDITIONS AND PARAMETERS IN THE SHELTERS FOR DAIRY COWS AND THEIR INFLUENCE ON THE ANIMALS WELFARE

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Abstract

Agriculture is reinventing itself, in a world in constant motion, where the current generation of farmers seems to be much more informed about new technologies (sensors, software, agrobots, tractors guided by GPS, satellites, etc.) that have direct results in increasing business efficiency which they develop in the agricultural field, while protecting their yields. The new regulations at the level of the European Union create pressure on farmers, who are forced to rethink the business model they are developing, based on sustainability principles and with new technologies, which once implemented can create new economic opportunities for farmers and for the communities from which they are part, as well for the environment. SMART Livestock Farming (S - simple, specific; M - measurable; A - acceptable and achieved; R - realistic; T - temporal, that is mean with a time limit) should include a repetitive cycle of collecting and processing data, namely: ⇨ Observation (by sensors) ⇨ Diagnostics (interpretation of the data transmitted by the sensors) ⇨ Decisions (in real-time and informed) ⇨ Implementation (evaluation and action).
At the European Union level, an important percentage of the value of agricultural output is represented by milk production (approximately 154 million tonnes/year, 70% being produced in Germany, France, Poland, Netherlands, Italy and Ireland).
In Romania, animal husbandry was, is and will be for the future, a prime occupation, in guaranteeing the agri-food goods necessary to feed the population. Without a doubt, cattle in Romania are one of the most valuable farm animals, due to the multiple advantages they offer us. Cow farms need to ensure optimal environmental conditions with constant parameters for performance and competition, in obtaining milk and meat production from a quantitative and qualitative point of view, as well as animal health. Following the research carried out on the farm for the breeding of milk cows, the necessary parameters for the assessment of the main microclimate factors were determined and the results obtained were compared with the existing norms in the specialized literature, regarding the conditions for raising and exploiting cattle. Animal health is an element that must concern us permanently. Only a healthy animal will perform in the production, to benefit the farm, farmers and consumers.

Keywords: SMART Livestock Farming, dairy farms, microclimate conditions,microclimate parameters

1. INTRODUCTION

These days we are talking more and more about SMART Farming, but what is mean and what benefits is creating?
SMART Farming provides agriculture with advanced technology being software-managed and sensor-monitored. In this way, it increases the capability of ensuring productivity and sustainable production, based on the agricultural potential and the resource-efficient approach.
We can speak of a green revolution in the field of agriculture based on the use of new technologies, with can provide in the future better food traceability and more efficient use of natural resources like soil, water, as well as to optimize the treatments and inputs.
In the case of SMART Livestock Farming, the new technologies used at the farm level can monitor the needs of each animal, to ensure their nutrition accordingly, well-being and health, thereby preventing disease and enhancing herd health and can help make strategic decisions with result in optimizing production.
In Romania, animal breeding was, is and will be, a prime occupation, in guaranteeing the agricultural agri-food goods necessary to feed the population.

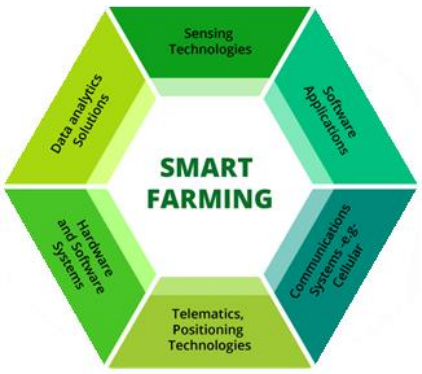


Figure 1. Smart Farming (by SCIFORCE, 2020)

Cattle are one of the most valuable species among farm animals due to the multiple advantages they offer. As we well know, cows are the most important suppliers of milk, a food product of first necessity, which ensures the vigor and health of the population. Also, this species offers a highly appreciated variety of meat, with multiple dietary qualities. Cattle, being the species that efficiently exploits the fodder resources in the natural meadows, can be considered an important factor in the management of the rural space and contribute to the protection of the natural landscape.

Manure from cow farms is used in agriculture as an organic fertilizer for all types of crops due to the improvement in soil fertility and the activity of soil microorganisms, which leads to high agricultural production. Cow farms need to ensure optimal environmental conditions with constant parameters for performance and competition, in obtaining milk and meat production from a quantitative and qualitative point of view, as well as animal health. Animal health is an element that must concern us permanently. Only a healthy animal will perform in the production, to benefit the farm, farmers and consumers.

2. MATERIALS AND METHODS

The methodology used consisted in the collection of data and the analysis of the maintenance conditions and the parameters of the microclimate factors of the Agrozootehnica farm, with cows of the Holstein-Friza breed, namely: ☞ the calculation of the volume of the shelter; ☞ determining the temperature inside the shelter and in the surrounding environment (Targoviste area); ☞ determination of humidity correlated with temperature. The humidity was determined with the help of the Assmann Psychrometer and the temperature was measured with the mercury thermometer. Particular attention was paid to the action these factors have on the health, well-being and of cows during the lactation period. Following the research carried out on the farm for the breeding of milk cows, the necessary parameters for the assessment of the main microclimate factors were determined and the results obtained were compared with the existing norms in the specialized literature, regarding the conditions for raising and exploiting cattle.

3. RESULTS AND DISCUSSIONS

Analysis of farm maintenance technology. In the analyzed farm, dairy cows are kept in free-stall shelters. Limiting the effect of natural factors and creating the most uniform microclimate conditions is achieved through shelters (Figure 2). Proper maintenance of cows during the lactation period leads both to the well-being of the animals and to obtaining higher quantitative and qualitative milk production.



Figure 2. Shelter for dairy cows

3.1. Constructive elements of the shelter

The construction of the shelter for dairy cows was made on a reinforced concrete foundation to ensure good stability of the resistance structure (Figure 3).

The walls are made of a material that gives good insulation to the construction, are light, does not promote condensation and, from an economic point of view, are as cheap as possible.



Figure 3. Shelter for dairy cows

The roof - within the farm, the roof of the shelter is made of heat-insulating panels with polyurethane foam 5 cm thick, which maintains a thermal comfort of approximately 9°C, as can be seen in Figure 3.

Modern systems for maintaining dairy cows pay close attention to the animals' microclimate requirements. To ensure high milk yields, they need a high volume of fresh air that can only be provided through a proper ventilation system. Inside the shelter are rotating brushes. These rotary brushes are designed to improve the health, comfort and well-being of cows. The operating system is fully electronically controlled. The brushes automatically turn on when touched by animals and turn off when they stop using them. The direction of brushing is horizontal, but it also allows a slight movement in the vertical plane and thus, a good brushing of the animals' backs.

Rest mattresses are made of a mixture of latex and polyurethane foam, elastic, comfortable and resistant, they lose only 2% of their elasticity in 10 years. They have antibacterial, antifungal properties and are covered with a moisture-resistant material. Length: 1,600-1,700 mm; width: 900-1,100 mm; thickness: 25-45 mm.

The surface of the shelter can be estimated as the physical surface, resulting from the internal dimensions of the walls, being obtained from the length x width of the shelter (L x W). The physical surface is important because it expresses the size of the shelters, compartments and implicitly the accommodation capacity. The accommodation area is related to the breeding and exploitation of animals, being arranged in the form of stalls, booths, cages etc. It must provide the animals with rest and comfort, a wide space for movement, feeding, care and easy exploitation.

From the rules and recommendations regarding the accommodation area of cattle during the lactation period in a free stable, it appears that the area determined by calculations, of 9.62 m^2/head of the animal, is sufficient for the animals in the analyzed farm to have the comfort of movement and rest. In cattle farms, the concept of microclimate represents the observance of certain norms and parameters, being necessary to address the problems of the elements that make up, mainly, the environmental environment.

3.2. Temperature in the shelter

Temperature is the most important microclimate factor because it largely conditions the thermal comfort in the shelter, as well as the action of other physical, chemical and biological factors, the health and production of the animals. The air temperature in the shelter is determined by natural or artificial heat sources and heat losses through thermal transmission, ventilation and technological evaporation. Depending on the temperature level, thermogenesis or thermolysis mechanisms intervene.The fight against cold is achieved through thermogenesis (intensification of metabolism by mobilizing body reserves in order to increase body heat), and against heat through thermolysis (dissipation of heat in sensible form - 60%, through conductive, convective, radiation and latent - 40%, through sweating, sweating or polypnea). Heat loss is influenced by the level of temperature and humidity in the shelter, as well as by the intensification of air currents. Cattle, like other production animals, are homeothermic. As a result, they are able to adapt to a wide range of ambient temperatures, maintaining their constant temperature with little energy expenditure. Thermal comfort is that in which the animal does not fight against heat or cold, developing minimal metabolic activity, in order to maintain its body temperature between 38.3-38.7°C.

Table 1. The monthly average temperature in the Târgoviște area, from January 2019 – December 2021

°C

Month	2019	2020	2021
January	4.80	-2.10	0.25
February	-2.80	-4.20	1.90
March	4.40	5.20	6.80
April	10.00	11.60	11.95
May	15.90	15.30	20.70
June	19.60	20.30	19.20
July	21.80	23.40	21.50
August	20.80	21.00	22.10
September	18.90	16.90	13.60
October	9.40	12.50	9.90
November	2.40	7.00	7.21
December	2.60	-0.30	1.60

From table 1 of the monthly average temperatures in the Targoviste area, provided by the Targoviste Meteorological Station, it appears that the highest temperatures were recorded in July 2020, when the average was 23.4°C. This table also shows that the lowest temperatures were recorded in February 2020, the average being -4.2°C.

Table 2. Temperature norms in cattle shelters

No.	Category	Minimal	Maxim	Optimum
1	Cows	6	24	10-14
2	Maternity	12	24	20
3	Calves 0-15 days	12	24	15-18
4	Calves 16-20 days	10	24	12-15
5	Calves 21-90 days	8	24	10-15
6.	Calves 91-180 days	8	24	10-12
7.	Youth 6-12 months	6	24	8-10
8.	Heifers	6	24	8-10

By comparing the data in table 1 with the data in table 2 we can deduce that to ensure the optimal temperature during the summer, artificial ventilation inside the shelter is necessary, especially in the months of July and August. Artificial ventilation is done with the help of six fans with individual motors equipped with temperature sensors that are automatically activated when the temperature rises above the value of 25°C. During the winter, even if the external temperatures recorded exceed the optimal thermal comfort limits of the animals, the materials and construction method of the shelter allow good thermal insulation, keeping the internal temperature close to optimal.

For cows of the Holstein-Friesian breed, the temperature values at which changes in physiological constants are observed are presented as follows:

✓animals start to reduce feed consumption when the temperature rises above 20°C, an effect that is also accompanied by an acceleration of the respiratory rate, above 16°C;

✓ cows during the lactation period decrease their body weight at temperature values above 28°C, and the rectal temperature increases;

✓the most important aspect, which derives from the reduction of feed consumption, is the decrease in milk production, and in the case of lactating cows of the analyzed breed, this occurs at around 30°C;

✓as the temperature increases more, the negative effects become more known so that at over 37°C, the animals suffer an acceleration of the heart rate and the "caloric shock" sets in.

The upper lethal temperature for homeotherms is relatively close to the normal body temperature. Body temperatures above 43.5°C prove lethal for most mammals. Thermal comfort in cattle shelters is achieved by directing the temperature. For this purpose, the thermal balance (the ratio between sources and heat losses) must be known.

Drăghici shows that the thermal balance is determined by: the sensible heat removed by the animals, the total heat losses through the closing elements of the shelter (walls, ceiling, windows, doors, floor), the heat consumed for heating the air, of ventilation at temperatures in the shelter and for technological evaporation from wet surfaces inside.

3.3. Humidity in the shelter

Air humidity acts synergistically with temperature and in close correlation with the speed of air currents and with the spectrum of solar electromagnetic radiation. The comfort zone for humidity is 60-80%. But, the optimal humidity depends on the temperature level as follows: at 15-20°C it is 70-80%, and at low and high temperatures it is 60%.

Table 3. Maximum humidity for different air temperatures

T°C	Water vapor g/m^3	T°C	Water vapor g/m^3
-10	2.400	16	13.559
-9	2.499	17	14.395
-8	2.670	18	15.330
-7	2.887	19	16.308

-6	3.113	20	17.160
-5	3.369	21	18.210
-4	3.619	22	19.286
-3	3.900	23	20.459
-2	4.190	24	21.615
-1	4.526	25	22.867
0	4.870	26	24.200
1	5.210	27	25.590
2	5.569	28	27.010
3	5.970	29	28.530
4	6.385	30	30.150
5	6.798	31	31.850
6	7.265	32	33.632
7	7.739	33	35.496
8	8.264	34	37.408
9	8.800	35	39.155
10	9.380	36	41.524
11	9.984	37	43.723
12	1.600	38	46.032
13	1.290	39	48.455
14	1.773	40	50.655
15	1.764		

The interrelationships between temperature and humidity lead to simultaneous actions on the thermoregulation function and it was considered necessary for the action of the two microclimate parameters to be reproduced by a synthetic index, which was called the temperature and humidity index. - T.U.I. The temperature-humidity index, which ensures the comfort of cattle, is 51-59; discomfort is created when the temperature is lower than the temperature-humidity index below 45 and higher than 72.
The growth rate in cattle is not negatively influenced by humidity deviations from the neutral zone when the temperature is ensured within the limits of the comfort zone. Conversely, the increase in growth is significantly reduced in young cattle in the case of high humidity and temperature, due to the decrease in feed consumption.

Table 4. The monthly values of the temperature and humidity index recorded in the farm

Month	The value of the T.U. I.
January	50.50
February	56.20
March	57.54
April	58.89
May	60.10
June	63.80
July	67.50
August	65.70
September	61.70
October	58.60
November	57.20
December	55.60

Analyzing the data from table 4 of the T.U.I., it was found that its results fall within the existing norms The closest value to the higher temperature and humidity index is recorded in July, when both temperature and humidity have higher values.

Regarding the lower temperature, the value of the T.U.I. that approaches the minimum value in the norms is recorded in January, also when temperatures and humidity are lower than in the rest of the year.

4. CONCLUSIONS

Following the analysis of the microclimate factors, the following conclusions can be drawn:
⇨The importance of milk in the diet is well known and for this reason, the farmer must provide the animals with optimal conditions inside the shelter in order to obtain high production.
⇨From the analysis made on the farm, it appears that the microclimate factors are respected inside the shelter. Compliance with these factors correlated with proper hygiene and nutrition led to obtaining high milk production, 8 400 l/year/cow.
⇨The volume of the shelter is sufficient for the current herd, its construction gives the animals space for rest, movement, care and proper nutrition.
⇨Correlating temperature with humidity makes it easy to keep these two parameters within appropriate ranges for cattle during the lactation period.
Thus, in the summer, fans are put into operation so that the temperature is maintained at optimal values, even if the monthly averages inside the shelter exceed by 2-3°C, this does not have a pronounced impact on the health of the animals.

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