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ASSESSMENT OF THE READINESS TO ADAPT TO CLIMATE CHANGES OF CATTLE BREEDS RAISED IN BULGARIA

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Abstract: *More than 800 recognized cattle breeds are bred worldwide, as 50-60 breeds are easily available for breeding in Europe, and 19-22 breeds are raised in different parts of Bulgaria. The present paper evaluates the modern achievements of the development of technologies in the agricultural sector, respectively in animal husbandry, related to changes in the climate of the agricultural sector. A definition of acclimatization and various adaptation processes is given. The features and trends in the adaptation processes, as well as the factors influencing them, have been studied. The research work is based on an analysis of concepts and scientific developments dedicated to climate changes and their impact on cattle populations around the world, in Europe and in Bulgaria. As a methodological basis for conducting the study, general scientific research methods, information-logical analysis of scientific and scientific-practical information, as well as materials for marketing research on the market of various cattle breeds and cattle crossings in agriculture were used.*

Keywords: *climate, temperature, cattle, adaptation, acclimatization*

INTRODUCTION

Characteristic of the current time is a constant increase in ambient temperatures and values that have not been reached in the past more than 200 years. At the beginning of the new era, the climate was cool and humid, but later it warmed and acquired features close to modern ones. From the middle of the 13th century, the climatic conditions began to deteriorate. Temperatures drop, permanent cooling occurs, known as the "Little Ice Age." A characteristic feature of the climate in the XIII-XV centuries was the great variability of the weather. Very harsh and dry winters, droughts and floods suceeded one another, and strong storms were not rare. After the 17th century, temperatures began to rise, but they still remained relatively low. In the second half of the 18th century and throughout much of the 19th century, the slow increase in temperatures continued and the climatic conditions then were close to those at the end of the 20th century. At the end of the 19th century, a faster rise in temperatures began in all geographical areas latitudes and in all seasons (Vekilska, 2004, Rachev, 2018, Matev, 2020).

The strongest warming occurred in the 1930s. From the middle of the 1940s, a decrease in temperatures began, to which the glaciers and polar ice sheets, which increased their areas, reacted the fastest. The cooling continued until the 1970s, when it ceased and a smooth and gradual warming process began, continuing until the end of the century, but at an accelerated rate. At the beginning of the new century, a step was formed in the curve of anomalies – warm years, but with approximately the same values of the anomaly. This hold in warming levels is short-lived, and over the past decade we have seen another sharp rise in temperatures. In recent years, there has been a progressive increase in the average annual temperature in the European continent. In most countries of Western, Central and Eastern Europe, 2022 was the warmest year since 1950. Much of Europe and the Mediterranean were affected by drought. River basins such as the Rhine, Loire, Seine and Danube have reached critical levels (Matev, 2020a). Many of the observed and projected climate changes are significantly higher in temperate latitudes (IPCC 2001), where Bulgaria is also located.

Climate change caused by anthropogenic activities is emerging as one of the most pressing global challenges. Rising emissions of greenhouse gas emissions, mainly carbon dioxide (CO_2) and methane (CH_4), have led to increases in average global temperatures and changes in precipitation patterns in Europe and around the world (IPCC, 2014). These changes have profound implications for agricultural systems, creating both direct and indirect risks for agriculture and, in particular, ruminant livestock.

Cattle graze approximately 30% of the rangelands on Earth, making their interaction with the planet's social and ecological systems critically important. They have gone through a long process of evolution and domestication. Some breeds are more adapted to specific environmental conditions, influencing ecosystems differently (McIntosh et al. 2023).

Cattle, as an integral part of global agricultural systems, are particularly vulnerable to the impacts of climate change. Their vulnerability stems from their physiological limitations, dependence on natural resources and sensitivity to temperature extremes and changing climate conditions. Several key factors contribute to the vulnerability of different cattle breeds:

a) **heat stress:** increased environmental temperatures can logically lead to heat stress in cattle. Heat tolerance is considered as one of the most important adaptive aspects in cattle, and the lack of heat-resistant breeds is a major limitation to cattle breeding in many countries. Heat stress negatively affects their performance, reproductive ability and overall health (Gaughan et al., 2008). It also reduces food intake, impairs nutrient utilization, and greatly increases water requirements, resulting in reduced growth and development rates, reduced milk and meat production, and reduced fertility.

Heat stress affects dairy, mixed and beef cattle breed grazing on artificial and natural rangelands, especially during the summer months. High temperature, combined with low humidity and solar radiation, leads to a significant decrease in milk productivity, nutritional disorders and reproductive problems (Chan et al., 2010, Kurbanova, 2018)

A number of researchers have worked on the significance of summer heat for dairy cattle breeds, as during the lactation of the animals, they have established specific regularities of their compensatory-physiological mechanisms (Madzharov, 1980, Singh et al., 2013, Barnabucci et al., 2014) .

Heat stress is important not only for the thermal environment and the metabolic, biochemical processes taking place in the organism of cattle, but it is also a factor related to maintaining the homeostatic status (Dismen et al. 2012, Mokhov and Shablina, 2013, Vdovichenko et al., 2017 , Validov and Talashina, 2019).

According to Carabano et al. (2019), the strategies in cattle breeding are related to improving tolerance to heat stress and have an impact on technological-production systems. This issue will be addressed and developed in future cattle breeding programs.

b) water shortage: Animals have different requirements for water at different environmental temperatures. Water requirements vary between breeds depending on their adaptability, growing region and environmental temperature (Naqvi et al. 2015). Changes in precipitation patterns can lead to water shortage, which directly affects ruminants' access to clean drinking water and the availability of suitable grazing areas. Droughts and reduced water availability can lead to fodder shortages, compromising the nutritional needs of ruminants (FAO, 2018).

(c) infectious diseases: changed climatic conditions may affect the spread of vector-borne infections. Warmer temperatures and increased humidity can expand the range of vectors, such as ticks, mosquitoes and fleas, facilitating the spread of vector-borne diseases. This poses significant health risks to cattle, sheep and other ruminant populations (Perry et al., 2017).

d) availability and quality of fodder: Climate change affects the productivity and quality of rangelands and fodder crops. Increased temperatures, altered precipitation patterns, and extreme weather events can reduce the availability and nutritional value of rangelands and harvested fodder. This can lead to fodder shortages, increased costs and compromised nutritional adequacy of cattle (Thornton, 2010).

(e) genetic diversity**:** limited genetic diversity in cattle breeds helps limit their ability to adapt to rapidly changing environments. Breeds with narrow genetic backgrounds may not have the genetic variation needed to cope with new climate challenges, making them more vulnerable to the impacts of climate change (Gandini et al., 2014).

To address the vulnerability of cattle breeds to climate change, proactive adaptation strategies are essential. These strategies include identifying and promoting climate-resilient breeds, implementing sustainable management practices, and developing breeding programs that prioritize traits associated with climate change resilience (Thornton et al., 2018).

Studying and understanding the vulnerability of cattle breeds to climate change is critical in developing effective adaptation and mitigation strategies. Taking into account the specific challenges that large ruminants face in a changing climate, policy makers, researchers and livestock producers can and should work together to improve the resilience of cattle populations to ensure the sustainability of livestock systems.

The aim of the present research work was to review the world and European achievements on the problem and to establish the readiness for adaptation of the cattle breeds that are raised in Bulgaria.

MATERIALS AND METHODS

The research work is based on an analysis of concepts and scientific developments dedicated to climate changes and their impact on cattle populations around the world, in Europe and in Bulgaria. As a methodological basis for conducting the study, general scientific research methods, information-logical analysis of scientific and scientific-practical information, as well as materials for marketing research on the market of various breeds of cattle and cattle crossings in agriculture were used. Descriptive and retrospective analysis were also applied. Environmental data were analyzed using appropriate statistical or modeling techniques to assess the climatic and environmental conditions in the study area. To achieve the goal, we used aggregated data for the Bulgarian, European and world cattle breeding in the period 2018-2023. The information used is mainly from publications of the FAO, the Ministry of Agriculture, Food and Forestry, the Customs Agency, Agrostatistics Department, agrarian reports and reports on marketing and market analysis. The paper quotes moments from the works of Bulgarian and foreign authors. Summaries and conclusions were made.

RESULTS AND RESEARCH

More than 800 recognized cattle breeds are raised worldwide, with 50-60 breeds easily available for breeding in Europe, as 19-22 breeds are raised in different parts of Bulgaria.

Acclimatization is a fundamental biological process by which animals adapt to environmental changes, which allows them to maintain homeostasis and optimize their physiological functions. It includes a set of physiological, morphological and behavioural adjustments that allow organisms to cope with changes in environmental factors such as temperature, humidity, altitude and resource availability (Feder and Hofmann, 1999, Bakken, 2010, Alemneh and Akeberegn , 2019). Acclimatization plays a crucial role in the survival and survivability of animals by improving their ability to survive in different habitats and climates.

The acclimatization process allows animals to optimize their physiological functions in response to environmental challenges. For example, in response to temperature changes, animals can undergo adjustments in their metabolic rate, insulation properties and thermoregulatory mechanisms (Bakken, 2010). These adaptations help maintain inner body temperature within a narrow range that is essential for maintaining biochemical processes and overall health (Somero, 2010).

The ability to acclimatize to different environments is of paramount importance to animals as it directly affects their survival, reproduction and overall fitness. For example, animals that are able to acclimatize to cold environments can avoid freezing, maintain metabolic activity, and continue foraging during the winter months (Stevenson, 2017). Similarly, species that inhabit high-altitude regions can acclimatize to low oxygen levels by increasing red blood cell production and improving oxygen-carrying capacity (Beall, 2007).Acclimatization is special

Acclimatization is particularly important for species that are distributed across different geographic regions, such as migratory birds, marine mammals, and terrestrial mammals such as cattle. These animals face significant variation in environmental conditions throughout their area, necessitating effective adaptive responses. Cattle, for example, are raised extensively in different climate zones, from temperate regions to hot and humid tropical regions. Their ability to acclimatize to different climatic conditions has significant implications for their health, productivity and overall well-being (Silanikove, 2000, Bernabucci et al., 2014).

Improving and understanding the acclimatization mechanisms in animals is of great importance for several reasons. First, it provides insight into the basic physiological and biochemical processes that underlie adaptive responses to environmental change. Investigation of these mechanisms may reveal key molecular pathways, gene expression patterns, and physiological adjustments that facilitate acclimation (Feder and Hofmann, 1999). Such knowledge can contribute to a deeper understanding of the organism's biology and evolutionary processes.

The study of acclimation has practical implications for conservation biology, agriculture, and human health. In the face of climate change, the ability of species to acclimate to altered environmental conditions will determine their resilience and survival. Understanding the limits and constraints of acclimation can help predict and mitigate climate change impacts on biodiversity (Chown et al., 2010). In agriculture, knowledge of acclimation processes can guide the development of improved breeding strategies and cattle management practices, increasing productivity and reducing environmental stress (Bernabucci et al., 2014). In addition, findings from acclimatization research can inform human health, particularly in areas where populations are exposed to extreme climatic conditions.

Cattle are a vital component of the global livestock industry, providing essential resources such as meat, milk and other by-products. The ability of large ruminants to acclimatize to different climatic conditions directly affects their productivity, profitability for farmers and sustainable agricultural practices. From an economic perspective, the animal husbandry sector, including cattle breeding, contributes significantly to the global economy. It creates employment opportunities, supports rural livelihoods and contributes significantly to food security (Thornton et al., 2009, Bernabucci et al., 2014)

Cattle acclimatization plays a critical role in overcoming these challenges. By adjusting their physiological and behavioural reactions to different climatic conditions, cattle can improve their ability to withstand heat, cold, humidity or other environmental stressors (Silanikove, 2000, Nardone et al., 2010;). For example, during hot and humid conditions, acclimatized cattle may alter their thermoregulatory mechanisms, such as increased sweating and altered respiratory rate, to dissipate heat efficiently and maintain normal body temperature (Bernabucci et al., 2014).

Improved acclimatization of cattle can lead to increased productivity in several ways. First, acclimatized cattle demonstrate improved fodder efficiency and nutrient utilization, which positively affects growth rates and weight gain (Rhoads et al., 2013, Bernabucci et al., 2014). Second, acclimation can affect milk production and quality, with acclimated cows showing higher milk yield and better composition (Rhoads et al., 2013, Bernabucci et al., 2014). These improvements contribute to the economic viability of cattle farming and the availability of high quality animal products for human consumption.

From an ecological point of view, acclimatization is critical to mitigating the environmental impact of cattle farming. Cattle are raised in different geographic regions with different climates, ranging from temperate rangelands to arid or tropical environments. The ability of cattle to adapt and acclimatize to these diverse conditions reduces their vulnerability to climate-related stressors, such as heat waves, extreme cold, or changes in precipitation patterns (Silanikove, 2000).

Acclimatized cattle are able to better utilize available feed resources, optimize nutrient uptake and reduce reliance on supplemental fodders, thereby minimizing the environmental footprint of animal husbandry production (Thornton et al., 2009). Furthermore, by adapting to local conditions, acclimatized cattle can contribute to the preservation of local breeds that are adapted to specific regions, promoting biodiversity and maintaining genetic diversity in cattle populations (FAO, 2014).

The relevance of acclimatization extends beyond the economic and environmental aspects of the general welfare and health of cattle. Animals that can acclimatize effectively experience reduced levels of stress and improved welfare as they are better equipped to cope with environmental challenges (Silanikove, 2000). Acclimatized cattle show a lower incidence of heat stress-related disorders such as heat stroke or reduced fertility, resulting in improved animal welfare and reduced economic losses for farmers (Bernabucci et al., 2014).

In Bulgaria, the physiological indicators, such as body temperature, respiratory rate and pulse rate, are of practical importance for establishing the nature of the metabolism of cows during the summer months and reflect their physiological state. Genetic selection on these indicators results in improved animals resistant to heat stress. The calculation of the index for temperature and humidity allows to create a portfolio of the specific farm every year to avoid the negative influence of stress-unfavorable, high summer temperatures.

The body temperature is meausred twice, early in the morning, between 6 and 7 a.m. when the ambient temperature is 17-19 C° and in the middle of the day, between 3.30 p.m. and 4.30 p.m., when the ambient temperature is is 35-37 C° and more degrees C°, and the cows return from the pasture. At the same time, measurements of respiratory movements and pulse are made. Minimum and maximum temperatures, average daily temperature and air humidity are taken from the weather bulletin of the weather station closest to the area of the animal breeding site.

The following indices and coefficients useful for practice are calculated:

Heat resistance index (IH) according to Rauschenbach (1975)

IH= 2(0,6t2 – 10ΔT+26)

Where: T 1 is body temperature in neutral zone

T 2- is body temperature during exercise

ΔT- is the difference between T2 and T1

t 2- is mean daily temperature

26 - is reduction factor

Adaptation coefficient (AC) according to Benezra (1954)

AC = BT + FR

38,3 23,3

Where: BT - is body temperature during measurement

FR - is frequency of respiratory movements per 1 minute

38.3 - is the optimal temperature for raising cattle

23.3 - is the optimal number of respiratory movements

Temperature and humidity index (THI)

THI = 0.8 X ambient temperature + (relative humidity: 100 X ambient temperature -14.4) +46.6

Visual observations showed adaptability and adaptive plasticity of the studied 19 breeds of cattle in our country. On days with high temperatures, at 37-39 C°, the animals graze, lie down or stand under the sun's rays without showing side reactions.

Relatively few side effects are observed in some British beef cattle breeds, such as Aberdeen Angus, due to their black body colour and hair coat, and Hornless Hereford due to their genetically determined light mucous membranes. The Limousin cattle breed, the small populations of Gascon gray cattle and Aubrac have acclimatized well and tolerate climate changes relatively calmly. Small populations of Wagyu and Hefland have also acclimated well. The high-blooded meat-producing stock crossings are also relatively well acclimatized.

Combined breeds, such as Simmental, Montbéliard and Normande cattle tolerate climate changes well and show good acclimatization plasticity and productivity.

The specialized breeds for milk, such as Black-and-White, Red-and-White, Holstein breeds with its high bloodiness and plasticity, also cope well with the climatic changes that have occurred. Norwegian Red Cattle, Brown American Cattle, Brown Cattle, Red Danish Cattle have also acclimatized well.

The best acclimatization ability is shown and realized by the local autochthonous breeds, such as Rhodopean Short-horned Cattle, Gray cattle, Iskar cattle, Bulgarian Rhodopean Cattle.

CONCLUSION

The importance of acclimation in the context of cattle is significant both economically and ecologically. By acclimatizing to different climatic conditions, cattle can improve their technological productivity, profitability and efficiency, optimize the use of resources and contribute to the development of sustainable agricultural practices. Acclimatization plays a critical role in minimizing the environmental impact of rearing large ruminants and promoting the welfare, health and condition of these animals.

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