MODERN CATTLE BREEDING AND CLIMATE CHANGE - CHALLENGES AND RESPONSES*

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Review paper

Summary

According to the reports of the UN Food and Agriculture Organization (FAO), in anthropogenic emissions of greenhouse gases, animal husbandry participates with 14.5% (translated into CO2 equivalent, about 7.1 Gt), which puts it in third place, behind the energy sector and industry. and in front of the traffic. On the other hand, climate changes significantly affect livestock production in terms of increasing the frequency of animal diseases (heat stress), changes in environmental factors (microclimatic conditions) and changes in nutritional conditions (impact on grassland composition). Reducing greenhouse gas emissions will only be possible by adopting good agricultural practices. That is why the researches carried out for this purpose are more numerous and more current in a large number of countries.
Key words*: animal husbandry, climate change, heat stress, greenhouse gases*

INTRODUCTION

Climate changes and their consequences emerged as one of the biggest global problems on the planet Earth from the beginning of the industrial revolution until today, and they arise as a direct consequence of human activities.

The average temperature increases due to the so-called greenhouse effect, which causes an increase in the concentration of certain gases in the air. The most significant impact is the concentration of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The concentration of CO_2 (57%) has the greatest impact on climate change, while the percentage share of CH_4 and N_2O is 27% and 16%, respectively (Johnson *et al*., 2007). Global warming leads to an increase in the average temperature of the air, land, sea and ocean, and thus to a change in the precipitation regime, resulting in extreme droughts which are becoming more frequent; short-term heavy rains that lead to flash floods, landslides, erosion; occurrences of atmospheric phenomena uncharacteristic for certain areas (storms and tornadoes).

The change in the rainfall regime has a negative impact on the entire agricultural activity. There is a decrease in arable land, changes in the composition and quality of

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the soil. Also, the yield (amount of plant products used in food) and the quality of plant products (incidence of mycotoxins, change in chemical composition and nutritional value). Also, its has direct and indirect negative effects on livestock production.
Paradoxically, one of the strongest negative contributors to greenhouse gas emissions and global climate change is agriculture. Cultivation of land, conversion of land (deforestation, destruction of plant cover, drying of water bodies), use of artificial fertilizers, production of animal feed, processing of agricultural products and transport increase CO_2 emissions. Enteric processes in ruminants and manure production are a significant source of methane (Rojas-Downin *et al.*, 2017). Livestock production affects soil degradation, air and water pollution and the destruction of biodiversity. (Bellarbi *et al.*, 2013; Reinolds *et al.*, 2010; Steinfeld *et al.*, 2006; Thornton and Gerber, 2010).
Given that agricultural activity has a significant contribution to the disruption of climate (third major impact, after the energy and industrial sectors), the attention given to this situation must be proportional to it. It is important to work on raising global awareness and education about the seriousness of the situation in all segments. The beginning of the process of adaptation and adjustment of cattle production to climate change is the training of agricultural experts who will be the bearers of modernization and new research in this area. This is necessary in order to meet the needs for skilled and prepared workforce in the agricultural sector in the conditions of climate change.

CATTLE PRODUCTION IN CONDITIONS OF CLIMATE CHANGE

Climate change affects cattle production in two ways - indirectly and directly.
The indirect impacts are primarily reflected in the difficult supply of water and food. Agriculture uses 70% of freshwater resources, making it the world's largest consumer (Thornton *et al.*, 2009). The frequent occurrence of long-term droughts leads to difficulties in supplying animals with water. At the same time, drought leads to a decrease in the yield of forage crops. In addition to yield reduction, in the regime of disrupted water supply, there is a more frequent occurrence of plant diseases and pests and the occurrence of mycotoxins in plant-based nutrients. This significantly reduces the quality and nutritional value of plants. One of the indirect effects of climate change on cattle production is the change of agro-ecological zones. Climate changes at low latitudes generally go in a negative direction, leading to arid climate conditions. In areas on higher latitudes, climate change leading to an increase in temperature could be beneficial in terms of allowing a longer growing season for plants (Yohannes, 2016). A change in climatic conditions often leads to the appearance of various diseases uncharacteristic for certain areas. Pathogenic agents, as well as the vectors that transmit them, are also changing. Changes in climate lead to changes in pathogens or parasites, the spread of vector-borne diseases, food-borne diseases, and reduce host resistance to food and water scarcity (Nardone *et al.*, 2010; Thornton *et al.*, 2009; Tubiello *et al.*, 2008).
The direct influence of climatic and microclimatic conditions on animals is reflected in

the incidence of the so-called heat stress, which has multiple negative effects. Cattle are able of withstanding large fluctuations in air temperature (their thermal comfort is between 10 and 20^0C) and easily adapt to temperatures up to -40^0C with exercise and adequate nutrition. A serious problem is adaptation to high air temperature (above 22^0C), especially if it is accompanied by high air humidity (Samolovac, 2016). The most common indicator used to determine and evaluate heat stress, as well as to evaluate the impact of heat stress on production and reproductive characteristics of cows, is the temperature-humidity index (THI), which is determined based on temperature and air humidity. The negative influence of the TH index, whose value is higher than 68, is multiple.

- Growth and development of animals in conditions of heat stress are slowed down, primarily due to reduced consumption and conversion of food, which results in a decrease in body weight and condition of animals. The mode of food intake changes, so that animals prefer to consume food at night when the temperature is lower and closer to the thermal optimum. Heat stress causes hormonal and metabolic changes in the body. Hormones that initiate catabolic reactions in the body are activated, liver function decreases, food intake decreases, and the immune response to pathogenic agents decreases (Nardone *et al.*, 2010).
- Heat stress has a negative effect on milk production in terms of quantity and composition, i.e. quality of milk. In conditions of heat stress, the content of milk fat and fat free dry matter in milk decreases. The decrease in protein content is less pronounced. The quality of milk decreases because the number of bacteria and somatic cells in milk increases, which reduces the nutritional value of milk and milk products (Samolovac *et al.*, 2012., Mićić *et al.*, 2022).
- Due to the negative impact of high temperatures and air humidity on the hormonal status, in female animals there is an irregular ovulation cycle and a weaker expression of estrus. In male animals, poorer spermatogenesis occurs. All this impairs the conception rate and affects poor reproductive results.
- With the increase in external temperature, heat release increases through the mechanism of vasodilation in the skin, but up to a certain limit. If the temperature of the environment exceeds 31^0C, vasodilatation cannot ensure the efficient release of heat, so there is an increase in the body temperature of animals (increase in rectal temperature). Thermoregulation is also carried out by evaporation of water through the skin (sweating) or through the respiratory organs (fast breathing with the mouth open). This causes increased water consumption. Cortisol - the stress hormone - is also secreted more in the body, which impairs the body's ability to adapt and resist. Consequently, morbidity and mortality in herds increases.

CLIMATE CHANGE UNDER THE INFLUENCE OF CATTLE PRODUCTION

Cattle production has a negative impact on the climate in several ways, mainly through the emission of greenhouse gases (GHG) - carbon dioxide (CO_2), methane (CH_4) and

nitrous oxide (N_2O). According to some research, the livestock sector contributes with 10-12% (Crossona *et al.*, 2007), and even up to 14.5% to global greenhouse gas emissions (Rojas-Downin *et al.*, 2017). At the same time, the emission of CH_4 contributes the most (44%). According to FAO reports, the agricultural sector, taking into account direct and indirect emissions, is responsible for about 30% of global warming. Fossil fuels used on farms; deforestation; change of land cultivation method, change of land use, etc., are the most significant sources of CO_2 emissions. Fermentation in the digestive tract of ruminants, organic waste (primarily manure), biomass burning, cultivation of rice, etc., lead to an increase in methane concentration. The increase in the concentration of nitrogen oxides occurs due to the irrational use of artificial fertilizers.

Cattle production is considered to be a direct or indirect cause of soil degradation, air and water pollution, and destruction of biodiversity. Direct GHG emissions from animal sources include enteric fermentation, respiration, and excretion (Jungbluth *et al.*, 2001). The two main sources of CH_4 on cow farms with high-yielding dairy are enteric fermentation and CH_4 release from manure. Enteric fermentation involves biochemical processes in the foreguts of ruminants during which CH_4 is produced. At the same time, methane produced by enteric fermentation has a share of 25% in anthropogenic CH_4 emissions (Wuebbles and Hayhoe, 2002), and cattle, for the most part (95%), eliminate it by regurgitation and exhaling, while only a small part is removed by flatulence (Kirovski *et al.*, 2022). Manure is also a significant source of CH_4, especially when stored in anaerobic conditions and inadequately "processed".

Indirect gas emissions refer to gases obtained as a result of the cultivation of fodder crops, the use of manure and inorganic fertilizers, the use of machinery for agricultural activities, the processing of livestock products, transportation and distribution, the conversion of land necessary for livestock production, etc.

When looking at cattle production, research shows that the biggest negative contribution to GHG emissions is milk production and cattle fattening for meat production, which accounts for 65% of the total greenhouse gas emissions. If the assessment is made on the basis of the obtained products, meat production participates the most with 41%, followed by milk production with 20% (Gerber *et al.*, 2013).

The conversion of forests into pastures and arable land is a continuous process as a result of the constant pressure of livestock production to meet the nutritional needs of animals. Land use change affects the natural carbon cycle. Releasing a large amount of carbon into the atmosphere increases greenhouse gas emissions. Forests accumulate more carbon in soil and vegetation compared to crops and pastures, thereby reducing CO_2 emissions into the atmosphere. By clearing forests and increasing the area under pasture and arable land, CO_2 emissions into the atmosphere also increase.

Animal feed production accounts for 45% of global anthropogenic GHG emissions related to animal husbandry (Gerber *et al.*, 2013). For the most part, due to the use of manure and artificial fertilizers, especially nitrogen (Steinfeld *et al.*, 2006), and a significant amount of these gases are also released during the processing and transportation of nutrients.

POTENTIAL SOLUTIONS

Adaptation of cattle production to increasingly pronounced climate changes and the ever-present phenomenon of heat stress can be achieved in two ways, biological and technological adaptation.

Biological adaptation implies: intensive selection of dairy cattle, in addition to selection for production and functional traits, use of those bulls for AI whose offspring are more resistant to heat stress, use of genomic selection; introduction of new breeds for milk production.

Technological solutions are, among others: changing the way and time of feeding (increasing the quality of nutrients, increasing the share of energy in the meal, using additives in the diet, feeding during the part of the day with lower air temperatures), providing sufficient amounts of water, controlling the temperature and humidity of the air in buildings (using various applications), thermal insulation, ventilation and cooling of facilities for housing animals, enabling the movement of animals by keeping them on free ranges, controlling insects, etc.

Some of the mentioned solutions have a double positive effect, in a way that they also have a positive effect on climate change. By changing the technology of breeding and feeding, introducing new breeds and using genomic selection, the productivity of animals increases. This results in a larger amount of product per number of farmed animals per unit area, which reduces the emission of harmful gases.

Changing the diet and cultivation method reduces the emission of enteric methane. However, the method of storing manure is more important for reducing the concentration of methane. Manure management and adequate use (storage in aerobic conditions, use of solid manure, etc.) significantly reduces the spread of this gas.

The use of pastures, afforestation, reduction of intensively cultivated areas, reduces the emission of carbon dioxide into the atmosphere.

In addition to all of the above, the use of nitrogen fertilizers in limited amounts and for a limited time (only when and where they are necessary, in the vegetation phase when they are necessary and in the smallest amount that meets the needs of the plants) reduces the harmful impact of nitrogen oxides.

If we look at all of the above, it can be concluded that the organic method of production has a significant potential to mitigate the consequences of harmful anthropogenic effects on the climate, which is also confirmed by some studies (Johnson *et al.*, 2007.).

CONCLUSION

Agricultural activity contributes to global climate change through the emission of greenhouse gases (GHG) such as carbon dioxide, methane and nitrous oxide. At the same time, agriculture could be a solution to climate change through the widespread adoption of climate change mitigation and adaptation actions. Global action must be focused on reducing GHG emissions, preserving the climate, but also adequate

development of agricultural production in order to ensure safe food supply, eradication of hunger, malnutrition and poverty, especially in underdeveloped regions of the world.

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SAVREMENO GOVEDARSTVO I KLIMATSKE PROMENE – IZAZOVI I ODGOVORI

Rezime

Prema izveštajima Organizacije UN za hranu i poljoprivredu (FAO) u antropogenim emisijama gasova staklene bašte stočarstvo učestvuje sa 14,5% (prevedeno u CO_2 ekvivalent, oko 7,1 Gt), što ga stavlja na treće mesto, iza energetskog sektora i industrije, a ispred saobraćaja.

S druge strane, klimatske promene značajno utiču na stočarsku proizvodnju u smislu povećanja učestalosti pojave bolesti životinja (toplotni stres), promene faktora životne sredine (mikroklimatski uslovi) i promene u uslovima ishrane (uticaj na sastav travnjaka). Smanjenje emisije gasova sa efektom staklene bašte biće moguće samo usvajanjem dobrih poljoprivrednih praksi. Zbog toga su istraživanja koja se vrše u tom cilju, sve brojnija i aktuelnija u velikom broju zemalja.

Ključne reči: *stočarstvo, klimatske promene, toplotni stres, gasovi staklene bašte*