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Indigenous cattle breeds of the Carpathians – the basis of scientific and transboundary aspects of the implementation of the „Carpathian Convention"†

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Abstract

In the author's opinion, indigenous cattle breeds of the Carpathians are the basis of scientific and transboundary aspects of the implementation of the "Carpathian Convention" and protocols thereto. These indigenous cattle breeds are as well the national heritage of the country in which these breeds are bred. The publication provides data on the distribution of 19 local breeds in the Carpathian region, the possibility of restoring officially extinct ones. Based on the results of the study and analysis of scientific works, their list was compiled, the number of breeding stock and the average number in one farm are given. A number of differences in territorial distribution and their different genesis have been established; this is due to the long history of development. A limited number of breeding stock has been identified, a clear trend towards decline is observed, which indicates the threat of extinction. The succession of breed composition that is currently taking place in the region is indicated. The results obtained are important for continuing further research based on cooperation between various institutions of the united countries in the Carpathian Euroregion, studying the features of cattle breeding and the impact of the industry on the functioning of landscapes, preserving biodiversity, restoring the transformed meadow ecosystem and sustainable

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development of communities in the Carpathians. They indicate the expanded functions of aboriginal cattle breeds. It is emphasized that one of the forms of wildlife protection is the organization of the preservation of indigenous breeds of cattle, which act as a matrix of farm animal populations and is based not only on ecological and biological principles, but also covers the entire spectrum of ideological, economic, socio-cultural, ethical and ethnic problems.

Keywords: biodiversity, ecology, indigenous breeds, sustainable development, transboundary cooperation

Introduction

According to FAO (2015), over the past decades, population growth, intensification of agricultural production has degraded 25% of the world's soils, 50% have been damaged, and a significant part of indigenous breeds of cattle and natural meadow ecosystems have disappeared. In view of this, it is important to study ways to restore local livestock in the Carpathians – scientific and transboundary aspects of the implementation of the "Carpathian Convention" and its protocols, diversification of environmental technologies and innovative products, development and application of political and economic solutions. Accordingly, the foundations of sustainable development of the Carpathian region will be laid, the biodiversity of cultivated breeds of farm animals will be preserved, the fair and equitable distribution of benefits from the use of genetic resources will be established, which is provided for by the provisions and protocols to the “Carpathian Convention”, in particular Art. 6 and Art. 10 – the preservation of traditional animal breeds of the Carpathians, the Action Plan for the 21st century (1998) and the Framework Convention (2004).

In addition, the adopted documents serve as legal mechanisms and provide the basis for international cooperation, especially in the context of globalization and climate change. Therefore, the importance of transboundary and subregional cooperation is growing, ensuring the ecological integrity of the territory with an area of 210 thousand km² and improve the quality of life of more than 18 million people.

It is important to use local resources sparingly and effectively in harmony with nature and the environment, applying an ecosystem approach to managing a significant sector of the economy – cattle breeding. To reorient the industry in a strategic perspective to more profitable innovative management, to fulfill the obligations of the Carpathian states in this area (VORONINA and DEMURA, 2004). EGEN (2010) noted that even before the last century, the Carpathians had better opportunities for

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animal production than the Alps. At the same time, it will be possible to avoid the irreversible loss of a component of cultural and genetic biodiversity – aboriginal cattle, which has lost its dominant role and is a rare element in some countries, or is on the verge of extinction. For example, only in the Transcarpathian region of Ukraine, the Ryzhka, Mokan, and Hutsul cattle have been lost forever.

In the Carpathian region, 19 native breeds are on the verge of extinction. In the hierarchy – production, balanced development, non-production priorities, protection of nature, environment, traditions, climate, quality of life – they are living evidence of uniqueness of Carpathian region, a platform for scientific research.

Despite the above, in some Carpathian countries of the association, there is not enough research, scientific and technical developments. Also funding from budget appropriations does not have a systematic approach, which can cause economic instability in mountainous, depressed areas.

Research of varying degrees of environmental impact of animals that have been bred here for centuries would allow to reorient the industry, using knowledge about their genetic differences, anatomical structure, biology and physiology, to a more profitable, balanced, long-term and integrated way of management, restore degraded Polonian ecosystems to their natural state. Because during the reduction of the cattle population, the reduction, in many cases the cessation of traditional management, the biotopes of meadows, pastures, especially high-mountain ones, have become overgrown with non-native phytocenoses and have displaced plants, including endemic species. In addition, a real threat to the Carpathians and biodiversity is the large-scale production and expansion of highly specialized commercial breeds of European-American origin, uncoordinated actions of countries. For example, in Poland, 96% of the Holstein cow population, all bulls of the named breed have American roots according to pedigrees.

The listed problems will be solved by the development and implementation of joint projects for the sustainable development of mountain areas based on the use of local resources, indigenous cattle breeds, green gold – natural pasture lands. Parallel transition to organic, biological, organobiological, biodynamic and other modifications will include a self-regulating mechanism for restoring ecological connections, ecological conversion (MANIVCHUK, 1996). The task of the scientific community is to promote the implementation and introduction of the "Carpathian Convention" and its protocols based on scientific and transboundary aspects of cooperation and local initiatives. The development and use of environmentally friendly technologies will contribute to the improvement and provision of the diversity of life in the ecosystem (BOYKO, 2002).

The relevance of the article is due to the requirements of the "Carpathian Convention" and its protocols, the presentation of the current state of interaction and the capabilities of individual countries in organizing ecological production, restoration, conservation and management of genetic resources. It is now most necessary to study the impact on the mountain phytocenoses of the Carpathians, to

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publish the maximum amount of information related to indigenous breeds, especially in Ukraine due to martial law, as this will ensure their preservation and development of mountain areas in harmony with nature.

Purpose of the study was to evaluate the impact of indigenous cattle breeds of the Carpathians on the scientific and transboundary aspects of the implementation of the "Carpathian Convention" and its protocols, and on natural meadow ecosystems. To obtain new data about them, to show biological features. Scientific development and practical implementation of joint projects in conditions of sustainable development.

Material and methods

The research was conducted during 2019 – 2023. The study area covers the mountainous territories of the Carpathian region of Slovakia, Romania, Poland, Hungary, the Czech Republic, Serbia and four regions including Transcarpathia of Ukraine. The social, historical and cultural, economic, and resource status were assessed. Local breeds, the main threats to them, the principles and trends of changes in breed composition and the impact of production on the environment were studied. The feasibility of their use in the Carpathians was substantiated as the basis for the scientific and transboundary aspects of the implementation of the "Carpathian Convention" and its protocols.

Indigenous cattle breeds will ensure the transition to the requirements of the provisions of the European Green Deal and the Common Agricultural Policy, and the main Sustainable Development Goals defined in the UN program documents on livestock, "Combating Climate Change", "Conservation of Terrestrial Ecosystems", etc. The implementation of the principles of the Circular Economy, the use of direct product sales channels is presented. The vision is set out for combining the development of the livestock industry, preserving biodiversity, restoring meadow ecosystems, reducing the impact on the state of the environment in the region. The definition and names of cattle breeds were carried out according to the Breeding Resources of Ukraine, 1998 and its summaries.

Results and discussion

The research has established that one of the elements of the basis of scientific and transboundary aspects of cooperation between countries, the implementation of the "Carpathian Convention" and its protocols are indigenous cattle breeds of the Carpathians. The international document clearly defined what an extremely interesting region in the biogeographic sense should be in the 21st century. Implementing its provisions, it is necessary to abandon resource-based approach, protection categoricalness and strict restrictions on economic activity even in

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protected areas, based on the fundamental paradigm of modern ecology, in which the concept of biodiversity is the leading one. Animals and territories should be considered as a single ecological and economic system with signs of integrity.

After all, cattle breeding in the Carpathians has its own history and features determined by economic, soil and climatic conditions, relief, altitude, limited land, traditions, dispersed settlement of people, etc. The industry is based on its own natural and breed, human and financial resources. A significant number of natural hayfields and pastures, a humid climate, contribute to the richness of the floristic composition and high productivity of meadow formations.

Favourable geographical location, large capacity of domestic and foreign markets, stable demand for high-quality, healthy, safe, craft products of animal origin determine that it is promising to engage in the production of milk, beef with deep processing in the future. Also, this type of activity, built based on aboriginal breeds, can partially eliminate the problem of employment, provide a significant source of income for hundreds of thousands of personal farms, a significant number of small businesses, replenish local budgets and ensure sustainable and long-term development of communities.

There is a lot of information about the value of local animals in the scientific literature. Realizing this, employees of the University of Life Sciences in Lublin, Poland, through the implementation of a pilot project and perseverance, hard work and connections with farmers, regenerated in 2003 the aboriginal white-spine breed of cattle, which was officially considered extinct in the 60s of the last century. Now the animals are used for grazing in the Roztochanskyi National Park and other parks, which ensures the development of agricultural production in protected and problem areas, its low cost, higher profitability, productive longevity of cows, climate neutrality and enrichment of biodiversity while preserving the originality of landscapes.

There are a weak documentary and information base about the main means of production, aboriginal breeds of cattle in the Carpathians, limited data in scientific sources. Therefore, with the support of the above-mentioned scientific institution, a study of local breeds of cattle in the mountainous areas of the Carpathian countries was conducted and 19 breeds were identified. The gene pool covers 479,425 animals. Breeds were differentiated by the following characteristics: dairy-meat or meat-dairy direction of productivity, the highest level of variability, reproductive ability and longevity of productive use. The colour is mostly uniform, the animals have a strong constitution and hoof horn, a well-developed respiratory system, better reactive properties, resistant to many diseases, genetically determined production of high-quality milk, meat, best adapted to eating grass vegetation of natural meadows and pastures and converting it into milk, beef, etc. Due to the combined direction of productivity and relatively low live weight, they are characterized by an unshakable balance of "genotype – environment", emit 10% less methane into the atmosphere

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(FAGAN, 2016). Individual breeds originate from the domestication of the small Carpathian aurochs.

At the same time, globalization, unification and introduction, have caused structural, quantitative and qualitative changes in the breed composition. There is a significant decline in the breeding stock. Generalized data on breeds in breeding countries are presented in Table 1.

It should be noted that a significant part of breeds is distributed in the zone of anthropogenic landscapes and in protected areas, therefore it requires constant monitoring and conservation in order to optimize the functioning of historically formed ecosystems. Analysis of the data obtained allows us to confirm that the most widespread are the Czech motley, Simmental and Slovak motley breeds. The highest share (35.5%) is made up of genetic resources of Czech motley cattle. Its gene pool is concentrated in 1141 farms. A significant area is covered by Serbia motley cattle. A small number of livestock breeds such as Polish red, Ukrainian gray, Ukrainian white-headed and Lebedynska are in Ukraine; black-white and white-spine breed in Poland.

Table 1: Native cattle breeds of the Carpathian region, total number and average per farm, heads.

Country	Breed	Total no.	Average no. per farm
Czechia	Czech motley	170,000	149
Hungary	Hungarian grey/Magyar	4,965/14,000	24/36
	Romanian brown, Bruno	1,000	18
Poland	Polish red	2,399	9
	black-white	1,575	12
	red-white	3,293	10
	white-spine	653	6
	Simmental	100,000	15
Romania	Romanian brown, Bruno	3,000	3
Slovakia	Slovak motley	105,229	84
	Pinzgau	3,412	107
Serbia	motley cattle	43,000	5
Ukraine	Carpathian brown	24,051	1
	Lebedynska	640	160
	red-steppe	1,609	201
	Polish red	126	126
	Ukrainian grey	173	173
	Ukrainian white-headed	300	300

In the current situation, the balanced and long-term development of the regions where indigenous breeds are bred is lost. The production of ecological milk and the income per year per cow is 2.4 times higher than in the production of conventional

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(SZUMIEC and MUSIAL, 2021). The Figure 1. presents the criteria for measuring the assessment of balanced and long-term development according to the aforementioned authors.

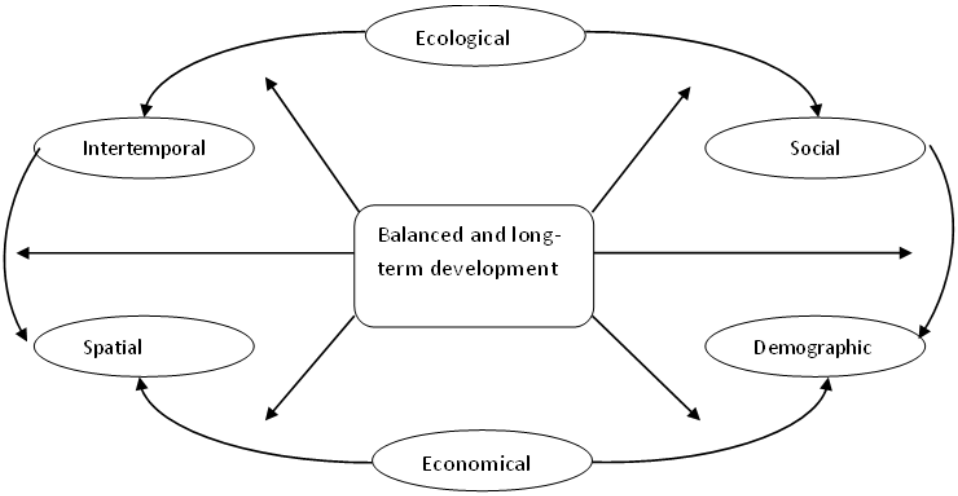


Figure 1: Criteria for measuring the assessment of balanced and long-term development according to SZUMIEC and MUSIAL, 2021

In addition, made from valuable in a biological sense, vitaminized milk obtained in the pasture system on natural meadows, craft, environmentally friendly, organic, butter, hard cheeses also have a bouquet of specific aromas. For example, in Ragusano cheese 27 aromatic compounds have been identified, while in cheese made from milk obtained from cows that consumed a traditional diet only 13 (CARPINO et al., 2004).

Leading the Polonian economy, adhering to the age-old traditions and culture of the Hutsuls, Boykas, Lemkos and other ethnic groups, today they have learned to use the genetic, biological, anatomical, physiological properties of local cattle, to live in harmony with nature and the environment, as required by the "Carpathian Convention" and its protocols. After all, closely connected with the Carpathians is the fate of the ancestors, who began to inhabit this territory in the early Palaeolith – more than a million years ago.

As in ancient times, cows are kept for 8-10 hours a day, and young animals are kept around the clock in the spring-summer-autumn periods on natural meadows and pastures, consuming green, high-quality, highly digestible feed with an optimal ratio of protein-carbohydrates-energy, with partial feeding with concentrates and hay in winter, while fertilizing poor soils. It should be noted that thanks to this technology, animals have good indicators of somatic development and the ability to maximally manifest genetically laid down growth and development tendencies and phenotypic

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parameters that are inherent in breeds, coexist with wild herbivores and birds common in these areas, and pastures reach a yield of 60-70 centners/ha of feed units. The basis of motivation is also the economic component. The level of feed conversion into products increases, the cost of the ration decreases, and its good payment is noted. The calculations in Table 2 confirm the lowest relative cost of green mass. That is, if the mass unit of natural pasture fodder we take as 100 percent, the cost of concentrates will cost 31.6 times more, and in terms of nutritional value 3.92 times more. It is this kind of maintenance and feeding that ensures competitive and profitable production of milk and beef, increases the growth rate of grasses in height, mass of stems and leaves, and stimulates changes in the diversity of botanical composition for the better.

Table 2: Relative cost of green fodder of natural meadows and pastures

Indicators	In % of pasture fodder	
	natural	feed units
Green mass of natural pastures	100	100
Green mass of mowed perennial grasses	230	158
Green mass of corn and annual grasses	400	332
Hay from natural hayfields	608	247
Hay from sown perennial grasses	960	301
Hay from sown annual grasses	1,210	380
Forage root crops	960	1,051
Concentrated feed	3,160	392

In addition to economic and economic significance, pastoral traditions that are passed down from generation to generation contribute to the restoration of anthropogenically transformed meadow ecosystems. The day of entering on the alpine meadows is solemnly celebrated. It is known that now throughout Europe such a system is encouraged, supported by state and EU subsidies, and is consistent with global trends. This means that the importance of cross-border and subregional cooperation in this regard is growing, and the “Carpathian Convention” has opened new opportunities for using the reserves laid down by nature itself.

It is necessary to conduct comprehensive studies of the consequences of economic activity, to reach an agreement on technological processes to be used for balanced, economic management of the livestock industry, elimination of contradictions between production and ecology, preservation of biodiversity and development of local cattle breeds for the benefit of people who live and work here, to activate the formation of environmental awareness among the population.

Despite partial positive developments after the adoption of the “Carpathian Convention” and its protocols, the establishment of cooperation between various authorities of the Carpathian Euroregion countries, the issues of forming the local market for milk and beef, solving the shortage of animal protein, preserving the environment, fauna, flora, genotypes of breeds of small populations of the food

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subcomplex, and studying the advantages of local breeds over commercial ones remain problematic. The main reason is the systematic reduction of active herds of aboriginal breeds. Most of them have reached their limit minimum, the force of influence of which can really threaten their disappearance, the sustainability of not only cattle breeding, but also the crop industry and production shortage in mountainous areas. To prevent negative trends in the future and for a detailed assessment of such a phenomenon, an in-depth study and analysis of the situation in a specific region of the Carpathians, Transcarpathian region, Ukraine was conducted. Based on the results of our own research, it was found that the peak of the development of the main Brown Carpathian breed (BCB) falls on the mid-90s of the last century, when the number of BCB animals was 113.4 thousand. The dynamics of the livestock are given in Table 3.

Table 3: Absolute and relative indicators of the Brown Carpathian breed and all cows total, production and demand for livestock products in Transcarpathia in 1986; 2004 and 2023

Years	No. of BCB cows, in thousands	No. of BCB cattle, in thousands	Milk production		Beef production	
			yield, kg in thousands	deviation from need	live weight, kg in thousands	deviation from need
1986	113,4	141,7	356	-119	45	-15
2004	100,9	140,2	438	-37	34	-26
2023	36,1	42,0	283	-192	27	-33
change 1986-2023	-77,3	-99,7	-73		- 18	-
% change 1986-2023	-314.1	-337.4	-21		- 40	-

Note: milk demand – 475 thousand tons; meat demand – 60 thousand tons

The results obtained clearly confirm the negative dynamics, a significant decrease in the number of cows during the analysed period in both absolute and relative indicators. Thus, in absolute figures, the number of BCB cows decreased by 77.3 thousand heads, the total decrease – by 99.7 thousand heads. Thus, having considered the above changes and retrospective sources, it can be stated that the brown Carpathian cattle has proven its viability even in different socio-political conditions since 1911. Despite this, its population is steadily decreasing and reaching a critical limit. Per 100 hectares of agricultural land, there was also a significant decline in number of cows (from 30.9 to 9.2) between 1986 and 2023, the condition is assessed as very low. The situation is similar if it the number of cows is assessed per 100 inhabitants; this decreased from 11.3 to 3.3 during the period. More animals are kept in mountain areas, but the above-mentioned patterns are observed, production has partially moved to the lowlands.

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At the same time, gross milk production, after growing by 18.7% in 2004, fell by 35% last year, and beef production recorded declines of 24.4% and 20.7%. As a result, the need for valuable food products has become consistently negative and in 2023 it is provided by 59.6% and 45.0%, respectively. This problem leads to a violation of the basic indicators of good nutrition of the local people, primarily by protein of animal origin. In the structure of the caloric content of the diet, products of animal origin account for 30%, at an optimal level of 55% with a predominance of poultry meat.

It should be noted that the decline of traditional farming on high-mountain pastures has changed the harmonious landscapes typical to the Carpathian territories and worsened the botanical composition of the herbage, impoverished the biodiversity of phytocenoses, which provoked the uniformity of the plant cover of natural meadows and pastures, the role of which in nature is equal to forests. Recent surveys indicate invasions of common juniper, green alder, etc., which displace grass cenoses.

The coefficient of use of available solar energy, which worsened the potential indicators of photosynthesis and, accordingly, the recreational potential, is one of the causes of soil degradation. Such a problem is also observed in Transcarpathia, Ukraine. Currently tussocks, low-value weeds, shrubs and trees are widespread (Figure 2). Of the total land fund of the mountainous part, 571.6 thousand hectares (53.5%) have been declared an area of extreme ecological situation.



Figure 2: Modern appearance of the former natural pasture, photo by the author, 2024

The prolonged disparity in prices for livestock products, goods and services of other sectors of the national economy, not in favour of farmers, the liquidation of the public sector of the economy, breeding farms, processing enterprises during the transition

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period to a market economy accelerated the regression of the BCB population in 2011 to 75 thousand cows or by 52.9%. At the same time, the fact that the coefficient of added value of sold livestock products is 3.2% in the chains of “raw materials – consumption – by-products and raw materials for the light and pharmaceutical industries" is undeniable.

In order to stabilize the state, scientific and transboundary aspects of the implementation of the “Carpathian Convention” and its protocols, the sustainable use of natural and genetic resources, and the creation of a new model of industry management, we have developed the “Concept for the Preservation of the Local Brown Carpathian Breed and the Development of Dairy Cattle Breeding in the Transcarpathian Region by 2025”, Ukraine. The concept was approved and recommended for publication by the Academic Council of the Institute of Animal Breeding and Genetics of the NAAS on December 18, 2012, protocol No. 411. The concept combines the interests and real possibilities of the state, the region, and small producers. The establishment of a breed association was taken care of, which was officially registered in 2014. In the same year, on October 16, a cooperation agreement was signed with the Association of the Brown Maramorosh breed – Bruno, Sighet city, Romania. In accordance with the recommendations of the FAO, a gene bank was organized in Mukachevo city, Ukraine, where biological material of different generation periods since 1962, of different bloodlines and belonging to different lines of 10 purebred and 28 crossbred BCB bulls is stored. Biomaterial from four of them was transferred to the National Bank of Animal Genetic Resources at the Institute of Animal Breeding and Genetics named after M.V. Zubets, NAAS. At the meeting of the Technical Council of the Regional Office for Eastern Europe and Central Asia of the Food and Agriculture Organization of the United Nations (FAO), Budapest, Hungary, on the issue of preserving priority local breeds, on April 30-31, 2015, the Chairman of the Board of the Association presented the Brown Carpathian breed and argued the feasibility of paying for genetic research. During the following period, meetings of the working group were held at the National University of Bioresources and Environmental Management, Kyiv, Ukraine. In August 2017, a financing project was approved. Practical work was carried out on the research of 183 heads. On August 30, 2016, the BCB Association was accepted into the Federation of Brown Breeds of Europe, Zug city, Switzerland. Membership in the Federation opened opportunities for involving European genetics, the latest techniques and technologies for preserving aboriginal cattle in the breeding process. To establish research cooperation, an agreement was concluded with the Slovak University of Agriculture in Nitra city on February 24, 2017. The results of joint genetic research on the BCB and Slovak Spotted breed were published by KASARDA et al. (2019). To contribute to the development of practical and scientific cooperation, an agreement was concluded on April 5, 2019, with the University of Life Sciences in Lublin, Poland. As a result, on June 15, 2022, a presentation was made at the international conference at the university on the topic "Engaging the

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capabilities of the Carpathian Euroregion and other institutions for the preservation of cattle biodiversity and sustainable development of local communities in the Carpathian countries". With the financial and advisory support of university employees, indigenous breeds of the Carpathian region countries were studied (TERPAI et al., 2023). Under the agreement dated May 29, 2019, with the Institute of Zootechnics, Krakow – Balice, Poland, within the budget, molecular genetic identification of 83 BCB heads was carried out in 2022 to detect the A1A2 allele in animals and genotyping for A2A2, a database was created. The influence of the A2A2 gene polymorphism on milk productivity and technological qualities of the obtained milk with the content of A2A2 protein and the production of hard cheese from it is being studied. The foundations of cooperation with the association of scientific institutions of the countries of the Danube region were laid in 2019 and the possibility of publishing works in the scientific publication DAGENE was opened. According to the scientific and technical task of the Institute of Animal Breeding and Genetics named after M.V. Zubets of the NAAS, an expeditionary survey of the BCB breeding stock was conducted (TERPAI, 2024).

Thus, the listed studies using zootechnical, economic, organizational measures, with further in-depth cross-border cooperation, will help to achieve the results outlined in the "Carpathian Convention" and its protocols. These studies also will contribute to development of a long-term strategy for livestock farming in the Carpathian region, based on aboriginal cattle breeds, using genomic selection and an ecosystem approach in organizing production. As well as to improve methods for preserving cattle's gene pool and restoring meadow ecosystems. Predict structural changes under the influence of global and regional climate change and the selection of tolerant measures to minimize the negative impact.

Conclusion and recommendation

The implementation of the "Carpathian Convention" and its protocols on the basis of indigenous cattle breeds, scientific and transboundary aspects of cooperation between the countries that have united in the Carpathian Euroregion, will return the integration of science and practice, herds of indigenous cattle breeds to natural meadows and pastures, preserve and enrich the biodiversity of flora and fauna, ensure sustainable development of communities and improve the lives of local residents. The reformatting of monobreeding, preferring only one breed in cattle livestock will become an effective mean of adapting the industry to climate change and prevent disruption of pasture and meadow ecosystems of the Carpathians. It is necessary to continue research on the full identification of indigenous breeds to create a cadastre. To eliminate the information deficit and improve the planning of response measures, it is necessary to create an integrated transboundary network for monitoring and assessing the population of indigenous breeds in the countries of the

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Carpathian Euroregion. It is also necessary to organize an international conference on traditional farming in the Carpathians as well as educational and informational publications.

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