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# PROGRAM FOR THE ANIMAL GENETIC RESOURCES CONSERVATION AND USE IN SLOVENIA FOR THE PERIOD 2024-2030

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***Kratak sadržaj***

*Brza erozija globalnog biodiverziteta animalnih genetskih resursa zahteva robusne nacionalne strategije očuvanja kako bi se osigurala poljoprivredna otpornost i bezbednost hrane (FAO, 2007a; Groeneveld et al., 2010). Ovaj rad detaljno predstavlja sveobuhvatni slovenački "Program za očuvanje i održivo korišćenje genetskih resursa životinja za period 2024–2030" (MKGP, 2023), osmišljen u skladu sa međunarodnim mandatima, uključujući Globalni akcioni plan FAO (FAO, 2007b), Konvenciju o biološkoj raznovrsnosti (UN, 1992) i Strategiju EU za biodiverzitet do 2030. godine (CBD, 2020). Program integriše sistematsko praćenje,* in situ *i* ex situ *metodologije očuvanja, okvire održive upotrebe, posvećene istraživačke inicijative, obrazovni rad i međunarodnu saradnju. Ključni fokus stavljen je na autohtone slovenačke rase, koje su jedinstveno prilagođene raznolikim lokalnim agroekosistemima i poseduju višestruku ekološku, ekonomsku i kulturnu vrednost. Strateška implementacija kombinuje genetičko praćenje populacija sa direktnom finansijskom i institucionalnom podrškom za uzgajivače, napredne operacije genskih banki, te ciljana istraživanja tržišnog potencijala i jedinstvenih genetskih svojstava. Ovaj integrisani pristup, koji povezuje očuvanje biodiverziteta sa širim ciljevima ruralnog razvoja, pozicionira slovenački program kao model za efikasnu nacionalnu implementaciju globalnih ciljeva očuvanja AnGR.*

***Summary***

*The rapid erosion of global livestock biodiversity necessitates robust national conservation strategies to ensure agricultural resilience and food security (FAO, 2007a; Groeneveld et al., 2010). This paper details Slovenia's comprehensive "Program for the Conservation and Sustainable Use of Animal Genetic Resources for the Period 2024–2030" (MKGP, 2023), designed to align with international mandates, including the FAO Global Plan of Action (FAO,*

*2007b), the Convention on Biological Diversity (UN, 1992), and the EU Biodiversity Strategy to 2030 (CBD, 2020). The Program integrates systematic monitoring,* in situ *and* ex situ *conservation methodologies, sustainable utilization frameworks, dedicated research initiatives, educational outreach, and international collaboration. A core focus is placed on native Slovenian breeds, which are uniquely adapted to diverse local agro-ecosystems and possess multifaceted ecological, economic, and cultural value. The strategic implementation combines rigorous population genetic monitoring with direct financial and institutional support for breeders, advanced gene bank operations, and targeted research into both market potential and unique genetic attributes. This integrated approach, linking biodiversity conservation with broader rural development objectives, positions Slovenia's program as a model for effective national implementation of global AnGR preservation goals.*

***Key words:*** *livestock biodiversity, genetic resources, conservation, local breeds, Slovenia*

## INTRODUCTION

The increasing demands of a growing global population exert substantial pressure on agricultural systems, necessitating enhanced productivity while simultaneously ensuring long-term sustainability and resilience (FAO, 2023). Within this paradigm, animal genetic resources (AnGR) are paramount for global food security, supporting diverse livelihoods, and delivering essential ecosystem services (FAO, 2007a). However, the prevalent trend of intensified livestock production has disproportionately favoured a limited number of high-producing breeds, leading to a significant contraction of the global genetic base (Groeneveld *et* al., 2010). This alarming genetic erosion not only compromises the adaptive capacity of livestock systems to emerging environmental stressors and climate change (Hoffmann, 2010) but also risks the irreversible loss of invaluable cultural heritage and traditional knowledge intrinsically linked to local, adapted breeds.

In response to these global challenges and recognizing the critical importance of safeguarding its native AnGR, Slovenia has developed and adopted its fifth successive national program: "The Program for the Conservation and Sustainable Use of Animal Genetic Resources for the Period 2024–2030" (MKGP, 2023). This strategic framework is firmly grounded in international commitments and scientific principles, drawing extensively from the Convention on Biological Diversity (UN, 1992), the Nagoya Protocol on Access and Benefit-sharing (CBD, 2011), the FAO Global Plan of Action for Animal Genetic Resources (FAO, 2007b), and the overarching EU Biodiversity Strategy to 2030 (CBD, 2020). The Program signifies a proactive national commitment to the systematic conservation and sustainable utilization of domestic animal breeds through a methodically structured, adequately funded, and scientifically robust policy framework.

## NATIONAL CONTEXT AND HISTORICAL PERSPECTIVE OF AnGR CONSERVATION IN SLOVENIA

Slovenia's formal engagement in AnGR conservation commenced in the early 1990s, catalyzed by the critical endangerment status of several native breeds. For instance, populations of the Cika cattle and the Drežnica goat had diminished to perilously low numbers, necessitating urgent intervention. In response, the Slovenian government, primarily through the Ministry of Agriculture, Forestry and Food, initiated formal conservation measures, bolstered by the Livestock Farming Act (Ur. list RS, 2002) and active engagement with various breeding organizations. These foundational efforts established the precursor to a systematic approach, encompassing population monitoring, initial genetic preservation efforts, and fostering stakeholder collaboration.

Critically, since 2006, demographic trends for the majority of native Slovenian breeds have demonstrated a positive curve. This success is largely attributable to sustained public subsidies, targeted breeder incentives, and augmented public awareness campaigns. Conversely, non-native traditional breeds have generally exhibited declining population trends, underscoring the necessity for differentiated and nuanced conservation strategies. The current 2024–2030 Program (MKGP, 2023) builds upon this historical legacy, integrating contemporary scientific insights, expanding *ex situ* conservation capacities, and implementing enhanced robust population monitoring systems.

## PROGRAM STRUCTURE AND STRATEGIC OBJECTIVES

The Program conceptualizes livestock biodiversity broadly, encompassing all animal breeds integral to Slovenian agriculture, with a pronounced emphasis on nationally recognized native and traditional breeds (MKGP, 2023). Its strategic objectives are multifactorial and include:

- Ensuring the long-term genetic integrity and demographic viability of local breeds through integrated *in situ* (on-farm) and *ex situ* (gene bank) conservation methodologies.
- Promoting the sustainable and economically viable utilization of local breeds within traditional and extensive production systems, particularly in marginal or ecologically sensitive areas, thereby contributing to ecosystem services and landscape management.
- Enhancing public and stakeholder awareness and educational initiatives to strengthen societal support and engagement in AnGR conservation.
- Fostering robust international cooperation and knowledge exchange, ensuring alignment with and contribution to global biodiversity strategies.

- Establishing and securing long-term financial and institutional support mechanisms, including adaptive emergency intervention protocols for critically endangered populations.

Each objective is systematically operationalized through breed-specific management plans, executed via national and regional coordination. This involves the implementation of standardized genetic monitoring protocols and comprehensive data collection through the national Register of breeds, which facilitates dynamic assessment of endangerment levels (MKGP, 2023).

## CONSERVATION METHODOLOGIES AND IMPLEMENTATION

Conservation efforts under the Program are executed via a complementary dual approach: *in situ* and *ex situ* conservation.

- ***In situ* conservation:** This pillar directly supports breeders through technical assistance, expert advice, and financial subsidies. This ensures that local breeds are maintained within their evolutionary and productive environments, thereby preserving their adaptive capacity and gene-environment interactions. This approach not only directly contributes to the maintenance of genetic diversity but also underpins rural livelihoods, traditional farming practices, and the distinctive cultural landscapes associated with these breeds.
- ***Ex situ* conservation:** This method involves the cryopreservation of genetic material, including semen, embryos, and somatic cells, in national gene banks managed by public research institutions. These biological reserves serve as critical safeguards against catastrophic breed loss and provide invaluable resources for future breeding programs, genomic research, and potential breed reconstruction (FAO, 2007a). As of 2023, Slovenia has successfully cryopreserved genetic material representing all its recognized local breeds (MKGP, 2023).

The centralized Register of breeds serves as the authoritative national database for continuous monitoring of demographic trends, evaluating endangerment status, and assessing genetic diversity metrics (e.g., effective population size, heterozygosity). Currently, the Register encompasses 14 local, 14 traditional, and 27 non-local breeds. Of native, eight are officially classified as critically endangered and five as endangered, based on established national and international criteria (MKGP, 2023).

## RESEARCH, INNOVATION, AND CAPACITY BUILDING

Scientific research forms the bedrock of the Program's activities. Priority research areas include:

- **Genetic characterization:** In-depth genomic analyses are undertaken to elucidate the genetic architecture and distinctiveness of local breeds.

For instance, recent genome-wide studies have conclusively validated the unique genetic profiles of the Cika cattle and Drežnica goat populations. These studies often employ high-density SNP arrays and whole-genome sequencing to assess breed purity, identify unique alleles, and quantify genetic diversity parameters (Groeneveld *et* al., 2010).

- **Performance evaluation:** Comprehensive evaluations of production traits, adaptability, and resilience of local breeds under diverse management systems are conducted to quantify their specific advantages in extensive and organic farming.
- **Development of molecular markers:** Research focuses on identifying and validating molecular markers associated with economically important traits, disease resistance, and adaptive capacities, facilitating more precise and efficient breeding decisions (Woolliams *et* al., 2015).

Despite advancements in genetic characterization, significant research gaps persist concerning the market potential of products derived from local breeds, consumer perception, and robust economic valuation methodologies as well as ecosystem services related to the local breeds. The Program actively fosters interdisciplinary collaboration among universities, public research institutes, and breeding organizations to bridge these gaps. Furthermore, substantial investment is directed towards training programs for breeders and professionals, public awareness campaigns, and educational initiatives. These efforts are designed to cultivate a highly knowledgeable, engaged, and skilled community capable of sustaining long-term conservation efforts.

## INTEGRATION WITH INTERNATIONAL AND REGIONAL FRAMEWORKS

Slovenia's national program is meticulously designed to ensure comprehensive alignment with key global and regional biodiversity and agricultural initiatives. This integration includes:

- The Food and Agriculture Organization (FAO)’s Global Plan of Action for Animal Genetic Resources (FAO, 2007b), which provides a global framework for AnGR management.
- The Convention on Biological Diversity (UN, 1992) and its associated Aichi Biodiversity Targets (CBD, 2020), emphasizing the importance of biodiversity conservation for sustainable development.
- The European Union Biodiversity Strategy for 2030 (CBD, 2020), which outlines ambitious goals for biodiversity restoration and sustainable use within the EU.
- The Animal Genetic Resources Strategy for Europe (ERFP, 2021).

By proactively integrating these international frameworks into national policy, Slovenia ensures programmatic coherence, optimizes access to international funding opportunities, and actively contributes to coordinated global action for

AnGR conservation. The Program also actively promotes and supports participation in regional scientific networks and transboundary conservation projects, recognizing the interconnectedness of genetic resources across geographical boundaries.

## KEY MEASURES AND INSTITUTIONAL MECHANISMS

The successful implementation of Slovenia's national program is predicated on robust institutional coordination and clearly delineated responsibilities (MKGP, 2023). The Ministry of Agriculture, Forestry and Food (MKGP) serves as the primary supervisory authority, overseeing the public service responsible for the national gene bank and establishing the overarching financial and strategic frameworks. The public service, in turn, collaborates extensively with breeders' associations, academic institutions, and other rural stakeholders to effectively execute conservation activities.

Financial sustainability for conservation efforts is secured through various mechanisms, including direct payments to breeders of endangered breeds, dedicated research funding, and strategic capital investments in critical infrastructure such as cryogenic storage facilities and advanced monitoring systems. Furthermore, comprehensive emergency response plans are in place to safeguard small or critically endangered populations from unforeseen threats, such as disease outbreaks or natural disasters. The Program also incorporates stringent mechanisms to ensure accountability, including annual reporting requirements, transparent data policies, and regular publication of breed status updates (MKGP, 2023). These national data management protocols are fully harmonized with international data-sharing commitments, particularly under the FAO's Domestic Animal Diversity Information System (DAD-IS) (FAO, 2023).

## CONCLUSION AND FUTURE OUTLOOK

The Slovenian Program for the Conservation and Sustainable Use of Animal Genetic Resources (2024–2030) represents a scientifically informed, robust, and forward-looking national strategy (MKGP, 2023). Its foundation in contemporary scientific research, seamless policy integration, and extensive stakeholder collaboration provides a compelling and replicable model for smaller nations seeking to balance agricultural productivity with critical biodiversity conservation imperatives. The Program's dual emphasis on both proactive conservation and sustainable utilization, supported by transparent implementation mechanisms, ensures that Slovenia's animal genetic diversity remains a vital pillar of national food security, enhances climate change adaptation capabilities, and contributes significantly to rural vitality.

A key determinant of the Program's continued success lies in its effective integration of traditional knowledge, accumulated through generations of

breeding and husbandry, with cutting-edge modern genetic and data-driven tools. The pivotal role of breeders as primary custodians of this invaluable biodiversity is actively recognized, supported, and economically valorized. Moreover, the strategic leveraging of regional and international instruments, including the EU Biodiversity Strategy (CBD, 2020) and the Nagoya Protocol (CBD, 2011), ensures that national efforts are seamlessly aligned with and contribute to overarching global biodiversity goals. To sustain and amplify these achievements beyond 2030, continuous and targeted investment in human capacity building, advanced digital infrastructure, and expanded cross-border cooperation will be essential. This Program also directly contributes to several United Nations Sustainable Development Goals (SDGs), notably SDG 2 (Zero Hunger) through its support for resilient food production systems, and SDG 15 (Life on Land) by promoting the conservation of terrestrial biodiversity. Indirectly, it supports SDG 13 (Climate Action) by preserving livestock breeds adapted to marginal environments and SDG 12 (Responsible Consumption and Production) through the promotion and valorization of breed-specific products. Ultimately, Slovenia's program robustly underscores that biodiversity conservation in agriculture is not merely an ecological imperative, but a fundamental cornerstone of national food sovereignty and sustainable rural development.

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