MOUNTAIN AREA – ANALYSIS AND DEVELOPMENT PROSPECTS

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Abstract

Mountain areas play an important role in the agricultural and environmental sustainability of Romania, particularly through their extensive permanent grasslands and livestock production systems. The aim of this study was to analyze the development potential of mountain agriculture and forage resources using a SWOT (Strengths, Weaknesses, Opportunities, Threats) approach. The research was based on a bibliographic and documentary analysis, and strategic assessment of the factors influencing agricultural development in mountain regions. The results highlighted several strengths, including the high biodiversity of permanent grasslands, the availability of local forage resources, the ecological benefits of grassland ecosystems, and the potential for agritourism development. The study emphasizes the importance of sustainable grassland management, support for mountain farming systems, and the implementation of rural development measures aimed at preserving biodiversity and improving the economic viability of mountain communities.

Keywords: *biodiversity, mountains, fodder crops, SWOT analysis*

INTRODUCTION

Mountainous areas are distinguished by specific natural conditions, which directly influence the production of fodder and the organization of livestock farming systems (PĂCURAR and GHEȚE, 2025). The rugged relief, the more severe climate, the soil types and the characteristic biodiversity determine distinct particularities compared to the plain regions (POSEA, 2005). The steep slopes and the fragmentation of the relief make it difficult to mechanize agricultural work and favor the practice of traditional methods of land use (ROTAR AND CARLIER, 2010, VÎNTU et al., 2011). Also, agricultural lands are dispersed and difficult to access, an aspect that influences both the harvesting and the conservation of fodder. Under these conditions, natural meadows and hayfields constitute the main fodder resources for animals (WORLD BANK and MADR, 2023).

Forage crops are the basis for the development of mountain animal husbandry, providing the necessary resources for raising cattle, sheep and goats. In conditions where natural grasslands do not fully cover the nutritional

needs, forage crops complement the animal diet and stabilize production.

Grazing-based feeding systems, especially those in mountain and sub-mountain areas, are associated with obtaining animal products with superior nutritional characteristics. Green fodder from natural grasslands is rich in polyunsaturated fatty acids and their precursors, which leads to an increase in the content of omega-3 fatty acids and conjugated linoleic acid (CLA) in milk and meat, as well as an improvement in the ratio of omega-6 to omega-3 fatty acids (ALOTHMAN *et al.*, 2019). These changes are considered beneficial for consumer health, being associated with cardioprotective and anti-inflammatory effects (ALOTHMAN *et al.*, 2019). In the case of mountain grasslands, the high floristic diversity and the presence of species rich in secondary metabolites further contribute to improving the quality of dairy products. Milk from animals fed on alpine pastures presents a more favorable lipid profile, an increased content of bioactive compounds and sensory properties appreciated by consumers, being often associated with traditional products with high added value (LOPEZ *et al.*, 2022; 2023).

The aim of this study was to assess the development potential of mountain agriculture and forage resources through a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis. The research focused on identifying the main internal and external factors influencing the sustainable management of permanent grasslands and livestock production systems in mountain areas.

MATERIAL AND METHOD

The methods used in this paper are: bibliographic and documentary analysis and SWOT analysis (table 1).

Bibliographic and documentary analysis was used to consult and interpret specialized literature, rural development strategies and official documents on mountain agriculture and permanent grassland management.

KOTLER and KELLER (2012) consider SWOT analysis one of the most widely used methods of strategic analysis in project management and organizational development.

The internal factors of SWOT analysis, namely strengths and weaknesses, are determined by elements specific to the organization or system being analyzed, such as available resources, level of organization, human resources, managerial capacity, existing infrastructure or the way resources are used.

Table 1

Description of the methodology used

Method used	Description	Role in the research
Bibliographic and documentary analysis	Method used for consulting and interpreting specialized literature, rural development strategies and official documents regarding mountain agriculture and permanent grassland management.	Ensures the theoretical and scientific substantiation of the research and supports the interpretation of the information analyzed in the work (CHELCEA, 2007, YIN, 2014).
SWOT analysis	Strategic analysis tools are used to identify strengths, weaknesses, opportunities and threats specific to mountain agriculture.	Contributes to the evaluation of the local agricultural system and the formulation of proposals for management and sustainable development (KOTLER and KELLER, 2012).

RESULTS AND DISCUSSIONS

Strengths:

An important strength of the mountain area is the extensive area of permanent grasslands and natural meadows, which provide favorable conditions for livestock breeding and fodder production (HOPKINS and HOLZ, 2006). The area has a diversified vegetation cover, consisting of valuable species of grasses and spontaneous legumes, which contributes to obtaining fodder of good nutritional quality (PEETERS, 2004). The mountain and hilly meadows of Transylvania are recognized for their high biodiversity and important pastoral value (MARUȘCA, 2018, FAO, 2015, PĂCURAR and ROTAR, 2014, TASSER and TAPPEINER, 2002).

Natural fertilization through spontaneous legumes is an ecological method of improving soil fertility, based on the ability of these plants to fix atmospheric nitrogen through symbiotic bacteria of the genus *Rhizobium*, present in the nodules on the roots (PEETERS, 2004, CARLSSON and HUSS-DANELL, 2003, FRAME, 2005).

Perennial legumes (*Trifolium pratense, Trifolium repens*) and forage grasses (*Dactylis glomerata, Lolium perenne, Festuca rubra*) contribute to increasing biomass production and improving the nutritional value of forage. Legumes are of particular importance due to their capacity for biological nitrogen fixation, reducing the need for chemical fertilizers and improving soil fertility (WHITEHEAD, 2000). Nitrogen fixation can reach significant values in forage agroecosystems, contributing to increasing productivity and

reducing production costs (POP, 2010).

From an economic point of view, permanent grasslands are the fodder base of mountain livestock, supporting animal husbandry and the production of traditional products such as milk, meat and cheeses specific to mountain regions. At the same time, they contribute to the maintenance of local economic activities and the development of rural communities. Reducing livestock activities or abandoning the traditional use of grasslands can lead to their degradation and the loss of characteristic biodiversity (WORLD BANK and MADR, 2023).

The use of local fodder resources reduces dependence on concentrated fodder and reduces production costs. In mountainous areas, where access is difficult and transport costs are high, fodder autonomy becomes a major economic advantage (FAO, 2015).

The grasland protects the soil against erosion on the slopes, stabilizes the land and contributes to water infiltration. Mountain meadows are important reservoirs of biodiversity and contribute to carbon sequestration (PIMENTEL and KOUNANG, 1998; CONANT *et al.*, 2001)

Natural grazing allows for the production of dairy products and meat with superior organoleptic characteristics, appreciated on the market and associated with mountain identity.

Another advantage is the potential for the development of agritourism and ecotourism (PIMENTEL and KOUNANG, 1998). Natural landscapes, rural traditions and local agri-food products can be important factors for the economic development of the commune (OECD, 2020, PLIENINGER *et al.*, 2015). Regional development strategies highlight the importance of capitalizing on the tourism and rural resources of the North-West Region (TOURISM SECTOR STRATEGY 2021-2027 for the North-West Development Region -January 2026 version).

Last but not least, the commune preserves an important cultural and traditional heritage, specific to the Transylvanian village. Local customs, rural architecture and traditional agricultural practices represent important elements for the local identity and for the sustainable development of the community (COUNCIL OF EUROPE, 2000, EEA, 2020).

Weaknesses

Development in mountain areas is influenced by several constraints: fragmentation of agricultural land, poorly developed agricultural infrastructure, low mechanization, difficult accessibility, aging of the rural population, depopulation of mountain villages, and low productivity of some grasslands

(EUROPEAN COMMISSION, 2021; OECD, 2020).

One of the main weaknesses is the fragmentation of agricultural land, a phenomenon frequently encountered in rural areas of Transylvania. Farms are small and dispersed, which makes it difficult to mechanize agricultural work and apply modern, efficient technologies. This situation leads to high exploitation costs and low productivity of grasslands. Land fragmentation has been identified as an important obstacle to agricultural competitiveness and sustainable rural development in many European mountain regions (VERBURG *et al.*, 2010; OECD, 2020).

Climate change represents another important challenge for mountain agriculture, influencing fodder production, species composition, water availability and ecosystem stability. Mountain grasslands are particularly sensitive to changes in temperature and precipitation patterns, which may affect both forage yield and biodiversity conservation (IPCC, 2023; FAO, 2015).

Another negative aspect is the degradation of grasslands through excessive grazing and inadequate maintenance. In many pastoral areas, the phenomenon of soil compaction occurs, together with the reduction of valuable forage species and the expansion of unproductive or invasive vegetation. Overgrazing can significantly reduce the ecological and productive value of permanent grasslands and negatively affect soil quality (MARUȘCA, 2018; FAO, 2015).

The lack of maintenance work, such as organic fertilization, weed control or over-seeding, favors the decrease in the pastoral value of the vegetation cover and may accelerate grassland degradation processes (MARUȘCA, 2018; OSPA Cluj, 2022, CIREBEA *et al*, 2020).

Population aging and the migration of young people to urban areas or abroad reduce the availability of labor and limit the capacity for innovation and investment in mountain agriculture. These demographic trends contribute to the gradual abandonment of agricultural land and threaten the long-term viability of rural communities (EUROPEAN COMMISSION, 2021; OECD, 2020).

Opportunities

In the context of European policies on sustainable development and environmental protection, mountain agriculture can benefit from various financial support programs aimed at the conservation of permanent grasslands, the development of livestock farms, support for young farmers, adaptation to climate change, and the modernization of agricultural activities. The European Union's Common Agricultural Policy promotes environmentally friendly

farming practices and supports the sustainable development of rural and mountain areas (EUROPEAN COMMISSION, 2021; 2023).

By efficiently using local resources and implementing sustainable agricultural projects, the mountain area has the potential to develop a competitive and sustainable agricultural system. Sustainable management of grasslands and livestock systems can contribute to increased economic resilience while maintaining ecosystem services and biodiversity (FAO, 2015; OECD, 2020, TILMAN *et al*., 2002).

The natural landscapes, local traditions, and the specific characteristics of mountain agriculture can attract tourists interested in rural tourism, traditional gastronomy, and recreational activities. Rural tourism is increasingly recognized as an important tool for diversifying local economies and enhancing the value of natural and cultural heritage in mountain regions (EUROPEAN COMMISSION, 2021; OECD, 2020).

Another important opportunity is the growing demand for traditional, local, and mountain-certified food products. Consumers increasingly value products associated with high environmental quality, traditional production methods, and territorial identity, creating new market opportunities for mountain farmers (BELLETTI and MARESCOTTI, 2011; EUROPEAN COMMISSION, 2021).

Last but not least, the development of road and digital infrastructure in Cluj County can facilitate local farmers' access to larger markets and new economic opportunities. Investments in transport, digitalization, and rural connectivity are considered essential factors for improving competitiveness and supporting economic development in rural areas (EUROPEAN COMMISSION, 2021; OECD, 2020).

Threats

One of the most important threats to agriculture and pastoral ecosystems in the mountain area is represented by climate change. Increasing temperatures, changes in precipitation patterns, and the higher frequency of extreme weather events can affect forage production, biodiversity, water availability, and the stability of mountain ecosystems. Grassland productivity and species composition are particularly vulnerable to climatic variability, which may compromise the sustainability of livestock systems (IPCC, 2023; FAO, 2015).

A major threat to the mountain area is represented by the migration of the young population to cities or to other European countries. The reduction of the active population in rural areas leads to the abandonment of agricultural land and the decline of

traditional livestock breeding activities. The depopulation of mountain villages affects the continuity of agro-pastoral practices and reduces the community's capacity to capitalize on local agricultural resources. In many rural areas of Transylvania and other European mountain regions, the aging of the agricultural population and the shortage of skilled labor negatively influence agricultural development and the maintenance of permanent grasslands (EUROPEAN COMMISSION, 2021; OECD, 2020, MACDONALD *et al*., 2000).

In the context of reduced agricultural activities and insufficient maintenance of grasslands, many areas are affected by the invasion of woody vegetation and species with low forage value. The expansion of shrubs and invasive species reduces the area effectively available for grazing and contributes to the decline of valuable grassland habitats. This phenomenon is frequently encountered in abandoned or extensively managed mountain and hilly regions, where traditional management practices have been reduced or discontinued (TASSER *et al.*, 2007; KEENLEYSIDE *et al*., 2014). In the absence of maintenance measures such as shrub removal, controlled grazing, fertilization, or over-seeding, grassland degradation tends to accelerate over time, resulting in reduced pastoral value, lower productivity, and biodiversity loss (MARUȘCA, 2018; FAO, 2015).

The SWOT analysis highlighted the multifunctional role of mountain agriculture in maintaining biodiversity, supporting livestock production and preserving rural heritage. Similar findings have been reported in previous studies emphasizing the importance of permanent grasslands for ecosystem services and sustainable rural development (FAO, 2015; Marușca, 2018; OECD, 2020). However, demographic decline, land fragmentation and climate change remain significant constraints that require targeted policy interventions and improved grassland management practices.

CONCLUSIONS

The importance of this work is determined by the need to develop sustainable agricultural systems in mountain areas, based on the efficient use of fodder resources and the application of modern agricultural management measures.

In the context of climate change, grassland degradation and depopulation of mountain areas, efficient management of agricultural holdings and the implementation of rural development projects are essential elements for maintaining agricultural activities and preserving the ecological balance of mountain ecosystems.

However, local agriculture is affected by structural problems such as land fragmentation, low

mechanization and underdeveloped infrastructure. Access to European funds and the development of organic farming can represent important opportunities for the modernization of agricultural holdings and the diversification of the rural economy.

The results of the work can contribute to identifying sustainable development solutions for agricultural holdings in mountain areas.

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