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THE ROLE OF MEDICINAL PLANT SPECIES IN THE GREEN TRANSFORMATION OF AGRICULTURE: LINKING BIODIVERSITY CONSERVATION WITH ECONOMIC VALUE

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Abstract: The cultivation of endangered medicinal plant species is a key element in the green transformation of agriculture, linking species conservation with sustainable market development. The cultivation of endangered and/or protected medicinal plant species represents an effective conservation strategy, reducing harvesting pressure on wild populations while ensuring the preservation of genetic resources. Their production systems are suitable for low-input and agroecological practices, often requiring minimal chemical inputs and enabling cultivation on marginal or less intensively farmed land. Furthermore, these medicinal plants support climate-resilient agriculture due to their adaptability to specific ecological conditions and their role in crop diversification. The development of sustainable value chains, supported by traceability, certification, and environmentally friendly processing technologies, increases their market value while contributing to Green Agenda objectives, including biodiversity protection, circular economy principles, and rural development. In this context, medicinal plants serve as a strategic bridge between environmental responsibility and economically viable agribusiness models.

Keywords: MAPs, Endangered species, Sustainable agriculture, Plant conservation

INTRODUCTION

The increasing pressure on natural ecosystems from agricultural expansion and intensification, combined with global economic and environmental challenges, has underscored the urgent need for more sustainable agriculture practices that balance productivity with biodiversity conservation and ecosystem preservation (Dajic Stevanovic et al., 2012; Pereira et al, 2025). In this context, the EU Green Deal, particularly its Farm to Fork and Biodiversity Strategies, emphasizes the integration of environmentally responsible practices into agriculture while ensuring economic viability and rural development (Schippmann et al., 2002). Medicinal plant species represent a key component of the green transformation of agriculture, as their cultivation and sustainable use offer opportunities to link species conservation with market-oriented agriculture, ultimately contributing to both biodiversity preservation and economic development (Mofokeng et al., 2022).

Endangered Medicinal Plant Species with High Economic Value

Although the demand for medicinal plant species is increasing, as well as the awareness for their protection, many of them are endangered in their natural habitats, primarily due to habitat loss, overharvesting, and environmental degradation (Schippmann et al., 2002; Stanik et al., 2020; Prijic et al., 2024; Krstic et al., 2024). This highlights the delicate balance between wild harvesting and sustainable use. The European Red List of Medicinal Plants (European Commission & IUCN, European Red List of Medicinal Plants, IUCN 1993; Allen et al., 2014) assessed approximately 400 vascular taxa with documented medicinal uses. Species such as peony (*Paeonia* spp.); saffron (*Crocus* spp.); mountain arnica (*Arnica montana*), a widely used anti-inflammatory herb, is threatened by habitat loss and unsustainable harvesting; gentian (*Gentiana* spp.) long exploited for its bitter roots in digestive remedies and spirits, is reported in several national conservation assessments as being under pressure from overcollection exemplifying this dual role (Barata et al., 2016).

At the same time, these species possess high economic value across multiple sectors, including the pharmaceutical, cosmetic, food, and animal feed industries (Table 1), which makes them attractive candidates for sustainable cultivation and commercial development (Booker et al., 2012; Lubbe and Verpoorte, 2011). Currently, nearly 80% of the world's population relies primarily on plants and plant-derived products for healthcare. Global trade in medicinal and aromatic plants has expanded substantially over recent decades, rising from USD 2.4 billion in 1996 to USD 6.2 billion in 2013, with an average annual growth rate of 5.4% over 18 years and an accelerated growth rate of 10.7% in more recent years. The global herbal medicine market is projected to continue this upward trend, reaching approximately USD 129.7 billion by 2023, with a compound annual growth rate of 5.88% (Parvin et al., 2023).

Table 1. Endangered Medicinal Plant Species, Economic Value, and Possible Uses

Latine name	Common name	Conservation Status	Main Economic Uses	Reference
<i>Arnica montana</i>	Arnica	Endangered	Cosmetics, topical medicine	Melero et al., 2012
<i>Gentiana lutea</i>	Yellow gentian	Endangered	Food bitters, liqueurs, pharma	Pasdaran et al., 2023
<i>Valeriana officinalis</i>	Valerian	Vulnerable	Pharmaceuticals, animal feed	Bączek et al., 2022
<i>Paeonia</i> spp	peony	Protected	Pharmaceuticals, cosmetics	Prijic et al., 2024
<i>Melissa officinalis</i>	Lemon balm	Overharvested	Food, cosmetics, pharma	Gordanić et al., 2025
<i>Primula veris</i>	Cowslip	Protected	Herbal teas, syrups	Yankova-Tsvetkova et al., 2022
<i>Artemisia absinthium</i>	Wormwood	Declining	Repellents, veterinary use	Szopa et al., 2020
<i>Inula helenium</i>	Elecampane	Rare	Veterinary medicine, feed	Kenny et al., 2022
<i>Foeniculum vulgare</i> (wild)	Wild fennel	Protected	Food, animal feed, fungicide	Khaleil et al., 2021
<i>Angelica archangelica</i>	Garden angelica	Rare	Food, cosmetics, pharma	Nautiyal et al., 2006

Impact of Climate Change on the Endangerment and Conservation of Medicinal Plant Species

Climate change, manifested through rising temperatures, changed precipitation regimes, and an increasing frequency of extreme weather events, presents a significant threat to wild plant populations as well as conventional cultivation systems (Shruti et al., 2024). It is increasingly recognized as a critical factor influencing the endangerment and conservation of medicinal plant species by changing their habitat fitness, phenology, and population dynamics. An analysis of more than a century of temperature records from 15 meteorological stations across Serbia reveals a significant rise in minimum winter temperatures, accompanied by the occurrence of extremely warm and dry winters approximately once per decade. (Đorđević, 2008). Notably, during the past decade, such extremes have been recorded three times (2014, 2018, and 2024) (RHSS). Previous studies indicate that rising temperatures drive plant species to migrate to higher altitudes, where survival was previously constrained, and/or to shift northward from their current distributions in the Northern Hemisphere (Glick et al., 2001; Root et al., 2003). These climate-driven shifts pose a particular challenge for plant species with limited seed dispersal capacity and constant habitat loss, as well as species that require a combination of low temperatures for successful germination and/or flowering, such as *Paeonia* spp. (Prijić et al., 2024) and *Crocus* spp. (Krstić et al., 2024). In addition to distributional effects, climate change can modify secondary metabolite profiles (Sun et al., 2023), which are central to medicinal value, and have already been shown to alter phytochemical composition in other medicinal herbs under heat and drought stress (Bistgani et al., 2024).

Under these conditions, conservation through cultivation represents a climate-resilient strategy that reduces pressure on natural populations while supporting sustainable agricultural production. By carefully integrating medicinal plants into diversified cropping systems, it is possible to enhance ecological resilience, optimize soil use, and maintain high economic returns.

These ecological and biochemical impacts underscore the need for climate-adaptive conservation strategies, including *in situ* protection, *ex situ* germplasm banks, sustainable cultivation practices, and dynamic monitoring of phenology and chemical quality, to ensure the persistence and sustainable use of medicinal plant resources in Europe.

CONCLUSION

Balanced food and feed production, along with biodiversity conservation and environmental protection, represent one of the greatest challenges of the modern era. The intensification of agricultural production and climate change both contribute to biodiversity loss and the erosion of the genetic pool of natural resources. Medicinal plants provide a link between biodiversity conservation and economic development within the green transformation of agriculture. Their cultivation and sustainable use support the preservation of genetic resources, enhance agroecosystem resilience, and reduce pressure on wild plant populations. At the same time, medicinal plants offer high market value through pharmaceuticals, nutraceuticals, cosmetics, and functional foods, thereby creating new income opportunities for rural communities. Integrating medicinal plant production into

sustainable agricultural systems, therefore, contributes not only to environmental protection but also to long-term economic viability and social sustainability.

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