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Editorial

Sustainable Management and Governance of Non-Wood Forest Products: Unlocking Their Potential

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1. Introduction

Forests are unique ecosystems that offer a vast array of ecosystem services, including non-wood forest products (NWFPs)—also known as wild forest products—that contribute to the wellbeing of societies worldwide. Non-wood forest products are cross-categorical ecosystem services that have recently received substantial attention from researchers and practitioners. The European Commission in the new EU Forest Strategy to 2030 [1], as well as the European bioeconomy strategy [2], acknowledge the multifunctional role of forests and their services as a source of innovation and resilience. NWFP are used in pharmaceuticals, cosmetics, food, medicines, and various health-promoting and livelihood-supporting products which often have a strong link to local economies and traditional forest management practices. The potential of the NWFPs is remarkable in terms of the valorisation of traditional indigenous knowledge, innovative products, and tools, with high potential for generating benefits. The latter are influential for enhancing their sustainable provision and profitability and to foster the development of favourable market conditions through adapted economic and governance strategies. However, the path to fully realizing the potential of NWFPs is fraught with challenges related to their characterization, management, and marketing, given the diverse forest conditions and socio-cultural environments. Over the past few decades, the forest management philosophy has evolved remarkably to integrate the provision and management of various ecosystem services, including NWFPs, driven by scientific advancements and public demand [3–5]. Several studies highlight the significance of various NWFPs in forest management planning, emphasizing the development of production models for each NWFP and their integration into forest management decision support systems [6,7]. The uniqueness of each NWFP and the complexity of their categorization and inventorying make it challenging to develop a comprehensive framework to accommodate them in forest management planning. Developing a decision support system to integrate NWFPs with other ecosystem services is further complicated by conflicting interests among stakeholders. Additionally, marketing these products in a coordinated and systematic effort to increase their added value to producers presents its own set of challenges. Despite these challenges, the increasing demand and high socio-economic value of various NWFPs in forest ecosystems have spurred scientists to study and address multiple aspects of these valuable products. As we move forward, it is crucial to continue fostering innovation and collaboration among researchers, policymakers, and market actors to unlock the full potential of NWFPs, ensuring their sustainable use and significant contribution to both local and global economies.

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This Special Issue brings together several studies that highlight the diverse potential and challenges of products NWFPs across various regions and contexts, contributing significantly to the state of the art in this field. Key insights include the substantial potential for diversifying the forest bioeconomy through joint wood and NWFP production, where the emphasis of the latter varies with regional specificity, e.g., emphasis on mushrooms and truffles, on understory plants (e.g., bilberries, lavender), on tree products (e.g., cork, pine nuts), and on products of animal origin (e.g., honey, wild boar). The Mediterranean truffle sector was analysed to identify key trends and propose actions to strengthen truffle culture and market recognition. The economic contributions of various wild fruits to rural households in Iran were explored, underscoring the need for policy support and facility upgrades. A framework was proposed to integrate NWFPs into sustainable tourism through territorial marketing models, specifically mycotourism and truffle tourism. Challenges and priority actions for the medicinal and aromatic plants sector in the Mediterranean were identified, with a focus on certification, market development, and process innovation. Sustainable cultivation methods for *Aralia elata* were presented, showcasing optimal stubble and root-cutting treatments to enhance growth and sprouting. Stakeholders' perspectives on specialty mushroom cultivation in Finland were highlighted, revealing significant interest from forest professionals and owners and identifying information gaps as a major barrier. Lastly, a review of honeybee management in Indonesia recommended policy enhancements to support sustainable honey production and environmental sustainability. Collectively, these studies underscore the economic, social, and ecological importance of NWFPs and emphasize the need for integrated management strategies to fully realize their potential.

2. Framework for the Sustainable Management of NWFPs

The fundamental framework for integrating sustainable management and harvesting of NWFPs with other ecosystem services encompasses three major components: a technical, an economic, and a social component.

1. Technical component: This involves characterization and planning, supported by decision support systems. Characterization involves identifying both the existence (rate or amount of coverage) and spatial distribution of each NWFP. This is the most challenging component, requiring a scientific approach to inventory cataloging and potential resources involving both the quantification and mapping of each product. It also includes estimating the per-area yield (production capacity) of each product. It further requires the design of appropriate production systems for each product. After characterizing the current conditions, a method is needed to incorporate NWFPs into the forest-management-planning framework to develop and implement appropriate management strategies. This includes preparing suitable technical and management options for producing NWFPs.
2. Economic component: This focuses on the value assessment of current and potential NWFPs, their potential costs of production, and aspects connected to the marketing of each product based on current and future market conditions. NWFPs significantly contribute to rural economies by generating and diversifying income, creating added value downstream in the value chain, and positively impacting employment opportunities [8]. Despite their often-underestimated value in delivering forest ecosystem services—primarily because only formally marketed NWFPs are considered and non-priced socio-cultural services are ignored—Lovric et al. [9] estimated that the total economic value of collected NWFPs in Europe is approximately 23.3 billion EUR per year, equating to 20.5 EUR per hectare of forest and other wooded lands. Therefore, developing appropriate valuation and marketing strategies is crucial to fully utilize the economic potentialities associated with these products.
3. Social component: This involves the cultural services provided by NWFPs, including recreation and tourism, ecological knowledge, the preservation of collective forest culture, and personal well-being. NWFPs significantly influence transport, food, and

accommodation services [10]. Therefore, integrating and promoting each product within the forest management plan to enhance societal well-being is a vital aspect of the social component.

Sustainable management of NWFPs calls for research approaches that align with a holistic conceptual framework. Addressing the technical, economic, and social components of NWFP management can enhance its contributions to forest ecosystems and rural economies, while also promoting sustainability and cultural values.

3. Case Studies with NWFP Presented in the Special Issue

Based on the general framework outlined above, the number of papers published in this Special Issue is summarized. Huber et al. [11] explored the future potential of 38 NWFPs for diversifying the forest bioeconomy through multi-criteria analysis, including stakeholder interaction and expert involvement. Their study showed that forest owners are willing and can be effectively encouraged to engage in the joint production of wood and NWFPs, as demonstrated by six case studies across different biogeographical zones in Europe. They highlighted the significant potential to enhance the economic viability of rural areas, contribute to the forest bioeconomy, and maintain the ecological integrity of forest ecosystems across Europe by the investment in region-specific combinations of wood and NWFPs. They also highlighted that NWFP-based enterprises offer opportunities for cross-sectoral collaboration, providing valuable insights into new and innovative products and services.

Oliach et al. [12] carried out an in-depth analysis of the truffle sector in the Mediterranean region, focusing on the current situation and future challenges in the main producing countries: Spain, France, Italy, Croatia, and Greece. Using a Delphi process approach with 17 expert panellists from different positions in the supply chain, they provided a comprehensive overview of the current truffle supply chain and identified significant changes in the sector due to the successful cultivation of several tuber species. They highlighted three key trends: a decline in the number of wild truffle collectors selling to small itinerant buyers, an increase in the number of truffle hunters collecting for farmers and specialty wholesalers, and a recent trend in falling truffle prices. In order to overcome these challenges, they proposed as priority actions: (i) strengthening the link between truffles, tourism, and gastronomy, (ii) ramping up efforts at the European level to recognize truffle production, thereby supporting truffle culture and marketing, (iii) increasing consumer awareness and consumption of truffles, and (iv) developing tourism workshops for truffle farmers.

Ghanbari et al. [13] presented a case study to assess the potential contribution of various fruits from 14 woody species as NWFPs to rural household economies in Iran through collection, processing, and marketing. They found that forest fruits contributed an average of 27% to household income. Specifically, sumac contributed an average annual household income of USD 1822 from harvesting and sale, while redberry generated USD 142 per household annually. In terms of processing efficiency, plum, cornelian cherry, and sumac were among the most efficient products. Finally, they highlighted the need for policy support, equipment upgrading, regulatory revisions, and efforts to promote agroforestry systems and increase information sharing, training, and awareness of the value of NWFP in Iranian forest management.

An interesting review by Rovira et al. [14] summarized how NWFPs may help achieve sustainable tourism through territorial marketing models, such as nation- and city-branding tourist destinations, with the aim of improving social and economic development, promoting innovation, and facilitating the conditions for business activation. They suggested that most authors emphasize the growing interest in territorial marketing-process models, which include stakeholder participation and place identity and image, as well as their interaction in rural areas. They proposed a phased framework for the development of a new territorial marketing model (such as, mycotourism and truffle tourism) linked to rural livelihoods, traditional knowledge, local culture, gastronomy, and conservation issues for the effective management and marketing of the NWFP.

Taghouti et al. [15] assessed the current status of the medicinal and aromatic plants (MAPs) sector in the Mediterranean region, identifying key challenges and priority actions for its development. Through a supply chain analysis and interviews with 23 experts from Croatia, France, Greece, Spain, and Tunisia, they conducted a SWOT analysis using the Delphi approach. The study identified key regional challenges, including certification and labelling, quality of life and wellbeing, market and research development, and transformation and processing. To address these challenges and improve the sustainability and profitability of the MAP sector, the authors proposed several strategies related to political, legal, organizational, and institutional frameworks. Key recommendations include (i) collection, processing, and marketing of MAP by leveraging traditional knowledge of rural populations in forest areas and implementing co-management approaches; (ii) promotion of new uses and awareness raising: encouraging innovative uses for MAP and increasing consumer awareness; (iii) process innovation: developing new harvesting methods to reduce costs and improve product quality; and (iv) new marketing approaches: meeting consumer expectations through improved design, packaging, and distribution channels. Improving horizontal cooperation between small producers and better vertical integration for more effective marketing.

The study by Zhang et al. [16] investigated the impact of stubble- and root-cutting methods on the artificial cultivation of *Aralia elata*, a plant with significant medicinal and edible value, to determine sustainable practices for NWFP use and cultivation in northeast China. Over a three-year period, they found that both stubble- and root-pruning treatments were effective in increasing the plant's ability to sprout roots. They identified the optimal methods as short stubble height treatment (6–15 cm) for larger *A. elata* and a 100% root-cutting ratio at 0.25 m for smaller *A. elata*. However, the study noted that the effects of these treatments on the growth and sprouting ability were time-dependent and recommended that treatments be repeated every two years.

Miina et al. [17] investigated the perspectives of different stakeholders on the introduction of specialty wood-decaying mushroom cultivation on stumps alongside timber harvesting in Finland. The stakeholders included forest owners, NWFP-harvesting entrepreneurs, forest professionals, and natural products entrepreneurs. They found that forest professionals (34%) showed the highest interest in mushroom cultivation, often in cooperation with companies that sell cultures or buy mushrooms. Approximately 23% of forest owners also expressed interest, with many willing to cultivate mushrooms themselves or lease their forests for this purpose. Forest owners who had commercialized other non-timber forest products (NTFPs) or were willing to sell licenses to collect NWFPs were more interested in mushroom cultivation than household users. Factors such as part-time forest entrepreneurship, younger age, male gender, and higher education significantly increased the likelihood of forest owners being interested in mushroom cultivation. About 25% of harvesting entrepreneurs were interested in marketing and providing mushroom cultivation services to forest owners during timber harvesting. Speciality mushrooms were already used by 26% of these entrepreneurs, and 40% indicated potential future use. They indicated that a lack of information on cultivation success, yield, costs, and profitability analyses was a major barrier for all actors in the supply chain.

Harianja et al. [18] reviewed the current state of honey-producing bee management in Indonesia, covering cultivation, harvesting, marketing, socio-economic values, and environmental functions. They identified four common bee species in honey production, each with unique characteristics in terms of habitat, production capacity, derivative products, and management practices to meet honey standards and support sustainable livelihoods. Multiple stakeholders, such as beekeepers, honey collectors, intermediaries, and the processing industry are involved in the value chain for bee products such as honey, propolis, pollen, royal jelly, and wax. The study highlighted the significant link between environmental sustainability and economic function, reflecting global trends in favour of a forest-based bioeconomy. The authors recommended policy improvements to foster collaboration among stakeholders and promote sustainable honey production as part of

community-based forestry programmes that contribute to the conservation and sustainable management of agro-forest ecosystems.

4. Discussion and Conclusions

Support for improved forest ecosystem management for multiple functions continues to gain prominence in forest research, and there is a need to design a framework that may help address the characterization and management of NWFP in a holistic manner.

1. A consistent forest management policy framework (i.e., regulations of property, access, and harvesting rights) needs to be developed or re-visited to benefit the full potential of NWFPs that triggers the governance and business development for diversifying bioeconomy.
2. The incorporation of NWFPs, particularly in case of innovative and high-value products, in land-use policy and rural development decision-making can significantly promote ecological integrity, economic viability, and social equity in the involved jurisdiction [11].
3. Considering the challenges posed by the forest-based bioeconomy, climate change, and population growth, the policy framework should leverage the potential of NWFPs to facilitate the transition towards a more renewable resource-based society. This requires adopting a new perspective on NWFPs that aligns with a comprehensive vision of the bioeconomy, including socio-cultural ecosystem services like recreation, gastronomic tourism, education, green health, social inclusion, also through the management and use of NWFPs. There is an opportunity to more-closely connect NWFPs with current trends in organic products and nature-based solutions—such as outdoor activities, nature-based foods and medicines, and social and educational initiatives—to fully harness the social benefits of NWFPs, from recreational services to medicinal resources that enhance human well-being [8].
4. Efficient management of NWFP is crucial in contributing to the livelihoods and food security of communities, especially indigenous people and traditional populations in rural areas.
5. It is important to develop accounting systems that can internalize forest externalities connected with NWFPs management.
6. Recognizing the economic value of the social dimensions or cultural significance of NWFPs is critical for policymakers. This type of understanding is vital not only for adopting efficient and effective property and harvesting right regulations and management practices but also for enhancing forest welfare and ensuring the sustainable supply and maintenance of NWFPs.
7. Despite the potential challenges of implementation, certification and labelling may be necessary as they provide monetary revenues (via the premium price and the reputational values given to NWFP suppliers), social benefits, improving market access and increasing transparency, controlling harvesting rate and methods, therefore helping sustainable management and trade and strengthening and empowering local actors [19].
8. When policy frameworks and economic incentives are carefully crafted, a powerful synergy can be generated, fostering innovation partnerships and the production and marketing of NWFPs. This approach can stimulate innovation, drive new business generation, and promote entrepreneurship.
9. Improving inventory methods and yield models for each NWFP and its encapsulation in decision support systems (DSS) may contribute to the efficiency and the effectiveness of NWFP sustainable management.
10. Considering diverse supply and demand for forest ecosystem services, forest management planning should incorporate multiple uses and objectives, including NWFPs, within a comprehensive DSS. These tools will help the generation of optimal output mix that sustainably fulfil diverse societal needs based on various scenarios, including tailored silvicultural prescriptions.

In conclusion, NWFPs-related knowledge management, including the traditional knowledge associated with awareness creation, training activities, and advanced management tools, are necessary for supporting rural development based on responsible use of forest resources. A scenario and trade-off analysis with an appropriate DSS in coordination with other sectors (e.g., agriculture, health, food, tourism) is vital for addressing the interests of various stakeholder groups. Readers are welcome to contribute to the further exploration and implementation of NWFP-related works to keep supporting rural development and contribute to the well-being of society, as well as greening the planet.

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