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Concept note

# Forestry research: strategic insights for a healthy planet and thriving society

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**ABSTRACT** Research plays a pivotal role in driving methodological and technological advancements and translating them into practical applications, an endeavor especially crucial in an era defined by energy, digital, and demographic transitions. Through an interdisciplinary approach, forestry research should generate knowledge that supports policy-making, stimulates technological innovation, and promotes community engagement. The purpose of this note is to highlight several key aspects within this context. To that end, a commented discussion is provided, with particular emphasis on aspects related to silviculture and forest culture.

**KEYWORDS**: Silviculture, forest culture, methodological advancements, technological innovation, interdisciplinary approach.

From both a conceptual and practical perspective, we believe it is crucial for forestry research to emphasize goals such as those driving the European Forest Institute's developing "Strategy 2040": advancing the understanding of forests through a collaborative and impactful research and knowledge network; providing knowledge-driven support to decision-makers in addressing environmental, economic and social opportunities and challenges; fostering connections between science, expertise and society to deepen dialogue and knowledge about forests. This vision aligns with the forward-looking perspective for a healthy planet and thriving society underpinning the latest "State of the World's Forests" report by FAO (2024). This note aims to highlight several key aspects within this context. Accordingly, a focused commentary is presented, with particular attention to aspects related to silviculture and forest culture.

Research plays a pivotal role in driving methodological and technological advancements and translating them into practical applications, an endeavor especially crucial in an era defined by energy, digital, and demographic transitions. Through an interdisciplinary approach, forestry research should generate knowledge that informs policy decisions, drives technological innovation and fosters community engagement. In this context, we believe that special attention should be paid to silvicultural and cultural aspects, as they are often overlooked despite being essential.

Over the past decades, the scientific progress in forestry has rapidly expanded research topics to numerous emerging fields, such as genomics, biotechnology, meccatronics, geomatics, information technology (including artificial intelligence) and wood engineering. Conversely, silviculture remains relatively underrepresented in scientific literature: less than 10% of articles published worldwide under the "Forestry" subject category in Scopus directly address silvicultural aspects, as indicated by the presence of terms like "silviculture" or "silvicultural" in their titles or abstracts or keywords. Even in this journal, which is specifically dedicated to silviculture, silvicultural practices remain undervalued in relative importance: fewer than 25% of the most cited articles directly address these topics (Corona and Chiavetta 2023).

Moreover, aside from manuals, in recent decades there have been very few monographs that have addressed scientific and technical advancements in silviculture. Among these, we consider the following as fundamental: Ciancio (1997), who introduced the concept of the forest as a complex biological system and proposed a silvicultural theory, systemic silviculture, which takes into account the complex nature of forest ecosystems; Kohm and Franklin (1997), who explored silvicultural practices aimed at creating or maintaining microhabitats in forests, arguing that, in qualitative terms for forest functionality, what is left in the forest (the so-called legacies) is generally more important than what is removed; Messier et al. (2013), who have operationally developed the concept of complexity in the context of various biomes, also through modeling approaches; Palik et al. (2020), who have proposed both silvicultural principles to address current forest management challenges and the practical methods for applying them.

The lack of scientific publications on strictly silvicultural topics has critical consequences. Research should aim to understand how to apply the principles underlying new silvicultural approaches, such as those mentioned in the monographs above, in different environmental and socio-economic contexts. Today, growing awareness of an uncertain future is driving the search for innovative silvicultural management solutions. Acknowledging that the future will differ from both the past and the present underscores the need for flexible management strategies that enhance adaptability. This, in turn, requires fully embracing the experimental nature of silviculture. From a scientific perspective, a key premise is the recognition of forests as complex biological systems that are inher-

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ently adaptive. From this perspective, the management approach should focus on continuously refining operational practices and adapting to change through learning from real-world applications (Nocentini et al. 2017). However, this must not lead to mere empiricism or intuitionism. Ignoring a methodological approach when exploring and interpreting the consequences of different management alternatives raises concerns about relying solely on technical experience, an approach that assumes relatively stable operational conditions over time. Therefore, systematic research and experimentation remain essential. Comprehensive and extensive silvicultural experiments are complex to implement and maintain due to significant cost and time constraints. However, they are essential: there are successful examples (D'Amato et al. 2011, Pretzsch et al. 2019, Corona 2019), but such initiatives likely need greater recognition, particularly in the literature.

Strengthening interdisciplinary collaboration, increasing funding for long-term studies, integrating traditional ecological knowledge with modern science, and ensuring excellent researcher training are key priorities for advancing forestry research. At the same time, a deep-rooted forestry culture is essential, one that is, above all, grounded in historical knowledge of how forestry thought has evolved (e.g., Nocentini et al. 2021). A lack of historical perspective often hinders the effective dissemination and practical application of forestry research findings, even when innovative solutions are available.

Understanding the theories behind past research developments and their evolution helps place current studies within an appropriate conceptual framework (Nocentini 2024). Indeed, for meaningful progress, data collected using increasingly sophisticated tools and techniques must be integrated into a coherent theoretical structure: as Deléage (2000) pointed out, making observations and gathering data, no matter how refined, without the guidance of a theory amounts to little more than "scientific philately".

Therefore, grasping the conceptual paths and theories that have shaped the history and present of forest sciences is crucial. This foundation enables researchers and practitioners to continuously redefine and revitalize their commitment, drawing on new ideas and motivations to keep pace with the rapid changes in the global landscape. Behind every fact, there are ideas, and ideas are among the primary driving forces of both history and science.

Ultimately, establishing strong scientific and cultural foundations for new silvicultural approaches will not only aid in restoring ecological complexity to forest systems, many of which have been shaped by centuries of timber-oriented management, but will also provide contemporary foresters with renewed dignity and purpose as they navigate the increasing environmental awareness of 21st-century society.

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