New analysis shows that tree diversity builds climate resilience and boosts economic return

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24 April 2025 -- In the face of mounting threats from climate change, mixed species forests have been called an 'insurance policy' for UK forestry in a new literature review supported by DEFRA and Teagasc.

Looking beyond a traditional monoculture approach to forestry, the paper – published in the Quarterly Journal of Forestry – shows that greater species diversity in productive forests can address multiple crises, from climate change and biodiversity loss, to housing and domestic timber shortages.

The authors, Andrew Leslie of Forest Research and Ian Short of Teagasc, suggest that mixed species forest stands (consisting of broadleaves or broadleaves with conifers) can increase resilience to extreme weather, benefit wildlife, reduce damage from pests and diseases, increase productivity and improve the financial returns from broadleaved trees.

As broadleaved trees, also known as hardwoods, occupy the majority of British woodlands, these findings are of particular importance, not just for addressing climate change and biodiversity decline, but also meeting sustainable housing targets laid out in the government's new Timber in Construction Roadmap.

This strategy aims to address the housing and climate crises through greater adoption of sustainable building materials while strengthening the UK's domestic timber market and meeting construction targets.

Comparing the average production volume of hardwood sawlogs against France and Germany demonstrates how far the UK is lagging behind its European counterparts. According to data presented in the paper, the UK produces approximately six times less hardwood sawlogs per hectare annually than France and fifteen times less than Germany.

“Considering the mounting pressures on our forests from escalating pest and disease outbreaks and the accelerating impacts of climate change, the timing of this review is critical," said co-author Dr Ian Short, Silviculture Senior Research Officer with Teagasc, the Irish Agriculture and Food Development Authority. "We recognised that while mixed species stands, especially those with broadleaves, constitute a significant portion of the forest area in Great Britain, there's a noticeable scarcity of formal research specifically investigating their potential for timber production.

Co-author Andrew Leslie, Head of Silviculture and Wood Properties at Forest Research, added: “The potential for increased timber productivity in these diverse forest stands can contribute to a greater supply of domestically grown wood, potentially supporting the construction sector’s growing demand for timber. The increased resilience of mixed stands to climate impacts, coupled with potentially higher overall biomass production, can also play a role in climate change mitigation through carbon sequestration. Additionally, the species diversity inherent in these stands supports a more complex ecosystem, which is vital for enhancing biodiversity."

Building resilience through diversity

The review describes how different tree species respond differently to physical stresses such as storms, drought and extreme temperatures.

Research compiled in the paper shows that species like sycamore and lime (diffuse porous species) respond differently to drought than species such as oak and ash (ring porous). This diversity in response means that when one species struggles, others may continue to thrive.

In upland areas, where growing conditions are more challenging, mixed stands have demonstrated particular benefits. Evidence from trials in the North York Moors showed improved growth of broadleaves when mixed with conifers like Scots pine and Japanese larch, while studies at Gisburn forest showed that sessile oak performed better with Scots pine and alder than in monoculture.

The literature review also points to soil health improvements through strategic mixing. Incorporating nitrogen-fixing trees like alder, for example, can enhance overall growth, particularly in nitrogen-poor soils.

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Economic advantages of mixed stands

Mixed stands aren't just a benefit for the conservation of woods and wildlife, they also have the potential to increase yield if managed well, addressing the gap in UK hardwood production.

Growing oak with species that create a dense understorey canopy can inhibit epicormic growth and improve stem form. This practice is already common in Germany where beech, lime or hornbeam are planted with sessile oak to achieve quality stems managed on long rotations.

The paper also discusses "overyielding," where mixed stands produce more volume than monocultures of the same species. Analysis across multiple experiments in Europe showed that mixing beech and oak can increase productivity by approximately 30% compared to monocultures, particularly on poorer quality sites.

Financial returns can be further enhanced by combining species with different rotation lengths, allowing for earlier revenue from fast-growing species like Scots pine, while maintaining the longer-term value of slow-growing species like oak.

Protection against pests and diseases

Threats from pests and diseases are intensifying with a changing climate. Statistics released by Forest Research show there were 2350 tree pests and diseases reported via the TreeAlert service between April 2023 and March 2024. The tragic impact of ash dieback on monoculture ash stands across Britain highlights the vulnerability of single-species forests.

In light of this, the authors describe mixed species stands as an 'insurance policy' against potentially devastating pest or pathogen incidents.

The paper explains that mixing tree species may reduce the "apparency" of host trees to pests and pathogens and decrease the transfer of these damaging agents between trees of the same species. Research from France cited in the review showed that decreasing the proportion of pedunculate oak in mixed species stands reduced damage by leaf miners.

Looking ahead: preventing a 'catastrophic' collapse

The review concludes that while there is convincing evidence for the benefits of mixed species forest stands, more research is needed to understand the specific impacts of different species combinations.

As recent climate-related events demonstrate the vulnerability of monoculture stands to extreme weather, this research has never been more timely. A 50-year horizon scan carried out by Forestry England and the University of Cambridge last year identified 'catastrophic forest ecosystem collapse' caused by interrelated extreme weather events as the most highly ranked issue facing the forestry sector.

Dr Short added: "We chose to undertake this review to consolidate the existing body of knowledge, drawing from available literature and the practical experiences of forest managers and landowners. This synthesis is vital to better understand the silviculture of these mixtures and to highlight their potential importance in a rapidly changing environment, particularly as we strive to improve the productivity of our broadleaved woodlands.

The literature review was supported by DEFRA core funding under the 'Silvicultural Systems' project and Teagasc under the 'RForestS – Diversifying broadleaf stand structures to promote resilience project'.

Read the full paper: (2025) Mixed species broadleaved and broadleaved/conifer stands in Great Britain for timber production. Quarterly Journal of Forestry, 119(2): 82-88.

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