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CLIMATE CHANGE AND CARBON SEQUESTRATION (O CAMPOE, SECTION EDITOR)

Stakeholders' Perspectives of Species Diversity in Tree Plantations: a Global Review

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Abstract

Purpose of Review Increasing the diversity of commercial tree plantations is a promising approach to adapt forests to climate change, but it may complicate management. Here, we evaluate stakeholders' perspectives about tree-species diversity in plantations and explore policy alternatives to make mixed plantations a viable strategy for climate change mitigation and adaptation.

Recent Findings Current evidence shows that improving the diversity of tree species in plantations can be a viable, scalable, and economically accessible strategy for sustainable wood production and reconciling economic and environmental benefits. Tree diversity is particularly important in the context of global environmental changes and associated increases in abiotic and biotic stresses, such as severe droughts and pest outbreaks. Even though there is substantial scientific evidence supporting mixed-tree plantations, most forest plantations globally are still conventional monocultures.

Summary Our findings (i) describe the geographical distribution of publications investigating human perspectives about forest plantation diversity; (ii) build understanding of how political engagement and governance systems can support forest initiatives on forest conservation, management, and restoration; and (iii) demonstrate how these perspectives can create possibilities and opportunities for sustainable development in forestry. We conclude that new strategies will only be widely applied if there is political and institutional interest, particularly in strengthening land-governance systems.

Keywords Forestry · Mixed tree plantations · Biodiversity · Climate change

Introduction

Tree planting has become a cornerstone nature-based solution to sequester carbon, attracting increased attention and investments worldwide [1, 2]. The World Resource Institute suggests that about 2 billion hectares offer opportunities for forest restoration or afforestation interventions across the globe [3], much of which is found in tropical regions [4–6], where opportunities to sequester carbon in forest biomass are greatest [6]. In response to this emerging demand, more than 60 nations made pledges to restore over 200 million hectares of deforested and degraded landscapes as part of the Bonn Challenge [7]. Accordingly, in 2021, the United Nations launched the Decade on Ecosystem Restoration [8]. However, recent studies have suggested that implementing these commitments may be unfeasible [9], and others have criticized the predominance of monoculture tree plantations in forest landscape restoration programs [10]. Companies and farmers usually prefer tree monocultures for their ease of management and rapid wood production. Yet single-species plantations have limited co-benefits for biodiversity and ecosystem services compared to mixed plantations [11, 12]. Thus, an essential concern of implementing the global forest landscape restoration agenda is to ensure that restored areas become multifunctional and resilient forests.

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In recent decades, tree monocultures have been an important safeguard of the wood and other raw material supply, providing fast and significant financial returns to landowners [13–15]. In some legal and economic contexts, they also reduce pressure on native forests [16]. However, because dense monoculture tree plantations are historically designed to maximize wood production to supply the demand of the increased global trade, they usually have little multifunctionality or resilience to disturbances [17]. This makes forest monocultures vulnerable to global changes and associated increases in abiotic and biotic stresses such as severe droughts and pest outbreaks [17, 18]. Tree monocultures frequently lead to declining soil fertility and productivity, damaged hydrological cycles, biological invasions, increased catastrophic fire risks [19], and various social problems [20]. In contrast, strategically placed monocultures in landscapes might also provide environmental benefits. For example, fast-growing densely planted trees can reduce nutrient leaching to watercourses while simultaneously producing woody biomass [21].

Mixed tree plantations simultaneously grow two or more tree species on the same land for commercial or protective purposes, which may result in more complex forest structure and functioning than monocultures [22, 23]. A growing body of evidence suggests that mixed tree plantations are more resilient to many types of disturbances, making tree diversity a central element in adapting forests to climate change [17, 24, 25]. Mixed tree plantations can have greater carbon sequestration and productivity than monocultures [26] due to asynchrony of tree species dynamics [27, 28], primarily related to deciduousness and light interception. A large variety of species increases functional diversity, so mixed plantations tend to better explore and use available resources in space and time (nutrients, light) and better cope with stresses related to climate change and pests [24, 29]. However, the resulting multifunctionality and ecosystem services strongly depend on which species or varieties are planted in the mixture [30, 31], as well on their management.

Mixed plantations, designed according to scientific and technical knowledge, represent an opportunity for climate change mitigation and adaptation [22, 23, 32–35]. However, diversifying current forestry operations may upend well-consolidated practices, from seedling production to timber harvesting, increasing the system's heterogeneity and management complexity. Indeed, despite the robust ecological evidence in favor of mixed plantations, monocultures still dominate the forestry sector worldwide [11, 36, 37]. Therefore, potential stakeholders resistance to new practices must be addressed by decision makers when promoting species mixtures [38].

In this context, we must better understand stakeholders' multiple, and sometimes contrasting, perspectives about mixed plantations, while clarifying potential questions and addressing emerging concerns or tradeoffs. Rather than pre-adopting a conceptual definition, we consider "perspectives" to encompass all information researchers obtain about someone's opinion or experience on the subject discussed. A recent study [35] of forest managers analyzed the main challenges of mixed tree plantations and identified the key knowledge gaps in 22 European countries. It found that the current scientific knowledge about the plantations management and the associated costs is still little disseminated among people related to practice mixed forests.

A study of Finnish forest owners' willingness to take measures safeguarding biodiversity in plantations highlights the importance of understanding the drivers of stakeholders' choices of monocultures vs. mixed plantations [39]. Forest owners were more often willing to implement measures that had less impact on property rights, and the conclusions suggest the need for flexible voluntary conservation programs [39]. The authors showed that information was essential, as people uninterested in conservation initiatives usually have less knowledge of the options available.

To maximize the applicability and visibility of mixed forests to forest managers worldwide, it is vital to understand perspectives on the diversity of plantation species held by forest stakeholders. Our goal was to understand how stakeholder perspectives about species diversity can contribute to better policies to foster and enable mixed plantations that are appropriate to mitigate and adapt to climate change. To achieve this, we (i) reviewed the existing literature on stakeholders' perspectives about species diversity in forest plantations and (ii) synthesized information from these studies on how to promote more diverse plantations.

Methods

We searched Web of Science for papers about stakeholders' perspectives on tree species diversity. Selected articles must contain at least one keyword from each of the following groups: (a) "perception" or "perspective"; (b) "community," "citizen," or "stakeholder"; (c) "forest," "forestry," "tree," or "plantation"; and (d) "diversity," "mixed," or "monoculture." We focused on keywords associated with methods like questionnaires and interviews. Our survey addressed English-language primary literature published between 2000 and 2021. We considered articles from the last 20 years because this subject is relatively new and few relevant publications predate this period. This search returned 345 articles. All their abstracts were read to determine if they addressed (a) a human perception or perspective and (b) forestry at any level of species diversity. Studies not fulfilling these criteria were excluded. All types of stakeholders were considered, which we categorized as rural communities, citizens and tourists, academics, and managers of either companies or

forest properties. By rural communities, we mean any group of people that develops and lives in the countryside, far from urban centers. We also considered all levels of tree diversity and specific topics associated with this key research. Topics here are the different themes highlighted and explored in the papers in which respondents' perspectives were reported, as ecosystem services, policy and science gaps, and main challenges.

We were interested in people's perspectives, so we included all papers that used questionnaires and/or interviews. These criteria resulted in a final sample of 15 articles, and some of these articles present samples from different countries and categories of stakeholders, which were categorized by respondent type (i.e., rural communities, citizens, forest managers, and academics), plantation type and tree diversity level (monocultures, mixed plantations, and mixed forests), method (questionnaires, interviews or both), number of respondents (numeric), main topic addressed, study conclusions, and other important features.

By organizing into three main categories, we could explore their unique aspects and address their recommendations more accurately. Here, we consider mixed forests as those derived from naturally dispersed seeds or sprouting, while mixed plantations are composed of trees planted by humans for forest restoration, afforestation, biodiversity conservation, or commercial production of wood and other products [40].

Social–Ecological Distribution of Studies

The selected articles reported responses from 6905 people across the globe, of whom 53% were from rural communities ($n = 3637$ respondents), 34% were citizens ($n = 2374$ respondents), 12% forest managers (landowners, forestry company workers, public sector employees, NGOs; $n = 854$ respondents), and 1% academics ($n = 40$ respondents; Fig. 1). Studies on mixed-species forests and plantations (with productive or protective intentions) represented 66% of the articles evaluated, while monocultures totaled 33% of the sample (Fig. 2A). Forty-six percent of the evaluated articles applied interviews with the respondents, 40% applied questionnaires/survey, and 13% used both methods (Fig. 2B).

This review included samples from 44 countries (Fig. 1) on five continents (Africa, America, Asia, Europe, and Oceania; Fig. 1). The cases were predominantly in tropical latitudes (52%), followed by temperate (28%), and subtropical (20%). This distribution reflects forest plantation effort predominance in tropical countries possibly because many retain a considerable portion of their native forest, and these usually have high species diversity. Perhaps surprisingly, our sample found no studies dealing specifically with stakeholder perspectives from the USA or Canada, in spite of their strong forestry sectors and high publication rates [41]. Additionally, we did not find studies from the Russian Federation, despite it is holding a large proportion of the world's forests. These findings may be related to a low regional interest in plantation diversification [42] or in studying the human perspectives on those practices. The representation of African countries was also small, with only two papers. Again, this contrasts with Food and Agriculture Organization estimates that 16% of the world's forested area is in Africa [43]. African countries also have high potential for carbon sequestration [44] but require investments in improved agronomic management [45]. The implementation of these opportunities depends on the governance of the forestry industry, under development in many locations [46].

Fig. 1 The locations where reviewed publications' samples (interviews and questionnaires) took place. The points sizes are proportional to the number of respondents, and their colors indicate the stakeholder type

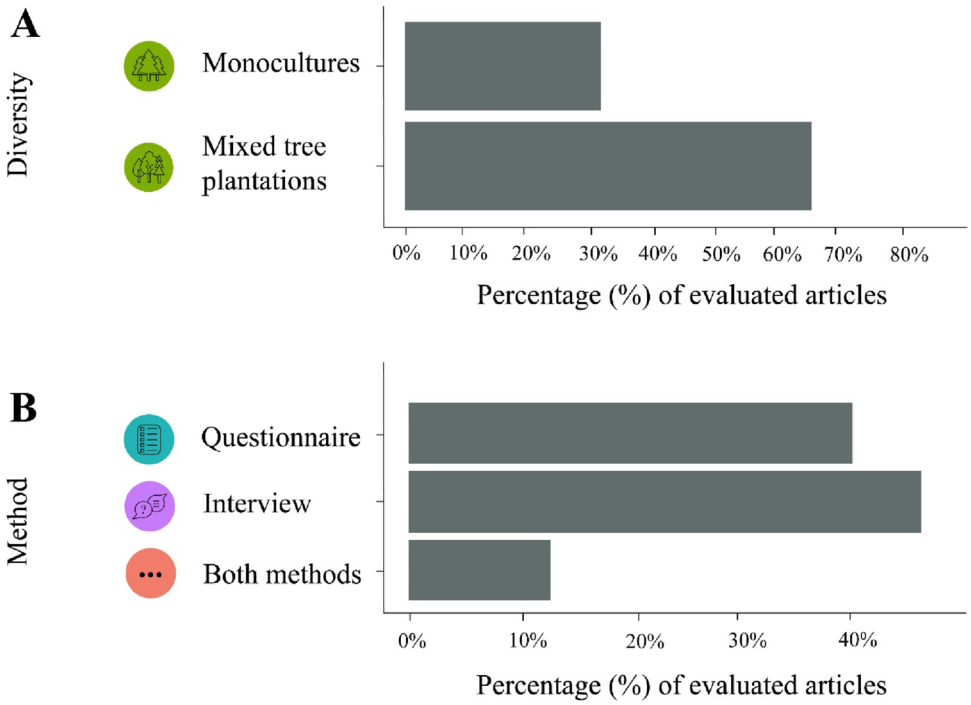

Fig. 2 Frequency of cases in the systematic review by **A** tree diversity and **B** data-collection method

Almost half of the studies in this review are from Europe, which may indicate that social perspectives are considered relevant by researchers there. Another reason may be the economic contribution of planted forests on the continent, although European Union holds only 5% of the world's forests (159 million ha) [47], it contributes to most of the world's wood production. In addition, European forest area has been growing in recent decades, but the opposite happens in other continents where tree cover loss still prevails (Table 1) [48].

Perceptions of Ecosystem Services from Mixed Versus Monoculture Plantations

When rural inhabitants were asked about the ecosystem services provided by mixed forests, only positive feedback was obtained [59]; people who recognized and were aware of the importance of forest ecosystem services and forest conservation were more likely to prefer mixed forests. Moreover, one study [59] noted that personal attitudes toward ecosystem services were more consistently related to the degree of preference for mixed forests than other socio-economic variables investigated, such as gender and education. Forest managers had a higher probability of preferring mixed forests, compared to monocultures, especially when considering two ecosystem services: carbon sequestration and biodiversity conservation. In contrast, urban citizens manifested a lower preference for mixed forests [59].

A recent study on rural communities' perceptions about *Eucalyptus* monocultures also found a negative view. Even though monoculture plantations have brought positive economic returns to local development, they were associated with negative environmental impacts [49]. In the same study, farmers reported a need to change their agricultural practices based on monocultures because the environmental conditions (especially water and soil) were no longer favorable after the massive *Eucalyptus* plantations in the nearby areas. A study of community perceptions about tree plantations in Australia [55] found that monoculture plantations tended to be perceived as an unacceptable risk by rural respondents, while forestry represented risks and benefits for participants who attributed meaning focused on production. This reflects a clear division in stakeholders' perspectives on the importance of tree diversity to the provision of ecosystem services. Understanding how rural communities perceive the tree diversity around multi-use landscapes is essential when these people are affected by the lack of some ecosystem services [60].

Policy and Science Gaps Around Mixed Species Plantations

We identified a consensus in the reviewed articles that sustainable forest management needs more political engagement to be effective for mixed tree plantations, whether for restoration and protective actions, or for timber production. Governance systems were considered the best way to connect the gap between scientific knowledge and decision making in forestry in tropical regions [53]. Collective action and effective communication are also necessary to seize opportunities for large-scale growth and sustainable development.

Table 1 Synthesis of reviewed papers

Reference/country	Stakeholders	Method	Conclusion
[49] China	Rural communities	Interview	Based on the responses, 57% felt that the overall situation got worse after the establishment of industrial *Eucalyptus* industrial plantations. (The study area was previously covered by other types of non-industrial plantations)
[50] Scotland	Forest managers	Interview	For a resilient forest economy, the article argues it is necessary to foster knowledge and innovation in forest management through "species and silvicultural diversity," "intelligent forest design," and "multi-rotation and age structure"
[51] Belgium	Citizens	Online questionnaire	People prefer landscape diversity, high biodiversity and good site accessibility. Their results suggest that respondents are positive about nature restoration projects that involve forest conversion
[52] India	Rural communities	Interview	Government policy aimed at fast profit through monocultures and restricting harvesting of forest resources can dismantle long-standing agricultural traditions that play a role in managing and protecting the ecological integrity of tropical forests. Among farmers, 96.5% believe that conservation is only possible if forests remain under their management
[53] Cambodia	Rural communities and forest managers	Interviews, group discussions and exploratory walks	This article discussed the development of large-scale reforestation concessions, where natural forests were cut down, and replaced by a managed monoculture. This has driven the expropriation of local land users and environmental concerns such as forest degradation, associated with land grabbing
[54] 17 countries in Latin America	Forest managers	Interview and questionnaire	Different stakeholder perceptions and the existence of intersectoral conflicts show the importance of efforts to improve governance mechanisms and policy integration
[55] Australia	Rural communities	Interview	Large-scale forest plantations were viewed as compromising the scenic quality of the landscape, and ecologically negative, mainly concerning soil and water
[56] 23 countries in South and Central America, Asia, and Africa	Forest managers	Interview	Successful forest restoration projects negotiate trade-offs between forest actions and stakeholders. There are promising strategies related to the development of tangible economic returns for local actors engaged in productive restoration projects

Table 1 (continued)

Reference/country	Stakeholders	Method	Conclusion
[57] Australia	Rural communities	Interview/postal questionnaire	According to the interviewees, soil changes due to extensive monoculture plantations appeared to be more consistently associated with negative socioeconomic impacts on employment and population
[58] Ghana	Rural communities	Interview	Even considering only agroecological zones (high diverse plantations), rural communities in Ghana suffer greatly from the vulnerability and consequences of climate change and must be assisted. Relevant stakeholders can implement policies that help them to adapt to natural disasters and climate variability. These policy measures must achieve the SDGs
[59] Poland	Citizens and forest managers	Postal questionnaire	This article found that stakeholders who value biodiversity, landscape and carbon sequestration tend to prefer mixed forests over monocultures, especially public administrators, and forest managers
[40] UK	Forest managers	Online questionnaire	31% prefer planting a mixture of native trees to control tree diseases
[60] Borneo	Rural communities	Questionnaire	It is very important to understand rural communities' perceptions in dynamic and multi-use landscapes, specially because they often are directly affected by the decline in ecosystem services
[61] Belgium	Forest managers and academics	Questionnaire	The study found that practitioners and scientists had positive perceptions of ecosystem services in mixed plantations in Belgium, different from what had been reported in the literature
[35] 22 countries in Europe	Forest managers	Questionnaire	The main knowledge gaps about mixed plantations are the identification of tradeoffs behind the stability effects and service provision of mixtures and the understanding of space–time scales in which the effects of mixed plantations operate regarding resistance and adaptability to climate change

For example, a study [35] conducted in Europe analyzed the management of mixed forests and the role of species mixtures on the stability of forests in terms of resilience to environmental changes and providing ecosystem services to society. The authors concluded that current scientific knowledge about these questions is not enough to understand the management of mixed forests over time and its associated costs. Most research projects have sought to evaluate whether mixed forests are more stable or if they provide more goods and services than monocultures. Instead, information on the underlying mechanisms and tradeoffs behind these effects is still incomplete. Another study [50] suggests that future forest management should foster knowledge and innovation through "species and silvicultural diversity," "intelligent forest design," and "multi-rotation and age structure."

A lack of knowledge on spatial–temporal scales hinders the operationalization of forest-management techniques. Thus, it follows that more studies on management are needed, especially considering that mixtures are often more

complex than monocultures, which makes planting and management more complicated, sometimes needing more operational interventions [62] dependent on specialized knowledge. Although studies demonstrate the benefits of mixed plantings, most of them are still established at an experimental scale [63], and often use only manual procedures.

On the other hand, forestry operations deployed on thousands of hectares commonly use monocultures because they depend heavily on machinery, perform standardized silviculture and harvesting operations, and process uniform products preferred by industry. These activities are still designed for homogeneous forest stands [64]. Connecting the gaps between scales and operational procedures is a central issue to be considered to foster mixed plantations. Still, it is important to emphasize that land policies involving the establishment of extensive monoculture plantations can dismantle long-standing agricultural traditions that manage and protect the ecological integrity of tropical forests [52]. Management should not promote land-use practices that convert natural forests into wood-based monoculture plantations but should rehabilitate degraded lands through heterogeneous plantations to meet the needs of underserved rural communities. To sustain production levels, dialog between rural communities and governments must take place in decision making processes [52].

Challenges Associated with Implementation of Mixed Species Plantations

Forest restoration can be carried out through different methods, including the mixed planting of trees (combined with other actions). This is currently a popular strategy with potential to mitigate climate change if widely disseminated. Even so, some studies suggest it must be better studied to properly incorporate the ecological and social consequences of these actions. For instance, a study [53] found three problematic assumptions commonly associated with using forest plantations to mitigate climate change. First is the idea that shifting cultivators (people who make temporary use of land) generally cause deforestation which is based on a history of misunderstandings rather than facts. Second, it is when people define priority areas for restoration and reforestation actions without involving local land users in knowledge production. The final problem is focusing narrowly on technical definitions of "forest" while overlooking what local residents rely on them for [65]. The study also found that contrasting perceptions and the prevalence of cross-sectoral conflicts highlight the importance of efforts to improve governance mechanisms and regional policy integration.

According to another study [56], stakeholders' perceptions of key challenges for effective forest restoration projects are easy to understand from a landscape view. They showed that context dependence was evident in local norms of natural resource governance, although few projects appeared to be designed by local people. The main economic challenges for implementing these types of forest restoration projects were the short duration and availability of funding, high implementation costs, and poor short-term returns. To overcome these challenges, promising strategies were to increase the economic income of actors engaged in productive restoration projects [56], for instance, by (i) interconnecting native species' planting with viable commercial crops; (ii) sustainable exploitation of non-timber forest products; and (iii) planting commercial fast-growing timber species in rows intercropped with non-commercial native tree species to speed up canopy closure and offset implementation costs [6].

Another study conducted in Belgium [51] suggests that citizens are positive about nature restoration, even if it is necessary to convert forest plantations into conservation areas, depending on the characteristics of the area to be converted. The study showed that small conversions (about 50 ha) were more accepted and that interviewees valued more diverse forest structures. Finally, it is essential to emphasize the importance of establishing trees rather than just "planting" them [66]. There are many recent examples of tree planting and restoration-oriented initiatives that have failed [53]. One argued reason is projects' focus on the number of planted trees, whereas they often neglect the attention needed for the growth and maintenance of seedlings, the diversity of planted trees, and the social impacts of initiatives [67].

Sustainable Development in the Forestry Sector

In all evaluated studies, four points stood out: (i) the importance of preserving existing forests; (ii) the economic importance of forest resources for people; (iii) the challenge of climate change that will likely impact people's lives and several sectors of the world economy; and (iv) other long-term and global challenges such as rising sea levels, rising average temperatures, and climate effects on energy production [68].

Several initiatives and international events were created so that stakeholders, policymakers, researchers, and governments could discuss and find solutions to mitigate the effects of climate change globally. The concept of sustainable development and the creation of the Sustainable Development Goals (SDGs) by the United Nations [69] are attempts to align countries' economic growth with natural resource sustainability. Planting mixed species for timber production or to restore degraded areas is a promising way to align the forestry sector with the SDGs.

SDGs 3, 8, 9, 12, and 13 were the most prominent in the reviewed scientific articles [69]. SDG 3, which states that "ensuring a healthy life and promoting well-being for all, at

all ages," have seen in the positive perspectives of people about ecosystem services generated by forests with higher species diversity. SDG 8, ("to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all"), SDG 9 ("to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation"), and SDG 12 ("to ensure sustainable production and consumption patterns") were seen through the productive potential of mixed plantations for commercial purposes, in having ecological characteristics more similar to the natural forests, and more sustainable and efficient forest management. Given the carbon sequestration potential of planted forests, especially from forest restoration projects, using mixed plantations can be aligned with SDG 13 (i.e., "Take urgent action to combat climate change and its impacts") and 15 ("Protect, restore and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt the loss of biodiversity"). The importance attributed to restoration has been growing since the United Nations proclaimed 2021–2030 as the Decade on Ecosystem Restoration. There are many potential benefits of ecosystem processes at multiple scales when efficient techniques for restoring forests are used. Ecological restoration can provide key ecosystem services, such as carbon storage, soil erosion control, and water provisioning [11, 70, 71].

Conclusion

Our review shows that many strategies are available to foster sustainable practices in the forestry sector using mixed tree plantations. This may be achieved through operational and educational actions, promoting training on technical knowledge of planting in regions suitable for these activities. Broad-scale activities with national or international impact for the recovery of habitats and planting to protect fragile areas and prioritize areas for conservation and restoration may be useful. Yet these strategies and visions will only be widely disseminated, applied, and productive if there is political will and organizational interest. These outcomes might be strengthened by governance systems in the forestry sector that connect the gap between policymakers, stakeholders, academic institutions, and science and technology researchers.

The adoption of mixed-tree planting is a challenge for companies and wood producers, who find it difficult to increase systems' diversity due to many operational challenges, such as (i) the difficulty of producing or buying seeds and seedlings; (ii) coordinating fertilization, pest control, and variable rotation times of different species in the same plot; and (iii) the lack of genetic control and plant breeding for species with potential but low commercial use. Regarding economic barriers, there is a fear of decreased productivity/revenues, and initiatives fail to keep up with market demands and trends. In terms of decision making, stakeholders consider it hard to modify already-established long-term practices for plantation establishment, management, and harvest, on top of the general lack of technical knowledge or poor knowledge transfer about mixed-species stands.

Despite these barriers, we observed that studies report that forest managers tend to value plantations with greater biodiversity, as they are concerned about the effects of climate change on plantations' performance [72, 73]. We found that most people value tree-species diversity. This may be due to most interviewees in the reviewed studies living in rural communities, and therefore benefiting from ecosystem services provided by more diverse forests. Also, researchers (who tend to value the diversity of species and are aware of the scientific basis for adopting it) and people engaged in forest-restoration practices (who have experienced the benefits of increasing species diversity) tend to value tree species diversity. In contrast, citizens tend to appreciate the benefits of ecosystem services that forest restoration and conservation can offer, but they do not perceive many alternative impacts arising from different arrangements of plantations for commercial purposes.

Our results discover examples of strategies that may promote increased diversity in forest plantations by creating policies and collaborative actions to raise awareness of climate. First, plantations' objectives should be classified by the level of diversity they would support to make them operationally and economically viable. The classification scheme for tropical and subtropical areas could be (i) plantations for biodiversity conservation — where it is possible to implement a multi-species approach — based on the principles of forest restoration; (ii) plantations for high-quality wood production — in this case, we recommend combining at least two (ideally three) species; and (iii) plantations for low-quality wood production and for pulp production (especially for industry). This latter case only makes sense when transitioning to mixed plantations very difficult due to high costs, and we therefore suggest a gradual change, which will consider the mixture of clones, until future research advances allow higher levels of diversity.

To promote increased diversity of forests in temperate and boreal regions, we suggest developing (i) management schemes for forests involving tree species with different rotation times and (ii) technologies to produce products from different tree species. Increased revenues from sales of wood

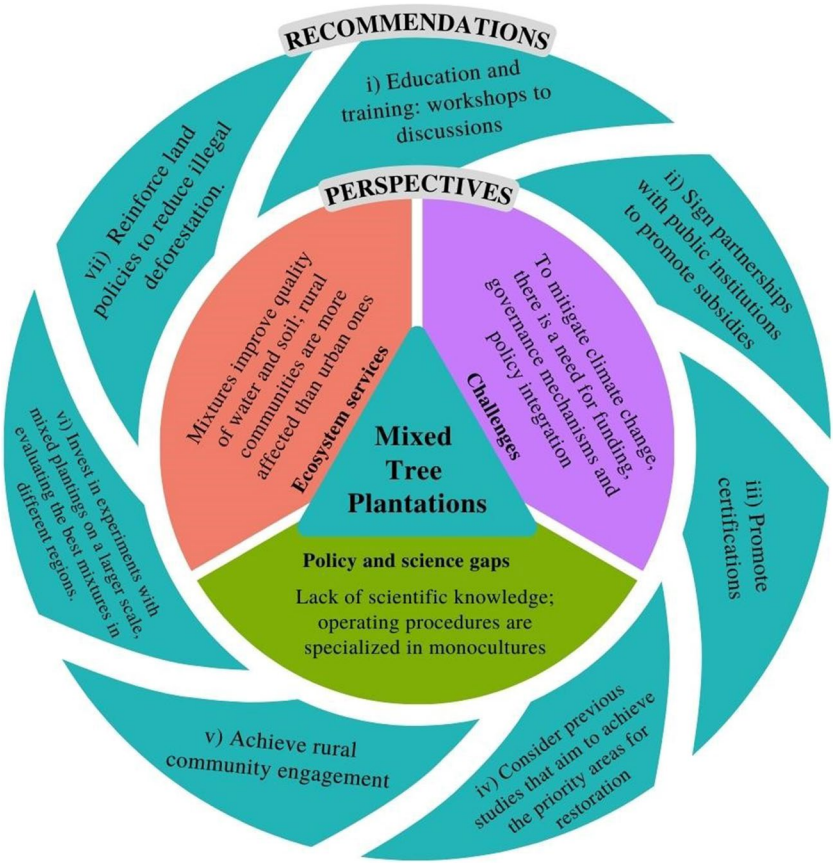

Fig. 3 Synthesis of the main stakeholders' perspectives about ecosystem services, policy and science gaps, main challenges, and seven recommendations for promoting mixed-tree plantations at a broader scale

from different tree species would increase the landowners' motivation to manage their forests as multi-species stands.

Regarding forest management, we encourage forums and workshops among researchers, companies, and landowners for discussions, sharing results, education, and training about carbon storage and sequestration in forestry, and technical issues to get satisfactory results in the field. Knowledge transfer is important, especially when promoting mixed-tree plantations that have more complex design and management than monocultures (Fig. 3). These activities should be aligned according to the three planting objectives mentioned above. We also recommend engaging with public environmental organizations to devise strategies that may assist and subsidize the costs of rural producers in transitioning to more diverse plantations. This will likely advance a more sustainable forestry sector, better aligned with the global environmental agenda. Furthermore, it can be a good strategy to establish partnerships with private organizations to promote official certifications for companies and owners who are committed to increasing the diversity of tree species in their plantations.

We also suggest (i) considering previous studies to discover the priority areas for forest restoration; (ii) incorporating information from studies that evaluate rural people's opinions, views, and expectations (e.g., job opportunities) when deciding what restoration projects can do to enhance stakeholder engagement; (iii) implementing the highest number of native species in new plantations to reach a resilient ecosystem and high functional diversity; (iv) focusing on growing trees than just planting; and (v) enhancing policymakers' ability to consider land conversion to plantations as a way to reduce poverty and reverse illegal deforestation.

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Data Availability Not applicable.

Declarations

Conflict of Interest Dr. Pedro H. S. Brancalion is a co-founder of the company Re.green and a member of its scientific advisory board, and has received research funding from *Eucalyptus*-production companies to develop cost-effective approaches to restore tropical forests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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