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SYSTEMATIC REVIEW OF SUSTAINABLE FOREST MANAGEMENT: INTEGRATING COMMUNITY FORESTRY AND AGROFORESTRY APPROACHES

SISTEMATIČNI PREGLED TRAJNOSTNEGA GOSPODARJENJA Z GOZDOVI: INTEGRACIJA SKUPNOSTNEGA GOZDARSTVA IN PRISTOPOV KMETIJSKO-GOZDARSKIH SISTEMOV

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ABSTRACT

This systematic review addresses the need for integrating social, ecological, and economic dimensions into sustainable forest management to enhance resilience and sustainability. Existing research reveals a gap in understanding community involvement and governance effectiveness. The review synthesizes findings from diverse studies, focusing on community forestry and agroforestry practices. An analysis of 48 peer-reviewed articles and case studies was conducted to identify the best practices and key themes. Results indicate that robust institutions and effective governance are essential for sustainable forest management. Community engagement and education significantly enhance sustainable practices, with fiscal subsidies in forestry proving more effective than agricultural subsidies. Agroforestry emerges as a strategy that boosts agricultural income and biodiversity through improved market access. The conclusions emphasize the need to address social inequalities and urban pressures while fostering community participation for effective forest management. Recommendations include strengthening institutional frameworks, promoting education for sustainable practices, developing targeted policies that address identified barriers, and leveraging community participation in decision-making processes.

Keywords: agroforestry systems, community forestry, institutional governance, sustainable forest management

IZVLEČEK

Ta sistematični pregled se ukvarja s potrebo po integraciji socialnih, ekoloških in ekonomskih dimenzij v trajnostnem upravljanju gozdov za krepitev odpornosti in trajnosti. Obstoječe raziskave razkrivajo vrzel v razumevanju vključevanja skupnosti in učinkovitost upravljanja. Pregled sintetizira ugotovitve iz različnih raziskav, osredotoča se na prakse skupnostnega gozdarstva in kmetijsko-gozdarskih sistemov. Izvedena je bila analiza 48 recenziranih člankov in študiji primerov za opredelitev najboljših praks ter ključnih tem. Rezultati kažejo, da so aktivne institucije in učinkovito upravljanje ključnega pomena za trajnostno upravljanje gozdov. Vključevanje skupnosti in izobraževanje pomembno izboljšujeta trajnostne prakse, pri čemer so ekonomske spodbude v gozdarstvu učinkovitejše od tistih v kmetijstvu. Kmetijsko-gozdarski sistemi se izkažejo kot način, ki povečuje kmetijski dohodek in krepi biotsko raznovrstnost prek tudi preprostejšega dostopa do trgov, saj ti sistemi zagotavljajo večjo raznolikost proizvodov. V zaključkih poudarjamo potrebo po obravnavi socialne neenakosti in pritiskov urbanizacije, hkrati pa izpostavljamo pomen sodelovanja skupnosti. Priporočila vključujejo krepitev institucionalnih okvirov, spodbujanje izobraževanja za trajnostne prakse, razvoj ciljno usmerjenih politik, ki obravnavajo jasno opredeljene ovire, ter sodelovanje skupnosti v procesih odločanja.

Ključne besede: kmetijsko-gozdarski sistemi, skupnostno gozdarstvo, institucionalno upravljanje, trajnostno upravljanje gozdov

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1 INTRODUCTION

1 UVOD

Agroforestry, which integrates trees with crops or livestock, is widely recognized as a promising approach for achieving sustainable agriculture and forestry. This approach has the potential to address various ecological, economic, and social challenges, including biodiversity conservation, climate change adaptation and mitigation, ecosystem restoration, and rural development (Wilson and Lovell, 2016; Montagnini, 2017; Quandt et al., 2023). Despite its benefits, there is a need to synthesize existing knowledge on agroforestry, identify key success factors, and highlight best practices applicable across different contexts. A study by Plieninger et al. (2020) emphasizes that agroforestry requires an interdisciplinary approach that considers ecological, agricultural, and socioeconomic factors. Consequently, this study aims to investigate the integration of sustainable forest management practices with agroforestry to enhance environmental sustainability. It will focus on the ecological, social, and economic aspects to contribute to the development of more effective and sustain-

able agroforestry practices. Challenges remain, such as integrating traditional knowledge, improving market access for agroforestry products, and scaling up successful systems (Montagnini, 2017). Agroforestry is emerging as a viable alternative to monoculture production, offering a more sustainable and holistic approach to land management (Nair, 2007). This research is crucial for addressing environmental degradation and supporting sustainable development.

Although studies have demonstrated the benefits of sustainable forest management (SFM) and agroforestry practices, further research is needed on how these approaches can be effectively integrated to achieve environmental sustainability (van Noordwijk, 2019; Lintangah et al., 2022). The social and economic implications of agroforestry practices are not well understood, and more investigation is required to explore their potential for scaling up and integration into SFM strategies (Gangadharappa et al., 2003; Tebkew and Atinkut, 2022). Additionally, research is needed on the policy and governance frameworks that support the integration of SFM and agroforestry. While some studies have examined the role of policy and governance in sustainable land use, further exploration is necessary to design and implement effective frameworks that facilitate this integration (Tebkew and Atinkut, 2022). Although previous research has highlighted the importance of SFM and agroforestry for maintaining ecological balance and promoting environmental sustainability, gaps remain in understanding their integrated approach, particularly concerning ecological, social, and economic dimensions. This research aims to fill these gaps by offering new insights through a comprehensive review of how SFM and agroforestry practices can be integrated for enhanced environmental sustainability.

Agroforestry plays a crucial role in sustainable development, especially with the global population projected to reach 9.4-10.1 billion by 2050 (United Nations, n.d.). To meet this demand, agricultural production needs to increase by 25% to 70% by 2050, depending on future economic growth and dietary changes (Giller et al., 2021; Galanakis, 2024). Agroforestry principles and practices are key to enabling the global agri-food sector to adopt more sustainable methods of food and fiber production, providing economic benefits for farmers and environmental benefits for society. Agroforestry offers numerous provisioning, regulating, cultural, and supporting ecosystem services while promoting eco-intensification based on more efficient resource use (Pantera et al., 2021). Addressing these challenges requires sustainable practices such as agroecology, which integrates mixed cropping, agroforestry, and crop-livestock systems (Akanmu et al., 2023). Furthermore, research into sustainable forest and agroforestry management is essential to mitigate environmental damage caused by unsustainable practices. This research aims to develop effective strategies that enhance environmental sustainability through improved forest and agroforestry management practices.

In this study, the researcher explores several key questions: What are the key comprehensive approaches to sustainable forest management? How can community forestry promote sustainable development? How resilient are agroforestry practices in achieving sustainable agricultural outcomes? Additionally, how do institutions, decision-making processes, and fiscal policies influence the success of sustainable forest management and agroforestry practices? This study aims to provide new insights into the integration of sustainable forest management and agroforestry for enhancing environmental sustainability. It seeks to advance practices that support both forestry and agriculture, and to offer valuable information for policy and decision-making, addressing pressing environmental and social challenges.

2 METHODS
2 METODE

This study used a systematic review to synthesize existing knowledge on a particular topic by evaluating findings from previous studies (Mengist et al., 2020). A thematic analysis approach was used to identify key themes and patterns in the data. The keywords used to search the literature included agroforestry, sustainable agriculture, sustainable forestry, community engagement, and rural development. The steps in this systematic review are shown in the PRISMA diagram in Fig. 1.

Inclusion criteria for selecting documents included relevance to the topic of agroforestry, publication in peer-reviewed journals or reputable organizations, open access, and availability of full-text articles. The search was conducted using Publish or Perish version 8 software (Harzing, 2016) with the Crossref online database, initially yielding 1000 articles (Haddaway et al., 2015). Articles were filtered to remove those that did not meet the criteria, such as non-peer-reviewed sources or articles lacking full text. This process resulted in 305 relevant journal articles. These 305 articles were then further refined by removing duplicates and articles focused on corrections or updates, leaving 281 articles. These were categorized based on Scopus quartiles: Q1 (77 articles), Q2 (61 articles), Q3 (25 articles), Q4 (2 articles), and not indexed by Scopus (116 articles). Of the 165 Scopus Q1-Q4 indexed articles, 48 were selected based on their relevance to the study topic. This selec-

tion was done by reviewing the abstracts and introductions to determine relevance. The 48 articles meeting the inclusion criteria were then analyzed in detail.

The data analysis process included coding and categorizing the data using thematic analysis (Naeem et al., 2023). Codes and categories were developed based on research questions and objectives. The analysis involved identifying key themes and patterns in the data, as well as synthesizing findings from previous studies. Data validity was ensured through a systematic and transparent approach to data search, selection, and analysis. The study also utilized a peer review process to ensure the quality and validity of the findings.

The review results are presented according to the categorized topics and themes identified during the analysis. Each theme is discussed in detail, highlighting the key issues and patterns that emerged from the data. The results are organized to reflect the various categories, providing a clear and structured overview of the findings. For each category, specific examples and insights from the data are used to illustrate the broader trends and implications. This structured presentation helps in understanding how different aspects of the research questions are addressed and how the findings contribute to the study's overall objectives.

3 RESULTS AND DISCUSSION
3 REZULTATI IN RAZPRAVA

This section outlines the synthesis of literature on sustainable forest management and agroforestry. The first part reviews *Comprehensive Approaches to Sustainable Forest Management*, introducing broad strategies and frameworks for sustainable management. The second part, *Community Forestry and Sustainable Development: Insights and Opportunities*, narrows the focus to community-level efforts, illustrating how broad strategies are applied and their impact on sustainable development. The third part, *Agroforestry: A Sustainable and Resilient Agricultural Practice*, discusses agroforestry as a specific practice within sustainable management, showcasing methods to achieve sustainability and resilience in agriculture. The final part, *The Role of Institutions, Decision-Making, and Fiscal Policies in Sustainable Forest Management and Agroforestry*, addresses

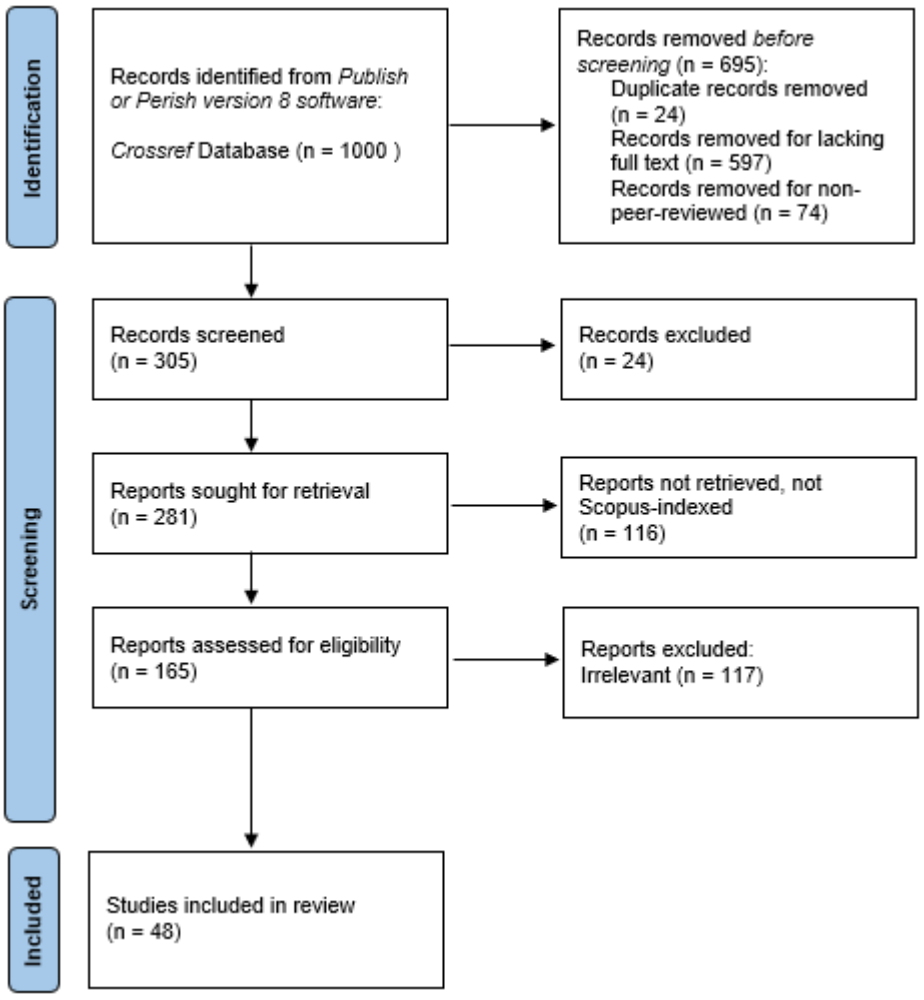

Fig. 1: PRISMA approach diagram of the study

Slika 1: Diagram raziskave po pristopu PRISMA

the institutional and policy frameworks necessary to support the discussed strategies and practices, covering how governance, decision-making processes, and fiscal policies influence implementation and success.

3.1 Comprehensive approaches to sustainable forest management
3.1 Celostni pristopi k trajnostnemu upravljanju gozdov

Sustainable forest management is important for the health and resilience of forest ecosystems, as well as human well-being and economic development. A study by Keleş (2019) assessed the hydrological functions of forest ecosystems and emphasized the importance of considering the water cycle in forest management decisions (Keleş, 2019:12). Similarly, Ofoegbu and Ifejika Speranza (2017) examined the intentions of rural people to adopt sustainable forest use and management practices in South Africa, highlighting the need for community-led initiatives and education (Ofoegbu and Chirwa, 2019:25). These studies show the significance of considering social and ecological aspects in forest management to achieve sustainability.

Resilience is crucial for sustainable forest management. Fuller and Quine (2016) explain that the complexity of resilience in forest systems cannot be captured by a single definition. A more effective approach is to analyze four key components: resistance, recovery, transformation, and adaptation. A study by Chia et al. (2020) using the Analytic Hierarchy Process (AHP) to assess barriers to adopting sustainable forest management practices in Cameroon identified lack of funding and inadequate institutional capacity as major obstacles (Chia et al., 2020:32). This research underscores the need for a comprehensive approach to forest management that considers the complex relationships between trees, ecosystems, and human communities. Delić et al. (2017), in their value chain analysis of non-wood forest products in Bosnia and Herzegovina, revealed the potential for sustainable development of forest resources and rural areas (Delić et al., 2017:28), while Edame et al. (2014) highlighted the importance of managing agriculture, forestry, and water resources for sustainable development in Nigeria, emphasizing integrated approaches to natural resource management (Edame et al., 2014:35). Collectively, these studies demonstrate that considering the economic and social benefits of forest management is essential for achieving sustainable development.Best Management Practices (BMPs) in forestry have been implemented in various regions to reduce environmental impacts. A literature review by Cristan et al. (2016) indicates that BMPs are effective, although their implementation and enforcement vary widely across the United States (Cristan et al., 2016:12). Understanding stakeholder perceptions is crucial for the successful adoption of BMPs. For instance, a study by Tumpach et al. (2018) in Georgia revealed differing perceptions between landowners and forest managers, with the latter group being more positive about BMP effectiveness compared to environmental groups and the general public, who were more skeptical (Tumpach et al., 2018:25). To promote sustainable forestry practices, the Sustainable Forestry Initiative (SFI) has been implemented in several regions. A study by Karnatz et al. (2023) in the southeastern United States showed that SFI certification can positively impact BMPs and biodiversity conservation, although its effectiveness varies depending on the region and type of certification (Karnatz et al., 2023:37). Regional variations in rules and BMPs also lead to inconsistencies and inefficiencies in forestry practices, as found in a study by Pendly et al. (2015) in New Zealand, which recommended a more coordinated approach to forestry policies and regulations to address these issues (Pendly et al., 2015:50).

Reduction of Emissions from Deforestation and Forest Degradation (REDD+) has been implemented in various countries to promote sustainable forest management and reduce greenhouse gas emissions. However, research by Poudel (2014) in Nepal indicates that REDD+ projects often prioritize carbon sequestration over local development needs, leading to conflicts with local communities (Poudel, 2014:62). Another study by Bastakoti and Davidsen (2014) in Nepal reveals that REDD+ projects can undermine forest tenure security, especially for indigenous and local communities (Bastakoti and Davidsen, 2014:75). Conversely, research by Bayrak and Marafa (2020) in Central Vietnam found that Vietnamese farmers have a positive perception of sustainable forest management and REDD+, although they lack the knowledge and resources to implement these practices (Bayrak and Marafa, 2020:90). Additionally, forest concession management has become a concern in several countries. A study by Bulkan (2014) in Guyana shows that forest concessions can lead to the displacement of indigenous communities and forest degradation (Bulkan, 2014:105). Community-based forest management programs implemented in several countries, as studied by Chinangwa et al. (2017) in Malawi, have shown positive impacts on forest conditions, though their effectiveness depends on community engagement levels and resource availability (Chinangwa et al., 2017:120).

In conclusion, achieving sustainable forest manage-

ment requires a multifaceted approach that integrates ecological, social, and economic considerations. Studies highlight the crucial role of maintaining forest resilience by addressing components such as resistance and adaptation, while also emphasizing the importance of community involvement and education in adopting sustainable practices. Effective forest management requires robust value chain analyses and BMPs, as well as a coordinated approach to policy and regional variations. Although initiatives like REDD+ and forest co-management programs offer promising avenues for reducing emissions and improving community engagement, their success often hinges on balancing environmental goals with local development needs and securing forest tenure. A comprehensive strategy that considers these factors is essential for promoting both ecological health and human well-being.

3.2 Community forestry and sustainable development: insights and opportunities

3.2 Skupnostno gozdarstvo in trajnostni razvoj: uvidi in priložnosti

Community forestry plays a crucial role in achieving sustainable development goals by increasing household income and promoting sustainable forestry practices in rural areas. Research in Bhutan indicates that community forestry supports sustainable development (Moktan et al., 2016), while studies in Nepal highlight the importance of institutional interactions within the community forestry framework (Aryal et al., 2020). These findings illustrate the potential of community forestry to enhance rural livelihoods. However, community forest management is influenced by various factors, including social and economic contexts. For example, in Kenya, Musyoki et al. (2016) identified factors affecting the participation of community forest associations in forest management, while in Thailand, Apipoonyanon et al. (2020) explored factors influencing household participation. The importance of understanding these contexts is critical. Additionally, social inequality can significantly impact community forestry. Research by Race and Sumirat (2015) in Indonesia and Assuah et al. (2016) on the Wetzin'kwa Community Forest Corporation in Canada highlights the need to address social inequality to promote fairer and more sustainable forest management practices.

Community forest management faces significant challenges, particularly from urban growth and land acquisition. Bridhikitti and Khadka (2020) analyzed factors influencing the success of small-scale community forest management in Thailand amid urban expansion, while Carig and Carig (2022) explored the impacts of migration and land acquisition on community-based forest management projects in the Philippines. Both studies highlight the importance of addressing these challenges to support the sustainability of community forest management. Active community participation is crucial for achieving these goals. Paudel and Sah (2015) recommend enhancing participation through techniques that maximize forest recovery and sustainable ecosystem services. Vianna and Fearnside (2014) assessed the impact of community forest management on biomass carbon stocks in Brazil. Together, these studies underscore the essential role of community involvement in promoting sustainable forest management.

Industrial tree plantations significantly impact community forestry, making it crucial to consider their perspectives and effects. Byakagaba and Muhirwe (2017) explored the views of local communities near industrial tree plantations in Uganda, while Nath and Magendran (2021) assessed the management and public use of urban community forests in Malaysia. Both studies emphasize the importance of understanding how industrial tree plantations affect community forestry. Community-based conservation can provide substantial benefits for forest ecosystem services and household income. Communally managed indigenous forests offer valuable insights into sustainable forest management practices. For instance, Lambini and Nguyen (2022) examined the impact of community-based conservation associations on forest ecosystem services and household income in Kenya, while Munyati and Sinthumule (2014) investigated forest-community boundaries in South Africa. These studies highlight the advantages of community-based conservation and communal management in promoting sustainable forest management and enhancing livelihoods in indigenous communities.

In conclusion, community forestry plays a vital role in achieving sustainable development goals by promoting household income and sustainable forestry practices, thereby improving livelihoods. Research from Bhutan, Nepal, Kenya, and Thailand demonstrates the positive impacts of community forestry on rural livelihoods, influenced by factors such as social and economic context. However, challenges such as social inequalities, urban growth, and land acquisition must be addressed to ensure equitable and sustainable management. Studies from various regions underscore the importance of community participation, institutional support, and considering the impact of industrial plantations in promoting effective forest conservation and sustainable ecosystem services.

3.3 Agroforestry: a sustainable and resilient agricultural practice

3.3 Kmetijsko-gozdarski sistemi: trajnostna in odporna kmetijska praksa

Agroforestry is a promising approach to sustainable agriculture and rural development, relying on factors such as market access, farmer behavior, and traditional knowledge. This integrated land use approach contributes to sustainable agriculture, reduces environmental degradation, and improves livelihoods. To maximize its benefits, policies and programs should promote agroforestry practices. By integrating trees into agricultural landscapes, agroforestry enhances food security and reduces environmental harm (Wilson and Lovell, 2016). This practice fosters biodiversity processes that can increase yields and mitigate negative impacts. For example, in southern Ethiopia, the conversion of Acacia woodland to managed pastureland, parkland agroforestry, and treeless cropland has shown significant effects on soil carbon stock, total nitrogen, and various soil properties (Gurmessa et al., 2016). Specifically, parkland agroforestry systems exhibit higher soil carbon stock and total nitrogen levels compared to both treeless cropland and managed pastureland, underscoring the critical role of agroforestry in promoting food security while minimizing environmental damage.

In Tigray, Ethiopia, parkland agroforestry meets the demand for firewood, reducing pressure on natural forests, enhancing energy security, improving livelihoods, and lowering poverty in local communities (Tadele et al., 2020). Traditional agroforestry practices in Wonchi District, Ethiopia, are influenced by land use and land cover dynamics, which are crucial for developing sustainable land use practices (Meragiaw et al., 2022). In Ghana, the economic outcomes of cocoa agroforestry are affected by shade levels, farm size, and farmer experience; farmers using higher shade levels achieve greater yields and incomes compared to those with lower shade levels (Owusu et al., 2022). Additionally, in Kwale and Kilifi, Kenya, the choice of market outlets by agroforestry-based mango producers is influenced by farm size, education level, and access to credit, with producers implementing agroforestry practices being more likely to choose formal market outlets, improving their market access and prices (Mwembe et al., 2021).

Agroforestry practices significantly impact agricultural income and rural development. In rural Khyber Pakhtunkhwa, Pakistan, a study found that farmers who adopted agroforestry experienced increased agricultural income and were more likely to reinvest in their operations (Saqib and Khan, 2022). Behavioral factors such as attitudes, perceptions, and social norms play a crucial role in the adoption of these practices (Goltz et al., 2020; Leduc and Hansson, 2024). Understanding these factors is essential for promoting agroforestry adoption and enhancing agricultural income. Additionally, agroforestry provides ecological advantages. Research on hybrid aspen 'Crandon' in central Iowa, USA, revealed that tree spacing and soil type significantly influence coarse root biomass and root architecture. Systems with wider tree spacing exhibited greater coarse root biomass and more extensive root structures (Headlee et al., 2019).

Agroforestry practices offer considerable benefits for sustainable agriculture, rural development, and environmental conservation. They enhance soil health, biodiversity, and ecosystem services while boosting crop yields and farm income. The success of agroforestry depends on several factors, including market access, farmer behavior, traditional knowledge, and institutional support. Policies and programs should address these factors to promote the widespread adoption of agroforestry. Furthermore, agroforestry helps reduce pressure on natural forests, promotes energy security, and mitigates climate change. The evidence supports agroforestry as a promising approach for achieving sustainable agriculture and rural development, and its adoption should be encouraged and supported through targeted policies and institutional programs.

3.4 The role of institutions, decision-making, and fiscal policies in sustainable forest management and agroforestry

3.4 Vloga institucij, odločanja in fiskalnih politik pri trajnostnem upravljanju gozdov in kmetijsko-gozdarskih sistemov

Sustainable forest management (SFM) is crucial for addressing deforestation and preserving forest resources. Institutions play a vital role in implementing effective SFM practices through policies, laws, and economic incentives (Kant and Berry, 2005). The failure of certain economic policies and forest institutions has contributed to deforestation, necessitating sound pricing policies and strong enforcement mechanisms (D`Silva and Appanah, 1993). Benefit-sharing schemes and local community involvement are essential for successful SFM implementation (D`Silva and Appanah, 1993; Sarfo-Adu, 2021). The concept of SFM gained prominence after the 1992 Rio Conference, leading to increased attention to forest-related policies and laws (Sarfo-Adu, 2021). Market-based approaches, such as trading environmental services and carbon sinks, offer potential solutions for SFM (D`Silva and Appanah, 1993; Kant and Berry, 2005). However, challenges remain in developing

optimal institutions for SFM, balancing property rights, and addressing the limitations of sustainable forestry in a globalized economy (Kant and Berry, 2005).

Institutional challenges pose a significant obstacle to sustainable forest management. Girma and Beyene (2015) examined these challenges in the Gambella Regional State of Western Ethiopia, highlighting the need for stronger institutional capacity and coordination among stakeholders (Girma and Beyene, 2015:20). Similarly, Malatinec et al. (2016) evaluated the convergence of Slovak state administration with EU requirements for sustainable agriculture, land use, forestry, and natural resource management, identifying areas for improvement (Malatinec et al., 2016:40). These studies demonstrate the importance of strong institutions and governance structures in supporting sustainable forest management.

Strong institutions, including markets, are crucial for sustainable forest management. Improved governance may reduce deforestation indirectly, but direct reforms in the forestry sector are more effective (Kishor and Belle, 2004; Kant and Berry, 2005; Broekhoven et al., 2012). A unified forestry organization is recommended, along with support from forestry associations for private and community-managed forests (Fraser, 2019). Various policy instruments, such as regulatory, financial, and technical measures, can support sustainable forest management (Fraser, 2019). Countries that gained forest area employed approximately twice as many people in forestry compared to those that lost forest, indicating a need for increased staffing to achieve sustainable forest management globally (Fraser, 2019).

Fiscal subsidy policies play a crucial role in promoting sustainable forest management and agricultural practices. A study by Qin et al. (2015) in China found that forestry fiscal subsidy policies are more effective than agricultural subsidies in encouraging sustainable practices, although both face limitations and challenges (Qin et al., 2015:135). This highlights the need for further research on the effectiveness of forestry Best Management Practices (BMPs), REDD+, and fiscal subsidy policies while also addressing regional variations and the issue of forest grabbing. While fiscal policies are essential for promoting sustainable forest management, their effectiveness can vary significantly. In Nepal, inconsistencies in fiscal instruments for community forestry have hindered sustainable and market-oriented forest management (Paudel and Weiss, 2011; Paudel and Weiss, 2013). Taxation can similarly undermine sustainability in tropical forests, leading to proposals for alternative mechanisms, such as a bond system (Leruth et al., 2001). In China, forestry fiscal subsidies lag behind agricultural subsidies, limiting support for forest workers despite their vital contributions to wood supply and ecological security (Qin et al., 2015). To address these challenges, policymakers should consider revising fiscal policies to ensure consistency, expanding the categories of forestry subsidies, and improving standards (Qin et al., 2015). Additionally, involving stakeholders in policy formulation and enhancing coordination among government units, community forest user groups, and non-governmental organizations could effectively tackle practical issues in community forestry (Paudel and Weiss, 2013).

Understanding farmer behavior and decision-making processes is critical for promoting sustainable forest management. Feola et al. (2015) found that decision-making models, cross-scale pressures, and temporal dynamics are essential for understanding farmer behavior, which can guide future interdisciplinary studies (Feola et al., 2015:18). Hitchner et al. (2023) emphasized the need for culturally sensitive approaches based on case studies of black forest landowners in Georgia, United States (Hitchner et al., 2023:22). Similarly, Papaioannou et al. (2019) compared forest management practices in chestnut forests of Greece, stressing the importance of ecosystem health in decision-making (Papaioannou et al., 2019:30). These studies demonstrate the significance of considering the social and ecological aspects of forest management to promote sustainable practices.

Key factors such as economic characteristics, risk perceptions, and demographic aspects like age and education significantly influence decisions regarding forest management (Li et al., 2004; Thoai and Ranola, 2010; Nastis et al., 2019). Agent-based modeling reveals that knowledge of forest policies, laws, and regulations, as well as labor availability, significantly influence farmers' decisions on woodlot establishment (Ahimbisibwe et al., 2021). To promote sustainable forest management, it is essential to improve farmers' awareness of benefits, modify existing policies to ensure adequate compensation, and address misconceptions about land tenure rights (Li et al., 2004; Thoai and Ranola, 2010; Ahimbisibwe et al., 2021). The complexity of forest management decisions has increased, necessitating adaptive approaches and improved decision support tools (Lawrence and Stewart, 2011). Adaptive management is considered a key social ecosystem process for long-term sustainability, emphasizing the importance of learning and learning-based planning (Bormann et al., 2017).

Decision-making frameworks can help address environmental challenges by considering cultural context,

planning activities, decision-making modes, and decision actions (Tonn et al., 2000). The science of decision-making offers valuable concepts and tools for resource managers to address risks, stressors, and challenges in sustainable forest management (Thompson et al., 2022). However, there is a need for better integration of social and institutional processes in the development and use of decision support tools, as well as a focus on fostering sustainable environmental and social systems while meeting obligations to future generations (Tonn et al., 2000; Lawrence and Stewart, 2011).

In conclusion, sustainable forest management (SFM) requires a multifaceted approach, with institutions, policies, and community involvement playing vital roles in its success. Strong institutions and effective governance are essential for addressing deforestation and promoting sustainable practices, as shown by the importance of economic incentives, fiscal subsidies, and benefit-sharing schemes. Additionally, understanding farmer behavior and incorporating culturally sensitive approaches are key to fostering sustainable management at the local level. Adaptive management and decision-making frameworks can support long-term sustainability by integrating social, ecological, and institutional dynamics. However, challenges remain in refining fiscal policies, improving decision support tools, and ensuring stakeholder coordination to meet the demands of sustainable forest management in a globalized context.

Agroforestry systems have significant potential to enhance economic and environmental sustainability, yet their adoption is shaped by various socioeconomic, institutional, and policy factors (Alavalapati et al., 2001). Decision-making in agroforestry is complex due to its long-term nature, requiring collaboration from multidisciplinary teams (Wood, 1988). Property rights and collective action are critical in defining responsibilities related to tree management, impacting associated externalities (Place et al., 2004). Government policies play a pivotal role in encouraging the widespread adoption of agroforestry, especially when they create market opportunities and economic incentives (Ajayi and Place, 2012). However, despite the growing integration of agroforestry into national development programs, some policies still pose challenges. To ensure sustained adoption, it is essential to complement agroforestry dissemination with favorable policy, institutional, and economic incentives (Ajayi and Place, 2012).

Strong institutions and governance structures are fundamental to the effective implementation of agroforestry systems. Institutional backing is critical in designing policies for land rehabilitation that yield economic and ecological benefits (Nuddin et al., 2019). Governance challenges such as coordinating polycentricity, addressing power imbalances, and integrating various types of knowledge must be overcome to optimize agroforestry adoption (Katic, 2021). Emerging governance patterns create both opportunities and constraints, with key issues revolving around land and tree tenure, forest classification, and environmental service rewards (Swallow et al., 2006). In Melanesian contexts, informal institutions like women's groups and traditional land tenure systems play vital roles in balancing individual entrepreneurship with community development, thus supporting agroforestry (Addinsall et al., 2016). A comprehensive governance framework is needed to incorporate agroforestry into climate change adaptation and mitigation strategies (Katic, 2021).

Fiscal subsidy policies are crucial in promoting agroforestry. Financial support, such as the European Union's Common Agricultural Policy, positively impacts farmer income and woodland expansion (Galluzzo, 2015). In regions like Africa and Asia, government policies have facilitated agroforestry by creating market opportunities and offering economic incentives for adoption (Ajayi and Place, 2012). In China, agricultural subsidies have boosted production and incomes, though forestry subsidies lag behind, highlighting the need for balanced support (Qin et al., 2015). Agroforestry also contributes to climate change adaptation, increasing tree cover, enhancing carbon stocks, and conserving biodiversity (Zoysa and Inoue, 2014). Ensuring sustained adoption requires regulatory changes, awareness development, and climate-smart landscape planning (Zoysa and Inoue, 2014). Thus, integrating agroforestry into national programs with supportive policies and incentives is essential for broader adoption (Ajayi and Place, 2012).

Understanding farmer behavior is key to promoting agroforestry adoption. Research has identified factors influencing farmers' decisions, including economic considerations, environmental benefits, and social norms (Tanveer Hussain et al., 2012; Fleming et al., 2019). Farmers often perceive the advantages of agroforestry, such as increased income and pollution control, to outweigh potential disadvantages like agricultural interference (Tanveer Hussain et al., 2012). Socioeconomic variables such as family size, land ownership, and income positively impact adoption, while age negatively influences it (Ahmad et al., 2023). Membership in networks enhances adoption through knowledge sharing and technical support (Leduc and Hansson, 2024). Although psychological factors from

the Theory of Planned Behavior show some influence, their effect remains inconclusive (Leduc and Hansson, 2024). To enhance adoption rates, policies should focus on expanding agricultural extension services and farmer training programs (Ahmad et al., 2023).

Decision-making processes play a pivotal role in agroforestry adoption, particularly for smallholder farmers. Factors influencing adoption include extrinsic variables, such as farmer characteristics and external environments, and intrinsic ones like knowledge, attitudes, and perceptions (Meijer et al., 2015). Due to the longer time scales involved in agroforestry compared to traditional agriculture, decision-making is more challenging (Wood, 1988). Economic considerations, such as soil fertility management and natural capital, significantly influence farmers' decisions (Izac, 2002). While various approaches to understanding decision-making have been compared, the Theory of Planned Behavior has shown the highest accuracy in predicting adoption rates, unlike other models that may overestimate adoption (Noeldeke et al., 2022). A multidisciplinary approach, along with the formation of interdisciplinary committees, may expedite decision-making in agroforestry research and development (Wood, 1988).

In conclusion, agroforestry systems have significant potential for enhancing economic and environmental sustainability, but their widespread adoption depends on various factors. Strong institutional support, favorable policies, and clear property rights are essential for promoting agroforestry, while governance challenges such as power imbalances and tenure issues must be addressed. Fiscal subsidies and market incentives enhance adoption, particularly when integrated into national development programs. Additionally, farmer decision-making, influenced by economic, social, and psychological factors, plays a crucial role, highlighting the need for comprehensive agricultural extension services and multidisciplinary approaches to optimize agroforestry adoption.

4 CONCLUSION
4 ZAKLJUČKI

Sustainable forest management (SFM) is crucial for maintaining forest ecosystems, enhancing human well-being, and fostering economic development. A holistic approach that integrates tree, ecosystem, and community interactions is essential. Effective SFM requires strong governance and institutions, as well as integrating value chain analysis to balance environmental, social, and economic outcomes. Understanding farmers' behavior and decision-making is key to promoting SFM. Community forestry and agroforestry provide pathways for both environmental protection and livelihood improvement. Engaging stakeholders—such as farmers, policymakers, and landowners—in decision-making ensures their interests align with sustainability goals (Latip et al., 2013; Poudyal et al., 2020). Raising awareness about the long-term benefits of SFM, including improved market opportunities, reduced production costs, and enhanced ecosystem resilience, fosters trust and adoption (Glover et al., 2013; Fatima et al., 2024). Demonstrating successful examples, like agroforestry, increases stakeholder confidence.

A resilience-based approach to SFM is essential, focusing on climate change mitigation, enhancing institutional capacity, and stakeholder coordination. Community-led initiatives and education programs can promote sustainable management practices. Key policy recommendations include: (1) supporting agroforestry through fiscal incentives, technical assistance, and financial access; (2) capacity building for farmers and forest managers in sustainable techniques; (3) strengthening governance to protect community rights and secure land tenure; (4) developing sustainable value chains for forest products; and (5) ongoing research on best practices, including agroforestry and REDD+, tailored to local conditions. By adopting these strategies, policymakers can promote sustainable forest use, enhance livelihoods, and protect ecosystems. Further research is needed on the long-term impact of agroforestry and REDD+, as well as financial mechanisms to scale up successful practices.

5 SUMMARY

Agroforestry, which integrates trees with crops or livestock, presents a promising method for sustainable agriculture and forestry by addressing ecological, economic, and social challenges such as biodiversity, climate change adaptation, and rural development. To develop effective agroforestry practices, it is essential to synthesize existing knowledge to identify key success factors and best practices tailored to different contexts while overcoming challenges such as incorporating traditional knowledge, improving market access for agroforestry products, and scaling up successful systems. Despite the benefits of sustainable forest management (SFM) and agroforestry, there is a critical need for more research on integrating these approaches to enhance environmental sustainability. The social and economic implications of agroforestry, alongside the policy and governance frameworks that support SFM, remain underexplored. Research should focus on designing and implementing frameworks that facilitate this integration, addressing the ecological, so-

cial, and economic dimensions of both practices. As the global population grows and food demand rises, agroforestry offers a sustainable alternative to monoculture, enhancing resource use efficiency and providing vital ecosystem services. This study employs systematic review and thematic analysis to identify key themes and patterns in agroforestry and SFM research, aiming to provide insights for policy and decision-making to tackle environmental challenges.

Sustainable forest management (SFM) is essential for ecosystems and human well-being, requiring an approach that integrates hydrological functions and emphasizes community involvement and education. Research highlights the importance of resilience by understanding resistance, recovery, transformation, and adaptation to enhance management strategies. Effective practices must overcome barriers such as funding and institutional capacity. Best Management Practices (BMPs) can reduce environmental impacts, but their success varies regionally, necessitating better stakeholder engagement. Programs like REDD+ aim to promote sustainable management but often struggle with local development needs and community tenure security. Community forestry plays a critical role in sustainable development by improving rural livelihoods, but it also faces challenges from social inequalities and urban growth.

Agroforestry offers a promising path for sustainable agriculture, enhancing food security while reducing environmental degradation. Its successful adoption relies on market access, traditional knowledge, and supportive policies. Achieving sustainable management requires integrating ecological, social, and economic dimensions, with active community participation being vital for effective practices. Strong institutions that enforce policies and economic incentives are crucial, as inadequate frameworks have worsened deforestation and highlighted the need for better pricing and enforcement mechanisms. Since the increased focus on forestry policies after the 1992 Rio Conference, local community involvement and benefit-sharing schemes have become essential, along with market-based approaches that trade environmental services. However, challenges persist in establishing effective institutions that balance property rights and support sustainable forestry in a globalized economy.

Institutional challenges significantly hinder sustainable forest management (SFM), with studies highlighting the need for stronger governance and stakeholder coordination. While improved governance can reduce deforestation, direct reforms in the forestry sector have a more substantial impact. Establishing a unified forestry organization, supported by associations for private and community-managed forests, is recommended to enhance efficacy. Various policy instruments—regulatory, financial, and technical—can bolster SFM, with evidence suggesting that nations that successfully increase their forest area also employ more forestry workers, indicating a need for greater staffing in this sector. Fiscal policies play a crucial role in promoting sustainable practices, with research demonstrating that forestry fiscal subsidies are often more effective than agricultural subsidies; however, inconsistencies in these policies can impede sustainable management. Engaging stakeholders in policy development and improving coordination among government and community groups are essential for addressing practical issues in community forestry. Additionally, understanding farmer behavior and decision-making processes is vital for advancing agroforestry and SFM. Key influencing factors include economic characteristics, risk perceptions, and demographic elements, all of which shape decision-making. Ultimately, both SFM and agroforestry require integrated approaches that consider institutional, ecological, and social dynamics, alongside adaptive management strategies for long-term sustainability.

6 POVZETEK

Kmetijsko-gozdarski sistemi, ki združujejo drevesa s poljščinami ali živino, so obetaven način za trajnostno kmetijstvo in gozdarstvo, saj obravnavajo ekološke, gospodarske in družbene izzive, kot so biotska raznovrstnost, prilagajanje podnebnim spremembam in razvoj podeželja. Za razvoj učinkovitih praks kmetijsko-gozdarskih sistemov je treba povzeti obstoječe znanje in opredeliti ključne dejavnike uspeha ter najboljše prakse, prilagojene različnim okoliščinam, hkrati pa premagati izzive, kot so vključevanje tradicionalnega znanja, izboljšanje dostopa do trga za kmetijsko-gozdarske proizvode in razširjanje uspešnih sistemov. Kljub koristim trajnostnega gospodarjenja z gozdovi in kmetijsko-gozdarskih sistemov je nujno potrebnih več raziskav o povezovanju teh pristopov za povečanje okoljske trajnosti. Družbene in gospodarske posledice kmetijsko-gozdarskih sistemov, skupaj z okviri politike in upravljanja, ki podpirajo trajnostno gospodarjenje z gozdovi, so še vedno premalo raziskane. Raziskave se morajo osredotočiti na oblikovanje in izvajanje okvirov, ki olajšujejo to povezovanje in obravnavajo ekološke, družbene in gospodarske razsežnosti obeh praks. Ker svetovno prebivalstvo narašča in povpraševanje po hrani narašča, ponujajo kmetijsko-gozdarski ukrepi trajnostno alternativo monokulturam, ki povečuje učinkovitost rabe virov in zagotavljajo pomembne eko-

sistemske storitve. Ta raziskava temelji na sistematičnem pregledu in vsebinski analizi, s pomočjo katere so opredeljene ključne teme in vzorci v raziskavah na področju kmetijsko-gozdarskih sistemov in trajnostnega upravljanja gozdov, da bi zagotovila vpogled v politiko in sprejemanje odločitev za reševanje okoljskih izzivov.

Trajnostno upravljanje gozdov je bistvenega pomena za ekosisteme in blaginjo ljudi, zato je potreben pristop, ki vključuje hidrološke funkcije ter poudarja vključevanje in izobraževanje skupnosti. Raziskave poudarjajo pomen odpornosti z razumevanjem odpornosti, okrevanja, preobrazbe in prilagajanja za izboljšanje strategij gospodarjenja. Učinkovite prakse morajo premagati ovire, kot sta financiranje in institucionalna kapaciteta. Najboljše prakse upravljanja lahko zmanjšajo vplive na okolje, vendar se njihov uspeh regionalno razlikuje, zato je potrebno boljše sodelovanje deležnikov. Cilj programov, kot je REDD+, je spodbujati trajnostno upravljanje, vendar se pogosto spopadajo s potrebami lokalnega razvoja in zagotavljanja lastniških pravic skupnosti. Gozdarstvo v skupnosti ima ključno vlogo pri trajnostnem razvoju, saj izboljšuje preživetje na podeželju, vendar se sooča tudi z izzivi zaradi socialne neenakosti in rasti urbanih območij.

Kmetijsko-gozdarski sistemi so obetavna pot za trajnostno kmetijstvo, ki povečuje prehransko varnost in hkrati zmanjšuje degradacijo okolja. Njihova uspešna uvedba je odvisna od dostopa do trga, tradicionalnega znanja in podpornih politik. Za doseganje trajnostnega upravljanja je treba vključiti ekološke, družbene in ekonomske razsežnosti, pri čemer je za učinkovito prakso bistvenega pomena dejavno sodelovanje skupnosti. Močne institucije, ki uveljavljajo politike in ekonomske spodbude, so ključnega pomena, saj so neustrezni okviri okrepili krčenje gozdov in poudarili potrebo po boljših mehanizmih določanja cen in mehanizmih izvrševanja. Odkar se je po konferenci v Riu leta 1992 gozdarskim politikam posvetila več pozornosti, so postali ključni – vključevanje lokalnih skupnosti in sistemi delitve koristi ter tržni pristopi, ki omogočajo trgovanje z okoljskimi storitvami. Vendar pa še vedno ostajajo izzivi pri vzpostavljanju učinkovitih institucij, ki uravnotežijo lastninske pravice in podpirajo trajnostno gozdarstvo v globaliziranem gospodarstvu.

Institucionalni izzivi močno ovirajo trajnostno gospodarjenje z gozdovi, študije pa poudarjajo potrebo po močnejšem upravljanju in usklajevanju interesnih skupin. Z boljšim upravljanjem se lahko zavre krčenje gozdov, vendar imajo neposredne reforme v gozdarskem sektorju večji učinek. Za povečanje učinkovitosti je priporočljiva ustanovitev enotne gozdarske organizacije, ki jo podpirajo združenja za zasebne gozdove in gozdove v upravljanju skupnosti. Različni instrumenti politike - regulativni, finančni in tehnični - lahko okrepijo trajnostno gospodarjenje z gozdovi, pri čemer dokazi kažejo, da države, ki uspešno povečujejo gozdne površine, zaposlujejo tudi več gozdarskih delavcev, kar kaže na potrebo po večjem številu osebja v tem sektorju. Fiskalne politike imajo ključno vlogo pri spodbujanju trajnostnih praks, saj raziskave kažejo, da so davčne spodbude za gozdarstvo pogosto učinkovitejše od kmetijskih podpor; vendar lahko nedoslednosti v teh politikah ovirajo trajnostno gospodarjenje. Vključevanje zainteresiranih strani v razvoj politik ter izboljšanje usklajevanja med vlado in skupinami skupnosti sta bistvena za reševanje praktičnih vprašanj v gozdarstvu. Poleg tega je razumevanje vedenja lastnikov zemljišč in procesov odločanja bistvenega pomena za napredek kmetijsko-gozdarskih sistemov in trajnostnega gospodarjenja z gozdovi. Ključni vplivni dejavniki vključujejo ekonomske značilnosti, zaznavanje tveganja in demografske elemente, ki vplivajo na sprejemanje odločitev. Navsezadnje tako trajnostno upravljanje gozdov kot kmetijsko-gozdarski sistemi zahtevajo celostne pristope, ki upoštevajo institucionalno, ekološko in družbeno dinamiko ter strategije prilagodljivega upravljanja za dolgoročno trajnost.

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