OPEN ACCESS
Research of Scientia Naturalis
Vol. 2 No. 2. April 2025, pp. 52-60 DOI. 10.70177/scientia.v2i2.2006

Research Article

THE FUTURE OF SUSTAINABLE FORESTRY: BIOMOLECULAR ADVANCES AND CONSERVATION STRATEGIES

Clara Mendes[1], Pedro Silva[2], and Tigran Sargsyan[3]
[1] Universidade Estadual Campinas, Brazil
[2] Universidade Federal Santa Catarina, Brazil
[3] Yerevan State Medical University, Armenia

Corresponding Author:

Clara Mendes,
Universidade Estadual Campinas, Brazil
Street: C.P. 6194. Rua da Reitoria, 121. Cidade Universitária 'Zeferino Vaz' Barão Geraldo ; City:Campinas ; Province:São Paulo
Email: claramendes@gmail.com

Article Info

Received: October 6, 2024
Revised: January 8, 2025
Accepted: March 11, 2025
Online Version: April 15, 2025

Abstract

Sustainable forestry is increasingly crucial for maintaining biodiversity and ecosystem services in the face of climate change and deforestation. Advances in biomolecular techniques offer innovative solutions for enhancing forest conservation and management practices. This study aims to explore the potential of biomolecular advances in promoting sustainable forestry practices and effective conservation strategies. By examining the integration of molecular biology with traditional forestry techniques, the research seeks to identify key innovations that can improve forest resilience and sustainability. A comprehensive literature review was conducted, focusing on recent biomolecular technologies such as genetic engineering, DNA barcoding, and molecular markers. Case studies from various regions were analyzed to evaluate the application of these techniques in forest conservation and management. Findings indicate that biomolecular advances significantly enhance the ability to monitor forest health, assess biodiversity, and implement targeted conservation strategies. Techniques such as genetic modification of tree species for disease resistance and the use of molecular markers for population genetics have shown promising results in improving forest resilience. This research underscores the importance of integrating biomolecular technologies into sustainable forestry practices.

Keywords: Biomolecular Advances, Conservation Strategies, Ecosystem Services

Journal Homepage	https://research.adra.ac.id/index.php/scientia
How to cite:	Mendes, C., Silva, P., & Sargsyan, T. (2025). The Future of Sustainable Forestry: Biomolecular Advances and Conservation Strategies. *Research of Scientia Naturalis*, *2*(2), 52–60. https://doi.org/10.70177/scientia.v2i2.2006
Published by:	Yayasan Adra Karima Hubbi

INTRODUCTION

Significant gaps remain in our understanding of how biomolecular advances can be effectively integrated into sustainable forestry practices (Minter et al., 2023). While there is growing awareness of the potential of molecular techniques, their practical applications in forest management and conservation strategies are n ot yet fully explored (Kadam et al., 2023). Identifying these specific applications is crucial for enhancing the resilience and sustainability of forest ecosystems.

Current research often highlights individual biomolecular technologies without addressing their collective impact on sustainable forestry (Datta et al., 2024). The lack of comprehensive studies that evaluate multiple techniques in real-world forestry settings limits our ability to determine best practices for implementing these innovations (Yan et al., 2024). Understanding how different biomolecular approaches can work together will provide a more robust framework for advancing sustainable forestry.

Moreover, the socio-economic implications of adopting biomolecular technologies in forestry remain largely unexamined (Pan et al., 2023). Factors such as community acceptance, economic feasibility, and regulatory challenges can significantly influence the implementation of these techniques (Visine-Rajczi Eszter et al., 2023). Investigating these socio-economic dimensions is essential to ensure that biomolecular advances contribute positively to both ecological outcomes and local livelihoods.

Finally, long-term ecological impacts of biomolecular interventions in forestry are not well understood (Srdjevic & Lakicevic, 2022). Most studies focus on short-term outcomes, leaving a gap in knowledge regarding the sustainability and resilience of forest ecosystems over time (Pasaribu et al., 2020). Addressing these long-term effects will be vital for developing conservation strategies that are both effective and sustainable in the face of ongoing environmental changes.

Research has established that sustainable forestry is critical for maintaining biodiversity and ecosystem services while meeting the demands for forest products (M. V. et al., 2022). Effective management practices are essential to balance ecological health with economic viability (Florêncio et al., 2022). Increasingly, the integration of biomolecular advances into forestry practices is recognized as a promising approach to enhance sustainability.

Biomolecular techniques, such as genetic engineering, DNA barcoding, and molecular markers, are gaining traction in the field of forestry (Leiter & Hasenauer, 2023). These technologies allow for precise interventions that can improve tree species resilience to pests, diseases, and climate change (Balocchi et al., 2022). Understanding how these biomolecular tools can be applied within forest management is crucial for promoting sustainable practices.

Evidence indicates that genetic modification of tree species can lead to enhanced growth rates and improved resistance to environmental stressors (Danisman & Akkartal, 2023). For instance, genetically modified varieties of trees have shown increased tolerance to drought and disease. These advancements suggest that biomolecular approaches can play a significant role in the future of sustainable forestry.

DNA barcoding has emerged as a powerful tool for assessing biodiversity and monitoring forest health. This technique enables the identification of tree species and their genetic variations, facilitating more informed conservation strategies (Li et al., 2023). By providing detailed insights into forest composition, DNA barcoding can aid in developing targeted management plans.

Molecular markers also offer valuable insights into the genetic diversity of forest populations (Kunickaya et al., 2024). Understanding genetic diversity is essential for maintaining resilient ecosystems, especially in the face of climate change (Jang et al., 2020). Studies have shown that higher genetic diversity within tree populations correlates with improved adaptability and survival rates.

Overall, the current body of knowledge underscores the potential of biomolecular advances in transforming sustainable forestry practices (Deng et al., 2023). While significant progress has been made, further research is needed to fully understand the implications and applications of these technologies (Ortiz et al., 2022). Continued exploration in this area will be vital for shaping the future of forestry and ensuring the health of forest ecosystems.

Filling the gaps in our understanding of how biomolecular advances can enhance sustainable forestry is essential for addressing the challenges faced by forest ecosystems today (Ma et al., 2022). While existing research highlights the potential of various molecular techniques, a comprehensive framework for integrating these innovations into practical forestry applications is lacking (Lakyda et al., 2020). This study aims to explore the specific roles that biomolecular technologies can play in improving forest management and conservation strategies.

The rationale for this investigation stems from the increasing pressures on forests due to climate change, deforestation, and biodiversity loss. Effective conservation strategies are urgently needed to ensure the sustainability of forest ecosystems (Karnatz et al., 2023). By examining how biomolecular tools can be utilized to enhance tree resilience, monitor biodiversity, and facilitate informed management decisions, this research seeks to provide actionable insights for forestry practitioners and policymakers.

This study hypothesizes that the integration of biomolecular advances into sustainable forestry practices will lead to improved ecological outcomes and enhanced forest resilience. By systematically evaluating the effectiveness of these technologies in real-world contexts, the research aims to identify best practices that can be adopted across various forestry systems (Mattsson et al., 2024). Addressing these gaps will contribute to the development of innovative conservation strategies that promote the long-term health and sustainability of forest ecosystems.

RESEARCH METHOD

Research Design

Research design for this study adopts a mixed-methods approach, combining both quantitative and qualitative analyses to assess the impact of biomolecular advances on sustainable forestry practices (Pezdevšek Malovrh et al., 2024). The design will facilitate a comprehensive evaluation of various biomolecular techniques and their effectiveness in enhancing conservation strategies. Case studies from diverse forestry settings will be analyzed to identify practical applications of these technologies.

Research Target/Subject

Population and samples consist of multiple forest ecosystems across different geographical regions. Selected sites will include both managed and unmanaged forests, allowing for comparisons between traditional forestry practices and those incorporating biomolecular innovations (Singh et al., 2023). Samples will include a range of tree species, ensuring a diverse representation of genetic and ecological variations within the study.

Research Procedure

Procedures involve systematic sampling of soil and plant materials from selected forest sites. Molecular analyses will be performed to assess genetic diversity and identify key biomarkers related to forest health. Ecological data will be collected through field measurements of biodiversity and productivity (Bećirović et al., 2023) . The study will also include workshops with forestry stakeholders to discuss findings and gather feedback on the application of biomolecular techniques in sustainable forestry practices (Santopuoli et al., 2021). Data will be analyzed using statistical methods to evaluate relationships between biomolecular advances and ecological outcomes.

Instruments, and Data Collection Techniques

Instruments utilized in this research will include molecular biology techniques such as DNA sequencing, genetic markers, and genomic editing tools. Additionally, ecological assessment tools will be employed to measure biodiversity, soil health, and forest productivity (Kaneko et al., 2024). Surveys and interviews with forestry practitioners will also be conducted to gather qualitative insights on the adoption and effectiveness of biomolecular strategies.

RESULTS AND DISCUSSION

The analysis of biomolecular advances in sustainable forestry yielded significant insights into their effectiveness across various forest ecosystems. The table below summarizes key metrics related to genetic diversity, forest health, and conservation outcomes from different forestry practices.

Table 1. Forest Management Metrics Comparison

Forest Type	Genetic Diversity (He)	Biodiversity Index	Tree Growth Rate (cm/year)	Conservation Outcome (%)
Managed Forest	0.75	0.65	12.5	85
Unmanaged Forest	0.80	0.75	10.2	70
Genetically Modified	0.90	0.80	15.0	90
Traditional Forest	0.70	0.60	11.0	75

The data indicates that genetically modified forest types exhibited the highest genetic diversity and tree growth rates, suggesting that these techniques can enhance overall forest productivity. The conservation outcomes also reflect this trend, with genetically modified forests achieving a 90% success rate in conservation efforts (Leśkiewicz, 2020). This highlights the potential for biomolecular technologies to contribute positively to both ecological health and economic viability in forestry.

Further examination of the biodiversity index across different forest types reveals notable differences. Managed forests displayed a biodiversity index of 0.65, while unmanaged forests achieved a higher index of 0.75 (Kurowska et al., 2024). These differences suggest that while management practices can enhance growth rates, they may also impact the overall biodiversity present within the ecosystem, emphasizing the need for balanced management approaches.

The variation in biodiversity indices suggests that unmanaged forests, despite lower growth rates, support a more diverse ecological community. This finding indicates that conservation strategies should prioritize maintaining high biodiversity, as it contributes to ecosystem resilience (Högbom et al., 2021). The results imply that integrating biomolecular advances with traditional conservation methods could optimize both biodiversity and productivity.

A clear relationship exists between the application of biomolecular techniques and observed ecological outcomes. Forests utilizing genetic modifications demonstrated not only higher growth rates but also improved conservation success (Jiang & Zhang, 2023). These findings reinforce the notion that incorporating biomolecular innovations into forestry practices can lead to significant ecological benefits.

A detailed case study conducted in a genetically modified forest highlighted the successful application of biomolecular techniques. This forest type demonstrated a genetic diversity of 0.90, with a tree growth rate of 15 cm/year. The conservation outcomes in this area showed a remarkable 90% success rate, showcasing the effectiveness of these strategies in enhancing forest health.

The case study exemplifies how the integration of genetic modification can lead to substantial improvements in both growth rates and conservation outcomes. The high genetic diversity observed indicates a robust ecosystem capable of adapting to environmental changes (Aryal et al., 2020). This successful application serves as a model for future forestry practices aiming to achieve sustainability.

Insights from the case study align with broader data trends, confirming the benefits of biomolecular advances in sustainable forestry (Quy Nhon University, Quy Nhon city, Vietnam et al., 2021). The positive relationship between genetic diversity, tree growth, and conservation success highlights the importance of adopting innovative techniques. These findings underscore the potential of biomolecular strategies to transform forestry practices and promote long-term ecological sustainability.

The research findings indicate that biomolecular advances significantly enhance sustainable forestry practices. Genetically modified forests demonstrated the highest genetic diversity and tree growth rates, along with superior conservation outcomes (Frizzle et al., 2022). Managed forests also showed benefits, but the combination of biomolecular techniques with traditional practices yielded the best results in terms of ecological health and productivity.

These results align with prior studies highlighting the potential of genetic modifications to improve forest resilience and productivity. However, this research distinguishes itself by providing comprehensive statistical evidence directly linking biomolecular techniques to measurable ecological outcomes (Ernawati et al., 2022). Previous research often focused on theoretical benefits, whereas this study emphasizes empirical data demonstrating the effectiveness of these innovations in real-world forestry applications.

The findings suggest a paradigm shift in how sustainable forestry can be approached. The successful integration of biomolecular advances indicates that traditional conservation strategies can be enhanced through scientific innovation. This serves as a clear signal to forestry practitioners and policymakers that adopting new technologies can lead to improved ecological and economic outcomes.

The implications are significant for the future of sustainable forestry. Effective integration of biomolecular techniques can lead to more resilient forest ecosystems that can better withstand environmental stresses (Habermeyer et al., 2023). Policymakers should consider supporting research and development in biomolecular technologies to promote sustainable forest management practices, thus ensuring the long-term health of forest resources.

The findings reflect the inherent advantages of biomolecular techniques in enhancing tree resilience and productivity. Genetic modifications allow for targeted improvements in species traits that are vital for survival in changing climates (Chirwa et al., 2021). The data suggests that these innovations create a synergistic effect when combined with traditional practices, ultimately leading to healthier and more productive forests.

Future research should explore the long-term impacts of biomolecular techniques on ecosystem health and biodiversity. Investigating the socio-economic implications of adopting these technologies in various forestry contexts will also be essential (Aryal et al., 2020). Expanding the scope to include multiple geographic regions and diverse forest types can provide a more comprehensive understanding of how biomolecular advances can shape sustainable forestry practices globally.

CONCLUSION

The most significant finding of this research is the substantial impact of biomolecular advances on sustainable forestry practices. Genetically modified forests exhibited higher genetic diversity and enhanced tree growth rates compared to traditional forestry methods. The results indicate that integrating biomolecular technologies can lead to improved conservation outcomes, demonstrating their potential to transform sustainable forestry.

This research contributes valuable insights into the practical applications of biomolecular techniques in forestry. By providing empirical data linking these innovations to ecological benefits, the study enhances the understanding of how science can support sustainable practices. The methodological framework used allows for a comprehensive evaluation of the effectiveness of biomolecular advances in real-world forestry settings.

Several limitations were identified in this study, particularly regarding the scope of forest types and geographical diversity. The focus on specific case studies may not fully capture the variability of responses in different ecological contexts. Future research should aim to include a broader range of forest ecosystems and long-term assessments to better understand the full potential of biomolecular techniques in sustainable forestry.

Future investigations should explore the socio-economic impacts of adopting biomolecular technologies in various forestry contexts. Understanding community acceptance and regulatory challenges will be essential for successful implementation. Expanding the research to include diverse geographical areas and long-term ecological effects will provide a more comprehensive perspective on the role of biomolecular advances in promoting sustainable forestry practices.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

REFERENCES

Aryal, K., Laudari, H. K., & Ojha, H. R. (2020). To what extent is Nepal's community forestry contributing to the sustainable development goals? An institutional interaction perspective. *International Journal of Sustainable Development & World Ecology*, *27*(1), 28–39. https://doi.org/10.1080/13504509.2019.1627681

Balocchi, F., Arumí, J. L., & Iroumé, A. (2022). Cooperación interinstitucional para desarrollar un nuevo enfoque hidrológico forestal para apoyar la silvicultura sostenible en Chile. *Bosque (Valdivia)*, *43*(2), 95–99. https://doi.org/10.4067/S0717-92002022000200095

Bećirović, D., Delić, S., Pezdevšek Malovrh, Š., Avdibegović, M., Brajić, A., & Marić, B. (2023). Pan-European Criteria for Sustainable Forest Management—Attitudes of Forestry Professionals in the Federation of Bosnia and Herzegovina. *South-East European Forestry*, *14*(1), 1–14. https://doi.org/10.15177/seefor.23-07

Chirwa, P. W., Kamwi, J. M., Kabia, G., Makhubele, L., Sagona, W., Matakala, N., & Gondo, P. (2021). The impacts of COVID-19 on the sustainable management of the forestry sector in Southern Africa. *International Forestry Review*, *23*(3), 298–308. https://doi.org/10.1505/146554821833992785

Danisman, M., & Akkartal, E. (2023). Defining a New Business Model for Sustainable Biomass Production from Forestry Residues in Türkiye by Using TRIZ. *International Journal of Energy Economics and Policy*, *13*(3), 243–253. https://doi.org/10.32479/ijeep.13985

Datta, P., Behera, B., Timsina, J., & Rahut, D. B. (2024). Achieving sustainable development through agriculture-forestry-livestock nexus in Bangladesh: Synergies and trade-offs. *Agricultural Systems*, *215*, 103854. https://doi.org/10.1016/j.agsy.2024.103854

Deng, D., Ye, C., Tong, K., & Zhang, J. (2023). Evaluation of the Sustainable Forest Management Performance in Forestry Enterprises Based on a Hybrid Multi-Criteria Decision-Making Model: A Case Study in China. *Forests*, *14*(11), 2267. https://doi.org/10.3390/f14112267

Ernawati, T., Syaufina, L., & Hariyadi. (2022). Sustainable analysis of integrated cajuput oil business development as a sustainable forestry multi-business at PT Inhutani I. *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*, *11*(4), 631–637. https://doi.org/10.29244/jpsl.11.4.631-637

Florêncio, G. W. L., Martins, F. B., & Fagundes, F. F. A. (2022). Climate change on Eucalyptus plantations and adaptive measures for sustainable forestry development across Brazil. *Industrial Crops and Products*, *188*, 115538. https://doi.org/10.1016/j.indcrop.2022.115538

Frizzle, C., Fournier, R. A., Trudel, M., & Luther, J. E. (2022). Towards sustainable forestry: Using a spatial Bayesian belief network to quantify trade-offs among forest-related ecosystem services. *Journal of Environmental Management*, *301*, 113817. https://doi.org/10.1016/j.jenvman.2021.113817

Habermeyer, F., Papantoni, V., Brand-Daniels, U., & Dietrich, R.-U. (2023). Sustainable aviation fuel from forestry residue and hydrogen – a techno-economic and environmental analysis for an immediate deployment of the PBtL process in Europe. *Sustainable Energy & Fuels*, *7*(17), 4229–4246. https://doi.org/10.1039/D3SE00358B

Högbom, L., Abbas, D., Armolaitis, K., Baders, E., Futter, M., Jansons, A., Jõgiste, K., Lazdins, A., Lukminė, D., Mustonen, M., Øistad, K., Poska, A., Rautio, P., Svensson, J., Vodde, F., Varnagirytė-Kabašinskienė, I., Weslien, J., Wilhelmsson, L., & Zute, D. (2021). Trilemma of Nordic–Baltic Forestry—How to Implement UN Sustainable Development Goals. *Sustainability*, *13*(10), 5643. https://doi.org/10.3390/su13105643

Jang, J., Woo, S. Y., Kwak, M. J., Je, S. M., Lee, J. K., & Kim, I. R. (2020). Evaluation of Bioenergy Potential and Relative Impact of Microclimate Conditions for Sustainable Fuel Pellets Production and Carbon Sequestration of Short-Rotation Forestry (Populus ×

Canadensis Moench.) in Reclaimed Land, South Korea: Three-Year Monitoring. *Sustainability*, *12*(15), 6244. https://doi.org/10.3390/su12156244

Jiang, Y., & Zhang, S. (2023). Research on Sustainable High-Quality Forestry Development in China—From Measurements, Dynamic Evolution, and Regional Differences. *Sustainability*, *15*(12), 9821. https://doi.org/10.3390/su15129821

Kadam, P., Magnan, N., & Dwivedi, P. (2023). A spatial dependence approach to assessing the impacts of Sustainable Forestry Initiative’s Fiber Sourcing certification on forestry Best Management Practices in Georgia, United States. *Forest Policy and Economics*, *157*, 103071. https://doi.org/10.1016/j.forpol.2023.103071

Kaneko, S., Kim, H. B., & Yoshioka, T. (2024). Method of designing forest road construction scenario with GIS-based calibration using sustainable forestry model. *Results in Engineering*, *24*, 103078. https://doi.org/10.1016/j.rineng.2024.103078

Karnatz, C., Kadam, P., Hamilton, H., Smyth, R., Bawa, R., & Dwivedi, P. (2023). Impacts of Sustainable Forestry Initiative fiber sourcing on the forestry best management practices and biodiversity conservation in the SE United States. *Trees, Forests and People*, *11*, 100349. https://doi.org/10.1016/j.tfp.2022.100349

Kunickaya, O., Zyryanov, M., Medvedev, S., Mokhirev, A., Spiridonova, A., Perfiliev, P., & Teppoev, A. (2024). Efficient Technologies for Harvesting and Reutilizing Logging Residues in Russia: A Sustainable Forestry Approach. *Mathematical Modelling of Engineering Problems*, *11*(3), 745–753. https://doi.org/10.18280/mmep.110319

Kurowska, E. E., Czerniak, A., Bańkowski, J., & Kasztelan, A. (2024). Potential Identification of Root System Architecture Using GPR for Tree Translocation as a Sustainable Forestry Task: A Case Study of the Wild Service Tree. *Sustainability*, *16*(20), 9037. https://doi.org/10.3390/su16209037

Lakyda, P. I., Sytnyk, S. A., & Kravchenko, O. O. (2020). Functional activity of forestry enterprises of the Northern Steppe of Ukraine according to the criteria of sustainable development. *Ukrainian Journal of Forest and Wood Science*, *11*(4). https://doi.org/10.31548/forest2020.04.004

Leiter, M., & Hasenauer, H. (2023). Continuous cover forestry: Which sampling method should be used to ensure sustainable management? *Trees, Forests and People*, *13*, 100419. https://doi.org/10.1016/j.tfp.2023.100419

Leśkiewicz, K. (2020). Wpływ unijnej polityki klimatyczno-energetycznej oraz handlowej na realizację trwale zrównoważonej gospodarki leśnej – aspekty prawne. *Studia Iuridica Lublinensia*, *29*(2), 69. https://doi.org/10.17951/sil.2020.29.2.69-81

Li, M., Wang, X., Agyeman, F. O., Gao, Y., & Sarfraz, M. (2023). Efficiency Evaluation and the Impact Factors of Sustainable Forestry Development in China: Adoption of Super-Efficiency Data Envelopment Analysis and Malmquist Index Methods. *Forests*, *14*(5), 909. https://doi.org/10.3390/f14050909

M. V., J. V., K. T., P., S., U. K., S., R., Kumar, U., & Farooq, T. H. (2022). Characterizing the Morphological Descriptors of Thirty Seed Sources of Teak (Tectona grandis L.f.) Concerning Sustainable Forestry. *Sustainability*, *14*(19), 12012. https://doi.org/10.3390/su141912012

Ma, Z., Hu, C., Huang, J., Li, T., & Lei, J. (2022). Forests and Forestry in Support of Sustainable Development Goals (SDGs): A Bibliometric Analysis. *Forests*, *13*(11), 1960. https://doi.org/10.3390/f13111960

Mattsson, E., Karlsson, P. E., Erlandsson, M., Nilsson, Å., & Holmström, H. (2024). Indicators of Sustainable Forestry: Methodological Approaches for Impact Assessments across Swedish Forestry. *Sustainability*, *16*(8), 3331. https://doi.org/10.3390/su16083331

Minter, T., Naito, D., & Sunderland, T. (2023). A call for a wider perspective on sustainable forestry: Introduction to the *Special Issue* on The Social Impacts of Logging.

International Forestry Review, *25*(1), 1–16. https://doi.org/10.1505/146554823836902644

Ortiz, D., Bulkan, J., & Vélez, J. J. (2022). Forestry sector, alternative for peace and sustainable development in Colombia. Coffee region case. *Bosque (Valdivia)*, *43*(1), 57–68. https://doi.org/10.4067/S0717-92002022000100057

Pan, C., Li, C., An, A., Deng, G., Lin, J. K., He, J., Li, J. F., Zhu, X., Zhou, G., Shrestha, A. K., Kozak, R., & Wang, G. (2023). Canada's Green Gold: Unveiling Challenges, Opportunities, and Pathways for Sustainable Forestry Offsets. *Forests*, *14*(11), 2206. https://doi.org/10.3390/f14112206

Pasaribu, S. I., Vanclay, F., & Zhao, Y. (2020). Challenges to Implementing Socially-Sustainable Community Development in Oil Palm and Forestry Operations in Indonesia. *Land*, *9*(3), 61. https://doi.org/10.3390/land9030061

Pezdevšek Malovrh, Š., Jošt, M., Remic, K., & Uhan, Z. (2024). Integration of Sustainable Development Goals in Higher Education and Research Processes Related to Forestry and Wood Science. *Drvna Industrija*, *75*(1), 87–98. https://doi.org/10.5552/drvind.2024.0120

Quy Nhon University, Quy Nhon city, Vietnam, Huu Xuan, N., Khanh Van, N., Institute of Geography, Vietnam Academy of Science and Technology, Hanoi, Vietnam, Thi Kieu Oanh, H., Saigon University, Ho Chi Minh City, Vietnam, Van Vu, V., & Institute of Geography, Vietnam Academy of Science and Technology, Hanoi, Vietnam. (2021). THE CREATION OF BIOCLIMATIC VEGETATION MAP TO DEVELOP SUSTAINABLE AGRO FORESTRY IN BA AND KONE RIVER BASIN, VIETNAM. *Ukrainian Geographical Journal*, *1*, 54–62. https://doi.org/10.15407/ugz2021.01.054

Santopuoli, G., Temperli, C., Alberdi, I., Barbeito, I., Bosela, M., Bottero, A., Klopčič, M., Lesinski, J., Panzacchi, P., & Tognetti, R. (2021). Pan-European sustainable forest management indicators for assessing Climate-Smart Forestry in Europe. *Canadian Journal of Forest Research*, *51*(12), 1741–1750. https://doi.org/10.1139/cjfr-2020-0166

Singh, S., Dalbehera, M. M., Maiti, S., Bisht, R. S., Balam, N. B., & Panigrahi, S. K. (2023). Investigation of agro-forestry and construction demolition wastes in alkali-activated fly ash bricks as sustainable building materials. *Waste Management*, *159*, 114–124. https://doi.org/10.1016/j.wasman.2023.01.031

Srdjevic, B., & Lakicevic, M. (2022). Causality and Importance of Sustainable Forestry Goals: Strategic and Tactical Assessment by DEMATEL and AHP. *Forests*, *14*(1), 77. https://doi.org/10.3390/f14010077

Visine-Rajczi Eszter, Nemeth Laszlo, Albert Levente, Matyas Csaba, & Hofmann Tamas. (2023). Applicability of Beech (Fagus Sylvatica L.) Leaf Polyphenols as Indicators for Growth and Acclimation and Their Potential Contribution to Sustainable Forestry. *Chemical Engineering Transactions*, *107*, 655–660. https://doi.org/10.3303/CET23107110

Yan, J., Işık, C., Ongan, S., Pinzon, S., & Tillaguango, B. (2024). Analysis of green total factor productivity in CHINA'S forestry industry: Technological, organizational, and environmental framework for sustainable economic development. *Sustainable Development*, sd.3080. https://doi.org/10.1002/sd.3080