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Editorial

Sixty Years of UGM Forestry Faculty's Work in Preserving Indonesia's Forests and Environment

Enam Puluh Tahun Kiprah Fakultas Kehutanan UGM dalam Menjaga Kelestarian Hutan dan Lingkungan Indonesia

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ABSTRACT

Given a mandate to preserve the Indonesia tropical forest through its education, research, and community service activities, the Faculty of Forestry Universitas Gadjah Mada (FoF UGM) has reached broad stakeholders to support sustainable forest management and climate mitigation (SDG 13 and 17). FoF UGM supports basic and applied research contributing to forestry industrialization (SDG 9), such as improved planting materials for *Tectona grandis* and *Eucalyptus* sp. In collaboration with the community (SDG 1 and 2), FoF UGM also diversifies kajuput essential oil produced in Wanagama and UGM teaching forests. Technology innovations such as glue and cross-laminated timber, biodiesel, information systems, and drone technologies for land rehabilitation and carbon accounting represent the institution's commitment to improving Indonesia's forest, forestry, community, and national economy (SDG 13 and 15).

KEYWORDS
Faculty of Forestry; UGM, sustainable forest management; climate mitigation, sustainable development goals.

INTISARI

Dengan mandat untuk melestarikan hutan tropis Indonesia melalui kegiatan pendidikan, penelitian, dan pengabdian kepada masyarakat, Fakultas Kehutanan Universitas Gadjah Mada (FKT UGM) telah menjangkau pemangku kepentingan yang luas untuk mendukung pengelolaan hutan lestari dan mitigasi iklim (SDG 13 dan 17). FKT UGM juga mendukung penelitian dasar dan terapan yang berkontribusi terhadap industrialisasi kehutanan (SDG 9), seperti perbaikan bahan tanam untuk Tectona grandis dan Eucalyptus sp. *Bekerja sama dengan masyarakat (SDG 1), FKT UGM juga melakukan diversifikasi minyak atsiri kajuput yang diproduksi di hutan pendidikan Wanagama dan UGM. Inovasi teknologi seperti lem dan kayu laminasi silang, biodiesel, sistem informasi, dan teknologi drone untuk rehabilitasi lahan dan penghitungan karbon merupakan komitmen lembaga ini dalam meningkatkan hutan dan kehutanan, masyarakat, dan perekonomian nasional Indonesia (SDG 13 dan 15).*

KATA KUNCI
Fakultas Kehutanan; UGM; pengelolaan hutan lestari; mitigasi perubahan iklim, tujuan pembangunan berkelanjutan.

Introduction

The Faculty of Forestry Universitas Gadjah Mada (FoF UGM) was established on 17 August 1963, officially stipulated by the Ministry of Higher Education and Science decree No. 99/1963 with a mandate to preserve the Indonesia tropical forest through its education, research, and community service activities. This role is crucial as Indonesia hosts more than 120 million hectares of high-biodiversity tropical forests (MoEF 2022) and has committed to reducing greenhouse gas (GHG) emissions. Indonesia signed the Paris Agreement in 2016 and submitted its Nationally Determined Contribution (NDC). The NDC has been updated with the Enhanced Nationally Determined Contribution (ENDC), committing 31.89% emission reduction without international support and 43.20% with international support. In addition, Indonesia also has a high ambition to reach at least equal or higher carbon absorption from forestry and other land uses (FOLU) to its national emissions by 2030 (FOLU Net Sink 2030). The forestry sector has a prominent and strategic role in achieving the ENDC, accounting for 58% of the ENDC target. Critical land rehabilitation with improved planting materials, such as high-carbon absorber species, becomes one of the climate action efforts in the Sustainable Development Goals (SDG 13).

In addition, advancing agroforestry practices, such as the Integrated Forestry and Farming System (IFFS) in the social forestry (SF) areas, will improve soil conditions and landscape sustainability (SDG 15) and support national food security (SDG 1 and 2). Improving planting material is also one of the crucial aspects of developing productive agroforestry. However, the SF implementation needs to consider landscape, socio-cultural, and economic characteristics to allow the innovation of appropriate technologies and nature-based solutions (NBS) for land and environmental services management and to integrate sustainable regional development for uplands and lowlands.

Strategic partnerships play an essential role, allowing FoF UGM to reach broader stakeholders in its education, research, and community service activities to support sustainable forest management, climate mitigation, and adaptation to prevent environmental deterioration and native species extinction (SDG 17). FoF UGM also supports basic and applied research contributing to forestry industrialization (SDG 9), such as improved planting materials for teak, *Eucalyptus* sp. In collaboration with the community, FoF UGM also diversifies kajuput essential oil produced in Wanagama and UGM teaching forests (Pujiarti et al. 2011). Innovation in appropriate technologies, such as glue and cross-laminated timber, biodiesel, information systems, and drone technologies for land rehabilitation and carbon accounting, become part of the FoF UGM commitment to contribute to improving Indonesia's forest and forestry, community, and national economy.

In 2023, the FoF UGM celebrated its 60 anniversary. Its celebration has a theme *60 Tahun Kiprah Fakultas Kehutanan UGM dalam Menjaga Kelestarian Hutan dan Lingkungan Indonesia* or 60 Years of UGM Forestry Faculty's Work in Preserving Indonesia's Forests and Environment. This anniversary becomes a momentum to reflect on and look forward to its scientific contributions to better forests and forestry to support a better future life and the SDGs. The editorial highlights the significant achievements and contributions of the FoF UGM in 60 years in forest management, silviculture, forest resources conservation, and forest product technology. The topic organization is merely to simplify the writing, while by nature, the FoF UGM primarily works in multi- and interdisciplinary practice.

Social forestry (SF) intends to empower the community surrounding the forests by improving their access rights to forest resources and solving land-related conflicts (Colchester 1994). The first generation of (SF) is based on intercropping or agroforestry (1970–1990s) and mainly implemented in the teak plantations in Java, managed by Perhutani. The second generation of SF is based on the forestry partnership (1990s–2016). The implementation of the third generation of SF (2016–recent) intends to accelerate the adoption of productive community-based forest management to improve community prosperity. The SF is a proven approach, continuously evolving to address the attributed issues (Nugroho et al. 2023). Recently, SF with agroforestry has become one of the alternative strategies to rehabilitate disturbed forest areas through monoculture

plantations, such as oil palm. The *Strategi Jangka Benah* (SJB) or target period strategy is a socio-technical and policy effort to improve the structure and function of disturbed forest ecosystems within a certain period (Susanti 2021).

In 1963, the FoF UGM pioneered the critical land in Wanagama education forest Gunung Kidul Regency, Yogyakarta. This rehabilitation area becomes a teaching forest and field laboratory to advance silvicultural techniques for critical land restoration. The experience gained from Wanagama instilled a strong foundation for further developing intensive silvicultural (SILIN) techniques to improve forest productivity. Tree improvement, environment manipulation, and integrated pest management become the basis for SILIN development (Na'iem 2014; Budiadi et al. 2017: Figure 1). Many Forest Management Units (FMUs) of industrial forest plantations and natural forests have become strategic partners of FoF UGM and have implemented SILIN using these improved species to produce construction timbers (teak and Dipterocarpaceae), resin (pine), and fibers (eucalyptus) (Widiyatno et al. 2020, 2023; Nugrahanto et al. 2022). The thinning of teak plantations using improved planting materials could become valuable raw materials for downstream products, such as cross-laminated timber (CLT) and glue-laminated timber (GLT), high-quality materials for green building constructions (Widyorini et al. 2023).

The improved Dipterocapaceae material for enrichment planting in secondary natural forests through SILIN contributes significantly to increasing carbon absorption and preventing the extinction of Dipterocapaceae, a native species of Indonesian tropical forests (Widiyatno et al. 2016, 2020). The estimation of carbon absorption from the enrichment planting using Dipterocarpaceae is 221,11 tons C/ha. In addition, enrichment planting with native species could maintain the habitat of endemic species, such as orangutans (*Pongo* sp), flat-head wild cat (*Prionailurus planiceps*), otter civet (*Cynogale bennettii*), clouded leopard (*Neofelis nebulosa*), and sun bear (*Helarctos malayanus*) (Samejima & Semiadi 2012; Widiyatno et al. 2013; Figure 2)

The FoF UGM commits to tropical forest conservation in Indonesia. One of its significant contributions is the development of science-based conservation to support the resort-based management (RBM) program in 2007 in Alas Purwo National Park, Ministry of Environment and Forestry. The RBM Model in Alas Purwo National Park has become the primary national reference for the national park model (TN Model) and science-based conservation area management. The *Strategi Jangka Benah* (SJB) is also a strategy to enhance the recovery of disturbed forests for their ecological functions (Budiadi et al. 2022), which the regenerating forest may maintain potential conservation values (Mahayani et al.. 2022).

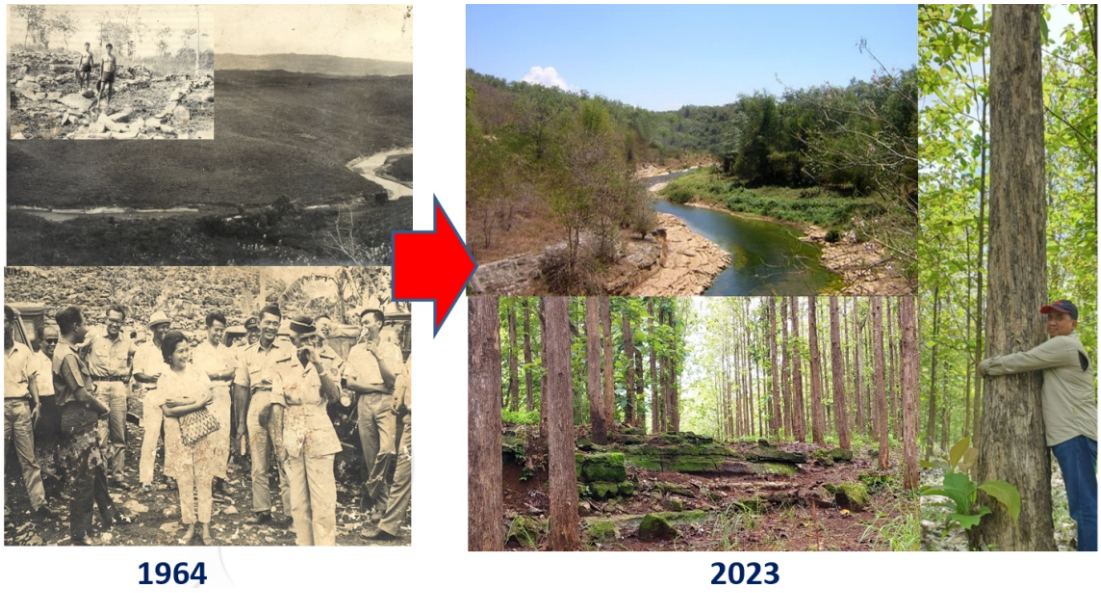

Figure 1. Implementation of intensive silvicultural (SILIN) techniques to improve forest productivity in Wanagama Education Forest, Gunung Kidul, Yogyakarta

Figure 2. (a) Enrichment planting with native species in secondary tropical rainforest; (b) endemic animal species in Borneo's secondary tropical rainforest

Drone technologies for land rehabilitation and carbon accounting are alternative approaches for monitoring forest resource changes efficiently (Marhaento et al. 2022). These are especially crucial for the areas with challenging accessibility.

The CLT could use small-diameter timber of fast-growing species to produce materials with larger diameter and better strength and dimension stability for construction, furniture, and other products that require strength and durability. Research on timber and non-timber forest product quality becomes the core of forest product technology development and the downstream of forestry industries. Knowledge of the physical, mechanical, and chemical properties of wood becomes crucial in advancing its derivative products, such as pulp and paper, construction materials, energy/biomass, activated charcoal, laminated timber-CLT, and natural fiber composites (without adhesive or with natural adhesive) (Widyorini et al. 2023). Downstreaming non-timber forest products contributes to forest product diversification, such as pine with high resin productivity (*bocor getah*), essential oils (chemical, bioactivities, and products), biorefinery, natural dye, and eco print (Pujiarti & Kusumadewi 2020; Pujiarti & Putri 2021; Pujiarti et al. 2021; Arisandi et al. 2023).

The CLT strength and dimension stability are due to its fiber direction, which is perpendicular to each other (Figure 3). Previously, only construction projects used CLT exclusively, but recently, the furniture industry has also increasingly used CLT (Huang et al. 2022). The cross-lamination in CLT produces sturdy, durable, and visually attractive furniture. This unique CLT construction allows designers to create sophisticated, unique, and innovative furniture beyond traditional materials. CLT furniture is elegant and has a warm and natural appearance of timber (Smardzewski & Łabeda 2018; Fellin et al. 2022). The CLT structure generally uses low-density timber as the core (Mohebby & Broushakian 2022), while the outer layers use high-density timber to produce good-quality composites (Espinoza & Buehlmann 2018). This CLT structure indicates that low-density and low-quality timbers could contribute to producing high-quality composites. Processing low-quality timber into high-quality products could become a solution to reducing negative environmental impacts attributed to timber harvesting (Trisatya et al. 2023).

In the energy sector, Indonesia aims to reduce 12.5% without international support and 15.5% with international support in 2030. Biodiesel production uses chemical processes involving vegetable oils and

Figure 3. C*ross-laminated timber* (CLT) of mahogany-sengon-mahogany (Widyorini et al. 2023)

alcohol (Utami et al. 2017). The biodiesel produces lower CO_2, CO, HC, NO_x, SO_x, and carcinogenic compounds while lubricating the engines. Exploration of plant species with prospective bioenergy, such as kepuh (*Sterculia foetida*), nyamplung (*Calopyhilum innophyllum*), dan malapari (*Pongamia pinnata* (L.) Pierre), becomes an effort to stimulate renewable energy sources. Kepuh is a premium biodiesel source without any mixture of fossil fuels. In addition, using kepuh seeds as a bioenergy source led to a minimum competition between the fuels and food nexus, as kepuh seeds are not edible.

Conclusion

Some significant achievements and contributions of the FoF UGM in 60 years in forest management, silviculture, forest resources conservation, and forest product technology are social forestry with agroforestry, the *Strategi Jangka Benah* (SJB), developing intensive silvicultural (SILIN) techniques, drone technologies for land rehabilitation and carbon accounting as well as products of cross-laminated timber (CLT) and glue-laminated timber (GLT) representing high-quality materials for green building constructions. The FoF UGM has also been actively contributing to achieving climate change mitigation and adaptation and SDGs. They are achieved through multi- and interdisciplinary ways to improve Indonesia's forest and forestry, community, and national economy.

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