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A Community-Based Nursery Program for Economic Empowerment Surrounding KDU, Ngawi District, East Java

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Abstract Indonesia's commitment to addressing climate change was declared at the 27th Conference of the Parties (COP) in 2021, with its Intended Nationally Determined Contribution (NDC) pledging to reduce greenhouse gas (GHG) emissions by 31.89% (unconditional) and 43.2% (conditional) by 2030. The forestry sector played a vital role by accelerating forest cover through restoration and rehabilitation programs. KHDTK DIKLATHUT UGM (KDU) consistently organized such programs by planting various species. To fulfill seedling needs, local communities were involved through community-based nursery initiatives. The establishment of the community-based nursery program aimed to: (1) encourage community participation around the forest to support the success of the KHDTK DIKLATHUT UGM forest restoration and rehabilitation program, (2) develop competent local community cadres skilled in producing high-quality seedlings for plantation, and (3) provide additional job opportunities and increase income for the local community. Three targeted villages were located in Ngawi: Pitu, Kalang, and Nglebak. The methods used in this program included: (1) focus group discussions (FGDs), (2) field observation and surveys, (3) education and training, and (4) monitoring and evaluation. The results showed that 12 local communities had established community-based nurseries with various species being propagated. The program also demonstrated good financial feasibility, generating a profit of IDR69,272,273 or approximately IDR289 per seedling. However, seedling handling and health maintenance remained challenging. Therefore, further education and training could be initiated to improve the local community's knowledge and skills.

1. INTRODUCTION

Climate change has become a serious global issue, including in Indonesia (Kurniawan et al., 2022; Mursyid et al., 2021). Its consequences include intense droughts, water scarcity, rising sea levels, flooding, melting polar ice, potential pest outbreaks, and declining biodiversity (Heryani et al., 2022; Surmaini et al., 2024; Triana & Wahyudi, 2020; Yamamoto et al., 2021). Therefore, addressing this issue is extremely urgent. Indonesia's latest NDC reflected a stronger commitment to GHG reduction, with updated targets of 31.89% (unconditional) and 43.2% (conditional), compared to 29% and 41%, respectively, in the previous version (Kementerian Perencanaan Pembangunan Nasional, 2019). The forest and land-use sector accounted for approximately 10% of global net greenhouse gas (GHG) emissions, and the Indonesian government aimed for the forestry sector to go beyond carbon neutrality and become a net carbon sink by 2030. Concrete actions to realize this vision included accelerating forest restoration and rehabilitation (FRR), increasing forest productivity, preventing the conversion of forest land to other uses, maintaining the sustainability of peat and mangrove ecosystems, and implementing sustainable forest

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management practices (Kementerian Lingkungan Hidup dan Kehutanan, 2020).

On August 9, 2016, the Indonesian government, through the Decree of the Minister of Environment and Forestry of the Republic of Indonesia No. 632/Menlhk/Setjen/PLA.0/8/2016, granted Universitas Gadjah Mada (UGM) the right to manage 10,867.19 hectares of Forest Areas with Specific Purpose for Education and Training (KDU). However, it faced several serious challenges, including illegal logging, the destruction of rehabilitation areas, the conversion of forest land into corn and sugarcane fields, and socio-economic issues such as high levels of poverty and unemployment among people living around the forest. As stated by Höhl et al. (2020), such problems were commonly caused by a lack of local involvement and a mismatch between the objectives of local communities and those of the managers. There was a high risk of project failure if the goals and needs of local communities were not considered in project planning and implementation. Therefore, these problems needed to be addressed urgently not only by UGM as the manager, but also by national, regional, and local governments, public and private companies, indigenous peoples, and local community groups.

Various programs were conducted, one of which was the initiation of a community-based plant nursery to support forest restoration and rehabilitation and to increase community income. In a case study in Ethiopia, local nurseries proved to be profitable and showed potential as businesses capable of creating permanent employment for one to two unemployed individuals per nursery (Molla et al., 2020). Similar benefits were expected for the surrounding communities. The initiation of the community-based plant nursery program was implemented in several villages, namely Pitu, Kalang, and Nglebak. The establishment of the community-based nursery program aimed to (1) encourage community participation surrounding the forest in supporting the success of the KDU forest restoration and rehabilitation program, (2) develop competent local community cadres skilled in producing high-quality seedlings for plantation, and (3) provide additional job opportunities and increase income for the local community.

2. METHOD

This community service activity began in 2018 and targeted the local communities. Three villages located in Ngawi—Pitu, Kalang, and Nglebak—were selected based on several considerations related to their capacity to provide a suitable environment for the nursery. These included accessibility, the availability of natural resources such as water and growing sites, as well as existing infrastructure and human resources.

The methods used to implement this community service activity included (1) focus group discussions (FGDs), (2) field observation and surveys, (3) education and training (e.g., generative and vegetative propagation, nursery management), and (4) monitoring and evaluation. The FGDs were facilitated by a lecturer from the Department of Silviculture and attended by village heads, community leaders, the youth organization (Karang Taruna), and local community members. Initially, ten individuals from each village (thirty in total) were invited. Community interest was assessed through a combination of research and development methods, including observations, interviews, and documentation supported by secondary data. Field observations and surveys involved visiting water sources and identifying suitable sites for nursery establishment. The quality and quantity of seedlings were determined through direct measurements. The sustainability of the activity was supported by regular monitoring and evaluation, conducted at least once every six months, from 2018 through 2024.

3. RESULT AND DISCUSSION

3.1 Focus group discussion

The first FGD was carried out on May 5, 2018. This discussion was attended by a lecturer from the Department of Silviculture, the village head, community leaders, the youth organization (Karang Taruna), and local community members (Figure 1). This discussion represented a critical step in reaching an agreement among the parties and was primarily used to explore the local community's understanding of the KDU reforestation and rehabilitation program, as well as the potential for initiating a community-based nursery. Since the main program focused on reforestation and rehabilitation to increase forest cover and enhance carbon capture and storage, a large number of high-quality seedlings were required. To meet this need, a nursery was initiated to produce both generative and vegetative seedlings. The management of the plant nursery was expected to involve many laborers from the local community, thereby contributing to their economic well-being. Based on the discussion, all parties agreed to establish a community-based plant nursery.

The sustainability of this activity was ensured through regular monitoring and evaluation, conducted at least once every six months from 2018 to 2024. An exception was made from 2019 to 2021 during the COVID-19 pandemic, when coordination could only be carried out through virtual media. Annual FGDs were resumed from 2022 to 2024, attended by nursery leaders and community members, with

Figure 1 . Discussion with the village head, community leaders, and meeting with the local community members of Pitu Village

at least 30 participants in total. The scope of participation broadened beyond the initial three villages to include communities from nearby areas as well.

The topics of the FGDs varied dynamically, usually reflecting the most pressing issues at the time. In 2022 and 2023, discussions focused on regaining economic and health independence in the post-pandemic period. In 2024, greater attention was directed toward implementing various propagation techniques, tree improvement strategies, and environmental manipulation to enhance both the quality and quantity of seedlings.

Figure 2 . Field observation/survey to get the most suitable site for plant nursery: (a) Site candidate for nursery; (b) Suitable site for nursery establishment

3.2 Field observation/survey

The FGD activity was followed by a field observation and survey aimed at identifying a suitable location for the nursery. A lecturer from the Faculty of Forestry and local community members observed several locations to determine the most appropriate site for plant nurseries. Marjenah (2018) described a nursery as a place or area specifically prepared for the maintenance or production of seedlings, whether through generative propagation (seeds) or vegetative propagation (cuttings, grafting, etc.), until they are ready to be planted in the field. A nursery site should provide optimal conditions for germination and the early growth of seedlings. To obtain high-quality seedlings, several criteria for nursery location must be met, including (1) proximity to plantation sites, (2) availability of irrigation water, (3) safety from natural disasters such as flooding, (4) access to infrastructure (e.g., roads, electricity), and (5) availability of labor (Irawan et al., 2020). Based on these criteria, a suitable nursery site was successfully identified on land owned by Purwadianto, a member of the youth organization (Figure 2). One year after the training was conducted in 2019, Purwadianto volunteered to lead the development of the plant nursery.

3.3 Education and training

Proper nursery management is essential for producing healthy and uniform seedlings. It requires a range of skills and technical knowledge, as seedlings can be grown in open areas or protected structures/shade. It is the duty and responsibility of nurserymen to provide environmental and edaphic conditions suitable for seedling growth and development. Nursery practices need to support the physiological processes of seedlings, thereby ensuring high potential for growth and survival after outplanting. Nursery management, therefore, brings together human resources, funding, and materials within a defined timeframe to achieve the economical production of planting materials.

Figure 3 . Education and training of nursery management by the Department of Silviculture, Faculty of Forestry, UGM: (a) Preparing media for plant nursery; (b) Initial result of education and training in nursery

Key nursery management activities include species or variety selection, nursery bed preparation, soil management, planting procedures, seedling density control, watering, fertilization, pest and disease control, root pruning, and hardening off. Errors made during the seedling growth stage cannot be corrected later and will negatively impact productivity, wasting both time and resources. For these reasons, lecturers from the Department of Silviculture, Faculty of Forestry UGM, organized an education and training program in nursery management (Figure 3). This program aimed to provide an overview and insight into key aspects of leadership, nursery management practices, and technical skills related to plant nursery operations.

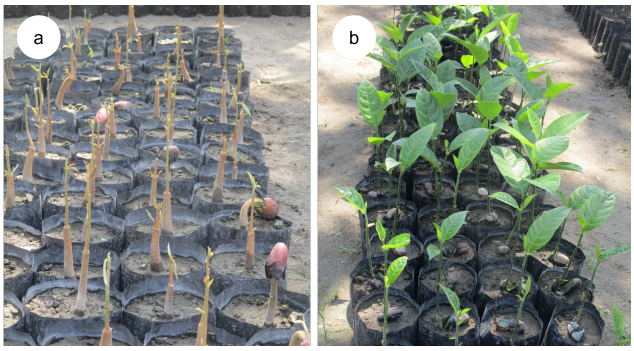

Figure 4 . Propagation technique for seedlings production at community-based nursery: (a) Planting in polybag; (b) Germinated seed in polybag

Plant propagation can be carried out generatively using seeds or vegetatively through grafting, cutting, and in vitro culture. The community was introduced to both generative and vegetative propagation methods during the training activity. The generative method employed seeds as propagation material, while the vegetative method involved grafting techniques. In the initial stage, two species – *Sterculia foetida* and *Anacardium occidentale* – were propagated generatively by the local community. *Sterculia foetida* was selected for its strong potential as a source of biofuel and biodiesel raw materials, contributing to ecological sustainability by reducing reliance on environmentally harmful fossil fuels (Badan Standarisasi Nasional, 2017; Devarajan & Damian, 2024).

On the other hand, *Anacardium occidentale* was used as a fruit tree, valued for its nuts, which have a high selling price. Cashew nuts are also known for their nutritional benefits, including a very low percentage of trans-fatty acids (Salehi et al., 2019). Both *Anacardium occidentale* and *Sterculia foetida* seeds were easy to cultivate. Scarification was carried out by soaking the seeds in water for 3–4 days to facilitate water imbibition and accelerate germination. After soaking, the seeds were rinsed and tightly covered with a tarpaulin. Once germination began, the seeds were individually planted into polybags (Figure 4).

3.4 Monitoring and evaluation

In 2023 and 2024, monitoring and evaluation were conducted to assess whether the program was on track and achieving its objectives. The results showed that 12 households had established plant nurseries at their homes (previously only one individual, Purwadianto), and they were able to produce a wide variety of seedlings beyond *Anacardium occidentale* and *Sterculia foetida*. The propagated species included *Anacardium occidentale*, *Sterculia foetida*, *Callophyllum inophyllum*, *Mangifera indica*, *Artocarpus heterophyllus*, *Swietenia macrophylla*, *Persea americana*, *Syzygium cumini*, *Artocarpus altilis*, and *Melaleuca cajuputi* (Figure 5). In total, they were able to produce approximately 240,000 seedlings per year. All seedlings were distributed to KDU for its forest restoration and rehabilitation program. This figure even met 30% of the annual seedling demand in 2023.

The monitoring results also revealed differences in production quantity across nurseries (Attachment 1). Several factors influenced this variation, including land ownership area, available capital, infrastructure, and skill in seed handling and maintenance. Nevertheless, the quality of seedlings produced across all nurseries was superior and uniform. This consistency was attributed to the use of standardized procedures for seed extraction, media type and composition, container size, shade percentage, and maintenance practices.

Quality seedlings produced in a well-managed nursery therefore result in better yields and increased profits. Based

Figure 5 . Various seedlings produced by community-based nursery, e.g. (a) *Sterculia foetida*; (b) *Anacardium occidentale*; (c) *Swietenia macrophylla*; (d) *Callophyllum inophyllum*; (e) *Artocarpus altilis*

Table 1 . Community-based nursery cost details

No.	Components	Necessity	Unit	Price per unit (IDR)	Total price (IDR)
1	Growth media/top soil	38	rit	100,000	3,769,146
2	Polybag	739	kg	25,000	18,467,154
3	Shading net	6	roll	1,200,000	7,538,292
4	UV Plastic	26	roll	310,000	8,175,635
5	Daily labor wages	2,160	HOK	80,000	172,800,000
	Total Cost				210,750,227

Table 2 . Community-based nursery revenue details

No.	Species	Seedling's quantity	Selling value per seedling (IDR)	Total selling value (IDR)
1	*Anacardium occidentale*	48,861	1,500	73,291,500
2	*Sterculia foetida*	85,842	1,000	85,842,000
3	*Callophyllum inophyllum*	60,935	1,000	60,935,000
4	*Mangifera indica*	7,622	1,500	11,433,000
5	*Artocarpus heterophyllus*	9,394	1,000	9,394,000
6	*Swietenia macrophylla*	9,323	1,000	9,323,000
7	*Persea americana*	4,188	2,000	8,376,000
8	*Syzygium cumini*	3,504	1,000	3,504,000
9	*Artocarpus altilis*	7,520	2,000	15,040,000
10	*Melaleuca cajuputi*	2,884	1,000	2,884,000
	Total Income	240,073		280,022,500

on the results obtained from this study, the community-based nursery generated a total revenue of IDR280,022,500, with a profit of IDR69,272,273, or approximately IDR289 per seedling. Details of costs and revenue are presented in Table 1 and Table 2. This economic profit can serve as a reference for developing community-based nurseries in other villages surrounding KDU, such as Bodeh, Mendenrejo, Ngrawoh, Megeri, Gempol, and others. Therefore, the positive impacts of the reforestation and rehabilitation program have had direct effects on the broader community surrounding the forest.

Despite the recorded success stories mentioned above, several challenges remained in seed handling and biotic and abiotic management. For example, Attachment 1 showed that only 2 to 4 out of 14 individuals were producing *Mangifera indica*, *Artocarpus heterophyllus*, and *Persea americana* seedlings. Fruit seeds are generally recalcitrant, meaning they cannot withstand drying and freezing during storage (Lah et al., 2023). As such, these recalcitrant seeds were prone to deterioration under both low and high

Figure 6 . Damage to various species of seedlings: (a) Yellowing and leaf black spot on *Anacardium occidentale*; (b) Leaf wilting; (c) Dryness on *Callophyllum inophyllum* and *Sterculia foetida*; (d)Fungi on *Mangifera indica*

moisture conditions. The seed storage process was a key factor in maintaining the viability of recalcitrant seeds. Syamsuwida et al. (2020) proposed that the simplest way to minimize desiccation was by reducing the transit period as much as possible.

Additional problems related to seedling health were also observed, arising from both biotic and abiotic factors. These included yellowing and leaf spots on *Anacardium occidentale*, dryness in *Callophyllum inophyllum* and *Sterculia foetida*, and fungal attacks on *Mangifera indica*, *Artocarpus heterophyllus*, and *Persea americana* seeds, which posed a risk of rotting and led to seed germination failure (Figure 6). In these cases, seed and seedling handling practices, especially regarding regulation of appropriate light intensity for each species, were still insufficient. Therefore, intensive maintenance efforts should be enhanced to reduce nursery production failures.

4. CONCLUSION

The establishment of the community-based nursery program successfully: (1) encouraged community participation surrounding the forest in supporting the success of the KDU forest restoration and rehabilitation program by providing the necessary planting materials (seedlings), (2) developed twelve competent local community cadres skilled in producing high-quality seedlings, with improved knowledge and skills that may enable their communities to generate more income and, indirectly, reduce dependence on forest resources, and (3) provided additional job opportunities and increased income for the local community. From a financial perspective, the community-based plant nursery proved to be profitable and demonstrated potential as a feasible business model.

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CONFLICT OF INTERESTS

The authors declare there is no conflict of interest.

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