

# Bamboo for Riverbanks Rehabilitation and Economy Empowerment of Local Community of Pitu Village, Pitu Subdistrict, Ngawi Regency, East Java

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**Abstract** Pitu Village, Pitu subdistrict located along the Bengawan Solo River in Ngawi, East Java, is one of the regions with a high risk of flooding due to human activities like as settlement and intensive agriculture along the riverbanks. This phenomena causes soil erosion and crop failure, which reduces the income of the Pitu local community. A rehabilitation strategy is required to resolve this issue, not only for the recovery of the riverbanks but also for the enhancement of the local community's revenue. The objective of this community activity is to educate the public about the use of bamboo species in riverbank restoration (*Dendrocalamus asper*). Bamboo is selected because it has both ecological and socioeconomic benefits. This project was conducted between March and September of 2022 on the Grojogan riverbanks, Bengawan Solo River, Pitu Village, and Pitu Subdistrict. This exercise utilized Focus Group Discussion, lecture, and practice or training as its methods. The population of Pitu Village might simply adopt bamboo species and cultivate them along riverbanks. The community and the community service team from the Silviculture Department planted 1,000 bamboo seedlings. The survival rate of bamboo plantations exceeded eighty percent, and new shoots grew swiftly (5–15 cm for 5 months). Training in bamboo growing and bamboo product processing improved their skills well. The community generates bamboo seedlings successfully through vegetative propagation. In addition, three local communities in Cebongan, Sleman, and Yogyakarta participated in a four-day bamboo processing training program. They were also producing some tables, chairs, and handicrafts with success (woven bamboo).

## 1. INTRODUCTION

Ngawi Regency is one of the East Java regions with a significant flood risk (Hidayat, 2015). This is because of the area's placement within the Bengawan Solo River, Solo Watershed (DAS). Based on the vulnerability research, Ngawi Regency was the second most important area for flood control after Bojonegoro (Miardiani & Saragih, 2019). According to a research on the level of flood susceptibility in Ngawi Regency, there are four types of flood vulnerability: not vulnerable, less vulnerable, vulnerable, and extremely vulnerable. The percentage of land classified as extremely susceptible was around 26.74%

or 37,249.21 hectares. In addition, Pitu Subdistrict was one of the Subdistricts listed as having flood-prone level (Hidayat, 2015). This phenomena was anticipated due to the concentration of anthropogenic activity along riverbanks, such as settlement growth and intensive agriculture.

Based on the problems stated above, the Silviculture Department proposed a community service program in Pitu Village, Ngawi Regency, East Java through riverbanks rehabilitation and local community empowerment in processing bamboo into some valuable products.

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Vegetation acts as a protector of river banks with their root ability to create soil solidity (Pertiwi et al., 2020). Bamboo is selected as a species/vegetation for conserving the riverbanks area. It is because bamboo is well adapted to a wide variety of soil and climatic conditions across the world (Hossain et al., 2015; Bhowmik, 2019), has fast growth and produces high biomass (Emamverdian et al., 2020). Bamboo also plays a significant function in terms of economic value. The bamboo shoot is used for housing, crafts, pulp, paper, panels, boards, veneer, flooring, roofing, and fabrics, among other things (Hossain et al., 2015; Li & He, 2019; Bhowmik, 2019). In addition to protecting riverbanks from soil erosion and flooding, it is anticipated that the success of bamboo-based riverbank rehabilitation would allow for the widespread planting of bamboo and offer sufficient material for the production of a variety of valuable goods. Consequently, bamboo can serve as an alternate or supplementary source of indirect income for Pitu Village.

## 2. METHOD

This activity was conducted in Pitu Village, Ngawi Regency, East Java, from March to September 2022. Up to sixteen individuals of Pitu Village were expected to participate. The activities are: (1) Focus Group Discussion / FGD or Rapid Participatory Evaluation, (2) Establishment of a Bamboo Plantation Plot, (3) Training to Develop Bamboo Nursery or Propagation, and (4) Training on Bamboo Processing. Pitu Village, students, and faculty from the Silviculture Department of the Faculty of Forestry at Universitas Gadjah Mada attended the FGD. The FGD sought an in-depth insight into the flood disaster situation in Ngawi Regency and how the community perceives the issue. In addition to delivering a lecture, the community service team introduced the rehabilitation and local community empowerment program. To determine whether or not the establishment of the bamboo plantation demonstration plot was effective, a monitoring activity was conducted to determine the proportion of living and growing bamboo. In addition, the impact of the activities on the community was evaluated qualitatively using observation and output-based evaluation. The description of each sub-activity (i.e., creating a bamboo nursery, including bamboo propagation skills, and producing bamboo-based items) was evaluated using the community's product outcomes to illustrate the impact of community service activities.

## 3. RESULT AND DISCUSSION

FGD was carried out on Saturday, March 19, 2022, from 18:00 to 21:00 WIB (Figure 1 (a)). Based on the discussion, the local community of Pitu Village faced the problem of soil erosion and flooding, which regularly happened on Grojogan riverbanks when the rainy season comes. This phenomenon had a negative impact on crop yields (i.e., crop failure) that significantly decreased the community's income. Previously, Grojogan riverbanks were occupied by grass, shrub, corn, and banana (Figure 1 (b)) which have less mechanism to prevent soil erosion and flood disaster.

To overcome these problems, Grojogan riverbanks should be rehabilitated and conserved. Vegetation is the key point of the riverbank's conservation. Local communities were recommended to plant fast tree species with good root



**Figure 1 .** (a) FGD between the community service team of Department Silviculture and the local community of Pitu village; (b) Grass, shrub, corn, and banana grown at Grojogan river banks

systems to create soil solidity. One of the potential species is bamboo (Figure 2 (a)). Bamboo has a rapid growth rate, and its dense root system spreads in all directions (Abadega & Abawaji, 2021). The system contributes to the stability of riverbanks; in addition to deep roots, bamboo plants facilitate absorption into the soil or are beneficial in water conservation. The ability of bamboo plants to absorb rainwater is quite large (interception). Therefore, bamboo can reduce the potential for runoff and erosion (Pertiwi et al., 2020). Of this explanation, local communities of Pitu Village agreed to plant bamboo species. On Sunday, March 20, 2022, from 07.00 to 13.00 WIB, as many as 1,000 bamboo plants (*Dendrocalamus asper*) were planted at the Grojogan riverbanks (Figure 2 (b)). *Dendrocalamus asper* is selected because the local communities have already familiar with it, thus, it could be easier to be adopted. *D. asper* is one of the popular bamboo species with various uses and has a wide range from lowland to upland areas (Jihad et al., 2021).

Monitoring activities were conducted to evaluate the success of the bamboo plantation during September 2022, when the bamboo is 5 months old (Figure 2 (c)). The evaluation revealed that the percentage of living bamboo is significant (above 80%). It shows that bamboo was well adapted to the natural conditions of the Grojogan riverbanks. In addition, the scientists discovered that numerous bamboo plants created new buds that developed into new shoots (5–15 cm in growth). Bamboo is reportedly one of the world's



**Figure 2 .** (a) Bamboo (*Dendrocalamus asper*) seedlings; (b) Bamboo planted in the Grojogan river banks; (c) Monitoring activity of bamboo live percentage and growth

fastest-growing plants. The growth rate of bamboo ranges from 30 mm to 100 mm per day, and it can spread quite rapidly (Akwada & Akinlabi, 2016; Vãn, 2018; Yasin & Priyanto, 2019). These advantages render bamboo efficient for preventing soil erosion and enhancing soil quality and hydrologic function (Emamverdian et al., 2020; Vijay & Berry, 2022). In a short amount of time, bamboo also maintains and recovers native sustainable ecosystems, protects and improves ecosystem services, and manages habitats for other species (Bhowmik, 2019).

Growing bamboo starts with the sourcing of materials for planting. Such materials may come in the form of seeds (generative). However, bamboo is difficult to propagate generatively using seeds, due to its long interval of flowering. Thus, bamboo is propagated vegetatively using rhizomes or offsets, culms cuttings, branch cuttings, layering, and tissue culture (Kenya Forestry Research Institute, 2017; Bhowmik, 2019; Vijay & Berry, 2022). The propagation of high-quality seedlings is an essential aspect of the rehabilitation effort. Team taught the residents of Pitu Village how to grow bamboo so that they can generate bamboo seedlings independently in the future. If the local community can build a good nursery, they will also be able to supply others with bamboo seedlings. It has the potential to become a bamboo nursery. This training introduced propagation strategies and the fundamental conditions required for vegetative proliferation, such as site preparation for controlling air humidity and light intensity or shading, waterlogging or watering, and winds. Additionally, the introduction of many types and characteristics of rooting medium and how to protect seedlings from pest and disease damage was delivered.

Bamboo provides not just ecological benefits but also significant economic importance (Abadega & Abawaji, 2021; Paudyal et al., 2022). The strength, straightness, and lightness of the culms, combined with the bamboo's hardness, range of size, hollowness, long fibre, and workability, make it appropriate for a number of applications. Arrows, baskets, beds, blinds, boats, bottles, bows, bridges, brooms, brushes, crat-yokes, chairs, chopsticks, coffins, coms, containers, cooking utensils, fences, fish traps, fishing nets, fishing roads, flagpoles, flutes, flower pots, fuel, furniture, hats, handicrafts, house construction, etc. are a few of the uses. Additionally,

bamboo tender shoots can be used to make pickles and curries (Emamverdian et al., 2020; Li & He, 2019; Bhowmik, 2019). Bamboo provides not just ecological benefits but also significant economic importance (Abadega & Abawaji, 2021; Paudyal et al., 2022). The strength, straightness, and lightness of the culms, combined with the bamboo's hardness, range of size, hollowness, long fibre, and workability, make it appropriate for a number of applications. Arrows, baskets, beds, blinds, boats, bottles, bows, bridges, brooms, brushes, crat-yokes, chairs, chopsticks, coffins, coms, containers, cooking utensils, fences, fish traps, fishing nets, fishing roads, flagpoles, flutes, flower pots, fuel, furniture, hats, handicrafts, house construction, etc. are a few of the uses. Additionally, bamboo tender shoots can be used to make pickles and curries (Emamverdian et al., 2020; Li & He, 2019; Bhowmik, 2019).

Local communities of Pitu Village are familiar with bamboo and its product. However, they did not have enough knowledge and capability to process raw bamboo to become a more valuable product that can increase their income. To empower the local community, the community services team conducted training on bamboo product processing. The Pitu community (represented by 3 persons) was asked to study how to process raw bamboo at Cebongan, Sleman, Yogyakarta for 4 days. In this place, they got: (1) the training material (introduction to bamboo species variety and its utilization), (2) practice on making simple furniture until the finishing process, and (3) practice on making handicrafts (bamboo woven) (Figure 3 (a), Figure 3 (b)). They also visited the bamboo industry to understand that bamboo is a promising bus that can increase the community's income. During 2 days, they could produce 3 simple pieces of furniture and bamboo products (Figure 3 (c), Figure 3 (d)). In this case, the capability of each participant is categorized as excellent because normally one product needs 3 days or more to be finished. It showed that the participants have a good talent for developing such entrepreneurial skills.

Overall, the community services activities in Pitu Village has had a great impact on society. According to the evaluation method, the results show that the form of social impact in Pitu Village varied. For instance, it improved knowledge related to the introduction of bamboo propagation, nursery development, bamboo-based



**Figure 3 .** (a) Training in making furniture products; (b) Training in making bamboo woven; (c) Chair and table made by the local community of Pitu Village; (d) Bamboo woven made by the local community of Pitu Village

fertilizer, bamboo-based furniture product. During two days, they could produce three simple pieces of furniture and bamboo products (Figure 3 (c), Figure 3 (d)). In this case, the capability of each participant is categorized as excellent because, normally, one product needs three days or more to be finished. It showed the participants have a good talent for developing such entrepreneurial skills. Moreover, the society has a capability to develop bamboo-based product such as fertilizer and furniture.

#### 4. CONCLUSION

The rehabilitation of Grojogan riverbanks, Bengawan Solo River using bamboo is expected to preserve the riverbanks from soil erosion and flood disaster. Local communities of Pitu Village are welcome to adopt bamboo species for this rehabilitation. Bamboo plantations showed a high percentage of live (>80%) and growth rapidly (5–15 cm). Bamboo supports an ecological service and provides a high economic value since it can be processed into many useful products. Through training activities, the local community of Pitu Village can propagate and produce bamboo seedlings by themselves. They can also improve their skills to make some bamboo products, such as a chair, tables, and bamboo weaves for handicrafts with high economic value. In the future, community service may continue to guide the local community to promote their products and start the bamboo business independently.

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#### CONFLICT OF INTERESTS

There is no conflict of interest occurred related to this publication. The manuscript submitted is our original work that has not been published elsewhere nor is being considered in other journal publications. The authors confirm that the manuscript has been read and approved by all named authors and that are no persons who satisfied the

criteria for authorship but are not listed. All authors have been notified and approved of the corresponding author as the only contact regarding the manuscript's submission, revision, and approval processes.

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