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Analysis of the Availability and Distribution of Forestry Seeds to Support Sustainable Development and Ecological Sustainability of Forest Rehabilitation Programs in Bengkulu Province

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Abstract

The availability of quality forestry seeds and an efficient distribution system are key factors in supporting the success of the Forest and Land Rehabilitation (RHL) program. This study aims to analyze seed availability, distribution patterns, and various challenges in the forestry seed system in Bengkulu Province. The approach used is a literature study with descriptive analysis based on secondary data sourced from government agency reports and scientific publications. The study results indicate that Bengkulu Province has significant forest resource potential, but the availability of quality seeds remains inadequate and their distribution is uneven. The Community Seed Garden (KBR) program has contributed to the provision of seeds, although it still faces various obstacles, such as logistical and institutional constraints, and limited certified seeds. Therefore, strengthening the seed system based on local seed sources, accompanied by increasing institutional capacity, is a strategic step to support sustainable development and maintain the sustainability of ecological functions.

Keyword: forestry seeds, RHL, Bengkulu, seed distribution, sustainability.

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INTRODUCTION

Forests have a strategic role in maintaining ecosystem balance while supporting environmental development in Indonesia, including through the function of water management, carbon storage, erosion control, and biodiversity protection (Kementerian Lingkungan Hidup dan Kehutanan, 2023); (Santoso, 2021). In Bengkulu Province, the existence of forests is also very important as a buffer for River Basin Areas (DAS), protectors of coastal and mountainous areas, and as a source of community livelihoods (Badan Pusat Statistik Provinsi Bengkulu, 2024). However, various pressures such as deforestation, forest degradation, and land conversion continue to occur, which have an impact on the decline in the area and quality of forest cover and increased disaster risks (Food and Agriculture Organization of the United Nations (FAO, 2022); (KLHK, 2023).

As a recovery effort, the government implemented the Forest and Land Rehabilitation (RHL) program, with BPDAS Ketahun as the main implementer in the Bengkulu region (Kementerian Lingkungan Hidup dan Kehutanan, 2024); Bengkulu Province Environment and Forestry Service, 2023). The success of this program is greatly influenced by the availability of quality seeds and seedlings that are suitable for local ecological conditions (Nugroho, 2020); Kementerian Lingkungan Hidup dan Kehutanan, 2019). However, its implementation in the field still faces various obstacles, such as limited local seeds, uneven distribution, and lack of data and coordination between stakeholders (Widjayanti, 2022;Kementerian Lingkungan Hidup dan Kehutanan, 2023).

Within the framework of sustainable development, an effective seed system aims not only to meet planting needs but also to maintain genetic diversity and enhance ecosystem resilience. Therefore, a study of the availability and distribution of forestry seeds in the Ketahun BPDAS working area is crucial for identifying existing problems and formulating strategies that can support successful forest rehabilitation, both from an ecological and socioeconomic perspective.

METHOD

Research Approach

This study employs a descriptive qualitative approach using a library research method. This approach was selected to obtain a comprehensive understanding of the availability and distribution of forestry seeds, encompassing policy, institutional, and implementation aspects of the Forest and Land Rehabilitation (RHL) program in Bengkulu Province. The descriptive qualitative method enables the researcher to systematically describe existing phenomena based on available secondary data, without manipulating or intervening in the variables under study (Sugiyono, 2019).

Data Sources

This study relies on secondary data drawn from a range of credible and relevant references, organized into three primary categories: government reports, policy documents, and scientific literature. Government reports include official publications from the regional government of Bengkulu Province as well as data from relevant agencies such as the Department of Environment and Forestry (DLHK) and the River Basin Management Center (BPDAS). Policy documents encompass legislation pertaining to forestry plant seeds, technical guidelines for forest rehabilitation, and seed certification systems. Scientific literature includes national and international journal articles, academic books, and research reports related to forestry seed production and forest rehabilitation.

Data Collection Techniques

Data collection was conducted through a systematic literature study involving several sequential stages. These stages included identifying relevant literature using keywords such as forestry seeding, forest and land rehabilitation (RHL), and Bengkulu; selecting sources based on their relevance, credibility, and year of publication, with priority given to publications within the last ten years; and reviewing and extracting key information pertaining to the availability, distribution, and challenges of the seed system. The source selection process was carried out rigorously to ensure that the data used were accurate, current, and scientifically accountable.

Data Analysis Techniques

Data analysis was conducted using qualitative content analysis, which consisted of three stages. The first stage, data reduction, involved filtering and grouping relevant data and classifying information into major themes such as seed availability, distribution systems, and existing constraints. The second stage, data display, involved organizing data in the form of descriptive narratives, tables, and cross-source comparisons to illustrate the actual conditions of the forestry seed system in Bengkulu. The third stage, conclusion drawing and verification, involved identifying patterns, relationships, and trends within the collected data, while simultaneously developing interpretations of relevant problems and potential solutions.

Analytical Framework

This study employs an analytical framework that integrates several core aspects in a coherent manner. The framework encompasses the components of the forestry seed system, including seed sources, production, certification, and distribution; the dimensions of sustainable development, comprising ecological, economic, and social aspects; and the indicators of forest rehabilitation success, which include seed quality, availability, and planting success rates. The integration of these three aspects aims to provide

a holistic and systematic picture of the state of forestry seeding in support of the RHL program in Bengkulu Province.

Data Validity

To ensure the validity of the data, this study applied several validation techniques. First, source triangulation was employed by comparing data obtained from government reports, policy documents, and scientific literature to achieve consistent and reliable information. Second, content validation was conducted by cross-referencing information from multiple sources to verify the consistency and accuracy of the data. Third, the use of credible sources was prioritized, with emphasis placed on official government documents and peer-reviewed scientific journals as the primary basis for analysis.

Research Limitations

This study is subject to limitations arising from its exclusive reliance on secondary data, which may not fully reflect actual field conditions. Available secondary data do not always provide detailed or up-to-date information on the dynamics of forestry seeding at the site level. Accordingly, the findings of this study should be followed up with further research employing quantitative approaches or field surveys in order to obtain more detailed, representative, and accurate data.

Research Objectives

Based on the problems identified and the analytical framework established, this study aims to: (1) analyze the level of forestry seed availability in Bengkulu Province; (2) analyze patterns of forestry seed distribution within the Forest and Land Rehabilitation program; (3) identify factors that inhibit seed availability and distribution; (4) evaluate the contribution of forestry seeds to ecological sustainability and sustainable development; and (5) formulate strategies to optimize the availability and distribution of forestry seeds in Bengkulu Province.

RESULTS AND DISCUSSION

Conditions of Forestry Seed Availability in Bengkulu

a. Seed Production and Provision

Based on 2024 data, the number of forestry seedlings distributed to communities in several areas of Bengkulu Province was recorded at around 23,681. The seedlings distributed included forestry plant species and MPTS (Multi-Purpose Tree Species), such as avocado, mango, durian, guava, and matoa. In addition, there were also plants typical of coastal areas, including mangroves (Rhizophora), sea pine, coconut, and ketapang. The selection of these types was based on considerations of dual functions, namely ecological value and economic potential, so that they can support rehabilitation activities while providing benefits to the community (Kementerian Lingkungan Hidup dan Kehutanan, 2023.Widjayanti, 2022)

Seedling distribution showed regional variation. Bengkulu City received approximately 6,300 seedlings, Rejang Lebong Regency approximately 5,330 seedlings, Central Bengkulu Regency approximately 3,260 seedlings, and Mukomuko Regency and Seluma Regency received approximately 8,791 seedlings in total. This pattern reflects efforts to ensure equitable planting across various regions, including highlands, river basins, and coastal areas vulnerable to degradation Pusat Statistik Provinsi Bengkulu, 2024; Dinas Lingkungan Hidup dan Kehutanan Provinsi Bengkulu, 2023).

However, the number of distributed seedlings is still relatively limited compared to the area of critical land and the forest and land rehabilitation (RHL) targets that continue to increase from year to year in Bengkulu Province. This condition indicates that the production and distribution capacity of seedlings is still unable to meet the maximum needs (Kementerian Lingkungan Hidup dan Kehutanan 2024. ; Nugroho, 2020)In addition, various obstacles in the seed system, such as limited sources of certified seeds, uneven distribution, and obstacles to access to certain locations, also affect the effectiveness of rehabilitation implementation in the field (Widjayanti, 2022).

Therefore, efforts are needed to strengthen the forestry seedling production and distribution system, designing it in a more structured and sustainable manner. Possible steps include increasing nursery capacity, optimizing the use of local seed sources, and strengthening coordination between stakeholders. These efforts are crucial to ensuring sufficient seedling availability, both in quantity and quality, thereby supporting successful ecosystem restoration and sustainable development in Bengkulu Province.(Food and Agriculture Organization of the United Nations FAO), 2022; Kementerian Lingkungan Hidup dan Kehutanan, 2023).

b. Diversity of Seed Types

The types of plants used in Forest and Land Rehabilitation (RHL) activities in Bengkulu Province are relatively diverse, including forestry plants (woody), multi-purpose plants (MPTS/ Multi Purpose Tree Species), and coastal plants such as mangroves. This selection of species is intended to restore the area's ecological function while providing added economic value to the community, particularly through the utilization of non-timber forest products and fruit commodities. (Kementerian Lingkungan Hidup dan Kehutanan, 2023; (Dinas Lingkungan Hidup dan Kehutanan Provinsi Bengkulu, 2023).

However, in practice, plant selection tends to be limited to those readily available in nurseries or with sufficient stock. Furthermore, fast-growing plants with high economic value, such as sengon, acacia, and various commercial fruit trees, often dominate over local or endemic species.(Nugroho, 2020; Widjayanti, 2022)This is influenced by the limited availability of local seed sources, pressure to meet planting targets, and considerations of short-term economic benefits.

This tendency toward the dominance of certain species has the potential to negatively impact ecological conditions. If not balanced with local species diversity, this can lead to stand homogeneity and a decline in biodiversity. However, the use of local species with high genetic diversity is crucial for increasing plant adaptation to environmental conditions, including climate change and pest and disease attacks.(Food and Agriculture Organization of the United Nations FAO), 2022; Santoso, 2021In addition, species diversity also plays a role in restoring the overall function of the ecosystem, such as maintaining soil stability, improving the water cycle, and providing habitat for animals.

Therefore, a more balanced approach is needed in determining plant species for RHL activities in Bengkulu. Species selection should take into account various aspects in an integrated manner, such as seed availability, site suitability, economic value, and the importance of local species conservation. With this approach, rehabilitation success is expected to be measured not only by the number of plants planted, but also by the ecological quality and long-term sustainability of ecosystem function.(Kementerian Lingkungan Hidup dan Kehutanan, 2024; Widjayanti, 2022).

Forestry Seed Distribution System

The distribution of forestry seeds and seedlings in Bengkulu Province is carried out through various mechanisms involving many parties. These include direct distribution by government agencies such as the BPDAS (Regional Agency for the Assessment and Application of Forestry) and the Environment and Forestry Department (DLHK), community-based programs such as the People's Seed Garden (KBR) or Village Seed Garden (KBD), and the provision of seedlings from permanent nurseries managed by the government or partners. These various schemes aim to expand distribution reach while increasing community participation in Forest and Land Rehabilitation (RHL) activities (Kementerian Lingkungan Hidup dan Kehutanan, 2023.Dinas Lingkungan Hidup dan Kehutanan Provinsi Bengkulu, 2023)

However, in practice, the distribution process still faces several obstacles. Bengkulu's geographical conditions, dominated by hilly areas, river basins, and coastal areas with limited access, present challenges in distributing seedlings to planting sites. Furthermore, limited transportation facilities and infrastructure, such as inadequate roads and difficult access to rehabilitation sites, also slow down the distribution process (Kementerian Lingkungan Hidup dan Kehutanan, 2024).

Another equally significant issue is the mismatch between seed distribution and the planting season. In some cases, seedlings are only received after the ideal planting time has passed, resulting in low success rates. Planting that doesn't coincide with the growing season can potentially cause plant stress, water shortages, and even death, especially in unfavorable climates.(Nugroho, 2020; Food and Agriculture Organization of the United Nations (FAO), 2022)This confirms that timely distribution is an important factor in the seed system.

Therefore, efforts are needed to improve seed and seedling distribution management, including through more targeted logistics planning, improved supporting infrastructure, and adjustments to distribution schedules in line with the planting season calendar in each region. These steps are expected to increase the effectiveness of the RHL program, not only in achieving planting targets but also in ensuring optimal and sustainable plant growth.(Widjayanti, 2022; Kementerian Lingkungan Hidup dan Kehutanan, 2023).

The Role of Institutions and Society

The forestry seed institutional system in Bengkulu Province involves various parties with mutually supportive functions in implementing the Forest and Land Rehabilitation (RHL) program. The primary government role is played by agencies such as the Environment and Forestry Agency (DLHK) and the Ketahun Water Resources Development Agency (BPDAS), which are responsible for planning, seed supply, and activity supervision. Meanwhile, forest farmer groups play a direct role in the field, implementing

activities from seedling production to planting and maintenance.(Kementerian Lingkungan Hidup dan Kehutanan, 2023; Dinas Lingkungan Hidup dan Kehutanan Provinsi Bengkulu, 2023).

One effort to increase community involvement is through the People's Seed Garden (KBR) program. This program is considered effective because it not only encourages active community participation in seed provision but also provides direct economic benefits. In this scheme, communities are not only recipients of aid, but also act as seed producers that support rehabilitation activities in their own areas (Kementerian Lingkungan Hidup dan Kehutanan, 2024. Nugroho, 2020)In its implementation, the choice of plant types is often directed more towards high-value economic commodities, such as durian, petai, and rubber, because they are considered to be able to provide long-term benefits in addition to ecological benefits.

However, strengthening seed institutions still faces several challenges. One of the main challenges is the limited technical capacity of farmer groups in managing seeds and nurseries. This includes selecting seed sources, using appropriate nursery techniques, and controlling seedling quality. Furthermore, the availability of certified seeds with guaranteed genetic and physiological quality remains limited, which can impact successful plant growth in the field.(Widjayanti, 2022; Kementerian Lingkungan Hidup dan Kehutanan, 2023).

Another prominent issue is the lack of ongoing support from relevant agencies. Support in the form of training, outreach, and monitoring remains suboptimal, even though these aspects are crucial for building community capacity and ensuring that seed production and planting activities are carried out according to technical standards.(Food and Agriculture Organization of the United Nations (FAO), 2022; Nugroho, 2020).

Therefore, strengthening seed institutions in Bengkulu needs to focus on increasing human resource capacity, providing broader access to quality, certified seeds, and developing an integrated and sustainable mentoring system. These efforts are expected to improve the quality and quantity of seed production, while simultaneously supporting the success of forest rehabilitation from both ecological and socioeconomic (Kementerian Lingkungan Hidup dan Kehutanan, 2024perspectives .Widjayanti, 2022)

Analysis of Main Problems

The results of a study on the forestry seed system in Bengkulu Province indicate a number of major problems that influence the effectiveness of the implementation of the Forest and Land Rehabilitation (RHL) program.

One of the main problems relates to the limited availability of quality seeds. In practice, seeds used are not entirely sourced from certified seed sources that guarantee genetic and physiological quality. As a result, the resulting seedlings tend to be of inconsistent quality, potentially reducing the success of plant growth in the field.(Kementerian Lingkungan Hidup dan Kehutanan, 2023; Widjayanti, 2022). In addition, seeds that do not meet standards also tend to have lower adaptability to local environmental conditions.

The next problem relates to seedling production capacity, which is still not keeping pace with the need for critical land rehabilitation at the provincial level. The number of seedlings produced each year remains relatively small, while the area requiring rehabilitation is much larger. This indicates that the capacity of nurseries, both permanently managed and community-managed, is still unable to optimally meet demand (Dinas Lingkungan Hidup dan Kehutanan Provinsi Bengkulu, 2023; Nugroho, 2020).

On the other hand, the seed and seedling distribution mechanism has also not been operating effectively. Distribution has not fully considered the specific needs of each location (site-specific), resulting in some cases in the type and quantity of seedlings received that do not match local biophysical conditions, such as soil characteristics, microclimate, or area function. This inaccuracy can reduce the success rate of rehabilitation and reduce the efficiency of resource utilization.(Kementerian Lingkungan Hidup dan Kehutanan, 2024; (Food and Agriculture Organization of the United Nations (FAO), 2022).

In addition to these technical aspects, there is also a tendency in plant selection to prioritize economic value over ecological function. While the use of fast-growing or commercially valuable plants does provide economic benefits to communities, if not balanced with species diversity, it can lead to stand homogeneity. This condition has the potential to reduce biodiversity and weaken the forest's ecological function in the long term.(Santoso, 2021; Widjayanti, 2022)

Overall, these various issues reflect that the forestry seed system in Bengkulu still requires comprehensive improvement. Strengthening of seed source quality, increasing production capacity, improving distribution, and balancing economic interests with ecological sustainability are necessary. These improvement efforts are crucial for the success of a sustainable forest rehabilitation program (Kementerian Lingkungan Hidup dan Kehutanan, 2024).

3.5 Implications for Sustainable Development

Limited availability of forestry seeds and a suboptimal distribution system can significantly impact the success of the Forest and Land Rehabilitation (RHL) program. One consequence is low planting success rates, as the seeds used do not always come from quality sources or are not suited to the characteristics of the planting location. This situation has the potential to lead to high plant mortality rates and ultimately reduce the overall effectiveness of rehabilitation activities.(Kementerian Lingkungan Hidup dan Kehutanan, 2023; Nugroho, 2020).

Furthermore, limited seed availability, both in terms of species and genetic diversity, has the potential to reduce biodiversity. The use of plant species that tend to be uniform results in a less varied ecosystem structure and composition, thus diminishing the ecological function of forests as habitats for various flora and fauna.(Santoso, 2021; Widjayanti, 2022)In the long term, this can trigger ecosystem imbalances, including disruptions to the hydrological cycle, soil stability, and the forest's ability to adapt to environmental changes.

On the other hand, a well-designed and managed, sustainable seed system can have significant positive impacts. The availability of superior seeds from appropriate sources increases the chances of successful plant growth, allowing for more effective ecosystem restoration and land cover. The use of diverse plant species suited to local conditions also contributes to increased carbon sequestration, which plays a role in climate change mitigation efforts.(Food and Agriculture Organization of the United Nations (FAO), 2022; Kementerian Lingkungan Hidup dan Kehutanan, 2024b).

Not only from an ecological perspective, improving seed systems can also support increased community welfare through the utilization of economically valuable plants, such as non-timber forest products and fruit trees. Community involvement in seed production activities, including through the Community Seed Garden (KBR) program, contributes to empowerment and strengthens the local economy (Nugroho, 2020). Overall, a well-managed seed system will increase ecosystem resilience in the face of various pressures, including climate change, and support the sustainability of forestry development as a whole.(Widjayanti, 2022; Food and Agriculture Organization of the United Nations (FAO), 2022).

Strategy for Strengthening Seed Systems in Bengkulu

To improve the performance of the forestry seed system in supporting the success of the Forest and Land Rehabilitation (RHL) program in Bengkulu Province, it is necessary to implement various integrated and sustainable strategies.

First, developing local seed sources needs to be a top priority. Utilizing native or local species from Bengkulu is crucial for maintaining biodiversity and improving plant adaptability to local environmental conditions. Seeds from local sources generally have greater resistance to various environmental stresses, such as climate change, pest attacks, and disease.(Widjayanti, 2022; Santoso, 2021).

Second, increasing nursery capacity is a crucial step to ensure the availability of quality seedlings. This can be achieved through the implementation of more modern nursery technologies, such as proper planting medium management, efficient irrigation systems, and optimal seed quality control. Furthermore, strengthening human resources through technical training and mentoring is also necessary to ensure the seedling production process meets established standards (Nugroho, 2020; Kementerian Lingkungan Hidup dan Kehutanan, 2023).

Third, improvements to the seed and seedling distribution system need to be made, taking into account the specific needs of each region (site-specific) and the appropriate planting time. Distribution tailored to biophysical conditions and the planting season calendar will increase the success rate of plant growth and the efficiency of rehabilitation implementation.(Food and Agriculture Organization of the United Nations (FAO), 2022; Kementerian Lingkungan Hidup dan Kehutanan, 2024).

Fourth, strengthening institutions within the seed system is crucial for ensuring sustainability. Closer collaboration between the government, communities, and the private sector is needed to improve coordination, efficiency, and access to resources and technology. Strong institutions also play a role in monitoring seed quality and ensuring effective distribution (Kementerian Lingkungan Hidup dan Kehutanan, 2023;Dinas Lingkungan Hidup dan Kehutanan Provinsi Bengkulu, 2023).

Fifth, the implementation of digitalization in the seed system is an innovation that can increase transparency and management efficiency. Through a digital-based information system, seed availability, nursery production capacity, and seedling distribution can be monitored in real time . This enables faster and more accurate decision-making and reduces the gap between seed demand and availability in the field (Food and Agriculture Organization of the United Nations (FAO), 2022).

Overall, the implementation of these various strategies is expected to strengthen the forestry seed system in Bengkulu, so that it can support the success of the forest rehabilitation program in a more optimal, sustainable, and balanced manner between ecological and socio-economic aspects.

CONCLUSION

The availability and distribution of forestry seeds in Bengkulu Province still face various challenges, particularly in terms of seed quality, production scale, and distribution systems. While programs such as KBR have helped increase seed supply, strengthening a more integrated seed system based on local seed sources and supported by strong institutions is needed. These efforts are crucial to supporting sustainable development and maintaining ecological sustainability in Bengkulu Province.

Based on the analysis, several strategic recommendations are available to improve the effectiveness of forest and land rehabilitation in Bengkulu. These include: strengthening certified seed sources based on local species, improving nursery capacity and technology, and optimizing seed distribution tailored to regional conditions and planting seasons. Furthermore, institutional strengthening is needed through multi-stakeholder collaboration, developing a digital-based seed information system, and diversifying crop types to maintain ecological balance.

On the other hand, continuous monitoring and evaluation are also crucial to ensure program success and adaptive policy improvements. Implementing this strategy is expected to increase the success of forest rehabilitation, improve ecosystem function, support carbon sequestration, and enhance community well-being, as well as the achievement of the Sustainable Development Goals (SDGs).

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