Economic Analysis of Agroforestry Applications by Dryland Forest Farmer Group in Pelambik Village, Central Lombok District, Indonesia

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Abstract. Agroforestry is one of the potential land rehabilitation techniques to provide forest ecosystem services which is needed by people. This study aims to analyze the economic value of agroforestry system as one of rehabilitation plan establishment inputs of degraded forest and dry land in Pelambik Village, Central Lombok District, Indonesia. The data used in this study were the proportion of agricultural crops and socio-economic characteristics of agroforestry farmers, whereby the proportion of plant area was obtained by direct measurements in the field and socio-economic data were collected by interviewing the farmers. Analysis of the agroforestry level was carried out by classification that is in accordance with crop plant area proportion. Economic analysis was conducted by calculating economic feasibility parameters which are farmer revenue, costs, profits and B/C or R/C ratio of agroforestry system. The analysis showed that 41% of the farmers apply initial agroforestry, 35% intermediate and 24% advanced agroforestry. The implementation of agroforestry in the more advance level was conducted by senior farmers such as those who have more family members, larger land area and higher education. The results of the economic analysis indicated that the initial agroforestry has the profit value of IDR. 4,235,142/ha/y (B/C ratio = 1.65), intermediate agroforestry profit IDR. 4,659,293/ha/y (BC ratio = 1.93) and advanced agroforestry IDR. 3,287,166/ha/y (B/C ratio = 2.08). Thus, the implementation of farmer capacity development strategies and the use of silvicultural technology are needed to increase the current productivity of agroforestry in a more sustainable way.

Keywords: Agroforestry · Capacity Development · Economic Value · Land Rehabilitation · Sustainable Environmental Services

1 Introduction

Agroforestry is one of the approaches applied by the community in utilizing forest resources. Agroforestry is a win-win solution strategy to achieve the sustainability of ecological functions and socio-economic functions altogether. Ecologically, in some

A. Amrullah et al. (Eds.): ACCESS 2021, ASSEHR 686, pp. 5–11, 2023.
https://doi.org/10.2991/978-2-494069-21-3_2

cases, agroforestry systems have succeeded in creating a non-monoculture environment, so that the ecological balance is more secure and crop production can increase [1]. Agroforestry also has an impact on hydrological cycle regulation [2]. Socio-economically, agroforestry can increase the income and welfare of the people living around the forest because in terms of time, they can get income from agricultural crops and non-timber forest products (NTFPs). Timber forest products and NTFPs from an agroforestry activity will also provide a long-term economic benefit [3].

The success of agroforestry in realizing sustainable forest management can be a solution to several issues that concern the global community, such as: poverty, food security and global warming [4]. There are a number of challenges in realizing the success of agroforestry, such as government policies, the capacity of communities around the forest, business capital and product marketing [5]. Government policies play an important role, especially in terms of regulating community access to forest resources, providing capacity building and technology in the development of agroforestry as a forest and land rehabilitation system [6].

Central Lombok District has 17.5% forest area from the 120,839 ha of total district area. The forest cover area in Central Lombok Regency is still smaller than the national forest cover area which, according to the standard, ideally encompass 30% of the total area [7, 8]. The potential for decreasing forest cover area in Central Lombok has a downward trend that is in line with the increasing forest destruction due to encroachment, illegal logging, and changes in the function of forest areas into settlements and infrastructure. This can lead to a decrease in environmental quality, including reduced potential for CO2 absorption, decreased soil fertility due to erosion, flooding, and drought [9].

Pelambik Village is one of the villages in Central Lombok Regency which has experienced forest area damage. On one hand, several community groups apply agroforestry techniques on private land outside of the forest area. This agroforestry technique can potentially be adopted as a reference in applying ecosystem rehabilitation techniques [10]. A sustainable ecosystem rehabilitation technique is one that can create a balance between economic, ecological and social aspects of sustainability [11]. Economic information generated from agroforestry activities can be a decisive factor used in determining rehabilitation techniques, especially in determining extension strategies for farmer empowerment [12].

Hence, this study aims to analyze the economic value of applying agroforestry techniques, conducted by dryland forest farmer groups in Pelambik Village, Central Lombok District. This analysis is expected to be one of the considerations for policy makers in determining sustainable forest ecosystem restoration techniques, with which a balanced economic, social and ecological sustainability can be achieved.

2 Material and Method

The research was conducted in Pelambik Village, which is located at the geographical coordinates of 116.15–116.19 East Longitude and 8.77–8.72 South Latitude [7, 8]. Administratively, it is located in Southwest Praya Subdistrict, Central Lombok District, West Nusa Tenggara Province. The object of this research was agroforestry land located

on a land belonging to Pelambik Village. This land is managed by a farmer group outside (buffer zone) of *Pelangan Tastura* Forest Management Unit (FMU) forest area.

The data used in this study were categorized into two based on its sources: primary and secondary data. Primary data consisted of crop plant area proportion and socio-economic characteristics of the farmers, while secondary data was collected from authorized agencies, literature, and other relevant data sources. The crop plant area proportion was obtained by field measurements. Social economic data of the farmers was collected through an interview with 37 active farmer group members. The active farmer group still has collaborative management with *Pelangan Tastura* (FMU) agency, especially in the implementation of land rehabilitations program.

The analysis of agroforestry development level was classified based on the horizontal space for agricultural crop plant cultivation that is in reference to Hani and Suryanto [13]. It consisted of initial agroforestry (Level I) with more than 70% crop plant cultivation area proportion; intermediate agroforestry (Level II) with 20–70% crop plant cultivation area proportion; and advanced agroforestry (Level III) with less than 20% crop plant cultivation area proportion. Economic analysis of each agroforestry development level was conducted by feasibility analysis of agribusiness investment [14], which estimate some parameters, namely profit, revenue, cost, and B/C ratio which generated agroforestry development.

3 Result and Discussion

3.1 Socio Economic Characteristics of Farmers

Based on descriptive analysis of the primary data which have been collected by interviewing the farmers, it is discovered that 41% of the farmers applied initial agroforestry, around 35% of the farmers applied intermediate agroforestry and 24% of the farmers applied advanced agroforestry. The initial level of agroforestry was dominated by farmers with an average age of less than 45 years old, average family member of 3 people, less than 0.5 ha land area. In addition, in regards to the education levels, most of the farmers in this category either did not get basic education or only went to primary school. In contrast, the higher agroforestry development level was dominated by the more senior farmers with larger family members and land, as well as higher education levels (Fig. 1).

Ruhimat in his research explained that there was a close relationship between socio-economic characteristics in awakening farmers' perceptions and motivations in implementing agroforestry systems more intensively [15]. In addition, Rustandi et al., in their research stated that the strategy to increase farmer productivity can be done by increasing capacity through farmer groups, access to information, education-training and intensive counseling strengthening [16]. Sjah et al. further explained that in order to increase the success of an extension, farmers and resource-centered approach were needed. Capacity building must also be accompanied by agroforestry management institution strengthening. Wulandari et al., elucidated that several aspects that support the development of agroforestry institutions in a more sustainable manner are incentives provision, infrastructure and organization strengthening, reward and punishment, access and collaborative management [17].

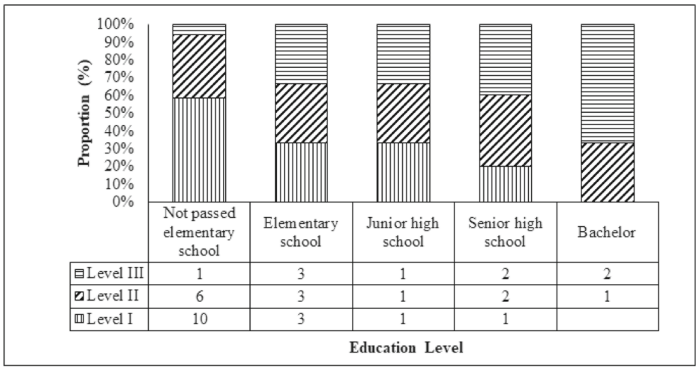

Fig. 1. Education level of agroforestry farmers in Pelambik Village

3.2 Economic Value of Agroforestry

Based on economic analysis result, it was found that intermediate agroforestry (Level II) with a balanced composition of agricultural crop plant that is rainfed paddy plant (*Oryza sativa L.*); fruit plant consisting of banana (*Musa paradisiaca L.*), coconut (*Cocos nucifera L.*), mango (*Mangifera indica*) and jack fruit (Artocarpus heterophyllus); and tree plants including teak (*Tectona grandis*) and silk tree (*Paraserianthes falcatari*a) has higher profit (IDR 4,659,293,-/ha/y) compared to initial (profit = IDR 4,235,142/ha/y) and advanced agroforestry development level (profit = IDR 3,287,166/ha/y).

By intensively balancing the proportion of the crops and the tree plant, the intermediate agroforestry level was able to provide optimal growth for both agricultural and forestry plants. The agricultural crop component at this level was able to provide short-term income for farmers, while forestry tree plants provided medium-term income by producing non-timber forest products (NTFs) which are fruits. Perennials also provide long-term income for farmers by producing timber forest products which can be harvested in 5 years for silk tree and in 8–10 years for teak, mahogany (*Swietenia macrophylla*) and gmelina (*Gmelina arborea*). The concept of intensification and diversification of plant species in this system would provide various alternative sources of income for farmers in the short, medium, and long run.

On the other hand, with a larger proportion of the agricultural sector, the agroforestry products for the initial agroforestry development level were dominated by rainfed paddy plants which required intensive resource inputs requiring higher production costs. This was indicated by a lower B/C ratio value. While at advanced agroforestry level, forest farmers in Pelambik Village did not intensify the land to plant shade-tolerant agricultural crops such as tubers and shade tolerant herbs. This causes short-term income from agricultural crops being considered as improper. Although the costs incurred were lower and the B/C ratio was higher, the advanced agroforestry development level would not be suitable for farmers with limited land area. This pattern was applied by more farmers who had excess land area with a wider alternative source.

There are some key factors that contribute to the success of agroforestry development, namely (1) the selection of species; and (2) maintenance and spatial arrangements that focused on light capture and root systems. These things were all required by both plants

optimally by maximizing existing land resources and minimizing unfavorable competition between plants that make up agroforestry [18]. The selection of agroforestry plant species should be made by considering a balance in the economic, social and ecological aspect to ensure the sustainability of their management [19]. From the ecological aspects, the selection of plants tends to consider the objectives of ecosystem service provision such as regulating hydrological balance [20], carbon sequestration or CO2 emission reduction [21] and preservation of biodiversity [22]. From socio-economic aspect, the selection of agroforestry plants can be carried out by considering market demand and community culture with the potential to support the forestry [23]. Agroforestry can be developed as a producer of food variety sources to support tourism activities [24, 25].

4 Conclusion

Based on the result of the analysis, it was discovered that 41% of the farmers in Pelambik Village applied initial agroforestry, 35% applied intermediate agroforestry and 24% applied advanced agroforestry. The higher agroforestry development level was dominated by older farmers with a larger number of family members, a wider area of agroforestry land and a higher level of education. The result of the economic analysis showed that the intermediate development level with a balanced proportion of agricultural crop plant and forestry perennial tree plant produces a higher profit of IDR. 4,659,293,-/ha/y than the initial development level (IDR. 4,235,142,-/ha/y) and advanced level (IDR 3,287,166,-/ha/year). The establishment of growing space in the land and the selection of plant species that generate short, medium, and long-term economic income were able to provide many sources of income for farmers during the managing of agroforestry. The Agroforestry improvement strategy in Pelambik Village should be conducted by increasing community capacity through extension services, institutional strengthening, and development of agroforestry technology by synergizing spatial arrangements, as well as by selecting plant species to optimally provide various ecosystem services needed by the community.

Acknowledgments. The authors would like to acknowledge Central Lombok District Government, BKPH Pelangan Tastura, Central Lombok BPS, Forest Farmers Group in Pelambik Village and all related parties who give support in the finalization of this research.

Authors' Contributions. NE: Conceptualization, methodology, data collection-analysis, investigation - validation, writing – review and editing; TS: investigation - verification, review-writing and editing. MHI: investigation-verification, writing - review and editing. All authors have read and approved the final manuscript.

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