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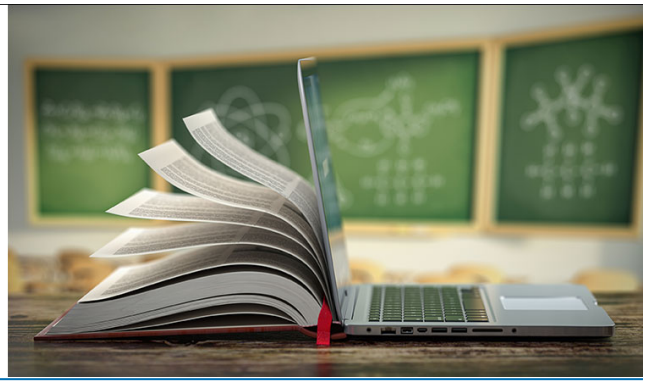

Economic analysis of application two agroforestry combinations in the sloping lands

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Abstract. The degraded lands on sloping lands can be rehabilitated by implementing the two agroforestry systems of Falcataria moluccana (sengon)–Arachis hypogaea (groundnut) and Anthocephalus cadamba (jabon)–Glycine max (soybean). The aims of this research were to estimate the production cost, revenue, and profit of two agroforestry systems of sengon–groundnut and jabon–soybean, analyze their financial feasibility, and and select one of two agroforestry systems for the rehabilitation of the sloping lands. This research calculated the production cost, revenue, profit, Net Present Value (NPV), Benefit Cost Ratio (Net B/C Ratio), and Internal Rate of Returns (IRR). The application of agroforestry system of sengon–groundnut needs production cost and produces revenue and profit also has the NPV and Net B/C Ratio values bigger rather than that of jabon-soybean. Two agroforestry systems of sengon-groundnut and jabon-soybean are feasible to be implemented for rehabilitation the degraded lands on sloping lands. From an economic perspective, the application of the agroforestry system of sengon-groundnut is better compared with that of jabon-soybean to rehabilitate the degraded lands on the sloping lands, and this recommendation is further supported by the hydro-orological and silvicultural aspects.

1. Introduction

Rehabilitating the degraded lands on the sloping lands can be achieved through conservation activity by involving the community. The cultivation technique in the marginal and sloping lands should focus on the integrated environmental factors [1]. Conservation activity aims to prevent moreover degraded land [2]. In this respect, agroforestry has become an alternative method to rehabilitate the sloping lands. Systems of agroforestry combine the cultivation of forestry and agricultural plants. The forestry plants can be planted for soil and water conservation in a long-term program. In the earlier years, it is hoped the agricultural plants will cover the ground.

The combination of plants will determine the success of rehabilitation on sloping lands. Such a combination must satisfy the biogeophysical conditions of the land and be compatible with the social, economic, and cultural aspects of the local community [3]. The previous researches have implemented two agroforestry systems of *Falcataria moluccana* (Miq.) Barneby & J.W. Grimes (sengon)-*Arachis hypogaea* L. (groundnut) and *Anthocephalus cadamba* Mig (jabon)-*Glycine max* (L.) Merrill (soybean) on degraded land at different soil slopes [3][4]. By using an agroforestry system of sengon–groundnut, the land rehabilitation, as well as the soil and water conservations, effectively suppresses the erosion rate to a low erosion hazard [3]. The application of jabon–soybean in a mixed cropping system therefore has the potential to rehabilitate the sloping lands [5].

Previous research has found that the two agroforestry systems of sengon–groundnut and jabon–soybean are applicable from the benefit–loss perspective of project when that research was done [4]. However, their financial feasibility has yet to be explored. Feasibility study is an assesment method to know what project ideas are feasible to be done or not and it is important as foundation to choose the acurate rehabilitation method for critical lands. Evaluation and chosen among some projects are needed to be done because of the scarce resources [6]. The decision can be determined related on investment in one or some projects [7]. Financial analysis is conducted to establish the benefits of a project from the community perspective of those who have direct interests in the project or who invest their capital in it. Therefore, the results of previous research have yet to give recommendations in this respect on the best agroforestry system for the rehabilitation of the sloping lands.

The aims of this research were to estimate the production cost, revenue, and profit of two agroforestry systems of sengon–groundnut and jabon–soybean, analyze their financial feasibility, and select one of two agroforestry systems for the rehabilitation of the sloping lands. This research show the assessment results of two agroforestry systems of sengon–groundnut and jabon–soybean as the methods to rehabilitate the sloping lands.

2. Methods

This research was conducted over six months from July to December 2016, on degraded lands which are categorized as sloping lands in Education Forest, Forestry Faculty, Mulawarman University, East Kalimantan, Indonesia. Cost is calculated from price and quantity of inputs, thus revenue is price of production yield, and meanwhile profit is revenue minus cost [8]. The exchange rate was 1 USD equal with 14,107.80 IDR at 18 November 2020. Financial feasibility was known by using certain investment criterias such as Net Present Value (NPV), Net Benefit Cost Ratio (Net B/C Ratio), and Internal Rate of Returns (IRR). The investment criterias are if Net B/C Ratio $\geq$ 1, NPV $\geq$ 0, dan IRR > i [7]. Selection one of two agroforestry systems was done by comparing the mean of revenue, profit, NPV, Net B/C Ratio of two agroforestry systems then choose the bigger values.

3. Results and discussion

3.1. Production cost, revenue, and profit of agroforestry system of sengon-groundnut

The initial first year is first planting season for groundnut and the production cost for sengon and groundnut planting as much as USD778.65 ha^{-1} [4]. The expected revenue is USD2,977.08 ha^{-1} $year^{-1}$ if there is 3 times groundnut planting throughout a year. It will produce profit as much as USD981.37 in the first year from the agroforestry system of sengon and groundnut. Total cost is estimated as much as USD1,825.59 ha^{-1} for production activity of groundnut in the second year. The revenue will produced from selling groundnut yield at 3 planting season in the second year and it is probably same with the first year. Meanwhile in the third and fourth years, the activities cover sengon maintenance and groundnut planting.

Total cost for sengon maintenance is estimated USD768.72 ha^{-1} in the fifth year. It is no revenue in the fifth year because of no yield selling therefore the loss is predicted USD768.72 ha^{-1}. In the sixth and seventh years, the activities are done similar with in the fifth year. Total cost is predicted as much as USD1,279.08 ha^{-1} in the eight year for maintenance activity and sengon harvesting. The potential revenue is USD12,248.54 ha^{-1} in the eight year. The profit of that activity is predicted as much as USD10,969.46 ha^{-1} in the eight year.

The activity of land rehabilitation and soil conservation by using agroforestry system of sengon and groundnut expands cost as much as USD11,057.71 ha^{-1} with USD1,382.21 ha^{-1} $year^{-1}$ on average. Total and mean of revenues during 8 years are estimated as much as USD24,156.85 ha^{-1} and USD3,019.61 ha^{-1} $year^{-1}$, respectively. Total profit can be reached as much as USD13,099.14 ha^{-1} during 8 years or USD1,637.39 ha^{-1} $year^{-1}$ on average.

3.2. Production cost, revenue, and profit of agroforestry system of jabon-soybean

Total cost is estimated as much as USD 1,889.52 ha^{-1} in the first year for land rehabilitation and soil conservation by agroforestry system of jabon and soybean. The potential revenue is as much as USD 1,240.45 ha^{-1} in the first year, if soybean farming is done until 3 times $year^{-1}$. The loss is predicted as much as USD 649.07 ha^{-1} in the first year. Maintenance of jabon and soybean is continued in the second year. The same activities are also done in the third year.

Farming cost and revenue in the fourth, fifth, and sixth planting seasons is same each USD 554.23 ha^{-1} ps^{-1} . It is estimated the loss as much as USD174.16 ha^{-1} from soybean farming in the second year. Some activities in the fifth, sixth, and seventh years is same with the activities at the fourth year. Total maintenance cost in the eight year is estimated same with the fourth year until the seventh year as much as USD 768.72 ha^{-1}. The potential revenue in the eight year is USD 7,938.59 ha^{-1}. Therefore, the profit of jabon harvesting is estimated as much as USD 6,744.57 ha^{-1} in the eight year.

The agroforestry system of jabon-soybean expands cost as much as USD 9,483.83 ha^{-1} during 8 years with USD 1,185.480 ha^{-1} $year^{-1}$ on average. Total revenue of that activity is predicted USD 12,156.11 ha^{-1} for 8 years with mean revenue reachs USD 1,519.51 ha^{-1} $year^{-1}$. Potential total profit by using agroforestry jabon-soybean is USD 2,672.28 ha^{-1} in 8 years or USD 334.04 ha^{-1} $year^{-1}$ on average.

3.3. Feasibility analysis of the agroforestry system of sengon–groundnut

NPV 12% (USD6,602.58 ha^{-1}) > 0 meant that the agroforestry system of sengon–groundnut is feasible for application. If the funding uses credit (with a mean interest rate of 12%), the application of an agroforestry system of sengon–groundnut can be implemented for now. An investment with a credit fund can result in profit; although the profit level is lower than an investment that does not use a credit fund, it was estimated as much as USD6,602.58 ha^{-1} during 8 years. Meanwhile, if it does not use a credit fund, the capital investment can make profit as much as USD13,099.14 ha^{-1} in the agroforestry system of sengon–groundnut for 8 years.

Net B/C Ratio of 12% was 6.63, meaning that the comparison between the equivalent value (now value) of profit and loss was as much as 6.63. Net B/C Ratio of 12% > 1 indicates that it is feasible to apply the agroforestry system of sengon–groundnut. The investors have the opportunity to achieve profit from the application of that system (although by using their own capital or credit) for now, with a mean interest rate of 12%. The result of this research is similar with the result of other research [9] which showed that B/C ratio values of plantation sengon-pineapple and sengon-papaya in East Java, Indonesia are 6.76 and 6.63, respectively.

3.4. Feasibility analysis of the agroforestry system of jabon–soybean

It is feasible to apply the agroforestry system of jabon–soybean based on the NPV of USD219.76 ha^{-1} by using own fund or credit fund (with the mean interest rate of 12%), as both can produce profit. Total profit was estimated as much as USD219.76 ha^{-1} and can still be achieved in 8 years if the investor uses a credit fund. However, if the investment uses their own fund, the investment in the agroforestry system of jabon–soybean can yield a bigger profit compared to one who uses a credit fund, estimated as much as USD2,672.28 ha^{-1} for 8 years.

Net B/C Ratio of 1.09 indicates that the agroforestry system of jabon–soybean can be applied to rehabilitate the sloping lands. Investors who want to cultivate or develop the jabon–soybean farming in the agroforestry system by using their own capital therefore have the opportunity to get profit. Other investors who have insufficient funds and get capital from credit fund with an interest rate of 12% also have the same opportunity to reach a profit if they develop the agroforestry system of jabon–soybean.

The IRR value shows that NPV = 0 at a discount rate of 14.05%. IRR > interest rate prevails as the social discount rate (12%). The interest rate of loan is still low for now; therefore, if the application of the agroforestry system uses credit, the profit for now (NPV) will not be the same or different with 0. However, if the interest rate of the loan is more than 14.05%, the application of the agroforestry system using credit fund results in a profit as high as 0 for now. The agroforestry system of jabon–soybean can be applied to rehabilitate the degraded land, especially in sloping lands.

3.5. Selection of agroforestry systems

The average of production cost, revenue, profit, NPV, and Net B/C Ratio for the application of the agroforestry system of sengon–groundnut are bigger than that of jabon–soybean (Table 1). If more than a project will be chosen, the decision is if Net B/C Ratio > 1 meant that it is better to choose project with the bigger investment cost and if Net B/C Ratio < 1 meant that it is better to choose project with the smaller investment cost [11]. Factors that determine whether society will adopt agroforestry are its relative profitability with other existing crops as well as the price volatility of wood [12].

Table 1. The economic parameters.

No.	Investment criteria	Sengon–groundnut		Jabon–soybean
1	Mean of production cost	USD1,382.21 ha^{-1} $year^{-1}$	>	USD1,185.48 ha^{-1} $year^{-1}$
2	Mean of revenue	USD3,019.61 ha^{-1} $year^{-1}$	>	USD1,519.51 ha^{-1} $year^{-1}$
3	Mean of profit	USD1,637.39 ha^{-1} $year^{-1}$	>	USD334.04 ha^{-1} $year^{-1}$
4	NPV of 12%	USD6,602.58 ha^{-1}	>	USD219.76 ha^{-1}
5	Net B/C Ratio of 12%	6.63	>	1.09
6	IRR	None unique rate		14.05%

Source: Primary data analyzed (2016).

Table 2. The hydro-orological parameters.

Slope gradient (%)	Agroforestry system	Source	Surface runoff rate (m^3 ha^{-1} $year^{-1}$)	Potential erosion rate (ton ha^{-1} $year^{-1}$)	Erosion hazard index	Erosion hazard level
>8-15	No plantation	[5]	1012.21	45.53	1.82	Low
>15-25	Sengon–groundnut	[3]	794.55	20.05	0.80	Low
	Jabon–soybean	[5]	1095.43	32.13	1.29	Low
>25-45	Sengon–groundnut	[3]	846.61	45.50	3.25	Low
	Jabon–soybean	[5]	1330.89	52.51	2.10	Low

Table 3. The silvicultural parameters.

Slope gradient (%)	Plant	Source	Healthy plant (%)	Survival rate (%)	Ground coverage (%)	Yield (kg ha^{-1})
>15-25	Jabon	[5]	90 (Very good)	90 (Very good)	-	-
	Soybean	[5]	80–89 (Good)	-	70–79 (Moderate)	525
>25-45	Jabon	[5]	90 (Very good)	90 (Very good)	-	-
	Soybean	[5]	70–79 (Moderate)	-	60–69 (Low)	485
	Sengon	[15]	90 (Very good)	90 (Very good)	-	-
>45	Sengon	[15]	90 (Very good)	90 (Very good)	-	-

The selection result from economic aspect above is same with selection from hydro-orological aspect (Table 2). The potential erosion rate from the application of the agroforestry system of sengon–groundnut is smaller than that of jabon–soybean [5][13]. Data shows that it is better to apply the agroforestry system of sengon–rather than jabon–soybean on the sloping lands to reduce the surface runoff and prevent the erosion.

The selection results from economic and hydro-orological aspect are also supported with the selection result based on silvicultural aspect (Table 3). Soybean growth is better on a slightly steep slope rather than on a steep slope [14]. The average of soybean yields in the agroforestry system of jabon–

soybean was higher on a slightly steep slope (525 kg ha^{-1}) compared to on a steep slope (485 kg ha^{-1}) [5].

4. Conclusion

The production cost, revenue, and profit from application of agroforestry system of sengon-groundnut are estimated bigger than that of agroforestry system of jabon-soybean. The same things are also shown from the results of feasibility analysis in terms of NPV and Net B/C Ratio. The IRR value could be found in analysis of agroforestry system of jabon-soybean. Two agroforestry systems of sengon-groundnut and jabon-soybean are feasible to be implemented for rehabilitation the degraded lands on sloping lands from the economic aspect.

5. Recommendation

The agroforestry system of sengon-groundnut is better implemented to rehabilitate the degraded lands on sloping lands rather than that of jabon-soybean from economic, hydro-orological, and silvicultural aspects. The agroforestry system of sengon–groundnut is more feasible than that of jabon–soybean when comparing production cost, revenue, profit, NPV, Net B/C Ratio, and IRR values. From the hydro-orological aspect, the agroforestry system of sengon–groundnut is better than that of jabon–soybean at reducing the surface runoff and preventing erosion on sloping lands. The review of the silvicultural aspect shows that the agroforestry system involving planting sengon, jabon or soybean on sloping lands is an excellent practice because of the high rate of both plant health and survival.

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