STUDY ON ECONOMIC OF AGROFORESTRY SYSTEM ON VARIOUS PLANTING PATTERNS OF SEASONAL CROPS IN SUB SUB OF WATERSHED OF CIANTEN – CIPANCAR

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ABSTRACT

Application of vegetative conservation which is highly effective in erosion control is the Agroforestry systems, especially in seasonal crop patternthat are directly related to the productivity of annual crops. The different plantingpattern of seasonal crophasa direct impact on the amount of erosion which occurs perrain eventmeasured with a scale of small plots method. The seasonal crops provide economic benefits based on costs and benefits, which can be seen from the net benefit/cost, net present value (NPV), and the return on investment which depends on the value of the interest rate, and is indicated as the internal rate of return (IRR). Results showed that the agroforestry systems economically on forest trees of white teak with planting patterns of seasonal crop: inter-cropping plants, such as turmeric-corn- red bean – local cayenne pepper. This planting pattern gives the benefits; B/C ratio(1.44; 1.29; 1.59), NPV (Rp. 31.695.473; Rp. 21.009.395; Rp. 39.788.284) and IRR (0.22; 0.17; 0.15)respectively.

Keywords: Economic values, Agroforestry systems, Planting pattern, Seasonal crops

I. INTRODUCTION

Sub Subof Cianten – Cipancar Watersheds are parts of Sub Watershed of CimanukHulu, which have given a great contribution on land erosion and influence the service life of Jatigede Multiple Reservoir. The service life of a reservoir greatly influences the function of reservoir in accordance to the initial planning. If there is a decrease in service life, then there is a decrease in function economically, especially in water provision for agriculture. An earlier study showed that the land use of Cimanuk Hulu Sub Watershed has changed which resulted the service life of reservoir could not reach the service life of 50 years (Devianti, et.al.,2014). The pattern of change in land occurred in protected area, such as primary forest and secondary forest. Both areas became agricultural land; with a big increase in mixed farming (Devianti, et.al, 2014). Restoring the forest could not be conducted immediately, agroforestry system is required for changing land. The average area of agricultural land nationally is 0.25 ha. The agroforestry system is one of the conservation systems which is effective in reducing the amount of erosion, especially when it is related to the planting pattern of seasonal crops. Every planting pattern is related to different cost of cultivation, different crops productivity, and different ability in reducing the erosion (Devianti, 2015).

According to Smith (2010), the agroforestry system is a conceptual ofintegrated land use, which combines the forestry with agriculture in a sustainable production system to maintain biodiversity. It will balance the productivity by giving the protection to the environment. The farmers' land which is biodiversed with agroforestry system gives several advantages, such as: (1) crops which consists of several levels, (2) crop shade which covers the soil, (3) drop size of rainfall which could be controlled, so the rainfall kinetics energy could be smaller when it reached the soil surface (Nurpilihan, 2011). Previewed from the conservation of soil and water aspect, agroforestry system is very effective to reduce the erosion and sedimentation. The agroforestrysystem has several advantages, such as to increase the farmers' and land owners' income, and to maintain the land quality (Nair, 1992; Shuaibu, et.al., 2013; Icraf, 2013). The economic values of agroforestry systemare influenced by the planting pattern of seasonal crops. Those values are determined based on the values of benefit cost ratio (BCR), net present value (NPV), and internal rate of return (IRR)(Diksi; Kadariah,2000; Triwanto, 2011).

2. METHODOLOGY

This research was conducted in SimpenKaler village, sub district of Limbangan, district of Garutand included in administration of SubSubWatershed ofCiantenCipancar, Watershed of CimanukHulu (Figure 1).

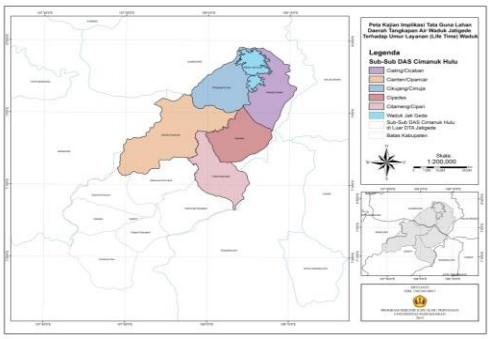

Figure 1. Sub Watershed of CimanukHulu

Data in economic analysis of agroforestry system was obtained from questionnaire and open interview of Focus discussion Group (FGD) with 20 members.Manager for agroforestry system in this study was the villagers of SimpenKaler.In addition, data was also derived from BPDAS Cimanuk- Citanduy (2010).

The application of agroforestry system consisted of yearly crop, white teak with seasonal intercrop: turmeric- corn- red bean- local cayenne pepper (plot 1);intercrop: turmeric- corn- red bean (plot 2) and monoculture: local cayenne pepper (plot 3). Pattern planting of seasonal monoculture crop and intercrop required different costs and had different benefits, so the economic appropriateness of agroforestry system could be attained from these following parameters:Net Present Value (NPV), Benefit and Cost Ratio (BCR), and Internal Rate of Return (IRR) as shown in equation 1,2 and 3.

$$NPV = \sum_{t=0}^{T} \frac{(B_t - C_t)}{(1+i)^t} \quad \text{……..} \quad (1)$$

where: NPV: net present value, i: discount rate, T: reservoir service life, t: year = 0,1,2,…,T, B: benefit, C : cost. The value of NPV > 1 means that the value of reservoir service is high and vice versa.

$$BCR = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+i)^t}} \quad \text{……} \quad (2)$$

where: Bt is benefit value until the year of T, C_t is cost until the year of T, I is the discount rate, n is number of year.

$$IRR = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} = \sum_{t=0}^{n} \frac{C_t}{(1+r)^t} \quad \text{…….....…….....…..} \quad (3)$$

where: IRR is Internal Rate of Return,Btis benefit value of year T, Ct is cost of year T, r is interest rate.

3. RESULTS AND DISCUSSIONS

The economic analysis of agroforestry system consisted of investment and maintenance costs. The investment is the present cost which has benefits in the future. The investment used to purchase yearly crop, fruit plants, planting cost, and terraces. The investment cost of agroforestry system is presented in Table 1.

Table 1. Investment cost of agroforestry system of plot 1, 2, and 3 for 1 ha of area

No.	Type of investment	Amount	Price (Rp.)	Total Price
1	Seed of forest trees :			
	White teak (Gmelina)	625 trees	700	43.7500
	Mahoni	277 trees	1350	373.950
	Suren	277 trees	1350	373.950
2	Seed of MPTS			
	Petai	400 trees	3500	1.400.000
	Alvocado	238 trees	1600	380.800
3	Establishing planting holes	214 DoW	35000	7.490.000
4	Planting	112 DoW	35000	3.900.000
5	Terrace	1724 DoW	35000	60.330.000
Total Investment				74.686.200

DoW: Day of Workers
Source: BPDAS Cimanuk-Citanduy (2010).

Maintenance cost is cost used when the planting started which has benefit values in a near future. For example: the production of seasonal crop which harvested within 3 months after planting. Various maintenance costs of agroforestry system with planting pattern on plot 1, 2, and 3 depend on the type of cultivated seasonal crop is presented in Table 2.

Table2. Maintenance cost of agroforestry system of plot 1, 2, and 3 for 1 ha of area

Plot 1 (Intercrop: turmeric, corn, red bean, local cayenne pepper)		
No.	Type of maintenance cost	Amount (Rp.)
1	Cultivating cost at year-1,3,4,5,6	6.118.000
2	Replanting crops at year- 2	242.850
3	Terrace	500.000
4	Cultivating cost at year- 2	6.360.850
5	Cultivating cost at year- 7	6.860.850
Plot 2 (Intercrop: turmeric- corn- red bean)		
No.	Type of maintenance cost	Amount (Rp.)
1	Cultivating cost at year- 1,3,4,5,6	6.078.000
2	Replanting crops at year- 2	242.850
3	Terrace	500.000
4	Cultivating cost at year - 2	6.320.850
5	Cultivating cost at year - 7	6.820.850
Plot 3 (Monoculture of local cayenne pepper)		
No.	Type of maintenance cost	Amount (Rp.)
1	Production cost at year - 1,3,4,5,6	12.918.500
2	Replanting crops at year- 2	242.850
3	Terrace	500.000
4	Cultivating cost at year - 2	13.161.350
5	Cultivating cost at year - 7	13.661.350

Source: Data analysis from Interview and BPDAS Cimanuk-Citanduy (2010).

Table 2 showed that various amount of price and maintenance cost consisted of (1) production cost of different seasonal crop in plot 1,2 and 3, (2) replantingof yearly crops and fruit plants, and (3) cost of terrace. Between the first year and the next years occurred a different cost, such as expend costs in year 1, 2, 3, 4, and 6. These costs were planting and maintenance seasonal crop costs;Rp. 6.118.000 was for plot 1, Rp. 6.078.000 was for plot 2, and the highest cost was in plot 3 which was Rp. 12.918.500. Fertilizer usage in the first year was for all including seasonal crops, forestry, and fruit plants. In the second year occurred an addition cost foryearly replanting cropfor Rp. 242.850. Therefore, total cost was Rp. 6.360.850 (plot 1), Rp. 6.320.850 (plot 2), and Rp. 13.161.350 (plot 3).

An addition cost also occurred in maintenance cost at year -7, which was for terrace (Rp. 500.000). So, the total cost at year – 7 became Rp. 6.860.850 for plot 1, and for plot 2 and 3 were Rp. 6.820.850 andRp. 13.661.350, respectively.

The investment cost for plot 1, 2 and 3 were the same amount. There was a different maintenance cost for plot 1,2 and 3. This was due to the comodity for each seasonal crop had a different price for seed. The agroforestry system had given 2 benefits which were productivities of seasonal crop and forestry tree. The productivity and price of seasonal crop were different since the selling price was depending on the market price. The productivity and selling price for seasonal crop of plot 1,2 and 3 is presented in Table 3.

Table 3. Productivity of agroforestry system of plot 1, 2, and 3 for 1 ha of area

Plot 1 (Intercrop : turmeric, corn, red bean, localcayenne pepper)		
No.	Productivity	Amount (Rp.)
1	Benefits at year-2 and 3	27.750.000
2	Benefits at year- 4	24.500.000
3	Benefits at year- 5,6,7,8, and 9	15.625.000
4	Benefits at year- 10	125.000.000
Plot 2 (Intercrop:turmeric, corn, red bean)		
1	Benefits at year- 2 and 3	19.850.000
2	Benefits at year- 4,5, and 6	18.500.000
3	Benefits at year- 7,8, and 9	17.050.000
4	Benefits at year- 10	125.000.000
Plot 3 (Monoculture of local cayenne pepper)		
1	Benefits at year- 2 and 3	35.360.000
2	Benefits at year-4 and 5	32.500.000
3	Benefits at year- 6 and 7	28.600.000
4	Benefits at year- 8 and 9	26.000.000
5	Benefits at year- 10	125.000.000

Analysis (2014).

Table 3 showed that the productivity of seasonal crop of plot 1,2 and 3 had various price for the same year and the next years. The highest to lowest productivity was plot 3, 1 and 2 respectively. In the second and third year had benefits of Rp. 27.750.000 for plot 1, Rp. 19.850.000 for plot 2, and Rp. 35.360.000 for plot 3 respectively. The productivity in the second and third year were bigger than the fourth year, which wasRp. 24.500.000 for plot 1, Rp. 18.500.000for plot 2, and Rp. 32.500.000 for plot 3.In the fifth and sixth year, the benefits of seasonal crop was getting smaller, which was Rp.15.625.000 (plot 1), Rp. 17.050.000 (plot 2) and Rp. 28.600.000 (plot 3). The benefits were getting smaller because the crop shed was getting bigger, so it is getting the way of sunlight which caused the photosynthesisdid not work well.

The benefits of agroforestry system were derived from white teak in the 10th year, where per log, net volume was 0.4 $m^3$with price of 1 m^3 was Rp. 500.000. The price was referred to the Bill of Trade Ministry No.22 Year 2012. Total benefits of white teak production of plot 1,2 and 3 were same, which wereRp. 125.000.000.

The investment cost and benefits used was based on the interest rate of Bank Indonesia, which was 12% in 2010. It was in the beginning of agroforestry system. The price in economic analysis was interpreted that in the 10th year, the white teak price when it was harvested would be the future value. This could be studied in the future based on the economic analysis, such as: NPV, B/C, and IRRI.

The economic analysis of agroforestry system with different planting patterns (plot 1, 2, and 3) which was worth effort with analysis parameters of NPV, B/C and IRRI is presented in Table 4.

Table 4. The economic analysis of agroforestry system of plot 1, 2 and 3 for 1 ha ofarea

Indicator	Economic Analysis	Financial Analysis	Decision
Plot 1 (Intercrop: turmeric- corn- local cayenne pepper)			
NPV	Rp. 31.695.473	Rp. 31.017.446	Worth> 0
IRR	0.22	0.22	Worth> 0
Net B/C Ratio	1.44	1.43	Worth> 0
Plot 2 (Intercrop: turmeric- corn- red bean)			
NPV	Rp. 21.009.395	Rp. 20.331.368	Worth > 0
IRR	0.17	0.17	Worth> 0
Net B/C Ratio	1.29	1.28	Worth> 0
Plot 3 (Monoculture local cayenne pepper)			
NPV	Rp. 39.788.284	Rp 39.110.257	Worth > 0
IRR	0.15	0.15	Worth> 0
Net B/C Ratio	1.51	1.50	Worth> 0

Source: Analysis (2014).

Table 4 showed that NPV, IRR, B/C ratio were the indicators of agroforestry system for 1 ha of area with various planting patterns on interest rate of 12%. The results showed that in this research, the agroforestry system for both economically and financially, the NPV, IRRI, and B/C was bigger than 1.The biggest values of NPV, B/C, and IRRI were on plot 3 and the smallest values were of NPV, B/C, and IRRI on plot 2. This was due to the price of local cayenne pepper was higher during the harvesttime (6 months) compared to the other commodity in plot 1 and 2.Based on Table 4, the different values of NPV financially on plot 3 and 1, plot 3 and 2, and plot 1 and 2 were Rp. 8.092.812, Rp. 18.778.890,Rp. 10.686.078 respectively. The monoculture had higher benefits than the intercrop on plot 1 and 2. Yet, the erosion in monoculture was bigger than the intercrop.

The increase and decrease of productivity and price of agriculture and forest tree influenced the sustainability of agroforestry system. This related to the increase of the interest rate. For further study of agroforestry system sustainability, the internal of return (IRR) was required. This study was conducted by comparing the NPV at the initial rate (NPV_1) with different value of (NPV_1) and (NPV_2) on the higher interest rate of the initial interest rate.The NPV_2 was obtained by trial and error until it reached NPV<0. The analysis showed that the agroforestry system in plot 1, 2, and 3 were worthless at the interest rate of 22, 17%, and 15% respectively.

4. CONCLUSION

The agroforestry system with planting pattern of monoculture (local cayenne pepper) had bigger benefits than the intercrop in plot 1(turmeric- corn- local cayenne pepper)and plot 2(turmeric- corn- red bean)with indicators: NPV: Rp. 39.110.257, Rp. 31.017.446, and Rp. 20.331.368; IRR: 0.15, 0.22, 0.17; B/C ratio: 1.50, 1.43, and 1.28, and worthless at the interest rate of 15%, 22%, and 17%.

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