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An Analysis on the Growth and Financial Feasibility of *Shorea Ovalis* and *Shorea Balangeran* Plantation Forest with Restoration using Indonesian Silvicultural Systems as a Model for Sustainable Natural Forest Management in East Kalimantan Province

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Abstract
This research aims to analyze (1) the growth and distributions of stand diameter and (2) to analyze the financial feasibility of dipterocarp plantation forest restored using Indonesian Silvicultural Systems as a model for sustainable natural forest management (SNFM) in East Kalimantan, located exactly at PT Balikpapan Forest Industry, applying the theory of production to estimate the increment and basal area while the financial feasibility was analyzed using Net Present Value (NPV), Net B/C ratio dan IRR.

This research applied scientific methods and the data were obtained up to ten years and then predicted and simulated up to 50 years.

The research findings showed that *S.ovalis* is harvested for the first time at the age of 35 years with the total volume of 97.31 m^3 even though the maximum mean increment is achieved at the age of 45; and subsequent harvests are performed every 15 years. *S. balangeran* is harvested for the first time at the age of 40 years with the total harvest volume reaching 112.95 m^3 although the maximum average increment is achieved at the age of 50 years and subsequent harvests are performed in every 20 years.

Restoration using Indonesian Silvicultural System Model has more comparative advantages compared with other natural silvicultural system. This model is more productive, having shorter cutting cycles, more profitable, having clearer analysis on its ecological growth.

The result of financial analysis using Net Present Value, Net B/C and IRR model proved that *S. ovalis* and *S. Balangeran* were feasible to cultivate because the values of their IRR was higher than the value of their MAR.
Keywords: Restoration, Increment, Finance, Dipterocarps

INTRODUCTION

A. BACKGROUND

Forest and its surroundings are basic assets for national development. With the diversity in its germplasms and timber products and non-timber products, forest provides a lot of advantages for human life. Arief (2001) explains that forest products are classified into tangible and intangible features. Intangible feature includes the products which are related to natural system of the forest such as hydrology and natural attractions, while tangible features include forest products such as wood. Forests also provide direct benefits. The community can take the benefits of the forest directly by collecting and using forest products such as timbers which become the major product of the forest and various types of non timber forest products such as rattan, resin, fruits, honey and so on (Salim, 1997).

In the era of 1970s to 1990s forest industries were popular industries in Southeast Asia and were able to fulfill the global demand for wood products including Japan. However, today's forest industries are decreasing in number of wood products indicated by the decrease of wood industries due to the lack of raw materials. The development of forest utilizations and concessions in Southeast Asia has been in line with the development of the countries in the region for the last millennium. The authority of the government over forest area has been extended while the rights of the community become increasingly eroded. This process occurred more rapidlyin the last years of the second millennium. Indigenous or local management systems were in conflict with the territorial authorities and with the practices of forest concessions which tend to exploit unsustainable and uncontrolled forests resulting in environmental degradation (Poffenberger, 1990).

The government through the Directorate General of Forest Utilization in 1993 introduced natural production forest management with silvicultural system which was called *Tebang Jalur Tanam Indonesia* (Indonesian selective cutting with line planting system) commonly abbreviated TJTI . Compared with TPTT system, TJTI silvicultural system has more advantages in that it is easy for remote sensing; it enables the community to make use of the small-sized timbers as well as to save most of the natural forest ecosystem from its conservation as plantation forests. Basically, the idea about the security of natural ecosystem is not only directed to achieve ecological purposes but it is also beneficial to increase the security of business (Dadang, 1997).

Another system is TPTII which can enrich the repertoire of silvicultue science in Indonesia. This system is expected to emerge because the fragmentation of primary natural forest into various types of land use and habitat is the result of cutting, illegal logging, illegal mining, forest fire, settlement and illegal trading (Indrawan 2013).

Restoration with Indonesian silvicultural system is forest cultivation management which emphasizes on the restoration of land function by considering scientific principles of silvicultural system which include: species selection, stand maintenance, thinning, and cutting selection. These principles are based on the wood quality, space and basal area as the main indicators to determine stand production by taking socio-economic and environmental factors into account.

The decrease in wood supply from tropical natural forests outside Java Island is not the fault of the cilvicultural system in the program of TPTI, TPTJ, TJTI and the Intensive System or even the IHMB. It is important to note that the original idea of this research was inspired by the techniques of the earlier cilvicultural system which is seen from its strengths and weaknesses. RSSI system is an alternative high-value management of natural production forests which is based on ecological and economic consideration in order to meet the needs of Science and Technology and to meet the market demands.

B. The purposes of the Research

The purposes of the research are as follows:

1. To analyze the simulation of the growth and class distributions of *S. ovalis* and *S. balangeran* plantation forest restored by restoration using Indonesian Silvicultural System (RISS).
2. To analyze the financial feasibility of *S. ovalis* and *S. balangeran* plantation forest with restoration technique by using Indonesian Silvicultural System.

RESEARCH METHODOLOGY

1. Location, time and materials of the research

This research was conducted for 5 months, starting from January 2013 to June 2013 and the activities included field orientation, research plan preparation, the implementation of the research plan and data collection. The research was conducted at PT Balikpapan Forest Industries located in Penajam Paser Utara District. The objects of the research included (1) *Shoreaovalis* with the planting distance of 20x2,5 m; (2) *S. ovalis* with the planting distance of 10x3 m; 3) *S. balangeran* with the planting distance of 20x2,5 m and (4) *S. balangeran* with the planting distance of 10x3 m.

2. Types of Data

a. Diameters at breast height

The stand diameters are measured based on the commonly used criteria, that is, measuring the diameters at breast height (130 cm) measured from the ground surface using *phi-band* with the precision in millimeter and the measurement is applied to all of the tress in the plot.

b. The heights of the trees

The heights of the trees are measured by using Clinometer Suuntowithout measuring the horizontal distance with the help of a 4-meter long measuring rod placed vertically on the tree trunks (Ruchaemi, 2002).

c. Basal Area Estimation

Treebasal area is the cross-sectional area of the tree trunks which is commonly derived from the conversion of the diameter of the circumference of a stand which is measured at breast height (1.30 m above the ground).

d. Volume Estimation

Tree volume is measured by using the formula (Ruchaemi, 2006) as follows:

$$V = \frac{1}{4}\pi\, d^2 \times h \times f$$

Notes: V = Tree Volume (m^3), π = 3.141592654, d = Treediameter at breast height, h = Tree height (m), f = tree shape factor.

e. Volume increment

Increment is the increase in the growth of stand dimensions (height, diameter, basal area, volume) at a certain age or in a given period of time. Increment can be classified according to its measurement time: Mean Annual Increment, Current Annual Increment, and Periodic Annual Increment

According to Ruchaemi (1988), to estimate the increment volume of Mean Annual Increment, the following formula is used:

$$MAI = \frac{VT}{n}$$

Current Annual Increment of stand is calculated using the following formula:

$$CAI = \frac{V_2 - V_1}{n}$$

Note: VT = Total volume in n years (m^3), n = The age of stand (years), V_2 =Final production volume (m^3), V_1 =Initial Production Volume (m^3)

f. Estimating Indirect Increment

This technique applies a formula of increment with its compound interest, namely, the increment is like the increase in capital at compound interestin which the annual interest is inserted in the formula (Djumansi 2002) as follows:

$$P\ \% = 100\ X \sqrt[n]{\frac{Xn}{Xo}} - 1$$

Notes: P% = Percentage of Increment (%), Xn = Dimension of tree or stand (volume) at the time of inventory after n years (m^3), Xo = Dimension of tree or stand (volume) at the time of the initial inventory (m^3), n = Time interval between the initial and the second inventory (years)

3. Analysis on Business Feasibility

To determine the business feasibility the following parameters are used: Net Present Value (NPV), Net B/C, Internal Rate Return (IRR).

***a. Net Present Value* (NPV)**

Net Present Value (NPV), is the difference between the present value of the benefit flow or cash inflow and the present value of cost flow or cash outflow. If NPV > 0, it means that the business is feasible. On the contrary if NPV < 0, it means that the business is not feasible and if NPV = 0, it means that the business earns no profit and no loss (breakeven) (Burhan 2004).

***b. Net Benefit Cost Ratio* (Net B/C)**

*Net Benefit Cost Ratio*is the comparison between the total of positive NPV the total of negative NPV. Net B/C gives a description of the total benefits that can be derived from the total cost expended. It is the subtraction between the benefits for every year and the cost to determine netpositive and negative benefits, and then the total of positive present value is compared to negative present value (Burhan 2004).

c. Internal Rate of Return (IRR)

Internal Rate Return (IRR) is an instrument used to estimate the internal rate of return or to calculate interest rate which equates the present value of the cash flow expected in the future (Lahjie 2004).

RESEARCH FINDINGS AND DISCUSSION

A. The Potentials of Dipterocarp Plantation Forest with Restoration using Indonesian Silvicultural System (RSSI)

1. *Shorea ovalis* with the planting distance of 20x 2,5 m

Table 1. Potential Production Volume of *S. ovalis* at the planting distance of 20x2,5 m

Age	N	d	h	TV	MAI	CAI	BA
5	180	6,6	4	2,25	0,4	0,8	0,62
10	160	14,0	8	14,77	1,5	2,7	2,46
20	140	25,2	12	57,79	2,9	5,0	6,98
30	120	36,7	16	121,80	4,1	6,8	12,69
40	100	47,2	18	188,88	4,7	6,0	17,49
45	95	50,0	19	212,54	4,7	4,7	18,64
50	90	52,4	20	232,79	4,7	4,0	19,40
60	80	58,0	21	266,19	4,4	3,2	21,13
70	80	59,5	22	293,47	4,2	2,7	22,23
75	80	60,0	23	305,21	4,1	2,3	22,61

Notes: n =Tree individuals, d = Diameter (cm), h = Height (m), TV = Total Volume (m^3/ha), MAI = Mean Annual Increment (m^3/ha/year), CAI = Current Annual Increment (m^3/ha/year), BA = Basal Area (m^2)

The above table shows that the maximum mean annual increment and the total volume of *S.ovalis* planted at the distance of 20x 2,5 m meet at the age 45 years with the total volume reaching 239,23 m^3/ha with MAI and CAI values of 5,3 m^3/ha/year and the basal area of 20,98 m^2. However, the trees can be harvested at the age of 40 years.

Graphically, the average growth increment of *Shorea ovalis* can be seen in Figure 1as follows:

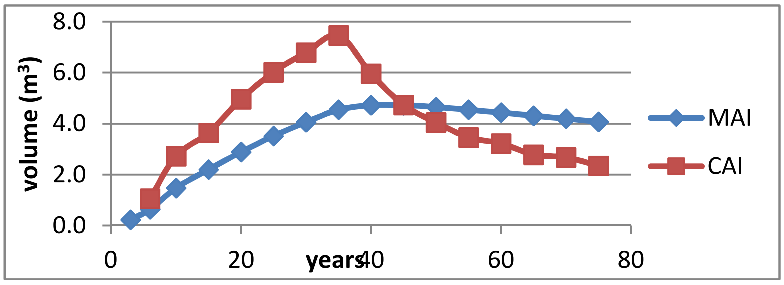


Figure 1.The relationship between increment and age of *Shorea ovalis* with the planting distance of 20 x 2,5 (data taken from Table 1)

Figure 1 shows that the intersection of CAI and MAI is at the age of 45 years. This indicates that the maximum increment at the age 45 years is 4,7 m^3/ha/year with the diameter of 50,0 cm and the total volume of 212,54 m^3/ha. The detailed explanation about stand distributions can be seen in Table 2 as follows:

Table 2. Diameter Distributions and the Total Volume of *S. ovalis* with the planting distance of 20 x 2,5 m at the age of 40 years

d	n	h	BA	TV(m3)	TV(%)
38 - 50	77	16	10.22	104.14	55%
54 - 62	23	19	7.27	84.74	45%
Total	100		17.49	188.88	100%

Notes: d = Diameter (cm), n = tree individuals, h = Height (m), TV = Volume (m^3/ha), BA= Basal area (m^2)

It can be explained in Table 2 that *S. ovalis* can be potentially harvested at the age of 49 years with the total volume of 211,95 m^3/ha. The average diameter is 54,5 cm and the total basal area is 19,63 m^2. The diameters can be divided into two types based on the diameter distributions and the total volume, namely: (1) the diameter of 40 – 52 cm with the total basal area of 10,00 m^2 and the total volume of 101,77 m^3/ha or 48% of the entire total volume, and (2) the diameter of 54-66 cm with the total basal area of 9,63 $m^2$and the total volume of 110,18 m^3/ha or 52% of the entire total volume. Based on the data of distribution, the trees with RSSI system have shorter ages.

Figure 2. Harvesting Simulation of *S. ovalis* with restoration using Indonesian Silvicultural System with the planting distance of 20 x 2,5 m

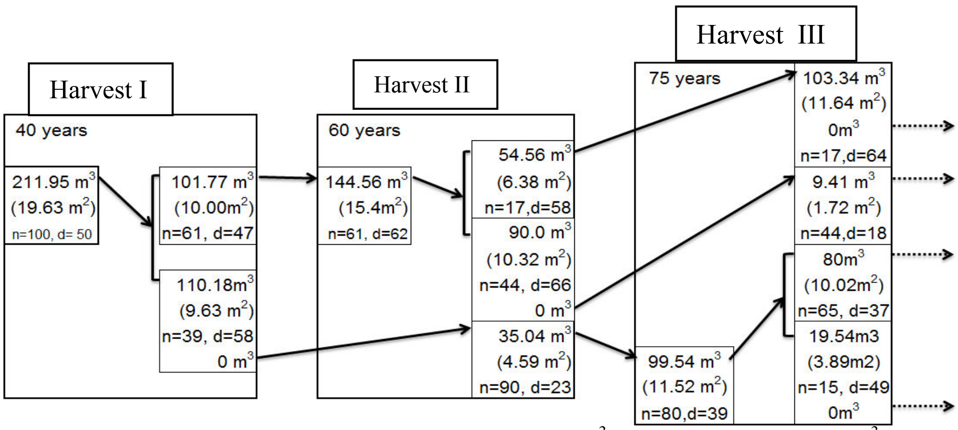


Figure 2 shows that the first harvest yields 110,18 $m^3$and sets aside 101,77 m^3 from the basal area of 10,00 m^2at the age of 40 years. The second harvest is performed after 20 years and yields 90 m^3at the age of 60 years. The third harvest yields103,34 $m^3$from the first harvest, 19,54 $m^3$from the replanting at the age of 40 years. The first plants spend 75 years old. Restoration using Indonesian Silvicultural System for *S. ovalis* plant with the planting distance of 20x 2,5 m makes it possible to harvest every 20 and 15 years.

2. *Shorea ovalis* with the planting distance of 10x3 m

Table 3. The potential production volume of *S. ovalis* with the planting distance of 10x3 m

Age	N	D	H	TV	MAI	CAI	BA
5	265	6,0	5	2,80	0,6		0,75
10	250	11,0	8	14,25	1,4	2,2	2,37
20	230	21,0	12	65,93	3,3	6,4	7,96
30	210	31,0	16	152,08	5,1	9,7	15,84
35	200	36,0	17	207,54	5,9	11,1	20,35
40	190	39,6	18	252,60	6,3	9,0	23,39
45	180	42,0	19	284,15	6,3	6,3	24,93
50	170	44,0	20	310,03	6,2	5,2	25,84
60	160	46,5	21	342,19	5,7	2,8	27,16
65	155	47,5	22	354,14	5,4	2,4	27,45

The table above shows that the maximum mean annual increment and the total volume of *S. ovalis* planted at the distance of 10x3 m meet at the age of 45 years with the total volume of 284,15 m^3/ha with the value of MAI and CAI of 6,3 m^3/ha/year and the basal area of of24,93 m^2. However, they can be harvested at the age of 35 years.

The growth graph of average increment volume of *Shorea ovalis* can be seen in Figure 3 as follows:

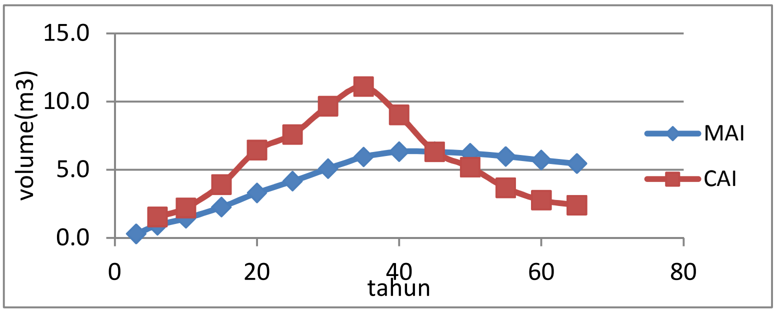


Figure 3.the Relationship between increment and age of *Shorea ovalis* planted at the distance of 10 x 3 (data from Table 3)

Figure 3 illustrates that the intersection point of CAI and MAI meets at the age of 45. This indicates that the maximum increment is achieved at the age of 45 with the total of 6,3 m^3/ha/year, with the diameter of 42.5 and the total volume of 284,15 m^3/ha. Stand distributions can be explained in details in Table 4 as follows:

Table 4. Diameter Distributions and the Total Volume of *S. ovalis* with the planting distance of 10x3 m at the Age of 35 years

D	n	h	BA	TV(m3)	TV(%)
28 - 38	135	16	11.72	110.19	53%
54 - 62	65	19	8.63	97.31	47%
Total	200		20.35	207.5	100%

Table 4 showed that the potential of *S. ovalis* at the age of 35 years can be harvested with the total volume of 207,50 m^3/ha. The average diameter of 42,0 cm and the total basal area of 20,35 m^2. If it is explained based on the diameter distribution and based on the total volume, the types of diameter can be divided into two types, namely: (1) the diameter of 28 – 38 cm with the total basal area of 11,72 $m^2$and the total volume of 110,19 m^3/ha or 53% of the entire total volume, and (2) the diameter of 40-48 cm with the total basal area of 9,03 m^2 and the total volume of 97,37 m^3/ha or 47% of the entire total volume. Based on the data of distribution, the harvesting simulation with RSSI can be estimated.

Figure 4. Harvesting Simulation of *S.ovalis* with Restoration using Indonesian Silvicultural System with the planting distance of 10x3m

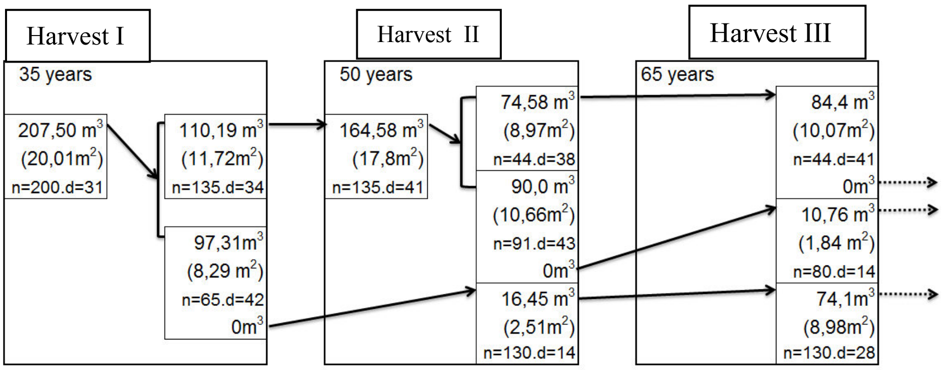


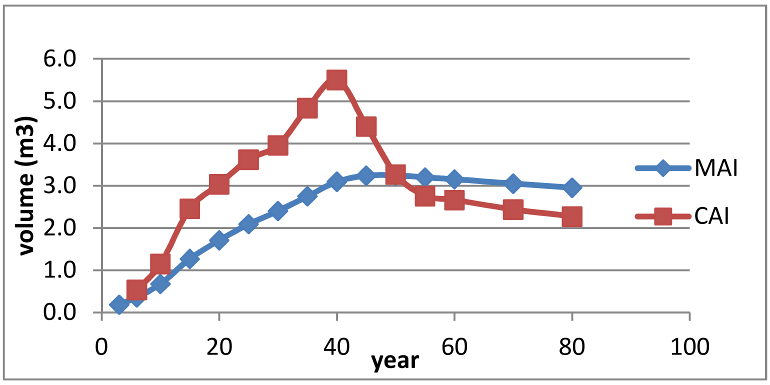
Figure 4 shows that the first harvest yields 97,31 m^3 and sets aside 110,19 $m^3$from the basal area of 11,72 m^3at the age 35 years. The second harvest is performed after 15 years and yields the total volume of 90 m^3at the age of 50 years. The third harvest yields 84,4 m^3. The first plants last 65 years old. Restoration using Indonesian Silvicultural System for *S. ovalis* with the planting distance of 10x3 m can be harvested in every 15 years.

3. *Shorea balangeran* with the planting distance of 20x2,5 m

Table 5.The potential Production Volume of *S. balangeran* with the planting distance of 20x2,5 m

Age	N	d	H	TV	MAI	CAI	BA
5	175	5,0	5	1,34	0,3		0,34
10	160	9,8	8	6,76	0,7	1,1	1,21
20	150	19,3	12	34,21	1,7	3,0	4,39
30	130	29,0	14	72,09	2,4	4,0	8,58
40	120	37,0	16	123,80	3,1	5,5	12,90
50	100	45,0	17	162,14	3,2	3,3	15,90
60	90	49,8	18	189,23	3,2	2,7	17,52
70	90	51,5	19	213,61	3,1	2,4	18,74
80	80	56,0	20	236,33	3,0	2,3	19,69

The above table shows that the maximum mean annual increment and the total volume of *S. balangeran* planted at the distance of 20x2,5 m meet at the age of 50 years with the total volume of 162,14 m^3/ha with the value of MAI and CAI reaching 3,2 m^3/ha/year and the basal area of 15,90 m^2.



Graphically, the average growth increment of *S.balangeran* can be seen in Figure 5 as follows:
Figure 5.The relationship between increment and age of Shorea balangeran with the planting distance of 20 x 2,5 (data from Table 18)

Figure 5 shows that the intersection of CAI and MAI is reached at the age of 50 years. This indicates that the maximum increment is achieved at the age of 50 with the total of 3,2 m^3/ha/year 45,0 cm and the total production volume of 162,14 m^3/ha.

S. balangeran with 20 x 2,5 m planting distance cannot be simulated using RSSI. The basal area is higher than 10 m^2at the age of 40 years and 45 years but its production volume is not large enough to reach its feasibility.

4. *Shorea balangeran* with the planting distance of 10x3 m

Table 6. Potential Production Volume of *S. balangeran* with the planting distance of 10x3 m

Age	N	D	H	TV	MAI	CAI	BA
5	240	5,7	5	2,29	0,5	0,8	0,61
10	230	10,5	7	10,31	1,0	1,7	1,99
20	230	19,6	11	50,36	2,5	5,1	6,94
30	220	29,0	13	117,06	3,9	7,1	14,52
40	200	38,5	16	223,40	5,6	11,2	23,27
50	190	44,0	17	294,53	5,9	5,8	28,88
60	170	48,0	18	332,07	5,5	3,1	30,75
70	160	50,0	19	348,54	5,0	1,6	31,40
80	150	52,0	19	362,97	4,5	1,4	31,84

The table above shows that the maximum mean annual increment and the total volume of *S.balangeran* planted at the distance of 10x3 m meet at the age of 50 years with the total volume of 294,53 m^3/ha and with the value of MAI and CAI reaching 5,9 m^3/ha/year and the basal area of 28,88m^2 but it can be harvested at the age of 40 years. Graphically, the average growth increment of *S.balangeran* tree can be seen in Figure 6 below:

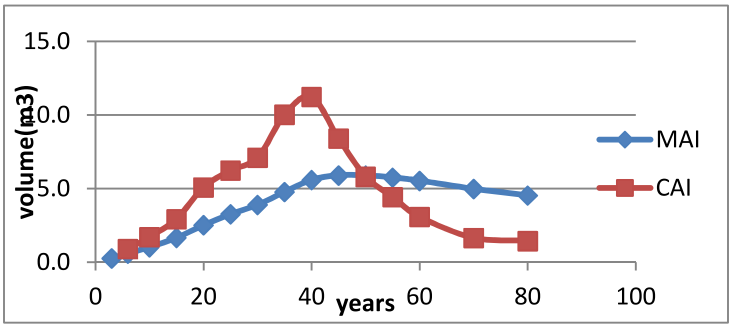


Figure 6.The relationship between increment and age of Shorea balangeran with the planting distance of 10 x 3 (data from Table 19).

Figure 6 shows that the intersection of CAI and MAI is reached at the age of 45 years. This indicates that the maximum increment is reached at the age of 50 with the total of 5,9 m^3/ha/year with the diameter of 44,0 cm and with the total volume of 294,53 m^3/ha. The details of stand distributions can be explained in Table 7 as follows:

Table 7. Diameter and Total Volume of *S. ovalis* with the planting distance of 20x 2,5 m at the Age of 40 years

d	n	h	BA	TV(m3)	TV(%)
26 - 40	135	16	12.58	110.45	49%
42 - 50	65	19	10.69	112.95	51%
Total	200		23.27	223.40	100%

Table 7 shows that the maximum potential of *S. balangeran* is reached at the age of 40 based on the total volume was 223,40 m^3/ha. The average diameter is 44,0 cm and the total basal area is 23,27 m^2. The diameters can be divided into two types based on diameter distributions and the total volume, namely: (1) the diameter of 26 – 40 cm with the total basal area of 12,58 m^2 and the total volume of 110,45 m^3/ha or 49% of the entire total volume, and (2) the diameter of 42-50 cm with the total basal area of 13,33 $m^2$and the total volume of 112,95 m^3/ha or 51% of the entire total volume. Based on the data of distribution, the harvesting simulation with RSSI can be estimated.

Figure 7. Harvesting Simulation of Restoration using Indonesian Silvicultural System for *S. balangeran* with the planting distance of 10 x 3m

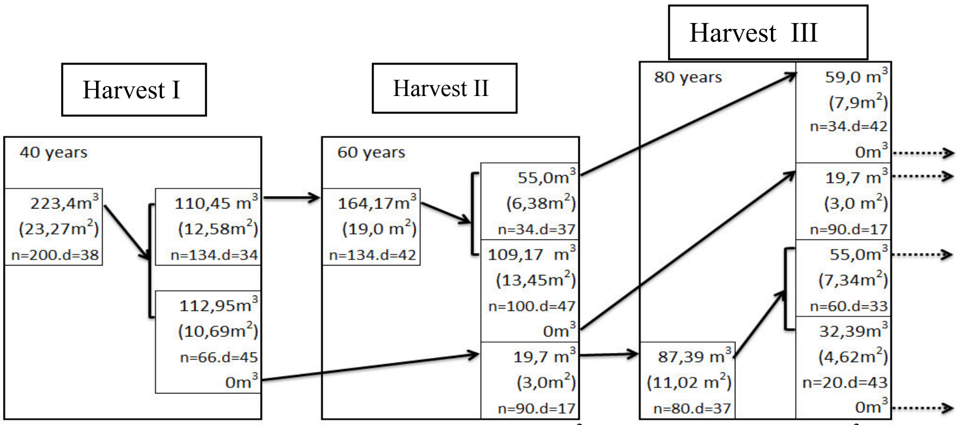


Figure 7 shows that the first harvest yields112,95 $m^3$and sets aside 110,45 $m^3$from the basal area of 12,58 m^2at the age of 40 years. The second harvest is performed after 20 years and yields109,17m^3at the age of 60 years. The third harvest yield 59 $m^3$from the first harvest, 32,39 m^3after replanting at the age of 40 years. The first plants lastfor 80 years old.Restoration using Indonesian Silvicultural System for *Shorea balangeran* with the planting distance of 10 x 3 m can be harvested every 20 years.

B. FINANCIAL ANALYSIS OF RESTORATION USING INDONESIAN SILVICULTURAL SYSTEM AND CLEARCUT SYSTEM

Table 8. Financial Analysis of *Shorea ovalis*

No.	Tree Species	Planting Distance	Model	Cycle	Financial Analysis		
					NPV	Net B/C	IRR
		(m)		Year	Rp.	Rp.	%
1	*Shorea ovalis*	20x 2,5	RSSI	75	24.742.000	1,82	6,7
2		20x 2,5	Clearcut	45	24.742.000	1,83	6,7
3		10x3	RSSI	65	36.981.000	2,38	7,6
4		10x3	Clearcut	45	36.672.000	2,36	7,5

The table above shows that at 5% interest rate, the financial analysis for Net Present Value (NPV), Net B/C and IRRof *S. ovalis* cultivation with the planting distance of 20x2,5 m using RSSI have the values of Rp 24.742.000; 1,82 and 6,7% respectively. The financial analysis for cultivation of *S. ovalis* with the planting distance of 20x2,5m using clearcut system have the values of Rp24.742.000; 1,83 and 6,7% respectively. When the RSSI model and clearcut model are compared, it is found that the result of financial analysis for clearcut system is fairly higher. However, by using RSSI model, the harvesting can be performed every 15 and 20 years while by using clearcut model, the harvesting time should wait until 45 years and it is more feasible.

The cultivation of *S. ovalis* with the planting distance of 10x3m with RSSI model has the values of Rp36.981.000; 2,38 and 7,6%. The cultivation of *S. ovalis* with the planting system of 10x3 m using clearcut model has the values of Rp36.672.000; 2,36 and 7,5%. When the RSSI model is compared to clearcut system, it is found that the value of financial analysis for clearcut system is fairly higher. However, by using RSSI model the harvesting can be performed every 15 years while by using clearcut model the harvesting time has to wait until 45 years and it is more feasible.

Table 9. Financial Analysis of*Shorea balangeran*

No.	Tree species	Planting Distance	Model	Cycle	Financial Analysis		
					NPV	Net B/C	IRR
		(m)		Year	Rp.	Rp.	%
1	*Shorea balangeran*	20x 2,5	Clearcut	50	5.379.000	1.21	5.5
2		10 x 3	RSSI	80	19.417.000	1.65	6.3
3		10 x 3	Clearcut	50	29.439.000	2.13	6.9

The table above shows that at 5% interest rate, the financial analysis of *S. balangeran* cultivation with the planting distance of 20x2,5 m using clearcut modelhas the NPV of Rp5.379.000 , Net B/C of 1,21 and IRR of

5,5%. These values indicate that the cultivation of *S. balangeran* with the planting distance of 20x2,5 m is feasible.

The cultivation of*S. balangeran* with the planting distance of 10x3 m using RSSI model has the values of Rp19.417.000; 1,65 and 6,3%. The cultivation of *S. balangeran* with the planting distance of 10x3 m with clearcut model has the values of Rp29.439.000; 2,13 and 6,9%. When the two models are compared, it is found that the value of the financial analysis for clearcut model is higher than the RSSI model. However, in RSSI model the harvesting can be performed every 15 years while in the clearcut model the harvesting time should wait for 50 years and it is more feasible.

CONCLUSION AND SUGGESTION

A. Conclusion

1. The maximum annual increment of *S. ovalis* is reached at the age of 45 years with the value of 6,5 m^3/ha/year with the planting distance of 10 x 3 m while for the planting distance of 20 x 2,5 m the value is lower but it can be harvested at the age of 35 years with the production volume of 97,31 m^3.
2. The maximum annual increment of *S. balangeran* is reached at the age of 50 year with the value of 5,9 m^3/ha/year with the planting distance of 10 x 3 m while for the planting distance of 20 x 2,5 m the value is lower but the tree can be harvested at the age of 40 years with the harvest volume of 112,95 m^3.
3. *S. ovalis* can be harvested sustainably every 15 years after the first harvest while *S. balangeran* can be harvested sustainably every 20 years after the first harvest.
4. Financially, the planting distance of 10x3 m model is more feasible than the that of 20x2,5 m model because the value of its NPV, Net B/C and IRR is higher than the value of its MAR.

B. Suggestion

The government through the Ministry of Forestry should immediately adopt RSSI model for the natural dipterocarp forest management by taking into account the superior seedling selection, thinning and logging methods which are suitable with silvicultural system based on basal area as the basis for restoration of sustainable natural forest management.

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