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Economic Viability of *Tectona grandis* sole Cropping and Intercropping for 20 years Planting Project

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Abstract

Economic viability of Tectona grandis sole cropping and intercropping for 20 years planting project were carried out at the Boonrich plantation in Lahad Datu, Sabah. The study was conducted to evaluate the economic viability and to compare between T. grandis sole cropping and intercropping of T. grandis with Salacca zalaca. The data of height, diameter, cost and prices were analysed. The parameter that used to measure the economic viability of the project were net present value (NPV), internal rate of return (IRR), benefit cost ratio (BCR), land equivalent ratio (LER), sensitivity analysis (SA) and payback period. The analysis was carried out by using Microsoft excel. From the study, the NPV of intercropping is RM27,063.70 (USD8,841.54), the LER is 1.37, 23.68% of IRR and have a shorter payback period (13 years) compare to the sole cropping. As a conclusion, the intercropping can give a higher profit to the company, not only that it has a shorter payback period than the sole cropping. In addition, it also showed a higher yield as the LER is more than one (1.37). Therefore, T. grandis intercrop with S. zalaca will gain extra benefit and greater output than the sole cropping.

Keywords: Agroforestry, intercropping, benefit cost analysis, economic indicator and sensitivity analysis.

Introduction

Tectona grandis (Teak) is one of the most well known timbers of the world. It belongs to family of Verbenaceae which is indigenous in Southeast Asia[1]. *T. grandis* has also been recommended as one of the favourite species to be planted in plantation Malaysia. In addition, *T. grandis* is being spread from Southeast Asia and India to the world wide, it is being grown in plantations in around 60 countries in Asia, Africa and Latin America. Due to its wide adaptability, it is becoming one of the best species in most of the plantation area. In tropical plantation forestry, most of the *T. grandis* plantations are under intensive short rotation management with 20 – 30 year rotation[2].

To solve the land limitation problem and rate of deforestation, agroforestry and intercropping has been strongly promoted in the early 20 centuries. The concept has evolved from the taungya system to the concept of agroforestry that combining of agriculture and forestry technologies to meet a more diversification and fully utilized land use system[3]. It is ideal is to plant 2 or more trees species, crops or grazing the livestock in the same land area, so that, it can achieve a greater output in order to meet other social and economic goals[4]. Economic measurement is the way to prove any cultivation project is viable or not by identify all the resources[5]. This also coincided by Seyednezhadfahim et al.[6] stated that profit is the major factor in investigating economic enterprises.

In this research, the study aims is to evaluate the economic viability and to compare between *T. grandis* sole cropping and intercropping of *T. grandis* with *Salacca zalaca* (a kind of fruit tree can be found in Southeast Asia, the common name for the fruit is 'salak' and the sole *T. grandis* planting).

Material and Methods

Study area and data collection: Boonrich Sdn Bhd is one of the biggest plantations in Lahad Datu, Sabah, the coordinate for the location is N 05˚09' 19.2'' E 118˚09' 38.3''. It has around 3,000 ha plantation out of 650 ha is *T. grandis* plantation. The spacing for the intercropping is 8 m x 5 m (teak) and 6 m x 3.5 m (*S. zalaca*), whereas the spacing for the sole crop is 4 m x 4 m (teak). The average monthly rainfall at the location is in the range of 120.78 - 253.45 mm, it indicated the water precipitation of the area is sufficient. The data were measured (height and diameter of the trees, so that we can calculate the volume of the tree) in the Boonrich plantation, the information about the cost was recorded by the Boonrich plantation.

Data analysis: The data were analyzed using the Microsoft Excel computer spreadsheet software. The profitability indicator that estimated were namely net present value (NPV), internal rate of return (IRR), benefit-cost ratios (BCR) and land equivalent ratio (LER). Most frequently method in the financial analysis used was NPV. This is because NPV indicates the present values of the costs and revenue attained from the investment activity[7]. NPV is the present value of net cash inflows that generated by a project. Net cash inflow equals total inflow during a period less the expenses directly uncured on generating the cash inflow. Formula for NPV as follows;

$$NPV = \left[\frac{R_1}{(1+i)^1} + \frac{R_2}{(1+i)^2} + \frac{R_3}{(1+i)^3} + \ldots \right] - \text{Initial Investment}$$

R is the net cash inflow expected to be gained for each period; i is the required rate of return per period.

Internal rate of return or IRR is the discount rate at which the NPV of an investment becomes zero [8]. IRR used also in order to measure the attractiveness of agroforestry project. If IRR of the project exceeds a company required rate of return, means that project is desirable. The formula of IRR is shown at below:

$$IRR = \left[\frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \ldots \right] - \text{Initial Investment} = 0$$

CF is the net cash flow at time of period; r is the internal rate of return.

Benefit Cost Ratio (BCR) is another parameter to measure the economic viability of agroforestry project. BCR defined as the total discounted benefits that are divided by the total discounted costs[9]. If he value of BCR is greater than 1, hence they have a positive net benefits and otherwise. The higher the ratio means the greater the benefits relative to the costs. The formula of BCR as follows;

BCR = Total Discounted Benefits / Total Discounted Costs

Land Equivalent Ratio (LER) was used in order to evaluate the efficiency of the intercropping system and to calculate monetary analysis as well[10]. According to Mead and Willey[11], LER defined as the total land area of sole crops that required producing the same yields with intercrops. The LER was calculated using the formula:

$$LER = (Y_{ab} / Y_{aa}) + (Y_{ba} / Y_{bb})$$

Y_{aa} and Y_{bb} are representative of sole crops while Y_{ab} and Y_{ba} are yields in intercrops. A LER of 1.0 indicates no difference in yield between the intercrops and monocrops. However, a LER value that greater than 1 (> 1.0) indicates advantage of intercropping over monocropping or sole cropping[12].

Results and Discussion

From the results, it showed a good result for the intercrop compare to the sole cropping. The NPV of the intercrop project showed a higher and positive value compare to the sole crop. From the table 1, it can clearly be seen that, the IRR for the intercrop is 23.7% which is higher than the sole crop (14.1%). This is showing the project is worth to invest as it has a higher IRR. In addition, for the B/C ratio, the sole crop have a slightly higher B/C ratio than intercropping which is 2.78 compared to 2.75, this may due to lower cost is needed in the sole cropping, and thus it will tend to produce a higher B/C ratio as the low cost of the project. For the 10% rate, the B/C ratio of the intercropping has a higher result than the sole cropping which is 1.99 and 1.61 respectively. The intercrop has a shorter payback period as it has a side-product (salak fruit) which can be harvested after 3 years planting. This is assisting the company to generate the income while waiting the tree to grow up as we know the wood-based industry will tend to have a higher payback period if there is no side product for the plantation. The LER of the intercrop is 1.37 which mean it have an extra 37% of yield than the sole cropping, This is also supported by many researches where they also showed a positive result for the intercropping system, for example, study done by Ng'ang'a et al.[13] showed the higher LER when intercrops grain Amaranth with soybean compared with sole cropping.

Table-1
Economic analysis of Intercropping and Sole cropping for 20 years planting project

Economic parameter		With project	Without project
NPV	5% 10% 15%	RM70,471.30 RM27,063.70 RM9,811.09	RM68,397.90 RM16,039.70 RM-1,941.98
IRR	10%	23.68%	14%
B/C Ratio	5% 10% 15%	2.75 1.99 1.49	2.78 1.61 0.90
Payback Period	5% 10% 15%	10 13.1 19.1	19.3 19.6 >20
LER		1.37	-

Note: Currency exchange USD1 = RM3.05, RM= Ringgit Malaysia

It is showing the NPV result for the different rate of the intercropping and sole cropping (figure-1). For the rate of 10% (standard rate), the NPV of intercropping has a higher amount than the sole cropping which is RM 27,063.70 (USD8,841.54), this is indicated that the intercropping project will give more profit to the company.

Furthermore, from the sensitivity analysis (table-2), it showed that the NPV of intercropping module can remain profit even the cost increase by 15% and the benefit decrease by 15%. This is showing that the intercropping module have a higher stability due with the market's change. Nawazish et al.[14] stated that some literatures suggested that future cash flow patterns can be predicted by current cash flows while others argued. Nevertheless, Rasoul et al.[15] stressed that identifying factors like financial policies that affecting the future stock value are crucial considerations in financial management. There have one research about the intercropping of coffee (tree) and the banana (fruit tree) tree, it is similar to *T. grandis* (tree) with salak (fruit tree), that intercropping of coffee and the banana will provide more profit and such as soil productivity improvement, agronomic management and so forth[16]. Therefore, the value of the project might change due to this factor and some environmental factor (like flood, land slide, typhoon and acid rain).

Conclusion

From this study, we can conclude that the intercropping can give a higher profit to the company, not only that it has a shorter payback period than the sole cropping. In addition, it also showed a higher yield as the LER is more than 1. Therefore, *T. grandis* intercrop with *S. zalaca* will gain extra benefit and greater output than the sole cropping.

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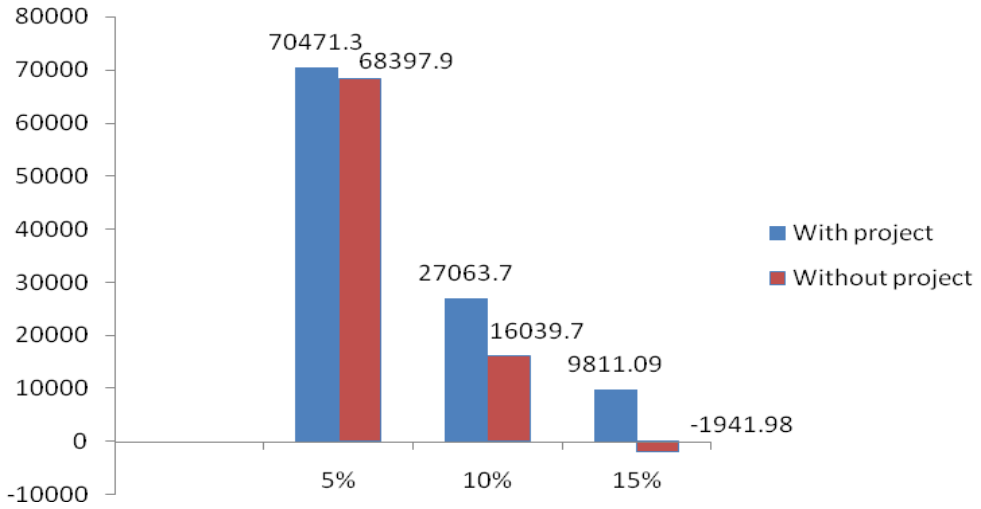

Figure-1
NPV of intercrop (*T. grandis* + *S. zalaca*) and sole cropping (without project, *T. grandis* only) at different discounted factor

Table-2
Sensitivity Analysis of intercropping for 10% Discounted Factor (*T. grandis* + *S. zalaca*)

	Change in Benefit							
		-15%	-10%	-5%	0%	5%	10%	15%
Change in Cost	-15%	23004.18	25723.75	28443.32	31162.89	33882.46	36602.03	39321.60
	-10%	21637.79	24357.36	27076.93	29796.50	32516.07	35235.64	37955.21
	-5%	20271.41	22990.98	25710.55	28430.12	31149.69	33869.26	36588.83
	0%	18905.02	21624.60	24344.17	27063.74	29783.31	32502.88	35222.45
	5%	17538.64	20258.21	22977.78	25697.35	28416.92	31136.49	33856.06
	10%	16172.26	18891.83	21611.40	24330.97	27050.54	29770.11	32489.68
	15%	14805.87	17525.44	20245.01	22964.59	25684.16	28504.73	31123.30

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