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FINANCIAL PROFITABILITY AND SENSITIVITY ANALYSIS OF PALM OIL PLANTATION IN INDONESIA

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Abstract

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Oil palm cultivation in Indonesia is increasing. This study investigates the financial and economic aspects of establishing an oil palm plantation using data collected in 2014. The financial case study is undertaken from the perspective of company in North Sumatra, Indonesia. A spreadsheet model was used to develop and calculate the net present value (NPV), return of investment (ROI), internal rate of return (IRR) and payback period (PP). Sensitivity analysis of the NPV to the default discount rate (10%) was included. A 8,000 ha plantation over 25 years was estimated to result in a positive NPV of USD 10,670 with a ROI 73.50% and an IRR at 14.83% and payback period of 6.75 years. Establishing an oil palm plantation seems to be very profitable investment on the basis of the assumptions made. System is tested on sensitivity in different capital and recurrent costs and in selling price of raw material, while change in selling price of FFB is more sensitive to NPV than change in investment and recurrent costs Discount rate is also one of the factors affecting NPV and system is tested between 5–15% change in discount rate.

Keywords: capital cost, fresh fruit bunch (FFB), labour need, plantation, recurrent cost and sensitivity analysis

INTRODUCTION

Global population growth, technological development and continuous depletion of fossil fuels lead to increasing demand for renewable energy, thus for vegetable oils that are used for the production of biofuels. Production of vegetable oils reached 160 million metric tons in 2014, which has almost doubled then in 2000 when the value was 90 million metric tons (Statista, 2015).

Palm oil is one of the raw stocks of vegetable oil used for producing biodiesel with annual yields of 3,94 t/ha (average value from: Yusoff and Hansen 2007; Ong *et al.*, 2012; MPOC, 2012; Mekhilef *et al.*, 2011; Lim and Teong, 2012). Biodiesel is a biological non-petroleum diesel derived using transesterification process (FAO, 2008; Pahl, 2008; Fisher *et al.*, 2009; Yee *et al.*, 2009) and it has similar characteristics as petroleum-derived diesel and when both mixed together it can be used in any Compression Ingition engines without regulation (APEC, 2008).

Other vegetable oil sources used for producing biodiesel include sunflower, rapeseed and soybean oil with annual oil yields of 0.47, 0.72 and 0.4, respectively (average value from: Yusoff and Hansen 2007; Ong *et al.*, 2012; MPOC, 2012; Mekhilef *et al.*, 2011; Lim and Teong, 2012). World share of palm oil accounts approximately 35%, soybeans 26%, canola 15%, sunflower 9%, others 15% (Statista, 2015) The demand for vegetable oils is supposed to be 240 Mt/year in 2020 (Corley 2009 OilWorld, 2013). Other non-edible vegetable sources include jantropha oil, waste or recycled oil, and animal fats (e.g. chicken fat, by-products from fish oil) (APEC, 2008; Lim and Teong, 2012; Fisher *et al.*, 2009; FAO, 2008; World Growth, 2011).

Indonesia is the largest global producer of palm oil. Global production of palm oil is expected to increase by 32% to almost 60 Mt by 2020 (World Growth, 2011). In Indonesia, 50% of palm oil plantations are owned by huge companies with mills. Small farmers in Indonesia own 40% of Indonesian plantations. The remaining 10% of plantations are owned by Indonesian Government (Rist *et al.*, 2010; World Growth, 2011; World Growth, 2010; Rianto, 2010).

The global harvested area of oil palm in 2013 was approximately 17 Mha, of which 7.08 Mha is in Indonesia (FAO, 2014). Production of crude palm oil (CPO) in Indonesia reached 28.4 Mt, in Malaysia 19.2 Mt and 2 Mt in Thailand. Indonesia and Malaysia supply 82% of total demand.

The aim of this study is to analyse costs and revenues of establishing palm oil plantation in Indonesia. Based on the data collected this study determines whether the system is more affected by a change in costs or in the selling price of raw material. The specific objectives are:

1) To review the factors determining the financial profitability of oil palm production (from the perspective of a plantation) in Indonesia.
2) To construct a bio-economic model of cultivating oil palm and to compare the sensitivity on the effects in different prices.

MATERIAL AND METHODS

Area Description

The research was carried out in North Sumatra. The plantation is located in the eastern part of the region Simalungun 19 km east of Pematang Siantar and 147 km southeast of the capital of North Sumatra – Medan at an altitude of 0–369 m. It is a unit Bah Jambi, which is one of the 40 business units Perkebunan PT Nusantara IV (Persero). This business unit is engaged in production and cultivation of oil palm and processing of palm fruits. The climate is tropical with a mean daily temperature of 27 °C and a mean annual rainfall of around 2,000 mm, which is primarily distributed from November to March. The relative humidity is around 85%. The topography is relatively bumpy and hilly with a maximum slope of 10°. The underlying geology is podzolic orange and brown soil. The water table is typically 80 cm below the surface. The population density round about is 190 person/km^2 (BPS, 2012). The oil palm company plantations PT Perkebunan Nusantara IV (Persero) were selected, because they are one of the largest plantations owners in North Sumatra.

Data Collection and Processing

Data were collected during face to face interviews with oil palm plantation managers involved in the production process. Data related to quantities and costs of all inputs and outputs of the establishment, maintenance, production, harvesting and sales. Future amounts of inputs and outputs were estimated from past experience. A spreadsheet model, developed in Microsoft Excel 2010, was found as appropriate method of summarising the data and therefore it is necessary to specify basic criteria:

- computation unit is one hectar of plantation,
- the main time scale is one year,
- recognize the impact of discounting the time value of money,
- check the system sensitivity to changes in input values.

The area of the case study plantation is 8,000 ha. The typical life cycle production chain is 26 years, while in first year the pre-nursery and nursery plantation is planted and the oil palms are removed in year 25. Concurrently the establishment of palm oil field is conducted, but the costs of overall establishment and nursery costs are summarised only in year zero. The main costs in each operation relate to labour, machinery, and input materials. Labour costs are expressed in “person-days” which is equal to 8 hours. Cost of worker and master is IDR 48,000 and IDR 66,000, resp., and men and women are equal. The sensitivity analysis compares the economics on the effects in different costs and selling price of raw material.

Technical and Financial Data

It was assumed that trees were planted at a triangular spacing of 9×9 m and the density of 143 trees.ha^{-1}. The yield of oil palm increased from zero at planting to about 27 t ha^{-1} at 7 years. It then plateaus before declining after about 14 years. An area of oil palms is planted at 143 palms per hectare

I: *Basic technical data of this case study*

System	Unit	Value
Plantation area	ha	8 000
Number of plants in plantation	unit/ha	143
Length of access roads and canals	km/ha	0.0005
Length of main roads and main drainage	km/ha	0.01
Length of collection roads and collection drainage	km/ha	0.34
Length of plantation drainage	km/ha	0.30
Pre-nursery area	ha	3
Nursery area	ha	103

would produce a mean annual yield of 22.1 tonnes FFB per hectare over a 25 year period. Basic technical data of this case study are shown in Tab. I. The price of FFB in the domestic market varies with factors such as product availability and market demand. The market price for selling FFB used in this study was IDR 1,700 per kg and it was used to conduct this study in July 2014, constant value counts also Ong (2012). FFB price varies directly proportional to the price of CPO and is around 20.4% of the CPO price. After determining that percentage the historical price of FFB was derived in IDR from the market price of CPO in IDR.

The USD exchange rate was taken as average value from 2014 (USD 1 = 11,500 IDR) (World Bank, 2012). Since 1996, real wages increased by 70%, therefore the analysis calculates with the rise of wages levels by 10% annually. This value was chosen because the statistics indicated a nationwide increase, which are mostly scientific workers, teachers and higher-ranking employees. In agriculture, there is no such sharp increase in wage increases and we can say that wages in this sector are the same.

Financial Analysis and Financial Assesments

Cost part of financial analysis uses full production cost (FPC), which includes not only the personnel cost and resources, but also the costs associated with total production and activities related to the final product. Therefore it also includes the cost of land and administrative costs. Cost analysis in this work is based on the distribution and the cost calculation by activities (ABC). The costs of production taken into account are capital and recurrent costs, both including labour and material costs.

When assessing the benefits of the business market with palm oil in Indonesia is first necessary to determine financial statement of cash-flow, which may acquire in income or expense. Then following the determination of net cash-flow which is the balance of net income and expenditure. These cash flows are discounted yearly over 25 years at varying rates of interest: 5%, 10% and 15%, with a default rate at 10%. The costs and revenues were calculated on an annual time-step. The result is a discounted cash-flow and cumulative discounted cash-flow. For the evaluation of the project is used as indicators of criteria, which are: net present value (NPV), return of investment (ROI), internal rate of return (IRR) and payback period (PP). It is necessary to take into account all evaluation indicators and do not constitute investment decision only on one of them. This analysis is used in order to investigate the feasibility and desirability of the system.

The second objective was to construct a spreadsheet model to describe the revenue and costs associated with oil palm plantation system over 25 years. It is considered suitable to determine the cash-flow. The cash-flow was determined as the revenue (*R*; units: IDR ha^{-1}) minus capital costs (*C*; units: IDR ha^{-1}) minus recurrent costs (*T*; units: IDR ha^{-1}) (Equation 1):

$$CF = R - (C + T). \qquad \text{(Equation 1)}$$

The Net present value (NPV) was used to determine the overall financial performance of the project (Brent, 1998; Sugden and Williams, 1990). Annual income and returns were estimated for 25 years, and then discounted to present values. The NPV of the project was calculated and derived from the total discounted income and costs. The net present value of a system over a period of time (NPV; units: IDR ha^{-1}) was derived using Equation 2, where cash-flows *(CF)* are specified for each year (*r*) over a time horizon of *R* (years), and *i* is the discount rate:

$$NPV = \sum_{r=0}^{r=R} \frac{CF_r}{(1+i)^r}. \qquad \text{(Equation 2)}$$

Internal rate of return (IRR) compares the amount of benefits and costs. IRR is the value of the discount rate at which the present value of expected investment returns equal to the present value of investment expenditure. It is interest income expected from the investment plan. This breakthrough discount rate is the value of cash outflows equal to the value of cash inflows. It is calculated using Equation 3, where: time (r), cash flow (CF), internal rate of return (IRR), net present value (NPV).

$$NPV = \sum_{r=0}^{r=R} \frac{CF_r}{(1+IRR)^r} = 0. \qquad \text{(Equation 3)}$$

Return of investment expresses net profit or loss in relation to the initial investment. This indicator simply evaluates the viability and feasibility of the investment. It is the ratio of the money earned to money invested and is given in percent. ROI is used to measure profitability over time, not to measure the effectiveness of the project such as in the IRR or PP. ROI was derived using Equation 4, where total revenue *(P), capital costs (C), recurrent costs (T)* are specified for each year (*r*) over a time horizon of *R* (years), and *i* is the discount rate:

$$ROI = \sum_{r=0}^{r=R} \frac{\frac{P_r}{(1+i)^r} - \left(\frac{C_r}{(1+i)^r} + \frac{T_r}{(1+i)^r}\right)}{\left(\frac{C_r}{(1+i)^r} + \frac{T_r}{(1+i)^r}\right)}. \qquad \text{(Equation 4)}$$

Payback period (PP) method is used to define the main time point when it is worth the initial investment in the project. PP calculation generally represents time (usually years), which is needed to restore the initial costs and the net cash flow is therefore zero. It is the time required to settle the cumulative income with cumulative costs. The shorter the payback period, the more advantageous because of lower riskiness and of such earlier possibility to use returned funds for future investment. PP is calculated as cost of investment divided by annual cash inflows.

RESULTS AND DISCUSSION

This study has sought to estimate the financial outcome of a new oil palm plantation. Externalities are not included in this study and are recommended for future studies.

The historic inflation rate peak came in 1998–1999 when inflation was reduced from 80% to zero (Global Rates, 2013). In the first decade of the millennium it fluctuated between 20% and 5%. In the last few years it started to go down and is around 5% per annum. Discount rate for this study was determined based on the long-term trend rate of inflation (IMF, 2014) and interest rates of the Central Bank of Indonesia (Bank Indonesia, 2014). It is not expected that the chosen discount rate would be influenced in future only by inflation value and therefore fixed discount rate of 10% p.a. also takes account of other possible risk, discount rate of 5% is calculated without additional risk and 15% discount rate involves a greater risk for investment. FFB in Indonesia are not subject to VAT (PWC, 2010).

Capital and Recurrent Costs

Capital Costs

Capital costs include expenses that occur before the first harvest and include the cost of:

- land acquisition,
- reconnaissance,
- establishment of pre-nursery and its operation,
- establishment of nursery and its operation,
- land clearing,
- construction of buildings and other facilities,
- construction of road and drainage infrastructure,
- machinery,
- planting plants in plantation.

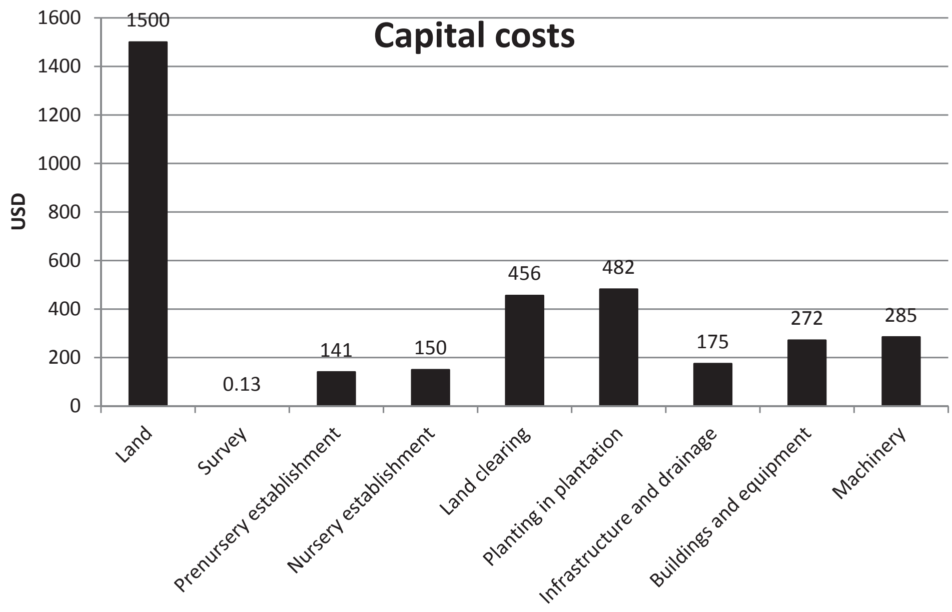
The following Fig. 1 is a summary of all capital costs. The largest capital cost per hectare of plantation related to the land acquisition, which is shown below. Other studies point to the largest capital costs associated with clearing the land, which in this case represents the second largest capital cost. This is because other studies do not include cost of land acquisition. The total capital cost is USD 3,460 per hectare of plantation. Without the cost of land included the value would be USD 1,960, which is almost half of the capital cost.

Recurrent Costs

Labour need for individual working activities are shown in Tab. II. Labours work 6 days a week, equivalent to 25 days of the month. Administrative staff work 5 days a week, equivalent to 22 days of the month. Recurrent costs include costs that occur during the project repeatedly, in different years, however, a number of inputs may vary. Recurrent costs include the following activities:

- fertilisation and other maintenance,
- survey,
- maintenance of roads and drainage infrastructure,
- pruning trees,
- maintenance of buildings and other equipment,
- harvesting and transport of FFB,
- salaries of administrative staff,
- operating costs.

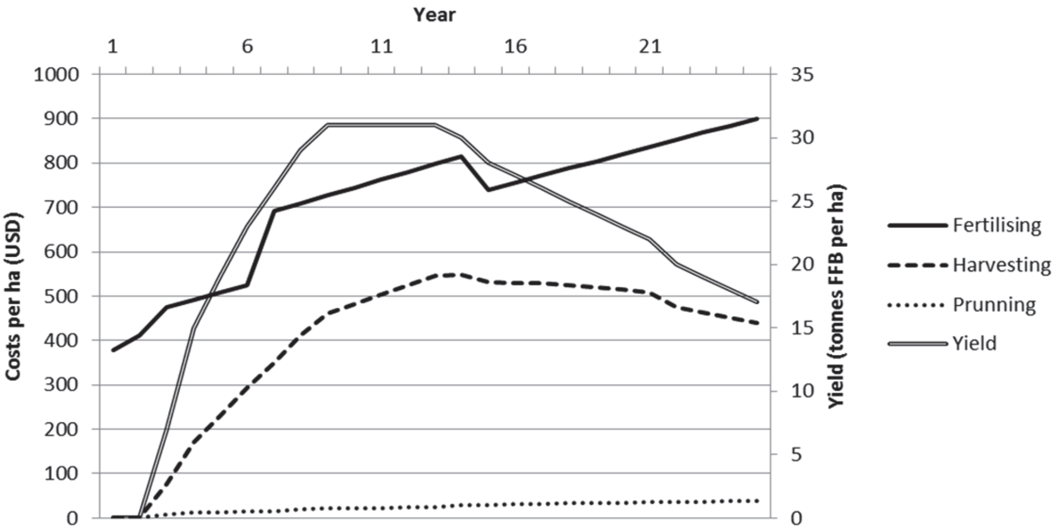
Costs of variable recurrent costs are shown in Fig. 2. These costs include fertilising, harvesting and pruning. Other recurrent costs belong to activities that remain constant during the time period for the entire duration of the project. This includes road and drainage maintenance survey, salaries of administrative staff, overheads. Infrastructure maintenance includes the largest share of these



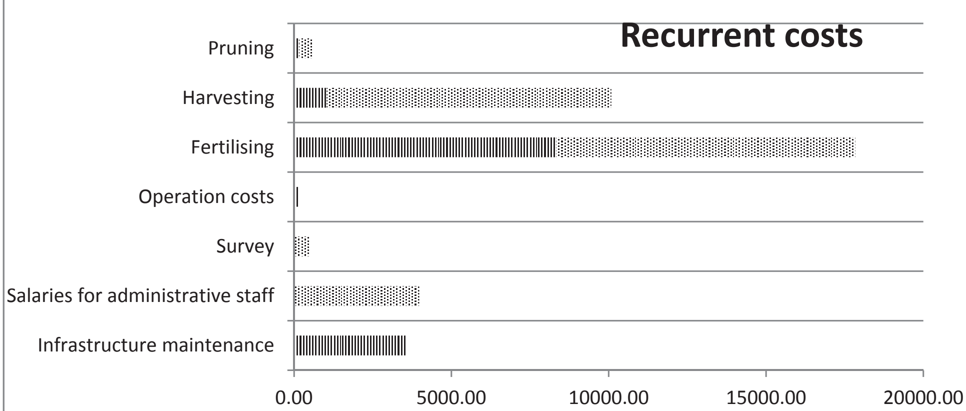
1: *Share of capital costs in plantation*

II: *Labour and mechanical need for different operations in plantation*

Operation	Unit	Labour need (days)	Mechanical work need (motohours)
Pre-nursery (4 months)	ha of pre-nursery	166 (+8)	-
Nursery (8 months)	ha of nursery	1097 (+45)	8
Land clearing	ha of plantation	61 (+3)	10
Planting trees in plantation	ha of plantation	68 (+4)	-
Infrastructure and drainage	ha of plantation	-	9*
Fertilisation and other maintenance (yearly)	ha of plantation	37 (+3.5)*	-
Maintenance of infrastructure and drainage (yearly)	ha of plantation	-	1*
Pruning (yearly)	ha of plantation	2	-
Survey (yearly)	ha of plantation	2	-
Harvest	ton of FFB	1.5	-



2: *Variable recurrent costs during the lifetime of the plantation*



	Infrastructure maintenance	Salaries for administrative staff	Survey	Operation costs	Fertilising	Harvesting	Pruning
Other	3549.72	0.00	0.00	168.66	8330.61	1033.87	156.52
Workers	0.00	3978.20	480.00	0.00	9506.56	9048.57	450.95

USD

3: *Share of recurrent costs in plantation for the lifetime of the project* costs. Share of recurrent costs in plantation is shown in Fig. 3.

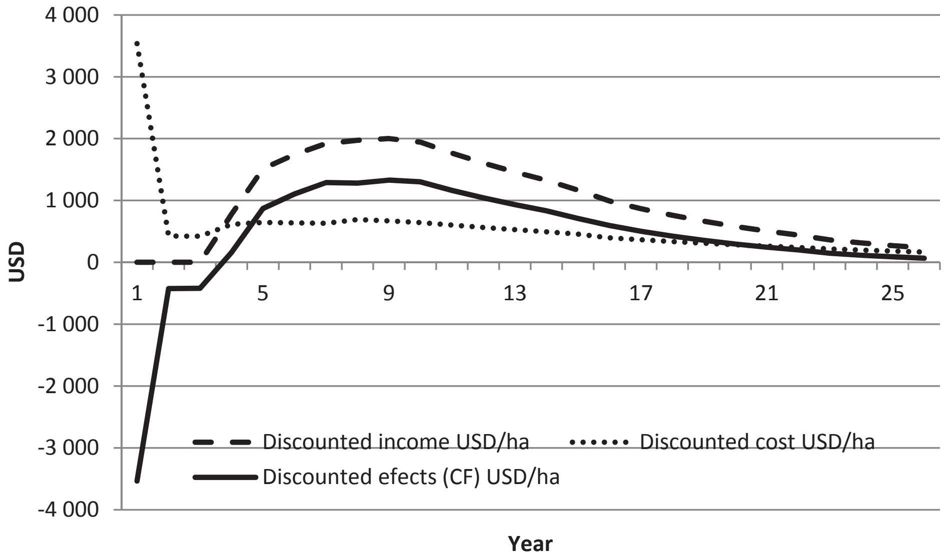
Financial Assessments

The key factors influencing financial side of the project are: the cost of inputs (material, labour and machinery), the market price of selling fruits, which affect the revenue and profit for company and discount rate. This part assesses the reasonableness of the case study mainly based on criterial indicators. To assess the cost-benefit analysis of a spreadsheet model, we used the following indicators: NPV, IRR, ROI and PP.

Fig. 4 shows annual cash flow for plantation. Costs are the biggest in the beginning of the project because of the significant capital costs, mainly for cost of land and clearing. In the next two years, the annual costs are reduced, but overall costs are still rising and then start to go down. Within the first three years there is no income because oil palms still not yield. Revenue begins to growth sharply during the fourth year, when oil palms begin to produce FFB. Subsequently, income starts to vary but stays stable up to Year 15 and begins to decline. The NPV suggest the total financial achievement of investment. For this cost-benefit analysis the annual income and costs are calculated for 25 years, and then discounted. Discounted cumulative net margin is the NPV of this investment. Using the discount rate at 10%, the NPV of the project, the discounted total revenue is USD 25,188 and the present value of total costs is USD 14,518. The NPV was calculated as USD 10,670. These values suggest that oil palm cultivation is profitable. The derived IRR is 14.83%, ROI 73.50% and payback period 6.75 years.

The cash flow for each year and the cumulative cash flow over 25 years have been calculated. The biggest difference is visible when the cash flow benefits became evident. The oil palm plantation system is profitable assuming a discount rate of 5%, 10% and 15% (Tab. III). Beyond this, it is necessary to take into consideration a high risk of establishing a plantation, because of high establishment costs and the fact that the plantation will first yield after 3 years from planting. We have to consider the risk of possibility that the forest burns before it starts getting profit. System is loaded by negative cash flow for six years and records a rapid growth after that. There are three ways of shifting NPV: 1) changing the discount rate changes the NPV. Higher discount rate makes minor NPV; 2) higher income amounts heighten the NPV and conversely; 3) formerly profits elevate the NPV and later profits reduce the NPV.

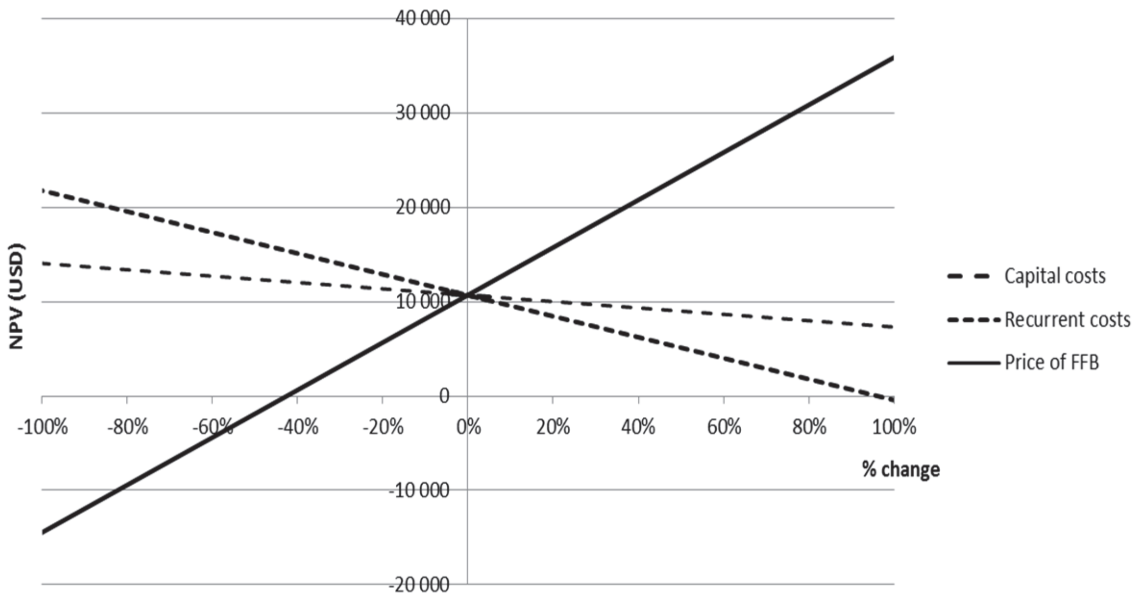
All evaluation indicators, namely IRR and ROI show that at the discount rate of 26% the project becomes financially disadvantageous investment. However that high discount rate is very unlikely to expect. Inflation in 2008 climbed to 58%, which was caused by the Asian financial crisis. Inflation started to fall immediately and in the period since 1980 has been fluctuating mostly below 10%. For this reason, it would not be realistic to determine discount rate higher 15%.



4: *Annual cash flow for plantation*

III: *Financial indicators for different discount rates*

Discount rate	NPV (USD.ha^{-1})	ROI	IRR	PP (years)
5%	20,775	92.92%	20.3%	6.06
10%	10,670	73.50%	14.83%	6.75
15%	5,304	49.82%	9.84%	7.69



5: *Sensitivity analysis*

Sensitivity Analysis

Sensitivity analysis facilitates us to assess the economic risks. We explore how strong the oil palm cultivation from the financial perspective may appear within shifting marketplace conditions. All financial indicators are affected by: income, costs and discount rate. The analysis was done by changing financial indicators for different possible changes in supposed circumstances. Results show how sensitive is the analysis to change in some of the factors. Sensitivity can be determined with distinction between the highest and lowest value for each scenario.

We test the sensitivity of the system to changes in FFB selling price, change in capital costs and change in recurrent costs (Fig. 5). Setting of NPV at a discount rate of 10%, the model was used to determine the sensitivity of the system. The system is being tested on a change in the purchase price of FFB. In case of reducing this price by 5%, from USD 147.8 of USD 7.4 to USD 140.4 revenues from selling FFB are reduced from USD 25,188.to USD 23,928. Difference is USD 1,260 and in case of increase in the selling price of FFB revenues increases to USD 26,447. In terms of NPV the value is USD 9,411 with reduction in the selling price and USD 11,929 with increase in selling price compared to USD 10,670. The difference in NPV is 11.8%. Another testing change is in capital costs, which are represented by USD 3,461. A 5% change in these costs is equal to the amount of USD 173. By increasing capital costs by 5% the NPV reaches USD 10,506 and vice versa while reducing capital costs the NPV is USD 10,843. The difference in NPV when changing capital costs is 1.6% compared to original NPV of the project USD 10,670. Recurrent costs are represented by the amount of USD 36,704 and 5% change in these costs is equal to USD 1,835. When these costs increase by 5% the NPV is reduced to USD 10,117. and vice versa reduction of these costs will increase NPV to USD 11,223. The difference in NPV when changing recurrent costs is 5.2%.

There have been several economic studies looking at profitability of oil palm plantation (e.g. Belcher (2004), Latif *et al* (2003), Noormahayu *et al*. (2009). Study by Noormahayu *et al*. (2009) is using the same discount rate at 4%. Results in their study show higher profitability in oil palm production with IRR of 63%. Lower costs in their study are probably affected by exclusion of building costs, recurrent maintenance costs and very low investment costs compared to our study. If they include all proper costs, the study would be more relevant and IRR will be similar to ours. Malaysian study by Latif *et al*. (2003) is using interest rate at 10%. They found that increasing the density up to 200 palms.ha^{-1} increase the NPV. The IRR varies between 21–27% (120–200 palms.ha^{-1}). This is more likely as our result.

CONCLUSION

In this study the economic analysis of oil palm plantation was developed. The practical part calculates the NPV for the system during 25 years long period in Indonesian agriculture production. With incorporation of 10% discount rate the discounted total revenue is USD 25,188 and the present value of total costs is USD 14,518.

The NPV of the system is positive at USD 10,670 and indicates that this investment is good and profitable. The ROI of 73.50% ensures a considerable return per hectare. This is obtainable due to inexpensive labour in oil palm plantation. The IRR of 14.83% forecasts high returns and payback period is 6.75 years. Sensitivity to change in discount rate indicates positive investment opportunity up to 26% of discount rate. In general, the higher discount rate, the lower NPV and investment attractiveness. The sensitivity analysis also shows that change in selling price of FFB is more sensitive than change in investment and recurrent costs This study presents that 5% change in selling price of FFB causes change in NPV by USD 1,259 whereas 5% change in capital costs make USD 173 change and 5% change in recurrent costs make USD 553 in NPV difference. Discount rate is also one of the factors affecting NPV. When the discount rate increases to 15% the NPV is reduced by USD 5,366 to USD 5304. Conversely with lowering the discount tare the NPV increased by USD 10,670 to USD 20,775.

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