Scholars Journal of Economics, Business and Management (SJEBM) **e-ISSN 2348-5302**
Abbreviated Key Title: Sch. J. Econ. Bus. Manag. **p-ISSN 2348-8875**

A Unit of Scholars Academic and Scientific Society, India
www.saspjournals.com

Determination of Rubber Plant Life: an Application of Capital Budgeting in Agricultural Sector

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Article History
Received: 07.03.2018
Accepted: 23.03.2018
Published: 30.03.2018

DOI:
10.36347/sjebm.2018.v05i03.017

Abstract: This research aims to determine rubber plants life in rubber plantation using capital budgeting analysis. The analysis was based on data indicated in the company's management report in 2007 to 2016. The estimation of cash flows for the capital budgeting analysis (i.e. NPV analysis) was based on the Monte Carlo's simulation. The discount rate in the analysis was based on cost of equity and cost of debt. The results of NPVs simulation has demonstrated that the rejuvenation time of rubber plant depends on the source of fund in the rubber plantation investment. Considering the variability of the components of NPVs analysis, which were simulated using Monte Carlo method, the rejuvenation time of rubber plant is correlated negatively with the cost of capital or discount rate being used in NPVs analysis.
Keywords: Replanting, rubber plantation, Monte Carlo simulation, capital budgeting.

INTRODUCTION

In Indonesia, the plantation sector comprises a sector that has an important contribution in the national economy. This sector supplies not only domestic demand but also the world demand. One of the fundamental issues in the management of plantation companies is the timing of the perennial crop rejuvenation. The timing of perennial crop rejuvenation will affect the commodity production (yield) in the futures.

Basically, the perennial crop has a gestation period (i.e. The period between rejuvenation of crops and its first harvest). Therefore, The timing of perennial crop rejuvenation must be calculated appropriately.

Theoretically, the time for rejuvenation can be determined by the concept of maginal analysis. The replanting must be conducted when the commodity revenues generated by plants equal to the operational costs of maintaining the plants. In this condition, maintenance of existing plants will cause losses for the company. One of approaches to determine the timing of crop rejuvenation is Net Present Value (NPV) analysis. NPV is based on the time value of money which considers one dollar owned today is worth more than a dollar at some time in the future [1].

NPV has been extensively applied in the investment feasiblity studies. Rodrigues *et al*. [2] conducted a feasibility analysis of solar power plants in 5 cities in China, namely Hangzhou, Hefei, Jingdezhen, Tingri, and Jiazi. China has the second largest electricity industry in the world and is playing an important role within the global economy and environment. The primary fuel mix is dominated by coal, which is contributing to significant local, regional and global environmental pollution. China is the second largest emitter of greenhouse gases in the world, just behind the USA [3, 4], and is coming under increasing international pressure to control its emissions [5]. The approach used in the three methods is sensitivity analysis, where the power plant is illustrated with 3 different powers, i.e. 1 kW, 3 kW, and 5 kW. The research finds the best investment priority.

Irvine *et al*. [6] tried to analyze some of the proposals related to airport development in London. He estimates the capacity of the airport as a basis for consideration of several airport development proposals using the Monte Carlo simulation. This study shows that the decision to increase airport capacity is not only based on practicality, but also must consider the configuration and condition of airports, socioeconomic and environmental conditions and the development of the global world.

Namah *et al*. [7] examines the economic and technical feasibility of Keprok SoE Farms in the South Central Timor region. Based on the NPV criteria the project is feasible because the rate of return is greater

than its investment expenditure. When using IRR criteria, the project is feasible because the rate of return is higher than its cost of capital. The Net B / C Criterion of the project is feasible because the rate of return is greater than its investment expenditure. The payback period is obtained in 1.97 years or 1 year 11 months and 20 days after the SoE Keprok Produced / harvested, ie in the fifth year. Several researchers also conducted studies on Keprok SoE citrus from different aspects. Pellokilla, Wiendyati & Raya [8]; Wei, Sherrie *et al*. [9]; Wei, Sherrei *et al*. [10] Wiendyati [11], investigate the impact of technology improvement in the profitability of mandarin; and Wei, Sherrie *et al*. [9]; Wiendyati [11] who studied on the marketing aspect of this product.

Zhang, *et al*. [12] discusses the issue of capital budgeting in multinational corporations involving foreign cash flows. Construction costs, annual net operating cash flows, project terminal values and foreign exchange rates are variable uncertainties. Solving the problem using a zero-one integer model. The method used in this study is Hybrid Intelligent Algorithm, which is a method that can integrate the 99 methods and algorithms provided. Based on the research, the most favorable project outcomes are 1 and 2 projects, namely in Mexico and India with the maximum expected profit (Net Present Value) of CYN 32.55 million. Bhattacharyya *et al*. [13] proposed an uncertain theory based multi-objective optimization technique for R & D project portfolio selection. Therefore we will also use uncertain measure to gauge the imprecise. Subjective evaluation and make use of uncertainty theory to select multinational projects with parameters containing subjective uncertainty.

A typical aspect of plantation crop management is the uncertainty in the various components. Productivity of the plant is strongly influenced by weather conditions and other natural factors. In addition, the world price of commodities and operational costs fluctuates relatively frequent. To accommodate fluctuation possibility in productivity, selling prices, and operational costs, NPV analysis must be applied by simulation concept.

One of the most strategic commodities in PT Perkebunan Nusantara XII, one of Indonesian plantation companies, is rubber. Currently, the company manages the rubber plant area of 16,785.15 hectarea of total 80,927.98 hectares of land owned by the company. Based on the 2016 Annual Report of PT Perkebunan Nusantara XII, sales of rubber commodities is the highest. It was Rp267 billion from total sales of Rp1,006 billion. Considering the proportion of area and sales, the determination time of rejuvenation of rubber plants is an critical aspect. If crop rejuvenation is done later than it should be, the company will suffer loss since the revenue generated from the sales of commodity is less than its operation costs.This article aims to determine the timing of annual crop rejuvenation, in this case the rubber plant, using NPV analysis with simulation approach.

METHODS

This study is a descriptive and simulation study. It described and simulated the data obtained from the object of the study and presented the result of the analysis to determine the time of the annual crop rejuvenation. The objects of the study was rubber plantation of PT Perkebunan Nusantara XII. The data, such as crop area, production of rubber, investment cost per stage, quantum sales, sales value, cost, production cost, selling cost, as well as administration and general cost, were obtained from the production division and the financial statements of the company. The analysis data is divided into two stages, namely random number generation and Monte-Carlo simulation based NPV. The random number generation was based on the historial data being analysed and Monte-Carlo simulation-based NPV was used to determine the time of the annual crop rejuvenation. The rejuvenating time was determined when NPV simulation results in more negative NPVs. The negative NPVs indicate that the cash inflow (revenue) generated by the rubber plantation is greater than cash out flow (the operation cost of rubber plantation).

RESULTS AND DISCUSSIONS

Production of rubber plantation

Rubber plant is a perennial crops that has a gestation periode and productive life in more than a year. On the average, the gestation periode (first harvest) of rubber plant is 7 years. The rubber plant cultivated in year t will start producing in year $t+7$. The production of rubber per hectare will be varied according to the age of the rubber plant. On the average, rubber plant can have a production life in more than 30 years. Table 1 presents the rubber production (in kilograms per hectare) data in 2007-2016. It shows the first harvest in the last 7 years varies from 195 kilograms to 1,400 kilograms. The production of rubber in general varies from around 1,000 kilograms to around 2,000 kilograms.

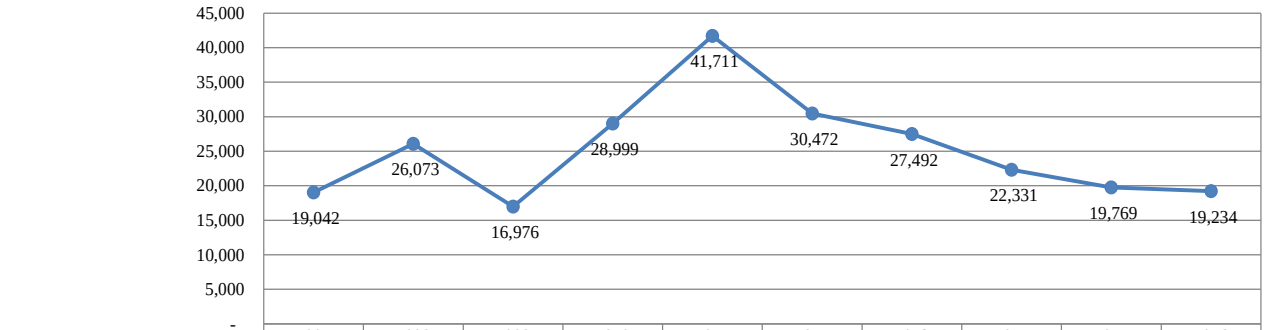
Table-1: Production of Rubber (in Kilogram) Per Year Planting

Year of Planting	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2000	1,018	1,468	1,680	1,800	1,460	1,521	1,571	2,312	1,961	1,963
2001	564	1,115	1,441	1,593	1,488	1,654	1,519	1,332	1,505	1,562
2002	-	195	552	1,340	1,898	1,747	1,487	-	-	1,786
2003	-	-	-	-	1,519	-	-	-	-	-
2004	-	-	-	-	1,603	-	-	-	-	-
2005	-	-	-	-	-	1,183	1,162	1,152	1,560	1,781
2006	-	-	-	-	-	1,092	1,033	1,107	1,234	1,455
2007	-	-	-	-	-	-	655	911	1,151	1,405
2008	-	-	-	-	-	-	-	-	1,244	1,400
2009	-	-	-	-	-	-	-	-	1,400	1,045

Source: primary data, 2017

Average selling price and sales volume

The averager selling (world) price has fluctuated during 2007-2016. It relatively increased in 2007-2011. It tended to decrease in the last six years. On the contrary, the sales quantum (in tons) of rubber showed a relatively low growth in 2007-2016. Figure 1 presents the dynamic of the average selling price and sales volume in 2007 up to 2016. The lowest average price of rubber crops occurred in 2009, while the highest price occurred in 2011. The highest price increase occurred in 2010 at 71%, while the sharpest decline occurred in 2012.



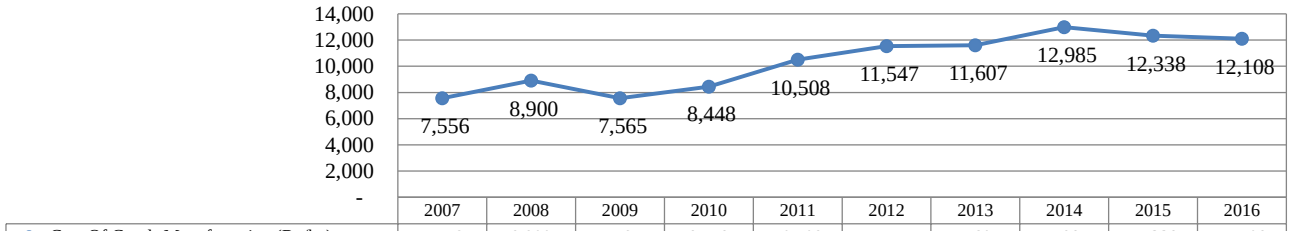
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Average Selling Price (Rp/kg)	19,042	26,073	16,976	28,999	41,711	30,472	27,492	22,331	19,769	19,234
Sales Value (In millions Rp)	229,372	323,177	216,212	370,419	496,957	340,572	324,791	274,906	263,207	267,134
Quantum Sales (ton)	12,046	12,395	12,737	12,773	11,914	11,176	11,814	12,310	13,314	13,889

Fig-1: Average selling price and sales volume

Source: primary data, 2017

Production cost

The production cost per kilogram for rubber plant have varied and tended to increase from year to year. The highest production cost per kilogram was in 2014 and the lowest one was in 2007. The biggest decrease in production cost per kilogram occurred in 2009 since production costs decreased while production quantity relatively increased in that year. The highest increase occurred in 2011 since production costs increased but production was relatively low. Figure 2 presents the production cost in 2007-2017.



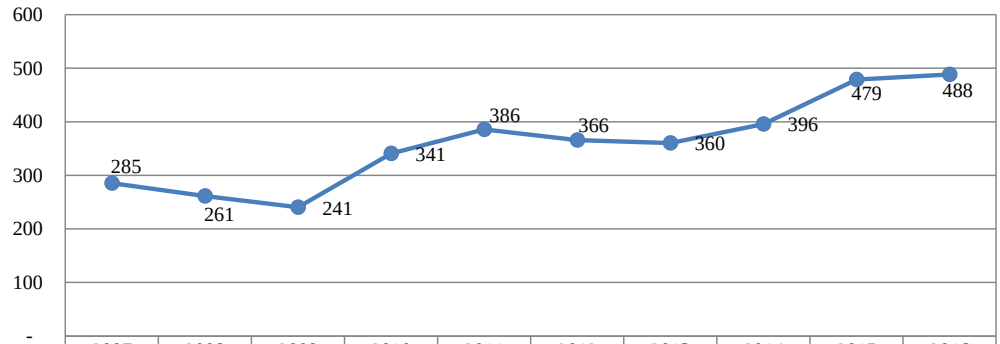
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cost Of Goods Manufacturing (Rp/kg)	7,556	8,900	7,565	8,448	10,508	11,547	11,607	12,985	12,338	12,108
Cost Of Goods Manufacturing (In millions Rp)	92,930	109,075	97,414	112,792	127,664	136,389	136,551	159,280	159,015	168,911
Quantum Production (ton)	12,298	12,256	12,877	13,351	12,149	11,812	11,765	12,266	12,889	13,950

Fig-2: Production cost per kilogram

Source: primary data, 2017

Sales cost

The sales cost has been relatively increasing during 2007-2016. The lowest cost of sales per kilogram was in 2009 and the highest one was in 2016. The lowest sales cost per kilogram occurred in 2009 meanwhile the highest sales cost per klogram was in 2016. In 2012, there was a high increase in total selling cost because sales volume increased by 0.29% but the increase in selling cost was 42%. Figure 3 presents the sales cost during 2007-2016.



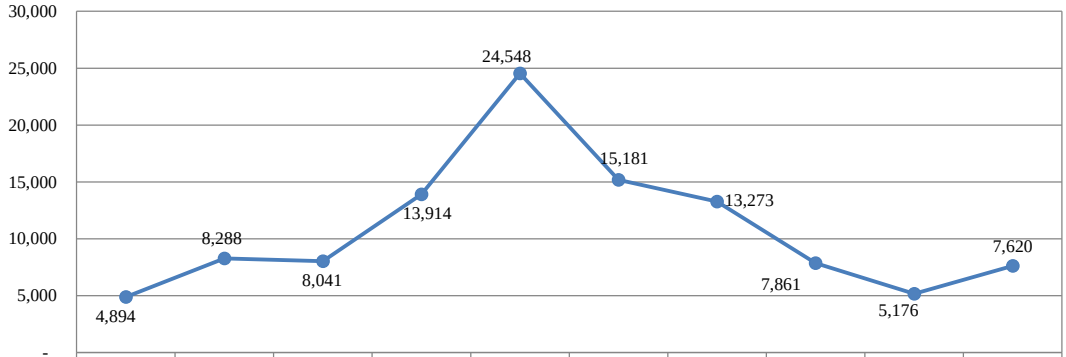
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cost Of Sales (Rp/kg)	285	261	241	341	386	366	360	396	479	488
Cost Of Sales (In millions Rp)	3,437	3,238	3,065	4,351	4,597	4,089	4,257	4,875	6,378	6,781
Quantum Sales (ton)	12,046	12,395	12,737	12,773	11,914	11,176	11,814	12,310	13,314	13,889

Fig-3: Sales cost per kilogram

Source: primary data, 2017

Administrative and miscellaneous expense

Administrative and miscellaneous expense per hectare has been fluctuated during 2007-2017. The highest one was in 2011. Starting from 2011, it tended to decline to its lowest level in 2017. Figure 4 presents the administrative and miscellaneous expense per hectare of rubber plants.



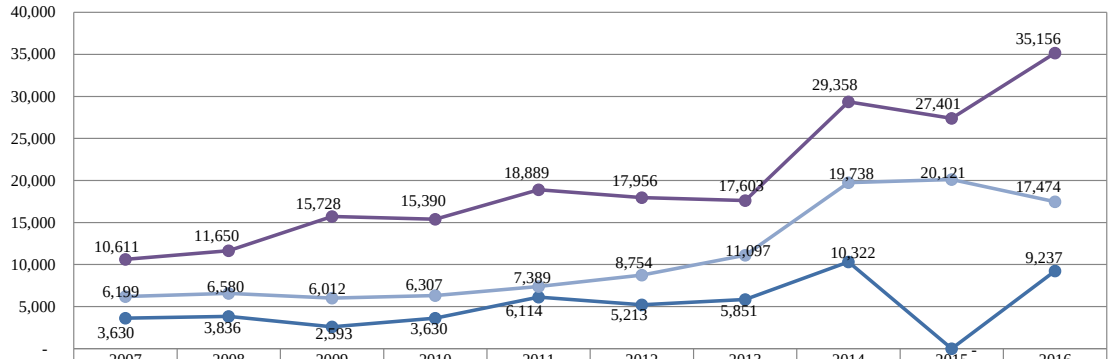
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
General Cost (In Thousand Rp/ha)	4,894	8,288	8,041	13,914	24,548	15,181	13,273	7,861	5,176	7,620
General Cost (In millions Rp)	41,160	68,711	64,863	109,435	191,843	118,579	111,676	76,549	51,649	76,969
Areal TM (ha)	8,410	8,290	8,067	7,865	7,815	7,811	8,414	9,738	9,978	10,100

Fig-4: Administrative and general expenses per hectare

Source: primary data, 2017

Investment Cost

Investment cost is related to the cost to maintain next-year-rubber-plant (*TTAD*), this-year-rubber-plant (*TTI*), and not-yet-producing-rubber-plant (*TBM*). Figure 5 shows that investment costs fluctuated. The highest increase in investment cost per hectare occurred in 2014 was 76% for TTAD, 67% for TTI, and 78% for TBM. The increase is due to the increase in investment costs, also affected by the decline in investment areas.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
TTAD (In Thousand Rp/ha)	3,630	3,836	2,593	3,630	6,114	5,213	5,851	10,322	-	9,237
TTI (In Thousand Rp/ha)	10,611	11,650	15,728	15,390	18,889	17,956	17,603	29,358	27,401	35,156
TBM (In Thousand Rp/ha)	6,199	6,580	6,012	6,307	7,389	8,754	11,097	19,738	20,121	17,474
TTAD Value (In millions Rp)	929	6,694	4,552	2,455	5,527	10,249	4,507	4,327	-	1,580
Areal TTAD (ha)	256	1,745	1,756	676	904	1,966	770	419	32	171
TTI Value (In millions Rp)	18,126	3,870	26,314	26,500	12,172	16,199	28,885	19,861	4,976	889
Areal TTI (ha)	1,708	332	1,673	1,722	644	902	1,641	677	182	25
TBM Value (In millions Rp)	11,978	22,782	22,813	34,529	53,152	68,247	85,203	150,099	146,789	113,375
Areal TBM (ha)	1,932	3,462	3,795	5,475	7,193	7,796	7,678	7,604	7,295	6,488

Fig-5: Investment cost per hectare
Source: primary data, 2017

Monte Carlo Simulation

The Monte Carlo simulation on the research data in Table 1 and Figure 1-5 was conducted by grouping each of data into 10 classes (Table 2). In each class, a random number between 00 and 100 is set. Furthermore, NPV simulation on various possible combinations of random numbers representing the research data was performed. Considering that rubber plants have an economic life of 25 years from the first harvest, the NPV simulation was runs for 27 years to 25 years time horisons from the first harvest.

Table-2: Class Division of Variables and Random Number

Variabel	Interval Class									
	1	2	3	4	5	6	7	8	9	10
Random Number (Min)	0	11	21	31	41	51	61	71	81	91
Random Number (Max)	10	20	30	40	50	60	70	80	90	100
Production (kg)										
Lowest	195	317	437	558	678	799	919	1,040	1,160	1,281
The Highest	316	436	557	677	798	918	1,039	1,159	1,280	1,400
Average	255	376	497	617	738	858	979	1,099	1,220	1,340
Average Selling Price (Rp/kg)										
Lowest	16,976	19,450	21,924	24,397	26,871	29,345	31,818	34,292	36,765	39,239
The Highest	19,449	21,923	24,396	26,870	29,344	31,817	34,291	36,764	39,238	41,711
Average	18,212	20,686	23,160	25,634	28,107	30,581	33,054	35,528	38,002	40,475
Cost Of Goods Manufacturing (Rp/kg)										
Lowest	7,556	8,100	8,643	9,186	9,729	10,272	10,815	11,357	11,900	12,443
The Highest	8,099	8,642	9,185	9,728	10,271	10,814	11,356	11,899	12,442	12,985
Average	7,828	8,371	8,914	9,457	10,000	10,543	11,086	11,628	12,171	12,714
Cost Of Sales (Rp/kg)										
Lowest	241	266	291	316	341	365	390	415	440	464
The Highest	265	290	315	340	364	389	414	439	463	488
Average	253	278	303	328	353	377	402	427	452	476
Administrative and Miscellaneous Expense (In thousand Rp/ha)										
Lowest	4,894	6,860	8,825	10,790	12,756	14,721	16,686	18,652	20,617	22,582
The Highest	6,860	8,825	10,790	12,756	14,721	16,686	18,652	20,617	22,582	24,548
Average	5,877	7,842	9,808	11,773	13,738	15,704	17,669	19,634	21,600	23,565
TTAD (In thousand Rp/ha)										
Lowest	-	1,032	2,064	3,096	4,129	5,161	6,193	7,225	8,257	9,289
The Highest	1,032	2,064	3,096	4,129	5,161	6,193	7,225	8,257	9,289	10,322
Average	516	1,548	2,580	3,613	4,645	5,677	6,709	7,741	8,773	9,806
TTI (In thousand Rp/ha)										
Lowest	10,611	13,065	15,520	17,974	20,429	22,884	25,338	27,793	30,247	32,702
The Highest	13,065	15,520	17,974	20,429	22,884	25,338	27,793	30,247	32,702	35,156
Average	11,838	14,293	16,747	19,202	21,656	24,111	26,565	29,020	31,474	33,929
TBM (In thousand Rp/ha)										
Lowest	6,012	7,423	8,834	10,245	11,656	13,066	14,477	15,888	17,299	18,710
The Highest	7,423	8,834	10,245	11,656	13,066	14,477	15,888	17,299	18,710	20,121
Average	6,717	8,128	9,539	10,950	12,361	13,772	15,183	16,594	18,005	19,415

This study assumed that there were two sources of funding that can be used by the company to finance the rubber plant, namely internal source (100% equity financing) and external source (100% debt financing). Therefore, there were two discount rate for the NPV analysis, namely cost of equity (for equity financing) and cost of debt (for debt financing). The proxy for cost of equity was the Central Bank rate (Bank of Indonesia Rate) in 2017, i.e. 4.75%. The proxy for cost of debt was the investment credit interest rate of commercial bank in 2016, i.e. 10.50%. In this study, 50 runs or simulations were performed. The results of NPV simulations using both financing scenarios is presented in Table 3 and Table 4.

Table-3: Results of NPV using internal

Simulation number	Years of Replacement								
	year 27	year 28	year 29	year 30	year 31	year 32	year 33	year 34	year 35
1	47,265,023	47,016,719	52,507,177	52,350,375	53,027,995	56,606,017	63,034,353	61,954,654	66,504,109
2	43,657,691	44,176,217	49,215,231	48,278,977	55,511,178	60,666,332	65,623,489	62,615,691	64,162,418
3	8,074,031	4,327,749	572,235	1,303,761	(204,007)	(4,562,017)	4,978,295	5,882,113	6,098,554
4	108,398,933	107,784,184	106,028,661	102,766,862	105,838,699	106,082,400	105,834,060	109,937,271	111,311,377
5	52,075,659	51,358,046	55,002,454	61,577,723	69,607,402	68,903,247	73,845,414	75,525,976	78,176,857
6	57,512,021	62,460,426	60,027,200	63,871,719	69,311,788	68,708,124	93,207,465	91,366,214	92,113,760
7	17,158,501	22,947,530	26,421,126	31,502,393	32,629,969	38,198,400	59,372,585	56,281,670	55,643,222
8	62,254,365	66,544,268	69,398,745	71,110,378	69,769,254	71,344,539	80,070,296	78,025,898	79,447,215
9	46,840,745	51,835,989	56,584,634	56,108,558	57,170,038	57,767,393	59,621,883	56,039,960	57,626,571
10	56,459,095	57,803,050	58,233,536	62,084,617	64,780,288	63,029,257	64,271,284	62,229,266	60,576,090
11	85,168,288	95,188,914	101,404,804	106,624,944	109,648,739	112,928,331	127,114,252	124,197,874	126,264,532
12	38,699,557	40,582,196	44,644,765	44,472,233	43,105,103	43,444,622	57,452,937	57,621,006	57,226,902
13	128,161,023	127,199,262	134,302,645	136,094,016	139,496,145	146,660,993	165,777,880	164,444,303	164,363,397
14	57,037,697	64,735,498	62,820,009	68,061,145	69,526,077	73,895,604	84,314,748	82,834,656	81,969,769
15	55,755,385	57,502,478	59,181,514	59,713,119	64,473,359	65,008,815	91,015,347	92,509,260	90,295,715
16	(3,591,623)	(3,617,164)	(5,093,618)	(2,340,623)	4,416,091	13,391,999	18,826,851	21,632,165	23,942,369
17	84,967,377	92,738,200	93,962,584	98,795,742	102,813,688	104,895,356	104,729,552	106,350,857	104,852,836
18	70,262,547	76,254,689	77,289,567	84,349,034	85,384,209	86,431,607	123,583,378	120,668,303	120,199,505
19	18,189,436	24,310,760	26,760,799	25,331,682	37,752,766	39,789,554	67,407,815	67,974,245	70,000,189
20	27,404,741	32,647,120	36,398,929	36,549,764	37,623,939	35,019,931	45,969,665	43,415,415	43,392,473
21	95,906,171	92,812,267	102,623,428	102,629,772	100,461,385	99,469,542	99,372,173	95,653,391	92,474,883
22	71,802,992	78,916,792	78,650,730	78,259,716	81,640,770	79,502,295	99,024,409	97,142,376	97,460,397
23	94,825,082	94,884,224	96,296,545	103,529,839	106,362,692	110,607,550	117,829,711	113,772,186	115,665,761
24	61,895,485	66,896,041	66,752,870	66,007,950	74,105,086	72,638,124	98,040,755	98,184,431	97,219,340
25	64,363,129	65,862,253	65,310,936	66,080,167	63,980,970	64,602,893	69,345,774	70,108,368	70,831,946
26	75,295,398	78,009,620	77,790,491	78,213,680	88,462,536	88,905,091	92,318,706	90,204,960	88,755,086
27	25,004,641	28,255,889	29,936,255	26,717,523	28,262,514	29,473,499	37,093,294	37,459,671	38,574,778
28	67,669,119	74,423,718	78,341,328	84,692,372	87,092,997	86,494,869	84,404,298	85,089,844	85,041,514
29	58,343,018	60,699,885	66,799,235	67,866,211	64,942,088	71,542,382	73,637,234	74,135,842	76,068,972
30	78,547,776	81,123,838	91,492,529	100,553,636	100,205,572	102,843,105	133,894,116	131,414,786	128,347,871
31	64,930,952	66,324,783	64,213,392	66,551,011	68,128,131	74,624,355	86,833,316	84,820,760	85,936,325
32	44,399,565	43,904,047	47,302,085	47,706,464	54,390,901	54,937,372	56,141,973	57,033,747	56,703,821
33	88,024,425	91,519,722	90,114,005	89,497,122	90,182,094	87,250,910	93,246,903	94,624,208	97,994,898
34	29,954,733	29,302,649	35,571,672	38,096,266	42,907,412	45,982,489	53,575,404	52,546,797	51,106,932
35	73,499,159	76,186,225	78,493,190	77,872,914	80,942,256	84,353,683	88,574,927	90,994,682	91,810,997
36	82,034,363	81,270,602	83,789,115	86,374,788	85,977,022	83,126,097	95,288,947	95,603,603	95,515,088
37	81,858,554	84,900,231	88,611,701	90,477,734	89,611,739	91,982,934	99,578,359	101,935,323	104,786,463
38	26,525,081	27,761,563	30,925,260	29,243,258	38,100,688	41,279,549	39,591,658	40,257,892	38,934,042
39	59,521,382	62,064,284	60,846,634	64,904,030	65,053,668	67,623,009	85,564,133	83,645,188	83,429,184
40	87,139,409	86,993,327	96,289,864	102,363,671	102,340,338	101,983,959	109,488,824	111,358,160	107,756,692
41	64,306,093	67,144,338	65,245,541	69,157,034	69,607,994	74,621,477	74,454,546	72,578,139	75,075,695
42	58,016,043	65,199,515	69,797,468	69,637,482	76,959,707	84,712,376	96,200,321	91,547,662	92,265,191
43	49,853,334	55,085,789	56,527,803	62,963,919	70,285,306	73,790,758	111,551,373	114,379,211	114,456,865
44	60,780,735	59,861,185	61,214,945	62,126,039	65,543,534	74,060,498	80,910,364	80,412,726	78,590,366
45	45,871,142	57,490,172	59,405,510	61,541,447	71,684,945	71,394,380	87,806,914	86,721,842	91,287,426
46	11,705,144	14,331,598	14,968,999	16,992,123	17,111,245	21,815,052	25,708,626	23,443,760	25,704,221
47	80,994,224	84,070,680	86,645,410	86,362,350	86,948,055	84,021,992	82,869,045	82,661,173	84,051,836
48	10,115,153	14,626,817	16,883,915	25,599,077	25,220,641	25,414,924	36,655,626	36,419,838	39,005,622
49	41,846,529	43,110,475	41,967,836	40,392,496	42,732,437	42,366,355	50,314,106	48,347,402	51,333,348
50	47,082,603	54,101,471	53,576,253	58,107,558	60,330,262	58,910,309	62,725,017	62,752,333	67,380,871
Negative NPV	1	1	1	1	1	1	-	-	-
Positive NPV	49	49	49	49	49	49	50	50	50

Table 2 shows that (a) 49 of 50 simulations results dominantly in positive NPVs for 27 to 32 years time horisons and (b) all simulations results in positive NPVs for 33 to 35 years time horisons. These results indicate that if the investment in rubber plantation is using internal financing (i.e. equity financing), the rubber plant can have an economic life up to 35 years (or maximum life span).

Table-4: Results of NPV using external sources

Simulation number	Years of Replacement								
	year 27	year 28	year 29	year 30	year 31	year 32	year 33	year 34	year 35
1	(12,745,200)	(12,800,810)	(11,635,157)	(11,666,715)	(11,537,435)	(10,890,324)	(9,788,210)	(9,963,688)	(9,262,764)
2	(20,665,196)	(20,720,806)	(19,555,153)	(19,586,711)	(19,457,431)	(18,810,320)	(17,708,206)	(17,883,684)	(17,182,760)
3	(18,874,142)	(18,929,752)	(17,764,099)	(17,795,657)	(17,666,377)	(17,019,266)	(15,917,152)	(16,092,630)	(15,391,706)
4	10,129,312	10,073,702	11,239,355	11,207,797	11,337,077	11,984,188	13,086,302	12,910,824	13,611,748
5	3,382,888	3,327,278	4,492,931	4,461,373	4,590,653	5,237,764	6,339,878	6,164,400	6,865,324
6	(7,558,603)	(7,614,213)	(6,448,560)	(6,480,118)	(6,350,838)	(5,703,727)	(4,601,613)	(4,777,091)	(4,076,167)
7	(15,893,156)	(15,948,766)	(14,783,113)	(14,814,671)	(14,685,391)	(14,038,280)	(12,936,166)	(13,111,644)	(12,410,720)
8	(14,035,836)	(14,091,446)	(12,925,793)	(12,957,351)	(12,828,071)	(12,180,960)	(11,078,846)	(11,254,324)	(10,553,400)
9	(11,215,491)	(11,271,101)	(10,105,448)	(10,137,006)	(10,007,726)	(9,360,615)	(8,258,501)	(8,433,979)	(7,733,055)
10	(17,300,287)	(17,355,897)	(16,190,244)	(16,221,802)	(16,092,522)	(15,445,411)	(14,343,297)	(14,518,775)	(13,817,851)
11	(12,169,283)	(12,224,893)	(11,059,240)	(11,090,798)	(10,961,518)	(10,314,407)	(9,212,293)	(9,387,771)	(8,686,847)
12	(12,079,469)	(12,135,079)	(10,969,426)	(11,000,984)	(10,871,704)	(10,224,593)	(9,122,479)	(9,297,957)	(8,597,033)
13	(7,868,395)	(7,924,005)	(6,758,352)	(6,789,910)	(6,660,630)	(6,013,519)	(4,911,405)	(5,086,883)	(4,385,959)
14	(15,438,525)	(15,494,135)	(14,328,482)	(14,360,040)	(14,230,760)	(13,583,649)	(12,481,535)	(12,657,013)	(11,956,089)
15	1,703,132	1,647,522	2,813,175	2,781,617	2,910,897	3,558,008	4,660,122	4,484,644	5,185,568
16	(18,932,823)	(18,988,433)	(17,822,780)	(17,854,338)	(17,725,058)	(17,077,947)	(15,975,833)	(16,151,311)	(15,450,387)
17	(2,595,693)	(2,651,303)	(1,485,650)	(1,517,208)	(1,387,928)	(740,817)	361,297	185,819	886,743
18	(5,095,695)	(5,151,305)	(3,985,652)	(4,017,210)	(3,887,930)	(3,240,819)	(2,138,705)	(2,314,183)	(1,613,259)
19	140,215	84,605	1,250,258	1,218,700	1,347,980	1,995,091	3,097,205	2,921,727	3,622,651
20	(11,475,815)	(11,531,425)	(10,365,772)	(10,397,330)	(10,268,050)	(9,620,939)	(8,518,825)	(8,694,303)	(7,993,379)
21	(11,998,793)	(12,054,403)	(10,888,750)	(10,920,308)	(10,791,028)	(10,143,917)	(9,041,803)	(9,217,281)	(8,516,357)
22	(18,101,360)	(18,156,970)	(16,991,317)	(17,022,875)	(16,893,595)	(16,246,484)	(15,144,370)	(15,319,848)	(14,618,924)
23	(14,068,918)	(14,124,528)	(12,958,875)	(12,990,433)	(12,861,153)	(12,214,042)	(11,111,928)	(11,287,406)	(10,586,482)
24	(12,242,604)	(12,298,214)	(11,132,561)	(11,164,119)	(11,034,839)	(10,387,728)	(9,285,614)	(9,461,092)	(8,760,168)
25	(5,002,602)	(5,058,212)	(3,892,559)	(3,924,117)	(3,794,837)	(3,147,726)	(2,045,612)	(2,221,090)	(1,520,166)
26	2,676,509	2,620,899	3,786,552	3,754,994	3,884,274	4,531,385	5,633,499	5,458,021	6,158,945
27	(5,599,507)	(5,655,117)	(4,489,464)	(4,521,022)	(4,391,742)	(3,744,631)	(2,642,517)	(2,817,995)	(2,117,071)
28	4,628,967	4,573,357	5,739,010	5,707,452	5,836,732	6,483,843	7,585,957	7,410,479	8,111,403
29	(11,353,737)	(11,409,347)	(10,243,694)	(10,275,252)	(10,145,972)	(9,498,861)	(8,396,747)	(8,572,225)	(7,871,301)
30	(31,473)	(87,083)	1,078,570	1,047,012	1,176,292	1,823,403	2,925,517	2,750,039	3,450,963
31	(15,694,793)	(15,750,403)	(14,584,750)	(14,616,308)	(14,487,028)	(13,839,917)	(12,737,803)	(12,913,281)	(12,212,357)
32	(12,812,254)	(12,867,864)	(11,702,211)	(11,733,769)	(11,604,489)	(10,957,378)	(9,855,264)	(10,030,742)	(9,329,818)
33	1,840,292	1,784,682	2,950,335	2,918,777	3,048,057	3,695,168	4,797,282	4,621,804	5,322,728
34	(15,016,375)	(15,071,985)	(13,906,332)	(13,937,890)	(13,808,610)	(13,161,499)	(12,059,385)	(12,234,863)	(11,533,939)
35	(7,809,613)	(7,865,223)	(6,699,570)	(6,731,128)	(6,601,848)	(5,954,737)	(4,852,623)	(5,028,101)	(4,327,177)
36	4,735,890	4,680,280	5,845,933	5,814,375	5,943,655	6,590,766	7,692,880	7,517,402	8,218,326
37	(20,207,330)	(20,262,940)	(19,097,287)	(19,128,845)	(18,999,565)	(18,352,454)	(17,250,340)	(17,425,818)	(16,724,894)
38	(2,769,540)	(2,825,150)	(1,659,497)	(1,691,055)	(1,561,775)	(914,664)	187,450	11,972	712,896
39	(14,121,388)	(14,176,998)	(13,011,345)	(13,042,903)	(12,913,623)	(12,266,512)	(11,164,398)	(11,339,876)	(10,638,952)
40	(7,300,559)	(7,356,169)	(6,190,516)	(6,222,074)	(6,092,794)	(5,445,683)	(4,343,569)	(4,519,047)	(3,818,123)
41	(9,339,387)	(9,394,997)	(8,229,344)	(8,260,902)	(8,131,622)	(7,484,511)	(6,382,397)	(6,557,875)	(5,856,951)
42	8,394,724	8,339,114	9,504,767	9,473,209	9,602,489	10,249,600	11,351,714	11,176,236	11,877,160
43	(6,646,234)	(6,701,844)	(5,536,191)	(5,567,749)	(5,438,469)	(4,791,358)	(3,689,244)	(3,864,722)	(3,163,798)
44	(12,956,944)	(13,012,554)	(11,846,901)	(11,878,459)	(11,749,179)	(11,102,068)	(9,999,954)	(10,175,432)	(9,474,508)
45	(4,079,917)	(4,135,527)	(2,969,874)	(3,001,432)	(2,872,152)	(2,225,041)	(1,122,927)	(1,298,405)	(597,481)
46	(1,643,821)	(1,699,431)	(533,778)	(565,336)	(436,056)	211,055	1,313,169	1,137,691	1,838,615
47	1,045,806	990,196	2,155,849	2,124,291	2,253,571	2,900,682	4,002,796	3,827,318	4,528,242
48	456,039	400,429	1,566,082	1,534,524	1,663,804	2,310,915	3,413,029	3,237,551	3,938,475
49	75,317	19,707	1,185,360	1,153,802	1,283,082	1,930,193	3,032,307	2,856,829	3,557,753
50	(4,507,359)	(4,562,969)	(3,397,316)	(3,428,874)	(3,299,594)	(2,652,483)	(1,550,369)	(1,725,847)	(1,024,923)
Negative NPV	38	38	37	37	37	36	34	34	34
Positive NPV	12	12	13	13	13	14	16	16	16

Table 3 shows that all of 50 simulations results dominantly in negative NPVs for 27 to 32 years time horisons. It means that that if the investment in rubber plantation is using external financing (i.e. debt financing), the rubber plant must be rejuvenated before 27 years. In other words, it is not feasible to maintain the rubber plant up to more than 27 years since the income generated by the rubber plantation is far less than the cost of maintaining the rubber plant.

DISCUSSION

The results of NPVs simulation has demonstrated that the rejuvenation time of rubber plant depends on the source of fund in the rubber plantation investment. Considering the variability of the components of NPVs analysis, which were simulated using Monte Carlo method, the rejuvenation time of rubber plant is correlated negatively with the cost of capital or discount rate being used in NPVs analysis. The lower the cost of capital the longer the rejuvenation time of the rubber plant, and vice versa. The results shows that using lower cost of capital or cost of equity of 4.75% the rubber plantation is in a productive condition during the time horison in the analysis. The possibility of getting positive NPVs using equity financing in the economic rubber plant life between 27 to 32 years is significantly high (i.e. ranging between 98% to 100%). It implies that if the company decide to set the required rate of return of 4.75%, the rubber plant will contribute positive revenue until 32 years.

Alternatively, using the cost of capital or cost of debt 10.50%, 78% of simulations resulted in the negative NPVs. It means that the rubber plant tends to be in a non-productive condition in between 27 to 32 years. In this case, the rubber plant has to be rejuvenated in year 27. This implies that if the company decide to set the the required rate of return of 10.50%, the rubber plant will not contribute positive revenue starting year 27.

These two cost of capital scenarios inform two financial decision. First, the required rate of return of rubber plant investment can be set between 4.75% and 10.50% when the company uses the equity financing. For example, if the company sets the required rate of return 6.00%, maintaining the rubber plant between 27 to 32 years can provide positive cash flow (income). The company can also set the required rate of return above 10.50% but as a consequence the rubber plant has to be rejuvenated before 27 years. Second, the use of external or debt financing should prudentially be taken into account. Assuming other things being equal, the cost of debt should not be more than 10.50%. Otherwise, the rubber plantation investmen is considered as not feasible since the rubber plant has to be rejuvenated earlier than it should be.

The NPV simulation in this study has a limitation. It did not consider the residual or terminal value of the rubber plantation. Practically, the company can harvest the rubber wood during the replacement of unprodcutive rubbet plant. Due to the difficutly in assesing the rubber wood price, this residual or terminal value was assumed to be zero. The incorporation of residual or terminal value can lengthen the rejuvenation time of rubber plant.

CONCLUSIONS

The decision to rejuvenate rubber plant is considered as a very important decision in the plantation company. If the rejuvenation is conducted earlier than it should be, the company will loose an opportunity to get revenue form the rubber plantation. On the contrary, if the rejuvenaton is conducted later than it should be, the will suffer economic losses since the revenue generated from the rubber plantation can not cover the cost of rubber plant maintenance. The NPV analysis, using Monte Carlo simulation method, can be used to determine the proper rejuvenation time for rubber plant.

This article demonstrates the NPV simulation process. All of cash flows components in the NPV is simulated using Monte Carlo method. And, two cost of capital scenarios have been applied to NPV analysis. The NPV analysis results tell that if the company uses a lower cost of capital (i.e. equity financing) then the rejuvenation time can be conducted in year 32. Alternatively, using a higher cost of capital (i.e. debt financing), the company should rejuvenate the rubber plant in year 27 or earlier.

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