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by Yosep Ruslim

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Forest gardens management under traditional ecological knowledge in West Kalimantan, Indonesia

BUDI WINARNI[1,♥], ABUBAKAR M. LAHJIE[2,♥♥], B.D.A.S. SIMARANGKIR[2], SYAHRIR YUSUF[2], YOSEP RUSLIM[2,♥♥♥]

[1]Department of Agricultural Management, Politeknik Pertanian Negeri Samarinda. Jl. Samratulangi, Kampus Sei Keledang, Samarinda 75131, East Kalimantan, Indonesia. Tel.: +62-541-260421, Fax.: +62-541-260680, ♥email: bwinarni14@gmail.com
[2]Faculty of Forestry, Universitas Mulawarman. Jl. Ki Hajar Dewantara, PO Box 1013, Gunung Kelua, SamarindaUlu, Samarinda 75116, East Kalimantan, Indonesia. Tel.: +62-541-735089, Fax.: +62-541-735379. ♥♥email: prof_abudir@yahoo.com; ♥♥♥yruslim@gmail.com

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Abstract. *Winarni B, Lahjie AM, Simarangkir B.D.A.S., Yusuf S, Ruslim Y. 2018. Forest gardens management under traditional ecological knowledge in West Kalimantan, Indonesia. Biodiversitas 19: 77-84.* Local wisdom of Dayak Kodatn people in West Kalimantan in forest management shows that human and nature are in one beneficial ecological unity known as Traditional Ecological Knowledge (TEK). Former cultivation forest areas are managed in various ways, including planting forest trees, fruit-producing plants, and rubber trees until they transform into the forest garden. This research used three models, monoculture rubber cultivation (Model 1), combined rubber and camphor cultivation (Model 2), and combined rubber and durian cultivation (Model 3). This research intended to: (i) analyze the production of rubber latex and durian fruit; (ii) analyze the growth increment of camphor and durian trees; (iii) analyze the financial feasibility of rubber tree plantation, combined rubber and camphor tree plantation, and combined rubber and durian trees plantation; (iv) formulate the model of rubber cultivation. This research also used measurement methods other than field measurement, which were tree diameter and height, rubber latex and durian fruit weight, and questionnaire interviews. The maximum productions of rubber latex from three models were achieved at the age of 17 years, while maximum production of durian fruits was achieved at the age of 55 years. The maximum growth increment of camphor and durian trees were achieved at the age of 40 years. Based on NPV analysis and IRR, those three models were worthy of being cultivated. Financially, the combined rubber and durian cultivation (Model 3) was the most profitable, followed by monoculture rubber cultivation (Model 1), and lastly the combined rubber and camphor cultivation (Model 2).

Keywords: Financial analysis, increment and production analysis, traditional ecological knowledge

INTRODUCTION

Forest resources have multiple functions that provide many benefits to human life (Mönkkönen et al. 2014). Forest benefits are not only obtained from timber management, but also from non-timber forest products (Jensen 2009). Non-timber forest products will provide more benefits and profits to locals especially those who live near the forest, since forests can provide various life necessities such as food, medicine, clothing and household appliances (Rist et al. 2012; Dawson et al. 2014; Martins et al. 2014). In addition to that, it will also encourage participation from locals to maintain the forest sustainability (Kovacs et al. 2014). Relatively small damages using mono-cable winch on forest floors induced by logs skidding on top soil and residual stands (Ruslim et al. 2016). Tropical forests play an important role in global carbon sequestration and the impact of land-use changes need to be concerned prior to preventing the loss function of tropical forests (Sarjono et al. 2017).

A central challenge for sustainable societies is balancing the individual use of shared natural resources with sustaining the "public goods" inherent in resources. For example, if we decide to sell Pacific old-growth forests on public lands, we give up public goods like water purification, soil retention, reductions in fire hazard, and unique biodiversity (Becker and Ghimire 2003).

The harmonization of the individual consumption of natural resources with sustaining the "public goods" inherent in natural resources has been indentified as the main challenge for sustainable society. Here, negative impact can occur when Pacific old-growth forests become public land, such as reduction in level of water purifications, soil retention, fire hazard and unique biodiversity (Becker and Ghimire, 2003). This condition can be analyzed into knowledge specific of Traditional Ecological Knowledge (TEK) (Gadgil and Berkes 1991; Warren and Rajasekaran 1993, Nabhan 1997). Generally, traditional monitoring method adopted by indigenous cultures have characteristics of rapid, low cost and traditional method in harvesting (Moller et al, 2004).

Traditional Ecological Knowledge cover the level of awareness of natural histories related to local wildlife to cultural norms, which is adopted for land management and resource allocation (Becker and Ghimire, 2003). Thus, the term of "Traditional Ecological Knowledge" has been approved by the work of the International Conservation Union (IUCN) working group (Johannes 1989, Williams and Baines 1993).

Dayak Kodatn is one of the Dayak tribes in West Kalimantan, spread into several villages in Sanggau District. Historically, the Dayak Kodatn people often leave their villages, moving from one place to another to hunt and farm. This habit of living out in nature ultimately forms a strong and intimate relationship between them and nature. This ultimately leads to awareness within the Dayak Kodatn community of the need for maintaining harmony with the forest. The Dayak Kodatn people have their own local wisdom in utilizing forest resources for the purposes of their life, for example in terms of cultivation. This is evident from the way they first clear forests for cultivation and eventually manage the area after the cultivation cycle is completed. The former forest farming areas are managed in various ways including planting various species of forest trees and fruit-producing trees, and rubber plantations to form forest garden areas. This local wisdom has been tested for hundreds of years since the time of their ancestors and it is evident that the forest they manage still exists today. One of the most popular uses of forest garden today is the rubber plantation. The rubber plantations have unique features, in which other species of plants can grow among the existing rubber plants, for example, rubber planting with tengkawang, rubber planting with durian, and rubber planting with camphor. Such conditions make rubber plantations look more like forests (Rufinus et al. 2011; Winarni et al. 2017). The relationship between the Dayak Kodatn people and the forest can be understood as what is called as Traditional Ecological Knowledge.

Sanggau District is the district with the widest rubber plantation area and the largest rubber production in West Kalimantan Province. The total area of smallholder rubber plantation in Sanggau District and West Kalimantan Province in 2015 was 63,653 ha and 349,090 ha, while the production was 42,575 tons and 209,993 tons with the number of farmers of 42,712 families and 261,575 households (General Secretary of Agriculture Ministry, 2016).

The existence of several models of rubber cultivation there needs financial analysis. The financial viability of the rubber cultivation model is intended to provide data and information related to rubber cultivation development strategies. This research intended to: (i) analyze the production of rubber latex and durian fruit; (ii) analyze the growth increment of camphor and durian trees; (iii) analyze the financial feasibility of rubber tree plantation, rubber combined with camphor tree plantation, and rubber combined with durian trees plantation; (iv) formulate the model of rubber cultivation.

MATERIALS AND METHODS

Study area

Sanggau District is a district with the widest area of rubber plantation and the largest rubber production in West Kalimantan Province. This research was conducted in 2016 for one year in Dusun Sanjan, Sungai Mawang Village, Sanggau District, West Kalimantan Province, Indonesia (Figure 1).

The objects of this study included: (i) farmers or locals cultivating forest garden with commodities using rubber plants (*Hevea braziliensis*), camphor (*Dryobalanops camphora*), and durian (*Durio zibethinus*) as respondents; (ii) rubber and camphor plants, harvested durian; (3) institutions or agencies that are able to provide information in this study, namely customary leaders, village heads and sub-district heads, also Forestry and Estate Crops Office of Sanggau District.

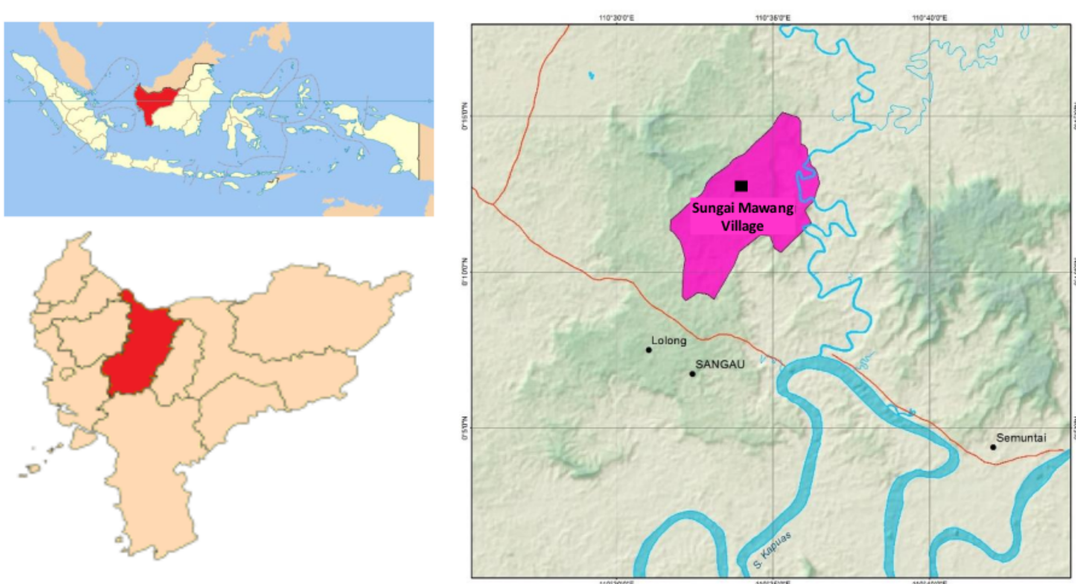

Figure 1. Research location in Dusun Sanjan (■), Sungai Mawang Village, Kapuas Sub-district, Sanggau District, West Kalimantan Province, Indonesia

Data collection

This study emphasized case studies which have been examined in developed countries, namely New Zealand and northern Canada. The study used data from direct and indirect approaches from 2000 to 2016. Here, direct approach included observation from perennial crop production, while indirect approach included secondary data through farmers and representatives.

This study identify traditional ecological knowledge as "a cumulative body of knowledge, practice and belief, emerging by adaptive processes and passing through to next generations by cultural transmission" (Berkes, 1999). The character of TEK is the agricultural productivity associated with local wisdom. It may be expected to adapt with a global problem oriented conservation based on western sciences. For example, The International Forest Resources and Institute (IFRI) research approach has been used as pilot-tested for the research of the Traditional Ecological Knowledge in Loma Alta by providing People Allied for Nature (PAN). Here, PAN provides a theoretical framework for understanding people–forest relationships in the watershed (Gibson and Becker 2000). This framework can be expected to support the economic resilience that increases food security, sustainability, preservation of local biodiversity and maintenance of cultural heritage.

Specifically, data collection was done in the following manner (Linger 2014): (i) observation by conducting direct observation on the operation of rubber, camphor and durian cultivation activities including: types of activities undertaken, production costs, and earned income; (ii) direct measurements in the field including: diameter and height of camphor and durian trees, the weight of rubber latex and durian fruit; (iii) library research, data collecting through literature review and reports from institutions related to rubber, camphor and durian cultivation activities in Sanggau District, West Kalimantan Province; and (iii) structured interviews with questionnaires, discussions and direct interviews with rubber, camphor and durian farmers and local government officials. The amount of US$ 1 was equal with IDR 9,595 in 2000 and IDR 13,436 in 2016. The difference of exchange rate US$ to IDR from 2000 to 2016 showed inflation of 2.1% year^{-1}.

Data analysis

Production and financial analyses were done for three models of rubber cultivation in forest garden, namely: (i) monoculture rubber plantation (Model 1); (ii) rubber combined with camphor tree plantation (Model 2); and (iii) rubber combined with durian tree plantation (Model 3). Analysis of camphor and durian timber production was done by calculating the total volume of standing stock and analyzing the growth increment of camphor and durian trees. The increment is an increase in tree dimension growth (height, diameter, base area, and volume) associated with tree age or a particular period. Based on the measurement period, there are mean annual increment (MAI) and current annual increment (CAI) (Van Gardingen et al. 2003).

$$\mathrm{MAI} = \frac{V_t}{t}$$

Where: MAI = mean annual increment, V_t = total standing volume at age t, t = tree age

$$\mathrm{CAI} = \frac{V_t - V_{t-1}}{T}$$

Where: CAI = current annual increment, V_t = total standing volume at age t, V_{t-1} = total standing volume at age t-1, T = time interval between each measurement age

The production analyses of rubber latex and durian fruit were done by calculating the total production of rubber latex and durian fruit, and then based on the period of measurement (cycle), average annual production (AP) and marginal annual production (MP) were calculated (Van Gardingen et al. 2003).

$$\mathrm{AP} = \frac{P_t}{t}$$

Where: AP =average annual production, P_t = total production at age t, t = tree age

$$\mathrm{MP} = \frac{P_t - P_{t-1}}{T}$$

Where: MP = marginal annual production, P_t = total production at age t, P_{t-1} = total production at age t-1, T = time interval between each measurement age

The financial feasibility of three rubber cultivation models was analyzed using several investment criteria, i.e. net present value (NPV) and internal rate of return (IRR). NPV calculation is based on the difference between the benefit and cost at present value (current time value). In this criteria, it is said that business is feasible if NPV > 0. IRR calculation is the average rate of annual profit for business in investing and expressed in percent. The magnitude of the IRR indicates the interest rate that a business can afford or in other words is the ability to gain income from the cost invested. If IRR > deposit rates, then the business is feasible (Graves et al. 2007).

$$\mathrm{NPV} = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+i)^t}$$

Where: B_t = benefit in year t, C_t = cost in year t, n = economic life time of cultivation, i = prevailing interest rate

$$\mathrm{IRR} = i_1 + \frac{(i_2 - i_1)(\mathrm{NPV})}{(\mathrm{NPV}_1 - \mathrm{NPV}_2)}$$

Where: NPV_1 = NPV is positive, NPV_2 = NPV is negative, i_1 = interest rate when NPV is positive, i_2 interest rate when NPV is negative

RESULTS AND DISCUSSION

Research location profile

Dusun Sanjan is a region dominated by hilly areas, surrounded by dense forest area combined with green yard plants that grow around the houses; there are rivers that divide the area of the village, the Solang River, Gang River, Sabal River, Sanjan River, and Awik River. The existence of forests is very influential on the availability and the clarity of the river water. These rivers become the lifeblood for the locals to meet various necessities of life, such as bathing, washing, even as drinking water.

Dusun Sanjan is included in the governmental area of Sungai Mawang Village, Kapuas Subdistrict, Sanggau District, West Kalimantan Province. From Dusun Sanjan, the Sanggau district capital, 13 km away, can be reached within 20 minutes by motor vehicle. The total area of Dusun Sanjan is about 5,260 ha which consists of residential areas, forest areas, fields, and locally owned farms. Dusun Sanjan is inhabited by 416 people or about 121 families. The majority of the residents of Dusun Sanjan are the Dayak Kodatn people whose main livelihoods are rubber incision in the morning and farming in the fields during the day (Rufinus et al. 2011).

Production potential of rubber latex and durian fruit

Rubber cultivation monoculture in Model 1 used a plant spacing of 7 m x 3 m. The data on the potential of rubber latex production in Table 1 shows that rubber trees can be tapped from 5 years to 25 years. The graph of rubber latex production, which was the graph of the relationship between the average annual production (AP) and the marginal annual production (MP) was presented in Figure 2.A.The graph shows that the point of intersection between AP and MP occurs at the age of 17 years with an AP value of 219 kg $ha^{-1}year^{-1}$. After the point of intersection, the value of AP and MP will decrease which means production will continue to decrease. At the age of 17 years, the average annual production of latex has reached the maximum, meaning maximum production potential of rubber latex totaling 219 kg ha^{-1} $year^{-1}$ will be reached at the age of 17 years.

Rubber cultivation in Model 2 was a rubber-camphor tree combined plantation. Camphor trees were planted among the rubber trees. The plant spacing between rubber trees was 7 m x 3 m. In this case, it was seen that the density of trees planted in forest garden in Model 2 was higher than that in Model 1, because of the presence of camphor trees among the rubber trees. The potential for latex production was presented in Table 1. The graph of latex production was presented in Figure 2.B. The intersection point between AP and MP occurs at the age of 17 years, meaning that in Model 2, maximum latex production is achieved at age 17 years with an AP value of 127.06 kg ha^{-1} $year^{-1}$. When compared to rubber latex production in Model 1 where the rubber trees were cultivated monoculture with an AP value of 219 kg ha^{-1} $year^{-1}$, then rubber combined with camphor cultivation in Model 2 has decreased the rubber latex production. This shows that tree density affects rubber latex production. Tree density will affect the intensity of sunlight, the process of photosynthesis and tree growth (Pompelli et al. 2010).

Table 1. Models of rubber latex potential production and durian fruit potential production

Age (year)	P	AP	MP
Rubber latex potential production (Model 1)			
5	780	156	-
7	1170	167	195
10	1885	189	238
13	2730	210	282
15	3283	219	276
17	**3725**	**219**	**221**
20	4082	204	119
25	4368	175	57
Rubber latex potential production (Model 2)			
5	480	96.00	-
7	714	102.00	117.00
10	1140	114.00	142.00
13	1596	122.77	152.00
15	1908	127.20	156.00
17	**2160**	**127.06**	**126.00**
20	2412	120.60	84.00
25	2616	104.64	40.80
Rubber latex potential production (Model 3)			
5	375	75.00	-
7	550	78.57	87.50
10	830	83.00	93.33
13	1170	90.00	113.33
15	1410	94.00	120.00
17	**1600**	**94.12**	**95.00**
20	1770	88.50	56.67
25	1860	74.40	18.00
Durian fruit potential production (Model 3)			
3	120	40.00	-
5	200	40.00	40.00
8	340	42.50	46.67
10	450	45.00	55.00
15	800	53.33	70.00
20	1260	63.00	92.00
25	1850	74.00	118.00
30	2600	86.67	150.00
35	3500	100.00	180.00
40	4500	112.50	200.00
45	5500	122.22	200.00
50	6365	127.30	173.00
55	**7000**	**127.27**	**127.00**
60	7450	124.17	90.00

Note: P = total production (kg ha^{-1}), AP = average annual production (kg $ha^{-1}.year^{-1}$), MP = marginal annual production (kg ha^{-1} $year^{-1}$)

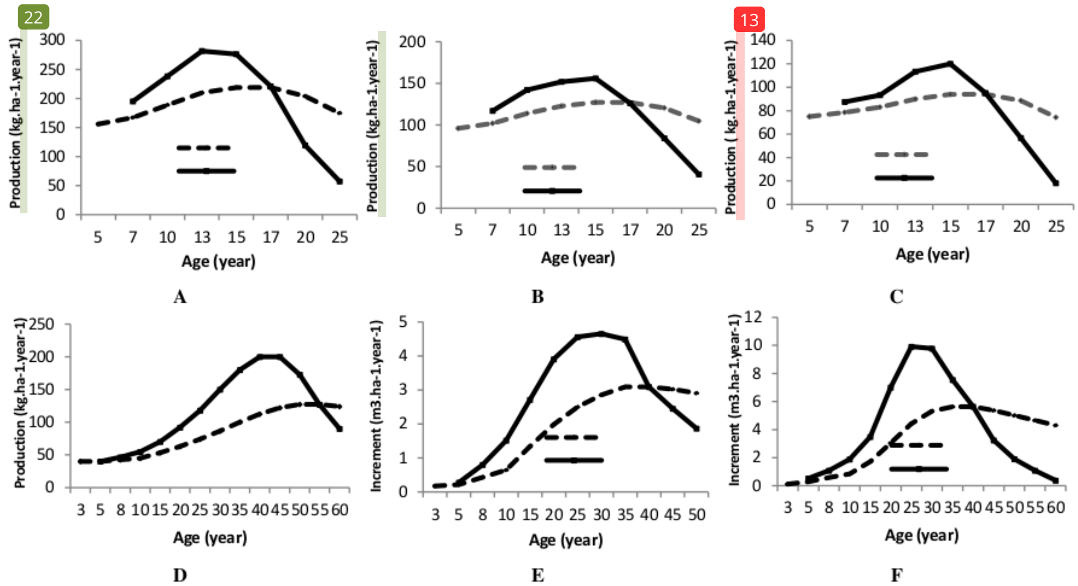

Figure 2. A. The production of rubber latex (Model 1), B. The production of rubber latex (Model 2), C. The production of rubber latex (Model 3), D. The production of durian tree (Model 3), E. Camphor tree standing volume increment (Model 2), F. Durian tree standing volume increment (Model 3)

Rubber cultivation in Model 3 was a rubber-durian tree combined plantation, where a forest garden area was planted with rubber trees and durian trees. The plant spacing of rubber trees was 7 m x 3 m, while durian trees were planted among rubber trees. The potential for latex production (Table 1) shows that AP values begin to decline after the age of 17 years. Based on the data in Table 1, a graph of latex production was created, i.e. graph of the relationship between AP and MP in Figure 2.C. The intersection point between AP and MP occurs at the age of 17 years with an AP value of 94.12 $kg.ha^{-1}.year^{-1}$, indicating that maximum latex production has been achieved because after the point of intersection, the value of AP and MP will decrease which means the production of latex will continue to decline. When compared to latex production in Model 1 (AP=219 $kg\ ha^{-1}\ year^{-1}$) in which rubber trees were cultivated in monoculture and Model 2 (AP=127.06 $kg\ ha^{-1}\ year^{-1}$) where rubber combined with camphor trees, Model 3 (AP=94.12 $kg\ ha^{-1}\ year^{-1}$), in which rubber was combined with durian trees, produced the smallest latex production.

Durian fruit production potential (Table 1) shows that AP values begin to decline after the age of 55 years. The graph of the relationship between AP and MP in Figure 2.D shows that the point of intersection between AP and MP occurs at the age of 55 years with an AP value of 127.27 kg $ha^{-1}\ year^{-1}$. This means that maximum durian fruit production has been reached, because after the point of intersection, durian fruit production will continue to decrease as indicated by the decreasing AP and MP values.

Production potential of camphor timber and durian timber

The forest garden model that planted camphor trees among rubber trees with plant spacing of camphor trees at 7 m x 3 m was Model 2. The potential for camphor growth increment (Table 2) shows that MAI values begin to decline after 40 years. Based on the data in Table 2, a graph of camphor tree standing volume increment was prepared, which was a graph of the relationship between MAI and CAI which can be seen in Figure 2.E. The relationship graph between MAI and CAI has the following characteristics: CAI curve reaches peak rapidly and decreases rapidly, while curve MAI peaks slowly and declines slowly (Dinga 2014; Muliadi 2017; Winarni 2017). From the graph of camphor tree standing volume increment in Figure 2.D, it can be seen that initially, the MAI is under CAI, and CAI reaches the first peak of the MAI. After the CAI reaches its peak, the CAI declines and at one time intersects with the MAI.

According to Muliadi (2017) and Winarni (2017) the cutting rotation of timber follows the biological cycle of the stand, i.e. the stand will be harvested when MAI is equal to CAI, i.e. at the point of intersection between MAI and CAI. The intersection point between MAI and CAI occurs at the age of 40 years with a MAI value of 3.09 $m^3\ ha^{-1}\ year^{-1}$. After the point of intersection, the MAI and CAI values will decrease, which means the volume will continue to decrease. At the age of 40 years, the mean annual increment of camphor tree has reached a maximum, meaning that the maximum production potential of camphor timber has been attained and the camphor tree is ready to be harvested.

The forest garden model that planted durian trees among rubber trees with plant spacing of durian trees at 7 m x 6 m was Model 3. The data in Table 2 presented the potential for durian growth increment combined with rubber trees (Model 3). The durian growth increment potential indicates that the value of MAI begins to decline after the age of 40 years. Graph of durian tree standing volume increment, i.e. the graph of the relationship between MAI and CAI was presented in Figure 2.F. The intersection between MAI and CAI showing that the maximum production potential of durian timber has been attained and the durian tree is ready to be harvested occurs at 40 years of age at MAI value of 5.64 m^3 ha^{-1} $year^{-1}$.

Financial feasibility of rubber cultivation model

Financial analysis is intended to determine to what extent an activity that requires cost can provide a return within a certain period. Thus, a planning and implementation tailored to the goals to be achieved are required. The purpose of the financial analysis is to assist decision makers in determining the investment selection in an appropriate activity, from various alternatives that can be implemented. Financial analysis is conducted for the benefit of the individual or institution that invests in the project, e.g. farmer, entrepreneur or company.

In performing financial analysis, data analysis on the stages of activities undertaken in rubber cultivation, cost and income component analysis, and feasibility analysis were done using NPV and IRR parameters. Sustainable local forest management in addition to local knowledge, needed to be taken into business account costs and with more definitive analysis to ensure that forest functions were maintained (Muliadi et al. 2017). The cost components required to cultivate forests include the initial costs for land preparation until harvest (Florian 2014). The income component was obtained from the sale of fruit, sap, timber, and firewood. According to Martins et al. (2014) trees provide an important meaning for the locals because they can produce firewood, timber for home construction and medicines. According to Jensen (2009); Rist et al. (2012); Dawson et al. (2014), the benefits of forests are not only derived from timber management but also other benefits of non-timber forest products. Harvesting activities begin in the 5th year for rubber latex, the 3rd year for harvesting durian fruit, while camphor timber is harvested in the 30th year and durian timber is harvested in the 25th year. Selling prices based on local market prices applicable at the time of the study were: rubber latex Rp 6,500 kg^{-1}, durian fruit Rp 10,000 kg^{-1}, camphor timber Rp 2,300,000 m^{-3} and durian timber Rp 500,000 m^{-3}.

The financial feasibility of three rubber cultivation models was analyzed using net present value (NPV) and internal rate of return (IRR) investment criteria. In these criteria, it is said that business is feasible if NPV > 0 and IRR > interest rates are applicable at the time the investment is implemented (Graves et al. 2007). The interest rate used was 6% $year^{-1}$. The recapitulation of the results of financial analysis on the three models of rubber cultivation was presented in Table 3.

Table 5. Camphor growth increment potential combined with rubber tree (Model 2) and Durian growth increment potential combined with rubber tree (Model 3)

Age (year)	n	D	H	F	V	MAI	CAI
Camphor growth increment potential combined with rubber tree (Model 2)							
3	400	3	2.3	0.8	0.52	0.17	-
5	360	4	3	0.79	1.07	0.21	0.28
8	350	6.4	4	0.77	3.47	0.43	0.80
10	340	8	5	0.76	6.49	0.65	1.51
15	320	12	7.5	0.74	20.08	1.34	2.72
20	300	16	9	0.73	39.61	1.98	3.91
25	280	20	10	0.71	62.42	2.50	4.56
30	250	23.6	11.2	0.7	85.69	2.86	4.65
35	220	27.7	12	0.68	108.13	3.09	4.49
40	**200**	**31**	**13**	**0.63**	**123.57**	**3.09**	**3.09**
45	160	35.3	14	0.62	135.85	3.02	2.46
50	140	38	15	0.61	145.21	2.90	1.87
Durian growth increment potential combined with rubber tree (Model 3)							
3	220	3.5	2	0.82	0.35	0.12	-
5	220	5.8	3	0.8	1.39	0.28	0.52
8	220	9.3	4	0.78	4.66	0.58	1.09
10	210	11.6	5	0.76	8.43	0.84	1.88
15	210	17.4	7	0.74	25.85	1.72	3.48
20	210	23.2	9.4	0.73	60.89	3.04	7.01
25	210	28.7	11.3	0.72	110.47	4.42	9.92
30	200	34.4	13	0.66	159.41	5.31	9.79
35	178	40	14	0.63	197.19	5.63	7.56
40	**155**	**45**	**15**	**0.61**	**225.45**	**5.64**	**5.65**
45	144	48	16	0.58	241.69	5.37	3.25
50	120	52	17.3	0.57	251.18	5.02	1.90
55	110	54.3	18	0.56	256.64	4.67	1.09
60	96	57.3	19	0.55	258.56	4.31	0.38

Note: n = number of trees (tree ha^{-1}), d = tree diameter (cm), h = branch-free height (m), f = tree form factor, V = total volume ($m^3.ha^{-1}$), MAI = mean annual increment (m^3 ha^{-1} $year^{-1}$), CAI = current annual increment (m^3 ha^{-1} $year^{-1}$)

Tabel 3. Recapitulation of financial analysis results of rubber cultivation in forest garden

Land model	Commodity	Cycle (year)	NPV (Rp)	IRR (%)	Business scale (ha)
1	Rubber	25	93,419,000	14.2	10.1
2	Rubber and camphor	50	83,482,000	12.3	14.7
3	Rubber and durian	60	228,324.000	12.8	5.6

Note: NPV = Net Present Value, IRR = Internal Rate of Return

The three rubber cultivation models in the forest garden yielded NPV > 0 and IRR > 6%, so the three models were feasible to be undertaken. Rubber cultivation combined with durian (Model 3) with 60 years plant cycles resulted in NPV value of Rp 228,324,000, IRR of 12.8%, and required land business scale of 5.6 ha to generate profit. The monoculture rubber plantation (Model 1) yielded a smaller NPV value than Model 3, which amounted to Rp 93,419,000, IRR of 14.2% and required a wider land business scale than Model 3, which was 10.1 ha. The rubber plantation combined with camphor (Model 2) yielded the smallest NPV value of Rp 83,482,000, IRR of 12.3%, and required the most extensive land business scale, i.e. 14.7 ha. From the results, it can be seen that rubber plantation combined with durian in forest garden was one of the promising alternatives to mobilize the economy of the locals. Non-timber forest products can contribute significantly to the economy of locals surrounding forests and well-managed forests will bring benefit both economically and ecologically (Jensen 2009; Mönkkönen et al. 2014).

The Dayak Kodatn community in West Kalimantan has its own local wisdom in cultivating forest resources for the necessities of life. Farmed forest areas are managed in various ways by planting various species of forest trees, and fruit plants, and rubber plants to form the forest garden area. This is a form of local wisdom from locals to preserve biodiversity. This day, the locals are growing more rubber. As rubber latex can be tapped anytime and the timing of sellout can be set, meaning that the locals can sell rubber latex when the market price is high. Rubber trees begin to be tapped at the age of 5 years (Winarni et al. 2017). Local wisdom has been tested and proven that the forest they manage is still there today. Local wisdom is a value that is believed to be true and a reference for the local community in taking daily action and becomes a determinant in the development of civilized society, because local wisdom contains elements of intelligence, creativity, and local knowledge provided by the community (Sumarniasih 2015; Lokers et al. 2016; Muliadi et al. 2017). Apuy et al. 2017 state the low production growth of plant biomass that produces timber is not solely influenced by modern human management, but also influenced by natural management and local management.

Although the new innovation rubber platation tend to decrease the price of rubber commodities, this innovation can still be adapted by harvesters due to the government programs through long term loan in order to increase standard of living of the harvesters. For example, the price of rubber in 2000 was IDR 12,200 kg^{-1} and the price went down to be IDR 6,500 kg^{-1} in 2016. It showed that the price of rubber decreased during the period of observation by around 4% $year^{-1}$. The commodity price of durian in 2000 was IDR 4,500 kg^{-1} and the price went up to be IDR 10,000 kg^{-1} in 2016. It showed that the price of rubber increased during the period of observation by around 5% $years^{-1}$. The price of *champor* in 2000 was IDR 1,430,000 m^{-3} and the price went up to be IDR 2,300,000 m^{-3} in 2016. It showed that the price of *champor* increased during the period of observation by around 3% $year^{-1}$. In comparison with staple commodities, the price of rice in 2003 was IDR 2,600 kg^{-1} and the price went up to be IDR 10,000 kg^{-1} in 2016. It showed that the price of rice increased by 10% $year^{-1}$. Based on the result, it can be concluded that business scale of perennial crops to get adequate food security must be 5 to 10 times as high as that of wetland rice.

It could be concluded that the maximum production of rubber latex of trees cultivated in the three models was achieved at the age of 17 years, which were 219 kg ha^{-1} $year^{-1}$ (Model 1), 127.06 kg ha^{-1} $year^{-1}$ (Model 2), and 94.12 kg ha^{-1} $year^{-1}$ (Model 3). The maximum durian fruit production was achieved at the age of 55 years, which was 127.27 kg ha^{-1} $year^{-1}$ (Model 3). The maximum annual growth increment of camphor was attained at the age of 40 years, which was 3.09 m^3 ha^{-1} $year^{-1}$ (Model 2) and the maximum annual growth increment of durian was attained at age of 40 years, which was 5.64 m^3 ha^{-1} $year^{-1}$ (Model 3). Based on the results of the financial analysis with NPV > 0 and IRR > 6%, the three models of rubber cultivation were feasible to be cultivated. Financially, rubber cultivation combined with durian (Model 3) was the most profitable, followed by rubber cultivation in monoculture (Model 1), and the last was rubber cultivation combined with camphor (Model 2).

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