Comparing farming income prospects for cocoa and oil palm in Asahan District of North Sumatera

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Abstract. Oil palm, rubber, and cocoa are the top three leading plantation commodities in Indonesia which are usually mutually converted one to each other. Oil palm plantation area and production in Indonesia over the past five years tend to increase, while the cocoa plantation area and production tend to decrease. According to the business ownership status, most of the cocoa plantations are cultivated by smallholders, while most of the oil palm plantations are cultivated by large private plantations. In North Sumatra, the cocoa commodity is the most often converted into oil palm. One of the factors that affect cocoa lands conversion into oil palm is the income prospects. The income analysis and the compare means analysis were used to see whether there are significant differences between the average income of cocoa and oil palm farming. The results showed that there are significant differences between the incomes of cocoa farmers and oil palm farmers, where the prospect of oil palm farmers' income is higher than the income of cocoa farmers.

1. Introduction

Oil palm, rubber, and cocoa are the top three leading plantation commodities in Indonesia that are mostly cultivated by both plantation companies and smallholders. Increasement of plantation commodities competitiveness in free trade is essential because the farm and agroindustries products of plantation commodities also contribute to the economy through exports [1]. Nowadays, the most important plantation commodity for the plantation business owners is oil palm. The tendency of plantation business owners to cultivate the oil palm can shift the allocation of plantation lands, which was planted with rubber and cocoa, into oil palm. This condition can reduce the national rubber and cocoa production so that it can no longer meet the needs of domestic industries and exports. The decline in exports and the high imports demand can become the pushing factors in weakening the Indonesian rupiah (IDR), which disrupt the stability of the national economy. In fact, in cultivating the plantation commodities which are dominated by annual plants, the replacement of cultivated plants cannot be conducted spontaneously because of the high costs and the annual time requirement. Consequently, an increase in land area, production, and productivity requires a long process and can not be conducted quickly.

Reviewed from the land size, the area of cocoa plantations in Indonesia in 2012 to 2016 tended to decline around 0.75 to 1.9 percent per year, in contrary, the area of oil palm plantations tended to increase by around 5.38 to 10.96 percent per year. Reviewed from the production, the cocoa beans production in Indonesia in 2012 to 2016 tended to decline around 2.65 to 18.54 percent per year, in contrary, the crude palm oil (CPO) production tended to increase around 5.38 to 8.42 percent per year. Based on its
ownership status, most of the cocoa plantations are cultivated and produced by smallholder plantations which in 2016 amounted to 1.66 million hectares (96.28%) of land area and 622.5 thousand tons (97.40%) of cocoa beans production. On the other hand, most of oil palm plantations are cultivated and produced by large private plantations which in 2016 amounted to 5.75 million hectares (50.56%) of land area and 18.26 million tons (58.88%) of CPO production, while the smallholders cultivated 4.65 million hectares (40.91%) of land area and produced 10.86 million tons (35.02%) of CPO production. This condition shows that larger scale plantations tend to plant the oil palm, while smallholders tend to plant cocoa [2-3].

Plantation business owners will definitely tend to increase their business scale and income. Along with the increase of business scale and the increase of income, they will increasingly tend to convert the cocoa plantation lands into oil palm plantations, especially with the support of better market access for oil palm commodities. In North Sumatra, the cocoa commodity most often converted into oil palm. Asahan District itself is one of the plantation commodities production centres, including cocoa and oil palm. In Asahan District, cocoa processing factory does not exist, but this district has many palm oil processing factories, those conditions tend to complicate the cocoa farmers. One of the factors that affect cocoa lands conversion into oil palm is the income prospects [4]. This study aims to compare the farming income prospects for cocoa and oil palm in Asahan District of North Sumatera.

2. Methods
Research location was determined purposively in Asahan District, North Sumatra because Asahan District has the largest cocoa area in North Sumatra which experienced the most significant decline in 2012-2016. Data collection was conducted from February to April 2018 in Asahan District, precisely in Sei Dadap, Air Batu, Tinggi Raja, Silo Laut, and Air Joman Sub-Districts because those five sub-districts once had cocoa auction sites.

2.1. Analysis of farm income
Economic benefits for cocoa and oil palm plantations were calculated using farm income analysis. Income in this study divided into two. The first was the income for cash costs (cash income), which are the costs that are truly spent in cash by farmers (explicit cost). The second was the income for total cost (total income), where all inputs used are calculated as costs. Mathematically, the farm income level can be written as follows [5-6]:

\[
TR = P \times Q \\
TC = \text{cash cost} + \text{calculated cost} \\
\pi \text{ on cash cost} = TR - \text{cash cost} \\
\pi \text{ on total cost} = TR - TC
\]

Descriptions:
\[
TR = \text{Total farm revenue (IDR/Ha/year)} \\
TC = \text{Total farm cost (IDR/Ha/year)} \\
P = \text{Output price (IDR/Kg)} \\
Q = \text{Total output (Kg)} \\
\pi = \text{Income or profit (IDR/ Ha/year)}
\]

Cash costs were used to see how much the liquid cash that was needed by farmers to carry out their farming activities. Cash costs consist of production facilities, non-family labours, and land taxes or rents. Moreover, non-cash costs (the calculated costs) were used to calculate how much the real income of the farmers if equipment depreciation value, farmers self-made seedlings and fertilizers value, and family labours value was calculated. The method used was a straight-line method. This method was used
because the amount of equipment depreciation each year was considered the same and was assumed couldn't be sold. The formula used was as follows [5]:

\[ \text{Depreciation cost} = \frac{Nb - Ns}{N} \]  

(5)

Descriptions:
\(Nb\) = Purchasing value (IDR)
\(Ns\) = Remaining value (IDR)
\(N\) = Economic period (year)

Calculation of farm income from all cocoa and oil palm area was conducted by counting the average value of farm income obtained from each respondent. The formula used to calculate the average income was as follows [5]:

\[ \pi f = \frac{\sum \pi f}{n} \]  

(6)

Descriptions:
\(\pi f\) = Average of farm income (IDR/Ha/year)
\(\pi fi\) = Total farm income of respondent i (IDR/Ha/year)
\(n\) = Total respondent (people)

Farming income was analysed for 25 years based on the productive age of cocoa and oil palm plants. The present value of income was calculated by a discount factor of 16 percent which was the average interest on microcredit from several banks in Asahan District. The mathematical equation was as follows [5]:

\[ PV_i = \sum_{t=1}^{n} \frac{A_{ti}}{(1 + r_t)^t} \]  

(7)

Descriptions:
\(PV_i\) = Present value of farm income of commodity i (IDR/ha)
\(A_{ti}\) = Farm income of commodity i on year t (IDR/ha)
\(r\) = Interest rate
\(t\) = Time span of analysis (year)

2.2. Analysis of farm feasibility
R/C Ratio was used to analyse whether a business is profitable or not. R/C Ratio can also be used to assess the economic efficiency of a business. A business is viable if the R/C Ratio is > 1, which means that for every one unit of the costs spent, the farmers could obtain the revenue as much as the R/C Ratio value. R/C Ratio in this study was divided into R/C Ratio for total cost and R/C Ratio for cash costs. The mathematical equation was as follows [5]:

\[ \text{R/C Ratio} = \frac{R}{C} \]  

(8)

Descriptions:
\(\text{R/C Ratio}\) = Revenue - Cost Ratio
\(R\) = Total revenue (IDR)
\(C\) = Total cash cost/total cost (IDR)
2.3. Compare means analysis (t-test)  
The compare means analysis used in this study was the independent sample t-test. Independent sample t-test or the compare means of two free samples test is used to test the differences in two mean groups of two different populations [7]. In this study, the compare means of two free samples test was used to analyse whether there is a significant difference between the average income of cocoa and oil palm farming, with the following hypothesis.

H0 : There is no significant difference between the average income of cocoa and oil palm farming 

H1 : There is a significant difference between the average income of cocoa and oil palm farming 

With the confidence level in this study of 5 percent or 0.05, the test criteria were as follows.
If t-count > t-table or Significance value < 0.05: H0 is rejected and H1 is accepted.
If t-count < t-table or Significance value > 0.05: H0 is accepted and H1 is rejected.

3. Results and discussion  
Marketing of cocoa beans in Asahan District is very limited. Farmers can only sell the cocoa beans to the brokers or commission men who have bought their cocoa beans regularly. Asahan District does not have a cocoa processing factory, and the number of cocoa beans wholesalers is also a few. It causes the farmers must sell their harvested cocoa to brokers that generally are agents of the same wholesalers. The alternative of cocoa beans marketing was established in 1984, which was a place for auctioning the cocoa beans/products in Sub-district of Sei Dadap, Air Batu, Tinggi Raja, Silo Laut, and Air Joman Districts. However, in 2016 the auction place had been closed.

In Asahan District, there are 13 large factories and 3 small factories of palm oil processing that operate. Each of these factories must reach a processing capacity that requires large numbers of oil palm fresh fruit bunch to avoid losses. These established factories spread their agents to accommodate the smallholders’ production. Easy marketing access due to the number of processing industries adds the interest of farmers to cultivate oil palm. The number of processing industries and various agents from different parties causes the received prices by farmers is very competitive, and the information about oil palm prices is also easily obtained. Besides, the agents of collecting traders are willing to lend funds to farmers for the farm operational costs so that the required processing quota of these factories is fulfilled. The simplicity of access to funds and marketing as well as more explicit price information on oil palm then resulted in the conversion from cocoa plantation lands into oil palm plantations by the farmers.

3.1. Costs  
The costs that must be spent by farmers are different each year. It caused by the requirement of different input or production factors of immature and mature plants. Descriptions and the amount of costs that must be paid by farmers to plant cocoa and oil palm from year 1, 2, and 3 to 25 are presented in Tables 1 and 2.

In the first year, all stages of land preparation for planting and fertilizing the cocoa spent considerable costs and production inputs. The amount of these costs was dominated by the needs for plant seedlings and labours used. At 3x3 cocoa plant spacing, the number of plants can reach about 1100 units. The death of the seedlings made the farmers have to overestimate the number of seedlings per hectare. The provided seedlings to plant were around 1143 units per hectare. The cocoa seedlings were obtained from subsidies, self-made by the farmers, or purchased. The seedlings obtained from subsidies and self-made were included to the calculated costs. The fertilizers were also used during the first year of cocoa cultivation. Generally, the cocoa farmers used the manure fertilizer which was self-made to fertilizer their plants.

Production costs and inputs spent in the first year of oil palm cultivation are quite large because cover all stages of land preparation until the oil palm planting stage. The amount of these costs was also dominated by the needs for plant seedlings and labours used. There were two types of oil palm seedlings used by farmers, namely certified and non-certified seedlings. The certified seedlings generally had a price of 25,000 IDR and the not certified had a price of 12,500 IDR. Moreover, the requirement of
A seedling for a hectare of oil palm area is around 130 pieces. The cost of fertilizers in the first year of oil palm cultivation was not high. It was because not all of the farmers use fertilizers on immature oil palm plants.

| Table 1. Farming Costs in First and Second Year |
|-----------------------------------------------|
| No. | Descriptions | Year 1 | Year 2 |
|-----|--------------|--------|--------|
|     |              | Cocoa  | Oil Palm | Cocoa  | Oil Palm |
| A.  | Cash Cost    |        |         |        |         |
|     | Seedling     | 1,960,144.93 | 2,196,135.80 |        |         |
|     | Fertilizer   | 100,515.95 | 128,035.02 | 204,220.30 | 269,320.03 |
|     | Tax or Rent  | 62,692.23 | 61,294.87 | 62,692.23 | 61,294.87 |
|     | Pesticide    | 599,101.01 | 557,199.13 | 301,120.55 | 557,199.13 |
|     | Non-family Labour | 906,167.68 | 697,503.75 | 123,381.64 | 88,333.33 |
| B.  | Calculated Cost |      |         |        |         |
|     | Self-made Seedling | 3,723,530.14 | 153,320.31 |        |         |
|     | Self-made Fertilizer | 39,664.60 | 1,687.50 | 79,329.19 | 3,375.00 |
|     | Depreciation   | 485,515.79 | 428,570.35 | 485,515.79 | 428,570.35 |
|     | Family Labour  | 3,422,226.35 | 2,451,969.76 | 642,259.16 | 415,493.77 |
|     | Total Cost     | 11,299,558.67 | 6,675,716.50 | 1,898,518.87 | 1,823,586.49 |

In the second year, the overall costs tended to be small because of the immature oil palm plants which have not produced, so that fertilization with a large amount had not been carried out and the labours amount was still a few. In the third year, plants began to produce therefore the maintenance process must be carried out more intensively. The required costs for the production year were assumed to be the same from the third year to the twenty-fifth year. In cocoa farming, the biggest cost was spent on fertilization and family labours. While in oil palm farming, the biggest cost was spent on harvesting and fertilizing labours. During this time, fertilization was carried out more intensively, and non-family labour began to be needed to harvest the farm.

| Table 2. Farming cost in 3rd to 25th year |
|-----------------------------------------|
| No. | Descriptions | Cocoa | Oil Palm |
|-----|--------------|-------|----------|
| A.  | Cash Cost    |       |         |
|     | Fertilizer   | 1,015,721.06 | 1,346,600.16 |        |         |
|     | Tax or Rent  | 62,692.23 | 61,294.87 |        |         |
|     | Pesticide    | 301,120.55 | 557,199.13 |        |         |
|     | Non-family Labour | 135,555.56 | 167,416.67 |        |         |
|     | Harvesting Labour | 3,223,072.01 |        |        |         |
| B.  | Calculated Cost |       |         |
|     | Self-made Fertilizer | 396,645.96 | 16,875.00 |        |         |
|     | Depreciation   | 485,515.79 | 428,570.35 |        |         |
|     | Family Labour  | 1,218,267.84 | 447,975.23 |        |         |
|     | Total Cost     | 3,615,518.99 | 6,249,003.42 |        |         |

3.2. Revenue

The cocoa production used was the bulk type cocoa production which was generally cultivated by farmers. Production of dried cocoa beans for revenue analysis for 25 years was projected using the bulk type cocoa production potential from Indonesian Coffee and Cocoa Research Institute (ICCRI) in the 3rd to 25th year. The assumption of the price used was the average price at farmers level in early 2018, which was 21,164.51 IDR per kilogram. The average percentage of cocoa farmers actual production was
0.986 times from the existing production potential. Revenue of Cacao for 25 years for one hectare of land was 453,038,084.41 IDR with an average of 18,121,523.38 IDR per year. Details of production potential, production volume, and cocoa revenues are presented in Table 3.

Table 3. Production potential, estimated production volume, and value of dried cocoa and oil palm FFB revenue per hectare according to the plant age

| Plant Age (year) | Production Potential (ton/year) | Estimated Production Volume (ton/year) | Revenue (IDR/Ha) | Plant Age (year) | Production Potential (dried kg/year) | Estimated Production Volume (dried kg/year) | Revenue (IDR/Ha) |
|------------------|---------------------------------|---------------------------------------|------------------|------------------|-------------------------------------|------------------------------------------|------------------|
| 3                | 7.30                            | 6.30                                  | 9,125,170.42     | 3                | 250                                 | 246.61                                   | 5,219,332.77     |
| 4                | 13.50                           | 11.65                                 | 16,875,315.17    | 4                | 350                                 | 354.25                                   | 7,307,065.88     |
| 5                | 16.00                           | 13.81                                 | 20,000,373.53    | 5                | 500                                 | 493.22                                   | 10,438,665.54    |
| 6                | 18.50                           | 15.97                                 | 23,125,431.90    | 6                | 700                                 | 690.50                                   | 14,614,131.76    |
| 7                | 23.00                           | 19.85                                 | 28,750,536.95    | 7                | 850                                 | 838.47                                   | 17,745,731.42    |
| 8                | 25.50                           | 22.01                                 | 31,875,595.31    | 8                | 1,000                               | 986.43                                   | 20,877,331.08    |
| 9-13             | 28.00                           | 24.16                                 | 35,000,653.68    | 9                | 1,100                               | 1,085.07                                 | 22,965,064.19    |
| 14               | 27.00                           | 23.30                                 | 33,750,630.33    | 10-15            | 1,200                               | 1,183.72                                 | 25,052,797.29    |
| 15               | 26.00                           | 22.44                                 | 32,500,606.99    | 16-20            | 1,000                               | 986.43                                   | 20,877,331.08    |
| 16               | 25.50                           | 22.01                                 | 31,875,595.31    | 21-25            | 950                                 | 937.11                                   | 19,833,464.53    |
| 17               | 24.50                           | 21.14                                 | 30,625,571.97    |                  |                                     |                                          |                  |
| 18               | 23.50                           | 20.28                                 | 29,375,548.62    |                  |                                     |                                          |                  |
| 19               | 22.50                           | 19.42                                 | 28,125,525.28    |                  |                                     |                                          |                  |
| 20               | 21.50                           | 18.55                                 | 26,875,501.93    |                  |                                     |                                          |                  |
| 21               | 21.00                           | 18.12                                 | 26,250,490.26    |                  |                                     |                                          |                  |
| 22               | 19.00                           | 16.40                                 | 23,750,443.57    |                  |                                     |                                          |                  |
| 23               | 18.00                           | 15.53                                 | 22,500,420.22    |                  |                                     |                                          |                  |
| 24               | 17.00                           | 14.67                                 | 21,250,396.88    |                  |                                     |                                          |                  |
| 25               | 16.00                           | 13.81                                 | 20,000,373.53    |                  |                                     |                                          |                  |
| Total            | 505.30                          | 436.06                                | 631,636,796.57   | Total            | 21,700                             | 21,405.55                                | 453,038,084.41   |
| Average          | 20.21                           | 17.44                                 | 25,265,471.86    | Average          | 868                                | 856.22                                   | 18,121,523.38    |

The average oil palm production from the 3rd to 25th year was projected with the production potential of fresh fruit bunch (FFB) from Indonesian Oil Palm Research Institute (IOPRI). The used price assumption was the average price at farmers level in early 2018, which was 1,448.5 IDR per kilogram. The average percentage of oil palm actual production by the farmers was 0.863 times from the potential production of IOPRI FFB. Revenues received by oil palm farmers for 25 years amounted to 631,636,796.57 IDR or an average of 25,265,471.86 IDR per year. Details of production potential, production volume, and FFB revenue value are presented in Table 3.

3.3. Income
Income of farmers obtained from the revenues for 25 years minus all of the farming costs. Details of farming income for 25 years is described in Table 4. There were several differences in the components of farming income from both plants. In cocoa farming, the calculated cost was higher than the cash cost, which was 59.35 percent of the total cost, while in oil palm farming, the calculated cost was only 16.05
percent of the total cost. It was because the cocoa farmers used more family labours and more self-made organic fertilizers which were included in the calculated costs, while the oil palm farming used more non-family labours in harvesting which was included in cash costs.

**Table 4. Income of farming for 25 years**

| No. | Descriptions            | Cocoa           | Oil Palm        |
|-----|-------------------------|-----------------|-----------------|
| A   | Total Revenue           | 453,038,084.41  | 631,636,796.57  |
| B   | Cash Cost               | 39,167,092.68   | 127,794,721.13  |
| C   | Calculated Cost         | 57,187,921.63   | 24,431,660.42   |
| D   | Total Cost              | 96,355,014.31   | 152,226,381.55  |
| E   | Income for Cash Cost    | 413,870,991.74  | 503,842,075.44  |
| F   | Income for Total Cost   | 356,683,070.10  | 479,410,415.02  |
| G   | PVNR                    | 44,629,869.87   | 77,428,876.44   |
| H   | R/C for Cash Cost       | 11.56           | 4.94            |
| I   | R/C for Total Cost      | 4.70            | 4.15            |

The amount of the calculated costs spent caused the cocoa R/C value for the cash costs became much higher than the oil palm. The R/C ratio in cocoa farming for the cash costs was 11.56 and for the total cost was 4.70, while for oil palm farming was 4.94 for the cash costs and 4.15 for the total cost. The R/C ratio showed that cocoa farming was actually more efficient and profitable compared to oil palm farming. The R/C ratio for the cash costs in cocoa farming was 11.56 which was far higher than in oil palm farming of 4.94, which means that every one rupiah of cash costs spent will generate revenue of 11.56 IDR, on the other hand, in oil palm farming, every one rupiah of cash costs spent will only generate revenue of 4.94 IDR. Therefore, if the calculated or non-cash costs were not included in the calculation, the profit of cocoa farming was much higher than oil palm farming. The R/C value for the total cost of oil palm was also below the cocoa, which was 4.70 for cocoa and 4.15 for oil palm, which means that every one rupiah of cash costs spent will generate revenue of 4.70 IDR in cocoa farming and 4.15 IDR in oil palm farming.

Although the R/C ratio of cocoa was higher, the far higher total revenue of oil palm plants caused the oil palm farming income in nominal was higher than cocoa. Based on the analysis of farming income in cocoa and oil palm within 25 years, it was found that the present value of oil palm farming income was higher than cocoa, which was 77,428,876.44 IDR in oil palm and 44,629,869.87 IDR in cocoa. It was in accordance with the theory of Land Rent which explained that the conversion of land used by some activities into other activities is caused by the differences of benefits that provide more profitable usage. Higher economic benefits of oil palm plantations could be one of the factors that influenced farmers to convert their lands.

### 3.4. Compare means analysis

The result of the compare means test on cocoa and oil palm farming income are presented in Table 5.

**Table 5. The result of the compare means test on cocoa and oil palm farming income**

| Income of | Mean      | Independent Samples Test | t      | df     | Sig. (2-tailed) | Mean Difference |
|-----------|-----------|--------------------------|--------|--------|-----------------|----------------|
| Cocoa     | 12,232,429.34 | Equal variances assumed  | -3.048 | 26,000 | 0.005           | 7,614,591.171  |
| Oil Palm  | 19,847,020.51 | Equal variances not assumed | -3.122 | 25,180 | 0.004           | 7,614,591.171  |

Levene's Test for Equality of Variances: F = 1.012, Sig. = 0.324
The Levene's Test for Equality of Variances showed a significance value of 0.324 (> α 5% or 0.05) which means that there were no significant differences between the variances of the two sample groups or both sample groups have the same variance. The compare means test on cocoa and oil palm farming income showed a significance value (sig. (2-tailed)) of 0.005 (<α 5% or 0.05) which means that there was a significant difference between the average income of cocoa and oil palm farming.

4. Conclusions
Oil palm farming income was higher and significantly different from the cocoa farming income. It is one of the causes of conversion of cocoa lands into oil palm in Asahan District, North Sumatra. Farmers who have limited land and capital but have sufficient resource of family labour should keep farming cocoa because the received income for every spent cost is quite large. Instead of directly converting their cocoa lands into other commodities, plant rejuvenation such as side grafting and grafting method could be conducted in the cocoa plantations so that the productivity of plants will increase. All of the cocoa supporting institutions, starting from the Department of Agriculture to Department of Industry and Trade, need to intensify the formation and activation of cocoa farmer groups, rural unit cooperative (KUD), as well as the auctioning place of cocoa beans by the local KUD. It is needed in order to create an alternative for the cocoa beans marketing and improve the bargaining position of farmers so that they will get a better price. Development of cocoa downstream industry is also needed to be conducted in Asahan as well as in Sumatera Utara and Indonesia.

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