Valuation of rubber farming business in support of food security: a case study in Pulang Pisau Regency

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Abstract. Government efforts to restore peat lands should consider to environmental benefits and considerable economic benefits for local communities. Rubber plant is one of the most cultivated commodities on peat lands and contributes to farmers’ income. Income from rubber business can improve their access to food sources to support food security. To ensure the sustainability of income from this business, this study aims to evaluate the rubber plantation business, map the marketing chain, and determine the contribution to household income. The research location is in Buntoi and Mantaren 1 villages, Pulang Pisau Regency, Central Kalimantan Province. Data are collected through in-depth interviews with farmers and rubber commodity marketers. The business valuation methods use Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit Cost Ratio (B / C Ratio). The results of the analysis show that the rubber plantation business meets the criteria for feasibility with a positive NPV value (cash inflow is greater than cash outflow), IRR is greater than the rate of return, and B / C is above 1. The rubber commodity marketing chain consists of farmers, traders, business groups, and processing industries. Farmers as producers play an essential role in ensuring the sustainability of the products released by considering the environmental aspects of the peat ecosystem characteristics. On the other hand, the processing industry plays an important role as a potential partner who can work directly with farmers/communities to guarantee the products released by the community and increase the added value of the products. Income from the rubber business has an important role in household income as well as supporting economic access to food.

1. Introduction
Food security is an important issue during the Covid-19 pandemic. This pandemic has a serious impact, even for some people, it is a threat to their ability to get access to basic food. This situation is, for example, the result of lost or reduced income due to job loss [1]. According to the World Food Program (WFP), the current Covid-19 pandemic could double the risk of acute sufferers by the end of 2020. Referring to the FAO concept, there are four dimensions to achieve the goal of food security, they are (1) sufficient availability (availability), (2) access to food (access), (3) proper use of food (utilization), and (4) availability of food stocks and prices (stability) [2]. The dimensions of food security are not only about food availability (physical) but also economic and physical access to food. Food security is achieved when all people, at all times, have physical and economic access to adequate, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life [3]. The
Government of Indonesia has implemented a number of policies, including food estate program in Central Kalimantan for defense to maintain national food security [1].

Peat ecosystems have various environmental service values such as hydrological controllers and regulators, sinks and carbon sequesters. However, unwise utilization and management has resulted in the destruction of the peat ecosystem. The government has launched peat land restoration efforts with a target of 2.49 million hectares within 5 years, one of which is in Central Kalimantan Province [4]. To increase the effectiveness of peat land restoration efforts, the government should pay attention to environmental benefits and consider the economic benefits for local communities. The challenge faced is how to maintain their livelihoods and cultural practices in the short term [5]. It is, therefore, important to not only assess the environmental benefits of peat conservation, but also to provide local communities with sustainable peat land-based economic activities [6]. Through the revitalization of livelihoods, communities are empowered to manage peat lands as places for cultivating crops that have economic value and must be in accordance with the type of land.

In implementing the use of peatland as agricultural land, areas with high peat depths cannot be managed for food crops, so it is necessary to look for other commodities that are suitable for cultivation. Rubber is a type of plant commodity that has long been cultivated on peatlands by people in Central Kalimantan. Besides, being planted as the main commodity, rubber is also planted with other crops in an intercropping way for a mixed garden/agroforestry pattern. Farmers’ income obtained from rubber cultivation is one source of income to support access to food. Farmers’ income obtained from rubber cultivation is determined by the price of rubber. Assuming high rubber prices, farmers’ income from rubber cultivation is able to meet the demands of food. This means that the farmer’s household is food insecure, because the proportion of expenditure on food is low and consumes enough energy [7] [8]. If it is so, the rubber commodity cultivated by the community on peatlands is not only a potential source of income but also contributes to food security [9]. Food security at the household level is the base for community food security, which in turn is acting as a pillar for regional and national food security.

Rubber cultivation as a dimension of economic access to food also contributes to the regional economy in Central Kalimantan. Pulang Pisau Regency is one of potential rubber producers in Central Kalimantan. In 2010 the community planted rubber almost simultaneously in Pulang Pisau Regency through the provision of seeds from an agriculture office. In 2015, the area of large state, private and community rubber plantations in Pulang Pisau Regency was 38,342 hectares with a production of 13,942.17 tons. Rubber plantations continued to develop until the year of 2019, covering an area of 41,291 hectares, with a production of 2,967.64 tons [10]. On the other hand, the management of peatlands with export value crops, such as oil palm and rubber, adds to the role of peatlands in the country’s economy through foreign exchange earnings. However, rubber/agroforestry plantations cause the lowest economic losses if it is compared to oil palm plantations, rice and horticulture farming.

To find out whether or not the income from rubber cultivation is sustainable as a source of household income, it is necessary to know whether or not the rubber cultivation business is financially feasible to operate, how the marketing aspect is, and how much the contribution to household income to support access to food is. So far, there is not much information about the feasibility of rubber business by the community. Based on this, the objectives of this research are (1) to evaluate the rubber plantation business managed by the community in the research location, (2) to map the marketing chain, (3) to find out the contribution of revenue from the rubber business.

2. Research method
2.1. Research location and data collection
The study is conducted in the villages of Buntoi and Mantaren 1, Kahayan Hilir Subdistrict, Pulang Pisau Regency, Central Kalimantan Province (figure 1). The locations of these two villages are around peatland areas which are included in the peatland restoration program that is launched by Indonesian government, Peatland and Mangrove Restoration Agency (Badan Restorasi Gambut dan Mangrove/BRGM). The people who live in these two villages have long cultivated rubber as a mainstay commodity that is economically profitable compared to other commodities.
Data are collected through in-depth interviews with farmers and rubber commodity traders. Total respondents are 46 farmers who have performed rubber cultivation and 3 rubber middlemen. The main aspects in the interview are related to business cash flow and mapping the value chain of rubber product. The interview was conducted in October and November 2020.

![Figure 1. Map of the study site](image)

2.2. Data analysis
The business valuation method uses the parameters Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit Cost Ratio (B/C Ratio). The analysis period is 25 years and the unit of land area analyzed is 1 ha. The rubber farming system by the community in the research village is monoculture and agroforestry by planting intercropping (cassava) in the rubber plantation area. The obstacle faced by farmers is the presence of monkeys that destroy food crops so that cassava plants do not grow optimally. Thus, the analysis is only carried out specifically for rubber plants. The following is a description of the analysis.

Net Present Value (NPV)
The present value of net benefits (NPV) is to calculate the present value of benefits less costs in the analysis period and a certain interest rate. With this criterion, the business is declared feasible if the NPV ≥ 0 or Profit 0

\[ NPV = \sum_{t=1}^{n} \frac{(R_t - C_t)(1+i)^{-t}}{t} \]
Internal Rate of Return (IRR)
Internal rate of return (IRR) is the rate of return (at a certain interest rate) that causes NPV = 0. With this criterion, a business is declared feasible if the IRR equals or is more to the prevailing interest rate

\[ \sum_{t=0}^{n} R_t (1 + i)^{-t} = \sum_{t=0}^{n} C_t (1 + i)^{-t} \]

Benefit Cost Ratio (B/C Ratio)
Benefit and cost ratio (BCR) is the comparison between the benefits and the current cost. With this criterion, the business is declared feasible if the BCR ≥ 1

\[ BCR = \frac{\sum_{t=0}^{n} R_t (1 + i)^{-t}}{\sum_{t=0}^{n} C_t (1 + i)^{-t}} \]

where:
- \( i \) = interest rate (%)
- \( t \) = analysis period (year)
- \( R_t \) = benefits at the end of each period \( t \) (IDR)
- \( C_t \) = costs at the end of each period \( t \) (IDR)
- \( n \) = current period (year)

3. Result and discussion
3.1. Rubber plants cultivation
In the research location, rubber is a type of plant commodity that has long been cultivated by the community. The average land ownership area is at least 2 ha/household. Based on the interviews with the farmers who cultivate rubber, the average rubber production in Buntoi Village is 1,179 kg/ha/year, and in Mantaren Village is around 2,606 kg/ha/year. The difference in productivity is due to the different types of land managed, where Mantaren Village has more rubber in mineral lands, while Buntoi Village has more peat. People still use the sidelines of the rubber tree by planting cassava, but they have problems with monkeys that are destroying food crops so that the growth of the plants is not optimal.

Various types of cultivated plants are the source of community livelihood. The sector that dominates economic activity in both villages is the agricultural sector.

The rubber seeds planted by the community generally come from local nurseries (without certification), nurseries from the Agriculture Office, and nurseries from watershed management center “Balai Pengelolaan Daerah Aliran Sungai” (BPDAS) that is located in Tumbang Nusa Village. Rubber management activities that are carried out by the community include land preparation, planting, fertilizing, and weeding.

Rubber trees have started to produce sap in the fifth year with production that is still half of the production that it should be. The latex coagulation process uses a coagulant, and the next process is sap drying. Some of the farmer respondents (46%) in the rubber farmers’ business group “Kelompok Usaha Bersama Karet (KUBK)” or the rubber social forestry business group “Kelompok Usaha Perhutanan Sosial (KUPS) Karet” in Buntoi village carry out processing drying for 10-15 days until the dry rubber content “Kadar Kering Karet (K3)” reaches 60-66%, and the rest directly sell wet rubber to middleman. Meanwhile, 87% of rubber farmers in Mantaren Village do not carry out such processing (drying), but they sell directly to traders.

3.2. Financial analysis of rubber plantation
To find out the extent of the business feasibility of the rubber plantations that have been so far
cultivated by the community in Buntoi and Mantaren I Villages, a rubber business valuation is carried out. The business analysis period is 25 years. The assumption for the production of rubber latex can be harvested as much as 150 kg/month/ha in the 5th and 6th years; the production of rubber latex in the 7th year onwards is 300 kg/month/ha. The price of rubber latex is 6,500 per kg and the interest rate that is used is 12%. The investment in equipment for the rubber business includes sprayers, hoes, machetes, lawn machines, tapping knives, buckets, wire bowls, gutters, and bowls. The number of units that is required for each tool is presented in table 1.

Table 1. Major equipment investment during the analysis period.

| Type of equipment     | Unit price (IDR) | Number of unit | Total price (IDR) | Description          |
|-----------------------|------------------|----------------|-------------------|----------------------|
| Sprayer               | 600,000          | 3              | 1,800,000         | Year 0              |
| Hoe                   | 150,000          | 3              | 450,000           | Year 0              |
| Machete               | 150,000          | 3              | 450,000           | Year 0              |
| Grass-cutting machine | 1,450,000        | 3              | 4,350,000         | Year 0              |
| Tapping knife         | 75,000           | 2              | 150,000           | 5th and 15th year   |
| Bucket                | 50,000           | 2              | 100,000           | 5th and 15th year   |
| Bowl wire             | 400              | 1,000          | 400,000           | 5th and 15th year   |
| Gutter tapping        | 400              | 1,000          | 400,000           | 5th and 15th year   |
| bowl                  | 400              | 1,700          | 680,000           | 5th and 15th year   |

Table 2. Inputs of production factors

| Components/activities         | Unit   | Unit price (IDR) | Number of unit | Total price (IDR) | Description          |
|-------------------------------|--------|------------------|----------------|-------------------|----------------------|
| Seeds                         | Seeds  | seed             | 3,000          | 400               | 1,200,000           | Year 0              |
| Land preparation and planting | Trench making | Manpower$^1$ day$^{-1}$ | 150,000        | 28                | 4,200,000           | Year 0              |
|                               | Stake installation | Manpower$^1$ day$^{-1}$ | 150,000        | 6                 | 900,000             | Year 0              |
|                               | Spraying | Manpower$^1$ day$^{-1}$ | 150,000        | 5                 | 750,000             | Year 0              |
|                               | Liming | Manpower$^1$ day$^{-1}$ | 150,000        | 4                 | 600,000             | Year 0              |
|                               | planting | Manpower$^1$ day$^{-1}$ | 150,000        | 6                 | 900,000             | Year 0              |
|                               | dolomit | kg               | 6,000          | 1,000             | 6,000,000           | Year 0              |
|                               | pesticides | liter             | 90,000         | 10                | 900,000             | Year 0              |
|                               | NPK fertilizer | kg               | 14,000         | 200               | 2,800,000           | Year 0              |
| Maintenance and Wiretapping   | Manpower for weeding and tapping | Manpower$^1$ day$^{-1}$ | 150,000        | 40                | 6,000,000           | annually from year 1 -5, the following years require half the manpower along with tapping |
Based on the data presented in table 1 and table 2, the results of the analysis show that the income from rubber latex begins to be accepted at IDR. 11,700,000,- in the 5th and 6th years; while starting the 7th year, farmers receive IDR. 23,400,000 per year. The results of the business valuation of the rubber business in the villages of Buntoi and Mantaren I show that the financial analysis for 25 years obtain a net present value of IDR. 11,984,373, the IRR is 14%, and the Benefit Cost Ratio is 1,136. This figure shows that the rubber plantation business at the farmer level is feasible and provides benefits for the managers. The profits that are obtained will certainly contribute to the farmers' income as a source of livelihood. The income which is earned becomes one of the dimensions of economic access to food, so that it can support food security.

To find out how the feasibility of smallholder rubber business is, if improvements are made in the use of seeds and intensification of the production process, a simulation of rubber business assessment is carried out. The assumptions in this simulation are the use of superior seeds at a price that is twice the price of ordinary rubber, the use of fertilizers which is twice as intensive, and rubber production increases by 1.5 times. The results of the analysis show that the net present value is IDR 51,928,874, the IRR of 18%, and the Benefit Cost Ratio of 1,530. This figure shows that the rubber plantation business at the farmer level is feasible.

### 3.3. Rubber product marketing chain

There are several rubber marketing chains that occur in Buntoi and Mantaren I Villages as shown in figure 2. The rubber commodity marketing chain consists of farmers, traders, business groups (KUBK or KUPS), and processing industries where each actor carries out various activities so as to obtain added value from the products released. The farmers sell their harvests to several parties as marketing partners, such as collector traders (middleman), and business groups. There are traders who come from the village concerned, traders at the sub-district and even district levels. The rubber commodity marketing chain consists of farmers, traders, business groups, and processing industries where each actor carries out various activities so as to obtain added value from the products.

The community selling process is still very dependent on the information submitted by traders. The prices of commodities to be sold are guided by the traders. There is no price negotiation process with buyers in negotiating quantity, quality, price, time, delivery, and payment methods because they have trusted traders who have worked together for a long time. Beside that, related to the quality of latex that has been sold, farmers tend to sell raw latex due to the limitations of drying technology and the insistence on daily needs.

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*Table 1: Resource Supply*

| Resource        | Unit | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total |
|-----------------|------|--------|--------|--------|--------|--------|-------|
| Manpower for fertilizing | day | 150,000 |        |        |        |        | 600,000 |
| Fertilizer      | kg   | 14,000 | 400    | 400    | 400    | 400    |        |
| S3P10 (freezer) | liter | 40,000 |        |        |        |        | 2     | 80,000 |
Farmers as producers play an essential role in ensuring the sustainability of the products by considering the environmental aspects of the peat ecosystem characteristics. On the other hand, the processing industry plays an important role as a potential partner who can work directly with farmers/communities to guarantee the products released by the community and increase the added value of the products. Traders from the village, sub-district, district, provincial, inter-island or exporter levels play an important role in the distribution of goods from the producer level to the consumer level. Business groups play an important role in opening and developing businesses, increasing income, and increasing the production of community products.

3.4. Rubber business income contribution to support household food access
The development of plantation commodities, especially rubber, dominates the use of land that is cultivated by the community. This commodity is favored by the people of Buntoi and Mantaren I Villages, among others, because it provides the greatest profit. The commodity that is most favored by the people here means more to the economic benefits than other commodities, but there are still many obstacles in its exploitation. The most common obstacles faced by Buntoi and Mantaren I farmers are the low selling price of the products and limited costs or capital for agricultural cultivation.

Research in Jabiren Subdistrict, Pulang Pisau Regency [11] provides information that the factors that mostly influence the sustainability of rubber cultivation are the intensity of extension (social dimension), stability of farmers' prices at harvest (economic dimension), pH of water on farmland and fluctuations in water discharge on farmers' land (environmental/ecological dimensions). To increase the productivity and sustainability of agriculture on peatlands, technological innovations are needed including: land preparation, water management, soil amelioration, fertilization, pest and plant disease control [12].

The average rubber production in Buntoi Village is 1,179 kg/ha/year (price range 5,000 - 10,000 IDR kg⁻¹), with a harvest frequency of 86 times a year. Meanwhile, rubber production in Mantaren 1 Village is twice as high as in Buntoi Village, around 2,606 kg/ha/year (price range 6,000 - 7,000 IDR kg⁻¹) with a harvest frequency of 100 times a year. The rubber productivity of Mantaren 1 Village is higher because the rubber plantation area in this village is mostly on mineral land, while in Buntoi Village, there is more peatland. Gross income from rubber in Buntoi Village reaches 7,266,643 IDR ha⁻¹ year⁻¹ and Mantaren 1 Village reached 16,896,750 IDR ha⁻¹ year⁻¹. The income obtained from this rubber cultivation business contributes to household income which encourages people's purchasing power so as to increase their access to food.

Based on the results of the study, the average income of rubber farmers in Mentaren 1 village is 16,391,591 IDR year⁻¹ in Buntoi village is 17,727,963 IDR year⁻¹. The contribution of net income from rubber to farmers' total income is 50.3% in Mentaren 1 Village, and 75.4% in Buntoi Village. These results indicate that the income from rubber business has an important role in household income. This income from rubber supports food security, especially in terms of economic access to food, which is one aspect of food security. With the support of the aspect of economic access, households that do not have land to produce food directly can fulfill their food by buying food from other parties from the income they earn. The ability of households to obtain food is an important and most critical factor in determining the level of household food security [13].

Access to food at the household level is determined by the level of household income, where household income is a proxy for household purchasing power [14]. Households who consume food not from their own production cause the ability to obtain food to be highly dependent on the household's purchasing power, where purchasing power is not only influenced by price, but also influenced by household income. With the increase in household income, it will lead to an increase in household food security [13]. Food security at the household level is the foundation for community food security, which in turn becomes a pillar for regional and national food security [15].

In addition to the income aspect that is obtained from rubber cultivation which supports economic access to food, rubber cultivation can also be combined with food crops through agroforestry patterns. Agroforestry is effective in improving the income distribution, households income, food production and
poverty alleviation in the communities nearby the forests [16]. Therefore, rubber cultivation, which has so far been financially feasible, needs to be supported in order to provide even better results, including through the marketing aspect. Marketing guarantees (such as higher and stable prices), increased value added through processing, and cooperation in product marketing are aspects that need attention

4. Conclusion
The results of the analysis show that the rubber plantation business meets the criteria of feasibility with a positive NPV value of IDR. 11,984,373, IRR value of 14% (greater than the rate of return), and B/C value which is 1,136. The simulation results for the rubber business when it use high-yielding seeds, which are more intensive in the management process and higher production, indicate that the NPV, IRR and B/C values provide a higher value than the usual rubber business. This higher revenue from the rubber business can improve the community access to food sources to support food security.

The rubber commodity marketing chain consists of farmers, traders, business groups, and processing industries where each actor carries out various activities so as to obtain added value for the products. Farmers as the producers play an essential role in ensuring the sustainability of the products by considering the environmental aspects of the peat ecosystem characteristics. On the other hand, the processing industry plays an important role as a potential partner who can work directly with farmers/communities to guarantee the products released by the community and increase the added value of the products. The income from the rubber business has an important role in household income as well as supporting economic access to food. The contribution of net income from rubber to farmers' total income is 50.3% in Mentaren 1 Village, and 75.4% in Buntoi Village.

This research is expected to be a reference for the government in making policies that provide opportunities for the community in managing plant commodities on peatlands. Community participation in peatland management as a place for cultivation can be increased. Thus, community dependence on forests will be reduced. Through the efforts to increase added value (processing) and marketing guarantees, the efforts to encourage an increase in people's income can also be achieved.

References
[1] Sianipar B, Tangkudung A G 2021 Tinjauan ekonomi, politik dan keamanan terhadap pengembangan food estate di Kalimantan Tengah sebagai alternatif menangani pangan di tengah pandemi Covid-19 Jurnal Komunikasi, Masyarakat dan Keamanan 3 (1) 30 –41
[2] [FAO] Food and Agriculture Organization 2008 An Introduction to the Basic Concepts of Food Security. FAO [http://www.fao.org/3/a-al936e.pdf].
[3] World Food Summit 1996 Rome Declaration on World Food Security.
[4] BRG 2019. 3 year peat restoration report (Jakarta)
[5] Hansson A, Dargusch P 2018 An Estimate of the Financial Cost of Peatland Restoration in Indonesia Case Stud Environ. 2(1) 1.37-8
[6] Wardhana B 2016 BRG’s Roadmap for Peatland Restoration. CBD & FAO Workshop: “Forest Ecosystem Restoration” Bangkok, 27 June 2016
[7] Dona A, Defidelwina, Ferbrinova R 2015 Household food security of rubber farmers in Pematang Berangan Village, Rambah District. In the National Seminar on Local Food, Business, and Eco-industry.
[8] Puspitasari M S, Amin Z, Arfandi A 2019 Level of income and consumption of rubber farmers in Marga Sakti Village, Muara Kelingi Musi Rawas District Journal of Food System and Agribusiness 2(2) 1-8.
[9] Masganti & Markus A 2016 Management and productivity of peatlands for various crop commodities, ed Agus F, Anda M, Jamil A, Masganti. Indonesia's Peatlands: Formation, Characteristics and Potential to Support Food Security (Jakarta: IAARD Press) p 1-5.
[10] Central Kalimantan Provincial Government and BRG 2019 Peatland ecosystem protection and management plan.
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