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Differences in Rubber Plant Production in Swamp and Land in North Sumatra

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Abstract: This study aims to analyze the differences in the production of rubber planting in swamp land and land in North Sumatra. Rubber plants are one of the mainstay commodities in North Sumatra Province along with oil palm plantations. It's just that lately many rubber farmers are converting rubber land to oil palm land. This causes the production and price of rubber commodities to fluctuate. One way to prevent this is to plant rubber in swampy soil. This research uses descriptive qualitative research. Collecting data by observation, interviews, document analysis, literature study, especially using previous research data. The results of this study indicate that there has been a decline in rubber production during the last ten years due to the conversion of rubber land to oil palm land whose main consideration is economic motives, both the increasing price of palm oil and decreasing rubber prices. It's just that, at the same time, rubber plantations have started in swamps that were previously untouched. However, the results are not quite satisfactory compared to rubber plants in dry land. Further research is needed on the factors that influence it and solutions to these problems.

Keywords: Rubber plantations; Swamp land; Dry land; Land conversion; North Sumatra

Introduction

Indonesia has learned a lot and obtained a lot of information about wetland management through various restoration, research and development projects (Tridakusumah et al., 2015). The original Finnish development for migrant settlements was haphazard and on a small budget. This is further challenged by unknown soil conditions in new areas. Unknown risks such as acid sulphate soils are important lessons in soil management (N. Nurhayati, 2020). Based on history and lessons learned, current and future land development must follow gradual development and continuous reconstruction to ensure sustainability. Based on a historical perspective, nowadays we can design technologies, especially in the areas of air management, cultivation strategies, culture improvement and plant management (N. Nurhayati et al., 2016; Y. Nurhayati et al., 2022).

Air management in swamps should avoid excessive runoff because it can cause exposure to sulfuric acid (Akcil & Koldas, 2006; Matondang & Nurhayati, 2022). In peatlands, excessive drainage can lead to peat oxidation, subsidence, increased hydrophobicity and emissions. Air conditioning should only circulate surface air to allow plant roots to survive. It is also important to dissolve standing water that accumulates acids and toxic elements (Iswanto et al., 2021; White et al., 1997).

Natural rubber is the newest natural resource, but modern production is highly questionable. In ten years, the global cultivated area has doubled and this trend is expected to continue. Much of the expansion resulted in the conversion of highly protected areas. In addition, rubber is widely grown in monoculture plantations in industrial agriculture; Therefore, conversion requires deforestation, which leads to carbon emissions, choices regarding biodiversity, and negative impacts on

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ecosystem functions and services. The rubber agroforestry system found high forest biodiversity in comparison. Most of the world's natural rubber is produced in Southeast Asian countries. In Indonesia, it should be noted that natural rubber is grown in large plantations. Sumatra Island is the main rubber producing area in Indonesia.

In 2015, French tire manufacturer Michelin began establishing a "rubber plantation model" as a concession in Sumatra and Kalimantan to produce "environmentally friendly" natural rubber tires. Most of the rubber area is owned by farmers, with an average area of rubber per family of 2 hectares (Syarifa et al., 2016). The concept of forest rubber is well known to smallholders, who they cultivate rubber with unsorted and low-yielding seeds mixed with trees, fruit trees, and various annual crops in immature (Hanasuki et al., 2016). The Metsäkumi practice offers advantages for smallholders, such as B. No fees, no maintenance work during adolescence; and additional income from fruit, timber and other non-timber products harvested from plantations. Although rubber harvesting is delayed compared to monoculture rubber on plantations, the crop still offers attractive income for smallholders. The indirect environmental benefits of forest rubber include soil conservation and restoration of degraded land (Syofiandi et al., 2016).

Aziz Pane, Director of Dekarindo, said that the government had initiated a rejuvenation of the rubber factory in 2017, but it was not implemented due to funding constraints (Listyarini, 2020; Wantu et al., 2021). Renovation of a 1-hectare rubber factory requires a minimum investment of IDR 50 million. Aziz said there were banks in Europe who were interested in helping to replant rubber plantations in Indonesia. The European Bank is interested in Indonesian rubber plantations because it wants to process rubber trees into rubber powder. He said, the use of rubber in the domestic market still needs to be controlled. If the rubber is not widely used, it is feared that more and more rubber plantations will be abandoned by farmers. Especially now that many rubber trees are sick and many farmers are replacing rubber trees with oil palm. Competing countries such as Laos, Vietnam, Thailand and Cambodia are intensively developing rubber.

Method

This research was conducted in the province of North Sumatra. The area of rubber plantations in North Sumatra is around 397,667 ha. This research uses descriptive qualitative research. Data collection through observation, interviews, document analysis, literature studies, and especially the use of previous research data. Descriptive research attempts to systematically describe situations, problems, phenomena, services or programs, provide information about, for example, people's living conditions, or describe attitudes towards a problem. Researchers ask respondents about their knowledge of certain phenomena (Creswell & Creswell, 2018).

The phenomenon that the researcher is discussing happened in the past and the researcher cannot describe it in any other way. It can refer to historical events such as wars that occurred at some point and somewhere in the past (Sugiyono, 2017). The phenomenon can also be associated with some current situations. In this case, the purpose of the researcher is to collect descriptive data before conducting an experiment or survey. For example, health researchers collect information from respondents; Farmers who cultivate rubber in swamps and villages. Researchers then use this information to design surveys or conduct experiments (E. T. Koh & Owen, 2000). Therefore, descriptive research can also deepen quantitative research. The purpose of this study was to analyze the differences in the production of rubber plantations in North Sumatra on swamps and land.

Result and Discussion

Rubber cultivation in North Sumatra

Sumatra Island is the most important agricultural area in Indonesia. Initially, rubber trees were grown in agroforestry systems, often referred to as “forest rubber”. Due to global market demand for natural rubber and the over-exploitation of the related gutta percha, a native gum, local farmers are reforesting this system with a new cultivar, the para rubber tree. These farmers adopted the variety from the Dutch, who cultivated it on their farms since the early 20th century. Beginning in the late 20th century, farmers gradually replaced agroforestry production systems with rubber tree monocultures. In 2013, about 30% of North Sumatra's land area was still forest (1.47 Mha), mostly in the western highlands, while 55% of the land had been converted to agricultural land. Analysis of land-use change shows that between 1990 and 2013, primary and secondary forests decreased by about a third. Most of the secondary forest is converted to oil palm and rubber plantations. The main agricultural products are oil palm and rubber. In 2015 the area of oil palm plantations was 0.74 Mha and of rubber, plantations were 0.38 Mha. Smallholders manage oil palm and rubber plantations in Jambi province. They grow 61% oil palm and 99% rubber. However, at the national level, the role of smallholders is less important because they only control 40 percent of oil palm plantations and 85 percent of rubber plantations.

Indonesia is the second largest natural rubber exporter in the world after Thailand (Siburian, 2012) and

also has the largest rubber plantation area. This sector has bounced back since early 2010 when global demand grew dramatically (Ardanari & Mukiwihando, 2020). According to the International Rubber Study Group, global demand for natural rubber is estimated to have reached 11.2 million MET in 2011, an increase of 6.6% from 2010. This trend will continue in the foreseeable future, as natural rubber consumption reached 16.2 million MET in 2020, placing Indonesia in an optimal position to utilize its abundant natural resources. Rubber plantations in Indonesia are largely dominated by smallholders who manage 86% of the 3.5 million hectares planted (Utami et al., 2017), with the remainder split equally between private companies and state-owned plantations. The main cultivation areas are in North and South Sumatra, as well as in Riau, Lampung and Java (Sadikin & Irawan, 2006). Total production in 2010 reached 2.736 million MET and production targets of around 3 million MET for 2011 and 3.6 million MET in 2015, according to the Indonesian Rubber Industry Association. About 90% of production is exported and the rest is used for the automotive and other industries in the country.

When natural rubber prices were low at USD 1.2/kg in late 2008 due to weak global demand during the financial crisis, the sector grew with the growth of the car trade in Asia and increasing demand for tires. At the beginning of the first quarter of 2011, world rubber prices rose to USD 5.75 per kilogram for technical specific rubber and USD 6,488 for strip smoke rubber (Singapore Stock Exchange) due to bad weather conditions which had a serious impact on rubber supplies from Thailand and Thailand. Malaysia, so the supply is reduced widely, Indonesia. An earthquake in Japan halted car production this year, causing prices to fall shortly after continued rains in Thailand and high demand for the commodity from China and India pushed prices up again. Under the China-ASEAN Free Trade Agreement (CAFTA), Indonesia is well positioned to serve the growing Chinese car owner market, which will soon make it the world's largest consumer of rubber, surpassing the United States. China took the lion's share of India's exports in 2010 of 600,000 MET and imported about 800,000 MET in 2011, followed by the United States, India, Japan and South Korea. Domestic rubber demand has also grown by an average of 23.2% per year since 2005, reaching 244,000 MET in 2010. With increasing sales of cars and motorcycles, Indonesia is expected to become a large rubber consumer, which is around 20% of total production for the next five years.

Rubber is one of the main crops which is the focus of the recovery program launched by the Ministry of Agriculture in 2007 (Pasaribu & Sayaka, 2014). The program aims to tackle the problem of low-quality crops and a total of up to 1.3 million hectares will be planted. Farmers will also receive loans of up to IDR 40 million per hectare of land to encourage replanting. By the end of 2010, the program had only a limited impact, with only 6,000 hectares newly rehabilitated, according to GAPKINDO. In late 2010, it was decided to extend the project until 2014, up to 400,000 hectares of plantations will be replaced with new trees and farmers will be trained in new technologies and logging techniques to increase yields. However, implementing state-funded programs requires greater cooperation.

Self-consumption in Indonesia is also increasing and existing tree plantations need to be revived urgently with young trees taking 5-7 years to be ready for production. Therefore, Indonesia has the potential to eventually become the world's largest rubber producer if the main problems of productivity and land fragmentation are resolved. The increased value of agriculture is increasing, supporting smallholders to invest in new technologies to increase future production as global demand continues. Indonesia is the second largest rubber producer in the world. Not surprisingly, rubber is also the second most important agricultural commodity in the archipelago after oil palm. However, domestic consumption is much less than exports. The decline in the production of rubber and plastic products in Indonesia's gross national product has slowed in recent years.

(a) (b)

Figure 1. (a) Swampland Rubber Plantation; (b) Land Rubber Plantation

More than 80 percent of Indonesia's rubber production comes from small farmers. This means that small farmers in Indonesia still earn the lowest average net wages compared to other sectors. The role of small farmers is getting more serious because small farmers increase their production while large rubber plantations decrease sharply, most rubber-producing areas are more profitable, especially oil palm. Palm oil production by the largest rubber companies in Indonesia such as Kirana Megatara Group, PT. Nusantara Plantations and Bakrie Sumatra Plantations grew while rubber production continued to decline.

Challenges faced by the Indonesian rubber industry

Indonesia has the largest rubber plantation in the world (Allen et al., 2015). But despite the extent of Indonesia's rubber plantations, there are still obstacles to maximizing their potential. Downstream activities such as post-harvest handling, manufacturing and processing are still not important due to the lack of infrastructure and production aspects. Without a new approach, the Indonesian rubber industry will remain heavily dependent on the export market for decades to come, while domestic consumption of rubber will remain low (Wakhid et al., 2017). In addition to infrastructure problems, Indonesian rubber plantations are also attacked by fungi. At the end of 2019, the outbreak reduced Indonesia's rubber production by more than ten percent. The use of cheap fertilizers bought by farmers and plantation owners when prices were cheap was the main cause of this outbreak. It took about two years for rubber production in Indonesia to recover. These issues are important to support smallholders in Indonesia. Providing better knowledge and financial support will not only alleviate the livelihood problems of Indonesia's small farmers but also lead the Indonesian economy.

Indonesia is the second largest rubber-producing country in the world after Thailand. In 2018, India produced 26 percent of world rubber production, while Thailand consumed the remaining 36 percent from other countries such as Vietnam, Malaysia, India, China, and others (L. P. Koh & Wilcove, 2008). The area of rubber in Indonesia in 2018 is around 3.7 million hectares with a total production of 3.6 million tons. 88.13% of this land is owned by small farmers and the rest is owned by private (5.16%) and government farms (6.7%) (Salim et al., 2019). At the smallholder level, productivity continues to be an issue. This is due to several factors such as B. adopting clones at the farm level, lack of garden maintenance and old/damaged rubber patches that need to be replanted. In 2018, the productivity of smallholder farmers in Indonesia was 1.1 tonnes/ha/year, lower than the productivity of the private and government sectors of 1.5 tonnes/ha/year. Rubber areas are scattered throughout the country. South Sumatra is the largest rubber province in Indonesia with a rubber area of around 1.3 ha in 2019 and production of nearly 1.2 million tonnes.

The government has made several efforts to increase productivity through subsidized farmer-level projects such as the Project and the Tree Crop Smallholder Sector Project. However, because state funds are also limited, they cannot reach all of the existing farmers' areas. Conditions for growing rubber have long been unfavourable. This is due to the drop in rubber prices in recent years, as well as production costs, especially yarn costs. Rubber prices peaked in 2011, but from 2012 to 2016 they fell further to a low of $1.38 per kilogram. At the beginning of 2017, the price of rubber was 2.2 USD, but in June 2017 the price of rubber returned to its lowest level of 1.43 USD per kilogram. The decline continued and in 2020 the price of rubber rose to $1.32 per kilogram. The drop in rubber prices had an impact on the socio-economic status of small farmers, especially in North Sumatra. The author found several socio-economic impacts from the decline in rubber, such as B. decreased farmer income, decreased farmer investment capacity, decreased farmer purchasing power, and changes in income sources to non-rubber sources. Some of the steps taken to overcome the problem of rubber prices at the farmer level include: 1) increasing farmers' income by growing better clones together with intercrops to generate additional income from raw materials, and 2) improving the quality of rubber raw materials for small farmers through an organized marketing system.

The concept of agroforestry has gained traction in recent days as it offers new business opportunities for small farmers. Agroforestry, with its various environmental and economic benefits, can help agriculture and forestry find innovative solutions to current problems (Hudiyani et al., 2017): including low profitability, negative environmental impact and public perception. This paper presents an introduction to the rubber farming system among small farmers. past levels, current situation and future scenarios of agroforestry to support rubber farmers.

Agroforestry System in North Sumatra

Farmers have long adopted the rubber farming system. Adjusted the double plant spacing, but in the current situation of low rubber prices, such agroforestry systems are suitable for smallholders. Rubber has been developed in Indonesia for more than a century and since then Indonesia has had the largest rubber area in the world. With rapid deforestation in North Sumatra, agroforestry is becoming the most important forest-like vegetation that we can find in a large sub-region

(Beukema et al., 2007). It has become a major reservoir for the forest species itself, providing a connection between forest remains for animals that require greater distances than forest remains. Although rubber forests cannot help natural forests in terms of conservation, the question of whether such production systems can contribute to the conservation of forest species, in general, is very important. Forest sap represents a large reservoir of forest species and provides links between forest remains for animals that require a wider range than forest remains (Brockerhoff et al., 2008).

A study by Narayanasamy (2011) found that the mean species richness did not differ significantly between forests, gums, and gums, but at the landscape level, the species coverage curve for gums was significantly higher. Parameters show higher beta diversity. Of all the traditional forest rubber plantations, both spontaneous and managed, the majority contain both woody and non-woody plants. The use of wood is divided into firewood and the construction of houses and furniture. Uses other than wood include edible uses. About two-thirds of all species in rubber farming systems have one or more uses. In the forest rubber system, rubber yields are low due to the use of unselected plant material. Therefore, to increase the yield of rubber plantations, it is important to find systems that provide optimal growing conditions for better varieties of rubber, supporting the most biodiversity.

Table 1. Effect of various types of land use Rubber cultivation on characteristics and soil surface biology

Landuse/rubber age	Sand	Silt	Clay	Bulk density	Total porosity	Bacterial count	Fungal Count	SOM	C/N ratio
			(g kg^{-1})	(g cm^{-3})	(%)				cfu*
Young rubber (3-10 yrs)	853.00	8.50	138.80	1.16^{ab}	55.41^{ab}	3.80^{c}	6.00	31.90^{c}	4.74^{c}
Middle age rubber(12-20 yrs)	814.00	8.60	180.30	1.09^{b}	58.74^{a}	10.00^{c}	9.80	50.69^{ab}	14.70^{b}
Old rubber (>25yrs)	824.00	9.90	166.10	1.14^{ab}	56.85^{ab}	41.30^{b}	6.00	51.21^{ab}	11.88^{b}
Fallow/forest	799.00	7.30	193.60	1.10^{b}	58.49^{a}	84.10^{a}	5.70	57.59^{a}	8.52^{bc}
Arable farm	799.00	10.60	190.30	1.23^{a}	57.31^{b}	6.00^{c}	10.70	46.90^{bc}	21.59^{a}
SE of mean	35.00	6.15	34.170	0.43	1.65	0.013	0.064	6.12	3.24

Modified from Orimoloye et al. (2012)

Table 2. Effect of different types of land use associated with rubber cultivation on soil chemical properties

Landuse/rubber age	pH H_2O	Avail P	Org C	Total N	Exch acid	Ca	Mg	Na	K	ECEC	B sat (%)	Fe	Cu	Mn	Zn
		mg kg^{-1}		(g kg^{-1})	c mol kg^{-1}							mg kg^{-1}			
Young rubber (3-10 yrs)	4.70^{a}	13.30	18.50^{bc}	3.90	0.60^{bc}	2.00	0.80^{ab}	0.29	0.40	4.29^{b}	86.60^{ab}	98.00^{bc}	7.86	204.80	29.60
Middle age rubber (12-20 yrs)	4.50^{abc}	15.60	29.40^{a}	2.00	0.42^{c}	1.95	0.81^{ab}	0.26	0.59	3.83^{b}	90.40^{a}	91.50^{c}	7.77	165.60	25.60
Old rubber (>25yrs)	4.41^{abc}	18.50	29.70^{a}	2.50	1.19^{ab}	2.02	0.91^{a}	0.20	0.26	5.34^{ab}	95.00^{a}	105.40^{abc}	7.80	168.00	31.90
Fallow/forest	4.48^{abc}	16.50	33.40^{a}	3.92	1.46^{a}	2.40	0.97^{a}	0.20	0.61	5.99^{a}	75.70^{bc}	118.90^{ab}	8.37	175.80	32.50
Arable farm	4.30^{c}	7.10	27.20^{ab}	1.26	1.16^{ab}	1.77	0.55^{b}	0.25	0.38	4.46^{b}	73.70^{c}	111.00^{abc}	7.13	188.70	30.20
SE of mean	0.12	5.72	4.04	0.37	0.30	0.26	0.14	0.12	0.24	0.64	5.19	10.06	0.68	22.05	5.15

Modified from Orimoloye et al. (2012)

Conducting participatory piloting requires close relationships and constant communication with farmers. Planning, implementation and modification of tests should be carried out in close consultation with smallholders. Building trust between researchers and farmers from the start of operations is critical to achieving the goals of the pilot farm. Once trust is established, the following programs and activities can be implemented more effectively. Commonly, farmers do not follow all the protocols previously designed and refined by the researcher. Such a situation was observed in both Jambi and West Kalimantan. Again, one of the tasks of participatory pilot farming is to get in close contact with the farmers and understand why they are not following the protocols. Intensive discussions are important to choose better technical options that are adapted to the needs of farmers. The trade-off between inputs (fertilizer, labour, chemicals) and plant growth or diversity has always been a concern for most people.

Due to the many constraints faced by farmers, especially the majority of Indonesian farmers, they must choose between consuming or dividing the family's labour. Maximum rubber growth is not always the goal of farmers in determining various RAS, while the most critical factor is the cost of maintaining young seedlings. The key question is how to provide technology options

to farmers given their labour constraints and capital capabilities. In the current fluctuating rubber price situation, rubber plantation forest management is very profitable, especially for increasing productivity and additional income for small farmers. The Sembawa Research Station has a large line spacing (18 m x 2 m) x 2.5 m.

With this great distance, farmers can plant cover crops between rubber and cash crops and annuals for a long time, even until the rubber is replanted. It was shown that the growth of rubber trees in the first year of autumn was slightly better with a single cropping system compared to the double cropping system, but the difference was not significant. The Indonesian Rubber Council (Dekarindo) stated that around 600,000 to 900,000 hectares or 20 to 30% of Indonesia's rubber plantations had to be replanted because they were old. Currently, the area of rubber plantations in Indonesia reaches 3 million hectares. Rejuvenation is needed to support national natural rubber production which reaches more than 3 million tons per year.

Table 3. Level of Respondents' Land Area in Converting Rubber Land to Oil Palm in North Sumatra

Land area (Ha)	Criteria	Value	Amount (Person)	Score amount	Percentage (%)
> 2.0	Very Wide	5	3	15	9.10
1.5 – 2.0	Wide	4	15	60	36.36
1.0 – 1.5	Not very wide	3	6	18	10.90
0.5 – 1.0	Narrow	2	9	18	10.90
< 0.5	Very narrow	1	0		
Total			33	111	67.26
Score obtained				111	
Score ideal				165	
Percentage land area level (%)				67.27	

Modified from Nasution (2019)

Table 4. Price Levels of Respondents' FFB in Converting Rubber Land to Palm Oil in North Sumatra

Price TBS (Rp/kg)	Criteria	Value	Amount (Person)	Score amount	Percentage (%)
> 1,600	Very expensive	5	3	15	9.10
1,500	Expensive	4	1	52	31.51
1,300	Expensive		3		
1,200	Expensive	3	8	24	14.54
1,000	Not very cheap				
900 – 700	Cheap	2	9	18	10.90
< 600	Very cheap	1	-	-	-
Total			33	109	66.06
Score obtained				109	
Score ideal				165	
Percentage of the TBS price level				66.06	

Modified from Nasution (2019)

In the construction of a new city in East Kalimantan, rubber can also be used in the construction of earthquake-resistant buildings, port construction, and a mixture of asphalt and rubber. Currently, natural rubber consumption in the domestic market is still 600,000-850,000 tons per year, while local natural rubber production is 3.50 million tons per year. Previously, the Minister of Agriculture Syahrul Yasin Limpo also encouraged the use of natural rubber in state road infrastructure to increase the price of this development project. Indonesia's natural rubber production is 3.20 million tonnes per year, and the domestic industry only consumes 0.60 million tonnes. On the other hand, the price of natural rubber which continues to increase in the international market is hurting farmers' income. Minister of Agriculture Syahrul Yasin Limpo made this statement during a meeting with the Minister of Public Works and Public Housing Basuki Hadimuljono. Later we will talk about rubber and irrigation. SYL and Basuki discussed further cooperation to conserve rubber raw materials. This aims to increase demand after the drop in world rubber prices.

Rubber is a global commodity whose price is determined by the international market which is currently experiencing a decline. Indonesia is one of the largest natural rubber producers in the world with an annual production of 3.20 million tonnes and 2.40 million tonnes exported. "It has become commonplace for them when commodity prices fall," said Edy. Gapkindo is watching the increase in rubber prices so that farmers do not abandon their agricultural land and damage crops, he said.

Table 5. Profits from Respondents' Oil Palm Farming in North Sumatra

Profit/Month	Category	Amount (Person)	Percentage (%)
> 4 Million	Very high	3	9.10
3 Million	High	16	48.48
2 Million	Moderate	8	24.24
1 Million	Low	6	18.18
< 1 Million	Very low	0	0
Total		33	100

Modified from Nasution (2019)

Table 6. Profitability in Converting Rubber Land to Palm Oil in North Sumatra

Profit/Month	Category	Amount (Person)	Score	Percentage (%)
> 4 Million	Very high	3	15	9.10
3 Million	High	16	64	38.78
2 Million	Moderate	8	24	14.54
1 Million	Low	6	16	9.69
< 1 Million	Very low	0	0	0
Total		33	119	72.15
Score obtained			119	
Score ideal			165	
Percentage of profit (%)			72.12	

Modified from Nasution (2019)

However, there is no other way to increase prices to a reasonable level, he said, adding, "There are many factors." Rubber prices follow developments in the oil market and also depend on demand, supply, supply and speculation in the international market of consumer countries, he said. He said the decline in rubber prices below $3 per kilogram was caused by the global crisis, the strengthening US dollar and false reports by speculators that the market was flooded with large surpluses. He said the government and Gapkindo worked together and separately to establish cooperation with other producers to improve these conditions, such as maintaining exports or reducing production. The world's largest producer, a member of the International Tripartite Rubber Council (ITRC), will reduce production by 10 percent. The ITRC introduced this practice in January-June 2009 and October 2011-March 2012 but still failed to raise prices to acceptable levels above $3 per kg. On March 27, the retail price of SIR20 natural rubber in the Singapore market was set at $1,868 per kilogram for April delivery. The government should help farmers build a buffer stock to buy rubber from farmers when prices fall, as Thailand did. "In the long term, it is not good if rubber farmers replace more of their crops so that Indonesia becomes a net importer of rubber," he said.

Table 7. Levels of Respondents' Economic Motivation in Converting Rubber Land to Oil Palm Land

Economic Motivation	Category	Amount (Person)	Score	Percentage (%)
The desire to meet the needs of the family	Very high	14	70	42.42
The desire to live a more prosperous life	High	8	32	19.39
Desire for higher income	Moderate	4	12	7.27
Desire to buy luxury goods	Low	7	14	8.48
Desire to own and increase savings	Very low	0	0	0
Total		33	128	77.57
Score obtained			128	
Score ideal			165	
Percentage of profit (%)			77.57	

Modified from Nasution (2019)

Exports increased while prices fell. Even though prices have fallen, rubber exports from North Sumatra, one of the largest rubber producers in the country, are still growing. The province's natural rubber exports rose 1.2 percent to 86,643 tons in the first two months of 2014 from 85,594 tons in the same period last year. Export growth, although enthusiastic, has yet to show market recovery this year, said Edy, adding that the increase was more due to the fulfilment of last year's transmission contracts. Gapkindo members' rubber exports from North Sumatra increased by 3.64 percent in 2013 to 509,126 tons. Director of the North Sumatra Central Statistics Agency (BPS) Wien Kusdiatmono said rubber was the province's second largest export producer after crude palm oil.

The lack of rubber plantations is the main source of income for residents in the area, he explained again, this was previously impossible to do because they considered farming was no longer profitable. The selling price of latex, which is currently estimated by buyers for rubber for daily needs, is around Rp. 4,000-5,000/kg, while the rubber price this month is Rp. 6,000/kg. In the last three years, the daily price of rubber was IDR 12,000/kg and the daily price of rubber was IDR 12,000/kg. According to him, the high price of rubber is now a distant memory because many local people have

cleared rubber plantations to replace them with palm oil or other plants that are considered more profitable.

Table 8. Levels of Respondents' Sociological Motivation in Converting Rubber Land to Oil Palm Land

Sociological Motivation	Category	Amount (Person)	Score	Percentage (%)
Desire to add to the relationship	Very high	5	25	42.42
Desire to cooperate with others	High	14	56	19.39
Desire to strengthen harmony	Moderate	8	24	7.27
Desire to exchange opinions	Low	6	12	8.48
Desire to get help from others	Very low	0	0	0
Total		33	117	70.90
Score obtained			117	
Score ideal			165	
Percentage of profit (%)			70.90	

Modified from Nasution (2019)

Conclusion

This study found that rubber production has declined over the past decade due to the conversion of rubber land to oil palm for economic reasons. Because rubber prices often fall and palm prices often rise. Coincidentally, at the same time, rubber plantations were established in previously untouched swamps. However, the results were less satisfactory than continental rubber plantations. Further research is needed on the factors that affect them and solutions to this problem. However, forest conversion to rubber plantations can increase high forest biodiversity, and plantation forests act as buffer zones around national parks. Although deemed feasible, new farming systems are emerging that challenge the dominance of agroforestry in the landscape.

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