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Value chain analysis for community livelihoods in peatlands: A case study in Southern Riau

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Abstract. Many of the Indonesian peatlands have been cleared of forest, then drained and burned for both large- and small-scale agricultural crop development. This has resulted in regular occurrences of haze from peatland fires during the dry season. Peatlands have long been a livelihood source providing up to 80% of earnings for nearby local communities. Nevertheless, many such communities apply unsustainable practices involving the use of fire for land preparation and drainage of wet healthy peatland ecosystems. For that reason, haze-free sustainable livelihoods need to be found immediately. This research analysed commodities traded in local markets as well as those with the potential for trade that could be grown in targeted villages. We collected data through market observations, focus group discussions and key informant interviews in nine targeted villages. Using Value Chain Analysis (VCA) methods, we analysed and assessed each commodity for their value chain distribution and governance, and power relations. The results of these assessments indicate that pineapple, areca nut, honey and fish are financially viable for generating income throughout the year and have fewer environmental impacts. These commodities have potential for consideration as alternatives in lieu of oil palm, which requires peatland drainage and often use of fire.

1. Introduction

Peatlands are important ecosystems for water management and carbon sinks. Peatlands have high water retention capacity and function as hydrological buffers for flood control, coastal protection, and freshwater resources [1, 2]. As a carbon sink, peat plays a critical role in climate change mitigation [3, 4, 5, 6]. Peat forests also provide valuable natural products for local livelihoods, with local communities' depending on peatland resources for up to 80% of their livelihoods [2, 7, 8, 9]. Tropical peatlands occupy 11% of the world's peatlands (441,025 km²), 56% of which (247,778 km²) are found in Southeast Asia, with Indonesia home to 206,950 km² of Southeast Asia's tropical peatlands [10]. Before the 1980s, peatlands had not been widely utilized because they are difficult to prepare and have low potential for agricultural use. However, population growth and land availability lead to a higher demand for land for settlements, crops, and plantations. Legal and illegal conversion of tropical peatlands and forests has become more extensive since the 1980s [11, 12, 13].

Despite the economic benefits, peatland utilization has an adverse impact on the environment. Peat ecosystems are being utilized and managed in an unsustainable manner, involving the draining, and converting of peat soils and extraction of their timber, which have left many peatlands open, dry, degraded and fire prone. The condition is compounded by the anthropogenic fires driven by rampant logging, large-scale transmigration programs, oil palm and industrial timber plantation development, and land clearing using fire [14, 15, 16, 17]. Forest fires on peatlands have caused huge losses. The Indonesian fire disaster in 2015 emitted 1.2 billion tons of CO_2 and burned 2.6 million ha, 33% of which were areas with peat deposits [18]. This disaster caused 24 people to lose their lives, and half a million cases of acute respiratory infections, as well as economic losses of USD 16.1 billion [19].

Peatland management is extremely challenging due to the trade-off between economic benefits and ecological functions to provide environmental services such as water management, biodiversity, and carbon sinks. Ramakrishna [7] revealed that local communities have their own economic rationale in determining which plants to cultivate on peatlands. Local communities tend to cultivate commodities that have established markets and favourable prices. Feintrenie [20] state that communities have no concern for deforestation or biodiversity if they can improve their economies and livelihoods.

Peatlands are mostly managed and utilized for agriculture, oil palm, and industrial plantation forest on small and middle scales as well as on a large commercial scale. Miettinen et al. [11] estimated that nearly half of Sumatra and Kalimantan's peatlands are used for smallholder agriculture and plantations. More than half (64%) of these plantations are oil palm estates developed by smallholders. As oil palms require well-drained soils, their development on peatlands involves the construction of drainage canals, which results in peatlands becoming dry and fire prone.

The goals of this study are to identify, assess and recommend economically profitable and ecologically suitable commodities for local communities to develop on peatlands. Most community livelihoods are land based, so we sought to assess land-based commodities. Understanding commodity governance is important as it defines how the commodity is being traded in the market. Bargaining power among different participating actors in the commodity chains is reflected in their governance. Different actors have different levels of power or influence towards the commodities. Our study specifically aimed to identify key commodities traded and cultivated in peatlands; calculate the distribution of added value to actors participating in those commodity chains; comprehend their commodity governance and compare and suggest suitable haze-free livelihoods for peatland communities.

2. Methods

The study was conducted in Indragiri Hulu, Indragiri Hilir and Pelalawan Districts in the southern part of Riau Province. Riau has the largest share of Indonesia's tropical peatlands at approximately 4.36 million ha [21, 11]. Indragiri Hulu, Indragiri Hilir and Pelalawan are home to 23%, 5% and 17% of Riau's peatlands respectively [21]. Three peatland villages for each district were selected based on their involvement in IFAD/GEF funded Sustainable Management of Peatland Ecosystems in Indonesia (SMPEI) project, which aims at developing haze free sustainable livelihoods. Altogether, nine peatland villages were studied, three of them located in Indragiri Hulu District (Redang, Sialang Dua Dahan and Tanjung Sari), three in Indragiri Hilir District (Bayas Jaya, Simpang Gaung and Teluk Kabung), and the remaining three in Pelalawan District (Bukit Lembah Subur, Mak Teduh and Teluk Meranti) as shown in Figure 1. These villages are all located in areas with peat deposits.

We studied key commodities in the nine villages using Value Chain Analysis (VCA) methods. A value chain is a systemic view of the production process and use of a product or service. VCA specifically assesses the processes involved in delivering a product or service, starting from the conception or design process through its production phases until it is delivered to end consumers, then disposed or recycled [22]. Value chains are complex and include various activities and phases [22]. We used modified methods from a study by Herr et al. [23] as our guideline. Our study comprised three main steps: (1) Identifying prioritized commodities and actors through focus group discussions (FGDs) at village levels; (2) Assessing the identified prioritized commodities for their governance and added value through key informant interviews; and (3) Comparing and prioritizing commodities to recommend them for haze-free sustainable livelihoods.

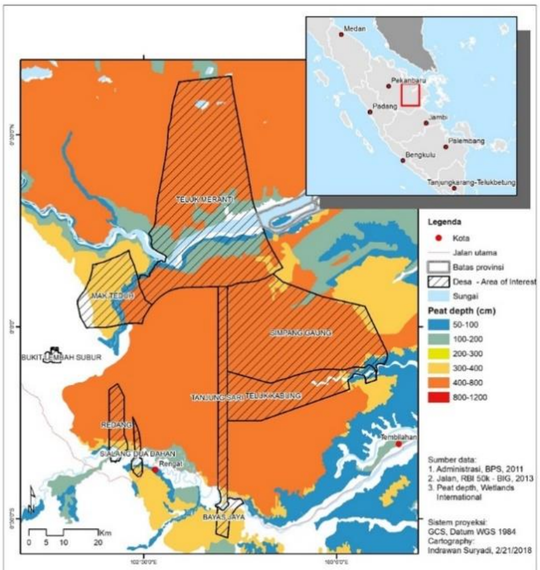

Figure 1. Value chain studies in nine villages on peatlands of various depths in Indragiri Hilir, Indragiri Hulu, and Pelalawan Districts in the southern part of Riau Province.

Step 1. *Identifying prioritized commodities based on markets and actors.* We initiated the study by surveying the markets near to the study villages. We observed and identified the commodities traded at the markets. We also surveyed the local landscapes to see what communities have developed and cultivated in their fields, and the degree that fire is used in growing the commodity. We then developed a list of commodities available at each market. Afterwards, we conducted FGDs in nine study villages with 15-20 participants in each FGD. The discussions were attended by men and women who were local leaders, local government employees, farmers, and local community members. We then identified the commodities which the communities cultivate and prioritize on peatlands. We asked the participants to rank the commodities. Then, we came out with a list of prioritized commodities and identified participating actors during the FGDs. Participating actors are defined as individuals or groups who are associated with or directly come to the markets where the commodities are traded. We tracked the participating actors regarding the trading flow of the commodities. We compiled and collected all information to generate initial value chain study maps and comprehensive lists of commodities available at the markets, regulations, and guidelines for peatland restoration, and FGDs.

Step 2. *Assessing prioritized commodities*. We collected more detailed data and information on prioritized commodities through key informant interviews with actors participating in the commodity value chains. We then purposively selected and interviewed 83 key informants who were participating actors in ten prioritized commodities. During key informant interviews, we: first, identified their relationships with other actors to establish value chain governance. We used the categories of Herr et al. [23] to identify governance structure, which influences the distribution of added value between actors along the chains. These categories were market-based, balanced network, directed network, and hierarchy. Second, we calculated added value and margins enjoyed by the actors involved. Added value is the value the participating actor adds into the chains. The value was calculated based on the difference between prices for products and subtracting their production costs. The exchange rate used is IDR 13,425 for USD 1.

Step 3. *Comparing the commodities' governance and added value*. We compared different value chains for the prioritized commodities for their governance and added value. We sought commodities with favourable bargaining positions and power. In addition to the aforementioned variables, the commodities in this study are being prioritized based on its ecological characteristics, i.e. soil moisture requirement. We highly considered to prioritize and recommend the commodity requiring moist-wet peat soil upon the cultivation. The moist-wet peat soil is one of the characteristics of healthy, fire prone-free peatland ecosystem which we seek to achieve.

3. Results

3.1. Prioritized commodities

We found 11 active markets: Air Molek, Lirik, Belilas, Pekan Heran, Rengat, Tembilahan, Simpang Gaung, Teluk Meranti, Bukit Lembah Subur, Petalangan and Ukui Traditional Market. Among all the study villages, Sialang Dua Dahan and Redang are the two with the greatest market access. These villages each have access to four markets: Air Molek, Lirik, Belilas and Pekan Heran, as opposed to other villages (1-2 markets). We documented and listed commodities traded at the 11 local markets. The list documents fruits, vegetables, herbs and spices and fish to be among many other locally traded commodities. In Air Molek market, for example, we found avocados, bananas, bean sprouts and water spinach were being traded. A similar variety of commodities was found in many other markets as well. However, Teluk Meranti, Bukit Lembah Subur and Petalangan markets were the only markets trading fish. While our study covered a diverse range of commodities, the traditional markets were limited to commodities for daily consumption. In terms of product diversity, Air Molek market had the highest variety with 30 different commodities being traded. Bukit Lembah Subur and Simpang Gaung markets had the lowest number of commodities traded with only 14 different commodities each.

In addition to being traded in the markets listed above, some commodities were also traded outside markets near the study villages. Our research revealed that some commodities, such as areca nut, edible swiftlet nests, honey, oil palm fruit and rubber were not available in domestic traditional markets. These commodities were being traded in specific and targeted market segments. Oil palm fruit and rubber, for instance, were plantation commodities primarily traded to commercial large-scale mills and factories respectively. Other commodities such as edible swiftlet nests and areca nut were mainly exported to international markets, whereas honey was usually traded through brokers (with minimum supply requirements) as well as directly to end consumers. Additionally, market coverage of these commodities might reach broader and wider ranges. Coconut, for instance, was available at Tembilahan, Simpang Gaung and Teluk Meranti markets and was also being exported to markets in Thailand and Malaysia.

After the market assessments, we identified community preferences. There were ten different commodities preferred for prioritization by local communities (Table 1). The ten key prioritized commodities were identified and ranked for each village based on local communities' preferences during FGDs. Their preferences were influenced by familiarity with the commodities and their cultivation, market opportunity/trend and demand, and suitability with the local context/ecosystem. Oil palm was ranked first in almost all villages except Simpang Gaung and Teluk Kabung where it was ranked third. Oil palm is a recently developed commodity in those two villages, starting around the 2000s, while coconut and areca nut have been developed since the 1970s and 1990s respectively. Accordingly, coconut and areca nut farming are the predominant land uses in Simpang Gaung and Teluk Kabung. In addition, prices secured for oil palm fruit in both villages are lower (USD 0.67/kg) compared to other villages (USD 0.74/kg) as farmers in both villages must bear higher costs, particularly for transportation.

In searching for sustainable commodities for planting on peatland, we refer to Ministry of Environment and Forestry (MoEF) regulation (P.16/MENLHK/SETJEN/KUM.1/2/2017[1]) and Peatland Restoration Agency (BRG) technical guidelines (BRG Technical Guidelines on Revegetation[2]). We found the majority of commodities suggested in the regulation and guidelines were neither available in

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[1] MoEF P.16/2017 on Technical Guidelines for the Restoration of Peatland Ecosystems specifies a list of recommended species based on biophysical conditions and purposes/advantages. Retrieved from: http://www.forda-mof.org//files/P.16_2017.pdf

[2] BRG developed a set of guidelines, one of which (Wibisono and Dohong 2017) specifies the types of species for revegetation (replanting native vegetation species). Retrieved from: https://brg.go.id/wp-content/uploads/2017/07/BUKU-Panduan-Teknis-Revegetasi-GAMBUT-BRG.pdf

local traditional markets, nor preferences for local communities. Most of the commodities proposed by regulation and guidelines were native vegetation from pristine peatland ecosystems consisting of timber, fruit-bearing, and resin-producing tree species. Ramin, for example, is listed by the International Union for Conservation of Nature (IUCN) as critically endangered —which implies a prohibition on trading the species. On the other hand, to intervene for behavioral changes in peatland restoration, the Indonesia government's Peatland Restoration Agency (BRG) emphasizes the 'Revitalization of Livelihoods' in its approach to peatland restoration. This livelihood revitalization approach recognizes the importance of developing alternative livelihoods and economically valuable commodities without jeopardizing ecosystems as well as biophysical suitability.

Table 1. Key commodities prioritized by local community in nine villages in Indragiri Hulu, Indragiri Hilir and Pelalawan Districts.

	Village								
	Redang	**Sialang Dua Dahan**	**Tanjung Sari**	**Bayas Jaya**	**Simpang Gaung**	**Teluk Kabung**	**Bukit Lembah Subur**	**Mak Teduh**	**Teluk Meranti**
Commodity	Oil palm	Oil palm	Oil palm	Oil palm	Coconut	Coconut	Oil palm	Oil palm	Oil palm
	Rubber	Rubber	Rubber	Rubber	Areca nut	Areca nut		Rubber	Edible swiftlet nests
	Sweet corn	Sweet corn	Sweet corn	Pineapple	Oil palm	Oil palm		Honey	Fish
	Spinach	Spinach	Pineapple					Fish	Rubber
								Edible swiftlet nests	Honey

Our study assessed the commodities traded and cultivated through BAU (Business as Usual) on peatlands. A number of existing commodities required dry soil (e.g., oil palm, spinach and sweet corn) meaning they can only be planted on dried degraded peatland or by draining water out of healthy peatland—which implies necessary actions should be taken to prevent new development or expansion of these commodities on peatlands. However, another existing commodity, pineapple, indicated high suitability for planting on peatland because of its wet soil requirement. Other commodities such as areca nut, coconut and rubber are suitable for planting on moist soil, while others such as fish, honey and edible swiftlet nests have no specific soil requirements.

3.2. Governance and value added to peatland commodities.

We calculated the value added for each of the 10 commodities on a unit basis (e.g., kg, bunch, piece etc.). We investigated mostly the added value along a specific chain in the governance of added value. In some cases, farmers also acted as small brokers if they had the capacity to mediate between farmers and larger brokers. The following explanation detailing the value chain and governance for three selected commodities i.e., pineapple, coconut, and oil palm due journal page limitation.

3.2.1. Pineapple. Actors involved in the pineapple value were farmers, brokers, retailers, and end consumers. In the pineapple value chain, farmers might sell their produce directly to brokers or retailers and in cases where farmers had direct access to roads to end consumers. Brokers bought pineapples from farmers through a directed network or balanced network relationship. Under the directed network relationship, farmers were required to sell more than 50% of their produce to brokers who would lend them money. Brokers would then sell the pineapples to the retailers or directly to end consumers. Retailers buying pineapples from brokers would then sell them on to end consumers. Pineapple value chain governance is illustrated in Figure 2.

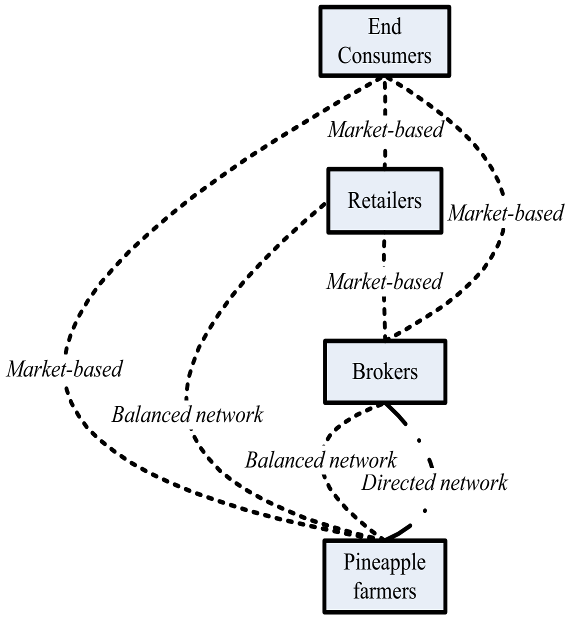

Figure 2. Value chain governance for pineapple

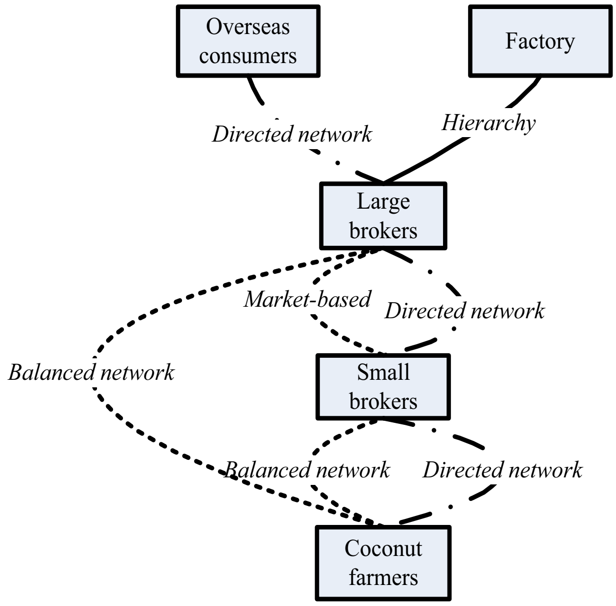

Figure 3. Value chain governance for coconut

Farmers sold pineapple to brokers under a balanced network for USD 0.60 each. Brokers would then sell pineapples to retailers for USD 0.67 each. End consumers would then buy pineapples for USD 0.75 each. Farmers received the highest profit, i.e., 68% of total profit. Farmers received more profit when selling their produce directly to end consumers. No mechanical processes were involved between farmers to end consumers, i.e., peeling or cutting. Consequently, product volume remained the same throughout the value chain. The value added by different actors along the pineapple value chains is shown in Table 2.

Table 2. Value added by different actors along a specific pineapple value chain.

Value chain actors	Product volume	Production cost	Selling price	Profit		Value added	
	piece	USD/piece	USD/piece	USD/piece	% total profit	USD/ piece	% selling price
Farmers (balanced network)	1	0.36	0.60	0.23	68%	0.60	80%
Brokers (market-based)	1	0.62	0.67	0.06	16%	0.07	10%
Retailers (market-based)	1	0.69	0.75	0.05	16%	0.07	10%
Total				0.34	100%	0.75	100%

3.2.2. Coconut. Actors in the coconut value chain were farmers, small and large brokers, factories, and overseas consumers. Farmers cultivated and harvested coconuts, while small brokers bought coconuts from farmers and sold them on to large brokers. Small brokers typically operated at the village level while large brokers had a wider scope of trading. Relationships between farmers and small and large brokers were either balanced network or directed network relationships depending on the presence or absence of loans. Large brokers sold coconuts to factories as well as to overseas markets in Malaysia and Thailand. The relationship between large brokers and factories was hierarchical. The relationship between large brokers and overseas consumers was a directed network relationship due to the huge demand from overseas markets with more than 50% of coconuts being sold to meet overseas market demand. Coconut value chain governance is shown in Figure 3.

We identified and calculated two coconut value chains (Table 3). In Chain 1, farmers would sell coconuts for USD 0.24/kg to the small brokers, who then sold them on to large brokers for USD 0.24/kg. These large brokers would then sell them for USD 0.27/kg. In Chain 2, farmers would sell coconuts for USD 0.24/kg to large brokers. Coconuts were subsequently sold for USD 0.27/kg to factories and overseas consumers. In Chain 1, farmers received 93 - 94% of total profit per kg of coconut, while small and large brokers secured 1% and 6% respectively. In Chain 2, farmers secured higher profits and added greater value. Product volume shrank when it was traded from large brokers to factories or overseas consumers. This shrinkage occurred due to low-quality coconuts breaking during shipping.

Table 3. Value added by different actors along two coconut value chains*)

Value chain actors	Product volume	Production cost	Selling price	Profit		Value added	
	kg	USD/kg	USD/kg	USD/kg	% total profit	USD/kg	% selling price
Chain 1							
Farmers (balanced network)	1	0.071	0.238	0.167	93%	0.238	89%
Small brokers (market-based)	1	0.240	0.242	0.002	1%	0.004	1%
Large brokers (market-based)	0.98	0.258	0.268	0.010	6%	0.026	10%
Factory or overseas consumers	-	-	-	-	-	-	-
Total				0.179	100%	0.268	100%
Chain 2							
Farmers (balanced network)	1	0.077	0.242	0.165	94%	0.242	90%
Large brokers (market-based)	0.98	0.255	0.268	0.010	6%	0.026	10%
Factory or overseas consumers		-	-	-	-	-	-
Total				0.175	100%	0.268	100%

*: We use three digits after the decimal point for this table because some numbers are very small.

3.2.3. Oil Palm. Actors in the oil palm value chain were farmers, small and large brokers, agents or DO (delivery order) owners and mills. Farmers cultivated oil palms and produced Fresh Fruit Bunches (FFBs). There were only two types of brokers: small and large. Small brokers operating at the village level bought FFBs from farmers and sold them on to large brokers at the sub-District or District level, who would buy either from small brokers or directly from farmers. Large brokers sold sell FFBs to mills through agents or DO owners who had agreements with the mills. Such agreements differentiated actors classified as agents and brokers.

Farmers, small and large brokers had balanced network and directed network relationships. Most were classified as directed networks because farmers would borrow from, be indebted to, and sell most of their FFBs to brokers. Small and large brokers formed hierarchical and directed network relationships. As small brokers were extensions of larger ones, they had a hierarchical relationship. In other cases, though small brokers used their own capital, they had directed network relationships with large brokers as they sold more than 50% of FFBs to them. Large brokers and DO owners had market-based and directed network relationships. Large brokers indebted to DO owners were obliged to sell their FFBs to them. This relationship fell under the directed network category. DO owners had a hierarchical relationship with mills that required them to meet FFB supply targets. Oil palm value chain governance is shown in Figure 4.

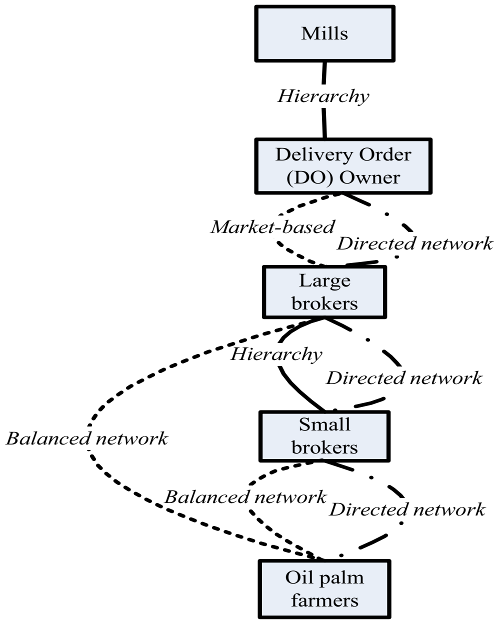

Figure 4. Value chain governance for oil palm

Farmers sold FFBs to small brokers in a directed network relationship for USD 0.09/kg. The FFBs were then sold to large brokers for USD 0.09/kg. Large brokers would then sell the FFBs to agents or DO owners for USD 0.12/kg. We were unable to obtain price data for the agent and mill level (Table 4). Farmers received 87% of the total profit per kilogram of FFBs, while small and large brokers secured 5% and 8% respectively. Farmers added 77.4% of FFB value, while small brokers added 3.5% and large brokers added 19.1%. FFB volume shrank by 3% when sold by large brokers to agents/DO owners. This shrinkage was due to the sorting process, where low quality FFBs were removed and excluded from trading.

Table 4. Value added by different actors along a specific oil palm value chain*)

Value chain actors	Product volume	Production cost	Selling price	Profit		Value added	
	kg	USD/kg	USD/kg	USD/kg	% total profit	USD/kg	% Selling price
Farmers (directed network)	1	0.026	0.089	0.063	87%	0.089	77.4%
Small brokers (market-based)	1	0.089	0.093	0.004	5%	0.004	3.5%
Large brokers (market-based)	0.97	0.109	0.115	0.006	8%	0.022	19.1%
Agents/ DO owners	-	-	-	-	-	-	-
Mills	-	-	-	-	-	-	-
Total				0.073	100%	0.115	100%

*: We use three digits after the decimal point for this table because some numbers are very small.

4. Discussion

4.1. Evaluation of methods

Value chain analyses, according to Kaplinsky and Morris [22], determine the profits earned by different parties in a linked activity. They also provide insights on power relations and interaction between the parties involved. We used this method to assess ten different commodities identified through FGDs with local communities. VCA is an appropriate method to understand market flow, distribution of profits and margins, as well as maps of power relations between parties in Riau Province involved in these commodities' value chains. We found the key commodities identified went through various market channels governed by four types of power relationships: hierarchy, directed network, balanced network and market-based. These relationships were characterized by the presence or absence of debts and agreements. Farmers who were indebted to brokers were obliged to repay their debts by selling more than half of their produce to them. In hierarchical relationships, those who could sell directly to mills or factories were those with pre-set supply agreements.

Our study suggests that key commodities pass many intermediaries prior to receipt and disposal by end consumers. Some commodities passed large-scale commercial intermediaries such as exporters, retailers, agents, mills, and factories. We also found commodities with broader linkage to the national and even global markets and economies, such as oil palm, coconut, and areca nut. We provide assessments for these commodities from various perspectives, though we do acknowledge that our data were limited to traceable domestic markets. Future studies should focus on assessing the extent of participation, linkages, and dynamics in national and global markets. Despite some commodities proving to be highly competitive at a certain point in time, there is the possibility of unsustainable income growth over a longer period [22]. Thus, we suggest modeling various scenarios to support commodities' sustainability in the global marketplace [24].

The ten key commodities identified were unique to their socioeconomic and ecological contexts. For example, despite being promising, spinach and pineapple were only being cultivated in areas of less than 1 hectare. In addition, though farmers appeared to secure the greatest benefits, they had smaller economies of scale compared to brokers, retailers or other higher intermediaries who collected commodities from many farmers and had bigger economies of scale. From an ecological context, promising commodities tend to be developed on a large-scale monoculture with little regard for promoting biodiversity. Some of the commodities assessed also appeared to be economically attractive, but require well-drained soil, which we found contradictory to our objective of developing peatlands in a more sustainable manner and without the use of fire.

4.2. Comparison of commodities planted in peatlands

Key commodities were those identified as being most favorable for development and/or are currently being developed, cultivated, and traded by local commodities in the nine study sites. Each of the key commodities had uniquely different characteristics, in terms of productive age, scale of business and annual harvesting times.

Sweet corn required dry soil to grow and might grow on canalized and shallow peat (less than 1 meter deep). Though it could be planted through intercropping with oil palm, most farmers were practicing sweet corn monoculture. When intercropping with oil palm, sweet corn could only be cultivated before oil palms reach 3 - 4 years of age. In monocultures, farmers were planting sweet corn on one-hectare areas with two planting periods (0.5 ha each). Farmers could commence their first harvests in less than a year (70 - 80 days/ 0.19 - 0.22 year after planting). In a year, farmers could harvest sweet corn up to 3 times with productivity of approximately 10,000 kg/ha per three months, or around 3,333 kg/ha/month. The sweet corn would be sold for USD 0.22/kg with a net income of around USD 4,769/ha/year (Table 6).

Spinach was cultivated in shallow peat with depths of less than one meter. However, it requires dry soil and was mostly planted in house lots. Generally, spinach cultivation occupied only a small portion of land at around 0.05 ha. It is easy to grow and low maintenance, so both men and women would take part in cultivation, maintenance and harvesting processes. It only took nearly one month (18 - 30 days/ 0.06 - 0.08 years after planting) to harvest spinach for the first time. Spinach could be harvested up to 12 times a year with productivity of around 2,000 bunches per month for 0.05 hectares. Farmers sold spinach for USD 0.11/bunch and received net income of USD 1,856/0.05ha/year.

Pineapple grows productively in wet, waterlogged peatland. It was cultivated through monocultures or intercropped with oil palm or rubber. However, intercropping with oil palm only works before oil palms reach 5 years old and start to inhibit production. Additionally, pineapple should be replanted after

4 - 5 years when it exceeds peak growth and productivity. Farmers mostly cultivated pineapple 0.5 - 1 hectare and would commence the initial harvest after six months to one year (0.5 – 1 year after planting). Then, they would gradually harvest pineapple every 4 months with productivity of around 30,000 pieces/ha/year or 2,500 pieces/ha/month. Pineapples would be sold at USD 0.60 each, and farmers received approximately USD 7,030/ha/year. With a cultivation scale of 0.5 ha, farmers received net income of around USD 3,515/0.5 ha/year.

Oil palm was widely cultivated and developed on a massive scale compared to other commodities. It requires dry peat soil to grow well and farmers usually cultivated oil palm on up to 10 hectares. In this study, most of our respondents developed an average of 2 hectares of oil palm plantations. Oil palm would normally be harvested at 5 - 7 years old after planting, when it produces fresh fruit bunches (FFBs). However, many of the farmers harvested oil palms at 3 years old when premature fruit, known as *buah pasir*, has a far lower harvest volume compared to FFBs. If the oil palm fruit is harvested at 5 - 7 years old as FFBs, productivity could reach 1,500 kg/ha/month with a frequency up to twice a month. Farmers sold FFBs for USD 0.09/kg and received net income of USD 1,134/ha/year. It is important to note that most farmers had more than one hectare of oil palm, so would typically receive USD 2,268/year for 2 hectares of oil palm plantation.

Areca nuts were cultivated in moist peatland. Most farmers planted areca nut with coconut through intercropping. They used 1 - 2 hectares for areca nut cultivation and commenced the first harvest in 4 - 5 years after planting. Subsequently, they could harvest areca nut every month with productivity of up to 500 kg/ha/month. Farmers mostly sold shelled wet areca nuts for USD 0.56/kg. They would receive net income of around USD 1,641/ha/year from areca nut cultivation.

Coconut required moist peat soil to grow and was a widely cultivated commodity in peatland, especially in Indragiri Hilir District. Local communities in Indragiri Hilir commonly cultivated 2 hectares of coconut using an intercropping system with areca nut to optimize their land use. Coconut productivity might reach up to 1,300 kg/ha/month and farmers could commence harvesting coconut 6 - 8 years after planting. During their productive period, coconuts could be harvested every three months. Farmers sold husk-peeled coconuts known as *kelapa jambul* for USD 0.24/kg with a net income of around USD 868/ha/year. Since most farmers owned more than one hectare of coconut palms, they could receive USD 1,736/year for 2 hectares.

Rubber planted on peatland required moist peat soil. Rubber was widely planted using local seedlings known as *bibit cabutan*, a wild seedling obtained by pulling it out from parent plants. Rubber trees planted using *bibit cabutan* had lower productivity than those derived from cloned seed. Farmers commenced harvesting rubber 5 - 7 years after planting, then subsequently 3 - 4 times a week, tapping latex in sunny weather to obtain optimum yield. Farmers sold rubber in the form of latex rubber, the productivity of which was 300 kg/ha/month. They sold latex rubber for USD 0.48/kg and received net income of approximately USD 496/ha/year.

Honey was an off-farm commodity harvested by farmers from *sialang* trees. Honey had no specific peat soil requirement or cultivation scale. Though harvest quantities might vary, generally, honey productivity could reach up to 75 kg/month or 900 kg/year with a harvesting frequency of around twice a year. Honey was being sold through brokers as well as directly to end consumers. In honey trading, local communities gained the highest profits, and their net income was USD 1,281 per household per year.

Fish was another potential off-farm commodity. Our analysis represented a marble goby value chain. Cultivation or harvesting of fish on peatland does not necessarily require any specific soil condition or cultivation scale. Productivity for fish was up to 33 kg/month or nearly 400 kg/year. Farmers might harvest fish 48 times in a year and secure profits of around USD 3.95/kg. Household net income from fish was USD 1,581/household/year.

Table 5. Comparison of each commodity in regard to its cultivation scale, productivity, profit, net income, and soil moisture requirement.

Commodity	Soil moisture requirement	Scale of HH cultivation (ha)	Productivity (unit^/ha/month)	First harvesting (year+)	Harvesting period (days*)	Harvesting times (times/year)	Profit (USD/kg)	Net income (USD/ha/ Year)	HH Net income (USD/HH /year)
Sweet corn	Dry	1	3,333	0.19 - 0.22	70 - 80	3	0.16	4,769	4,769
Spinach	Dry	0.05	2,000	0.06 - 0.08	20 - 30	12	0.08	37,113	1,856
Pineapple	Wet	0.5	2,500	0.5 - 1	120	3	0.23	7,030	3,515
Areca nut	Moist	1	500	4 - 5	30	12	0.27	1,641	1,641
Oil palm	Dry	2	1,500	5 - 7	15	24	0.06	1,134	2,269
Coconut	Moist	2	433	6 - 8	90	4	0.17	868	1,736
Rubber	Moist	1	300	5 - 7	2	192	0.14	496	496
Honey	-	-	75	-	80	2	5.69	-	1,281
Fish**	-	-	33	-	7	48	3.95	-	1,581
Edible swiftlet nests***	-	-	0.5	-	30	12	1,043	-	6,257

Note:
HH = household
+ 1 year is assumed to equal 365 days
* 1 month is assumed to equal 30 days
** Values are presented only for marble goby. Should other types of fish be included, the values will be higher than our estimation
*** Does not include the cost for constructing buildings to house swiftlets
^ All values are presented in kg/ha except for spinach (bunch/ha), pineapple (piece/ha), honey (kg/year), fish (kg/month) and edible swiftlet nests (kg/month)
^^ Four times a week

Edible swiftlet nests were recently cultivated by farmers in some of our study areas. Farmers would construct purpose-built buildings to allow swiftlets to nest. Although productivity was low, around 0.5 kg/month or 6 kg/year, edible swiftlet nests had very high market prices and appeared to be highly profitable. Compared to other commodities, edible swiftlet nests generated USD 1,043/kg profit with household net income of around USD 6,257/household/year. However, the initial investment for constructing the building was high at approximately USD 5,810 to USD 11,173. Additionally, market prices for edible swiftlet nests would tend to fluctuate.

4.3. Towards haze-free peatland community livelihoods

There are many local commodities with potential for development in Riau. The current state of development for many of the on-farm commodities involves the use of fire, especially at the land preparation stages. Most of the commodities in our study, however, are economically profitable, but only a few are ecologically suitable for cultivation and development on peatlands. Our study recommends areca/betel nut and pineapple for the on-farm commodities and fish and honey for the off-farms commodities to be developed on peatlands. We suggested the development of these commodities using agroforestry, to optimize the land use, and best practices, i.e., fire free land preparation and avoiding drainage of healthy waterlogged peatland.

More efforts and considerations should be directed at upgrading local commodity value chains, so benefits are distributed to local communities. Ensuring benefits for locals is a key strategy for increasing their voluntary participation in conserving and restoring tropical peatlands in Riau. The strong influence of the human dimension in peatland conservation and restoration is highly understandable as fire occurrence on peatlands is increasingly due to human activity (land use change, human access, and increased anthropogenic ignition risk) combined with other factors like policy initiatives and implementation [25]. Developing more sustainable and haze free livelihoods would be beneficial in gradually reducing anthropogenic pressure and risk to peatlands.

Farmers' cultivation scales were also relatively small, ranging from 0.05 to 2 hectares, which adds to complexities in remaining profitable and continuing with business, especially for small and intermediate-scale farmers [26]. In this study, we found pineapple, areca nut, honey and fish satisfied many of the indicators we considered. Future efforts should focus on increasing their effectiveness and upgrading their value chains.

One of the widely implemented peatland restoration approaches was revitalizing local communities' livelihoods. Although our study shows farmers received profits ranging from 44% to 99% from cultivating certain commodities, the added value secured by brokers and retailers was generally high as their economies of scale were much larger. This provided the suggestion that farmers should be allowed to act as brokers or retailers to secure greater added value. They could do so both individually or through farmer organizations or cooperatives.

An effective value chain, according to the Asian Development Bank involves differentiating its products, continuously innovating, creating higher value, using organizational mechanisms, forming alliances, and coordinating, going beyond spot market transactions, and introducing practices to satisfy environmental and social responsibility issues. To achieve effectiveness and upgrade value chains, Kaplinsky and Morris [22] suggest improving processes and products, changing functional positions, and moving out into a new value chain. In Riau, commodities were being traded primarily as raw materials and passed through many intermediaries. In some cases, the commodity was going through further processes, so there is an opportunity to secure higher prices. For example, farmers usually sold areca nuts in the form of shelled wet areca nuts. If they were to process their areca nuts through drying, they could potentially sell their produce for higher prices. In the case of pineapple, farmers could secure higher prices if they sold pineapples directly to consumers and bypassed all the intermediaries. These opportunities should be balanced with efforts to improve efficiency within processes as well as improving existing products. More research and development should be made possible to advance logistics and quality practices, expand and design marketing strategies, and optimize supply chain management procedures, while enhancing e-business capability and facilitating supply chain learning

[22]. Now, advances in technology enable more innovation in developing agricultural value chain production and marketing processes.

Many parts of the world have developed smart farming, which according to FAO[3] is "a farming management concept using modern technology to increase the quantity and quality of agricultural products". FAO further argues that farmers with access to technology might measure variations within their farming management then formulate and adapt strategies to increase efficiency and effectiveness. For example, referring to the UN Global Compact, in Tasmania, The Yield (a technology company) teamed up with Bosch and oyster farmers to reduce contamination in oysters by using sensors and predictive analytics, combined with a clear user interface to provide more accurate contaminant predictions. PepsiCo efficiently managed water inputs on potato crops by locating sources of wastewater to be reused for irrigation. Additionally, they developed a system to monitor soil moisture, forecast water, and manage more efficient irrigation. In Japan, Fujitsu partnered with Microsoft and others to develop sensors and analytics to control growing conditions and produce reduced-potassium lettuce.

In addition to the use of technology in production processes, technology has penetrated and transformed the way agricultural products are being marketed. Almost half of global services have been digitized and nearly one eighth of the global goods trade has been advanced through international e-commerce, by Alibaba, Amazon, eBay and many more. The digitization of global goods and services, as argued by McKinsey Global Institute, is a new means of expanding business models fostering cross-border flows, reaching more customers, alleviating asymmetric information, and increasing market efficiency though it might disrupt, cutting down the intermediaries' chain. Additionally, global digitization allows participation from more countries and enterprises.

The United States initiated the use of e-commerce in agriculture nearly two decades ago. USDA (1999) in [27] reported that by 2000, 1 out of 25 U.S. farms had bought or sold agricultural products through internet platforms. In 2012, 19 U.S. states and the District of Columbia participated in 'MarketMaker', a national network providing more than half a million profiles of food-related enterprises included agricultural producers [28]. Despite 'MarketMaker' being more of a platform for providing a catalog of producers' profiles, it was still relevant to reduce asymmetric information that was the spirit of global digitization. In China, Lee[4] specified that even though e-commerce agriculture only account for 3% of China's agricultural trade, online farm product transactions were valued at over USD 16 billion in 2014, according to China's Ministry of Agriculture.

In the status quo, the key commodities identified were being traded conventionally and traditionally without involving any digital platforms to support or foster the process. Recently, online platforms such as 'Sayur Box' and 'Rego Pantes' have emerged to market fresh agricultural products and facilitate fair trade. These innovations have been disruptive in the way they have created new markets and distorted existing conventional market chains. They promote win-win solutions to increase farmer and consumer benefits by cutting out intermediaries and facilitate farmers to sell their produce directly to consumers. These innovations have great potential to maintain volumes and values of agricultural products (freshness and quality), minimize asymmetric information in the market and empower local farmers, while promoting fair trade and minimizing perished agricultural waste at the same time. However, 'Sayur Box' and 'Rego Pantes' are partnered primarily with farmers from West Java and Central Java respectively.

Specifically in Riau, there are some platforms to facilitate local business development. For example, the government has a program on micro, small and medium enterprises (MSMEs). MSMEs in Riau account for 5 - 10% of growth, predominantly with trading (77,156 units), services (19,656 units), production (12,760 units), and industry (11,320 units)[5]. MSMEs are pivotal to fostering local rural business, especially in the context of revitalizing rural poor livelihoods. There are many facilities that MSMEs might access, for example MSME loans and events. Recently, the Riau Province Tourism

[3] http://www.fao.org/family-farming/detail/en/c/897026/ accessed August 13th, 2018.
[4] https://technode.com/2015/08/21/e-commerce-agriculture/ accessed August 10th, 2018.
[5] https://www.antarariau.com/berita/80571/jumlah-umkm-di-pekanbaru-mencapai-67728

Office hosted a 'digital market' event, where many MSMEs could showcase and sell their products directly to consumers. At the event, both MSMEs and consumers were required to use a fintech (financial technology) application for transactions. Additionally, there is 'One Stop Pages', an application specializing in business directories with 700 MSMEs in Riau. While both locally- and nationally- produced digital platforms for fostering agricultural markets are readily available, in the near future more efforts should be made to increase digital literacy. More evaluations should be carried out to gauge trading effectiveness and profits as well as business growth in the context of conventional and digital markets.

5. Conclusions

In this study, we found the 10 key commodities passed through various intermediaries and had broader linkages to the global market and economy. These commodities were being developed and cultivated by local communities. Many commodities were found in local traditional markets while others were being exported and traded in international markets. Although many parties have argued that the existing commodities are unsustainable, our study found that some appeared to be suitable for cultivation on moist-wet intact peatlands. We recommended pineapple, areca nut, fish, and honey for development on peatlands in lieu of oil palm, due to their financially viability, and to environmental impact considerations. Pineapple and areca nut could generate USD 3,515 and USD 1,641 per household per year respectively. Fish and honey were off-farm commodities generating USD 1,281 and USD 1,581 per household per year. Pineapple and areca nut could be cultivated in moist-wet peatland using intercropping techniques to maintain nutrients, water levels and biodiversity on peatlands. Extensive opportunities to upgrade and achieve effective value chains are also available. More efforts should focus on improving product quality and marketing strategies to increase benefits for local communities. Opportunities to develop these commodities become increasingly higher in the face of globalization and technological advances. Many digital platforms, small business loans and programs are readily available to foster local, rural small businesses. Finally, working closely with local communities should be done continuously to ensure they can cultivate peatlands in a more sustainable manner, without using fire.

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