Expanding the Cultivation of Jelutung Latex and Gemor Bark on Central Kalimantan Peatlands:
A Value Chain and Cost-Benefit Analysis

Louise Houweling

MSc Thesis in Environmental Systems Analysis

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Supervised by: Lars Hein
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Environmental Systems Analysis

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Examiners:
1st : Lars Hein
2nd : Rik Leemans

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Preface

This thesis is part of the final examination of the MSc Environmental Sciences program at Wageningen University and Research Centre, The Netherlands. The fieldwork for this thesis took place in Central Kalimantan, Indonesia, for six weeks between November and December 2016. Central Kalimantan is known for its extensive peatland areas, of which much has become drained degraded in the past few decades. The effects of peatland drainage include carbon emissions, deforestation, and biodiversity loss. Given the environmental impact of peatland drainage and degradation, I considered a research project concerning peatland use in Central Kalimantan as an important and urgent project. I was particularly interested in combining the environmental improvement of peatland use with business opportunities for local communities. Consequently, I investigated two potential options for peatland use that would minimize environmental damage whilst also generating economic benefits to local communities.

In general, there have been very few studies focused on the value chains of Jelutung latex and Gemor bark, and on the costs and benefits of cultivating the two crops on peatland. Neither crops, especially Gemor bark, have been documented extensively in the available literature. Furthermore, in the field, there was little known on the whereabouts of the respondents I wanted to interview for this project. Although this occasionally was challenging, it also highlighted the innovations of this thesis by focusing on two crops of which current knowledge on their value chains and economic benefits is limited. It also taught me a lot about the research process. Overall, it has been very rewarding to work on a thesis project that provides new, unique knowledge on Jelutung latex and Gemor bark cultivation in Central Kalimantan.

Firstly, I would like to thank my supervisor, Prof. dr. Hein who gave me the opportunity to work on this innovative project, and introduced me to many of his contact people in Central Kalimantan who were of great help to me. I also thank Prof. dr. Hein and Prof. dr. Leemans for the constructive feedback I received during the thesis writing process. I would also like to thank Prof. dr. van Noordwijk, who welcomed me to the World Agroforestry Centre in Bogor, introduced me to his colleagues, and helped me prepare for my fieldwork in Central Kalimantan. Next, a very big thank you to Dr. Suwarno and Mrs. Uda, who helped me a great deal with the logistics of my stay in Central Kalimantan and gave me a lovely introduction to the Indonesian culture. I also want to say a special thank you to Mr. Panjaitan from Banjarmasin, who shared his extensive local knowledge on Gemor bark cultivation with me and assisted me with the interviews with Gemor farmers. Mr. Panjaitan also introduced me to Mr. Tantono, the large-scale trader of Gemor bark, for which I am very grateful. Further, I wish to express my gratitude to Mr. Perdana from the World Agroforestry Centre in Bogor. Mr. Perdana shared his knowledge on the Jelutung latex value chain and sent my questionnaire to his contact person in PT Sampit, the large-scale trader of Jelutung latex. Without the help of Mr. Panjaitan and Mr. Perdana, large pieces of information on the Gemor bark and Jelutung latex value chains in Central Kalimantan would still be missing in this thesis. Finally, a special thank you to Jorrit Herrera Farfan, who accompanied me in Central Kalimantan and motivated me during the fieldwork.

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SUMMARY

Indonesian peatlands are subject to rapid land-cover change. In particular, peatland conversion to pulpwood and palm-oil plantations occurs commonly. The palm-oil industry provides income to a large proportion of Indonesia's rural population. In addition, Indonesia is one of the most efficient palm-oil producing countries and generates high financial benefits. Overall, palm-oil production is an important economic development opportunity for Indonesia. The conversions, however, that require peat drainage, lead to peatland degradation and other environmental problems. For example, the world's peatlands store as much carbon as all other terrestrial land-cover types combined. When tropical peatlands are drained for agricultural use, the consequent carbon emissions can reach up to 90 tonnes CO_2 ha^{-1} $year^{-1}$ for 25 years after drainage. This depends upon drainage depth and even excludes carbon emissions from fires. Other environmental issues include deforestation, biodiversity loss, and forest fires.

Given the environmental impact of peatland degradation and conversion into land uses that require peat drainage, a transition to sustainable peatland use and peatland emission control is critical. At the same time, options for sustainable peatland use should provide economic benefits to local communities. This thesis investigated two crops, Jelutung latex and Gemor bark, that can potentially minimize environmental damage whilst generating local economic benefits in Central Kalimantan. To determine whether these crops are feasible options for sustainable peatland use, the thesis' main objective was to determine the opportunities and barriers (with a focus on economic and environmental) of expanding the cultivation of the crops. This was done by a value chain analysis and a cost-benefit analysis. Data for the value chain analysis was collected through face-to-face interviews with farmers and traders during the fieldwork. Data for the cost-benefit analysis was based on both the interviews and the available literature. The results of the value chain and cost-benefit analyses provide up-to-date and unique knowledge on the markets and value chains of Jelutung latex and Gemor bark.

Both crops' value chains currently have too few buyers to avoid price setting, and neither value chain has enough product supply to attract new traders to enter their markets. Nevertheless, both crops have the potential to provide economic benefits to local communities and to minimize environmental degradation when cultivated on peatlands. When the two crops are compared, Jelutung latex is likely a more favourable option for sustainable peatland use than Gemor bark. This is because the cost-benefit analyses show that the Net Present Value and the Internal Rate of Return of a Jelutung latex plantation is higher than a Gemor bark plantation. In addition, Jelutung latex can be used to make several products, whereas Gemor bark can only be used to make two products, of which one has already been replaced by a synthetic material. Furthermore, tapping techniques for Jelutung latex are already sufficient to avoid environmental damage, whereas Gemor bark cultivation involves the use of unsustainable extraction practices. Consequently, Jelutung latex is likely a more favourable option for sustainable peatland use than Gemor bark.

Overall, this thesis highlights the importance of sustainable peatland use in Central Kalimantan and presents two crops as potential options to achieve this. Continuing research on how to effectively expand the cultivation of Jelutung latex and Gemor bark (and other potential crops) is critical to control peatland emissions, limit the environmental and social effects of peat fires and flooding, and preserve the habitats of Central Kalimantan's diverse and unique flora and fauna.

1. INTRODUCTION

1.1 Research Context

Land-cover change is occurring rapidly across the peatlands of Indonesia. The country is covered by approximately 20 million ha of peatland, of which more than half has become degraded or converted (Wahyunto et al., 2004; Miettinen et al., 2012). The conversion of peatland areas in Indonesia, particularly the conversion of peatlands to pulpwood and palm-oil plantations, is still ongoing (Gunaso et al., 2013). This ongoing conversion of land can be attributed to the importance of agriculture for the Indonesian economy (Hasan & Reed, 2016). In 2008, the agricultural sector contributed to almost 15% of the country's GDP (WorldGrowth, 2011). Within the agricultural sector, palm oil is the second largest product in Indonesia, after rice paddy, and is the most exported product (Hasan & Reed, 2016; WorldGrowth, 2011). Indonesia is said to be one of the most efficient palm-oil producing countries in the world, with relatively low production costs and a high financial internal rate of return (Hasan & Reed, 2016). In addition, the palm-oil industry provides income to a large proportion of Indonesia's rural population, with smallholders owning over 40% of all palm-oil plantations in the country in 2008 (WorldGrowth, 2011). Therefore, palm-oil production has been and remains an important economic development opportunity for Indonesia (Rifin, 2013).

However, for some land uses, such as palm-oil production, peatland conversion requires peat drainage (Hooijer et al., 2012; Suwarno, 2016). Due to the several environmental problems associated with peat drainage, the expansion of palm-oil production in Indonesia should be limited to non-peatland areas, such as mineral lands (Glenday et al., 2015). Peat drainage leads to high carbon dioxide emissions and soil subsidence. The carbon dioxide emissions from peatlands drained for agricultural use, with water table depths of around 70cm, range between 40 and 90 tonnes CO_2 ha^{-1} $year^{-1}$ for 25 years after drainage. This excludes carbon emissions from fires (Hooijer et al., 2012). Carbon losses from peatland drainage in Southeast Asia contribute to 1 – 3% of global carbon dioxide emissions from land use change, with Indonesia accounting for more than 80% of the emissions from Southeast Asia (Hooijer et al., 2010).

Furthermore, an environmental effect of peat drainage is soil subsidence (Hooijer et al., 2012; Suwarno, 2016). Peat is made up of 90% water and so peat drainage results in its compaction. Subsequently, peat compaction leads to soil subsidence of approximately 1 – 1.5m during the first years after drainage (Hooijer et al., 2012; Couwenberg & Hooijer, 2013). Following this, the drained peat oxidizes and the subsequent loss of organic matter causes further subsidence of 3 – 5cm per year, leading to a total subsidence of 2 – 3m in 25 years (Couwenberg & Hooijer, 2013). In tropical areas such as Indonesia, peat oxidation rates are higher than in temperate regions because of the higher temperatures in the tropics. Consequently, soil subsidence rates are typically faster in tropical peatlands (Couwenberg et al., 2010). Soil subsidence increases the risk of flooding when the surface gradients become too low for the inflow of water from rivers or other sources to be discharged easily by gravity (Lim et al., 2012). As a result, over time, the peat soil is less suitable or unsuitable for agricultural use (Sumarga et al., 2016). In addition, drained or degraded peatlands are highly susceptible to fires, which contributes to further carbon dioxide emissions as well as causing air pollution (Frankenburg et al., 2005; Hayasaka et al., 2014). Other environmental consequences of peat drainage and degradation include deforestation and biodiversity loss (Agus et al., 2009; Carlson et al., 2012; Gynch & Wells, 2014).

Given the serious environmental effects of peatland conversion into uses that require peat drainage, there is a strong need for sustainable peatland use and the control of peatland emissions (Tata et al., 2015; Sumarga et al., 2016). Moreover, sustainable peatland use should generate economic benefits in order to support local livelihoods and be competitive with commercial crops such as palm oil (Tata et al., 2015). Therefore, investigating possibilities for peatland use that ensure low peatland emission development (and other environmental benefits) without decreasing livelihood options for the local communities is essential. This study investigates two peatland crops that have the potential to fulfil this combination. The peatland crops chosen are Jelutung (*Dyera polyphylla*) and Gemor (*Nothapoebe coriacea*). Jelutung is a native peatland tree species found in peninsular Malaysia, Singapore, and Indonesia (Janudianto et al., 2014). According to Poesie et al. (2011), Jelutung is one of the most profitable species that can be cultivated on undrained peat. The sap from the Jelutung tree is used to make latex (known as Jelutung latex) which can in turn be used in the manufacturing of a variety of products, including airplane tyres, condoms, and chewing gum (Janudianto et al., 2014). The second jungle species, Gemor, is a bark-producing tree and is also found naturally in Indonesia's peat swamp forests (Wahyu et al., 2008). The bark of the Gemor tree can be used to make mosquito coils and is also used in some cosmetic products (Wahyu et al., 2008). Both Jelutung and Gemor trees can grow on peatland without requiring peat drainage (Poesie et al., 2011; Wahyu et al., 2008). In addition, both crops are non-timber forest products (NTFPs), meaning the cultivation of these crops does not involve deforestation (if they are cultivated sustainably) (Janundianto et al., 2014; Wahyu et al., 2008). Therefore, expanding the production of Jelutung latex and Gemor bark on peatlands could stimulate more sustainable peatland use and reduce peatland emissions. The potential economic benefits provided by these crops is another reason why they were chosen for this thesis.

The opportunities and barriers of Jelutung latex and Gemor bark cultivation as options for sustainable peatland use are determined through a value chain analysis and a cost-benefit analysis on the two peatland crops. The value chain analysis will be used to assess the market potential and potential of the two crops to support local livelihoods. The cost-benefit analysis will be used to further investigate the economic prospects of Jelutung latex and Gemor bark cultivation. Having an economic focus when examining possibilities for sustainable peatland use is important as the crops will not be considered viable peatland use options by local communities, policy makers, and other stakeholders, unless they provide economic benefits. The cost-benefit analysis also assesses the environmental impact of cultivating Jelutung and Gemor on peatlands to examine their potential contribution to improving the environmental sustainability of peatland use. These analyses will in turn aid in identifying the opportunities and barriers of expanding Jelutung latex and Gemor bark cultivation.

The case study area selected for this thesis is Central Kalimantan because the province is covered by a large area of peatland of around 3 million ha, with peat layers reaching up to 12m (Wahyunto et al., 2004). Moreover, Central Kalimantan is subject to rapid land conversion and high deforestation rates (relative to other Indonesian provinces). The forests of Kalimantan are considered one of the world's most species-rich environments, and are home to several endemic species such as the orang-utan, with Central Kalimantan forests providing refuge to more than half of the world's wild orang-utan population (Whitten et al., 2004; Johnson et al., 2005). Over the past few decades, however, the conversion of peatland into palm-oil plantations in Central Kalimantan has become very extensive, with the province accounting for the fastest growth rate in areas used for palm-oil production in Indonesia in the period 2007-2011 (Scherr et al., 2015; Gynch & Wells, 2014; Forest 500, 2016). In fact, conversion to palm-oil plantations in Central Kalimantan has been the leading cause behind the province having the second highest deforestation rate in Indonesia between 2000 and 2008 (Suwarno, 2016). Another reason for selecting Central Kalimantan as study area is because the province is one of the few provinces in Indonesia where the commercial production of Jelutung latex and Gemor bark has been documented in various studies (Perdana et al., 2016; Janudianto et al., 2014; Panjaitan, 2010).

This thesis has two main innovations. First, the focus on investigating the value chains of Jelutung latex and Gemor bark in particular. Very little is known about the market opportunities of these products, and a current and complete analysis of their value chains in Central Kalimantan is not yet available. This knowledge gap will be elaborated on in the literature review in Chapter 2.1. Filling the knowledge gap through a value chain analysis is essential to determine the economic opportunities and barriers to cultivating Jelutung latex and Gemor bark in Central Kalimantan. The second innovation is the cost-benefit analysis of a Jelutung latex and a Gemor bark plantation on peatland. Although a cost-benefit analysis of Jelutung already exists in the literature, this thesis provides an updated version based on the data collected during fieldwork, which may lead to new insights into the costs and benefits of cultivating Jelutung latex. A cost-benefit analysis of Gemor bark is particularly innovative as this has not been done before and is not available in the literature. The cost-benefit analyses provide further knowledge on the economic prospects of expanding the cultivation of the crops on peatlands.

Before going in depth on the value chain and cost-benefit analyses, understanding the background of peatland use in Central Kalimantan and other general information on the study area is important to further establish the context of this research. The background information is provided in Chapter 1.2.

1.2 Background Information

1.2.1 Study Area

The study was conducted in Central Kalimantan, Indonesia's third largest province (see Figure 1). Central Kalimantan covers 15.4 million hectares (ha), of which approximately 80% is forest and traditional, non-intensive agricultural land (Suwarno et al., 2016; Prasetyo & van der Meer, 2014). These Bornean forests are considered a biodiversity hotspot and provide a multitude of ecosystem services on a local to global scale, including carbon sequestration, timber and non-timber forest products, and nature recreation (Whitten et al., 2004; Suwarno et al., 2016). The total population of the region was 2.3 million in 2014, with a population density of 14 people km-2 (Sumarno et al., 2016, Prasetyo & van der Meer, 2014). The population is divided into 14 districts (or cities), which are further divided into more than 1500 villages. Approximately 50% of these villages are located along riverbanks; rivers are one of the main sources of livelihood for many local communities (Kinley, 2014). Central Kalimantan also has a few national parks, including Tanjung Puting National Park and Sebengau National Park. These parks act as protection for peatland areas and as a sanctuary for the endangered orang-utan (Prasetyo & van der Meer, 2014).

Figure 1. Map of Indonesia showing Central Kalimantan. (Source: UNODC, 2011).

1.2.2 Economy of Central Kalimantan

The main economic sectors in Central Kalimantan include palm oil, timber, and coal (Gynch & Wells, 2014). Palm oil is the largest industry, accounting for almost one third of the province's Gross Regional Domestic Product (GRDP). Moreover, palm oil accounts for the greatest percentage of investment in the agricultural sector of Central Kalimantan (Glenday et al., 2015). Between the period of 1998-2008, the size of land controlled by private palm-oil companies in Central Kalimantan increased rapidly by five times (Kinley, 2014). Later, between 2000-2010, the Central Kalimantan Province experienced one of the fastest expansions in palm-oil production in Indonesia (Suwarno et al., 2016). Out of the 15.3 million ha that make up Central Kalimantan, 1.2 million ha are covered by palm-oil plantations (Glenday et al., 2015).

1.2.3 Policy Environment

The policy environment surrounding peatland use in Indonesia is important for understanding the background of this study as it shows that efforts are being made to lower the environmental impact of peatland use. For example, the Presidential Instruction No. 8 is a national forest moratorium policy which was set up in 2015 to prohibit Indonesia's local governments from supplying new concessions in peatland and primary forests, which includes concessions for palm-oil production (Sumarga et al., 2016). Another national regulation related to peatland use prohibits the use of peat areas with a depth greater than 3 m, in an effort to preserve the hydrological functioning of these peatlands (Ministry of Agriculture, 2011). Furthermore, the government-supported Indonesian Sustainable Palm Oil (ISPO) set up a regulation that aims to help in the reduction of Indonesia's greenhouse gas emissions by 29% by 2030 (Glenday et al., 2015).

Despite the efforts made to limit peatland conversion and emissions, studies show that the current implementation of some of these regulations, such as the forest moratorium policy, are not yet completely effective (Suwarno, 2016; Law et al., 2015). For instance, Suwarno (2016) modelled the implementation of the national moratorium policy in two districts in the Central Kalimantan Province, assuming the policy would be extended for 25 years from 2011. In this scenario, the peatland forests of these districts will decrease by 5% in the Kotawaringin Barat District and 4% in the Kapuas District by the year 2025 (Suwarno, 2016). If the moratorium is not extended and patterns of land use change continue 'business as usual,' the areas of peat forest in the two districts in Central Kalimantan are expected to decrease by 11% by 2025 (Suwarno, 2016). This study provides an example of how the implementation of certain policies may not be entirely effective in controlling peatland conversion in all areas of Indonesia. Nevertheless, the establishment of the regulations mentioned above indicates a general awareness at the policy level of the environmental consequences associated with peatland conversion and degradation.

1.2.4 Environmental Issues

Central Kalimantan is a highly dense forested region, accounting for approximately 10% of Indonesia's total forested area (Glenday et al., 2015). However, over the last decade deforestation has been a serious issue (Suwarno, 2016). Between 2000 and 2008, Central Kalimantan experienced the second highest deforestation rate in Indonesia, losing approximately 0.9 million ha of forest (Suwarno, 2016). Deforestation results in a loss of valuable ecosystem services, such as timber and non-timber forest products, which many local communities depend on for their livelihoods (Suwarno et al., 2016). In addition to reducing the capacity of forests in providing products to local communities, deforestation also leads to biodiversity loss (Fairhurst & McLaughlin, 2009). As mentioned previously, converting natural land, including peatlands, destroys habitats that provide shelter for many species (Fairhurst &

McLaughlin, 2009). An iconic example of this for the Central Kalimantan Province is the orang-utan. This unique species is listed as critically endangered by the World Wildlife Fund, and nowadays the majority of orang-utans can only be found in remaining peat forests due to the clearance of its natural forest habitat (WWF, 2016; Sumarga et al., 2016). Moreover, it has been found that only 15% of primary tropical forest species can survive in palm-oil plantations, providing another indication of drastic biodiversity loss related to palm oil expansion (Fairhurst & McLaughlin, 2009; Fitzherbert et al., 2008). More specifically, there is an expected decline of 77% for bird species and 83% for butterfly species after forested areas are converted to palm-oil plantations (Fairhurst & McLaughlin, 2009).

Another environmental impact of deforestation and land conversion in the Bornean province is associated with peatland areas specifically. Peatland forests occur widely across Central Kalimantan, and a deep peat layer can store up to 7,700 tonnes C ha^{-1} (Suwarno, 2016). Converting peatland forest and subsequent peat drainage for agricultural uses causes carbon emissions of up to 90 tonnes C ha^{-1} $year^{-1}$ for 25 years after drainage, depending on water table depths (Suwarno, 2016; Hooijer et al., 2012). On a global scale, deforestation and the cultivation of peatland in Indonesia contributes to around 34% of the world's greenhouse gas (GHG) emissions related to land-use change and forestry (Fairhurst & McLaughlin, 2009). Moreover, a proportion of peatland areas that are converted for agriculture are left unused. In Indonesia, around 3.8 million ha of cleared peat forests have not been exploited (Agus, 2015). These areas remain bare or become covered by shrubs and grasses, losing both the original ecological functions of the peatland as well as the economic potential. According to Agus (2015), the carbon emissions from idle cleared peatland areas covered by shrubs may be higher than those from agricultural peatlands because they are more susceptible to fires during the dry season.

Lastly, as mentioned previously, the cultivation of peatland can lead to fires as drained peatlands are highly susceptible to catching fire (Hayasaka et al., 2014; Suwarno, 2016). The fires occur most frequently during the dry season and account for a decline in air quality both regionally and nationally. Over the past decade, air pollution in Indonesia has been at a record high, which has been strongly attributed to peat fires (Hayasaka et al., 2014). The photochemical smog and visibility-limiting haze that result from the fires have been found to have a negative impact on the health of local people. These health issues include increased risk of mortality amongst elderly above the age of 65, and respiratory problems such as frequent coughing and infections (Frankenberg et al., 2005; Hayasaka et al., 2014). Therefore, the conversion and degradation of peatlands causes environmental issues such as fires and air pollution, as well as influencing the health of local communities.

1.3 Problem Statement

At all levels, Indonesian governments and municipalities have set ambitious targets and plans to pursue further economic growth (Gynch & Wells, 2014). The development of the agricultural sector, including the palm-oil industry, is an important economic development opportunity for Indonesia. However, given the severe environmental impact of peatland conversion and degradation associated with peat drainage, the expansion of agricultural commodities on peatlands that require peat drainage should be limited. To achieve this, determining options for sustainable peatland use that provide economic opportunities, whilst minimizing environmental damage, is critical. One way these economic opportunities can be examined is through a value chain analysis and a cost-benefit analysis on potential sustainable peatland crops.

In particular, Jelutung latex and Gemor bark are considered as two crops that can provide an opportunity for the sustainable use of Central Kalimantan's peatland area. Very little is currently known about the markets and value chains of these products. For example, Tata et al. (2015) state that, "linkages along the value chain of Jelutung are currently less explored." Furthermore, the World Agroforestry Centre

Southeast Asia (ICRAF) urge in one of their project reports from 2010 for a value chain analysis on Jelutung due to the lack of detailed information currently available on the product and the need for this information to develop Jelutung planting programs (Joshi et al., 2010). To date, there is still no complete value chain analysis of Jelutung latex available. For Gemor bark, the value chain in Kalimantan has been analysed before, however this has been done in 2010 and market conditions have changed since then. Consequently, it is important to provide up-to-date analyses on the value chains of Jelutung latex and Gemor bark to fill the knowledge gap and aid in determining what the opportunities and barriers are for expanding their cultivation.

In addition, a cost-benefit analysis of the two crops will provide further insight into the economic prospects of Jelutung latex and Gemor bark cultivation on peat. This is essential for promoting Jelutung and Gemor as feasible options for sustainable peatland use, given that economic benefits are often a main driver for expanding a type of land use. Furthermore, the cost-benefit analysis will include the costs and benefits of the environmental effects of cultivating the crops on plantations, thereby examining how Jelutung latex and Gemor bark cultivation can contribute to sustainable peatland use from an environmental perspective.

1.4 Research Objective & Questions

This thesis aims to determine the opportunities and barriers of expanding Jelutung latex and Gemor bark cultivation on peatlands in Central Kalimantan. This will be done through an analysis of their value chains, costs and benefits. With this research objective, I want to promote sustainable peatland use and provide a final recommendation for stakeholders (i.e. policy-makers, businesses, local communities) interested in sustainable peatland use. The research objective is addressed by five research questions (RQs):

- RQ1: How is the value chain of Jelutung latex set up and what are the opportunities and barriers of improving and expanding the market, in particular for the first step of the value chain (i.e. the farmers)?
- RQ2: How is the value chain of Gemor bark set up and what are the opportunities and barriers of improving and expanding the market, in particular for the first step of the value chain (i.e. the farmers)?
- RQ3: What are the economic costs and benefits of cultivating Jelutung latex and Gemor bark on plantations on undrained peatland?
- RQ4: What is the potential environmental impact of enhancing Jelutung latex and Gemor bark cultivation in Central Kalimantan?
- RQ5 Are their potential additional crops that can generate value for farmers in Central Kalimantan?

The scope of the research focuses on the economic opportunities and barriers of expanding cultivation, given that economic benefits are generally a main driver of expanding a market or industry (i.e. Jelutung latex and Gemor bark). This economic focus is addressed by the first three research questions. The scope also covers environmental opportunities and barriers of expanding the cultivation of the two crops. This focus is addressed by RQ4. If other opportunities and barriers, such as institutional, of expanding the Jelutung latex and Gemor bark cultivation in Central Kalimantan come to light during the research process, these are discussed. However, they are not explicitly researched in this thesis as this is beyond the scope of the research. RQ5 is included because it is also important to consider whether there are any other crops that can be cultivated sustainably on peat whilst generating economic benefits.

Next, the research approach (including the literature review and the methodology) and results are described, followed by a discussion. The literature review is included in the research approach because the literature was used to build on the fieldwork methodology. The results are structured in separate sections in order of the research questions listed above, to ensure equal focus is provided to each research question. Finally, recommendations for stakeholders are made on which crop is potentially a more favourable option for sustainable peatland use, and what the next steps are for promoting sustainable peatland use. The final recommendation also addresses a potential barrier to expanding Jelutung latex and Gemor bark cultivation, and how this barrier could be overcome.

2. RESEARCH APPROACH

In this section, the research approach is described. First, the literature review is presented. This review is included in this chapter because it provides a starting point for the fieldwork methodology. For example, although the current knowledge on Jelutung latex and Gemor bark cultivation (especially their value chains) is limited, the available knowledge can be used to indicate how the value chains are set up and which value-chain actors exist and should be interviewed. Furthermore, the literature information is used to compare (where possible) the various results of this thesis and to assess their reliability. This comparison is done Appendix 7.8. In Section 2.1.3, a summary of the literature review is provided.

Following the literature review, the fieldwork methodologies are explained. This is divided into two sections: data collection and data analysis. The fieldwork was aimed at investigating the opportunities and barriers of expanding the Jelutung latex and Gemor bark cultivation in Central Kalimantan, through an analysis of their value chains. Moreover, the economic benefits of cultivating Jelutung latex and Gemor bark on peat were further assessed in a cost-benefit analysis. The cost-benefit analysis also follows an environmental perspective by including the impact on carbon emissions when cultivating the two products on peat, compared with palm-oil production on peat.

In this thesis, the value-chain actors are defined as follows:

- Jelutung tappers – the first actors of the Jelutung latex value chain, who cultivate the latex;
- Gemor farmers – the first actors of the Gemor bark value chain, who collect the bark;
- Collectors / middlemen – individuals who buy the latex or bark from the tappers or farmers;
- Local traders – local businesses that buy Jelutung latex or Gemor bark from the tappers, farmers, or middlemen and sell the products to the large-scale trader;
- Large-scale/provincial trader Jelutung latex – largest trader of Jelutung latex in Central Kalimantan, who exports the latex;
- Large-scale/provincial trader Gemor bark – largest trader of Gemor bark in Kalimantan who sells the latex to exporters in Surabaya and Jakarta;
- Exporters – companies that export Jelutung latex or Gemor bark to importing companies or countries; and
- Importers – countries or companies that import Jelutung latex or Gemor bark from the Indonesian exporters.

2.1 Literature Review

In the previous chapter, background information on the Central Kalimantan Province was provided. In this chapter, literature related to Jelutung latex and Gemor bark as two potential products for promoting sustainable peatland use is reviewed. The literature review is divided into two main parts. First, literature on Jelutung latex is reviewed. Second, literature on Gemor bark is examined. In both these sections the species and its habitat are described first. Following this, what is currently known on the process of cultivating the products and the tenure rights is reviewed. Literature on the environmental impact of cultivation is then discussed. Lastly, the economic aspects and the value chains of Jelutung latex and Gemor bark are evaluated to determine what is currently known and what is unknown in the literature about their markets and value chains.

Literature was found in scientific journals using the Google Scholar search engine and the Wageningen University library resources. Note that the generic literature on Jelutung latex and Gemor bark in Central Kalimantan (or elsewhere) is very limited. In particular, quantitative data on their value chains is lacking and detailed qualitative knowledge on the cultivation and trading process of Jelutung latex and Gemor bark is also missing in the literature. However, sufficient information was available to obtain a preliminary understanding of the set up of both value chains. In this thesis, a thorough and up-to-date analysis of the value chains of Jelutung latex and Gemor bark will be conducted, thereby contributing to filling the knowledge gaps on the two value chains.

2.1.1 Jelutung

Jelutung species and their habitat

Jelutung trees can be found in Central Kalimantan in the wild, in buffer zones, and on private plantations (Janudianto et al., 2014; Joshi et al., 2010). There are two species of Jelutung in Indonesia. *Dyera polyphylla*, also known as swampland Jelutung, grows naturally in peatland forests and is used commercially for its latex. The second Jelutung species, *Dyera costulata*, is locally known as dryland Jelutung and grows on mineral soils instead of peat soils (Tata et al., 2015). *Dyera polyphylla* is the Jelutung species that will be investigated in this thesis. Optimal conditions for the growth of swampland Jelutung are submerged locations. The species can also survive with a high water table as it has pneumatophore roots that facilitate the aeration required for root respiration (Tata et al., 2015).

Swampland Jelutung produces a white sap which is known as Jelutung latex, a NTFP. The latex has a lower resin content than natural rubber, increasing the elasticity of the latex. This trait means the latex can be used in the manufacturing of a diversity of products including airplane tyres, tubings, condoms, and insulation materials (Janudianto et al., 2014; Tata et al., 2015). Tata et al. (2015) claim that the recognized market value of swampland Jelutung contributed to a depletion of wild population stocks in Indonesia. There are additional studies indicating that the amount of Jelutung trees in Kalimantan has declined greatly, attributing this to deforestation and land conversion in the region (Perdana et al., 2016; Janudianto et al., 2014). In this thesis, Jelutung (latex) refers to swampland Jelutung, the *Dyera polyphylla* species.

Jelutung latex cultivation

The cultivation of Jelutung latex can occur in the wild and on plantations. The cultivation is known as 'tapping,' and the farmers are referred to as 'Jelutung tappers.' Tata et al. (2015), who conducted a study on the domestication of Jelutung in Jambi, Sumatra, found that tappers of wild grown Jelutung trees generally begin tapping in the early morning around 6 AM. The Jelutung tapping process involves using a special knife to make a V-shaped incision into the bark to release the sap (Bastoni & Lukman, 2004; Tata et al., 2015). The sap flows down to the bottom of the V and is then collected in a plastic bag or bucket. According to Tata et al. (2015), a tapper can tap 10 – 40 Jelutung trees in around 7 hours, depending on the experience of the tapper. In one day, after tapping once, a single tree can yield an average of 200 g of Jelutung latex (Tata et al., 2015). After having tapped the trees once, the tappers return within 10 – 16 days for the next tapping. This resting period allows the bark to recuperate before the tapping process begins again (Tata et al., 2015).

Jelutung latex can also be cultivated on plantations. Tata et al. (2015) describe domestication efforts of Jelutung trees in Indonesia. They found that in the Jambi province, 75% of the twenty Jelutung tappers interviewed had experience with the planting of Jelutung seedlings, and four of the tappers had set up Jelutung nurseries. The authors found that these tappers were motivated to plant Jelutung due to the success surrounding the cultivation of wild Jelutung at the time (Tata et al., 2015). The study showed that Jelutung seedlings can be intercropped with many other tree and shrub species such as coffee and palm oil, as long as the plantation is properly managed. A particularly important aspect found by Tata et al. (2015) is that the cultivation of Jelutung latex on plantations does not require peat drainage. The tapping of the latex on plantations occurs in the same way as it does in the wild. No literature is available on the difference in latex yield and quality between planted Jelutung trees and wild Jelutung trees. Overall, the study by Tata et al. (2015) provides an example of efforts being made towards the domestication of Jelutung in Indonesia.

Tenure rights

Jelutung latex cultivation in the wild also brings to light questions on social conditions and tenure rights. Joshi et al. (2010) conducted a feasibility study in the Lamandau River Wildlife Reserve, Central Kalimantan, investigating the potential for increasing carbon stocks in the eastern part of the reserve's buffer zone. A buffer zone is an area adjacent to a conservation zone that acts as an extra protection layer for the conservation zone (Zakiah et al., 2015). The results of Joshi et al. (2010) are important to consider for this literature review as the Lamandau buffer zone, making up 23,600 ha, was one of the biggest Jelutung production areas in Indonesia in 2010 (Joshi et al., 2010). The zone was also used for fishing and other small-scale extraction activities. The research by Joshi et al. (2010) included insights into the social conditions, tenure rights, existing carbon stocks, and land-use practices of the study area in Lamandau (Joshi et al., 2010). Regarding the social conditions relating to Jelutung latex cultivation in the buffer zone, the authors found that most of the Jelutung tappers were landless people that were from districts outside Lamandau's surrounding villages. These tappers depended on the Lamandau reserve and its buffer zone for their livelihoods (Joshi et al., 2010). However, Joshi et al. (2010) also found that interest in farming had declined in the surrounding areas of Lamandau due to recurring issues of flooding and sea water intrusion in fields. These issues are a result of peatland drainage in the area (Joshi et al., 2010; Janudianto et al., 2011).

Joshi et al. (2010) showed at the time of the study in 2010, an informal form of tenure amongst the local people in the Lamandau Wildlife Reserve buffer zone (Joshi et al., 2010). These local tenure rules involve individuals of the local communities making informal private claims over the Jelutung trees. In other words, tappers only tap the Jelutung trees they have claimed, minimizing the competition between the tappers (Joshi et al., 2010; Tata et al., 2015). Tata et al. (2015) also found this form of tenure was followed in the Jambi province of Indonesia. "Each tapper claimed individual rights to a number of tracks through the forest and a number of trees per track that could be tapped," (Tata et al., 2015, p. 624). Most tappers would claim around 10 – 16 tracks, with each track containing 10 – 40 Jelutung trees (Tata et al., 2015). According to Joshi et al. (2010) and Janudianto et al. (2011), the local tenure rules in Lamandau were not recognized by the local government, and there were some local communities who still considered the land as their own even after the declaration of the area as a protected zone. Today, the exploitation of Jelutung trees in protected areas such as the Lamandau buffer zone is prohibited, driven by sanctions applied to illegal tappers (Perdana et al., 2016; Tata et al., 2015). In general, indications are made in the literature of an informal system of tenure amongst Jelutung tappers in the wild in areas in Jambi and Central Kalimantan.

Environmental impacts

In the available literature, different environmental benefits associated with Jelutung cultivation on peat are discussed. The most important environmental benefit, highlighted by multiple authors in the literature, is that the cultivation of Jelutung both in the wild and on plantations does not require peat drainage (Janudianto et al., 2014; Tata et al., 2015; Lyons, 2003). Consequently, soil subsidence is avoided, carbon emissions are minimized, and the risk of flooding and forest fires is reduced in comparison with peat land uses that do require drainage (Janudianto et al., 2014). These benefits are reflected in the Jelutung tree's status as a forest rehabilitation species and its use by projects to restore degraded peatlands in Indonesia (Janudianto et al., 2014; Tata, 2016).

Joshi et al. (2010) conducted a scenario analysis to investigate the carbon stocks of the Lamandau buffer zone mentioned in previous sections of this thesis. The buffer zone is largely covered by peat swamp forests (Joshi et at., 2010). The baseline scenario represents the situation at the time of the study (2010) with five commodities in the buffer zone: rubber, timber, agroforest, rice, and Jelutung (as a NTFP). The Jelutung scenario, which involves expanding Jelutung cultivation in the buffer zone, was expected to increase biomass above the ground by 1.2 Mt (Joshi et al., 2010). Moreover, the authors found that promoting further Jelutung cultivation greatly increases the carbon sequestration rate, both inside the buffer zone and out. In fact, out of all five scenarios (baseline, Jelutung, logging, small palm-oil plantations, and large palm-oil plantations) the Jelutung scenario had the highest sequestration rate and subsequently the lowest carbon emissions (Joshi et al., 2010). The large palm-oil plantations scenario performed the worst in this criterion. Furthermore, regarding the carbon stocks at the time of the study, Jelutung mixed with rubber agroforests had one of the highest carbon stocks of 75 t ha^{-1}, higher than pandanus and nypa-palm stands, grasslands, and young rubber agroforests (Joshi et al., 2010). Consequently, Joshi et al. (2010) offer an example where Jelutung cultivation on peatlands is predicted to be beneficial for the environment by providing the highest carbon stock compared to the other peatland use scenarios investigated in the Lamandau buffer zone, Central Kalimantan.

Limited literature is available on the relationship between Jelutung cultivation and deforestation rates. However, due to the tree's status as a reforestation and restoration species and that the same tree can be harvested for up to 30 years, it is likely that deforestation rates from Jelutung latex cultivation are lower than other peatland uses that require forest clearance before use, such as pulpwood and palm-oil plantations (Janudianto et al., 2014; Sumarga et al., 2016). Less deforestation also suggests that biodiversity loss is more likely to be avoided with Jelutung cultivation on peatlands as opposed to other common peatland uses. This was evident from a study that found that the diversity of peatland macro-fauna when the peatland was covered with Jelutung agroforestry was higher than when peatlands were abandoned or covered with palm-oil monoculture (Harun, 2011). With regards to the impact of harvesting Jelutung trees in the wild, according to Harrison et al. (2010), the collecting of Jelutung sap in a peat swamp in Central Kalimantan did not harm the trees or the wildlife. However, this is provided that no dams are broken down or canals are built to help extract Jelutung latex from the forest (Harrison et al., 2010). If this is appropriately managed, the authors claim that Jelutung can be considered a sustainable use of the peat forests (Harrison et al., 2010). Overall, examples are provided in the literature reviewed of the environmental benefits of Jelutung latex cultivation on peatlands. There was no literature found that discussed potential negative environmental effects of cultivating Jelutung latex in the wild or on plantations.

Economic aspects

The main available source discussing the economic and value chain aspects of Jelutung latex in Indonesia is a study by Perdana et al. (2016). This study is highly relevant for the topic of this thesis as it focuses on understanding the value chain of Jelutung latex in Central Kalimantan (and Jambi) for the promotion of sustainable peatland management in Indonesia (Perdana et al., 2016). According to the Perdana et al. (2016), the commercial production of Jelutung latex in Indonesia began in the 1980s, and the industry grew to become the biggest in the world for Jelutung latex by the 1990s. The main national supplier of Jelutung latex has always been Kalimantan (Joshi et al., 2010). According to Lyons (2003), the Jelutung latex from Indonesia was used to make the covers of telephone and electric cables, but was mostly used for the manufacturing of chewing gum in Japan (Lyons, 2003). Tata et al. (2015) provide other findings of products made from Jelutung latex, namely tubings, condoms, and insulation materials (Tata et al., 2015). The main importers of the latex from Indonesia during the 1990s were Japan, Europe and the United States (Perdana et al., 2016).

In Jambi, the Jelutung domestication began in 1989 when companies and governmental agencies encouraged the establishment of Jelutung nurseries in the area, as a response to the high demand for Jelutung seedlings (Perdana et al., 2016). Perdana et al. (2016) do not mention the development of Jelutung domestication in Central Kalimantan. During the 1990s, the mass logging period in Indonesia took place, and the Jelutung cultivation began to decrease as the amount of trees in the wild became more rare. Perdana et al. (2016) claim that the latest recorded data on Jelutung latex cultivation in Jambi is from 2007, which is likely due to a stop in cultivation. Nevertheless, the production of Jelutung latex is still thought to be active today in other regions of Indonesia such as Central Kalimantan (Suwarno et al., 2016; Sumarga et al., 2016).

Suwarno et al. (2016) calculated certain economic characteristics of Jelutung latex in Central Kalimantan. They found that Jelutung latex production and labour costs latex per ha per year are lowest compared to other Central Kalimantan products traded on the market (i.e. timber, rubber, palm oil, rattan, and paddy) (Suwarno et al., 2016). Furthermore, according to Suwarno et al. (2016), Jelutung has the highest annual resource rent (net benefits) on peatland, after palm oil and paddy. Therefore, the study by Suwarno et al. (2016) provides an indication of the potential economic benefits associated with Jelutung latex cultivation in Central Kalimantan.

Concerning the economic potential of Jelutung latex in the future, Tata et al. (2015) state that besides the known products derived from the latex, there is also potential to use the resin from the latex as an active pharmaceutical ingredient which will provide additional economic benefits. Moreover, Poesie et al. (2011) claim that Jelutung has the potential to become the most profitable species that can be cultivated on undrained peatland. Therefore, when considering the literature on the economic aspects of Jelutung latex, it seems that the product was once successful in both national and international markets, but that due to deforestation and the expansion of the palm-oil industry, Jelutung production in Indonesia greatly decreased (Perdana et al., 2016; Janudianto et al., 2011; Tata et al., 2015). However, there is a consensus amongst the studies reviewed on the economic potential of Jelutung latex as a commercial peatland species (Tata, 2016; Perdana et al., 2016; Poesie et al., 2011; Suwarno et al., 2016).

Value chain

The literature on the value chain of Jelutung latex, describe the various stages of the chain in Jambi and in Central Kalimantan (Perdana et al., 2016). The main actors of the value chain of Jelutung latex are the tappers, the village collectors (also referred to as middlemen) and local traders, the large-scale/provincial traders, and the importers (Perdana et al., 2016). Perdana et al. (2016) explain that tappers of Jelutung latex form groups and go into the wild forests and protected areas (even though this is illegal) to tap Jelutung. In both Jambi and Central Kalimantan, tappers cannot negotiate the latex price. Instead, the middlemen determine the price when they receive the latex and check the quality (Perdana et al., 2016). Joshi et al. (2010) report that Jelutung prices at farmgate level (when the product leaves the farm or forest) in Central Kalimantan generally range around US$0.40 per kg. Suwarno et al. (2016) report this price to be approximately US$0.38 per kg. Perdana et al. (2016) do not provide an estimate of the Jelutung latex farmgate price, stating that this price can change daily. No literature was found on the production costs of Jelutung tapping in the wild.

According to Perdana et al. (2016), the middlemen and local traders of Jelutung latex are often tappers themselves. Some of them are distributors for the provincial traders and others have their own trucks to transport the latex themselves (Perdana et al., 2016). Middlemen occupy two important functions. First, they keep an eye on the market by visiting villages and tappers to keep updated on the product supply. Second, they sort the latex depending on its quality for further sale to the local and provincial traders (Perdana et al., 2016). As third step in the Jelutung latex value chain, Perdana et al. (2016) explain that all large-scale traders are private companies. These companies buy the raw latex directly from local traders and middlemen, and then export it to Singapore and Japan (Perdana et al., 2016). One Jelutung latex exporter from Jambi moved to Central Kalimantan because of the lower supply of latex in Jambi. The provincial traders either receive the latex directly from the tappers or from the middlemen or local traders (Perdana et al., 2016).

At the importing end of the Jelutung latex value chain, Perdana et al. (2016) claim that Lotte Co., Ltd. (Lotte), a multinational conglomerate with headquarters in Japan and South Korea, is currently the only Jelutung latex importer from Indonesia. This company uses the latex to manufacture chewing gum (Perdana et al., 2016). According to Perdana et al. (2016), Lotte only imports Jelutung latex from PT Sampit in Sampit, Central Kalimantan, since 2011. PT Sampit is the biggest Jelutung latex trader in Central Kalimantan, and ships approximately eleven containers of latex every year (Perdana et al., 2016). Every container holds 8000 kg of latex. In 2015, PT Sampit was only able to export seven containers of latex to Lotte, subsequently failing to meet Lotte's demand (Perdana et al., 2016). This was because of the limited supply of Jelutung latex available. Furthermore, Perdana et al. (2016) claim that Lotte is the only Jelutung latex importer, meaning that the market of the latex depends solely on the demand of this company. The authors see this as a downside of the Jelutung latex value chain (Perdana et al., 2016). Overall, the study by Perdana et al. (2016) demonstrates a clear, recent, and qualitative outline of the Jelutung latex value chain in Central Kalimantan. However, quantitative information on the value chain, such as the prices per kg of latex sold to the provincial trader and to Lotte, and the production costs at these stages are not available. This demonstrates a knowledge gap in the literature which is aimed to be filled by this thesis by collecting relevant quantitative (and further qualitative) information on the Jelutung latex value chain in Central Kalimantan.

2.1.2 Gemor

Gemor species and their habitat

The name Gemor covers two different species, *Nothaphoebe coriacea* and *Nothaphoebe umbelliflora*. The former is found in Peninsular Malayasia, Singapore, and Indonesia (in Sumatra and Kalimantan) (Wahyu et al., 2008). The latter species can also be found in these areas, and in Thailand and Papua New Guinea. In this thesis, *Nothaphoebe coriacea* is the Gemor species focused on, as it occurs more commonly in Central Kalimantan and because local communities generally prefer to collect the bark of this particular species (Wahyu et al., 2008). There are two types of *Nothaphoebe coriacea* producing Gemor bark. The first variety has relatively darker coloured bark that can be easily peeled off. The second variety represents the Gemor trees with yellow-red bark that are more difficult to peel off (Wahyu et al., 2008). The latter is less common in Central Kalimantan, making up just 20% of the total population of Gemor trees in the province (Wahyu et al., 2008). Both species are cultivated in Central Kalimantan but the variety with yellow-red bark is considered to produce better quality bark and so it is preferred by farmers and traders (Wahyu et al., 2008; Panjaitan, 2010).

Gemor (*Nothaphoebe coriacea*) grows naturally in Kalimantan's peat swamp forests with a peat depth of 1.5 – 2.2 meters (Panjaitan, 2010; Wahyu et al., 2008). From field observations by Panjaitan (2010), Gemor trees can also grow on thin peat soils with relatively little organic matter. The optimal soil pH for Gemor growh is a pH of 3 – 4 (Panjaitan, 2010). Gemor trees can also grow on mineral soils. A special characteristic of Gemor is its ability to naturally regenerate in an even distribution and in high numbers (Wahyu et al., 2008). A study by Wahyu et al. (2008) found that an average of 3 – 4 buds of Gemor sprout at the base of cut Gemor trees. This indicates that Gemor populations can be expanded through coppicing, a forest management technique which takes advantage of trees naturally making new growth from the stump (Wahyu et al., 2008). Furthermore, observations from Panjaitan (2010) and

Wahyu et al. (2008) suggest that the amount of Gemor trees in the wild is decreasing, and that the diameters of the trees are also relatively small in comparison to ten years ago. This is attributed to over-exploitation and deforestation in regions of Central Kalimantan (Panjaitan, 2010; Wahyu et al., 2008).

Gemor bark cultivation

Similar to Jelutung latex, the Gemor bark cultivation can be done in both the wild and on plantations. To collect Gemor bark in the wild, farmers/villagers generally go on 12 – 14 day forest expeditions in groups (Kristedi & Kieft, 2010). According to Lyons (2003), there are two main ways in which Gemor trees can be cultivated in the wild. The first way involves cutting down the entire tree. The Gemor bark is then extracted by felling the trees and stripping the bark with a knife (Lyons, 2003). The second way is more sustainable and involves removing only part of the Gemor bark (around 50%) without cutting the tree down (Lyons, 2003). However, Lyons (2003) claims that the second Gemor bark extraction method is very uncommon as farmers prefer to collect as much bark as possible in one go. This coincides with findings from Wahyu et al. (2008) and Kristedi & Kieft (2010), who also describe the method of cutting down the entire Gemor tree as the main method used by farmers, with almost every farmer involved in their studies cultivating Gemor bark in this way (Wahyu et al., 2008). In both methods the Gemor bark is dried after being extracted to decrease the water content (Lyons, 2003).

Limited literature is available describing Gemor bark cultivation on plantations and the differences with cultivation in the wild. Panjaitan (2010) states that there is a plantation of Gemor trees located in Tumbang Nusa village, which is used for both research and cultivation. According to Kristedi & Kieft (2010), no domestication efforts are being made for Gemor trees in Central Kalimantan, unlike for Jelutung trees. No further information was found on Gemor bark cultivation on plantations.

Tenure rights

There are issues with tenure rights surrounding the Gemor bark cultivation in both the wild and on communal lands. According to Panjaitan (2009), there are no official regulations, permits, or levies at the district level and the provincial level in Central Kalimantan that address the cultivation of Gemor bark. This is unusual given that Gemor bark has also been classified as a NTFP (like Jelutung latex) and thus should be subject to the same regulations (Panjaitan, 2009; Kristedi & Kieft, 2010). However, Panjaitan (2009) claims that Gemor bark has been listed as a non-priority product by the Central Kalimantan Department of Forestry because bark extraction was considered too little compared to the extraction of other forest products.

Kristedi & Kieft (2010) interviewed a local Gemor bark trader in Central Kalimantan about tenure security, and found that according to the trader, villagers have lost the incentive to invest in communal lands to cultivate Gemor bark. This is due to previous cases where farmers would spend time and money on planting and harvesting Gemor trees on communal lands to later have their land converted into a palm-oil plantation and only receiving a small amount of money in return (Kristedi & Kieft, 2010). As a result, there is uncertainty in the literature regarding the regulations of Gemor bark cultivation.

Environmental impacts

Gemor resources have been decreasing in Central Kalimantan and surrounding regions, according to Kristedi & Kieft (2010), Suyanto et al. (2009), and Wahyu et al. (2008). This is thought to be partially due to unsustainable extraction practices where Gemor bark collectors cut down the entire tree and remove all the bark, thereby preventing the tree from recovering (Kristedi & Kieft, 2010). The unsustainable extraction practices of Gemor bark have also caused a reduction in the average diameter of Gemor trees (Suyanto et al., 2009). In the past, 10 – 20 years ago, Gemor trees with a diameter of

90cm were available in the wild, producing up to 700kg of Gemor bark. Today, however, it is almost impossible to find a Gemor tree with a diameter larger than 12cm, producing around 15 – 20kg of bark (Wahyu et al., 2008; Suyanto et al., 2009). Therefore, it is possible that current unsustainable extraction practices affect both the population size of the trees as well as the diameters. However, note that if extraction practices are sustainable, meaning that no more than 50% of the bark is removed so the tree has time to recover, then Gemor bark cultivation has various environmental benefits (Kristedi & Kieft, 2010).

First, Gemor bark cultivation on peatlands, similar to Jelutung cultivation, does not require peat drainage (Wahyu et al., 2008). Gemor cultivation therefore has lower carbon emissions than agricultural commodities such as palm oil that do require peat drainage. Soil subsidence is therefore also avoided with Gemor bark cultivation (Wahyu et al., 2008). Another positive environmental effect of Gemor trees is that they can naturally regenerate, as mentioned previously (Wahyu et al., 2008). This means that the expansion of Gemor bark cultivation in the wild could be facilitated through coppicing, which would also contribute to the reforestation of degraded peatland areas, according to Wahyu et al. (2008). Furthermore, a report by the International Union for Conservation of Nature (IUCN) in 2014 listed Gemor as one of the examples of successful cultivation of native swamp trees in Indonesia (Buckmaster et al., 2014). In the report, the successful cultivation of native swamp trees as NTFPs is described as an income source for local communities and reforestation method, with the latter contributing to restoring the peatland hydrology and biodiversity (Buckmaster et al., 2014). In the report, it is stated that the expansion of Gemor bark cultivation could counteract the current species population decline as long as trees are felled sustainably (Buckmaster et al., 2014). Consequently, the literature presents examples of the environmental benefits of (sustainable) Gemor bark cultivation.

Economic aspects

In Central Kalimantan, the Gemor bark cultivation for commercial purposes began in the early 1970's (Wahyu et al., 2008). According to Rahmanto et al. (2001) and Zulneyly & Martono (2003), Gemor bark can be used as a material for producing mosquito coils and hio (an incense stick used in Buddhist rituals). Farmers receive a higher price from traders for Gemor bark from peatlands because the peatland Gemor generally has thicker bark with a higher resin content than Gemor from mineral soils (Kristedi & Kieft, 2010). Gemor bark cultivation also provides economic value to local communities. The bark of the tree accounted for 20% of NTFPs collected by villagers in five villages along the Sebangau River catchment, making it the second most harvested NTFP after fish in these areas in 2003 (Lyons, 2003). Suyanto et al. (2009) also discuss the importance of Gemor bark as an income source for local communities in the northern part of the Kapuas District, Central Kalimantan. In this area, Gemor bark accounted for approximately 35% of the income, and more than half of the thirty respondents in the study were involved in Gemor bark collection (Suyanto et al., 2009). This means that for many families living along the Sebangau River and in the Kapuas District, Gemor bark served as an important income source at the time of the studies in 2003 and 2009, suggesting that this product has at least local market potential (Lyons, 2003).

In 2006, approximately 300 tonnes of Gemor bark was produced in the Central Kalimantan (Kristedi & Kieft, 2010). This is the most recent statistic on Gemor bark production and the amount is much less than in previous years, when 33,500 tonnes of Gemor bark was produced in 2004 (Kristedi & Kieft, 2010). The decline in Gemor bark production coincides with the literature previously discussed stating that the availability of Gemor trees in the wild has been decreasing over the past decade (Panjaitan, 2010; Wahyu et al., 2008). This decline has been attributed to deforestation and unsustainable extraction practices, as described previously in this chapter (Wahyu et al., 2008; Suyanto et al., 2009). According to Suyanto et al. (2009), not only is it difficult for farmers to find Gemor trees in the wild, but the trees they do find have much smaller diameters than in the past, thereby yielding less bark per tree. This could also be a reason for the declining pattern of Gemor bark production in Central Kalimantan identified by Kristedi & Kieft (2010).

Amongst the studies reviewed in Section 2.1.2, the consensus emerges that Gemor bark cultivation has provided income and employment to local communities, but that the decline in the wild Gemor tree population has limited these economic benefits (Kirstedi & Kieft, 2010; Wahyu et al., 2008; Panjaitan, 2010; Lyons, 2003). Therefore, according to this consensus, it seems that expanding Gemor bark cultivation would have to coincide with a replenishment of the population in the wild or on plantations, to ensure a consistently stable product supply.

Value chain

There are three main sources available discussing the value chain of Gemor bark in Central Kalimantan. These are Suyanto et al. (2009), Panjaitan (2010), and Kristedi & Kieft (2010), whose findings can be used to identify what is already known on the Gemor bark value chain in Central Kalimantan, and can be compared with the thesis results. The set up of the Gemor bark value chain is similar to the Jelutung latex value chain in terms of the actors. In the Gemor bark value chain, the actors include the Gemor farmers, the village collectors, local traders, large-scale/provincial trader, and the national exporters. First, the Gemor farmers work in groups and stay in the forest for up to two weeks to collect the bark. Kristedi & Kieft (2010) and Suyanto et al. (2009) note the non-labour costs of the collecting expeditions to be almost US$40 per person for food, drinks, and gasoline. After two weeks in the forest, a single Gemor farmer can collect an average of 430kg of bark, transporting this back to the village by means of a traditional motor boat known as a 'kelotok' (Suyanto et al., 2009; Kristedi & Kieft, 2010). The study also noted the farmgate price in Central Kalimantan for dried Gemor bark at the time of the study in 2010 to range between US$0.30 – 0.50 per kg of dry bark (Kristedi & Kieft, 2010). According to Panjaitan (2010), the farmgate price in 2010 was between US$0.30 – 0.45 per kg of dry bark. Farmers receive a lower price if the bark is still wet, thus providing them with the incentive to dry the bark before selling it (Suyano et al., 2009; Kristedi & Kieft, 2010; Panjaitan, 2010).

The second step of the Gemor bark value chain involves the bark collected by a group of Gemor farmers being gathered by either a village collector or a local trader, similar to the Jelutung latex value chain (Kristedi & Kieft, 2010; Panjaitan, 2010). At this stage, the collectors or traders may continue the drying process or transport it directly to a provincial/large-scale trader of Gemor bark. According to both Kristedi & Kieft (2010) and Panjaitan (2010), there is one large-scale trader of Gemor bark (no name provided), located in Banjarmasin, South Kalimantan. The Gemor bark price from the local collectors/traders to the large-scale trader ranges between US$0.50 – 0.55 per kg (Kristedi & Kieft, 2010; Panjaitan, 2010). Interviews conducted by Kristedi & Kieft (2010) revealed that both local and large-scale traders mentioned that there were not many problems with the quality of the Gemor bark they received. The main quality issue has to do with the water content of the bark, which can be easily improved by drying (Kristedi & Kieft, 2010). However, some traders did report problems with the stability of Gemor bark supply, stating that there have been months where their demand was insufficiently met (Kristedi & Kieft, 2010; Panjaitan, 2010). Price pressure was also considered an issue, with traders claiming they sometimes had to lower the farmgate price because of a decline in demand for Gemor bark.

After buying the Gemor bark, the large-scale trader either continues the drying process, or directly packages the bark and ships it to the exporters (Kristedi & Kieft, 2010; Panjaitan, 2010). According to Kristedi & Kieft (2010), the exporters of Gemor bark are located in Surabaya and Jarkata. At the time of the studies (2010), these companies included mosquito-coil producers and milling facilities. According to Panjaitan (2010), the average price per kg of Gemor bark sold by the large-scale trader to the exporter is US$1.30. Panjaitan (2010) found that the Gemor bark was being imported by Taiwan; no other importer was mentioned. Further quantitative data on the amount of bark sold and the production costs at the later stages of the value chain are not available in the literature. Overall, the information from Kristedi & Kieft (2010) and Panjaitan (2010) provides an impression of the value-chain steps from the farmers until the national exporters with quantitative information regarding the price per kg of bark at each step. This information will also be researched in this thesis and further qualitative and quantitative data at each step of the value chain will be investigated.

2.1.3 Summary of Literature Review

The literature review indicates possible opportunities and barriers related to expanding Jelutung latex and Gemor bark cultivation in Central Kalimantan. These opportunities and barriers include the environmental benefits of Jelutung latex and Gemor bark cultivation on peatlands, and their potential to generate economic value in Central Kalimantan. In terms of the main environmental advantages, neither the cultivation of Jelutung latex or Gemor bark on peat soils requires peat drainage. This brings several benefits (relative to other peatland uses that do require drainage of peat), including carbon sequestration and limited soil subsidence.

The potential economic opportunities of Jelutung latex and Gemor bark are reflected in that the crops are (or have been) important livelihood sources for local communities in areas of Central Kalimantan. Efforts have been made by farmers to domesticate Jelutung trees and cultivate Jelutung latex on plantations with the hope to secure and increase their income. Available information on Gemor bark cultivation on plantations is lacking in the literature. Furthermore, according to Poesie et al. (2011), Jelutung has the potential to be the most profitable peatland species in Central Kalimantan that does not require peat drainage. Literature on the economic benefits of Gemor bark is more limited than on Jelutung latex, but in one paper it was indicated that Gemor bark was the second most popular NTFP collected by villagers living along the Sebangau river. Another study showed that more than half of the respondents in the northern part of the Kapuas District were engaged in Gemor bark collection. Therefore, the cultivation of Gemor bark was also highlighted in the available literature as an important income source for local communities in Central Kalimantan.

However, the reviewed literature also identified two main barriers hindering the expansion of Jelutung latex and Gemor bark cultivation. First, both the Jelutung and Gemor tree populations in the wild are declining. This has been attributed to deforestation and land-use conversion, and for Gemor bark also to unsustainable extraction practices. As a result, populations would have to be stabilized and replenished to facilitate an expansion of both Jelutung and Gemor cultivation in the wild. Declining population sizes of both species in the wild could also be an incentive to expand the cultivation on plantations rather than in the wild, to limit further reduction of natural population sizes.

Second, the cultivation of Jelutung and Gemor has reduced over recent years. This is partially due to the population decrease of Jelutung and Gemor in the wild. In the literature examined the tenure situation was also identified as a reason for farmers losing interest in Jelutung latex and Gemor bark cultivation. For Jelutung latex, farmers have no legal ownership of the trees in the wild, and for Gemor bark there have been cases where communal lands with Gemor trees have been converted to palm-oil plantations with very little financial return for the farmers. Consequently, when considering the literature reviewed, although expanding Jelutung latex and Gemor bark cultivation could generate both strong environmental and economic opportunities, there are also two existing barriers that could limit the expansion of cultivation.

2.2 Data Collection

Data collection took place between 1st November 2016 until 15th December 2016 in Central Kalimantan. Data collection involved interviews with the value-chain actors and additional interviews with other farmers for go obtain further relevant information on the Jelutung latex and Gemor bark value chains.

2.2.1 Value Chain Actor Interviews

Data collection in Central Kalimantan consisted of semi-structured interviews with actors of the Jelutung latex and Gemor bark value chains. Interviews were conducted with Jelutung tappers and Gemor bark farmers, with local traders of both products, and with the final, large-scale traders of Jelutung latex and Gemor bark in Kalimantan. The aim of the interviews was to obtain up-to-date qualitative and quantitative data on the value chains of Jelutung latex and Gemor bark. There was no specific number of interviews set for each value-chain actor group (e.g. five interviews with Jelutung tappers), as very little was known about the exact whereabouts of the actors and their willingness to be interviewed. Therefore, the aim was to conduct as many interviews as possible given the uncertain circumstances of the fieldwork.

Initially, before beginning the fieldwork the plan was to focus on Jelutung latex and Gemor bark cultivation and their value chains in the Kapuas District of Central Kalimantan. This specific location was chosen because of the existing relationship between the district forestry office in Kapuas and the staff from Wageningen University, which would ease the process of data collection. However, finding respondents in Kapuas proved more challenging than anticipated because most actors of both the Jelutung and Gemor value chains had recently left the region. Therefore, to increase the chance of finding relevant actors to interview, the fieldwork was spread throughout the whole Central Kalimantan Province. All interviews were conducted in the preferred locations of the interviewees. The Jelutung tappers were interviewed in two locations: Pangkalan Bun (Central Kalimantan) and Kubu village (West Kotawaringin District). The two tappers interviewed in Pangkalan Bun worked and lived near the Lamandau Wildlife Reserve, but wanted to be interviewed at a local charity office in Pangkalan Bun. The tappers from Kubu village were interviewed in their homes. The local Jelutung latex trader was interviewed at his business location in Pangkalan Bun. The large-scale trader of Jelutung latex was interviewed via email with a questionnaire, as the contact person did not want a face-to-face interview. The interviews with Gemor farmers took place in their homes in three areas: Mantangai (Kapuas District), Taruna village (Pulang Pisau District), and Kering Bangkirai (Sebangau District). The interview with the local Gemor trader was located at his business in Tumbang Nusa (Pulang Pisau District). The final, large-scale trader of Gemor bark was also interviewed at his business location in Banjarmasin (South Kalimantan). Figure 2 on the following page shows the different interview locations across the Central Kalimantan Province.

Figure 2. Map with red diamonds showing locations of interviews in Central and South Kalimantan. Source: Adapted from Google Maps.

The literature review provided a preliminary understanding of the set up of the Jelutung latex and Gemor bark value chains, and thereby helped in identifying the different value-chain actors that should be interviewed. Jelutung tappers and Gemor farmers were found using convenience sampling and the snowballing method. For example, the two Jelutung tappers interviewed in Pangkalan Bun suggested to visit Kubu village because they knew some tappers who lived there. Finding the tappers in Kubu village consisted of knocking on doors and asking villagers where the Jelutung tappers could be found. Whilst in Kubu village, after interviewing one Jelutung tapper and asking whether he knew any more tappers nearby, he brought the interviewer to two other Jelutung tappers in the village. Interviews were also set up via local contacts from staff at Wageningen University and the district forestry office in Kapuas. These local contacts either directly arranged the interviews with the value-chain actors or provided the contact details of other local people who could help to set up the interviews. Again, the snowballing method then enabled the setting up of more interviews with value-chain actors.

The interviews were semi-structured to ensure that certain essential information was obtained from all interviews, whilst still allowing the opportunity for the interviewer to ask follow-up questions and explore particular information further. The interview questions were prepared based on the knowledge gaps identified in the literature review in Chapter 2.1. The questions were open-ended to encourage full and personal answers from the respondents. The interviews were prepared and conducted in Bahasa Indonesia to ease the data collection process and improve communication between the respondents and the interviewer. A translator was present at all interviews to provide translation where needed. Both the interviewer and the translator had a copy of the interview questions to ensure all questions were asked and the interview stayed on track. The interviewer recorded the interviews if permission to do so was granted. In addition to recording the interviews, the interviewer also took notes during the interview. In all cases, the interviews with the Jelutung latex and Gemor bark value-chain actors were between 45 – 75 minutes.

In total, five Gemor farmers and six Jelutung tappers were interviewed, including one respondent who cultivated both Gemor bark and Jelutung latex. For the next step in the value chain, one local Gemor bark trader/collector was interviewed, and one local trader of Jelutung latex. For the large-scale trader step of the Jelutung latex value chain, a trader was identified in Sampit, known as PT Sampit, but it was not possible to conduct a personal interview with an employee from this company. Instead, a questionnaire was sent via email to the export and import manager of the company. The large-scale trader of Gemor bark was interviewed personally. The next sub-sections describe which interview questions were chosen, and why, for each of the value-chain actors of Jelutung latex and Gemor bark. In general, the interview questions were constructed to obtain relevant information for answering the RQ1, RQ2, and RQ5 of this thesis.

Jelutung Tappers and Gemor Farmers

For each step of Jelutung and Gemor value chains, specific questions were prepared for the actors (e.g. traders were asked different questions than the farmers). The interview questions for the Jelutung tappers and Gemor farmers were similar – only slight adjustments were made to address the originalities of each product. To ensure tappers and farmers would not experience the interview as challenging or intimidating, they were first asked simple, factual questions. The first question of the interview asked whether the tappers/farmers harvested any NTFPs (if yes, which NTFPs). The aim of this question was to get an idea of whether tappers/farmers generally only cultivate one NTFP or if they cultivate several – and if several, which NTFPs are currently 'popular' to harvest in Central Kalimantan. This information is useful for answering the RQ5 of this thesis: "Are their potential additional crops that can generate value for farmers in Central Kalimantan?"

For both the Jelutung latex tappers and Gemor bark farmers, the reviewed literature in Chapter 2.1 indicated that tenure security may be a barrier to cultivation. To further investigate this, farmers and tappers were asked where they collect the products and if they own any land (if so, how many hectares). Following this, farmers and tappers were asked how long they have been cultivating Gemor bark or Jelutung latex to understand whether cultivating these products is something done sporadically (e.g. when prices are high) or is something farmers commit to as a long-term income source. The Jelutung tappers and Gemor farmers were then asked how they collect the products – what method is used – to see if this coincides with the literature and to obtain more qualitative details on the cultivation process. The tappers and farmers were also asked how they maintain the latex or bark quality, to see whether the quality is consistent and not a barrier to cultivation. For further details on the cultivation process, farmers and tappers were asked if they collect their products in a group or by themselves (if yes in a group, how many people and how is the income shared), and whether they do any manufacturing to the product.

The following interview questions for Jelutung tappers and Gemor farmers targeted quantitative data for the Jelutung latex and Gemor bark value chains, and were formulated based on what is still unknown or outdated in the literature. For example, the quantitative information from the literature on the amount of Gemor bark produced per farmer, farmgate price per kg of dry bark, and the production costs is outdated (from 2010). For the Jelutung latex value chain, this quantitative data is more limited in the literature and thus also needed to be obtained through the interviews. Therefore, to gain an up-to-date and detailed quantitative impression on the first step of the Gemor bark and Jelutung latex value chains, farmers and tappers were asked how many days they go to the forest to collect bark or latex, how many trees they harvest on average per day, and how many kg of bark or latex they collect on average per day. When farmers did not know the average per day, they were asked to answer per month. In this way, the production amount of bark or latex per farmer per collecting period could be calculated. For updated data on the farmgate price per kg of Gemor bark and Jelutung latex in Central Kalimantan, farmers and tappers were asked directly for how much they sold 1kg of bark or latex (in Indonesian Rupiah). It was important here to specify for Gemor bark whether the price was for dry or wet bark. They were then asked if they felt the price is stable, to examine whether price fluctuations could be a potential barrier to Gemor bark or Jelutung latex cultivation. Farmers and tappers were also asked if they were satisfied with the prices. Following this, farmers and tappers were asked about the percentage of bark or latex they sell per month, to get an idea of whether there is enough demand to sell all the bark or latex they collect. As a final quantitative question, farmers and tappers were asked what their approximate production costs for cultivating Jelutung latex or Gemor bark are.

To investigate the link between these first steps of the value chains and the next (from the farmers/tappers to the traders), the farmers and tappers were asked to whom they sell their bark or latex. It was also asked whether these were the only people they could sell their bark or latex to, again to explore potential barriers to the cultivation process (e.g. if there is a monopoly due to the existence of only one local trader). At the end of each interview, the farmers and tappers were asked some questions targeting their opinions on Gemor bark or Jelutung latex cultivation. They were asked whether they wanted to cultivate more or less bark or latex (and why), to understand the willingness of farmers and tappers to continue cultivating these products in the future. Farmers and tappers were also asked for their opinion on the effects of peat fires and hydrology on the cultivation process. This question was included to examine the environmental aspects of cultivating Jelutung and Gemor. None of the farmers or tappers seemed to understand the meaning of the effects of peat hydrology, so after some interviews only their opinion on the effects of peat fires was asked. As final question, farmers and tappers were asked for their opinion on the barriers of cultivating NTFPs in general.

Local Traders of Jelutung latex and Gemor bark

The local traders of both Jelutung latex and Gemor bark had different interview questions than the tappers and farmers to target their particular role in the value chains. The interview questions were the same for the local Jelutung latex trader and the local Gemor bark trader as the same type of qualitative and quantitative data was targeted. First, the local traders were asked simple questions to ensure an easy, smooth start to the interview. They were asked for how many years they have traded Jelutung latex or Gemor bark, and which other products they are currently trading (if any NTFPs, and why these particular products). This was asked to get an understanding of how important Jelutung latex and Gemor bark are to the local trading businesses and which other products are also ‘popular’ to trade at a local scale in Central Kalimantan, thereby targeting RQ5: “Are their potential additional crops that can generate value for farmers in Central Kalimantan?” To further this understanding, the local traders were also asked whether Jelutung latex or Gemor bark are their main income sources, and if not which products are a better income source. Following this, more qualitative details on the flow of the products through their value chains was targeted. For example, local traders were asked whether they buy the latex or bark directly from the tappers or farmers (and if not, from whom they do buy it).

The interview questions were then directed at collecting quantitative information for the second steps of the Jelutung latex and Gemor bark value chains. Local traders were asked how many kg of latex or bark they buy in one month. They were also asked for how much they buy 1 kg of latex or bark, and whether this price is stable. This was asked to compare the answers of the local traders with the tappers and farmers to see if both actor groups give a similar farmgate price and have a similar experience with price stability. Furthermore, the local traders were asked what their production costs were per month for trading Jelutung latex or Gemor bark. Local traders were also asked how much latex or bark they sell per month and for how much they sell 1 kg of latex or bark.

These quantitative questions were supplemented with some qualitative questions to gain extra details on the trading process of Jelutung latex and Gemor bark in Central Kalimantan. The local traders were asked what the latex or bark quality that they receive is like, and if this quality is always good. This was asked to investigate potential barriers to Jelutung latex and Gemor bark cultivation. To get an idea of the efficiency of the local trading process, the traders were asked how much time there is between buying their products from the tappers and farmers and then selling it again. They were also asked whether they do any manufacturing or processing to the latex or bark they buy, and if so what exactly they do. In addition, local traders were questioned on whom they sell their latex or bark to, and what they know about what their buyers do with the products. The latter was asked to obtain some qualitative information about the next stage in the value chains, to compare their answers with the answers of the large-scale traders for further confirmation of the set up of the value chains.

Finally, similar to the last part of the interviews for Jelutung tappers and Gemor farmers, the local traders were asked questions targeting their opinions. First, they were asked what they thought about the Jelutung latex or Gemor bark markets (e.g. low/high demand, low/high supply). Given that this thesis is determining the opportunities and barriers to expanding the cultivation of Jelutung latex and Gemor bark, the opinions of local traders on the state of the latex and bark markets could aid in identifying such opportunities and barriers. For this question, it was important not to make suggestions towards the interviewee on how they might view the state of the market, to avoid asking a leading question. Following this, the traders were asked if there were any barriers, in their opinion, to trading Jelutung latex or Gemor bark, and if there were any barriers to trading NTFPs in general. These questions were also asked to obtain useful information for achieving the objective of this thesis.

Large-scale Jelutung latex trader

During the fieldwork, it was not possible to conduct a face-to-face interview with an employee from PT Sampit, the large-scale trader of Jelutung latex in Central Kalimantan. Via a contact person, the export and import manager of PT Sampit was contacted after fieldwork via email. He did not want to be interviewed via Skype; instead a questionnaire was designed and sent to him via email. His answers to the questionnaire were subsequently sent back via email. The questionnaire included similar questions as the interview questions for the local traders of Jelutung latex and Gemor bark.

Large-scale Gemor bark trader

The interview with the owner of the large-scale Gemor trader was located at his business in Banjarmasin, South Kalimantan. The interview questions were similar to the interview questions for the local traders of Jelutung latex and Gemor bark. However, the owner was also asked about his opinion on how the Gemor bark market has changed over recent years. He was asked this question because being a large-scale trader it was expected that he would have a clear idea of the market trends of Gemor bark at a provincial level (which would aid in investigating the opportunities and barriers of Gemor bark cultivation).

2.2.2 Additional Interviews

As mentioned previously, additional interviews were conducted with two farmers who own Jelutung plantations but are not yet cultivating the latex, and with ten farmers who do not cultivate either crops. This was done to investigate whether there were specific reasons why they chose not to, and what these reasons are. In turn, this could help to identify barriers to expanding the cultivation of Jelutung latex and Gemor bark in Central Kalimantan.

First, the interviews with the two farmers with Jelutung plantations were unplanned. Miscommunication between the contact person and the interviewer led the interviewer to believe the farmers were already harvesting Jelutung latex. During the interview, it was discovered that this was not the case and so the prepared questions had to be adapted and some questions had to be improvised to adjust to the situation. The farmers were first asked how many ha of land they own, which crops they grow on their land, and how many ha are covered by each crop. Out of these crops, the farmers were asked which crop is their main income source. The farmers were also asked whether their Jelutung plantation is located on peat soil. Following this, they were asked why they do not yet harvest Jelutung latex to identify possible barriers to cultivating Jelutung latex. To further investigate potential barriers to Jelutung latex (and general NTFP) cultivation, the farmers were asked for their opinion on the barriers to cultivating NTFPs in Central Kalimantan.

The interviews with non-Jelutung latex and Gemor bark farmers were very brief as only one main question was asked, namely why they do not harvest Jelutung latex or Gemor bark. This was asked to investigate possible barriers to the cultivation of Jelutung latex and Gemor bark. First, the farmers were asked which crops they do harvest, to determine whether there are other NTFPs that are more popular to cultivate amongst farmers. Following this, the farmers were asked whether they had heard of Jelutung latex and Gemor bark before, and if so, why they do not harvest these products.

2.3 Data Analysis

Data analysis involved two main methods. First, evaluating the interviews and using the results for the value chain analyses. This targets RQ1 and RQ2 of this thesis on how the Jelutung latex and Gemor bark value chains are set up and what the opportunities and barriers are of improving and expanding their markets. Second, conducting a cost-benefit analysis will provide the economic costs and benefits of Jelutung latex and Gemor bark cultivation, including the environmental impact, thereby targeting RQ3 and RQ4 of this thesis on the economic costs and benefits of cultivating the crops and the potential environmental impact of enhancing their cultivation.

2.3.1 Value Chain Analysis

Value chain analysis is a tool used to recognize value creation across the various activities required to bring a product through the stages of production to consumption (Webber, 2016). In other words, value chain analysis can be used to identify for which of these activities substantial value is being generated for the actors involved, and where value can be added (Webber, 2016). As a result, value chain analyses are generally conducted with the use of quantitative data (Webber, 2016; Glenday et al., 2015). In this thesis, the value chain analyses of Jelutung latex and Gemor bark will be presented with both quantitative and qualitative information, due to the limited qualitative information available in the literature.

All the quantitative and qualitative information in the value chain analyses was obtained from the interviews conducted during the fieldwork. After each interview, the questions and answers were typed up to ease the process of data analysis. Following the fieldwork, the interviews were analysed per value-chain actor group. For example, all the interviews with Jelutung tappers were analysed by grouping the information from these interviews together to compare the answers of the tappers and acquire a general impression of the first step of the Jelutung latex value chain.

The value chain analyses of Jelutung latex and Gemor bark are presented in the form of flow charts, as a visual depiction may allow for a clearer understanding of the steps of the value chains. Value chains are often analysed by dividing the value chain into upstream, mid-stream, and downstream. This is also done in this thesis, where upstream consists of the Jelutung tappers and Gemor farmers, mid-stream consists of the local traders, and downstream includes the large-scale traders, the national exporters, and the importers. The quantitative data collected in the interviews are provided in the value chain flow charts, with parts of the flow chart representing the different steps of the value chains. The quantitative data is presented in 'ranges,' to reflect the variety of information received. For example, some Jelutung latex tappers gave a lower farmgate price per kg of latex than other tappers, and so this difference should be reflected in the value chain analyses. The average values are also provided.

The value chain flow charts will be supported with qualitative explanations. For instance, an explanation of why there are ranges in the quantitative data, such as the farmgate prices, will be provided. This is done to ensure a more complete and well-rounded understanding of the structure of the Jelutung latex and Gemor bark value chains. If certain data is unknown, this will be displayed in the value chain flow charts as 'N/A,' so that the reader is clearly shown which knowledge is still unavailable. At the end of the value chain analysis of each crop, a summary of the value chain will be provided with the complete flow chart.

2.3.2 Cost-Benefit Analysis

The cost-benefit analyses include three different analyses: a palm oil, Jelutung, and Gemor plantation per ha of peatland. All plantations are based on a monoculture system. Each of the cost-benefit analyses includes the establishment of the plantation on peatland, assuming that the peat has not already been drained and is not degraded. In the case of a palm-oil plantation, this means that establishing the plantation requires peat drainage. The analyses include depreciation costs and a discount rate of 10%, to obtain a more realistic Net Present Value (NPV). The 10% discount rate was chosen based on Sumarga et al. (2015), who took the average of both the lending rate and the inflation rate in Indonesia over the period of 2009 – 2011. The depreciation costs are calculated by summing the investment costs (i.e. plantation establishment costs) and dividing this by the remaining number of years of the plantation cycle after investment.

The costs and benefits found in the literature are from different years (ranging from 2009 to 2016). To ensure that all costs and benefits are adjusted to reflect the year 2017, the Indonesian Consumer Price Index (CPI) is used. For example, the price of palm oil fresh fruit bunches used in the analysis is from 2011 and is US$137 per ton. To adjust for inflation between 2011 – 2017, the 2011 price is divided by the 2011 CPI, and the outcome is multiplied with the 2017 CPI. The average CPI in 2011 in Indonesia was 95 index points. The average CPI in 2017 was 128 index points. The calculation is as follows: (US$137 ÷ 95) × 128 = 185 or US$185 per ton for the price of fresh fruit bunches in 2017. These CPI calculations are done to any costs and benefits taken from sources from years earlier than 2017. The costs and benefits described in the remainder of this chapter have already been adjusted with the CPI calculations.

The analyses are run for one plantation cycle, one cycle being from the plantation establishment until the end of the productivity of the crops. This means that the end of each plantation cycle (i.e. the end of each cost-benefit analysis) does not include re-planting costs or the benefits of selling the timber from the Jelutung and Gemor trees at the end of their productivity cycles. Given that palm oil, Jelutung, and Gemor have different plantation cycle lengths, the Internal Rate of Return (IRR) is calculated for each of the analyses. The IRR is the implied annual return (in percentages), for which the NPV is zero. Hence, it is the normalized expected annual return on investment over the investment period. Being time-invariant, it allows for the comparison of the returns for the three crops. For example, since the Gemor plantation cycle is much longer than the Jelutung and palm-oil cycles, this could result in a bias regarding the NPV. This issue is resolved using the IRR. Therefore, calculating the IRR in each analysis enables direct comparison of the economic benefits generated by the different crops.

For all analyses, the Present Value (PV) of net benefits, the NPV, and the IRR are provided. In the following sections the values chosen for the costs and benefits and the assumptions made are explained. Some values were taken from the literature and others were calculated based on the quantitative information from the interviews with farmers and traders conducted for this thesis. For each cost-benefit analysis, sensitivity analyses are conducted to examine the sensitivity of the NPV to changes in the discount rate, crop prices, and carbon emission costs. These sensitivity analyses are presented in Section 3.4.3.

Carbon Emission Costs

A cost-benefit analysis provides the opportunity to quantify and assess the environmental impacts of a project by internalizing environmental externalities such as carbon emissions. This is done by placing a monetary value on the externalities. In this thesis, only carbon emissions are included as an externality because other environmental impacts such as biodiversity loss and susceptibility are difficult to quantify into monetary terms. Palm-oil production on peatland requires peat drainage and therefore causes carbon emissions. The costs of these carbon emissions are included in the palm-oil cost-benefit analysis. Since neither a Jelutung nor a Gemor plantation require peat drainage, and the plantations are assumed to be established on undrained and undegraded peat, these plantations do not produce carbon emissions. Therefore, the carbon emission costs in their cost-benefit analyses are equal to zero. By internalizing the externality of carbon emissions in the cost-benefit analyses and comparing the results, the analyses contribute to answering RQ4 of this thesis.

Estimates for the carbon emissions costs of palm-oil plantations on peatlands were made based on Hooijer et al. (2012). It is important to mention that in this analysis the peat must be drained to make the plantation suitable for palm-oil production (it is therefore assumed that the peat has not already been drained and is not degraded). According to Hooijer et al. (2012), a palm-oil plantation on peat with a water table depth of 50cm emits an average of 15 tonnes C ha^{-1} $year^{-1}$ for the first 25 years after drainage. This is a conservative estimate as a water table depth of 50cm is the most preferred drainage depth for palm oil from an environmental sustainability perspective. In reality, peat drainage depths are typically higher than 50cm, releasing more carbon emissions (Hooijer et al., 2012). To place a monetary value on the carbon emissions of a palm-oil plantation on peat, the Social Costs of Carbon (SCC) from the United States Environmental Protection Agency (2013) will be used. The SCC is an estimate of the monetary value of the damages associated with carbon emissions. The SCC value (adjusted using the Indonesian CPI) is US$138 tonnes C^{-1}. Recognizing that the SCC is generally calculated using a social discount rate, in this thesis a discount rate of 10% is used so that the monetary values of carbon emissions and sequestration can also be used in the cost-benefit analyses where the net benefits are discounted by 10%. Multiplying the SCC with the rates of carbon emissions and sequestration for each plantation yields the monetary values (in US$$ha^{-1}$ $year^{-1}$) for the different plantations. For example, multiplying the carbon emission rate of 15 tonnes C ha^{-1} $year^{-1}$ for palm oil on drained peat with the SCC of US$138 tonnes C^{-1} amounts to a value of US$2072 ha^{-1} $year^{-1}$. As this value is based on the SCC, which estimates the value of damages from carbon emissions rather than carbon sequestration, the value is a cost and thus will be treated as carbon emission costs in the cost-benefit analysis.

Palm-oil Plantation on Peatland

This analysis includes the establishment of a palm-oil plantation on peatland and the necessary drainage of the peat, assuming the peat has not already been drained. All costs and benefits have been adjusted to reflect 2017 values according to the Indonesian CPI.

Benefits

The productivity of a palm-oil plantation can be calculated according to the yield of fresh fruit bunches (FFB) ha^{-1} $year^{-1}$. The oil is extracted from the centre of each piece of fruit on the fruit bunch (Fairhurst & McLaughlin, 2009). The scenario is run for one plantation cycle, one cycle being 25 years with an average FFB yield of 19 tonnes ha^{-1} $year^{-1}$ (based on Sumarga et al., 2016, Fairhurst & McLaughlin, 2009, and USDA, 2009). The yield per year depends on the stage of the plantation cycle. Palm-oil trees typically begin producing FFB after three years (Fairhurst & McLauhglin, 2009; USDA, 2009). In Year 3, newly planted palm oil produces approximately 3.6 tonnes FFB ha^{-1} $year^{-1}$. In Years 4 – 9 of the plantation cycle, young palm-oil trees produce 15.2 tonnes FFB ha^{-1} $year^{-1}$. For the remainder of the plantation cycle, until year 20, the FFB yield of mature palm oil is around 24 tonnes ha^{-1} $year^{-1}$ (based on Sumarga & Hein, 2015). After this, it is assumed that the productivity of the palm-oil trees gradually decrease in the last five years of the plantation cycle. A 2017 price of US$185 ton^{-1} of FFB is assumed for this scenario. Note that there are strong price fluctuations for FFB. For the sake of simplicity, the price is assumed to be constant in the analyses.

Costs

Establishing a palm-oil plantation on peat soil costs US$1055 ha^{-1} $year^{-1}$ for a period of four years, including costs for land preparation (e.g. peat drainage), planting, and maintenance (based on Sumarga & Hein, 2015). Drainage costs are included because it is assumed the peat has not already been drained; therefore, drainage is necessary to prepare the land for palm-oil cultivation. For the first year of the scenario, land lease costs must be included. These include the costs of buying land and the necessary permits, and amount to US$470 ha^{-1} (Boer et al., 2012). After four years, there are no more costs of drainage and planting. The remaining costs per year are for farming, harvesting and transportation, and the fixed costs. Farming costs of palm oil on peat soil stay constant at US$1155 ha^{-1} yr^{-1} (based on Fairhurst & McLaughlin 2009). Harvesting and transportation costs gradually increase throughout the plantation cycle in accordance with an increase in FFB yield (based on Sumarga et al., 2016). The fixed costs were taken from Fairhurst & McLaughlin (2009) and amount to US$148 ha^{-1} yr^{-1}.

Jelutung Latex Plantation on Peatland

This analysis includes the establishment of the Jelutung plantation. Peat drainage is not included as Jelutung trees can grow and be cultivated on undrained peat. All costs and benefits have been adjusted to reflect 2017 values according to the Indonesian CPI.

Benefits

According to the interviews with Jelutung tappers, Jelutung trees can produce latex after approximately eight years when grown in the wild (based on interviews in Appendix 7.1). In this analysis, it will be assumed that Jelutung trees grow slightly faster on plantations as they do not have any natural competition with other plants and trees. Therefore, the first year of latex production is assumed to be in Year 7, seven years after establishing the plantation. The tappers also said that the same Jelutung trees can be tapped for 5 – 10 years in the wild. On plantations, the productivity cycle of Jelutung trees is expected to be up to twenty years (based on Harun, 2011). It is likely that Jelutung trees have a longer productivity cycle on plantations as they do not have the natural competition that wild Jelutung trees have. Therefore, the twenty-year productivity cycle of Jelutung trees on plantations will be used for this analysis. The total cycle of Jelutung trees on a plantation is thus 27 years from plantation establishment until the end of the tree's latex productivity.

The latex yield of the Jelutung plantation was calculated based on the interviews with Jelutung tappers and the owners of Jelutung plantations in Central Kalimantan. Pak Awat owns ten ha of Jelutung trees with 5000 trees in total, amounting to 500 Jelutung trees ha^{-1} (based on interview in Appendix 7.1). Similarly, pak Rapingun owns three ha of Jelutung trees with 1500 trees in total, also equalling 500 Jelutung trees ha^{-1}. Therefore, 500 Jelutung trees ha^{-1} will be assumed in this analysis. One Jelutung tapper, pak Yogi, collects 20 – 30kg of latex from 20 – 30 trees per day in the wild. Another tapper, pak Dedi, collects approximately 35kg of latex from 50 Jelutung trees per day in the wild. The process of tapping and collecting latex from each tree typically takes a month, as the tree needs time to release the latex and to recover from the cut. This means that tappers will collect latex from the same tree once per month. If all 500 trees ha^{-1} on the plantation are cultivated once per month, then an approximate latex yield of 1 – 1.4kg tree^{-1} month^{-1} is calculated. Converting this into the total monthly latex yield in tonnes collected per ha amounts to 0.5 – 0.7 tonnes. The yearly Jelutung latex yield is therefore 6 – 8.4 tonnes ha^{-1}. To avoid making an overly conservative or an overly optimistic estimate, a middle value of 7.2 tonnes ha^{-1} year^{-1} will be used for the latex yield in this cost-benefit analysis. Since this latex yield is based on data from Jelutung tappers who collect latex from the natural forest, the assumption is made that the latex yield from Jelutung trees on a plantation is the same as wild Jelutung trees.

It is assumed that in the last five years of the Jelutung plantation cycle, the latex productivity will decline gradually. This assumption is made as it is more realistic that the trees will lose their productivity gradually rather than instantly at the end of the plantation cycle. Moreover, interviews with Jelutung tappers revealed that according to them Jelutung trees can 'slowly become less productive.' Therefore, in Year 22 the average yield of latex of 7.2 tonnes ha^{-1} year^{-1} will decrease to 5.2 tonnes ha^{-1} year^{-1} in Years 23 and 24, and further decline to 3.2 tonnes ha^{-1} year^{-1} in Year 27. In this analysis, it is assumed that the price of Jelutung latex from the wild is the same as the price of plantation latex. This price is taken from the interviews with the Jelutung tappers. The average price per kg of latex is US$0.67, or US$670 ton^{-1} (see Section 3.1.1). A constant latex price will be assumed. The interviews with Jelutung tappers reveal that the tappers feel that overall the price of latex in Central Kalimantan is relatively stable. Nevertheless, it is recognized that assuming a constant price is a major simplification of this analysis. A sensitivity analysis will be conducted on the price of Jelutung latex to determine the effects of assuming a constant latex price.

Costs

For this analysis, the same land lease costs as for the palm oil-plantation of US$470 ha^{-1} in the first year of plantation establishment will be assumed. Investment costs include costs of establishing the plantation in Years 0 and 1 which are US$181 and US$516 ha^{-1} respectively. Planting costs occur in Years 1 and 2 and amount to US$55 ha^{-1} in Year 1 and US$11 ha^{-1} in Year 2 (based on Sumarga et al., 2016). Costs related to plant maintenance (e.g. fertilizers and watering) and equipment and inputs (e.g. tools) on Jelutung plantations cannot be taken from the interview results as the Jelutung tappers interviewed cultivated Jelutung trees from the natural forest. Therefore, these costs will be based on the study by Harun (2011). According to Harun (2011), plant maintenance costs vary between US$18 – 438 ha^{-1} year^{-1}. Equipment and input costs are also based on Harun (2011) and range between US$181 – 277 ha^{-1} depending on the different activities required in each year. The constant transportation costs of US$12 ha^{-1}, starting in Year 7 when the trees start producing latex, were assumed to be similar to costs of transporting palm oil in Kalimantan, based on Fairhurst & McLaughlin (2009).

Gemor Bark Plantation on Peatland

In this cost-benefit analysis, the establishment of the Gemor plantation will be included. Similar to the two cost-benefit analyses described above, it will be assumed that the plantation is established on undrained and undegraded peat. In addition, the extraction practices of Gemor bark on the plantation will be assumed to be sustainable, meaning that no more than 50% of the bark is taken during each harvest. Similar to the Jelutung latex cost-benefit analysis, a total of 500 trees ha^{-1} will be assumed for the Gemor plantation. The costs and benefits are all from 2017 (except for the land lease costs) and therefore do not need to be adjusted using the Indonesian CPI.

Benefits

In the wild, a Gemor tree can live up to 200 years if no bark is being extracted from it (Panjaitan, 2017). It has not yet been tested how long Gemor trees can survive on a plantation if the bark from the trees is extracted regularly using sustainable practices. However, it is unlikely that a tree on a plantation that is being harvested for bark will be able to survive as long as a wild Gemor tree that has never been harvested for bark. Therefore, an estimate of a fifty-year life cycle for Gemor trees on a plantation will be made (again assuming sustainable extraction practices). It should be noted that this is a very rough estimate which will be elaborated on in the discussion in Chapter 4.

According to the Gemor farmers interviewed, the minimum diameter for harvesting Gemor bark is 12cm. One farmer said it takes between 5 – 8 years for the trees to grow to a diameter that can be cultivated (12cm), and another said that it takes 8 – 10 years. Based on the experience of Gemor farmers, it will be assumed that Gemor trees on plantations can be cultivated for Gemor bark eight years after planting. According to Panjaitan (2017), the diameter of a Gemor tree grows by 0.3 – 0.5cm per year. Therefore, in Year 50 of the Gemor plantation cycle, assuming a steady increase in diameter each year, the diameters of the trees will reach around 24cm. In this analysis, the assumption is made that there is a proportional relationship between tree diameter and bark yield (i.e. bark yield increases as diameter increases).

The yield of Gemor bark per ha from a plantation is unavailable in the literature. Therefore, it will be assumed that Gemor trees on plantations produce a similar bark yield as Gemor trees in the wild (the same assumption was made in the Jelutung latex cost-benefit analysis). According to Kristedi & Kieft (2010), a Gemor tree with a diameter of 5 – 15cm can produce around 10 – 20kg of bark. According to the interviews with Gemor farmers, at a diameter of 12cm, the bark yield of one Gemor tree is around 8kg. This bark yield represents the yield when all the bark is extracted from the tree, as Gemor farmers do in the wild. Assuming sustainable extraction practices are followed on the plantation, the bark yields mentioned by the farmers must be halved. This means that on a plantation, a Gemor tree with a diameter of 12cm will yield approximately 4kg of bark. When the trees have a diameter of 24cm, and the bark is extracted sustainably, a bark yield of 8kg is assumed. With a plantation of 500 trees ha^{-1}, a bark yield of 2000kg ha^{-1} or 2 tonnes ha^{-1} for trees with around a 12cm diameter, and 4 tonnes ha^{-1} for trees with a diameter of 24cm, is expected.

When approximately half of the bark from a Gemor tree is extracted, the bark grows back and the tree can be harvested again after three years (based on Panjaitan, 2017). Therefore, this cost-benefit analysis will have a gap in Gemor bark yield every three years, representing the time it takes for the trees to recover from the harvest and regrow the bark. This means that Gemor trees can only be harvested once a year every three years. Similar to the cost-benefit analyses of Jelutung latex and palm oil, it will be assumed that the yield of Gemor bark will gradually decline towards the end of the plantation cycle.

The price of Gemor bark, in this analysis, will be taken from the average price given by Gemor farmers during their interviews. This price is US$640 ton^{-1}. Similar to the Jelutung and palm oil cost-benefit analyses, this price will be assumed to be constant.

Costs

In the first year of the Gemor plantation cycle, the same land lease costs of US$470 ha^{-1} as in the palm oil and Jelutung cost-benefit analyses will be used. According to Panjaitan (2017), the costs of establishing a Gemor bark plantation are US$75 ha^{-1} for the first two years of the plantation cycle. Planting costs are only made in Year 1 of the plantation cycle and amount of US$60 ha^{-1} (based on Panjaitan, 2017).

Plant maintenance costs of a Gemor bark plantation are also based on Panjaitan (2017). Gemor trees require maintenance on a plantation twice a year, amounting to maintenance costs of US$75 ha^{-1} $year^{-1}$. It will be assumed that these costs remain constant throughout the plantation cycle. The farming costs are based on information from the interview with pak Nunung, the local trader of Gemor bark from Tumbang Nusa, Central Kalimantan. He explained that he typically pays each employee US$7.50 per month to cut and dry Gemor bark. In this analysis, the assumption is made that farmers working on the plantation to cultivate and dry the bark have the same monthly salary as pak Nunung's employees. To estimate the number of farmers necessary per ha on a Gemor plantation, information from the interviews with the Gemor farmers is used. Gemor farmers can generally harvest around five trees per day. Therefore, for one farmer to harvest 500 trees ha^{-1} would take around 100 days or slightly over three months. Assuming the aim is to cultivate all Gemor trees per ha in one month, and that farmers take some days off during the month, then four farmers are necessary to cultivate all 500 trees ha^{-1} in 25 days. This amounts to farming costs of approximately US$30 ha^{-1} for the harvesting month which occurs once every three years, starting in Year 8 when the bark can first be harvested. The same transportation costs will be used in this cost-benefit analysis as are used in the previous two cost-benefit analyses.

3. RESULTS

In this chapter, the results of this thesis are presented. Chapters 3.1 and 3.2 include the results of the Jelutung latex and Gemor bark value chain analyses respectively. The aim of these results is to answer RQ 1 and RQ2 of this thesis: "How is the value chain of Jelutung latex / Gemor bark set up and what are the opportunities and barriers of improving and expanding the market, in particular for the first step of the value chain (i.e. the farmers)?" Chapters 3.1 and 3.2 are divided into the various stages of the value chains (i.e. upstream, mid-stream and downstream), and are further separated into the qualitative and quantitative data obtained during the interviews with the value-chain actors. Some of the value-chain actors are referred to by 'pak,' followed by their first name. 'Pak' is the Indonesian equivalent to 'Mr.' in English.

The quantitative data of each of the value-chain steps is displayed in flow charts. If certain data was not found or was unavailable, this is indicated with 'N/A.' This is done so that it is clear which data was obtained during the thesis research and which information is still unknown, thereby highlighting any remaining knowledge gaps. At the end of both sections, a summary of the value chain analysis is provided. This includes a complete flow chart of the Jelutung latex and Gemor bark value chains. In these flow charts, only the available information is provided (no N/A data is indicated).

For the value chain analyses it is important to understand the definitions of the terminology used:

- Production – all the Jelutung latex or Gemor bark (in kilograms) that is collected and sold by each of the value-chain actors in their step of the value chain. This definition assumes that the actors sell everything they collect. If this is not the case, this will be specified in the analysis;
- Production costs – costs the value-chain actor must spend on their Jelutung latex or Gemor bark activities. These can include transportation costs, equipment costs, and food and beverage costs (when farmers stay in the forest). Which costs are covered by the production costs are specified in the analyses;
- Farmgate price – price per kg at which the tappers or farmers sell their product to the next actor in the value chain; and
- Mid-stream / downstream price – price per kg at which value-chain actors at the mid-stream / downstream stages of the value chains sell the products. For example, the mid-stream price is the price at which the mid-stream actor (i.e. middleman or local trader) sells the product to the next actor in the value chain (i.e. large-scale trader).

In Chapter 3.3, following the value chain analyses, the results of the cost-benefit analyses are presented. The results of this section answer RQ3 of this thesis: "What are the economic costs and benefits of cultivating Jelutung latex and Gemor bark on plantations on undrained peatland?" Section 3.3.2 presents part of the results to RQ4: "What is the potential environmental impact of enhancing Jelutung latex and Gemor bark cultivation in Central Kalimantan?" The NPV of each cost-benefit analysis, both including and excluding the values of carbon emissions and sequestration, are displayed. The sensitivity analyses of the NPVs are also provided in this section. Finally, Chapter 3.4 provides the results of RQ5, on any potential additional crops that could generate value to farmers.

3.1 Jelutung Latex Value Chain Analysis

3.1.1 Upstream – Jelutung Tappers

Qualitative Data

The interviews with six Jelutung tappers provided qualitative information on the upstream step of the Jelutung latex value chain in Central Kalimantan. All the tappers cultivate Jelutung latex in the natural forest (in the wild). None of the tappers interviewed own land on which they grow Jelutung trees. Two of the tappers who do own their own land use it to grow rice for personal consumption. Moreover, none of the tappers interviewed harvest any other NTFPs besides Jelutung latex, except the tapper interviewed who also collects Gemor bark. Three tappers said that if the weather is bad and they cannot collect Jelutung latex, they will fish instead (for personal consumption). Two tappers, pak Alam and pak Suhadrani, tap together in a group with three other tappers near the Lamandau Wildlife Reserve (pak Alam is the head of the tappers group). The other four tappers collect Jelutung latex individually.

To reach the Jelutung trees in the forest, one tapper travels thirty minutes by motorbike. Two other tappers must travel two hours by motorbike to reach their Jelutung trees. The two tappers from the Lamandau Wildlife Reserve travel one kilometre by kelotok and then walk one hour to their tapping location. These answers indicate that tappers have varied ways of reaching the Jelutung trees in the forest, and some tappers must travel longer than others to reach their trees. Three tappers that were interviewed, from Kubu village, go back and forth to the forest every day to tap the latex. The other three tappers stay in the forest for 15 – 20 day periods. All the tappers explained that the Jelutung trees in the forest have been arranged in ‘lines.’ Every tapper has between 10 – 12 lines of Jelutung trees which they claim as their own lines based on an informal agreement amongst the Jelutung tappers in the same area. The lines from two tappers from the Lamandau area consist of 60 – 100 Jelutung trees per line. The tappers from Kubu village claimed to have around 50 Jelutung trees per line. According to pak Alam, who is the head of the Jelutung tappers group from the Lamandau area, the tappers know which trees belong to whom based on the characteristic of the cut / tap.

When the tappers were asked how they maintain the quality of the latex, all tappers answered that the quality is not difficult to maintain and that it is generally always sufficient. However, two tappers mentioned that it is important to ensure that the latex does not mix with rainwater as this will reduce the quality. None of the Jelutung tappers do any manufacturing / processing to the latex. Their only activities after collecting the latex from the forest is to place it in containers and add a slight amount of vinegar (10 – 15ml for 100l of latex) to the latex to keep it compact.

In general, there is a consensus amongst the tappers interviewed that the farmgate price of Jelutung latex is relatively stable, except for a significant decrease in 2014 when the price declined to US$0.45 per kg of latex. Three tappers mentioned this price reduction. The head of the tappers group in the Lamandau area, pak Alam, said that many tappers left the group to cultivate other crops because of the decrease in price of Jelutung latex in 2014. However, besides this occasion, tappers said that the price of latex is relatively constant. Four out of the six tappers interviewed are not satisfied with the price. One tapper acknowledged that although the price is higher than it was in 2014, he still thinks it is currently a bit too low. The two tappers from the Lamandau Wildlife Reserve area (who sell their latex for the highest price out of all the tappers interviewed) are satisfied with the farmgate price of latex in Central Kalimantan. Their lowest standard for the price is that they can buy 1 kg of rice from the money earned from selling 1kg of Jelutung latex (which is between US$0.64 – 0.75). When the Jelutung tappers were asked whether they would like to cultivate more or less Jelutung latex in the future, all tappers indicated they would like to cultivate more (as long as the price does not decrease). They said if they could they would cultivate more but that they are already working their hardest.

Concerning the effects of peat fires on Jelutung latex cultivation, two tappers, pak Alam and pak Suhadrani, who tap near the Lamandau Wildlife Reserve, explained that they collect less latex during months when there have been forest fires. They said that the productivity of the Jelutung trees is slightly lower when there is smoke and haze from the fires. Pak Yogi from Kubu village said that he did not notice any changes regarding the effects of fires on the productivity of Jelutung trees. However, pak Yogi did mention that Jelutung trees burn quickly and that three of his Jelutung trees burnt down during the dry season last year. The other tappers interviewed did not notice an effect of the forest fires on Jelutung latex cultivation.

To gain an impression of what the Jelutung tappers feel are barriers to cultivating Jelutung latex, they were asked for their opinions on this. The weather was mentioned as a main barrier by four tappers. According to two tappers this is because if it is too wet they cannot start working as early as usual which means they cannot collect as much latex on those days. Another tapper explained that if it is too wet in the forest then it is more difficult for him to tap the trees. Two out of these four tappers also explained that land tenure is a barrier to latex cultivation as they do not know how long they will be able to tap their Jelutung trees because they do not legally own the land. They want a community status on their Jelutung tree areas so they have less risk of losing the land. Another tapper, pak Yogi, mentioned the production costs that he has to lend to cultivate the latex as a main barrier. He answered that it is a barrier because he cannot determine the price of the latex he sells himself, and he cannot keep a portion of the latex he cultivates in stock because he has to sell everything to pay back the production costs. Pak Mohammad from Kubu village listed transportation (as well as weather conditions) as a main barrier to Jelutung latex cultivation. He explained that his travel time both to the Jelutung trees in the forest as well as to the local trader is long and that this limits his time to collect the latex. Lastly, one tapper said that the supply of Jelutung trees in the natural forest is decreasing and that this is a barrier of cultivation as it is harder to find trees to tap.

From the interviews, it is evident that there are two actor groups to whom Jelutung tappers can sell their latex in Central Kalimantan. First, they can sell it to a middleman who subsequently sells the Jelutung latex to the local trader. Second, Jelutung tappers can sell their latex directly to the local trader. According to the tappers, the only local trader in Central Kalimantan is PT SAS, located in Pangkalan Bun. Out of the six tappers interviewed, four used the latter method of selling their latex directly to PT SAS. Two tappers, pak Dedi from Kering Bangkirai and pak Yogi from Kubu village, sell their latex to a middleman instead of directly to PT SAS. According to pak Yogi, there are multiple middlemen who buy Jelutung latex from tappers and sell it to PT SAS; he works with his middleman because he trusts him the most. Other tappers also mentioned that their preference to sell their latex directly to PT SAS is based on trust.

Quantitative Data

Figure 3 displays the upstream step of the Jelutung latex value chain. The quantitative information of this step is based on the six interviews with Jelutung tappers in Central Kalimantan (of which one tapper is also a Gemor farmer).

Main upstream actors

Jelutung tappers

Per tapper

- Production (kg of latex / month): 300 – 600
  Average: **400**
- Production costs (USD / month): 98 – 188
  Average: **135**
- Farmgate price (USD / kg of latex): 0.60 – 0.75
  Average: **0.67**

Figure 3. Upstream step of Jelutung latex value chain in Central Kalimantan.

On average, tappers produce 400kg of latex per month. The amount of latex tappers produce per month ranges between 300 – 600kg. The weather conditions could be a reason for the range in Jelutung latex production per month. Four out of the six tappers mentioned that if it is raining or if the ground is too wet from the rain, they cannot collect as much latex as usual. Moreover, tappers generally work in the forest to collect Jelutung latex for 15 – 20 days. This range in time spent in the forest is another reason why tappers sometimes produce more or less latex. It is also possible that forest fires influence the production of latex per month, as two tappers said they notice a decline in the productivity of Jelutung trees during months when there is smoke and haze from forest fires.

The Jelutung tappers were also asked for their approximate monthly production costs of producing Jelutung latex. The average productions costs per tapper per month is US$135. These costs include food and beverages (and other necessities) during their stay in the forest, transportation costs (e.g. gas for their kelotok and / or motorbike), and equipment (such as the containers the latex is placed into and vinegar). The largest proportion of the production costs consist of the transportation costs. It is unclear from the interviews why some tappers have higher production costs than others. A possibility is that some tappers have to travel longer distances to collect and sell their latex.

The average farmgate price of 1kg of Jelutung latex is US$0.67. However, amongst the tappers interviewed this price can range between US$0.60 – 0.75 per kg of latex. The reason some tappers can sell 1kg of Jelutung latex for a higher price than other tappers is because some tappers do not have to lend production costs from the middleman or local trader. For example, the four tappers who sell 1kg of latex for the lower range of the farmgate price (US$0.60 – 0.64) all lend their production costs from the middleman or local trader they sell their latex to. According to one of these tappers, pak Yogi, this means the middleman / local trader can determine the farmgate price. Lending production costs also means they must sell all the latex they collect in order to pay back the production costs on time. On the other hand, two of the Jelutung tappers interviewed, pak Alam and pak Suhadrani, directly pay their production costs themselves. As these tappers do not lend production costs from the actor they sell their latex to, the tappers have more bargaining power and can sell their latex for a higher price (both sell 1kg of latex for US$0.75). Moreover, pak Alam and pak Suhadrani both keep around a third of the latex they collect every month as an ‘insurance’ in case a situation arises where they need to earn money quickly. Therefore, the range in the farmgate price of Jelutung latex depends mostly on whether the tappers lend their production costs or not. Five of the tappers interviewed earn all their income from cultivating Jelutung latex; they do not have any other income sources. The sixth tapper is also a Gemor farmer and therefore a proportion of his income comes from Gemor bark. This tapper, pak Dedi from Kering Bangkirai, gets around 25% of his income from cultivating Jelutung latex.

3.1.2 Mid-stream – PT SAS

As mentioned in the previous section, the Jelutung tappers in Central Kalimantan can sell their latex to either a middleman or directly to the local trader PT SAS. During the fieldwork, it was not possible to interview a Jelutung latex middleman. Therefore, this section will focus on the qualitative and quantitative information obtained from the interview with pak Mingky from PT SAS.

Qualitative Data

Pak Mingky has been the manager of PT SAS for 24 years. He describes PT SAS as the local trader of Jelutung latex in Pangkalan Bun, Central Kalimantan. PT SAS also used to trade rubber but now they only trade Jelutung latex. Pak Mingky explained that they collect Jelutung latex either directly from the tappers or from middlemen. Approximately fifty Jelutung tappers sell their latex to PT SAS. It takes around one week for PT SAS between buying the Jelutung latex from the tappers and middlemen and transporting it to the next actor in the value chain (the large-scale trader, PT Sampit).

When asked about the price stability of Jelutung latex, similar to the Jelutung tappers pak Mingky also described the decrease in price three years ago (around 2014), when it dropped to US$0.45 per kg of latex. He said that at this time many tappers quit and there were almost no Jelutung tappers left. He explained that the price is higher now, US$0.75 per kg, and as a result tappers are returning to the Jelutung latex business. Regarding the quality of Jelutung latex, pak Mingky answered that the quality is generally always good. However, if the quality is less good, PT SAS will charge a lower price for the latex. At PT SAS, they do not do any manufacturing or processing to the Jelutung latex. Their activities include checking the quality of the latex and packaging it into 70 – 100kg packages.

Pak Mingky was also asked about his opinion on the main barriers of expanding the Jelutung latex market in Central Kalimantan. He answered that he felt the supply of Jelutung latex is a main barrier. According to him, tappers still rely mostly on cultivating Jelutung latex from the natural forest, but that this supply is decreasing because of the conversion of land into palm-oil plantations. As a result, tappers have more difficulty finding Jelutung trees. Pak Mingky mentioned that ten years ago the supply of Jelutung latex to PT SAS was 2 – 3 times higher than what it is today. Furthermore, there used to be another local trader of Jelutung latex in Palangka Raya (the capital city of Central Kalimantan) but according to pak Mingky this business ended around three years ago due to the decrease in price of Jelutung latex and the limited supply. All the latex collected by PT SAS is picked up by transport arranged by PT Sampit. PT Sampit is the large-scale trader of Jelutung latex in Sampit, Central Kalimantan. Pak Mingky described PT SAS as a branch office of PT Sampit. This means that PT Sampit provides PT SAS with financial resources to fund all their operations, including for example paying for the employee salaries, the transportation of the latex from PT SAS to PT Sampit, and any other production costs.

Figure 4. Photo of PT SAS warehouse, Pangkalan Bun, Central Kalimantan. White packages contain Jelutung latex.

Quantitative Data

Figure 5 displays the mid-stream step of the Jelutung latex value chain. The quantitative information in this step is based on the interview with pak Mingky from PT SAS, the local trader of Jelutung latex in Pangkalan Bun, Central Kalimantan.

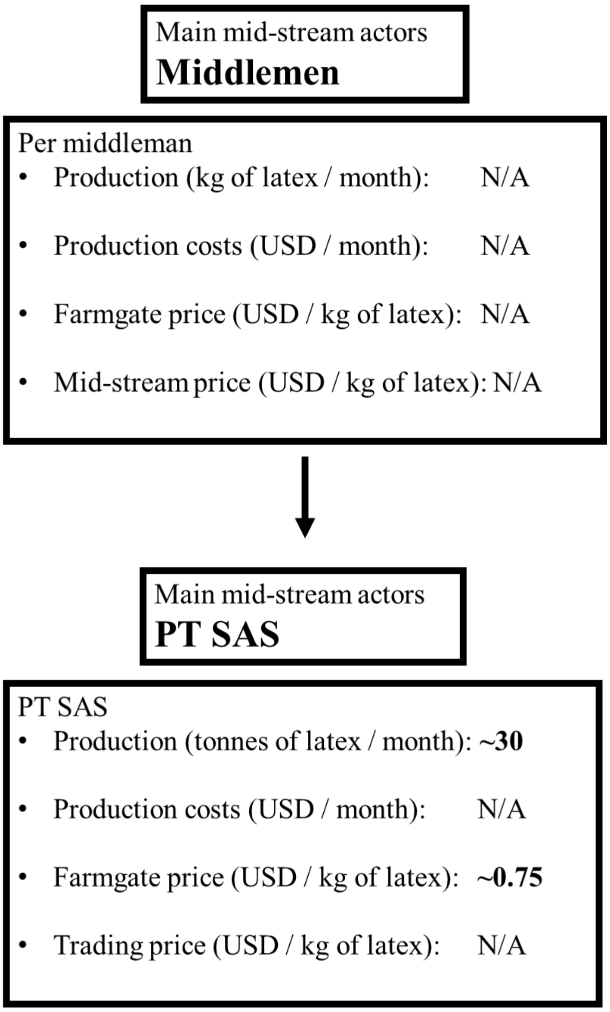

Figure 5. Mid-stream step of Jelutung latex value chain in Central Kalimantan. PT SAS is the local trader of Jelutung latex from Pangkalan Bun.

The interview with pak Mingky from PT SAS did not yield all the quantitative data that was initially aimed for. The average production of PT SAS is 30 tonnes of Jelutung latex per month. This refers to all the latex they buy from the tappers and middlemen and after packaging is transported to PT Sampit. Pak Mingky did not know the production costs of PT SAS (i.e. packaging, transport, and wages), claiming that PT Sampit pays for all production costs of PT SAS. Concerning the farmgate price of Jelutung latex in Central Kalimantan, pak Mingky said that PT SAS generally buys 1kg of latex from a tapper or middleman for US$0.75. The mid-stream price per middleman (which was not found) represents the price a middleman sells 1 kg of latex for to PT SAS. Furthermore, pak Mingky explained that PT SAS does not sell the Jelutung latex to PT Sampit as PT Sampit provides PT SAS with the finances to purchase the latex; PT SAS is a branch office of PT Sampit. Therefore, there is no mid-stream price available at this stage of the Jelutung latex value chain.

3.1.3 Downstream – PT Sampit & Importers

The downstream section of the Jelutung latex value chain consists of two value-chain actor groups, the large-scale trader of Jelutung latex in Central Kalimantan, PT Sampit, and the importers, Lotte and Gum Base. The qualitative and quantitative information on PT Sampit is based on the questionnaire answered by pak Ekri (the export and import manager of PT Sampit) and the interview with pak Mingky from PT SAS. No interviews were conducted with employees from Lotte or Gum Base and therefore the information on the final step of the Jelutung latex value chain is limited.

Qualitative Data

According to pak Ekri from PT Sampit, the company has been involved in the Jelutung latex business since the 1980's. PT Sampit also trades rubber (Standard Indonesian Rubber 10, 20, and 30). Pak Ekri said that he has not heard of any other large-scale traders of Jelutung latex in Indonesia. Pak Mingky from PT SAS also said in his interview that PT Sampit is the only large-scale trader and exporter of Jelutung latex in Kalimantan (and therefore also Central Kalimantan). Pak Ekri explained that PT Sampit gets the Jelutung latex from collectors / middlemen and tappers who deliver the latex to PT Sampit's depot in Pangkalan Bun. It can be assumed that this depot is PT SAS, as the business is located in Pangkalan Bun and pak Mingky said that all the latex from PT SAS goes to PT Sampit. The Jelutung tappers interviewed also said that PT SAS is the only local trader of Jelutung latex in Pangkanlan Bun. In the questionnaire, pak Ekri answered that the processing of Jelutung latex by PT Sampit consists of washing the latex, breaking it up into smaller pieces, and reducing the water content. Lastly, the latex is moulded into a rectangular box weighing 20kg per box which is 42cm long, 30cm wide, and 15cm high. When asked for his opinion on how the Jelutung latex market in Central Kalimantan has changed over recent years, pak Ekri answered that the demand for latex has been relatively stable, but that the supply has been decreasing rapidly. He also said that the price has not changed much. Regarding his thoughts on whether there is a market to expand the cultivation and trading of Jelutung latex in Central Kalimantan, pak Ekri does not think there is a market because of expanding oil palm plantations that limit the supply of Jelutung latex.

After manufacturing and processing, PT Sampit sells the Jelutung latex to a South Korean and Japanese company called Lotte, and an Italian company called Gum Base. Lotte is PT Sampit's biggest buyer, which has a long-term contract with the large-scale trader for a shipment of 18 tonnes of Jelutung latex per month. Pak Ekri said there is a stable demand from the buyers for Jelutung latex from PT Sampit. Furthermore, according to pak Ekri from PT Sampit, before delivering the latex to Lotte, PT Sampit sends a sample of the latex with lab test results to Lotte in Japan. PT Sampit ships the latex once Lotte has approved the lab results. Pak Ekri did not provide any further information on the processing of Jelutung latex by Lotte or Gum Base.

Quantitative Data

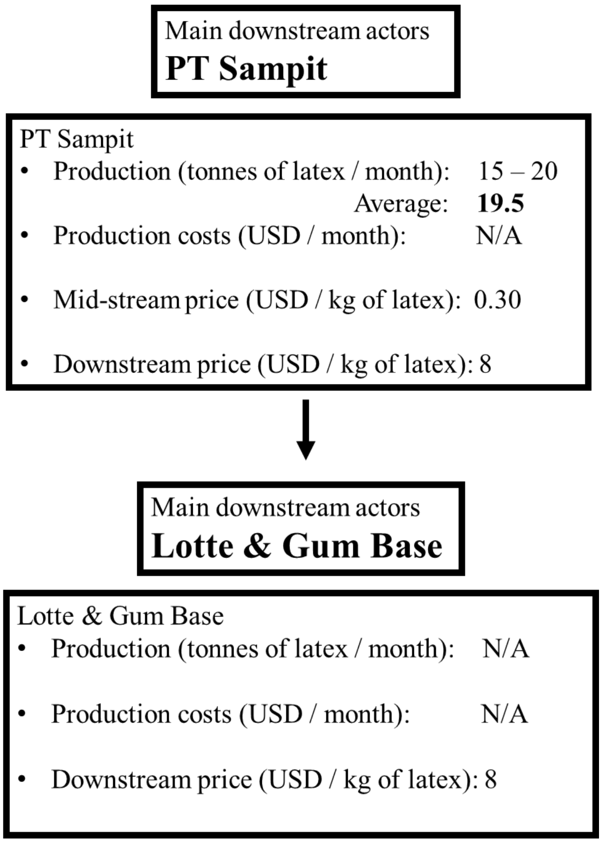

Figure 6. Downstream section of Jelutung latex value chain in Central Kalimantan. PT Sampit is the large-scale trader of Jelutung latex. Lotte and Gum Base are the importers.

According to the export and import manager of PT Sampit, pak Ekri, PT Sampit buys between 15 – 20 tonnes of latex per month from Jelutung tappers and collectors. The range of production depends on the supply of Jelutung latex, but the maximum amount of latex they buy per month never exceeds 20 tonnes. PT Sampit sells everything they buy, which on average is approximately 18 tonnes of Jelutung latex per month to Lotte, and 18 tonnes of Jelutung latex per year to Gum Base. This yields an average amount of latex production of 19.5 tonnes per month. Pak Ekri did not provide information regarding the production costs of trading Jelutung latex by PT Sampit. Concerning the mid-stream price of Jelutung latex, pak Ekri said that PT Sampit pays around US$0.30 per kg of latex. The latex is subsequently sold for a downstream price of US$8 per kg. Pak Ekri explained that the price of Jelutung latex is adjusted every two years, but also refers to the price as stable. As no interview was conducted with employees of Lotte or Gum Base, no quantitative information on their production amount and production costs was found. In addition, no data on the amount the sell their final product containing Jelutung latex (chewing gum) for was found.

3.1.4 Summary of Jelutung Latex Value Chain

The Jelutung latex value chain in Central Kalimantan begins with the Jelutung tappers. The tappers interviewed cultivate Jelutung latex in various places in the province, including near the Lamandau Wildlife Reserve, Kubu village, and Kering Bangkirai. Jelutung tappers cultivate the latex in the natural forest where the trees are arranged in lines based on an informal agreement amongst the tappers of the area. Each line can have between 50 – 100 Jelutung trees and each tapper has 10 – 12 lines. Tappers either go back and forth everyday between their homes and the forest, or they stay in the forest for 15 – 20 day periods. Once the latex has been collected, they place it into containers and add some vinegar to keep the latex compact. The quality of the latex is not an issue for the tappers, as long as it does not mix with rainwater. The amount of latex produced by Jelutung tappers typically depends on the weather conditions and the number of days spent working in the forest to cultivate the latex. Some tappers lend their production costs from a middleman or the local trader, whilst others pay for their own production costs. This influences the farmgate price per kg of Jelutung latex. Tappers who do not lend production costs can generally sell their latex for a higher farmgate price than those who do.

The next step of the Jelutung latex value chain is the mid-stream step. Jelutung tappers can either sell their latex to a middleman (who then sells it to PT SAS), or directly to the local trader known as PT SAS. Tappers claim that PT SAS is the only local trader of Jelutung latex in Central Kalimantan. To whom a tapper sells their latex is a matter of trust. Approximately fifty tappers sell their Jelutung latex to PT SAS. At this stage of the value chain, there are also no issues regarding the quality of the Jelutung latex. At PT SAS, there is no manufacturing or processing done to the latex. In total, the local trader buys around 30 tonnes of Jelutung latex per month from tappers and middlemen, and all of this is transported to the large-scale trader PT Sampit. The relationship between PT SAS and PT Sampit is such that PT SAS can be described as a branch office of PT Sampit. PT Sampit owns the local trader and provides all the financial resources for PT SAS to carry out its operations. Therefore, the relationship between PT SAS and PT Sampit is not a typical buyer-seller relationship. For this reason, the production costs of PT SAS are not available.

PT Sampit is the only large-scale trader of Jelutung latex in Central Kalimantan, and possibly also in Indonesia, and represents part of the downstream section of the Jelutung latex value chain. The company collects their Jelutung latex from PT SAS, their depot in Pangkalan Bun. The large-scale latex trader manufactures the latex by cleansing it and extracting the original water content from the latex. They also break it into smaller pieces and mould it into rectangular boxes of 20kg per box. PT Sampit sells the majority of their Jelutung latex to Lotte, a South-Korean and Japanese company which uses the latex to manufacture chewing gum. PT Sampit also sells some of the Jelutung latex to an Italian company called Gum Base. As neither Lotte or Gum Base employees could be interviewed, there is limited quantitative and qualitative knowledge on this final step of the Jelutung latex value chain.

Figure 7 on the following page provides a complete flow chart of the Jelutung latex value chain in Central Kalimantan, including all the known quantitative data obtained from the interviews.

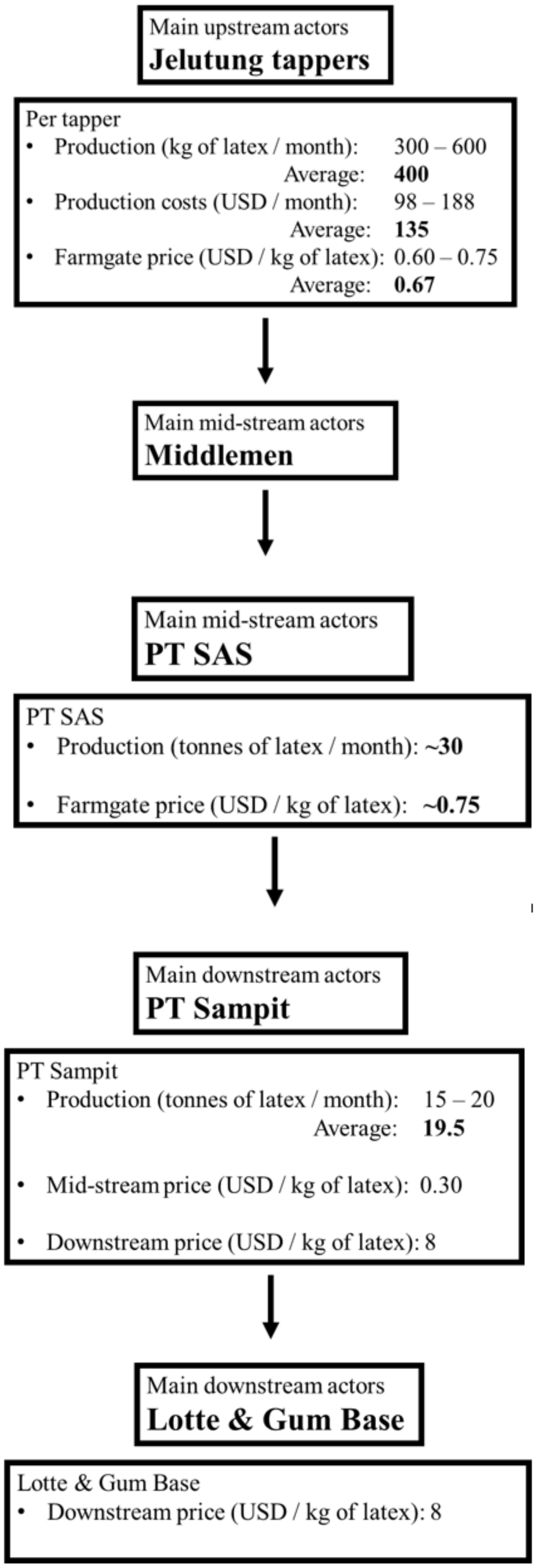

Figure 7. Jelutung latex value chain in Central Kalimantan (complete).

3.2 Gemor Bark Value Chain Analysis

3.2.1 Upstream - Gemor Farmers

Qualitative Data

Gemor bark farmers were interviewed to obtain qualitative information on the upstream section of the Gemor bark value chain in Central Kalimantan. In total five farmers were interviewed during fieldwork, including an interview with pak Dedi from Kering Bangkirai, who cultivates both Jelutung latex and Gemor bark. Four out of the five farmers own their own land, but none of them grow Gemor trees on their land. Two farmers with their own land said they used to have Gemor trees but that these all burnt down during forest fires in previous years. All the farmers interviewed go to the natural forest to cultivate Gemor bark.

Four out of the five farmers harvest other NTFPs besides Gemor bark. Pak Dedi also harvests Jelutung latex, pak Intau collects Rattan, pak Agan harvests rubber from the natural forest, and pak Gunawan collects Geharu, Damar, and Jelutung seedlings. Farmers generally travel one day by kelotok to reach the Gemor trees in the natural forest. One of these farmers explained that he travels so far because he knows that he can find bigger Gemor trees further away. Two other farmers said that in the past they could travel less than an hour by kelotok to find Gemor trees to cultivate, whereas now their travel time reaches 1 – 2 days. Only one farmer, pak Gunawan, reaches the Gemor trees he cultivates by walking for 30 minutes. This farmer goes back and forth to the forest every day to cultivate Gemor bark. The other farmers who have to travel further to collect Gemor bark usually stay in the forest for 2 – 3 weeks per month.

Amongst the farmers interviewed, there was a consistency in the method they use to collect Gemor bark. All farmers cut the entire tree down from 40 – 50cm above the ground, and then remove all the bark from the tree. Pak Supri from Karuna village explained in more detail that he uses an axe to cut down the tree and a skinner to remove the bark from the trunk. He leaves 50cm of the trunk with the knowledge that doing so will allow new shoots to grow back. According to pak Supri, after three months a new shoot of the Gemor tree will appear. Following this, it takes between 8 – 10 years before the tree is ready to be cut and harvested again. Three of the other Gemor farmers claim that it takes around five years for the Gemor trees to grow back to a suitable diameter for harvesting, provided the tree is cut 40 – 50cm above the ground. Pak Gunawan from Taruna village explained that the minimum diameter for harvesting a Gemor tree is around 12cm. According to him, a big Gemor tree has a diameter of around 40 – 50cm.

Furthermore, out of the five farmers that were interviewed, four collect Gemor bark in a group. The sizes of the groups range between 4 – 20 farmers. Pak Intau and pak Agan from Kering Bangkirai work in the same group with 10 – 15 farmers. The farmers who work in a group to cultivate Gemor bark were asked how they share the total income amongst group members. Two out of the four farmers explained that the income is shared based on the farmers' position in the group. For example, a senior famer (an older farmer with more experience) will receive a higher income per kilogram of Gemor bark than a junior farmer. The group in Kering Bangkirai with pak Intau and pak Agan has two senior farmers and the remainder of the group consists of 10 – 13 junior farmers. Pak Intau is a senior farmer and receives US$0.53 – 0.60 per kg of dry Gemor bark, whereas pak Agan, being a junior farmer, receives US$0.45 for a kg of dry Gemor bark. The other two farmers interviewed who also work in a group to collect Gemor bark said that they share the income equally between group members; they do not make a distinction between senior and junior farmers.

The quality of Gemor bark, is best, according to pak Gunawan, when it is collected at 10 – 15 years old because because he thinks this is the optimal age to ensure good quality bark. One farmer, pak Dedi from Kering Bangkirai, said that it is important to prevent water from getting the bark wet which might happen when it is raining or during transportation of the bark in his kelotok. Overall, however, the farmers claimed that the quality of Gemor bark is usually sufficient and that they do not do anything specific to maintain the quality. Before selling the Gemor bark, farmers dry the bark in the sun or above a fire. Three out of the five farmers dry their bark for 3 – 4 days in the sun before selling it. If it is cloudy, they may dry the bark for up to a week. The other two farmers, pak Intau and pak Dedi, dry the bark above a fire. Pak Intau lets the Gemor bark dry above a fire for one day and one night, and then further dries it in the sun for three days. Pak Dedi only uses a fire to dry his bark, positioning it 2m above the fire for one day and one night.

In the interviews, all the Gemor farmers indicated that in terms of the price stability of the farmgate price of Gemor bark, the price is increasing. Pak Supri from Taruna village explained that in 2010 the price was the lowest but that now the price is rising. Two of the five farmers attributed this price increase to the reducing supply of Gemor trees in the natural forest. Moreover, all the farmers that were interviewed are satisfied with the current farmgate price of Gemor bark. When asked whether they want to cultivate more or less Gemor bark in the future, all the Gemor farmers answered that they would like to cultivate more. Three out of the five farmers said that they want to cultivate more because they are satisfied with the price of Gemor bark and would like to earn more money by collecting more bark. However, there were also three farmers that mentioned the supply of Gemor trees in the forest as a problem for them to cultivate more bark. They explained that although they would like to cultivate more, it would be difficult because the natural supply of Gemor trees is low.

In general, there is a consensus amongst the Gemor farmers that the peat fires in Central Kalimantan negatively affect Gemor bark cultivation by decreasing the supply of Gemor trees both in the natural forest and on private land. Two out of the five farmers also mentioned a reduction in the quality of Gemor bark as an effect of the peat fires (they did not further explain this). All farmers mentioned the supply of Gemor trees has decreased as a result of the peat fires. Pak Supri noticed that after the 2015 peat fires in Central Kalimantan, around 75% of the Gemor trees in the forest area he works in were burnt down. The Gemor farmers were also asked about their opinion on the main barriers of cultivating Gemor bark. All farmers listed the limited supply of Gemor trees as a main barrier. Three out of the five farmers also mentioned the peat fires as a barrier of Gemor bark cultivation. One of these farmers claimed that the fires burnt down his personal stock of Gemor trees (on his private land). Pak Agan from Kering Bangkirai said that the lack of land available for farming is in his opinion a barrier to cultivating Gemor bark. He explained that the area where he typically collects the bark has already greatly decreased in size because of the establishment of forest conservation areas. Currently, pak Agan is cultivating Gemor in the buffer zone of the Sebangau national park, but he is worried this zone will also become a conservation area soon. Overall, the decreasing supply of Gemor trees was described as the main barrier of Gemor bark cultivation by the farmers interviewed.

There are two main actor groups to whom Gemor farmers sell their Gemor bark. These actors include the local traders of Gemor bark in Central Kalimantan, and the large-scale trader. Two out of the five farmers sell their Gemor bark to a local trader. One of these sells their bark to pak Banda, a local trader located in the Kapuas District of Central Kalimantan. The second farmer sells his Gemor bark to a different local trader in Tumbang Nusa (Pulang Pisau District), called pak Nunung. The other three out of the five farmers sell their bark directly to the large-scale trader in Banjarmasin, South Kalimantan. This large-scale Gemor bark trading business is called UD Kesuma Jaya and is owned by pak Tantono. Out of these three farmers who sell their bark directly to pak Tantono, two sell it by means of a village collector. For a fee this collector transports the bark from everyone in the Gemor farmers group to UD Kesuma Jaya. The third Gemor farmer gets his bark picked up once a month by speedboat by someone from UD Kesuma Jaya. Therefore, in Central Kalimantan farmers can sell their Gemor bark either to a local trader or to the large-scale trader (possibly via a collector).

<u>Quantitative Data</u>

Main upstream actors
Gemor farmers

Per farmer
- Production (kg of bark / month): 300 – 1000
  Average: **750**
- Production costs (USD / month): 10 – 110
  Average: **50**
- Farmgate price (USD / kg of bark): 0.45 – 0.75
  Average: **0.64**

Figure 8. Upstream section of Gemor bark value chain in Central Kalimantan.

The above figure shows the upstream section of the Gemor bark value chain with the quantitative data obtained during the interviews with five Gemor farmers. The amount of Gemor bark that farmers cultivate and sell per month ranges between 300 – 1000kg per month. The range in production amount depends partially on how many days per month farmers collect Gemor bark in the forest. Farmers that spend more days working in the forest per month also generally cultivate more Gemor bark in that month. One farmer, pak Intau from Kering Bangkirai, mentioned that 25 years ago he could collect twice as much Gemor bark per day compared to today because of the limited availability of Gemor trees in the natural forest. Hence, range in monthly production amounts amongst the farmers is also attributed to the fact that the supply of Gemor trees in the wild is decreasing, and in some months farmers are unable to find as many Gemor trees to cultivate as in other months. Pak Intau also explained that nowadays he has to harvest more Gemor trees than in the past because the diameters of the trees are smaller now. The average production of Gemor bark per farmer is 750kg per month. This represents the amount that farmers cultivate and sell. It is important to note that this amount represents the weight of the bark when it has already been dried.

The production costs of cultivating Gemor bark per farmer per month range between US$10 – 110, with average production costs of approximately US$50 per farmer per month. The low range of production costs is attributed to the fact that pak Gunawan, who spends around US$10 on production costs for cultivating Gemor bark per month, does not stay in the forest. Instead, pak Gunawan goes back and forth every day. Furthermore, he reaches the Gemor trees by walking so he does not have to spend money on gas to get to and from the trees unlike the other farmers who travel by kelotok. Pak Gunawan spends all his production costs on transporting the bark to the trader he sells it to. On the other hand, the other farmers stay in the forest for longer periods of time and therefore have to spend the production costs on necessities such as gas, food, and beverages for during their stay in the forest. These costs can differ depending on how long the farmers stay in the forest. All the farmers interviewed, except pak Gunawan, borrow their production costs from the trader they sell their bark to.

From the interviews with Gemor farmers it is also evident that farmers sell their bark at different prices. The farmgate price per kg of dry Gemor bark ranges between US$0.45 – 0.75. The average farmgate price is US$0.64 per kg of dry bark. One reason for a range in the farmgate price could be whether a farmer is a senior or junior member of the group. Another reason could be the different people that the farmers sell their bark to (i.e. local or large-scale traders), who may charge variable prices for the bark. Four out of the five farmers interviewed collect other NTFPs besides Gemor bark. However, for all these farmers Gemor bark still provides them with 70 – 75% of their total income. For example, pak Gunawan and pak Dedi, get 70% and 75% of their incomes from Gemor bark respectively.

3.2.2 Mid-stream – pak Nunung

In the previous section it was explained that Gemor farmers in Central Kalimantan can sell their bark either to a local trader or directly to the large-scale trader in Banjarmasin. One of the Gemor farmers, pak Gunawan, sells his Gemor bark to pak Nunung, the local trader in Tumbang Nusa. During the fieldwork, an interview was conducted with pak Nunung. The information from this interview will be used in this section to present qualitative and quantitative data on the mid-stream step of the Gemor bark value chain in Central Kalimantan. No other local traders were interviewed.

Qualitative Data

Pak Nunung has been trading Gemor bark for 25 years. His business is in Tumbang Nusa in the Pulang Pisau District. Besides Gemor bark, pak Nunung also trades Geharu, Klanis, Pasak Bumi, and Ginseng. These products are all NTFPs used to produce cosmetic and health products that are sold nationally. When asked which of the products traded by pak Nunung provide the largest source of income for him, he said that Geharu and Pasak Bumi are currently his best sources of income. He ranked Gemor bark as his third best source of income. To gain a better understanding of the connection between the upstream and mid-stream sections of the Gemor bark value chain, pak Nunung was asked from whom he collects the bark. He answered that he gets the bark directly from farmers (or the group collectors), primarily from Tumbang Nusa, Kering Bangkirai, and Sampit. He does not get any bark from outside of Central Kalimantan. Moreover, pak Nunung explained that there are no middlemen operating between him and the farmers (except the collector of a farmers group). Either pak Nunung goes to the farmers to collect the bark from them, or the farmers go directly to him in Tumbang Nusa. This coincides with the farmer pak Gunawan's answer, who said that he transports the bark himself to pak Nunung.

Pak Nunung collects his Gemor bark mostly from groups of farmers but also from some farmers who work individually. In total, pak Nunung works with approximately 30 – 40 Gemor farmers. Concerning the quality of Gemor bark, pak Nunung said that the quality of the bark is always good. At his business, they make sure to collect only the yellow-red species of bark (explained in Section 2.1.2 of this thesis) which, according to pak Nunung, is always of high quality. After buying the bark from the farmers, pak Nunung cuts the bark into smaller pieces and lays it in the sun for four days for further drying. Once the bark is completely dry, it is packaged into 25 – 30kg packages. Besides this, pak Nunung does not do any manufacturing or processing to the Gemor bark. Pak Nunung was also asked how long it takes between buying the Gemor bark from the farmers and selling it again. He answered that usually it takes around ten days as the bark still has to be dried, packaged, and transported. However, if the weather conditions are not optimal for drying the bark (i.e. it is rainy or cloudy), it may take a longer time before the bark can be sold.

Pak Nunung's opinion on the current market situation of Gemor bark in Central Kalimantan is that the supply of the bark is low. He explained that ten years ago he would trade up to 100 tonnes of Gemor bark per month but today this amount has decreased by ten times. Pak Nunung attributes this to a declining availability of Gemor trees in the natural forest. The limited supply of Gemor trees is also what pak Nunung feels is the main barrier of trading Gemor bark. Another barrier for him is the price stability; pak Nunung would like the price of the bark to be more stable as according to him the price has fluctuated throughout the years. Regarding the barriers of trading NTFPs in general, pak Nunung answered that the production costs for farmers to cultivate NTFPs is typically quite high. For pak Nunung this is a barrier because it means he has to pay the farmers more to collect the bark. Moreover, pak Nunung was asked what he would like to see change in his Gemor trading business next year. He said that he would prefer it if his production costs would be paid for by the large-scale Gemor bark trader, UD Kesuma Jaya, rather than paying the costs himself. Pak Nunung sells all the bark he collects to UD Kesuma Jaya, which he refers to as the final trader of Gemor bark in Kalimantan.

Quantitative Data

The quantitative information on the mid-stream section of the Gemor bark value chain, based on the interview with the local trader pak Nunung, is presented in Figure 9.

Main mid-stream actors
Pak Nunung

Pak Nunung
- Production (tonnes of bark / month): **10**
- Production costs (USD / month): **300**
- Farmgate price (USD / kg of bark): **0.67**
- Mid-stream price (USD / kg of bark): **1.20**

Figure 9. Mid-stream section of Gemor bark value chain in Central Kalimantan. Pak Nunung is a local trader from Tumbang Nusa.

From the interview with pak Nunung, it is clear that at this mid-stream step of the Gemor bark value chain the local trader produces around 10 tonnes of bark per month. This means that pak Nunung buys 10 tonnes of bark per month from the farmers, and sells all of that bark (also around 10 tonnes) to the large-scale trader in Banjarmasin. The production costs of pak Nunung's Gemor bark business are approximately US$300 per month. The majority of these costs consist of the employee salaries. Pak Nunung explained that typically he has four employees working on 1 ton of bark (with work involving drying and packaging), and each employee is paid around US$7.50 per month for these activities. With the business trading 10 tonnes of bark per month, a total of US$300 for employee salaries is calculated. It is possible that pak Nunung may have additional costs for example for transportation, however this was the total monthly production costs he provided in the interview. The farmgate price refers to the price at which pak Nunung buys 1 kg of Gemor bark from the farmers. According to pak Nunung, this is around US$0.67 per kg. The price can be slightly lower if the bark is not dry enough. However, for sufficiently dry bark a price of US$0.67 per kg is generally the price at which pak Nunung purchases Gemor bark. The mid-stream price represents the price at which pak Nunung sells 1kg of Gemor bark for to UD Kesuma Jaya, the large-scale trader. This price is US$1.20 per kg.

3.2.3 Downstream – UD Kesuma Jaya

The downstream section of the Gemor bark value chain consists of UD Kesuma Jaya, the large-scale Gemor bark trader owned by pak Tantono located in Banjarmasin, the national exporters, and the importers. No interviews were conducted with the latter two actor groups of the downstream step of the value chain. Therefore, this section focuses on the qualitative and quantitative information from the interview with pak Tantono.

<u>Qualitative Data</u>

Pak Tantono has been trading Gemor bark for fourty years through his business called UD Kesuma Jaya. Today, Gemor bark is no longer his main source of income. When asked what his other sources of income are, he said that he does not trade any other NTFPs and that the rest of his income comes from other businesses. Pak Tantono did not want to elaborate further on these businesses. The connection between the mid-stream and downstream steps of the Gemor bark value chain was further investigated during the interview with pak Tantono. He said that he collects his bark either directly from the Gemor farmers or from local traders. The bark that pak Tantono buys has already been sun dried and is still in its natural form (no further manufacturing). All of the Gemor bark comes from Central Kalimantan, as according to pak Tantono this is the main natural habitat for Gemor trees in Kalimantan.

Pak Tantono explained that the quality of Gemor bark varies depending on the thickness of the bark, which in turn depends on the way the farmers cultivate the bark. If the bark is too thick, it must be cut into smaller pieces. Pak Tantono also said that a variable quality is to be expected as Gemor bark is a natural product. There is no manufacturing or processing done to the Gemor bark at UD Kesuma Jaya, besides cutting the bark into pieces and further drying of the bark in the sun. The bark is dried further so that it can be packaged more easily. One package contains 45kg of Gemor bark. The process of drying and packaging generally takes around ten days.

When asked about his opinion on the Gemor bark market in Kalimantan, pak Tantono answered that currently there is less demand and supply than in the past. He attributes the decrease in supply of Gemor trees to the conversion of natural land into palm-oil plantations. Pak Tantono also thinks that another issue is that most farmers do not plant Gemor, meaning they still rely on the natural availability of the trees in the forest. Moreover, pak Tantono explained that there is less demand for Gemor bark because previously the bark was used to make mosquito coils, however now a synthetic replacement has been found. Therefore, today Gemor bark is only used to make incense sticks known as hio. Furthermore, due to the lack of demand for Gemor bark, pak Tantono does not think there is a market to expand the cultivation of Gemor bark in Kalimantan. He said that he has already switched to other businesses to earn his living, and that Gemor bark is considered a 'sunset' business because of its declining popularity.

Concerning the final stages of the downstream step of the Gemor bark value chain, pak Tantono sells his Gemor bark to factories in Surabaya and Jakarta. He did not want to name these factories. The bark is kept in his warehouse until one of the factories places an order for the bark. Pak Tantono then arranges the transportation of the bark to the factories, where according to him it is changed into powder. After this, pak Tantono claims the powder is either sold nationally or exported to China and Taiwan where it is used to make hio. According to pak Tantono, China and Taiwan are the biggest importers of Gemor bark powder.

Figure 10. UD Kesuma Jaya warehouse in Banjarmasin, South Kalimantan.

Quantitative Data

Main downstream actors
UD Kesuma Jaya

UD Kesuma Jaya
- Production (tonnes of bark / month): **15**
- Production costs (USD / month): **600**
- Mid-stream price (USD / kg of bark): **0.90**
- Downstream price (USD / kg of bark): **3.74**

↓

Main downstream actors
Factories

Surabaya & Jakarta factories
- Production (tonnes of bark / month): N/A
- Production costs (USD / month): N/A
- Downstream price (USD / kg of bark): N/A
- Export price (USD / kg of bark): N/A

Figure 11. Downstream section of Gemor bark value chain in Central Kalimantan. UD Kesuma Jaya is the large-scale trader in Banjarmasin.

From the interview with pak Tantono from UD Kesuma Jaya, the large-scale trader of Gemor bark, quantitative information was obtained on the downstream section of the Gemor bark value chain. Firstly, the production (the amount of bark that is bought and sold) by UD Kesuma Jaya is around 15 tonnes per month. In the interview, pak Tantono mentioned that ten years ago he traded 100 tonnes per month and that now it has decreased a lot because of the limited supply of Gemor trees in the natural forest. The production costs of pak Tantono's business activities related to Gemor bark are US$600 per month. These costs include the employee salaries and the transportation costs of the bark. Pak Tantono said that he spends approximately US$0.04 per kg of bark for production costs. When multiplying these costs per kg with the 15 tonnes of bark that UD Kesuma Jaya trades, a total of US$600 monthly production costs is calculated.

The mid-stream price shown in Figure 11 represents the price at which pak Tantono buys a kg of Gemor bark from the farmers and / or local traders. Pak Tantono claims that this price is usually around US$0.90 per kg. The downstream price of Gemor bark is the price at which pak Tantono sells a kg of Gemor bark for to the exporting factories in Surabaya and Jakarta. This price is US$3.74 per kg of bark. Pak Tantono sells all his Gemor bark (15 tonnes) to factories in Surabaya and Jakarta. Quantitative data on these value chain actors is not available as no interviews were conducted with them. Pak Tantono explained that after turning the Gemor bark into powder, the factories export the bark to China and Taiwan. This represents the final stage of the downstream value chain step of Gemor bark.

3.2.4 Summary of Gemor Bark Value Chain

The first actors of the Gemor bark value chain in Central Kalimantan are the Gemor farmers. The farmers who were interviewed live and collect Gemor bark in Taruna village and Kering Bangkirai. Some farmers harvest other NTFPs besides Gemor bark. However, Gemor bark still serves as the main source of income for the farmers interviewed. All farmers cultivate Gemor bark in the natural forest. Most farmers work in groups to collect the bark. Between group members the income is either shared equally or is divided depending on whether the member is a senior or a junior farmer. The majority of the farmers have to travel one day or longer by kelotok to reach the Gemor trees in the forest. In the past, the travel time was shorter because the trees were more widely available. To cultivate Gemor bark, farmers cut the entire tree down from 40 – 50cm above the ground. Following this, all the bark is removed from the tree and transported back to the village where it is spread in the sun and / or held above a fire to dry. Overall, farmers do not do anything in particular to manage the quality of the bark, claiming that it is generally always good quality. Depending on the number of days farmers spend in the forest to collect Gemor bark, the production amount can be higher or lower in different months. Farmers who stay in the forest during the collecting period spend more production costs than farmers who go back and forth every day. According to the farmers, the farmgate price per kg of Gemor bark is rising due to the decreasing supply of Gemor trees in the natural forest.

The next step of the Gemor bark value chain is the mid-stream step. The main actors at this stage of the value chain are the local traders. Pak Nunung, the local trader from Tumbang Nusa, trades Gemor bark as well as several other NTFPs, with Gemor bark being his third best source of income. Pak Nunung either collects the bark from the farmers himself, or the farmers transport the bark to him personally. Before selling the bark, pak Nunung cuts it into smaller pieces and lays it in the sun for further drying. Pak Nunung claimed that the quality of the bark is always good. All the bark that he buys is subsequently sold to the large-scale trader, UD Kesuma Jaya in Banjarmasin. Currently, pak Nunung uses his own money to pay for the production costs of his local trading business, but he would prefer it if he could lend money for the production costs from UD Kesuma Jaya instead.

UD Kesuma Jaya, owned by pak Tantono, is the large-scale trader of Gemor bark in Kalimantan and represents one of the downstream actors of the Gemor bark value chain. Pak Tantono buys his bark either directly from the farmers or from local traders. According to pak Tantono, the quality of the bark can vary depending on its thickness. At UD Kesuma Jaya, the bark is spread in the sun for further drying and then it is packaged. The production of Gemor bark by UD Kesuma Jaya has decreased by approximately seven times in the past ten years. Pak Tantono attributes this to a reduction in the demand for Gemor bark and the limited supply of Gemor trees in the natural forest. The bark from UD Kesuma Jaya is sold to exporting factories in Surabaya and Jakarta. These factories change the bark into a powder and then sell it to businesses in China and Taiwan, who are the main importing countries of Gemor bark powder (according to pak Tantono). The powder is used to make incense sticks known as hio.

Figure 12 on the following page shows the complete Gemor bark value chain in Central Kalimantan with the relevant quantitative data.

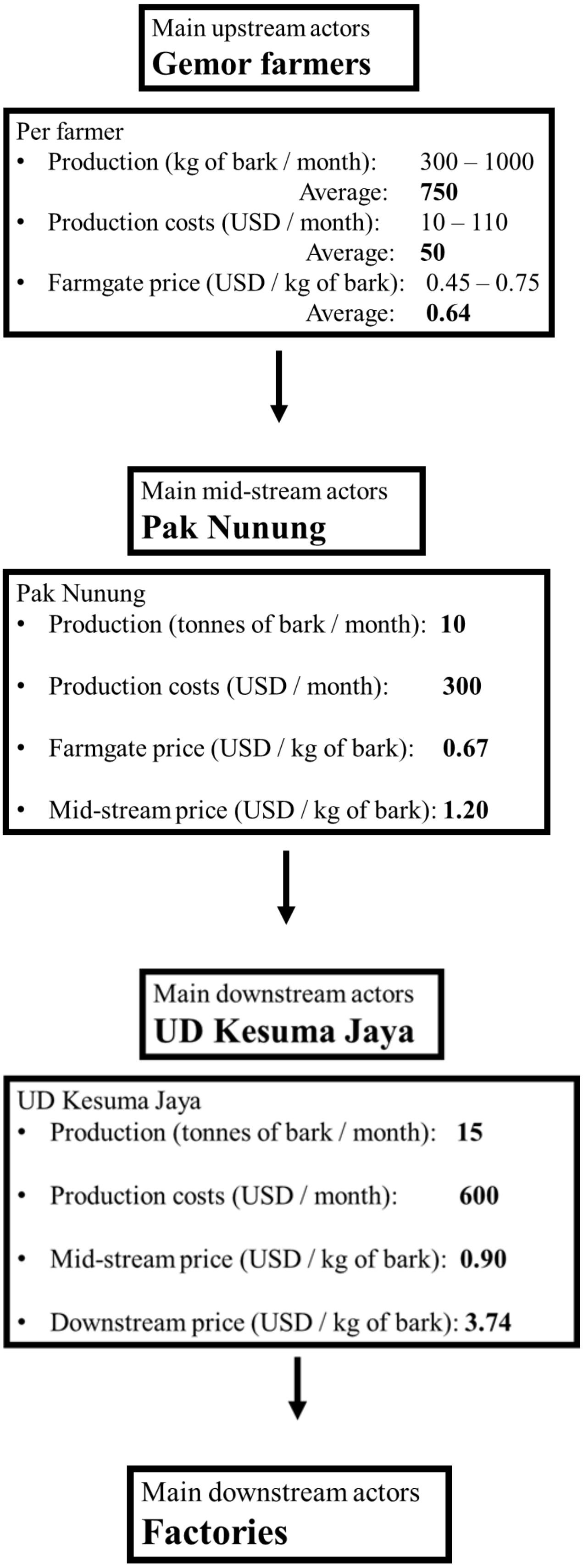

Figure 12. Gemor bark value chain in Central Kalimantan (complete).

3.3 Cost-Benefit Analyses

The cost-benefit analyses were conducted to further understand and quantify the economic costs and benefits of cultivating Gemor bark and Jelutung latex on peatland. A cost-benefit analysis of a palm-oil plantation on peat was also conducted for the sake of comparison with the Gemor and Jelutung plantations. In addition, the environmental impact of cultivation was investigated by running the analyses both including carbon emissions and sequestration values, and excluding these values. First, the NPV of each cost-benefit analysis will be presented. Following this, the results of the sensitivity analyses will be provided.

3.3.1 NPV & IRR

The table below shows the NPV per ha and the IRR of monoculture palm oil, Jelutung latex, and Gemor bark plantations for one plantation cycle. Additionally, the eNPV and eIRR are provided, which are the results of running the analyses including carbon emission costs. Note that all plantations are assumed to be established on undegraded and undrained peat soil. This means that for the palm oil cost-benefit analysis, drainage costs are included to reflect the drainage of peat that is necessary to establish a palm-oil plantation on peatland. The IRR is included to account for the different plantation cycle lengths of the crops; the IRR is independent of time.

Table 1. Table of the NPV per ha and IRR for monoculture palm oil, Jelutung latex, and Gemor bark plantations on peatland. The NPV excludes carbon emission costs and the eNPV includes carbon emission costs. IRR excludes carbon emission costs and eIRR includes these costs.

Crop	NPV (US$/ha)	eNPV (US$/ha)	IRR	eIRR
Palm oil	8947	-11,933	24%	-6%
Jelutung latex	18,731	18,731*	39%	39%*
Gemor bark	864	864*	14%	14%*

*These values are the same as the NPV and IRR values because the carbon emission costs of a Jelutung and Gemor plantation are zero.

The results presented in Table 1 indicate that when excluding carbon emission costs from the palm oil cost-benefit analysis, a Gemor bark plantation has the lowest NPV per ha. Nevertheless, the NPV and the IRR are positive which indicates that Gemor bark cultivation is still likely to be profitable. Note that the PV of net benefits of a Gemor bark plantation, is positive only once every three years throughout the plantation cycle (because the Gemor trees must recover and can therefore only be cultivated once every three years). This means that the Gemor PV of net benefits is positive only once every three years from Year 8 onwards, and is negative in all other years of the plantation cycle (see Appendix 7.7.4). Palm oil also has a positive IRR and NPV per ha when excluding carbon emission costs, which is an expected outcome considering the known profitability of palm-oil production. Jelutung latex has the highest IRR and NPV per ha, by a large amount, suggesting that this product has strong economic potential when cultivated on a peatland plantation.

3.3.2 Environmental Impact

Taking the carbon emission costs into account allows for an environmental perspective on the cultivation of Jelutung latex and Gemor bark on peatland, compared to peat drainage crops such as palm oil. Table 1 shows that the NPV per ha of a palm-oil plantation on peat greatly decreases to a negative NPV (the eNPV) when including the carbon emission costs of cultivating palm oil on peat. The IRR also becomes negative to -6%. This shows that when accounting for the carbon emission costs caused by peat drainage, palm-oil cultivation is not profitable. Since neither Jelutung or Gemor require peat drainage, the cultivation of these crops does not produce carbon emissions. This is reflected in that the NPV and IRR of both crops does not change when carbon emission costs are included in the cost-benefit analysis (because the carbon emission costs are equal to zero). These results indicate the environmental benefits of cultivating Gemor bark and Jelutung latex on peat, namely the limiting of carbon emissions, compared to crops that require peat drainage (such as palm oil).

3.3.3 Sensitivity Analyses

To examine the sensitivity of the NPVs of palm oil, Jelutung latex, and Gemor bark plantations to changes in the discount rate, crop prices, and carbon emission values, sensitivity analyses were conducted. The results of these analyses are shown in the tables below. The red cells represent NPVs that are 25% below the expected NPV for each cost-benefit analysis, and the green cells represent NPVs that are 25% above the expected NPV. The yellow cells include NPVs that are similar to the expected NPV. The expected NPV is the NPV outcome when running an analysis with the values selected in Section 2.3.2, and is displayed in bold with a border around the cell. The NPVs are in US$ per ha.

<u>Palm oil</u>

Table 2. Sensitivity analysis of palm oil on peat NPV without carbon emission costs. FFB price range US$145 – 225 ton^{-1} and discount rate range 0% - 20%.

8947	20.0%	17.5%	15.0%	12.5%	10.0%	7.5%	5.0%	2.5%	0.0%
145	-819	-190	689	1934	3727	6356	10287	16292	25682
155	-288	458	1491	2947	5032	8076	12613	19528	30320
165	243	1105	2294	3960	6337	9797	14940	22764	34958
175	775	1753	3096	4972	7642	11517	17267	26000	39596
185	1306	2401	3899	5985	**8947**	13237	19594	29237	44234
195	1837	3048	4701	6998	10252	14958	21921	32473	48872
205	2369	3696	5504	8011	11556	16678	24248	35709	53510
215	2900	4344	6306	9024	12861	18399	26575	38945	58148
225	3431	4991	7109	10037	14166	20119	28902	42181	62786

The bordered yellow cell shows the expected NPV of US$8947 ha^{-1} for a palm-oil plantation on peat excluding carbon emission costs, with a discount rate of 10% and a FFB price of US$185 ton^{-1}. Table 2 shows that the NPV is more sensitive to changes in the discount rate than changes in the FFB price. If the FFB price does not fluctuate below the estimated price of US$185 ton^{-1}, then the NPV will remain positive when the discount rate is 10% or higher. With a higher discount rates of 12.5% and 15%, the NPV stays positive with lower FFB prices, until the lowest FFB price of US$145 ton^{-1}. Overall, this sensitivity analysis indicates that the NPV of palm oil on peat will most likely be positive, even if the FFB price decreases slightly and assuming the discount rate will not be higher than 15%.

Table 3. Sensitivity analysis of palm oil on peat NPV with carbon emission costs. FFB price range US$145 – 225 ton^{-1} and discount rate range 0% - 20%.

-11933	20.0%	17.5%	15.0%	12.5%	10.0%	7.5%	5.0%	2.5%	0.0%
145	-13143	-13892	-14777	-15842	-17153	-18813	-20988	-23955	-28190
155	-12611	-13244	-13974	-14829	-15848	-17092	-18661	-20719	-23552
165	-12080	-12597	-13172	-13816	-14543	-15372	-16334	-17483	-18914
175	-11549	-11949	-12369	-12803	-13238	-13651	-14007	-14247	-14276
185	-11017	-11301	-11567	-11790	**-11933**	-11931	-11681	-11011	-9638
195	-10486	-10654	-10764	-10778	-10628	-10211	-9354	-7775	-5000
205	-9955	-10006	-9962	-9765	-9323	-8490	-7027	-4539	-362
215	-9424	-9358	-9159	-8752	-8018	-6770	-4700	-1303	4276
225	-8892	-8710	-8357	-7739	-6713	-5049	-2373	1934	8914

The cost-benefit analysis of a palm-oil plantation on peat including the carbon emission costs has an expected negative NPV of US$-11,933 ha^{-1} with a discount rate of 10% and a FFB price of US$185 ton^{-1} (shown in Table 3 as the bordered yellow cell). This sensitivity analysis shows that when including carbon emission costs, the NPV of a palm-oil plantation on peat is highly likely to be negative unless the FFB price is at the highest end of the price range and the discount rate is 0% - 2.5%.

Table 4. Sensitivity analysis of palm oil on peat NPV with carbon emission costs. FFB price range US$ 145 – 225 ton^{-1} and carbon emission costs range US$-2872 – -1072 ha^{-1}.

-11933	2872	2672	2472	2272	2072	1872	1672	1472	1272	1072
145	-17153	-17153	-17153	-17153	-17153	-17153	-17153	-17153	-17153	-8233
155	-15848	-15848	-15848	-15848	-15848	-15848	-15848	-15848	-15848	-6928
165	-14543	-14543	-14543	-14543	-14543	-14543	-14543	-14543	-14543	-5623
175	-13238	-13238	-13238	-13238	-13238	-13238	-13238	-13238	-13238	-4318
185	-11933	-11933	-11933	-11933	-11933	**-11933**	-11933	-11933	-11933	-3013
195	-10628	-10628	-10628	-10628	-10628	-10628	-10628	-10628	-10628	-1708
205	-9323	-9323	-9323	-9323	-9323	-9323	-9323	-9323	-9323	-403
215	-8018	-8018	-8018	-8018	-8018	-8018	-8018	-8018	-8018	902
225	-6713	-6713	-6713	-6713	-6713	-6713	-6713	-6713	-6713	2207

Table 4 shows the sensitivity analysis for changes in the FFB price and the carbon emission costs for the cost-benefit analysis of a palm-oil plantation on peat. The carbon emission costs are shown here as negative values because they are costs and therefore contribute negatively to the NPV. When the carbon emission costs are at the lowest end of the given range (i.e. the least costs), US$-1072 ton^{-1}, the NPV is positive only when the FFB price is at the highest values of US$215 ton^{-1} and US$225 ton^{-1}. This indicates that the NPV of a palm-oil plantation on peat is very likely to be negative when including carbon emission costs.

<u>Jelutung latex</u>

Table 5. Sensitivity analysis of Jelutung latex NPV. Latex price range US$570 – 770 ton^{-1} and discount rate range 0% - 20%.

18731	20.0%	17.5%	15.0%	12.5%	10.0%	7.5%	5.0%	2.5%	0.0%
570	4138	5741	7938	11003	15360	21688	31094	45429	67870
595	4429	6112	8418	11633	16202	22838	32700	47727	71250
620	4720	6483	8897	12263	17045	23989	34306	50025	74630
645	5011	6854	9377	12893	17888	25139	35911	52323	78010
670	5302	7224	9856	13523	**18731**	26289	37517	54622	81390
695	5592	7595	10336	14153	19574	27440	39123	56920	84770
720	5883	7966	10815	14783	20417	28590	40729	59218	88150
745	6174	8337	11295	15413	21260	29741	42335	61516	91530
770	6465	8708	11774	16043	22102	30891	43941	63814	94910

The sensitivity analysis in Table 5 shows that the Jelutung latex NPV is more sensitive to changes in the discount rate than changes in the latex price. Nevertheless, even with the highest discount rate of 20% and the lowest latex price of US$570 ton^{-1}, the NPV is positive. Therefore, it is very likely that the NPV of a Jelutung latex plantation will be positive regardless of price fluctuations or an increase in the discount rate.

<u>Gemor bark</u>

Table 6. Sensitivity analysis of Gemor bark NPV. Bark price range US$440 – 790 ton^{-1} and discount rate range 0% - 20%.

864	20%	17.5%	15.0%	12.5%	10.0%	7.5%	5.0%	2.5%	0.0%
440	-637	-560	-438	-236	114	761	2048	4829	11386
490	-586	-493	-347	-108	302	1053	2540	5738	13251
540	-535	-425	-256	19	489	1345	3032	6648	15116
590	-483	-358	-165	147	676	1638	3524	7557	16981
640	-432	-291	-74	275	**864**	1930	4016	8466	18846
690	-381	-223	18	402	1051	2222	4508	9375	20711
740	-330	-156	109	530	1239	2515	5000	10284	22576
790	-279	-89	200	658	1426	2807	5492	11193	24441

The sensitivity analysis in Table 6 shows the sensitivity of the Gemor bark NPV to changes in the bark price and discount rate. The analysis indicates that the NPV is more sensitive to changes in the discount rate than to changes in the bark price. If the discount rate stays at 10%, then even the lowest bark price still yields a positive NPV. Only when the discount rate is 15% or higher, the NPV will become negative if the price is the same, or lower, as the one used in the cost-benefit analysis of US$640 ton^{-1}.

3.4 Other Potential Crops

During the fieldwork in Central Kalimantan, the convenience sampling and snowballing methods (described in Chapter 2.2) used to find interview respondents occasionally led to interviewing other respondents than were initially aimed for. For example, two potential respondents were thought to be Jelutung tappers but instead they explained that they own Jelutung plantations but are not yet cultivating the latex from their plantations. The interviews with these farmers provided some relevant information for RQ5. In addition, the interview results with farmers who do not cultivate Jelutung latex or Gemor bark and do not grow the trees on their own land are provided. These interviews were useful for identifying more potential barriers of expanding the cultivation of the crops and for answering RQ5.

3.4.1 Farmers with Jelutung Plantations

Two farmers with Jelutung plantations who do not yet cultivate the latex, pak Awat and Pak Rapingun, both from Mantaren (Pulang Pisau District) were interviewed. Pak Awat owns 55ha of land of which 10ha consist of a monoculture Jelutung plantation on peatland. In total, he has 5000 Jelutung trees of which none of them are currently being harvested. When asked why he does not yet cultivate Jelutung latex, pak Awat said that he does not know how to access the local market of the latex (i.e. who to sell his latex to and for what price). He also does not sell Jelutung seedlings, explaining that there is very little demand for the seedlings. Rather than cultivating Jelutung latex, pak Awat is currently earning his income from the cultivation of Sengon trees (for timber products) and rubber trees. Pak Awat owns 15ha of land with Sengon trees and the remaining 30ha of his land are covered with rubber trees. Pak Awat was also asked about his opinion on the barriers of cultivating NTFPs (such as Jelutung latex and rubber). He answered that a declining price for NTFPs is the main barrier for him, but that he believes the price for both Jelutung latex and rubber will increase again in the near future. Fires are not an issue for pak Awat as he said he takes prevention measures against peat fires. Presently, rubber is pak Awat's main source of income. He can sell 1kg of rubber for approximately US$0.52. Overall, he earns a net income of around US$300 per month from cultivating rubber on his plantations. Pak Awat would like Jelutung latex to become a source of income for him, but first he wants to know more about the market opportunities.

The second farmer, Pak Rapingun, has 5ha of his own land of which 3ha are covered with Jelutung trees and the remaining 2ha are used for harvesting rubber. In total, pak Rapingun has 1500 Jelutung trees which he planted in 2004. He does not go to the natural forest to collect Jelutung latex and does not yet cultivate latex from any of his own Jelutung trees. When asked why he does not yet cultivate his Jelutung trees, pak Rapingun answered that he does not know who the best trader or middleman is to sell his latex to and what a reasonable price is. Similar to pak Awat, he is unsure on the best way to access the local market for Jelutung latex. Pak Rapingun was also asked why he decided to plant Jelutung trees on his own land. He explained that in the 1970's when he was working in logging he saw that Jelutung trees produce a lot of latex and that people were selling their latex for a higher price than rubber. He also sees his private Jelutung plantation as an investment for his children. Currently, rubber is pak Rapingun's main source of income. He sells 1kg of rubber for around US$0.61 (the range in price for Jelutung latex mentioned by Jelutung tappers is US$0.60 – 0.75 per kg). Pak Rapingun explained that he has noticed an effect of the peat fires when in 2015 he lost 4ha of his land with both Jelutung and rubber trees due to the fire. Overall, pak Rapingun would like to earn a large proportion of his income from cultivating Jelutung latex on his plantation, once he understands the local market.

Figure 13. Jelutung latex plantation owned by Pak Awat in Mantaren, Central Kalimantan.

3.4.2 Non-Jelutung Latex and Gemor Bark Farmers

The farmers who do not cultivate either Jelutung latex or Gemor bark were asked three questions to establish whether they know about Jelutung latex and Gemor bark, and if so, why they do not cultivate these products. Out of the ten farmers, five harvest Sengon trees, which is their main source of income. Three other farmers harvest both Sengon and rubber trees. One farmer cultivates both rattan (a NTFP) and rubber, and another farmer only harvests rubber trees. The last farmer harvests a combination of cassava, bananas, and palm oil. Eight out of the ten farmers know of both Jelutung latex and Gemor bark. The other two farmers know about Gemor bark but had not heard about Jelutung latex. When the farmers were asked why they do not cultivate Jelutung latex or Gemor bark, the general answer was that the seedlings of trees are hard to find, and cultivating them in the wild is difficult because of the limited natural availability. One farmer explained that the seedlings of Sengon trees are much easier to find and are also cheaper. Another farmer said that Jelutung and Gemor trees grow too slowly so he prefers to harvest Sengon and rubber trees that tend to grow at a faster rate. Overall, it seems that the difficulty of finding Jelutung and Gemor seedlings is a barrier of cultivating these crops on plantations (for the farmers interviewed).

3.4.3 Summary

It was found from the additional interviews that rubber trees are also a relatively popular NTFP harvested by farmers in Central Kalimantan. However, the two farmers interviewed who harvest rubber (Section 3.4.1), indicate that the farmgate price of rubber ranges between US$0.52 – 0.61 per kg. This is less than the average farmgate price of Jelutung latex. Furthermore, the interview with the local Gemor bark trader revealed that two other NTFPs, Geharu and Pasak Bumi, are better sources of income for him than Gemor bark, with Geharu being his best source of income. Geharu, also known as agarwood, comes from the heartwood of Aquilaria trees, of which various species can be found in Kalimantan (TheJakartaPost, 2010). When the heartwood becomes infected, the Geharu tree produces a dark resin with a strong fragrance. The fragrance of Geharu means that the wood is used for incense and cosmetic products including perfumes and body lotions. In Indonesia, the demand for Geharu is thought to be very high, but that the natural stocks of Geharu trees are depleting (TheJakartaPost, 2010). The other NTFP traded by pak Nunung, the local Gemor bark trader, is Pasak Bumi. This crop is a flowering plant known as *Eurycoma longifolia* which is native to Indonesia and other Southeast Asian countries (UNIDO, 2012). The roots and bark of Pasak Bumi are used as herbal medicine for stimulating sexual functions in both men and women (UNIDO, 2012). It is unknown whether Geharu or Pasak Bumi require peat drainage when cultivated on peatland.

4. DISCUSSION

Appendix 7.8 compares this thesis' results with the literature findings. This comparison provides a more well-rounded impression of the value chains and economic prospects of Jelutung latex and Gemor bark, and the environmental impact of expanding the crops' cultivation. In addition, comparing the results with the literature is useful to critically assess the reliability of the results. Note that due to the limited literature available on Jelutung latex and Gemor bark, only parts of the results are compared with the literature. The comparison of the results with the literature is presented in the appendix to maintain focus on the main discussion points of this thesis. These main discussion points include first, a chapter on the challenges and uncertainties of the data collection and data analysis methodologies. Second, a chapter discussing the results of the value chain analyses and cost-benefit analyses from a critical and broader perspective.

4.1 Challenges & Uncertainties

4.1.2 Data Collection

During the fieldwork, some data collection challenges were encountered. First, a general fieldwork challenge was that not all value-chain actors could be interviewed. As mentioned in Chapter 2.2, there was little knowledge on the exact whereabouts of the value-chain actors in Central Kalimantan. This meant that a large proportion of the time in the field was spent on finding respondents. The difficulty of finding respondents is also one of the main reasons why not all the value-chain actors could be interviewed. For example, although it was known that there are Jelutung middlemen as part of the mid-stream section of the Jelutung latex value chain, it was not known how to contact and find the middlemen (neither the tappers nor PT SAS wanted to provide the contact information). This was also why no specific target was set before fieldwork on the number of interviews to conduct with each of the value-chain actors. Despite these challenges, respondents were found successfully through the snowballing method and convenience sampling method. For both value chains, multiple tappers and farmers were interviewed, and also the local and large-scale traders of both value chains were involved in the research. In addition, the interviews were designed such that several relevant topics were covered and discussed with the respondents in detail (i.e. semi-structured interviews lasting 45 – 75 minutes each). Therefore, sufficient amounts and types of value-chain actors were interviewed thoroughly, which helped to obtain a representative impression of the Jelutung latex and Gemor bark value chains.

A potential source of uncertainty in the data collection methodology is the interview translations from Bahasa Indonesia to English and vice versa. It was not possible to hire a professional and-/-or permanent translator for the duration of the fieldwork. Instead, different (uncertified) translators were used to conduct the interviews. The reason different translators had to be used was because the fieldwork was located in different locations across the province. Occasionally, the possibility of direct translation between the interviewer and the respondent was limited. For example, if the respondent gave an answer that required a follow-up question, the translators were not always able to understand and translate the follow-up question the interviewer wanted to ask. Note that this was a rare occurrence and overall the translators could translate everything directly. In general, the potential uncertainty of translation was taken into account by recording all interviews (if permitted). The recordings were listened to after the interview and any moments where the answers of the respondents were still unclear were translated again to double-check the information. This helped to limit the possibility of losing information through translation and improved the reliability of the results.

Another possible general uncertainty of the interview data is the risk that respondents do not fully understand the questions and-/-or do not give entirely truthful answers. This could also have been the case during the interviews for this thesis. However, certain efforts were made to prevent this, such as interviewing respondents separately from other respondents, and asking follow-up questions if an answer was unclear or contradictory to previous answers. Moreover, overall there were consistencies and similarities in the answers between the respondents from the same value-chain actor groups. For instance, all Jelutung tappers answered individually that not much is done to maintain the quality of the latex, and most of the tappers mentioned weather as a barrier to cultivating the latex. Such consistencies between the respondents' answers indicate that it is unlikely that misunderstandings and lack of truthfulness during the interviews is a major uncertainty of the fieldwork data.

4.1.3 Data Analysis

<u>Value chain analyses</u>

Overall, the results from the interviews with Jelutung tappers and Gemor farmers show general consistencies amongst the answers given by the tappers and farmers in separate interviews. In particular, for most qualitative aspects tappers and farmers provide similar answers. For example, all Gemor farmers use the same method to collect the bark, and there is a consensus amongst the farmers that peat fires are one of the main barriers to Gemor cultivation. On the other hand, the quantitative data from the interviews with Jelutung tappers and Gemor farmers has a few inconsistencies. For example, some Jelutung tappers collect around 300kg of latex per month, whereas others said they collect 600kg per month. These inconsistencies can be explained. One explanation for the difference in latex collected can be attributed to the time the tappers spend in the forest; some tappers spend more time in the forest in one month than other tappers, thereby collecting more latex. Moreover, it is likely that there are personal differences between the individual tappers in their speeds of collecting latex (also considering that some tappers interviewed were two decades older than others). Overall, however, the answers from the interviews with the Jelutung tappers and Gemor farmers have generally consistent information.

Although the number of interviews conducted during the fieldwork could be considered relatively small, it is argued that this is not the case and that the data obtained is robust and reliable. First, in the upstream sections of the value chains, the data is based on six Jelutung tapper and five Gemor farmer interviews. The tappers and farmers interviewed came from different villages in different districts in Central Kalimantan, and therefore are representative of the province rather than a single village. Furthermore, the tappers and farmers provided similar answers to one another in separate interviews thereby indicating reliable results. For the following actor groups, the local and large-scale traders, one of each was interviewed for both the Jelutung latex and Gemor bark value chains. Only one local and large-scale Jelutung trader was interviewed because only one of each exists in Central Kalimantan. Therefore, these interviews are fully representative of the mid-stream and downstream steps of the Jelutung value chain. For Gemor, one large-scale trader was interviewed because only one exists in Kalimantan. Only one local trader was interviewed because no others could be contacted. Nevertheless, the trader answered all the prepared and follow-up questions during the interview in detail, thereby providing reliable results.

<u>Cost-benefit analyses</u>

The cost-benefit analyses of monoculture palm oil, Jelutung latex, and Gemor bark plantations on peat may also include some potential uncertainties. First, in all three analyses the prices of the products (i.e. FFB, Jelutung latex, and Gemor bark) were assumed to be constant throughout the period of the plantation cycles. In reality, prices fluctuate over time and this is recognizably a simplification of the analyses. This could influence the conclusions of the cost-benefit analyses as the NPVs may become negative with a lower price. However, the sensitivity analyses show that the NPVs of a Jelutung latex and a Gemor bark plantation are relatively insensitive to changes in the latex and bark prices (see Tables 2, 5, and 6 in Section 3.3.3). Both NPVs do not become negative when the prices are set at the lowest of the given price range with a discount rate of 10%. The NPV of a Jelutung latex plantation does not become negative even in the worst scenario with the lowest latex price and the highest discount rate. This indicates it is unlikely that the NPVs of a Jelutung latex and a Gemor bark plantation will become negative, even if negative price fluctuations were to occur. This is also the case for the NPV of a palm-oil plantation on peat (in the analysis excluding carbon emission costs). The NPV is slightly more sensitive to changes in the FFB price compared to the Jelutung latex and Gemor bark plantation NPVs (see Table 2 in Section 3.3.3), but the sensitivity analysis indicates that it is still improbable that a price decrease will lead to a negative palm oil NPV. Therefore, the assumption of a constant price in the cost-benefit analyses is not considered to be a major source of uncertainty in the results.

The costs and benefits used in the analyses were sourced from literature from different years (ranging from 2009 – 2016). Using these values in the cost-benefit analyses could have caused uncertainty because the final NPVs and IRRs would be based on costs and benefits from different calendar years. To limit this uncertainty, all costs and benefits were adjusted according to the Indonesian CPI to reflect the year 2017 (explained in Section 2.3.2). This improved the robustness of the results and allowed for a fair comparison of the costs and benefits of the three crops.

Another potential drawback of the cost-benefit analyses is the different lengths of each analysis due to the varying plantation cycle lengths of each crop. For example, the palm-oil analysis has a length of 25 years whereas the Gemor bark analysis has a length of 48 years. In addition, the length of the Gemor plantation cycle was based on a rough estimate. It was known that without being cultivated, Gemor trees can live up to 200 years in the wild. There was no further information available on how long Gemor trees can live when they are being cultivated for bark. Consequently, the assumption was made that when the trees are cultivated, they cannot live as long as 200 years. Based on this assumption, the plantation cycle length was estimated to be 48 years. This is a rough estimate and could have been a potential uncertainty of the analysis. However, the factor of time and the varying plantation cycle lengths were accounted for in the cost-benefit analyses by calculating the IRR for each analysis. As mentioned in Section 2.3.2, the IRR is time-invariant (unlike the NPV) and consequently allows for the direct comparison of the investment returns for the three crops, despite their different plantation cycle lengths. Furthermore, the IRRs calculated yielded the same results as the NPVs. Namely, that Jelutung cultivation will likely generate the highest economic benefits, followed by palm oil and lastly Gemor (when excluding carbon emission costs. The IRR for palm oil also became negative, similar to the NPV for palm oil, when including carbon emission costs in the analyses. Therefore, the different plantation cycle lengths do not influence the overall outcome of the cost-benefit analyses. Calculating the IRR alleviated the potential drawback of the different lengths of the cost-benefit analyses.

The cost-benefit analyses were run with and without carbon emission costs. These costs were based on Hooijer et al. (2012) and the SCC from the United States Environment Protection Agency. It is possible that the carbon emission costs are a source of uncertainty as they are based on only two sources. To account for this potential uncertainty, a sensitivity analysis of the NPV to changes in carbon emission costs was conducted. The analysis shows that the NPV of a palm-oil plantation on peat when including caron emission costs is only positive when the emission costs are at the lowest end of the given range (i.e. the least costs) and the FFB price is at the highest values of US$215 ton^{-1} and US$225 ton^{-1}. Furthermore, within a FFB price range of US$165 – 205 ton^{-1}, the NPV for palm oil stays 'yellow' (i.e. no more than 25% below and 25% above the expected NPV of US$-11,933 ton^{-1}). This indicates that the NPV for palm oil is relatively unsensitive to changes in carbon emission costs compared to changes in the FFB price or discount rate. Therefore, it is unlikely that the carbon emission costs used in the cost-benefit analysis strongly influence the reliability of the NPV outcomes.

4.2 Discussion of Results

4.2.3 General Impression of Value Chains

From the interviews with the value-chain actors of the Jelutung latex and Gemor bark value chains, a general impression of both value chains is that they are not yet completely developed. For example, in both the Jelutung latex and Gemor bark value chains, there is only one large-scale trader in Kalimantan. The large-scale traders therefore have the power to set the latex or bark price, which means farmers and tappers likely get a lower price than they would if there was competition amongst the traders. This situation can also be referred to as an oligopsony market, and is a key barrier to cultivation. At the same time, there is insufficient supply and production in both value chains whereby traders are not attracted to enter the Jelutung latex or Gemor bark market. For instance, pak Mingky from PT SAS mentioned that there used to be another local Jelutung latex trader in Central Kalimantan, but that they quit the business three years ago because of the limited latex supply. Therefore, the results indicate that the Jelutung latex and Gemor back value chains in Central Kalimantan are not yet fully developed and reflect oligopsony markets.

4.2.4 Cost-Benefit Analyses

One of this thesis' main innovations is the cost-benefit analysis of a Gemor bark plantation because such a cost-benefit analysis is not currently available in the literature. The NPV of a Gemor bark plantation calculated in this thesis can therefore not be compared with any existing literature. However, given that the data for the Gemor cost-benefit analysis is based primarily on the interview data, and overall this data is considered robust (discussed in Chapter 4.1), the results of the Gemor analysis can still be considered reliable. In addition, this thesis' results on Gemor bark cultivation present a first stepping stone for future research to build on and expand the knowledge base on Gemor bark in Central Kalimantan.

The NPV results of the palm oil and Jelutung latex cost-benefit analyses can be compared with the outcomes of a study by Sumarga et al. (2016), to assess the results against previously conducted cost-benefit analyses. Sumarga et al. (2016) conducted a cost-benefit analysis of a monoculture palm-oil plantation on peat and calculated a NPV of EUR 5104 ha^{-1}, or US$5505 ha^{-1}. This is similar to the NPV calculated in the cost-benefit analysis of this thesis, namely US$8947 ha^{-1}. Both these NPVs do not include carbon emission costs and have a discount rate of 10%. The closeness of the NPV from the literature with the NPV from this thesis can be attributed to the mutual use of the source Fairhurst & McLaughlin (2009) for data on the costs and benefits of a palm oil-plantation on peat. The reason the NPV outcomes are not exactly the same is because slightly different assumptions were made in the cost-benefit analysis of this thesis than in the cost-benefit analysis by Sumarga et al. (2016). In addition, in this thesis the costs and benefits of palm-oil cultivation were adjusted according to the Indonesian CPI, leading to slightly different values than those used by Sumarga et al. (2016).

Sumarga et al. (2016) also conducted a cost-benefit analysis of a monoculture Jelutung latex plantation. They calculated a NPV of US$4189 ha^{-1}. The Jelutung latex cost-benefit analysis in this thesis yielded a more than four times higher NPV of US$18,731 ha^{-1}. Both these NPVs reflect a discount rate of 10%. One of the main reasons for the large difference between the two NPVs is that in this thesis much higher benefits were estimated for a Jelutung latex plantation than were predicted by Sumarga et al. (2016). The benefits (latex yield and price) used in this thesis' cost-benefit analysis were based on the data collected from the interviews with Jelutung tappers. This data is considered reliable given that there are general consistencies in the answers regarding latex yield and price given by tappers in separate interviews. The same costs were used in both this thesis' cost-benefit analysis and the analysis by Sumarga et al. (2016), indicating that the costs are not the reason for the large difference in the two NPVs. A sensitivity analysis of the NPV to changes in latex price showed that even with the highest discount rate of 20% and the lowest latex price of US$570 ton^{-1}, the NPV would still be positive at US$4138 (see Table 5 in Section 3.3.3). The latex price would therefore have to be much lower than the price taken from the interviews to generate a negative NPV (i.e. no economic benefits). Consequently, although the benefits included in this thesis' Jelutung cost-benefit analysis are relatively high compared to the benefits used in the literature, the sensitivity analysis shows that even with lower benefits, a Jelutung latex plantation is still likely to generate high economic benefits. Further research into the stability of the latex price would be beneficial to better understand the potential degree of variation in the benefits generated by a Jelutung latex plantation each year.

4.2.5 Environmental impact

In this thesis, the cost-benefit analyses were also used to assess the environmental impact of expanding Jelutung latex and Gemor bark cultivation on peatland plantations in response to RQ4. This was done by incorporating carbon emission costs in the cost-benefit analyses and comparing the NPVs and IRRs of the three crops with and without emission costs. The NPVs and IRRs indicate that the environmental impact (in terms of carbon emissions) of expanding Jelutung latex and Gemor bark cultivation on peatland is likely to be highly positive, compared to palm-oil plantations on peat, as no carbon emissions are involved with Jelutung and Gemor cultivation. Instead, Jelutung and Gemor trees on undrained peat plantations serve as a source of carbon sequestration. Palm-oil plantations on peat on the other hand, produce carbon emissions. The carbon emission costs should be included in the cost-benefit analyses to internalize the effects of carbon emissions. When including these costs in the analysis, the IRR and NPV for palm oil greatly decrease such that both are negative. Therefore, when taking carbon emission costs into account, both Jelutung latex and Gemor bark are more favourable to cultivate on peatland than palm oil. This benefit is also discussed in the literature, where Wahyu et al. (2008) and Janudianto et al. (2014), and various other sources explain that Jelutung and Gemor trees can be cultivated sustainably on peatland because the peat does not have to be drained. Joshi et al. (2010) also offer an example where Jelutung cultivation on peatlands provides the highest carbon stock compared to other peatland uses including small and large palm oil-plantations, logging plantations, nypa palm stands, grasslands, and young rubber agroforests. Therefore, the examples provided in the literature on the environmental benefits of Jelutung and Gemor cultivation on peat in terms of (an absence of) carbon emissions coincide with the NPVs and IRRs calculated in the cost-benefit analyses when including carbon emission costs.

The cost-benefit analyses do not include other forms of environmental impact besides carbon emissions. This is because it is difficult to quantify and place a monetary value on other environmental aspects such as biodiversity, flooding, and forest fires. However, the literature review describes examples where Jelutung and Gemor trees on peatland have positive influences on these aspects, compared to peatland uses that require peat drainage. These positive influences include reducing the risks of flooding and forest fires, and increasing biodiversity (based on Janudianto et al., 2014; Harrison et al., 2010; Wahyu et al., 2008; Buckmaster et al., 2014). Therefore, it is likely that the overall environmental impact of expanding Jelutung latex and Gemor bark cultivation on peatlands is positive, compared to the impact of crops that do require peat drainage. Further research on the quantification of the environmental services of Jelutung and Gemor cultivation on peat would aid in calculating NPVs with a more detailed environmental perspective. Furthermore, this thesis' cost-benefit analyses only simulate plantations on undrained and undegraded peatland. It would be interesting to conduct a cost-benefit analysis for the same monoculture plantations assuming plantation establishment on already drained and degraded peatland, to analyse the differences in costs and benefits when plantations are established on this land type compared to undrained peatland. These analyses would also be useful considering that a large proportion of Central Kalimantan peatlands has already been drained.

5. CONCLUSIONS

The main research objective of this thesis is to determine the opportunities and barriers of expanding Jelutung latex and Gemor bark cultivation on peatlands in Central Kalimantan. The objective was achieved through a literature review and fieldwork, including a value-chain analysis and cost-benefit analysis. This chapter presents the opportunities and barriers of expanding Jelutung latex and Gemor bark cultivation in Central Kalimantan. The opportunities and barriers are divided into economic and environmental. In Section 5.2.5, other barriers (not environmental or economic) that were identified during the research are described. Finally, a recommendation is made on whether to focus further research on Jelutung latex cultivation or Gemor bark cultivation. For direct answers to the five research questions of this thesis, refer to previous Chapters 3.1, 3.2, 3.3, and 3.4 (in order of each research question).

5.1 Expanding Jelutung Latex Cultivation in Central Kalimantan

5.1.1 Economic Opportunities

An important potential economic opportunity of expanding Jelutung latex cultivation is the diversity of products that can be made from the latex. According to Perdana et al. (2016) and Lyons (2003), Jelutung latex can be used to make covers of electricity cables, tyres, chewing gum, condoms, and insulation materials. Although currently the latex is only being used to produce chewing gum, the diversity of products that can be manufactured using Jelutung latex present further market opportunities to expand the cultivation of the latex. In addition, there is little manufacturing or processing required for Jelutung latex until the latex is imported to Lotte and Gum Base. This is an opportunity particularly for motivating farmers to start tapping Jelutung latex, as they do not need extensive education on how to treat and process the latex after it has been cultivated. In addition, the latex quality is generally always sufficient and is not difficult to maintain, according to both the upstream and mid-stream value-chain actors. This is an economic opportunity as it suggests that tappers and traders can be relatively certain that they can sell all the latex they collect; their profits are not usually limited by varying qualities of the latex.

Another economic opportunity is that all the value-chain actors consider the Jelutung latex price as relatively stable since the increase in price in 2014. A stable price could provide an incentive for expanding the cultivation of Jelutung latex, as a stable price increases the chance of stable profits. Moreover, pak Ekri from PT Sampit (the large-scale Jelutung latex trader) said that the demand for Jelutung latex is relatively stable but that the latex supply is decreasing. The demand and supply situation of the Jelutung latex market is also an economic opportunity for expanding the latex cultivation. Namely, by expanding Jelutung latex cultivation the supply can be increased, thereby meeting the stable demand.

The cost-benefit analysis of a Jelutung latex plantation on peat presents an economic opportunity associated with expanding Jelutung latex cultivation. Namely, the NPV calculated is more than twice as high as the NPVs of a Gemor bark plantation and a palm-oil plantation on peat, both including and excluding carbon emission costs. The high NPV and IRR of a Jelutung latex plantation results from the relatively low production costs of cultivating the latex, compared to more labour intensive crops such as palm oil on peat. Additionally, Jelutung latex sells for the highest price per kg in comparison to Gemor bark and palm oil, thereby also generating high economic benefits. This coincides with the predictions by Poesie et al. (2011) that Jelutung has the potential to become the most profitable species that can be cultivated on undrained peatland. The NPV of a Jelutung latex plantation is also relatively insensitive to changes in the latex price. For example, the NPV is still higher than the NPVs of a Gemor bark plantation and a palm-oil plantation when the latex price is US$100 ton^{-1} lower than the price used in the analysis, and with a higher discount rate of 17.5%. Therefore, the cost-benefit analysis indicates that an opportunity of expanding Jelutung latex cultivation is the potentially high net benefits generated from cultivation on plantations. This is a very important opportunity given that economic benefits are one of the main drivers for expanding a market or industry.

A final economic opportunity regarding the attitudes of tappers and farmers towards Jelutung latex cultivation is that all tappers interviewed would like to cultivate more Jelutung latex than they are currently doing. Moreover, the farmers interviewed who own Jelutung plantations but are not yet cultivating the latex expressed a strong desire to start cultivating Jelutung latex and saw their plantations as an investment for their children. It is important, for expanding Jelutung latex, that the upstream actors of the value chain have an interest to continue cultivating the latex.

5.1.2 Environmental Opportunities

From an environment perspective, one of the most important opportunities of cultivating Jelutung latex is that cultivation on peat does not require peat drainage (Tata et al., 2015; Janudianto et al., 2014; Lyons, 2003). This means that establishing a Jelutung latex plantation on peat does not generate carbon emissions like crops such as palm oil that do require peat drainage for cultivation. This is also reflected in the cost-benefit analysis where the carbon emission costs of cultivating Jelutung latex are equal to zero. Including the carbon emission costs in the palm-oil cost-benefit analysis, on the other hand, decreases the NPV of a palm-oil plantation on peat by more than US$15,000 ha^{-1}. The major difference in the NPVs of a Jelutung latex plantation and a palm-oil plantation on peat when carbon emission costs demonstrates the strong positive environmental impact of cultivating Jelutung latex on peat, in terms of carbon emissions, as opposed to crops that require peat drainage.

Another environmental opportunity of expanding Jelutung latex cultivation is that the current tapping techniques for Jelutung latex in the wild can be considered sustainable. This is because tappers generally do not harm the Jelutung trees or surrounding wildlife when tapping them (Harrison et al., 2010), and tapping does not involve cutting down the trees (until the end of their production cycle). Furthermore, the same Jelutung trees can be tapped repeatedly for 5 – 10 years in the wild, and possibly longer if tapping methods are improved (according to pak Alam and pak Suhadrani). On plantations, it is likely that the same Jelutung trees can also be tapped repeatedly and that the trees do not have to be cut down until the end of their production cycles. Therefore, a potential environmental opportunity of expanding Jelutung latex cultivation is that the cultivation practices do not involve high rates of deforestation.

5.1.3 Economic Barriers

There are also various potential barriers to expanding Jelutung latex cultivation in Central Kalimantan. Firstly, some tappers are currently not satisfied with the farmgate price of Jelutung latex. They would like the price to be higher which could present a barrier to expanding Jelutung cultivation if tappers decide to switch to crops that have a better price. Dissatisfaction with the latex price could also discourage tappers to invest in establishing a Jelutung latex plantation. However, there are also tappers who are satisfied with the Jelutung latex price, and given that all tappers interviewed want to continue cultivating Jelutung latex, price satisfaction is not considered a major barrier to expanding Jelutung latex cultivation. Furthermore, some tappers have to lend their production costs which they consider a barrier to cultivating Jelutung latex. This should be considered when expanding Jelutung latex cultivation, as it may be necessary to provide certain financial incentives (e.g. low interest rates on paying back production costs) to encourage farmers to begin tapping Jelutung latex or to establish Jelutung plantations.

Another possible economic barrier is that currently there is only one large-scale trader of Jelutung latex in Central Kalimantan (which is also likely the only one in Indonesia) and two importers of Jelutung latex, creating an oligopsony market. This could present difficulties for expanding Jelutung latex cultivation, as the demand and price of the latex is determined by very few companies. Perdana et al. (2016) also considered this a downside of the Jelutung latex value chain. However, as mentioned in Section 5.1.1, Jelutung latex can be used to make many more products than just chewing gum. Thus, there are other market opportunities for Jelutung latex that can attract new companies and increase the demand for the latex, consequently reducing the price-setting effect of an oligopsony market.

The two interviews with farmers who own Jelutung plantations but are not yet cultivating Jelutung latex also revealed a potential economic barrier to expanding Jelutung latex cultivation. Both farmers are not yet cultivating the latex because they do not know how to access the market, who to sell their latex to, and for what price. Therefore, to promote the expansion of Jelutung latex cultivation, it may be beneficial to educate farmers on the value-chain set up and the market opportunities, to improve their understanding on how to successfully access the Jelutung latex market.

5.1.4 Environmental Barriers

A potential environmental barrier to expanding Jelutung latex cultivation is the effects of peat fires on cultivation. Some tappers noticed a slight decline in the productivity of Jelutung trees during the some and haze periods. However, not all tappers noticed productivity changes as a result of peat fires and so this is not considered a major barrier to expanding Jelutung latex cultivation as long as plantations have fire protection measures to prevent trees from burning down during the dry season. Further research would be useful in determining the effects of peat fires and haze on the productivity of Jelutung trees. Another possible environmental barrier is the decreasing supply of Jelutung trees in the natural forest (as identified by pak Mingky in his interview). Expanding Jelutung latex cultivation may have to be limited to plantations rather than in the wild (or be strictly controlled in the wild) to avoid decreasing the natural population size. This is a potential barrier to expanding cultivation as not all local communities will be able to afford establishing a plantation, and may rely on wild Jelutung trees as their income source.

5.2 Expanding Gemor Bark Cultivation in Central Kalimantan

5.2.1 Economic Opportunities

From the interviews with Gemor bark value-chain actors, various economic opportunities of expanding Gemor bark cultivation on Central Kalimantan peatlands were identified. First, according to the farmers, the farmgate price of Gemor bark has been increasing since 2010. This could be an economic opportunity because the prospect of higher profits could provide an incentive for more farmers to start cultivating Gemor bark. Another economic opportunity is that all farmers interviewed are satisfied with the bark price. Price satisfaction amongst the upstream value-chain actors is important for expanding Gemor bark cultivation. Furthermore, similar to Jelutung latex cultivation, the cultivation of Gemor bark requires little manufacturing or processing throughout the value chain until the factories in Surabaya and Jakarta process the bark into a powder. Farmers and traders only have to cut the bark into smaller pieces and dry it in the sun, meaning that production costs are relatively low in comparison to more labour-intensive crops such as pulpwood and palm oil. The Gemor bark quality is also considered to be relatively consistent and sufficient, which is beneficial in controlling the production costs.

Another potential economic opportunity of expanding Gemor bark cultivation is the positive NPV that was calculated in the Gemor bark cost-benefit analysis. Although the NPV is lower than both a palm-oil plantation on peat and a Jelutung latex plantation, the NPV is still positive and relatively insensitive to changes in the bark price if the discount rate does not increase above 12.5%. This means that the price of Gemor bark could decrease without yielding a negative NPV, indicating the likelihood of earning profits from a Gemor bark plantation even if negative price fluctuations were to occur. Finally, all Gemor farmers interviewed would like to continue cultivating Gemor bark in the future. This is a possible economic opportunity as it provides an indication that farmers' attitudes towards cultivating Gemor bark are long-term and that they are sufficiently satisfied with the benefits of cultivating the crop to continue doing so in the future.

5.2.2 Environmental Opportunities

There were no environmental opportunities of expanding Gemor bark cultivation identified from the interviews with the value-chain actors. However, in the literature an important environmental benefit was described. Namely, similar to Jelutung latex cultivation, Gemor bark cultivation on peat does not require peat drainage (Wahyu et al., 2008). A Gemor bark plantation on peat therefore provides carbon sequestration services rather than producing carbon emissions. This environmental benefit is also evident in the Gemor bark cost-benefit analysis, where the carbon emission costs associated with cultivation are equal to zero (because cultivation does not produce carbon emissions). The difference between the Gemor bark NPV compared to the NPV for palm oil when including carbon emission costs provides an indication of the environmental benefits, in terms of carbon emissions, of cultivating crops on peatland that do not require peat drainage.

5.2.3 Economic Barriers

The interviews with the value-chain actors also provide insight into the potential economic barriers to expanding Gemor bark cultivation in Central Kalimantan. For instance, pak Tantono, owner of the large-scale Gemor bark trading business, explained that according to him the demand for Gemor bark is declining. In his opinion, there is no market to expand the Gemor bark cultivation. Therefore, a lack of demand for Gemor bark is a potential barrier to expanding the cultivation of this crop. Furthermore, according to Rahmanto et al. (2001) and Zulneyly & Martono (2003), Gemor bark can only be used to make mosquito coils and hio (incense sticks). However, pak Tantono said in his interview that currently the bark is only being used to make hio, because companies have found a cheaper synthetic replacement for Gemor bark in mosquito coils. This is another reason why the demand for Gemor bark has been decreasing. The limited diversity of products that can made from Gemor bark present another potential economic barrier to expanding the cultivation of the bark, as it limits the possibility of increasing the demand for Gemor bark.

Similar to the Jelutung latex value chain, the Gemor bark value chain also reflects an oligopsony market. There is only one large-scale trader of Gemor bark in Kalimantan, UD Kesuma Jaya, giving this trader the power to set the bark price in Central Kalimantan and thereby lowering the price for Gemor farmers. This is a potential economic barrier to expanding Gemor bark cultivation because farmers may be less willing to start cultivating the crop knowing that the price will be set for them by one trader. In turn, if there is not enough production of Gemor bark by farmers, it is likely that less traders will enter the market. Additionally, it should be noted that although a Gemor bark plantation was calculated to have a positive NPV in the cost-benefit analyses, the PV of net benefits is positive only once every three years. This is a potential economic barrier of expanding Gemor bark cultivation as farmers / plantation owners may not be able to afford receiving negative cash flows for three consecutive years each time before they get one year of positive net benefits. However, as the Gemor NPV was calculated to be positive in the cost-benefit analyses, the overall outcome of establishing a Gemor plantation is likely to be profitable.

5.2.4 Environmental Barriers

Farmers identified peat fires as a barrier as they explained that peat fires have burnt down several Gemor trees and many farmers lost the Gemor trees on their plantations as a result of peat fires. Similar to Jelutung plantations, Gemor plantations should have fire protection measures to prevent trees from burning down during the dry season. This is not considered a major barrier to expanding Gemor bark cultivation as all crops on peatlands in Central Kalimantan are at risk of being burnt by forest fires and should be protected by appropriate measures.

Another possible environmental barrier is that farmers are currently using unsustainable extraction practices to cultivate Gemor bark. This was identified in both the literature (based on Kristedi & Kieft, 2010; Suyanto et al., 2009; and Wahyu et al., 2008) and in the interviews with Gemor farmers. Consequently, before Gemor bark plantations can be established to expand Gemor bark cultivation, farmers should be educated on how to extract the bark using a sustainable method, and that doing so will provide long-term economic benefits. This is important both for Gemor bark cultivation in the wild and on plantations. To ensure a maximum productivity Gemor plantation cycle, farmers must know how to extract the bark in a sustainable and productive manner. Both the peat fires and the unsustainable extraction practices contribute to another potential barrier to expanding Gemor bark cultivation, namely the decreasing supply of Gemor trees in the natural forest. Expanding Gemor bark cultivation in the wild should be carefully monitored to avoid further depletion of wild Gemor tree stocks, or should be limited to plantations.

5.2.5 Additional Barriers

There are also Gemor farmers and Jelutung tappers who are worried that the land on which they cultivate wild Gemor and Jelutung trees will be turned into a conservation area or converted into palm-oil plantations. This indicates that to expand Jelutung latex and Gemor bark cultivation in the wild or on plantations tappers and farmers may need legal and formal tenure rights and / or land ownership to incentivise them to continue tapping or to establish Jelutung plantations. Therefore, a potential institutional barrier to expanding Jelutung latex and Gemor bark cultivation is the extent to which the local and regional governments will support the expansion by providing tappers and farmers with legal tenure rights.

5.3 Final Recommendation

With the results of this thesis I want to promote sustainable peatland use and provide a final recommendation for stakeholders (i.e. policy-makers, businesses, local communities) interested in sustainable peatland use. Overall, it is recommended that stakeholders consider Jelutung latex and Gemor bark as potential, feasible options for sustainable peatland use in Central Kalimantan. Both crops generate economic benefits for local communities and can be cultivated on peatland without requiring peat drainage. No peat drainage leads to environmental benefits such as the control of peatland carbon emissions and a reduced risk of fires and flooding. Stakeholders who want to focus on expanding the cultivation of one crop for sustainable peatland use, are recommended to focus on Jelutung latex. First, this is because in the cost-benefit analyses the NPV of a Jelutung latex plantation was calculated to be more than twenty times higher than a Gemor bark plantation, and the IRR more than double the Gemor bark IRR. In addition, Jelutung latex can be used to make several products, whereas Gemor bark can only be used to make two products, of which one has already been replaced by a synthetic material. Therefore, there are more market opportunities for expanding Jelutung latex compared to Gemor bark.

Regarding potential stakeholder concerns on environmental impacts, Jelutung latex cultivation is also more favourable for sustainable peatland use as tapping techniques are already sufficient in avoiding environmental damage. Tappers do not cut down wild Jelutung trees and they re-use the same trees for several years. Gemor bark cultivation, on the other hand, generally involves unsustainable extraction practices. Farmers cut down the Gemor trees and take all the bark, thereby contributing to deforestation. This means that before expanding Gemor bark cultivation, farmers should be educated on how to extract the bark sustainably. In addition, farmers may have to receive financial incentives to prevent them from cutting down a Gemor tree in one go. This is unnecessary for expanding Jelutung latex cultivation because tapping techniques are already sustainable.

Stakeholders interested in expanding Jelutung latex and-/-or Gemor bark cultivation should also consider the oligopsony markets reflected in the value chains of the two crops. In both value chains, there are a small number of buyers and limited product supply, which is a potential barrier to expanding their cultivation. To overcome this barrier, the next step in promoting sustainable peatland use involve raising awareness on the environmental and economic opportunities of the crops to potential buyers. These buyers can include other large-scale traders in Indonesia (e.g. rubber traders) or other manufacturing companies. Particularly outside of Indonesia, very little is known about Jelutung and Gemor as peatland species, and almost no information on their potential to provide economic benefits is publicly available. Therefore, raising awareness and attracting additional buyers into the Jelutung and Gemor markets could limit the price-setting effect of an oligopsony market and motivate more local traders to enter the value chains.

Overall, this thesis highlights the importance of sustainable peatland use in Central Kalimantan and presents two crops as potential options to achieve this. Continuing research on how to effectively expand Jelutung latex and Gemor bark cultivation (and other potential crops) is critical to control peatland emissions, limit the environmental and social effects of peat fires and flooding, and preserve the habitats of Central Kalimantan’s diverse and unique flora and fauna.

6. REFERENCES

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7. APPENDICES

7.1 Jelutung Tapper Interviews

Interview pak Alam Mulyani, Pangkalan Bun, 23/11/2016

Pak Alam and pak Suhadrani are part of a Jelutung tappers community group from Lamandau Wildlife Reserve in Central Kalimantan. Pak Alam is the head of the farmers group but is also a tapper himself.

- How many Jelutung tappers are in the community group in Lamandau?
    - There are now five tappers.
- When was the group set up? How many tappers were there at the beginning?
    - It was set up in 2012, then there were twenty tappers.
- What other NTFPs do you (and the other tappers) collect?
    - We do not collect any other NFTPs. We do catch fish but this is for personal consumption.
- Do you own your own land?
    - Not for Jelutung trees, but we do have some of our own land to grow rice for personal consumption.
- Where do you tap Jelutung trees?
    - From the natural forest near the Lamandau Wildlife Reserve.
- How far are the Jelutung trees from your home?
    - First we take a small boat for 1 km to the edge of the forest and then walk for around one hour to reach the trees.
- How do you arrange the tapping period amongst the group?
    - We have divided the available trees in the forest into 'lines.' Each of these lines has around 60 - 100 Jelutung trees and can be up to 2 km in length. Every tapper in the group has ten lines. We do not share the latex we collect. We know which trees belong to whom based on the characteristic of the cut/tap. We do not put any signs to indicate which trees are whose.
- What method do you use to collect the latex?
    - Tapping one line takes around ten days. We go into the forest for 10 - 15 days to tap one of the lines that we have, and then we go back for another 10 - 15 days to collect the latex. After that, we start with the second line.
- How many days do you go to the forest to tap Jelutung in 1 month?
    - We go every week day, for two to three weeks per month.
- Do you do any manufacturing or processing to the latex you collect?
    - No. We only filter the latex and collect it in 100 l containers and add 10 - 15 ml of vinegar to keep the latex compact.
- How do you maintain the quality of the Jelutung latex? Is it always good?
    - We just add a bit of vinegar so the latex stays compact. The quality of the latex from the tree is always good.
- What are the approximate production costs per tapper in your group for 1 month?
    - Including transport costs, the costs we spend can range between Rp 1.3 - 2 million per month. We use our own money to pay these costs.
- How many kilograms of latex do you produce per month on average?
    - Around 350 - 400 kg. This is the same for the other tappers in the group. The lowest amount we get is around 300 kg but this rarely happens.

- How much do you get for 1 kg of Jelutung latex?
    - We get Rp 10,000 per kg. The price has been this way since early 2016.
- Is the price stable?
    - The price does fluctuate occasionally but overall it is quite stable. PT SAS has the monopoly here so they can determine the price. In 2014, the price was the lowest at Rp 6000 per kg. This is when many tappers in our group quit tapping.
- Are you satisfied with the price?
    - For now the price is ok since it is better than last year when the price was Rp 6500 per kg. Our lowest standard is that we can buy a kilogram of rice from the money we earn from selling 1 kg of Jelutung latex (this should be between Rp 8500 - 10,000 per kg).
- How much of the Jelutung latex that you collect do you sell?
    - We keep around one third of the latex as a kind of 'insurance' if we need more money quickly.
- To whom do you sell your Jelutung latex?
    - We sell it to PT SAS.
- How often do you go to PT SAS to bring your Jelutung latex?
    - Once every 1 - 3 months.
- What share of your income comes from Jelutung latex?
    - 100%.
- Have the peat fires influenced your production of Jelutung latex? If so, how?
    - After the 2015 fire, some group members lost part of their tree 'lines,' so they had less trees to harvest. Also, the smoke and haze from the fire slightly affects the productivity of the Jelutung trees. Less latex comes out during a period of fire. At this time, instead of getting 100 kg from one line of trees we may only get 60 kg. Fortunately, the peat fires have not affected the quality of the latex.
- What are, in your opinion, the main barriers to cultivating Jelutung latex?
    - Firstly, the weather is a big barrier for us. When it is too wet, we cannot go to the forest as early as usual which means we cannot do as much work on those days. Secondly, land tenure is an issue. Since the government owns the land we work on, we have some uncertainty about how long we will be able to tap the trees there. We would like the land to have a community status so there is less risk of losing it. Lastly, Jelutung trees take a long time to grow and they can only be tapped once their diameter is at least 30 cm, which can take around 8 years. This is not a direct barrier for us at the moment, but it may affect us later on if we need to plant new trees.
- For how long can you tap the latex from the same Jelutung tree?
    - It depends, it could range between 5-10 years. After this time the tree can slowly become less productive and we will leave to find new trees. However, there is potential to use the trees for longer if we find a method / technology that allows us to make higher cuts in the tree. In this way, we can tap more latex from the tree and use it longer. At the moment, we are limited by our own height for how far up the tree we can make cuts. We have already tried some simple techniques to achieve higher cuts, such as by using long sticks, but this did not work because then we had no control over how deep the cut was.

Interview pak Suhadrani, Pangkanlan Bun, 23/11/2016

- What other NTFPs do you (and the other tappers in your group) collect?
  - We only collect Jelutung latex, no other NTFPs.
- Do you own your own land?
  - In the tappers group we have some land to grow rice for personal consumption. We do not have any land with Jelutung trees.
- Where do you tap Jelutung trees?
  - In the natural forest close to the Lamandau Wildlife Reserve.
- How far are the Jelutung trees from your home?
  - Around 1 km by kelotok and then an hour long walk.
- How do you arrange the tapping period amongst the group?
  - The trees in the forest are divided into 'lines.' Each line has around 60 - 100 Jelutung trees and around 2 km long. Every tapper in our group has ten lines. We know which trees are whose based on what the cut in the tree looks like. We do not share the latex we collect.
- What method do you use to collect the latex?

  We stay in the forest for 10 - 15 days to tap one line, and then we go back for another 10 - 15 days to collect the latex. After this, we start with the second line.
- How many days do you go to the forest to tap Jelutung in 1 month?
  - We go for around two weeks a month.
- Do you do any manufacturing or processing to the latex you collect?
  - All we do is filter the latex, add 10 - 15 ml of vinegar, and put it in containers of 100 ml.
- How do you maintain the quality of the Jelutung latex? Is it always good?
  - The vinegar we add helps to keep the latex compact. The quality of the latex from the trees is always good.
- What are the approximate production costs per tapper in your group for 1 month?
  - Including transport costs, the costs are usually between Rp 1.3 - 2 million per month. We do not lend these costs.
- How many kilograms of latex do you produce per month on average?
  - Around 350 - 400 kg. In a bad month, the lowest amount we get is around 300 kg but this rarely happens.
- How much do you get for 1 kg of Jelutung latex?
  - Rp 10,000 per kg.
- Is the price stable?
  - I think in general the price is quite stable. PT SAS is the only local trader though so they determine the price. The price was very low in 2014, Rp 6000 per kg. This is when many tappers in our group left.
- Are you satisfied with the price?
  - The price is ok because it is better than previous years. Our lowest standard is that we can buy a kilogram of rice from the money we earn from selling 1 kg of Jelutung latex (this should be between Rp 8500 - 10,000 per kg).
- How much of the Jelutung latex that you collect do you sell?
  - I keep one third of the latex in case I need more money but do not have time to tap latex.
- To whom do you sell your Jelutung latex?
  - PT SAS.

- How often do you go to PT SAS to bring your Jelutung latex?
    - Once every 1 - 3 months.
- What share of your income comes from Jelutung latex?
    - 100%.
- Have the peat fires influenced your production of Jelutung latex? If so, how?
    - In 2015, the fires burnt down some of the 'lines' of some group members so they could not harvest as much latex. I have also noticed that the smoke and haze from the fire affects the productivity of the Jelutung trees a bit. Less latex comes out during a period of fire. I have not noticed that the peat fires have affected the quality of the latex.
- What are, in your opinion, the main barriers of cultivating Jelutung latex?
    - The weather is one of the main barriers. If it is very wet, we cannot go to the forest as early as usual or at all, meaning that less latex can be collected during this time. I am also worried about my tenure rights. The government owns the land we work on, so we cannot be sure how long they will let us tap there. It would be much better if the land could have a community status so there is less risk of losing it.
- For how long can you tap the latex from the same Jelutung tree?
    - I would say between 5 - 10 years, possibly longer if tapping techniques are improved.

<u>Interview pak Yogi, Kubu village, 24/11/2016</u>

- How long have you been tapping Jelutung latex?
    - Four years.
- Do you harvest any other NTFPs or other products?
    - No I only harvest Jelutung latex.
- Do you have your own land?
    - No I have my own Jelutung trees based on an informal agreement between me and the other Jelutung tappers in this village. We have divided the trees into 'lines' and we each have around 10 - 12 lines. I have ten lines with 500 Jelutung trees in total.
- How far are the Jelutung trees from your home?
    - I have to travel two hours by motorbike to reach them.
- What method do you use to tap Jelutung latex?
    - I go back and forth every week day to the forest. On average I can tap around 20 - 30 trees per day.
- How do you maintain the quality of the latex?
    - The quality is not difficult to maintain as every tree is consistent on producing good quality latex. However, if the rainwater mixes with the latex then this worsens the quality. Therefore, I try to avoid this by not working when it is raining.
- Do you do any processing or manufacturing to the latex?
    - I only add a bit of vinegar to the latex to keep it compact.
- How many days per month do you go to the forest to collect Jelutung latex?
    - Around 20 days per month.
- How many kilograms of latex do you collect on average per day?
    - Usually around 20 - 30 kg. On a very productive day it could be 70 kg.
- What are your production costs in one month? Do you pay these yourself?
    - Around Rp 2 - 2.5 million per month. I borrow the money for these costs in advance from the middleman whom I sell my latex to.
- For how much do you sell 1 kg of latex?
    - For Rp 8500 / kg.

- Is the price stable?
    - Yes I would say it is.
- Are you satisfied with the price?
    - Not really, I think it is quite low, but at least it is not as low as a few years ago when it was Rp 6000 per kg.
- To whom do you sell the latex you tap?
    - To a middleman who then sells it to PT SAS. I do this because I need my production costs in advance and the middleman can provide this to me. However, because of this I get a lower price for the latex than tappers who can pay their own production costs.
- Is the middleman the only person you can sell the latex to?
    - No there are a few more middleman and I could also sell to PT SAS (and get my production costs from them), but I chose this middleman because I trust him the most.
- What share of your income comes from Jelutung latex?
    - Everything
- Do you want to cultivate more or less Jelutung latex?
    - I am already working at maximum productivity so I cannot cultivate more latex, but I wish to continue cultivating Jelutung as long as the price does not go down again.
- Has there been any impact from peat fires on your cultivation of Jelutung latex?
    - I have not noticed that the fires have affected the productivity of my trees. However, Jelutung trees do burn easily and last year I lost three trees during the fire.
- What are, in your opinion, the main barriers to cultivating Jelutung latex?
    - For me, the production costs are the biggest barrier. I have to borrow these costs from the middleman which means he can determine the price. It also means I cannot keep my own stock pile and that I have to sell everything in order to pay back the production costs.

<u>Interview pak Anang, Kubu village, 24/11/2016</u>

- How long have you been tapping Jelutung latex?
    - For more than thirty years.
- Do you harvest any other NTFPs or other products?
    - No I only harvest Jelutung latex. I also fish for my personal consumption when the weather is bad and I cannot go to the forest.
- Do you have your own land?
    - No. I have around 11 lines of Jelutung trees in the natural forest with around 50 trees per line.
- How far are the Jelutung trees from your home?
    - I have to travel thirty minutes by motorbike.
- What method do you use to tap Jelutung latex?
    - I go back and forth every week day to the forest. I do not tap in a group, I go alone.
- How do you maintain the quality of the latex?
    - The quality of the latex is always good, I do not need to do much to maintain the quality.
- Do you do any processing or manufacturing to the latex?
    - I add a small amount of vinegar to the latex to keep it compact.
- How many days per month do you go to the forest to collect Jelutung latex?
    - Around 15 days per month.
- How many kilograms of latex do you collect on average per day?
    - On average around 20 - 30 kg.

- What are your production costs in one month? Do you pay these yourself?
    - Around Rp 2 million per month. I borrow the money for these costs in advance.
- For how much do you sell 1 kg of latex?
    - Rp 8500 / kg.
- Is the price stable?
    - The price stability is quite okay except for the strange decrease in price a few years ago.
- Are you satisfied with the price?
    - No I would prefer a higher price. For me, Rp 15,000 per kg would be a satisfactory price.
- To whom do you sell the latex you tap?
    - I sell it directly to PT SAS. They also provide me with the production costs.
- Is PT SAS the only option you can sell the latex to?
    - No there are also other middlemen but I prefer PT SAS because I trust them the most.
- What share of your income comes from Jelutung latex?
    - Everything.
- Do you want to cultivate more or less Jelutung latex?
    - It would be hard to cultivate more because I am already working my hardest, doing the maximum rotation of 10 - 15 days for one line, but I would like to continue cultivating Jelutung in the future.
- Has there been any impact from peat fires on your cultivation of Jelutung latex?
    - I do not see any effect.
- What are, in your opinion, the main barriers of cultivating Jelutung latex?
    - I would say termites and weather are a barrier to cultivating the latex. If it is too wet working in the forest is more difficult and it takes me longer to tap the trees. The termites sometimes attack the trees and drain the latex. This does not happen often but it is still frustrating when it does happen.

<u>Interview pak Mohammad, Kubu village, 24/11/2016</u>

- How long have you been tapping Jelutung latex?
    - For 35 years.
- Do you harvest any other NTFPs or other products?
    - No I only harvest Jelutung latex. However, when the weather is bad I do some carpentry.
- Do you have your own land?
    - No I only have my garden to grow rice for my own consumption. I have 10 lines of Jelutung trees in the natural forest. Each line has 40 - 60 Jelutung trees.
- How far are the Jelutung trees from your home?
    - Two hours by motorbike.
- What method do you use to tap Jelutung latex?
    - I go back and forth every week day to the forest. I do not tap in a group, I go alone.
- How do you maintain the quality of the latex?
    - The quality of the latex is good. I just make sure it does not mix with rainwater.
- Do you do any processing or manufacturing to the latex?
    - I add a small amount of vinegar to the latex to keep it compact.
- How many days per month do you go to the forest to collect Jelutung latex?
    - 15 - 20 days per month.

- How many kilograms of latex do you collect on average per day?
    - I collect around 20 - 30 kg.
- What are your production costs in one month? Do you pay these yourself?
    - Approximately Rp 2 million per month. I borrow the money for these costs in advance.
- For how much do you sell 1 kg of latex?
    - Rp 8500 / kg.
- Is the price stable?
    - The price is quite stable.
- Are you satisfied with the price?
    - Not really, I think it is a bit low at the moment. I would like to be able to buy 1 kg of good quality rice after selling 1 kg of Jelutung latex. This means the latex should be around Rp 15,000 per kg.
- To whom do you sell the latex you tap?
    - I sell it directly to PT SAS. They also provide me with the production costs.
- Is PT SAS the only option you can sell the latex to?
    - No there are also other middlemen but I prefer PT SAS because I trust them the most.
- What share of your income comes from Jelutung latex?
    - Everything.
- Do you want to cultivate more or less Jelutung latex?
    - I want to continue cultivating the same amount as I am today. I do not want to cultivate less because then I will have less income.
- Has there been any impact from peat fires on your cultivation of Jelutung latex?
    - I think there is no significant impact.
- What are, in your opinion, the main barriers of cultivating Jelutung latex?
    - For me weather and the transportation is an issue. I have to transport all of the latex I collect by myself on a motorbike for 2 hours, and then later take it all the way to PT SAS which is also far.

<u>Interview Gemor & Jelutung farmer, pak Dedi, 30/11/2016, Kering Bangkirai</u>

See interview with pak Dedi in Appendix 7.4 for further details on location etc.

- Where do you harvest Jelutung latex?
    - In the natural forest.
- What are the production costs for Jelutung latex?
    - Around Rp 1.5 million per person per week.
- How many days on average do you go to the forest to tap Jelutung per month?
    - Usually around 15 days, but it depends on the weather conditions. If it is raining I cannot tap Jelutung latex.
- How many trees do you tap on average per day?
    - Approximately 50 trees per day. I work in a circle so that I do not have to walk very far back and forth.
- How many kilograms of Jelutung latex do you tap on average per day?
    - Around 35 kg per person per day.
- For how much do you sell 1 kilogram of Jelutung latex?
    - Rp 8000 / kg.
- How much Jelutung latex do you sell in 1 month? Do you sell everything?
    - Yes I sell everything, around 400 kg per month.

- To whom do you sell the Jelutung latex you collect? Are they the only option you can sell to?
    - To PT SAS in Pangkalan Bun. They are the only trader I know that still trades Jelutung, which is unfortunate because they are so far away.
- Are you satisfied with the price of Jelutung latex?
    - I think the price could be a bit higher but it is okay.
- What share of your income comes from Jelutung latex?
    - 25%. The remaining 75% is from Gemor bark.
- What is your net income from Jelutung latex?
    - Around Rp 1 million per month.
- What are in your opinion the main barriers for cultivating Jelutung latex?
    - The supply in the natural forest is getting lower which makes the trees harder to find.

7.2 Local Jelutung Trader (PT SAS) Interview

<u>Interview pak Mingky, PT SAS, Pangkalan Bun, 22/11/2016</u>

- For how many years have you been a trader of Jelutung latex?
    - 24 years
- Do you trade any other products at the moment?
    - We used to also trader rubber, but now we only trade Jelutung latex.
- So Jelutung latex is the main source of income for PT SAS?
    - Yes
- Do you buy the Jelutung latex directly from the tappers?
    - Yes, we buy it directly or from middlemen. The tappers and middlemen bring the latex to PT SAS.
- How many tappers do you work with at the moment?
    - Around 50 tappers.
- How many kilograms of Jelutung latex do you buy in 1 month?
    - We buy approximately 30 tonnes per month. This is two or three times less than what we bought 10 years ago.
- For how much do you buy 1 kg of Jelutung latex?
    - Usually around Rp 10,000 / kg. We can also buy it for a slightly lower price depending on the quality and who we are buying the latex from.
- Is the price stable?
    - The price has recently been raised to Rp 10,000 per kg. Around three years ago it was Rp 6500 per kg which was very low. It was the worst price. At this time many tappers quit and almost no tappers were left. However, now, since the price is higher again, more tappers are coming back.
- What is the quality of the latex like? Is it always good?
    - Yes, the quality is always good - Rp 10,000 per kg is the average price. If we see that the quality is a little less good, we may charge a lower price.
- Do you do any manufacturing or processing to the latex you buy?
    - No, we just package the Jelutung latex into packages of 70 - 100 kg.
- To whom do you sell the Jelutung latex you buy?
    - We bring everything to PT Sampit. We do not sell it because we are a branch office of PT Sampit and so they are the ones giving us the money to buy the Jelutung latex. PT Sampit is the only large-scale trader of Jelutung latex in Kalimantan.
- Do you know to whom PT Sampit sells the Jelutung latex?

- To Lotte, a Japanese chewing gum manufacturer.

- What are the production costs at this stage for 1 kg of Jelutung latex?
  - We do not spend production costs ourselves because we are a branch office of PT Sampit. They pay all of the production costs and our salaries.
- How many kilograms of latex do you sell in 1 month?
  - We sell everything we buy but the weight of the latex might be slightly less because the water content decreases a little bit during packaging, stacking, and transport.
- How long does it take between buying the latex from the tappers and then bringing it to PT Sampit?
  - They arrange transport once a week to come and pick up the Jelutung latex from us, so around 7 - 8 tonnes per week.
- For how much do you sell 1 kg of Jelutung latex?
  - We do not sell it to PT Sampit because we are owned by PT Sampit so they take care of all the costs and sell the latex after they have processed it.
- For how much does PT Sampit sell 1 kg of Jelutung latex?
  - I do not know.
- What does PT Sampit do with the latex?
  - They cook the latex and take it through a purification process. After this, 1 ton of latex will only weigh 180 kg, as much of the original water content is removed.
- What do you think are the main barriers for the Jelutung latex market?
  - I think the main barrier is the supply. Tappers still rely on taking the Jelutung latex from the natural forest, but there is less availability of these trees because more land is being converted to palm oil. This means that the tappers have difficulty finding the Jelutung trees. Ten years ago the supply to PT SAS was 2 - 3 times more than it is today. Also, there used to be another latex trader in Palangka Raya but he quite around three years ago when he noticed the supply and price were decreasing.

7.3 Large-scale Jelutung Trader (PT Sampit) Questionnaire

- What is your name?
  - Ekri Suwantono
- What is your job at PT Sampit?
  - Export-Import Manager
- How long has PT Sampit been involved in the Jelutung latex business?
  - Since 1980s.
- Are there any other large-scale traders of Jelutung latex, like PT Sampit, in Indonesia?
  - Not that I know of.
- In your opinion, how has the Jelutung latex market in Central Kalimantan changed in recent years? For example, has there been more demand, less supply, changes in price etc.
  - Demand is stable, about 18 tonnes (one shipping container) per month but supply is decreasing rapidly. However, price does not change much.
- Does PT Sampit trade any other products besides Jelutung latex?
  - Yes.
- If yes, which products?
  - Compound rubber, rubber (SIR10, SIR20, SIR30) → SIR: Standard Indonesian Rubber
- From whom / where does PT Sampit buy the Jelutung latex?
  - From collectors who delivers jelutung to our Pangkalan Bun depot, collected directly from tappers in Pangkalan Bun and surrounding area.
- How many kilograms / tonnes of Jelutung latex does PT Sampit buy per month?
  - Between 15-20 tonnes per month due to low supply this past year, maximum never exceeds 20 tonnes.
- What is the price that PT Sampit pays for 100 kg of Jelutung latex?
  - Rp 4,000 per kg.
- Does PT Sampit do any manufacturing or processing of the Jelutung latex?
  - Yes.
- If yes, what do you do?
  - Processing consist of washing/cleansing, breaking up into smaller pieces, reducing water content, moulding into a rectangular box shape weighing 20 kg each, 42cm long x 30cm wide x15cm height.
- What are the approximate production costs of PT Sampit for 100 kg of Jelutung latex?
  - I have no information on this.
- How many kilograms of Jelutung latex does PT Sampit approximately sell per month?
  - 18 tonnes per month on regular basis.
- For what price does PT Sampit sell 100 kg of Jelutung latex?
  - USD 8 per kg.
- Is this price stable?
  - Yes, price is adjusted or increased every two years.
- To whom / where does PT Sampit sell the Jelutung latex?
  - Lotte, Japan and Gum Base, Italy.
- If there are multiple buyers, who is PT Sampit's biggest customer for Jelutung latex?
  - Lotte, Japan → long-term contract, shipment of 18 tonnes per month, while Gum Base, Italy purchases 18 tonnes per year.
- Is there a stable demand from these buyer(s) for Jelutung latex from PT Sampit?
  - Yes, on contractual basis.

- What do the buyer(s) do with the Jelutung latex they buy from PT Sampit? For example, what kind of products do they produce from the latex, what kind of manufacturing do they do, etc.
    - Before delivery, PT Sampit would send a sample with lab test results to Lotte, Japan. Shipment is done upon approval of the sample tests. Their representatives would visit the PT Sampit once a year, with short survey to farmers' jelutung plots. Unfortunately, we have no information on further processing.
- Do you think there is a market to expand the cultivation and trading of Jelutung latex in Central Kalimantan (i.e. enough demand)?
    - No, now it is much constrained due to expanding oil palm plantations.

7.4 Gemor Farmer Interviews

Interview pak Supri, Taruna village, 29/11/16

- How long have you been farming Gemor bark?
  - For seven years.
- Do you collect any other (NTFP) products?
  - I harvest paddy but no other NTFP.
- Do you have your own land? If yes, do you have Gemor trees on your land?
  - I have 2 ha of my own land but I do not have Gemor trees on the land. I grow paddy on my own land.
- Where do you harvest your Gemor trees?
  - The natural forest.
- How far do you have to travel to reach the Gemor trees?
  - I use my kelotok to get to the forest and I leave at 7am and arrive at 4pm in the forest.
- How do you collect Gemor bark? What method do you use?
  - I cut the whole tree with an axe/knife, and remove all of the bark. I cut the tree from around 50 cm above the ground so that hopefully new shoots of the tree will grow back. I use a skimmer to remove the bark from the tree trunk. The tree usually grows back when it is cut from 50 cm above the ground and after 3 months a new shoot appears. Then, it takes around 8 - 10 years before the tree is ready to be cut again. This is also why many people do not plant Gemor, because it takes a long time to grow.
- When you collect the Gemor bark, do you take all of the bark from the tree in one go? Or do you leave some of the bark?
  - Already answered.
- How do you maintain the quality of the Gemor bark? Is the quality always good?
  - I dry the bark in the sun. The natural quality is always good so I do not have to worry about it. I dry the bark so it is easier to transport.
- Do you collect the Gemor bark in a group or by yourself?
  - In a group.
- If in a group, how many people are in the group?
  - Four.
- If in a group, how do you arrange the farming? How do you share the income?
  - We share the income equally and travel to and from the forest together but cut our own trees.
- Do you do any manufacturing or processing to the Gemor bark? What do you do?
  - I just dry the bark for 3 - 4 days in the sun.
- What are the approximate production costs of collecting Gemor bark in 1 month?
  - For my group of four people we get Rp 3 million for one month in the forest.
- How many days on average per month do you collect Gemor bark?
  - I usually stay in the forest for 3 weeks per month.
- How many Gemor trees do you farm on average per day?
  - It depends on the diameter, but usually around 5 trees per day.
- How many kilograms of Gemor bark do you collect in 1 day?
  - In my group we collect on average 160 kg per day, so around 40 kg per person per day.
- For how much do you sell 1 kg of Gemor bark?
  - 1 kg of bark when I have already dried it a bit is sold for Rp 10,000 / kg.

- Is the price of Gemor bark stable?
    - I think the price fluctuates. The worst price is Rp 7000 / kg. This was the price in 2010. Luckily now the price is increasing again.
- How much of the Gemor bark that you collect in 1 month do you sell? How much percent?
    - In my group we collect 3 tonnes of bark per month and that is everything that we farm per month with the 4 people in my group. So we sell everything we collect.
- To whom do you sell your Gemor bark? Is this the only person you can sell it to?
    - I sell it to a local trader in Kapuas. His name is pak Banda and he sells it further to pak Tantono. I go to pak Banda myself by truck to transport the Gemor bark. To use the truck for one day costs Rp 700,000. There are other people I can sell my bark to but I trust pak Banda the most.
- Are you satisfied with the price of Gemor bark?
    - Yes I am satisfied.
- How much percent of your income comes from Gemor bark?
    - 100% of my income comes from Gemor bark.
- Do you want to cultivate more or less Gemor bark? Why?
    - I would like to harvest more to get more money but it is difficult to find more trees.
- Have you noticed an effect of the peat fires on the production of Gemor bark? How?
    - Yes I noticed that after the fire last year, around 75% of the Gemor trees in the natural forest where I go to were burnt down. I blame the palm oil plantations for this.
- What are for you the main barriers to cultivating Gemor bark?
    - I would say the peat fires are a big barrier. Also, the supply of Gemor trees is low so it is difficult to harvest as many trees as in the past. I think the demand is quite good.

Interview pak Gunawan, Taruna village, 29/11/2016

- How long have you been farming Gemor bark?
    - More than 20 years.
- Do you collect any other (NTFP) products?
    - I also collect Geharu, Damar, and Jelutung. For Jelutung I just collect the seeds which I sell for Rp 1000 / seedling.
- Do you have your own land? If yes, do you have Gemor trees on your land?
    - I own 4 ha of land but I do not plant Gemor trees. On my land I had Jelutung trees for harvesting Jelutung latex. I had 1000 Jelutung trees but after the 2015 fires almost all of the trees burnt down and now I only have four left. I just use these trees to collect the Jelutung seedlings now.
- Where do you harvest your Gemor trees?
    - The natural forest.
- How far do you have to travel to reach the Gemor trees?
    - The Gemor trees are 30 minutes walking from my home.
- What method do you use to collect the Gemor bark?
    - I cut the whole tree down from 50 cm above the ground. I leave some of the trunk so that 4 - 5 trees can grow back after cutting. The minimum diameter for harvesting a Gemor tree is around 12 cm. A big Gemor tree would be between 40 - 50 cm. I go back and forth every day to the natural forest so I do not have to sleep there.
- When you collect the Gemor bark, do you take all of the bark from the tree in one go? Or do you leave some of the bark?
    - I take all of the bark except for the 50 cm of the trunk that I do not cut down.

- How do you maintain the quality of the Gemor bark? Is the quality always good?
    - To make sure that the quality of my Gemor bark is consistently high I check that the bark is around 10 -15 years old. This is the optimal age in my opinion. I also make sure that the bark I skim is around 2 cm thick.
- Do you collect the Gemor bark in a group or by yourself?
    - Alone
- Do you do any manufacturing or processing to the Gemor bark? What do you do?
    - Yes, I dry the bark for 3 days in the sun.
- What are the approximate production costs of collecting Gemor bark in 1 month?
    - Since I do not have to stay in the natural forest, I do not have many production costs. However, I take the bark to my trader for which the transport costs are Rp 50,000 per 100 kg. I pay these costs myself.
- How many days on average per month do you collect Gemor bark?
    - I would say overall I spend around 20 - 25 days in the forest but I spend these days collecting other NTFPs as well as Gemor bark.
- How many Gemor trees do you farm on average per day?
    - I can cultivate 5 trees per day if the diameter is not too big. If the diameter is more than 40 cm, then I could only harvest one tree.
- How many kilograms of Gemor bark do you collect in 1 day?
    - On average I collect approximately 40 kg per day. In one month I collect 300 kg of bark.
- For how much do you sell 1 kg of Gemor bark?
    - The price of wet bark is Rp 4000 / kg and for dried bark it is Rp 9000 / kg.
- Is the price of Gemor bark stable?
    - I think the price is a bit higher now because the supply is lower so Gemor bark is more rare.
- How much of the Gemor bark that you collect in 1 month do you sell? How much percent?
    - I sell everything that I collect.
- To whom do you sell your Gemor bark? Is this the only person you can sell it to?
    - I sell it to pak Nunung, the Gemor trader in Tumbang Nusa. There are other people I can sell my bark to but I have the best business relationship with pak Nunung.
- Are you satisfied with the price of Gemor bark?
    - Yes I am satisfied with it.
- How much percent of your income comes from Gemor bark?
    - I think Gemor bark is around 70% of my total income. My net income from Gemor is usually Rp 700,000 / month.
- Do you want to cultivate more or less Gemor bark? Why?
    - I would like to cultivate more because the price is quite good and so I would get more money. However, I cannot harvest any more bark because the supply is too low. It is difficult to find the Gemor trees and the trees take too long to grow for planting.
- Have you noticed an effect of the peat fires on the production of Gemor bark? How?
    - The fires, especially the one from last year, has killed some of the Gemor trees in the natural forest. This means the supply goes down even more quickly.
- What are for you the main barriers to cultivating Gemor bark?
    - I think the fires are a big threat - and the availability of the trees in the natural forest is also a barrier.

Interview pak Agan, Kering Bangkirai, Sebengau District, 29/11/16

In Kering Bangkirai, there are around 50 Gemor farmers still left, according to pak Gunawan.

- How long have you been farming Gemor bark?
  - For 20 years.
- Do you collect any other (NTFP) products?
  - I also harvest Pantung rubber from the natural forest, but I only do this when I cannot get enough money from only selling Gemor bark.
- Do you have your own land? If yes, do you have Gemor trees on your land?
  - Yes, I have 2 ha. I used to have Gemor and rubber trees on this land but after the forest fire 5 years ago all of these trees are gone.
- Where do you harvest your Gemor trees?
  - The natural forest.
- How far do you have to travel to reach the Gemor trees?
  - I go by kelotok for one day to reach the trees. I go further than most Gemor farmers because I know that if I go far I can find the bigger trees.
- How do you collect the Gemor bark? What method do you use?
  - I cut the trees from around 50 cm above the ground and then I take all of the bark. I would say it takes around 5 - 8 years before the trees will grow back to a diameter that can be harvested again.
- When you collect the Gemor bark, do you take all of the bark from the tree in one go? Or do you leave some of the bark?
  - I take all the bark in one go.
- How do you maintain the quality of the Gemor bark? Is the quality always good?
  - I do not really do anything to manage the quality of Gemor bark. It is usually always fine, however nowadays the diameter of the trees is smaller than 10 - 15 years ago. This means that I cannot collect as much bark and maybe it also has an effect on the quality of the bark.
- Do you collect the Gemor bark in a group or by yourself?
  - Group.
- If in a group, how many people are in the group?
  - There are 10 - 15 farmers in the group.
- If in a group, how do you share the income?
  - The income is shared based on the position in the group. The senior farmers get a bit more money per kilogram than the junior farmers. This distinction depends on the age and the experience. Two people in our group are senior farmers. I am a junior farmer.
- Do you do any manufacturing or processing to the Gemor bark? What do you do?
  - I dry the bark in front of my house. Usually I dry it for 3 days but if the sun is weak I maybe have to dry it for one week.
- What are the approximate production costs of collecting Gemor bark in 1 month?
  - For 1 month the production costs we borrow for the whole group are Rp 6 million. We borrow this from pak Titi who is the overall collector in Kering Bangkirai.
- How many days on average per month do you collect Gemor bark?
  - In the group we usually go for two week periods. So around 2 weeks - 3 weeks per month. We stay in the forest because we have to travel a long distance.

- How many Gemor trees do you farm on average per day?
    - It depends on the diameter, it could be between 1 and 5 trees per day.
- How many kilograms of Gemor bark do you collect in 1 day?
    - For the whole group we can harvest around 400 - 500 kg per day - so around 40 kg per person.
- For how much do you sell 1 kg of Gemor bark?
    - 6 - 10 years ago I sold Gemor bark for Rp 4000 / kg (dry price). Now, depending on the thickness of the bark, I sell it for Rp 6000 / kg.
- Is the price of Gemor bark stable?
    - I think the price is going up because of the reduction in supply.
- How much of the Gemor bark that you collect in 1 month do you sell? How much percent?
    - I sell everything that I collect. The Gemor collector in Kering Bangkirai gathers all of my Gemor bark to bring it to the trader.
- To whom do you sell your Gemor bark? Is this the only person you can sell it to?
    - I sell it directly to pak Tantono. Pak Titi, the collector in this village, goes once per month to pak Tantono's warehouse to bring the Gemor bark.
- Are you satisfied with the price of Gemor bark?
    - Yes I am satisfied.
- How much percent of your income comes from Gemor bark?
    - Around 70%. The remaining 30% is from rubber trees.
- Do you want to cultivate more or less Gemor bark? Why?
    - Yes I would like to cultivate more Gemor bark but it is difficult because the trees are so far away from my home and the availability in the natural forest is low.
- Have you noticed an effect of the peat fires on the production of Gemor bark? How?
    - The fires kill the stem and the roots of the Gemor trees, so even if the tree has not burned down entirely, it still will not grow anymore because of the fire affecting the stem and roots. I think the fires also decrease the quality of the bark.
- What are for you the main barriers to cultivating Gemor bark?
    - I think it is the area of land that is available for me to farm. This area has greatly decreased because the Sebengau national park and WWF have created a forest conservation area. At the moment I am harvesting Gemor in a buffer zone of the national park, but I am worried this will also be made into a conservation area.

<u>Interview pak Intau, Kering Bangkirai, 30/11/2016</u>

Pak Intau is in the same Gemor farming group as pak Agan.

- How long have you been farming Gemor bark?
    - For 25 years.
- Do you collect any other (NTFP) products?
    - I also collect rattan. I fish as well but this is not a NTFP. I also harvest Jelutung from the natural forest.
- Do you have your own land? If yes, do you have Gemor trees on your land?
    - I have just 1 ha. I had Gemor trees on my land but they all burned down after the fire last year so now I am waiting for them to grow back but this takes a long time.
- Where do you harvest your Gemor trees?
    - The natural forest.

- How far do you have to travel to reach the Gemor trees?
    - 5 years ago I only had to travel one hour by kelotok but now I have to travel 1 - 2 days to reach the trees.
- How do you collect the Gemor bark? What method do you use?
    - I cut the entire tree down from 50 cm above the ground. I think it takes around 5 years for new trees to grow back and reach the diameter that is suitable for cutting again.
- When you collect the Gemor bark, do you take all of the bark from the tree in one go? Or do you leave some of the bark?
    - I do not leave any of the bark.
- How do you maintain the quality of the Gemor bark? Is the quality always good?
    - The quality is usually always fine.
- Do you collect the Gemor bark in a group or by yourself?
    - In a family group.
- If in a group, how many people are in the group?
    - 10-12 people.
- If in a group, how do you arrange the farming? How do you share the income?
    - The only difference between the income each member receives is if you are a senior farmer or a junior farmer. I receive a bit more income because I am a senior farmer.
- Do you do any manufacturing or processing to the Gemor bark? What do you do?
    - I cut the bark into smaller pieces and I also hold it above a fire so that the smoke can dry the bark a bit. I do this for 1 day and 1 night. Then I also dry the bark in the sun for 3 - 4 days afterwards.
- What are the approximate production costs of collecting Gemor bark in 1 month?
    - From pak Titi we get Rp 6 million for the group for 1 month of collecting Gemor bark.
- How many days on average per month do you collect Gemor bark?
    - We stay in the forest for around 3 weeks because it takes so long to travel to the trees.
- How many Gemor trees do you farm on average per day?
    - Around 10 years ago I only harvested 1 Gemor tree per day because the diameter of the trees was very big. However, now the diameter is smaller so I harvest around 4 - 5 trees per day.
- How many kilograms of Gemor bark do you collect in 1 day?
    - 25 years ago I collected 100 - 200 kg per day (per person). Today, it is around 50 kg per day because of the limited availability of Gemor trees.
- For how much do you sell 1 kg of Gemor bark?
    - 20 years ago the price was Rp 3000 / kg, now it is Rp 7000 - 8000 / kg.
- Is the price of Gemor bark stable?
    - I think the price is going up.
- How much of the Gemor bark that you collect in 1 month do you sell? How much percent?
    - I sell everything I collect, which is around 1 ton.
- To whom do you sell your Gemor bark? Is this the only person you can sell it to?
    - I sell it to pak Tantono in Banjarmasin. Someone from Banjarmasin comes by speedboat once a month to collect the bark. I could also sell my bark to a local trader but I trust pak Tantono more.
- Are you satisfied with the price of Gemor bark?
    - Yes now the price is fine.
- How much percent of your income comes from Gemor bark?
    - Around 75% of my income is from Gemor bark. Fishing is around 10 - 15% and rattan and Jelutung latex make up the rest. However, these shares do depend on the conditions

of the water and the weather. If the conditions are bad, I cannot go to the forest so then I may spend more time on fishing.

- Do you want to cultivate more or less Gemor bark? Why?
  - More to get more money because the price is better now.
- Have you noticed an effect of the peat fires on the production of Gemor bark? How?
  - Both the quality and the supply of Gemor bark has been affected negatively by the peat fires.
- What are for you the main barriers to cultivating Gemor bark?
  - I think the supply is a big barrier and also the fires as they burnt down my personal supply of Gemor trees.

Interview pak Dedi, Kering Bangkirai, 30/11/2016

Pak Dedi is not in a group with the previous two farmers. He is also a Jelutung tapper.

- How long have you been farming Gemor bark?
  - For more than 30 years.
- Do you collect any other (NTFP) products?
  - I harvest Jelutung latex as well.
- Do you have your own land? If yes, do you have Gemor trees on your land?
  - No.
- Where do you harvest your Gemor trees?
  - The natural forest in Kapuas.
- How far do you have to travel to reach the Gemor trees (kilometers)?
  - I live in Tanjung Kalanis in Kapaus. 20 years ago it would take me around 30 minutes by kelotok from my house to the forest to find the trees. Now however, it takes me a whole day to reach the trees because their availability has decreased.
- How do you collect the Gemor bark? What method do you use?
  - I cut the entire tree down from 40 cm above the ground. Depending on the conditions the Gemor trees usually take around 5 years to grow back to a diameter that can be cut again.
- When you collect the Gemor bark, do you take all of the bark from the tree in one go? Or do you leave some of the bark?
  - I do not leave any of the bark.
- How do you maintain the quality of the Gemor bark? Is the quality always good?
  - First I hold the bark 2 m above a fire so the smoke can dry the bark and improve the quality. The quality is usually good unless water goes into my kelotok when the weather is bad and this makes the bark wet which is a problem.
- Do you collect the Gemor bark in a group or by yourself?
  - In a family group with 20 people.
- If in a group, how many people are in the group?
  - 20 people.
- If in a group, how do you arrange the farming? How do you share the income?
  - Usually we just collect the Gemor bark ourselves, so it is not a group activity. However, our group has a collector who can help us to sell the bark or from whom we can borrow money for production costs. We share the income equally.

- Do you do any manufacturing or processing to the Gemor bark? What do you do?
    - I dry the bark above the fire for one day and one night and that is all I do. I dry my bark by myself, not in the group.
- What are the approximate production costs of collecting Gemor bark in 1 month?
    - For one month, one person gets around Rp 1.5 million.
- How many days on average per month do you collect Gemor bark?
    - Around 3 weeks we stay in the forest (do not go back and forth). However, I do not farm Gemor trees on all of these days. Sometimes I also tap Jelutung. The days in the forest are dedicated to either Jelutung or Gemor, I do not farm both trees in one day. I usually spend more days harvesting Gemor bark than Jelutung latex, but this depends on the weather.
- How many Gemor trees do you farm on average per day?
    - Depending on the diameter, I harvest 1-3 Gemor trees per day.
- How many kilograms of Gemor bark do you collect in 1 day?
    - 50 kg of Gemor bark per person per day.
- For how much do you sell 1 kg of Gemor bark?
    - I sell the Gemor bark for Rp 10,000 per kg.
- Is the price of Gemor bark stable?
    - I think the price is going up, otherwise it is quite stable.
- How much of the Gemor bark that you collect in 1 month do you sell? How much percent?
    - I sell everything I collect, which is usually 1 ton.
- To whom do you sell your Gemor bark? Is this the only person you can sell it to?
    - I sell it to pak Tantono in Banjarmasin. The collector of my Gemor farmers group, pak Haji, goes to bring our bark to Banjarmasin. I think we could also sell the bark to other people, I do not know why the group has chosen pak Tantono.
- Are you satisfied with the price of Gemor bark?
    - Yes I am satisfied.
- How much percent of your income comes from Gemor bark?
    - Around 75% of my income is from Gemor and 25% is from Jelutung latex. However, this proportion depends on the weather conditions. It can be a bit more or less.
- Do you want to cultivate more or less Gemor bark? Why?
    - I would like to harvest more because the price is quite good now, better than Jelutung latex.
- Have you noticed an effect of the peat fires on the production of Gemor bark? How?
    - If the Gemor bark has been burnt, you cannot use it anymore. Therefore, the fires contribute to limiting the supply of Gemor trees in the natural forest.
- What are for you the main barriers to cultivating Gemor bark?
    - The main barrier in my opinion is the limited stock of Gemor trees in the natural forest. I would prefer to plant Gemor trees.

7.5 Local Gemor Trader (Pak Nunung) Interview

Interview pak Nunung, Tumbang Nusa, 29/11/16

- How long have you been trading Gemor bark?
    - 25 years.
- Do you trade any other products? If so, which ones?
    - We trade Geharu (a NTFP used for men's health products) which we get from Sampit, Kering Bangkirai, and Pangkalanbun. We also trade Klanis, Pasak Bumi, and Ginseng (all used for cosmetic/health products and all NTFPs).
- Which of these products generates the largest share of income for your company?
    - Geharu and Pasak Bumi are the best sources of income for us, then Gemor bark is the third best.
- From whom (and where) do you collect the Gemor bark you trade?
    - We collect it directly from local farmers from Tumbang Nusa, Kering Bangkirai, and Sampit (all in Central Kalimantan). There are no middlemen involved, we collect the bark directly from the farmers by going to the farmers or having them come to us.
- How many farmers approximately do you buy Gemor bark from?
    - We work with around 30 - 40 Gemor farmers. Most of these farmers are in groups but there are also a few individual farmers who we do business with.
- How much (in tonnes) of Gemor bark do you buy each month from the farmers?
    - We collect around 10 tonnes per month.
- For what price do you buy one kilogram of Gemor bark?
    - We buy the bark for around Rp 9000 / kg. Most of the bark we buy still requires some further drying so then we charge a slightly lower price.
- How much do you give to the farmers that need to borrow money for their production costs of Gemor bark?
    - One group of farmers needs around Rp 1.5 - 3 for 1 week - 10 days of collecting Gemor bark. The farmers have to pay this all back when selling the Gemor bark to us.
- Would you say the price for Gemor bark is stable?
    - There are a few fluctuations over the years but overall I would say the price is stable.
- What is the quality of the Gemor bark that you buy like? Is the quality always good?
    - Yes the quality is always good. We make sure to only collect and trade the red species of Gemor bark and this species is always high in quality.
- Do you do any manufacturing or processing to the Gemor bark that you buy?
    - We cut the bark into smaller pieces and then dry it in the sun for 4 days. Then we package the bark into packages of 25 - 30 kg. At this point the bark is dry.
- What are your approximate production costs for Gemor bark?
    - We have 4 employees working on 1 ton and each person is paid Rp 100,000. So in total for 10 tonnes per month the production costs I would say are around Rp 4 million as we don't have many more production costs than the wages.
- How much of the Gemor bark that you buy to do you sell?
    - We sell 10 tonnes, so we sell everything that we buy.
- To whom do you sell the Gemor bark?
    - We sell everything to pak Tantono. He is the final trader.

- How long does it take between the buying of the Gemor bark and selling it?
    - It takes around 10 days because we have to dry the bark, package it and also transport it. However, it also depends on how good the conditions are for drying the bark. If it has been a cloudy week we might need some more time to dry the bark.
- For how much do you sell the Gemor bark to pak Tantono?
    - We sell it for Rp 16,000 / kg.
- What is your opinion on the market of Gemor bark at the moment?
    - The supply is low. 10 years ago we would trade around 100 tonnes per month and now this amount has decreased by ten times because of the lower availability of Gemor trees in the natural forest.
- What would you say are the main barriers to trading Gemor at the moment?
    - A big barrier is that the supply is decreasing and it is hard for the farmers to find Gemor trees to cultivate. We also would prefer the price to be more stable.
- What are the barriers of trading NTFPs in general?
    - The production costs to pay local farmers to harvest NTFPs can be quite high which is a bit of a barrier because then the products are more expensive for me to buy from the farmers.
- What would you like to see happening with your business of Gemor bark trading next year?
    - We would like our production costs to be paid for by pak Tantono instead of having to pay them ourselves up front.

7.6 Large-scale Gemor Trader (UD Kesuma Jaya) Interview

Interview Pak Tantono, UD Kesuma Jaya, Banjarmsin, 15/11/2016,

- Where is your business based?
    - Banjarmasin, South Kalimantan
- How long have you traded Gemor?
    - 40 years
- In your opinion, how has the Gemor market changed in recent years? For example, has there been more demand, less supply, changes in price etc.
    - There is less demand, and also there is less supply. The price however has increased slightly in the past decade but not very significantly. There is less demand because Gemor bark used to be used to make mosquito coils but now a replacement has been found (glue) so Gemor bark is only used to make incense.
- Is trading Gemor your main source of income?
    - Not anymore.
    - If no, what other products do you trade that are better sources of income for you?
        - Just other businesses. Not any NTFPs.
- From whom do you buy your Gemor products?
    - Keeps changing but only from people in Central Kalimantan because that's the habitat for Gemor. I buy the bark directly from farmers and local traders.
- To where do you transport the Gemor bark you buy?
    - It is first in my warehouse as stock, which I then put in packages (depending on the order), and it is then sent to Surabaya or Jakarta. These companies change the bark into powder and then export it to China or Taiwan to make incense, or it is sold nationally. The Gemor bark is no longer used to make mosquito coils because a cheaper, synthetic replacement has been found.
- In what form do you buy the Gemor bark? (e.g. still in its natural form, already manufactured/processed)
    - Still natural, it has only already been spread and sun dried. But here in my warehouse we also spread and dry the Gemor bark.
- What is the quality of the Gemor bark like that you buy?
    - The quality varies, sometimes it's thicker, sometimes it's thinner - because it is a natural product so you cannot control the quality very well. It also depends on the diameter of the Gemor tree and the way the farmers cultivate the bark. In general though, the quality is pretty good. After a fire, the trees are gone so the supply is lower.
- How much (kilograms) Gemor bark do you buy from the farmers and local traders each time?
    - 10 years ago, around 100 tonnes of Gemor bark in total per month. Today, around 15 tonnes per month. The decrease in the supply is mostly due to the land conversion of natural land to palm oil plantations, which has decreased the availability of Gemor in the wild. Another issue is that people do not plant the Gemor trees, so they still count on its natural availability.
- How much do you pay for 100 kg of Gemor bark from the local trader or farmer?
    - 10 years ago, 1 kg of Gemor bark was bought for Rp 500. Now it is bought for around Rp 12,000. Of course, this price can differ slightly depending on who I am buying it from.

- Do you do any manufacturing or processing of the Gemor bark?
    - The bark is cut into smaller pieces and then it is further spread and dried so that the bark can be more easily packaged.
- Once you are ready to sell the Gemor bark, to whom do you sell it?
    - To factories in Jakarta and Surabaya.
- How much (kilograms) do you approximately sell in total in 1 month?
    - 15 tonnes are sold approximately.
- For how much do you sell 100 kg of Gemor?
    - I sell 1 kg of Gemor bark for Rp 50,000. It is sold in packages of 45 kg per package.
- What are the production costs?
    - It costs around Rp 500 per 1 kg of Gemor bark.
- How long does it generally take between buying the Gemor bark from farmers and local traders and selling it to your buyers?
    - Around 10 days, but it depends on the order (made by order).
- Do you know what the buyers do with the Gemor they buy from you?
    - They make it into powder for incense sticks called hio. The biggest importers of the powder are China and Taiwan.
- Do you think there is a market to expand the cultivation of Gemor bark?
    - No, because of the lack of demand. I have already switched to other businesses. Gemor bark is considered an 'afternoon/sunset' business because it is slowing down.

7.7 Cost-benefit Analyses

7.7.1 Palm Oil (excluding carbon emission costs)

Without emission costs																											
Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
FFB Yield	ton/ha	0	0	0	4	15	15	15	15	15	15	24	24	24	24	24	24	24	24	24	24	24	23	22	21	20	19
FFB Price	USD/ton	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185
Total benefits	**USD/ha**	**0**	**0**	**0**	**665**	**2806**	**2806**	**2806**	**2806**	**2806**	**2806**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4246**	**4061**	**3876**	**3692**	**3507**
Land lease costs	USD/ha	470	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drainage and planting costs	USD/ha	1055	1055	1055	1055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farming costs	USD/ha	0	0	0	0	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155
Harvesting and transportation costs	USD/ha	0	0	0	42	125	125	125	125	125	125	199	199	199	199	199	199	199	199	199	199	199	191	182	174	165	155
Depreciation	USD/ha	0	0	0	0	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184
Fixed costs	USD/ha	0	0	0	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
Total costs	**USD/ha**	**1526**	**1055**	**1055**	**1245**	**1611**	**1611**	**1611**	**1611**	**1611**	**1611**	**1685**	**1685**	**1685**	**1685**	**1685**	**1685**	**1685**	**1685**	**1685**	**1685**	**1685**	**1677**	**1669**	**1660**	**1651**	**1641**
Net benefits	**USD/ha**	**-1526**	**-1055**	**-1055**	**-580**	**1195**	**1195**	**1195**	**1195**	**1195**	**1195**	**2745**	**2745**	**2745**	**2745**	**2745**	**2745**	**2745**	**2745**	**2745**	**2745**	**2745**	**2568**	**2392**	**2216**	**2041**	**1866**
Discount rate		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Discount factor		1.00	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2.14	2.36	2.59	2.85	3.14	3.45	3.80	4.18	4.59	5.05	5.56	6.12	6.73	7.40	8.14	8.95	9.85	10.83
PV of net benefits	**USD/ha**	**-1526**	**-960**	**-872**	**-436**	**816**	**742**	**675**	**613**	**557**	**507**	**1058**	**962**	**875**	**795**	**723**	**657**	**597**	**543**	**494**	**449**	**408**	**347**	**294**	**248**	**207**	**172**

NPV	**USD/ha**	**8947**

7.7.2 Palm Oil (including carbon emission costs)

With carbon emission costs																											
Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
FFB Yield	ton/ha	0	0	0	4	15	15	15	15	15	15	24	24	24	24	24	24	24	24	24	24	24	23	22	21	20	19
FFB Price	USD/ton	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185
Total benefits	**USD/ha**	**0**	**0**	**0**	**665**	**2806**	**2806**	**2806**	**2806**	**2806**	**2806**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4430**	**4246**	**4061**	**3876**	**3692**	**3507**
Land lease costs	USD/ha	470	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drainage and planting costs	USD/ha	1055	1055	1055	1055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farming costs	USD/ha	0	0	0	0	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155	1155
Harvesting and transportation costs	USD/ha	0	0	0	42	125	125	125	125	125	125	199	199	199	199	199	199	199	199	199	199	199	191	182	174	165	155
Carbon emission costs	USD/ha	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072	2072
Depreciation	USD/ha	0	0	0	0	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184
Fixed costs	USD/ha	0	0	0	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
Total costs	**USD/ha**	**3598**	**3127**	**3127**	**3317**	**3683**	**3683**	**3683**	**3683**	**3683**	**3683**	**3757**	**3757**	**3757**	**3757**	**3757**	**3757**	**3757**	**3757**	**3757**	**3757**	**3757**	**3749**	**3741**	**3732**	**3723**	**3713**
Net benefits	**USD/ha**	**-3598**	**-3127**	**-3127**	**-2652**	**-877**	**-877**	**-877**	**-877**	**-877**	**-877**	**673**	**673**	**673**	**673**	**673**	**673**	**673**	**673**	**673**	**673**	**673**	**496**	**320**	**144**	**-31**	**-206**
Discount rate		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Discount factor		1.00	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2.14	2.36	2.59	2.85	3.14	3.45	3.80	4.18	4.59	5.05	5.56	6.12	6.73	7.40	8.14	8.95	9.85	10.83
PV of net benefits	**USD/ha**	**-3598**	**-2843**	**-2585**	**-1993**	**-599**	**-545**	**-495**	**-450**	**-409**	**-372**	**260**	**236**	**214**	**195**	**177**	**161**	**146**	**133**	**121**	**110**	**100**	**67**	**39**	**16**	**-3**	**-19**

NPV	**USD/ha**	**-11933**

7.7.3 Jelutung Latex

Jelutung latex																													
Year		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Latex yield	ton/ha	0	0	0	0	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	5	5	3	3	3
Latex price	USD/ton	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670	670
Total benefits	**USD/ha**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**4824**	**3484**	**3484**	**2144**	**2144**	**2144**
Land lease costs	USD/ha	470	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Establishment costs	USD/ha	181	516	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planting costs	USD/ha	0	55	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plant maintenance	USD/ha	0	26	26	26	26	26	97	438	26	26	26	18	89	430	18	18	18	18	89	18	18	18	18	18	18	18	18	18
Equipment and input costs	USD/ha	0	144	177	231	201	185	177	177	191	177	269	181	236	181	222	181	236	181	222	181	277	181	222	181	236	181	222	181
Transportation costs	USD/ha	0	0	0	0	0	0	0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Depreciation	USD/ha	0	0	0	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
Total costs	**USD/ha**	**651**	**741**	**214**	**283**	**253**	**238**	**301**	**654**	**255**	**241**	**333**	**238**	**364**	**650**	**279**	**238**	**293**	**238**	**350**	**238**	**335**	**238**	**279**	**238**	**293**	**238**	**279**	**238**
Net benefits	**USD/ha**	**-651**	**-741**	**-214**	**-283**	**-253**	**-238**	**-301**	**4170**	**4569**	**4583**	**4491**	**4586**	**4460**	**4174**	**4545**	**4586**	**4531**	**4586**	**4474**	**4586**	**4489**	**4586**	**4545**	**3246**	**3191**	**1906**	**1865**	**1906**
Discount rate		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Discount factor		1.00	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2.14	2.36	2.59	2.85	3.14	3.45	3.80	4.18	4.59	5.05	5.56	6.12	6.73	7.40	8.14	8.95	9.85	10.83	11.92	13.11
PV of net benefits	**USD/ha**	**-651**	**-674**	**-177**	**-213**	**-173**	**-148**	**-170**	**2140**	**2131**	**1944**	**1731**	**1607**	**1421**	**1209**	**1197**	**1098**	**986**	**907**	**805**	**750**	**667**	**620**	**558**	**362**	**324**	**176**	**156**	**145**

NPV	**USD/ha**	**18731**

7.7.4 Gemor Bark

Gemor bark																										
Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Bark Yield	ton/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	2.6	0.0	0.0	0.0	2.9	0.0	0.0	0.0	3.2
Bark Price	USD/ton	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640
Total benefits	**USD/ha**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1280**	**0**	**0**	**0**	**1472**	**0**	**0**	**0**	**1664**	**0**	**0**	**0**	**1856**	**0**	**0**	**0**	**2048**
Land lease costs	USD/ha	470	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Establishment	USD/ha	78	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planting costs	USD/ha	0	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plant	USD/ha	0	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78
Farming costs	USD/ha	0	0	0	0	0	0	0	0	31	0	0	0	31	0	0	0	31	0	0	0	31	0	0	0	31
Transportation	USD/ha	0	0	0	0	0	0	0	0	8	0	0	0	8	0	0	0	8	0	0	0	8	0	0	0	8
Depreciation	USD/ha	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Total costs	**USD/ha**	**548**	**219**	**81**	**81**	**81**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**
Net benefits	**USD/ha**	**-548**	**-219**	**-81**	**-81**	**-81**	**-81**	**-81**	**-81**	**1159**	**-81**	**-81**	**-81**	**1351**	**-81**	**-81**	**-81**	**1543**	**-81**	**-81**	**-81**	**1735**	**-81**	**-81**	**-81**	**1927**
Discount rate		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Discount factor		1.00	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2.14	2.36	2.59	2.85	3.14	3.45	3.80	4.18	4.59	5.05	5.56	6.12	6.73	7.40	8.14	8.95	9.85
PV of net	**USD/ha**	**-548**	**-199**	**-67**	**-61**	**-56**	**-51**	**-46**	**-42**	**541**	**-35**	**-31**	**-29**	**430**	**-24**	**-21**	**-19**	**336**	**-16**	**-15**	**-13**	**258**	**-11**	**-10**	**-9**	**196**

Gemor bark																									
Year		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Bark Yield	ton/ha	0.0	0.0	0.0	3.5	0.0	0.0	0.0	3.8	0.0	0.0	0.0	4.1	0.0	0.0	0.0	4.4	0.0	0.0	0.0	4.4	0.0	0.0	0.0	4.1
Bark Price	USD/ton	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640
Total benefits	**USD/ha**	**0**	**0**	**0**	**2240**	**0**	**0**	**0**	**2432**	**0**	**0**	**0**	**2624**	**0**	**0**	**0**	**2816**	**0**	**0**	**0**	**2816**	**0**	**0**	**0**	**2624**
Land lease costs	USD/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Establishment	USD/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planting costs	USD/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plant	USD/ha	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78
Farming costs	USD/ha	0	0	0	31	0	0	0	31	0	0	0	31	0	0	0	31	0	0	0	31	0	0	0	31
Transportation	USD/ha	0	0	0	8	0	0	0	8	0	0	0	8	0	0	0	8	0	0	0	8	0	0	0	8
Depreciation	USD/ha	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Total costs	**USD/ha**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**	**81**	**81**	**81**	**121**
Net benefits	**USD/ha**	**-81**	**-81**	**-81**	**2119**	**-81**	**-81**	**-81**	**2311**	**-81**	**-81**	**-81**	**2503**	**-81**	**-81**	**-81**	**2695**	**-81**	**-81**	**-81**	**2695**	**-81**	**-81**	**-81**	**2503**
Discount rate		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Discount factor		10.83	11.92	13.11	14.42	15.86	17.45	19.19	21.11	23.23	25.55	28.10	30.91	34.00	37.40	41.14	45.26	49.79	54.76	60.24	66.26	72.89	80.18	88.20	97.02
PV of net	**USD/ha**	**-8**	**-7**	**-6**	**147**	**-5**	**-5**	**-4**	**109**	**-4**	**-3**	**-3**	**81**	**-2**	**-2**	**-2**	**60**	**-2**	**-1**	**-1**	**41**	**-1**	**-1**	**-1**	**26**

NPV	**USD/ha**	**864**

7.8 Comparison of Results and Literature

7.8.1 Jelutung Latex Value Chain Analysis

Upstream

When comparing the interviews with Jelutung tappers with the literature on the Jelutung latex value chain, both similarities and differences between the two sources are found. First, Perdana et al. (2016) explain that Jelutung tappers form groups to tap Jelutung in the wild. According to the interviews, two tappers work in a group to collect Jelutung latex, whereas the other four tappers who were interviewed worked individually. Perdana et al. (2016) also state that Jelutung tappers cannot negotiate the price for which they sell their latex. Based on the interviews this is indeed the case when tappers have to lend production costs from a middleman or the local trader. In this situation, tappers cannot negotiate a higher price for the latex because they are dependent on a middleman or local trader for their production costs, giving the mid-stream actors the bargaining power for the latex price. Tappers who do not have to lend production costs however, are able to negotiate the price of latex.

The farmgate price of Jelutung latex provided in the literature by Joshi et al. (2010) is around US$0.40 per kg. The average farmgate price given in the interviews with Jelutung tappers was calculated to be US$0.67 per kg. Therefore, the results from this thesis indicate a higher farmgate price for Jelutung latex than is provided in the literature. It is possible that this variation in price is due to the different time the research for this thesis was conducted (Year 2016) compared to the literature research (Year 2010); price fluctuations over time may be the reason for these different outcomes. The thesis' data on the farmgate price are considered reliable given that multiple tappers and the local Jelutung trader were asked to list this price and all respondents mentioned higher prices than the ones indicated in the literature. A sensitivity analyses on the latex price was conducted in the cost-benefit analysis to assess whether a lower price would yield a negative NPV. This was not the case, thereby indicating that a lower latex price, such as the one identified in the literature, is still likely to generate a positive NPV.

According to the interviews with Jelutung tappers, tappers can cultivate between 20 – 50 Jelutung trees per day. This is comparable to the amount of Jelutung trees tappers can cultivate per day as indicated in the literature by Tata et al. (2015). They say that tappers can cultivate around 10 – 40 Jelutung trees in around seven hours. These similar results give a clear indication of the amount of trees tappers are typically able to cultivate per day. In the literature, Tata et al. (2015) and Joshi et al. (2010) explain the local, informal tenure rules surrounding Jelutung latex tapping in Central Kalimantan and the Jambi province. They describe the tenure rules as informal claims made by Jelutung tappers in local communities over the Jelutung trees in the natural forest (Joshi et al., 2010; Tata et al., 2015). According to these authors, tappers generally claim tracks or lines of Jelutung trees as their own to avoid competition with other tappers. This same informal tenure system was also described by the Jelutung tappers in their interviews. The tappers explained that the Jelutung trees in the forest are arranged in lines and the tappers can know which trees belong to whom based on the characteristic of the cut made in the tree. Other information regarding the upstream section of the Jelutung latex value chain collected from the interviews with Jelutung tappers, such as the production costs per tapper, was not found in the literature. Therefore, the results from the interviews provide unique knowledge on the upstream step of Jelutung latex value chain.

Mid-stream

Perdana et al. (2016) explain that the mid-stream section of the Jelutung latex value chain consists of the village collectors / middlemen and the local traders. According to Perdana et al. (2016), village collectors and local traders are often also tappers themselves, and some are distributors to the large-scale trader. In the value chain analysis of this thesis, the village collectors are referred to as the middlemen, and the local trader in Central Kalimantan is known as PT SAS. As no Jelutung middlemen could be interviewed, neither qualitative or quantitative information on the middlemen was found. Besides this, there was no information available in the literature reviewed regarding the mid-stream section of the Jelutung latex value chain. There was also no literature describing local traders of Jelutung latex or PT SAS specifically. Consequently, the results of this thesis provide new knowledge on this step of the value chain.

Downstream

Pak Ekri, the export and import manager of PT Sampit who answered the questionnaire for this thesis, explained that Lotte is PT Sampit's biggest buyer of Jelutung latex. Their only other buyer of the latex is Gum Base, an Italian company. Pak Ekri also answered that he does not know of any other large-scale traders of Jelutung latex in Indonesia. When comparing this information to the literature, Perdana et al. (2016) state that PT Sampit is the biggest Jelutung latex trader in Central Kalimantan and that the only importer of Jelutung latex, Lotte, imports all their Jelutung latex from PT Sampit. The thesis results also highlight the likelihood of PT Sampit being the only large-scale Jelutung latex trader in Central Kalimantan (and possibly in all of Indonesia), and that Lotte is an important importer of the latex. The literature however, does not include information on Gum Base, another importer of Jelutung latex from PT Sampit, thereby indicating that the results from this thesis provide new data on the Jelutung latex value chain.

7.8.2 Gemor Bark Value Chain Analysis

Upstream

Kristedi & Kieft (2010) explain in their study of the Gemor bark value chain in Central Kalimantan that Gemor farmers work in groups and spend around two weeks in the forest to collect Gemor bark. The interviews with Gemor farmers provide similar results to the information in the literature. Most farmers work in groups to collect the bark. Farmers who live far away from the Gemor trees stay in the forest for 2 – 3 weeks at a time. However, there was one farmer interviewed who does not collect bark in a group. This same farmer is also the only farmer interviewed who does not stay in the forest but instead goes back and forth every day to cultivate the bark. Therefore, although descriptions in the literature are similar to the interview results, the interview results indicate that there are exceptions to Gemor farmers working in groups and staying the forest to collect the bark.

According to Lyons (2003) and Wahyu et al. (2008), farmers can either cultivate the bark by cutting down the tree and taking all the bark, or by removing part of the bark from the tree without cutting the tree down. The latter method is very uncommon as farmers generally want to harvest as much bark as possible in one go (Lyons, 2003). The interview answers from the Gemor farmers coincide with the information from Lyons (2003) and Wahyu et al. (2008), as all farmers explained that they cultivate Gemor bark by cutting down the tree and removing all the bark in one go. None of the farmers use the more 'sustainable' method of Gemor bark cultivation. This is another example of similarities between the results of this thesis and the available literature.

Regarding the quantitative data on the upstream section of the Gemor bark value chain, in the literature data can be found on the monthly production amount of bark by farmers, the non-labour costs of production (i.e. food, drinks, and gasoline), and the farmgate price of dry bark (based on Suyanto et al., 2009; Kristedi & Kieft, 2010; Panjaitan, 2010). The monthly production amount as indicated in the literature is on average 430kg per farmer (Suyanto et al., 2009; Kristedi & Kieft, 2010). The interview results reveal an average monthly production amount of 750kg of bark per farmer. Therefore, the interview results indicate a higher average monthly production amount by Gemor farmers than is presented in the literature. However, the different Gemor farmers interviewed varied quite largely in the amount of dry Gemor bark they cultivate each month (ranges between 300kg – 1000kg per month). This is logical due to the decreasing supply of Gemor trees in the wild; in some months farmers cannot find as many (big) trees as in other months, thereby collecting less bark in those months. Therefore, it is to be expected that in other studies (i.e. by Suyanto et al., 2009 and Kristedi & Kieft, 2010) slightly different Gemor bark production amounts were found than in the interview results. Nevertheless, this discrepancy between the literature and the thesis results could be further investigated in future research, to determine the precise reasons why Gemor farmers vary greatly in the amount of bark they cultivate each month. Suyanto et al. (2009) and Kristedi & Kieft (2010) present the production costs of Gemor bark cultivation of around US$40 per farmer for food, drinks, and gasoline if they spend around two weeks in the forest. From the interviews with Gemor farmers for this thesis, the average monthly production costs were found to be US$50 per farmer. The similarity between the production costs presented in the literature and in the interview results provide further verification that the monthly production costs of farming Gemor bark in the wild are likely to be around US$40 – 50 per farmer.

Lastly, according to Kristedi & Kieft (2010) and Panjaitan (2010), the farmgate price of dry Gemor bark in Central Kalimantan is between US$0.30 – 0.50 per kg. The range in farmgate price presented in the interviews with Gemor farmers for this thesis is between US$0.45 – 0.75 per kg of dry bark. This difference in the farmgate price presented in the literature and in the interview results is to be expected as the literature is from 2010, whereas the interview results are from 2016. All farmers interviewed noticed that the price of Gemor bark has been increasing since the price was the lowest in 2010, suggesting that higher farmgate prices in 2016 than in 2010 are likely. Moreover, the farmgate price given by the Gemor farmers in their interviews coincides with the farmgate price given by pak Nunung, the local trader of Gemor bark. He said he usually buys Gemor bark for around US$0.67 per kg from farmers. This price fits in the range of farmgate prices mentioned by the Gemor farmers. Nonetheless, further research on the price fluctuations Gemor bark would be useful to provide a concrete explanation for the difference between the price of bark given in the literature and the price of bark found in this thesis. Overall, there is limited qualitative information available in the literature on the upstream section of the Gemor bark value chain in Central Kalimantan. As a result, a large proportion of the qualitative information collected from the interviews could not be compared with the literature.

Mid-stream

The mid-stream section of the Gemor bark value chain is described in the literature as consisting of local collectors/traders (Kristedi & Kieft, 2010; Panjaitan, 2010). The interviews with Gemor farmers also reveal that the mid-stream value chain actors are the local traders. In addition, according to Kristedi & Kieft (2010), local traders of Gemor bark do not experience many quality issues with the bark they buy from farmers. The main quality problem is the water content of the bark, which is easily improved by drying the bark above a fire or in the sun (Kristedi & Kieft, 2010). Pak Nunung, a local Gemor bark trader interviewed for this thesis, said that the quality is generally always good and that he dries the bark in the sun to reduce the water content. Therefore, regarding the quality of Gemor bark and the actors involved in the mid-stream step of the Gemor bark value chain, the information from the literature coincides with the interview results from pak Nunung. No further qualitative information on this step of the value chain is available in the literature. Consequently, the interview with pak Nunung provides unique insight into the mid-stream step of the Gemor bark value chain.

Concerning mid-stream quantitative data, Panjaitan (2010) found that the price of Gemor bark sold by the local traders to the large-scale trader in Kalimantan ranged between US$0.50 – 0.55 per kg at the time of the study in 2010. According to pak Nunung, he typically sells his bark to the large-scale trader for around US$1.20 per kg. This price is almost double the price given by Panjaitan (2010) which could be because of the rising price of Gemor bark since 2010 (discussed previously). The interview with pak Tantono, the large-scale trader of Gemor bark, revealed that he buys his Gemor bark for an average price of US$0.90 per kg either directly from farmers or from local traders. This is similar to the price of US$1.20 per kg given by pak Nunung and is also higher than the price range provided by Panjaitan (2010) of US$0.50 – 0.55 per kg. Since both pak Nunung and pak Tantono mention a higher price for Gemor bark between the local trader and the large-scale trader than is indicated by Panjaitan (2010), it is possible that the price of Gemor bark has risen since 2010, which could explain the differences between the interview results and the literature. Further quantitative data on the mid-stream step of the Gemor bark value chain is not available in the literature.

Downstream

The final step of the Gemor bark value chain consists of one large-scale trader located in Banjarmasin, South Kalimantan. This information is presented by Panjaitan (2010) and Kristedi & Kieft (2010), and is also evident from the interview results from this thesis. Moreover, according to Panjaitan (2010) and Kristedi & Kieft (2010), the large-scale trader sells the bark to exporters in Surabaya and Jakarta who subsequently export the bark to Taiwan. The bark is used to make mosquito coils (Kristedi & Kieft, 2010). This was also confirmed in the interview with pak Tantono, the owner of the large-scale trader of Gemor bark, who said that he sells his bark to factories in Surabaya and Jakarta who export the bark (after manufacturing it into a powder) to Taiwan and China. In the literature review it was explained that Gemor bark can be used to make mosquito coils, glue, and incense sticks (based on Rahmanto et al. (2001) and Zulneyly & Martono (2003)). Pak Tantono explained that currently Gemor bark is only being used to manufacture incense sticks. This is another example of the results from this thesis providing updated information on the Gemor bark value chain.

According to Panjaitan (2010), the large-scale trader of Gemor bark sells the bark for US$1.30 per kg to the exporters in Surabaya and Jakarta. Pak Tantono mentioned a higher downstream price of US$3.74 per kg. He explained that the price of Gemor bark has increased slightly in the past decade but that he did not consider it a significant increase. Nevertheless, the increase in the price of Gemor bark could explain why Panjaitan (2010) indicates a lower downstream price of Gemor bark during the time of his study in 2010, than is indicated by pak Tantono during his interview in 2016 for this thesis.