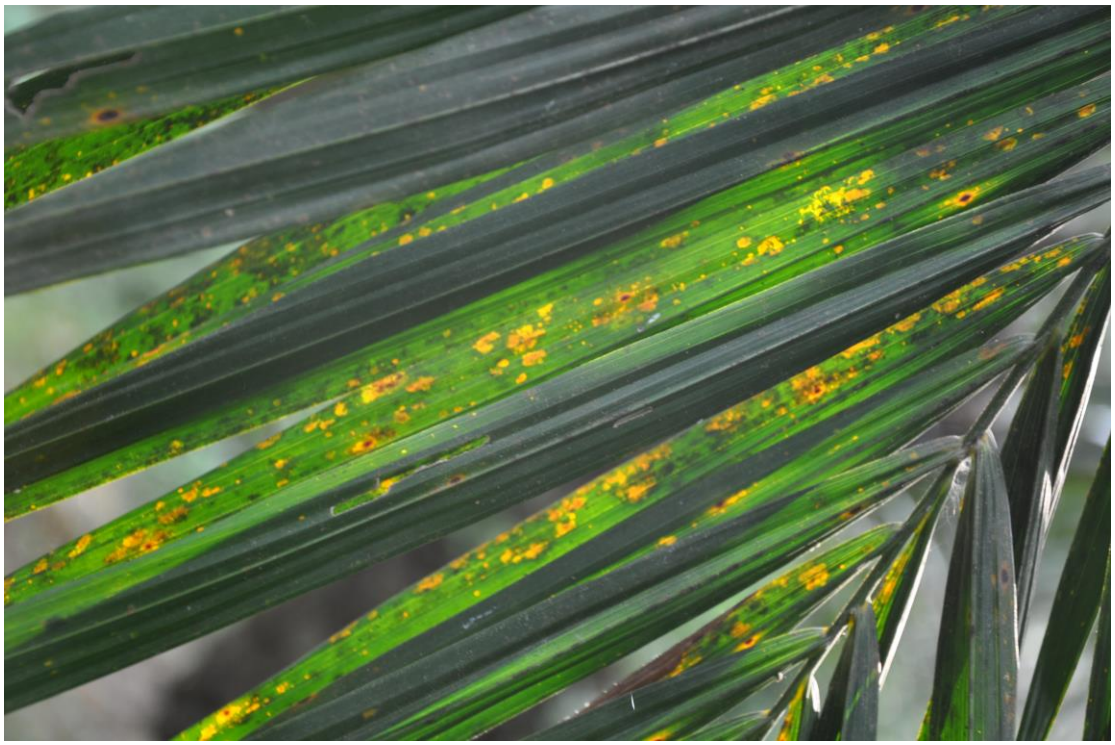

Baseline study for implementation of best management practices (BMPs) by oil palm (*Elaeis guineensis*) smallholders in the village of Ramin, Jambi, Indonesia

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February 2015

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SNV

Baseline study for implementation of best management practices (BMPs) by oil palm (Elaeis guineensis) smallholders in the village of Ramin, Jambi, Indonesia

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Course code:	PPS-80424 (24 ECs)

Acknowledgements

I am grateful for the guidance and the scientific support of my supervisors Maja Slingerland and Lotte Woittiez and to Ken Giller for the time he devoted to me, finding this project.
Lotte helped me getting acquainted with fieldwork in the tropics, and I want to thank her for that. I want to thank Maja for her patience and scientific support and feedback, she was the supervisor everyone wishes to have: freedom and good supervision.
I also want to thank Hans Smit and the team of SNV Indonesia for their support beforehand. Finally, I would like to thank my translator, Rina, with her enthusiasm, her trust and her view on the world: she broadened mine.

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Summary

Indonesia has been the world's largest producer of palm oil since 2008. In Indonesia oil palm development is strongly linked to economic prosperity for an increasing number of people, alongside demand for additional and limited (non) farmland. The increased adoption of oil palm cultivation by smallholders and their systematically lower yields compared to governmental and private plantations offers an enormous challenge to understand how smallholder yields could be improved, and how unlimited expansion in forest areas can be avoided. In order to improve productivity and secure income, best management practices (BMPs) need to be matched to the objectives of these smallholders. To analyse the potential for improving smallholder yields in Indonesia, Wageningen University and SNV Indonesia have started a pilot project in 2014, for which farmers in two research sites in Indonesia were selected to have experimental demonstration plots in their field for several years. On these plots, BMPs are implemented and their effect on oil palm growth, development and yields are closely monitored. For one of these research sites a baseline study was done. In this baseline study two groups of farmers and one group of traders were interviewed. Firstly, this baseline study showed us that the farmers with the demonstration plots in their field are not a good representation for the farmers in the village. Secondly, smallholders changed to oil palm, due to its profitability and steady income. Oil palm generated new livelihood strategies. Due to the introduction of oil palm, there is a higher social differentiation, while the average standard of living increased. Thirdly, BMPs are very likely to be adopted, while management practices are copied from other farmers, neighbours and family members. To optimize management practices and make them more efficient, labour should be better divided: skilled labour should be done by people from outside the household, while less skilled labour should be done by the household members. Furthermore, farmers with oil palms on peat soils have lower yields than farmers with oil palm on mineral soils. Giving the right training, more knowledge and the right planting material could increase yields and income. To be able to execute the best management practices, infrastructure needs to be improved. And finally, the current market structure in the village gives social and economic support but traders should be engaged more in the project, because they can facilitate the right fertilisers and also the right harvesting support.

1. Introduction

1.1. Introduction to the report

Indonesia has been the world's largest producer of palm oil, since 2008. Oil palm (*Elaeis guineensis*) is an efficient supplier of oil for food and non-food products, like cosmetics and biofuel. Over 50% of the vegetable oil used worldwide comes from oil palm and with the increase in demand for edible oils, oil palm plantations continue to expand (Feintrenie et al., 2010). Global demand of oil palm is furthermore set to double from 2006-2020 (Colchester et al., 2006).

In Indonesia, the development of oil palm production is strongly linked to economic prosperity for an increasing number of people, alongside demand for additional farmland, of which there are limited amounts (McCarthy et al., 2012). Up to 44% of the area used for oil palm production is managed by smallholders in Indonesia, while only 33% of the production is accounted for by smallholders: yields are often relatively low compared to more large-scale oil palm cultivation (Mahmud et al., 2010). In 2008 the productivity of smallholders in Indonesia was 35% below that of private plantations and 40% lower than the production of government plantations (Mahmud et al., 2010).

The increased adoption of oil palm cultivation by smallholders and their systematically lower yields offers an enormous challenge when trying to understand how smallholder yields could be improved, and how unlimited expansion in forest areas can be avoided. Smallholders are a heterogeneous group, with diverse objectives and often limited (economic) resources, all of which influence their commitment to farming, responsibilities and management practices (Amrouk, et al., 2013; Curry & Koczberski, 2004; Molenaar et al., 2013). They are therefore an important target group to study and to understand (McCarthy, 2010).

In order to improve productivity and secure income, all the while trying to minimize the amount of additional land required, best management practices (BMP) need to be matched to the objectives of these smallholders. BMP's are practices that allow the farmer to obtain maximum yields by managing their oil palms in the best possible way, taking into consideration various environmental, social and economic perspectives. By investigating current oil palm management practices in the context of smallholder livelihood systems, opportunities or potential constraints to moving to a more intensive and sustainable way of farming by smallholders can be identified.

To analyse the potential for improving smallholder yields in Indonesia, Wageningen University and SNV Indonesia started a pilot project in 2014, for which farmers in two research sites in Indonesia were selected to have experimental demonstration plots in their field for several years. On these plots, BMP's are implemented and their effect on oil palm growth, development and yields are closely monitored. A bordering second plot is managed according to current farmers practices, serving as a control. One of the research sites is Ramin, a village in Kumpeh Ulu district in Jambi province, Sumatra, where a booming oil palm trade can be found (McCarthy, 2010). This village is the research site of this particular study. To analyse how the farmer's livelihood status and management practices are now and how it will evolve how these will evolve over the next years in response to the project implementation, a baseline study was done. This comprised two parts: first, the current livelihood of farmers in the village was

investigated, with a special focus of the oil palm dependency of their livelihood. Secondly, the current oil palm management and marketing practices were explored.

To assess to what extent the farmers with a demonstration plot (hereafter called 'demo farmers') are representative for the farmers in the village, they are compared with a sample of other farmers in the village (hereafter called 'random farmers').

The first goal of this baseline study is therefore to see if the group of selected demo farmers is a good representation of the farmers in this village. We hypothesize it is very likely that these farmers are more prosperous than the average farmer, since the farmers are willing to help with this project and are thus probably more willing to take new opportunities and risks. This would mean that farmers engaged in the project have different endowments, constraints and objectives than other farmers in the village.

The second goal is to perform a general livelihood analysis of the farmers in the village and to analyse the influence and role of oil palm in their livelihood.

The third goal is to get an overview of the current management practices. This is done for two purposes: firstly, to see if other farmers in the village also change their management practices after implementation of the project, and secondly to see if the control plot is managed by the demo farmers in the same way before the project as it is at the end of the project. Since the demo farmers will get training in how to best manage their oil palm plots, it is very likely that they will also take these management practices to other fields and other farmers. However, to be able to show the difference between the best management practices and the current practices, it is necessary for the farmers to manage the control plot in the same way they always did. It is therefore essential to know how they managed their plots before the project started, to analyse if they changed their current practices.

The fourth and last goal is to show how the market structure for oil palm in the village is set up. The way farmers are incorporated in the oil palm economy and their dependency on the market for their income can influence their livelihoods.

To reach these goals, several research questions were raised before going to the area.

1. Are the demo farmers representative of the whole village?
    a. How do the demo farmers differ from the random farmers regarding income and properties?
2. What constitutes the livelihoods of these farmers?
    a. What resources do these farmers have access to (natural, physical, human, financial and social capital)?
3. What is the role of oil palm in the livelihood of these farmers?
    a. What did farmers cultivate before they started cultivating oil palm?
    b. Why did they change to oil palm and what are the main reasons for farmers to cultivate oil palm in general?
    c. To what degree are the farmers in the village socially differentiated, and what is the role of oil palm cultivation in this differentiation - is it a cause or an effect?
    d. How do farmers construct their livelihood, incorporating both farm and non-farm livelihood strategies? Can farmers be self-sufficient?
4. What are the current oil palm management practices of the random farmers?

a. Which management practices do they use and how do they perform them?
b. What are the constraints that farmers have to deal with when it comes to investing in best management practices?
c. Are farmers willing to invest in their existing fields (for example, by investing in BMP's) or would they rather invest in enlargement of their fields?

5. How is the market structure for oil palm in the village set up, and how does this influence the farmers?
    a. How are farmers incorporated in the local oil palm economy?
    b. What is the influence and power of traders on the local economy?
    c. Do farmers get a fair price for their products?

Based on what I have learned in the village I will find an answers to previous questions, by firstly giving an historical perspective on the village, followed by a description on how information was acquired (in the Materials and Methods section). In the Results section, demo farmers and random farmers will be compared, after which the resulting conclusions regarding the village livelihood will be presented. After showing the influence of oil palm in the village, management practices will be discussed, along with an overview of the institutional environment. A livelihood analysis in the discussion segment towards the end of this paper will provide the answers found as a result of this study.

1.2. Introduction to the study site

1.2.1. An historic perspective

In 1975 ethnic people living in Ramin sold their land to the government. At that point, the area was largely covered by forests. 86% of the random farmers who moved to Ramin before 1990 state that there was forest on the land they received from the government when they first arrived.

Regarding the surface area: every man older than 17 who transmigrated to Ramin received 2 hectares of land from the government. People from Java transmigrated here directly, as well as being moved here after first transmigrating to other areas in Sumatra. For the first decades they planted rice, chilli, corn, various kinds of beans, sweet potatoes, peanuts, cassava, and other vegetables. In addition, farmers also cultivated cash crops like rubber and sengon (*Albizia chinensis)*, a tree cultivated for timber.

There was a cooperative in the village, which originated from the first wave of trans-migrants that occupied this area from 1984 onwards. However, shortly after the introduction of oil palm in this area in 1996, the cooperative was met its end when the leader died and the office burned down. Important documents and records of the organisation all went up in smoke. There have been no similar initiatives in the village since.

Around the time of the fall of the cooperative, the village witness the rise of a mill. The mill started working around the year 2000, and was owned by a Chinese man living in Medan. When exactly he started building the mill or working with the farmers in Ramin is unclear. People who had a land title for their fields could give a copy of this title to the mill, which then worked as a contract. The mill then planted oil palm and in return, the farmers sold their product to the mill in a plasma scheme, which meant that farmers kept the fields they had. However, when the owner sold the mill in 2005, rules changed and unrest occurred between the farmers. In the end, no one in Ramin wanted to work with or for the mill anymore, resulting in its abandonment in 2005. People kept the fields that they used for the cultivation of oil palm, just like they had before the existence of the mill.

As mentioned before, the village currently has no cooperative. Farmers are independent and fresh fruit bunches are brought to mills outside the village since 2005. During this research, all traders brought the FFBs to the same mill, since it offers the best price for their product. The mill, called Palma, is located around 100 km away from the village. The traders did not pay much attention to the distance between the mill and the village, but mostly to the price received at the mill.

1.2.2. Demographics

Data about the total population of the village were obtained from the *monografi desa*, sheets with demographic facts about Ramin collected by people working in the village office. The village consists of 397 households, of which 321 are involved in farming (81% of the total). The village has a total of 905 men and 810 women (January 2014, *monografi desa*). The village covers an area of 3325 hectares of agricultural land, 2213 hectares of which are used for oil palm cultivation (67%). Peat soils account for 66% of the total area (2200 ha of the total 3325 ha).

2. Materials and methods

In the study area, the climate is hot and humid throughout the year. The average precipitation is lowest between June and September. The average annual precipitation is nearly 2500mm, in the driest months precipitation is still higher than 100mm. Average temperature is around 27 °C all year round (Miettinen et al., 2013). Average altitude in Kumpeh Ulu is between 0 and 20m above sea level.

For this baseline study two groups of farmers and one group of traders were interviewed. Firstly, the 6 farmers selected for participation in this project are documented. Next, more than 10% of the farmers in the village are documented to get a general idea of the livelihood in the area. Farmers were interviewed about their economic and social status and their current oil palm management practices. The group of traders present in the village were also interviewed, to get a better understanding of the market situation and to provide triangulation so as to confirm the information that is given by both farmers and traders.

2.1. Selection of farmers and traders

From all the farmers in Ramin, two different groups of farmers were to be selected. First, six farmers were selected who were willing to cooperate in the project on analysing the potential for increasing smallholder oil palm yields in Indonesia. A second group of farmers was then randomly selected to evaluate the economic and livelihood situation in the village that could be compared to the six selected farmers.

The six demo farmers were selected to host experimental demonstration plots, where best management practices are to be tested for a period of four years. These experimental demonstration plots will be compared to control plots, where the usual management practices that were in place before this project started will continue to be implemented. The farmers were selected after consulting with one of the leading farmers in the village, who is also one of the participants himself. Selection was based on farmers' willingness to learn and participate, and on specific field characteristics: low risk of flooding (this was especially important); no peat soils; good planting material; full stand of palms; no intercropping with tall trees. Following these selection criteria already points towards a selection bias, with the selected farmers being deliberately different from certain non-selected farmers.

Information about the farmers in the village of Ramin was obtained from the head of the village office. Only four of nine ID-registration books were present. These covered 161 households and contained names of all the household members, their dates of birth, professions and even their religion. Each book represented one of the nine districts in the village. The five missing books were either lent to people who had shown interest in them but never returned them, or had just vanished from the office without a trace. The fact that only four out of nine books were available allows for a selection bias, because not all districts were represented. Therefore, other research methods were considered, like taking transects or stratified sampling, but these were less viable options, either

because no homogeneous subgroups could be formed or because they were significantly more time consuming (mainly since the fields were never close to the farmers' house).

Due to these considerations the decision was made to use the four ID-registration books after all.

To create the second group of farmers, a random selection was made from other farming households in the village (hereafter: random farmers). The goal was to interview at least 10% of farming households. Because the village consists of 397 households, of which 321 are farmers, at least 33 farmer households were to be selected.

To start, forty farmers were selected semi-randomly from these ID-registration books. The first farmer was chosen at-random by drawing a number between 1 and 4 out of bowl. Next, every fourth farmer-household in the book was picked. When the registered person in question was not a farmer, the next household was selected instead. Because not all forty farmers could be found in the field, additional farmers were selected by making a list of all farmer households in the books (1-161). These numbers were randomized, and from the top of this list of randomized numbers, a number of households were selected to make up the necessary total. In the end, 39 members (mostly the head of the household) of different households were interviewed that were responsible for oil palm management practices. Most of the time these members were the heads of the household.

A list of the most often identified and important traders was obtained from interviews with farmers. A total of eight traders were interviewed. The researchers had visited two other traders before, when they were interviewed as random farmers.

2.2. Farmer interviews

To obtain the required information from both groups of farmers I did semi-structured interviews, making use of questionnaires. These questionnaires covered 4 themes (Appendix A):

1. Household and livelihood characteristics
2. Land properties and management practices of oil palm
3. Income and expenses of the household
4. Social, cultural and environmental perceptions within the village.

The first and third themes were mostly covered by quantitative questions. The questions asked were directed towards well-defined answers. For example, the question of how many members the household has can still be interpreted in different ways. Therefore we defined 'household members' as the number of people who were in some way dependent on the income of the household, without necessarily living in the house (for instance, an older child studying in the city). The second and fourth theme comprised more qualitative questions, prompting the formers to share opinions, descriptions of problems they encounter and their reasons for making certain decisions. These answers will be quantified when possible, or summarized to get an overview of all the answers given to a qualitative question. Since it is necessary to know how the farmers execute their management practices, all common oil palm management practices were enquired after, and attention was also paid to the farmers' explanations

of which additional practices they performed, if any.

The interviews were conducted one-on-one, which allowed me to get more carefully considered answers then one would when conducting a less personal survey. Working with an interpreter, I tried to stay open minded and repeat questions if a particularly unexpected answer was given, to make sure no information was lost in translation. The interviews took 1 to 3 hours per farmer to conduct, and most often took place during the evening or during holidays, when farmers did not have to work on their fields. The point of the questions was to determine the reasoning behind certain practices, and to obtain clear and unambiguous information from the farmers, which I could later compare with future measurements.

To see if the information on income, costs and expenses provided by the farmers was reliable, I also did triangulation by asking for total fertiliser costs and costs for all fertilisers separately. In addition, I asked where they bought their fertilisers and checked the prices in the local stores and with the traders, who were often the providers of fertilisers in the village.

2.3. Trader interviews

To analyse the market structure in the village, traders were asked about:

1. The domain of their trading
2. The way they manage the trade
3. The management practices of the farmers they deal with
4. Their expenses and the credit they provide.

These questions were all presented in one questionnaire comprised of 4 sections (Appendix B). Interviews with the traders took half an hour each to conduct.

2.4. Mapping

An historical overview of the village was obtained when farmers touched upon this subject during the interviews. More sensitive questions about the rise and fall of the local mill and the previous existence of a cooperative were asked during chats with the farmers I stayed with overnight, since the circumstances allowed for an atmosphere of mutual trust to be created, more so than during the more business-like interviews with the other farmers.

During the interviews with demo farmers, a map of the area was drawn up, showing the location of their house and the distance to their fields, including the ages and types of the oil palms per field. This was done to get the information on their fields as clearly represented as possible, to find out how they think their fields are situated in the village area, and to create an intermezzo between the rest of the questions.

GPS data were also collected to create a map of the village and to illustrate the location of the village traders. This was done with a Garmin eTrex 10 GPS device. A map that was provided by the head of the village was used to get a general idea of the layout of the village. This map, however, was a black and white document that mostly showed the original transmigration plan. These maps are shown in the results section.

2.5. Communication

A student from the Jambi University faculty of agriculture was hired to translate for us. Apart from English, she also spoke both Bahasa Indonesia and a Central Javan language.

2.6. Data analysis

The program SPSS was used for the statistical analyses of the data. For the analysis of variance, an ANOVA was carried out, using a threshold *P* value of < 0.05 to declare effects and interactions to be significant. If data were skewed, a log transformation was done to normalize the data. The output of the analyses can be found in Appendixes C, D and E.

A descriptive analysis was conducted by using Microsoft Excel to describe correlations and socio-economic characteristics that were observed in the research area.

As mentioned above, six farmer households have been selected to participate in an oil palm management and yield improvement project, so called 'demo farmers'. Another 39 farmers have been randomly selected for interviews, so called 'random farmers'.

Firstly, we will show whether demo farmers are representative of all farmers in the village by looking at their land size and income. Next, an analysis of the data on the livelihoods in the village and data that contribute to a better understanding of the social differentiation is presented. In the village, 97% of the farmers cultivate oil palm, which makes it an important part of the income and livelihood of the farmers. A more in-depth report about oil palm management and oil palm as a contribution to the livelihoods of the households in the village is then provided.

3. Results: A farmers comparison

In this section, the demo farmers are compared to other farmers in the village. The two criteria that are being compared are the total hectares of land used for oil palm cultivation owned by the respective farmers, and their total monthly income.

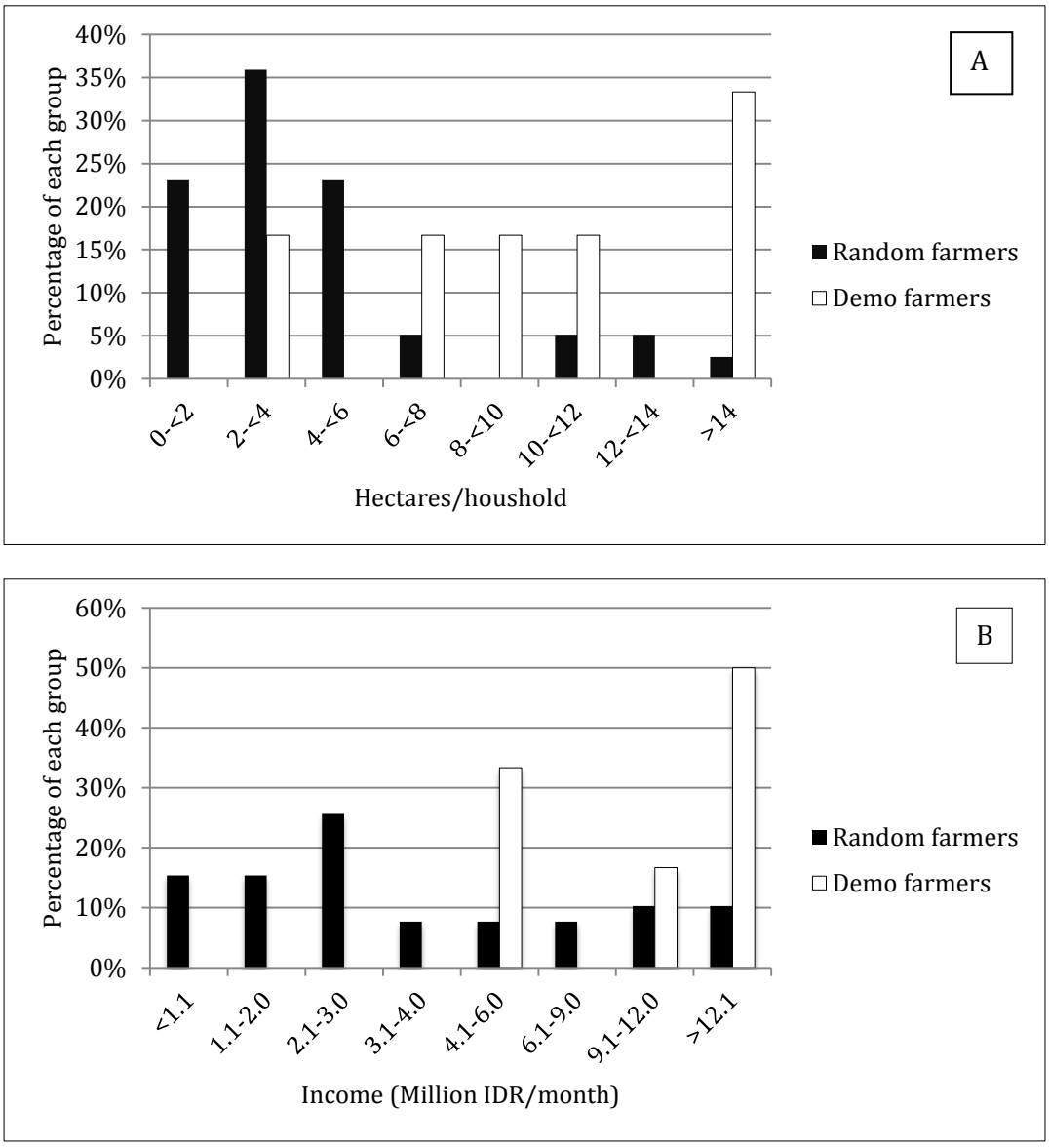

Figure 1A. The distribution of hectares of oil palm per household of random farmers (n=39) and demo farmers (n=6). B. The distribution of total income per household of random farmers (n=37, 2 have missing data) and demo farmers (n=6). Both groups of farmers are set to a total of 100%.

On average, the random farmers have 4.1 hectares of land while the demo farmers have, 19.0 hectares. Distributing random and demo farmers based on farm size in hectares per household in a graph (Figure 1 A) shows that random farmers are skewed towards the lower end and the demo farmers towards the upper end. Demo farmers differ greatly from average farmers in the village when hectares/household (Figure 1A) are compared ($p < 0.05$) and when total income per household is compared (Figure 1B, $p < 0.05$) (Appendix C). This means that the selection of farmers involved in the experiment is not representative for the whole community.

4. Results: Village livelihood

4.1. Village, farmer and household characteristics

In each section, we will clarify whether the data have been analysed for all farmers or not (n= 45; only demo n = 6, or only random farmers n = 39). Furthermore, because the demo farmers are not representative for the village, they may influence averages for yield, income and other wealth indicators. Therefore they are only included in correlations.

The average number of household members (n= 39) was 4 (4.23), in a range between 2 and 6. The heads of the households had an average age of 48, but this ranged between 22 and 80. Two major settlements may be observed in the village.

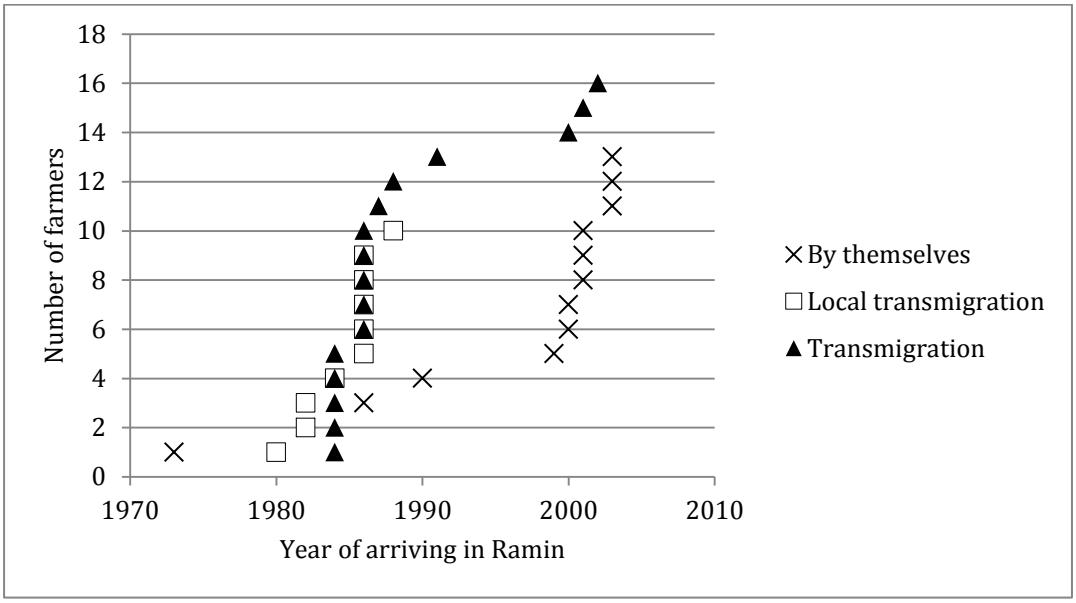

Figure 2 Accumulation of farmers that settled in Ramin seen through the years, either located in Ramin by the government through (local) transmigration or migrated by themselves (n=39).

The first settlement was mainly a governmental (local)transmigration post, settled around 1982-1988; the second was settled by people that immigrated spontaneously around 2000-2003 (Figure 2). Many farmers in this latter group came here looking for new opportunities; mostly to look for a job, but also to change their lives and find new ways to ensure their income. In the same time, an oil palm mill started in the village and oil palm was more widespread introduced. Therefore this second migration might be driven by oil palm, which created more livelihood opportunities in this rural area. Many of the current farmers joined the transmigration together with their parents and are now starting their own families in Ramin. Almost all farmers came from poor backgrounds when they transmigrated, looking for better opportunities in rural areas of Sumatra.

4.2. Land use change

Although most of the farmers that moved to Ramin between 1973 and 1999 currently cultivate oil palm as the main crop on their field (95%), they usually started out with various other crops, like rice, rubber and vegetables.

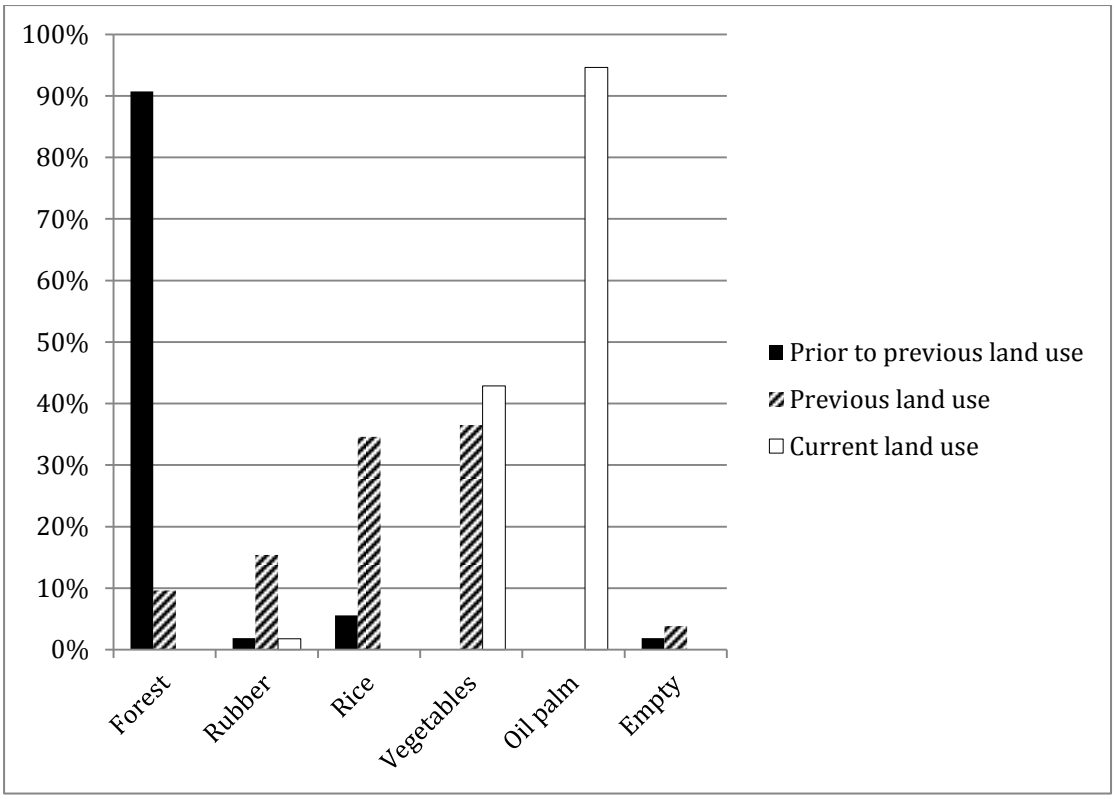

Figure 3 Farmers who moved to Ramin between 1973 and 1999 described their current land use, the previous land use and the land use they started with (n=28). Vegetables in the current land use are most of the time intercropped with oil palm and half of the farmers do sell these vegetables (chili, long bean and cucumber).

Prior to this, rice and rubber were cultivated here in small quantities, but most of the area was covered by forest. The farmers that cultivate oil palm also practice intercropping with vegetables and fruit trees like cacao (*Theobroma cacao)*, duku fruit (*Lansium parasiticum)*, durian (*Durio zibethinus*), coconut (*Cocos nucifera)* and banana (local *Musa* cultivars) (Figure 3).

Table 1 Current agricultural land use in Ramin (n=39). Vegetables consist of: chili, long bean, soybean, tomato, cucumber, cassava or peanuts. Fruits trees consist of: durian, duku, coconut or cacao.

Agricultural land use	Percentage of farmers
Doesn't cultivate anything	10%
Vegetables only	3%
Oil palm	87%
Fruit trees (independent or intercropped with oil palm)	38%
Vegetables (independent or intercropped with oil palm)	41%
Vegetables grown for selling	15%

Out of all the current farmers, 10% has no land to cultivate crops. 87% grows oil palm, which is often intercropped with vegetables or fruit trees in small quantities. Small non-productive oil palm trees are very often intercropped with vegetables like beans and chili, to create an extra income. Only 3 % of farmers cultivate vegetables only. Vegetables are grown by 41% of the farmers, but only 38% out of these 41% sell them. 38% of the farmers also grows fruit trees like duku, durian, cacao or coconut in their oil palm fields or in their farmyard. Fruits are sold very rarely. No staple crops like rice are grown in the village (Table 1). What also changed was the possession of land area.

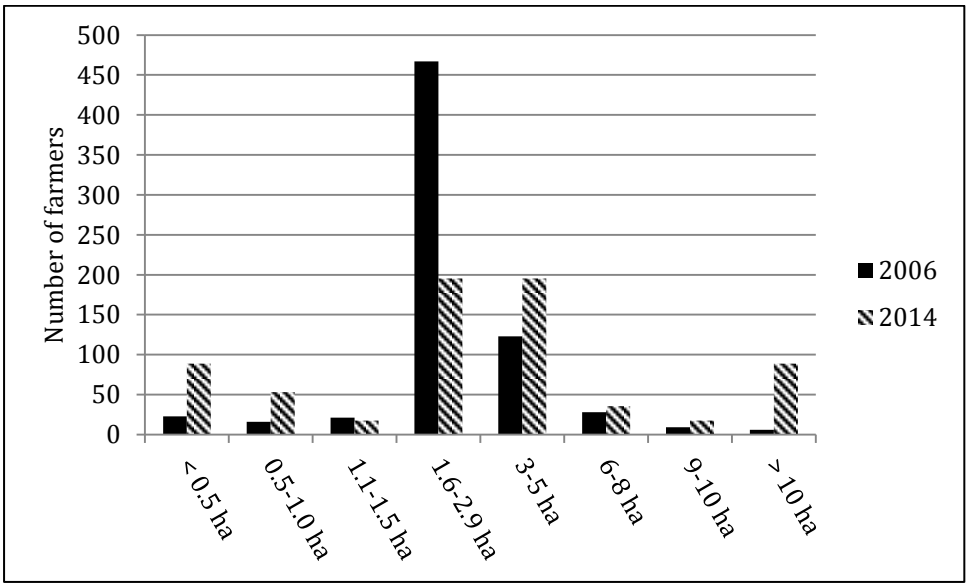

Figure 4 Land division among farmers in 2006 and 2014. Data from 2014 are extrapolated from the random subsample (n=39). Data from 2006 are exact numbers (n=693).

In 2006 the majority of farmers in the village owned between 1.6 and 2.0 ha of land. Within 8 years, the number of farmers owning between 1.6 and 2.0 ha of land had dwindled down to only a third of what it was in 2006. In addition, more farmers own less than 0.5 ha of land and more farmers own between 3 and 5 ha and more than 10 ha of land (Figure 4). Instead of an equal division among the farmers, with most of them owning around 2 ha of land, some farmers sold their lands while others procured more for themselves. The reasons farmers have for selling their land are often related to health issues or debts. Another cause for the increase in the number of farmers with less than 0.5 ha was voluntary immigration. All five farmers that have 0.25 ha or less moved to Ramin by themselves in 2001 or 2003, with all of them coming here to look for a job. Most people that were transmigrated here by the government received 2 ha of land.

4.3. Wealth differentiation

If we take a closer look at the issue of land division, we can see that there is income differentiation at play.

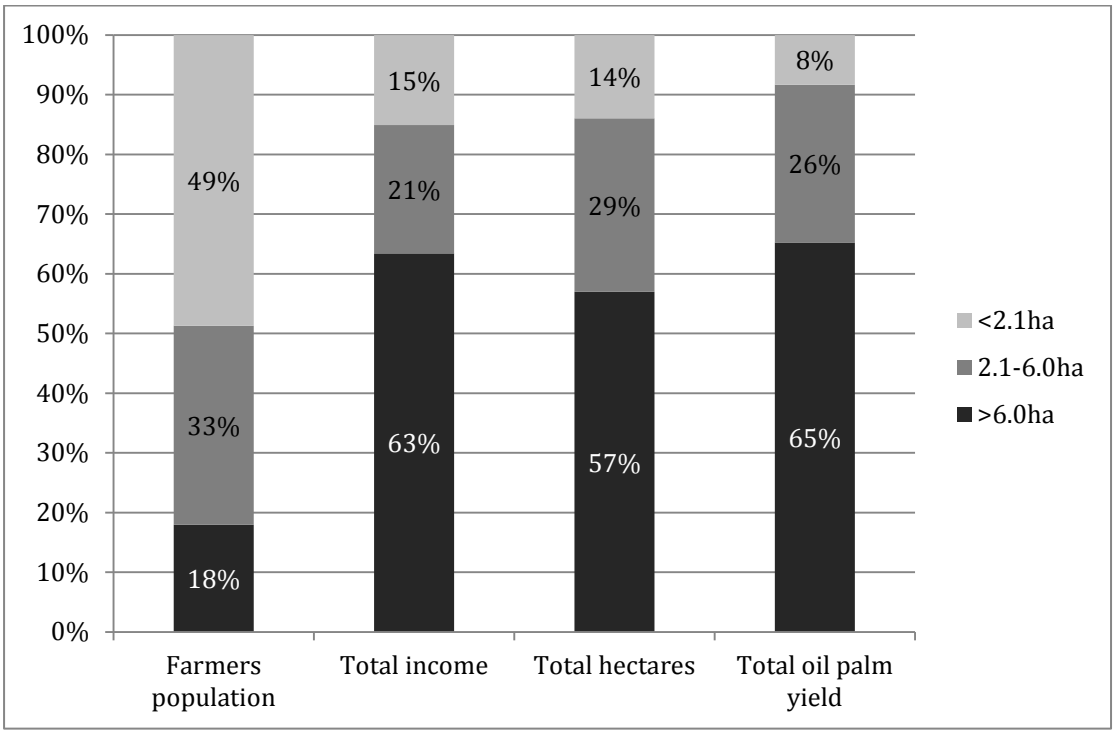

Figure 5 Division of farmers population, total income, total land area and total oil palm yields for groups of farmers with different land areas (n=39).

Of the random farmers, 18% owned more than 6 ha, which was 57% of the total amount of hectares, while they were earning 63% of the total income and getting 65% of the total oil palm yield. From the farmers 49% had less than 2.1 ha. These farmers got 15% of the total income and owned 14% of the total land area. They made up for 8% of the total oil palm yield. Compared to 2006, when most farmers owned between 1.6 and 2 ha of land, there is now a higher land differentiation (Figure 4 & Figure 5), which can be associated with a higher income differentiation.

4.4. Food self-sufficiency

No rice was cultivated in the village. None of the farmers were cultivating rice and no rice fields were observed. Out of all the 39 farmers, only 1 was fully self-sufficient when it came to vegetables and meat. Other farmers intercropped vegetables with small oil palm. Vegetables cultivated were chili, long bean, soybean, tomato, cucumber, cassava or peanuts, grown in small quantities and most often providing only a small percentage (5%) of their basic needs. Many farmers did not grow any vegetables, nor was there a central market. Groceries could be bought at local shops, and from salesmen with big cages on the back of their motorbikes, packed full of fruits and vegetables. These are regularly seen driving through the village, selling their goods.

When it comes to meat, the situation was slightly different, since most farmers kept at least some livestock.

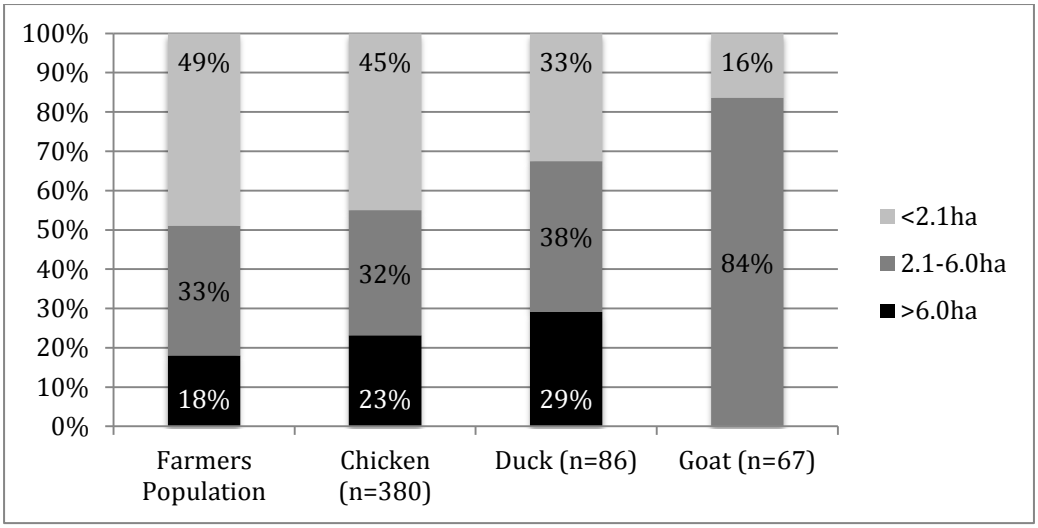

Figure 6 Division of chicken, duck and goat over the farmer's population separated by farm size (n = 39).

Most of the farmers were self-sufficient regarding meat (Figure 6). Chickens and ducks were mostly equally distributed over de farmers' population. None of the farmers with a larger estate had goats, but many farmers with a land size between 2.0 and 6.0 ha did. Only one of the farmers with more than 6.0 ha owned a cow. All chickens and ducks were mostly eaten by the families themselves, and occasionally sold. Goats were more often sold, but mostly also kept for household consumption.

4.5. Reasons to switch to oil palm

The main reason for farmers to switch to oil palm (41%) is that other farmers, neighbours or family members also decided to cultivate oil palm. Another often heard reason (41%) was that vegetables and rubber are very labour intensive and have a relatively low production compared to oil palm. Vegetables create the added problem of being eaten by animals. Thus, overall, oil palm gives a higher production and costs less labour. Two other appealing characteristics of oil palm production is that it gives farmers good prospects and a higher income (cited by 15% of the farmers as a reason for switching) and that the mill provided seeds and the right conditions to grow oil palm (a reason cited by 4%).

4.6. Investment from savings and borrowed money

Out of all the random farmers, 64% said they had no savings (n=39). The farmers that saved money (36%) most often just simply saved it (10% of all the farmers), used it to build a new house (8% of all the farmers) or spent it on their children's education (8% of all the farmers). Only 5% of the farmers saved money to buy new fields. The remaining 5% spent their profit on various basic living expenses. Investments from borrowed money show a different pattern.

Furthermore, none of the farmers were reliant on remittances. It happened more often that they supported someone else (a child, a family, parents) with money they earned.

Table 2 The allocation of borrowed money, from the bank or from traders, as percentage of total farmers (n=39). The percentage of the income source that is used to pay back the borrowed money is also shown.

	Bank	Traders
New oil palm fields	12%	1%
Fertilisers	0%	23%
Goods	10%	3%
Healthcare	0%	8%
Paid back by income from oil palm	71%	100%
Paid back by other income	29%	0%

Large amounts of money (over 20 million IDR) are borrowed from the bank. However, more farmers borrow money from traders, usually for buying fertilizers, or for financing treatment for acute health issues. Money that is borrowed from traders is always paid back from oil palm income. Money received as a loan from the bank is also paid back from other income sources, like trading FFBs, renting machinery or driving trucks with FFBs to the mill (Table 2). 23% of the farmers borrow money from traders to buy fertilizers. 36% of the farmers also borrow fertilizers from their traders. These fertilisers are also paid back with oil palm income. Besides borrowing money, 18% of the farmers also bought goods like cars, motorbikes or fridges on credit from salesmen. They pay these loans in monthly instalments, with the income generated by oil palm cultivation.

4.7. Income

Focusing on the origin of the farmers, we can observe income differentiation between different groups.

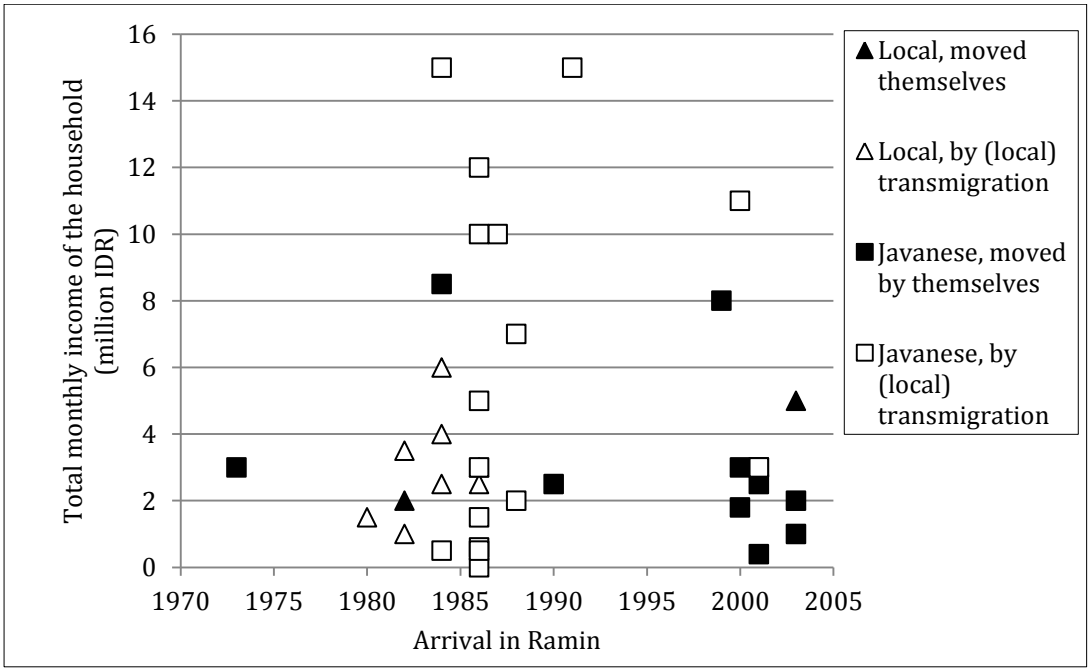

Figure 7 Total monthly income divided over locals and Javanese people who moved to this area themselves or were (locally) transmigrated here by the government (n=37. Two transmigrated Javanese farmers are not represented in the graph, because their income is >40million IDR per month).

Out of all 39 farmers, 74% originated from Java. 8% came from surrounding provinces, and only 18% originated from this very area (for instance, from neighbouring villages). Farmers in the subsample who were originally from Java now receive 92% of the total income, while the 26% local farmers have only 8% of the total income share. All local farmers stay under the 6 million IDR income per month, while the Javanese can also be found above this level (Figure 7, Table 3). When comparing amounts of hectares owned by locals and Javanese, both the spontaneous migrants and the governmental migrants, no difference among these groups is observed.

Table 3. Division between local and Javanese people in Ramin based on the number of people, the income from oil palm and hectares of oil palm (n=39).

	Locals	Javanese
Percentage of farmers	26%	74%
Income from oil palm	8%	92%
Hectares of oil palm	11%	89%

Around three quarters of the population originates from Java. This is, however, not in line with the total income they get from oil palm and the amount of hectares for oil palm cultivation that they own, which is around 90% of the total income from oil palm and hectares with oil palm. The Javanese thus receive the biggest share of the economic wealth.

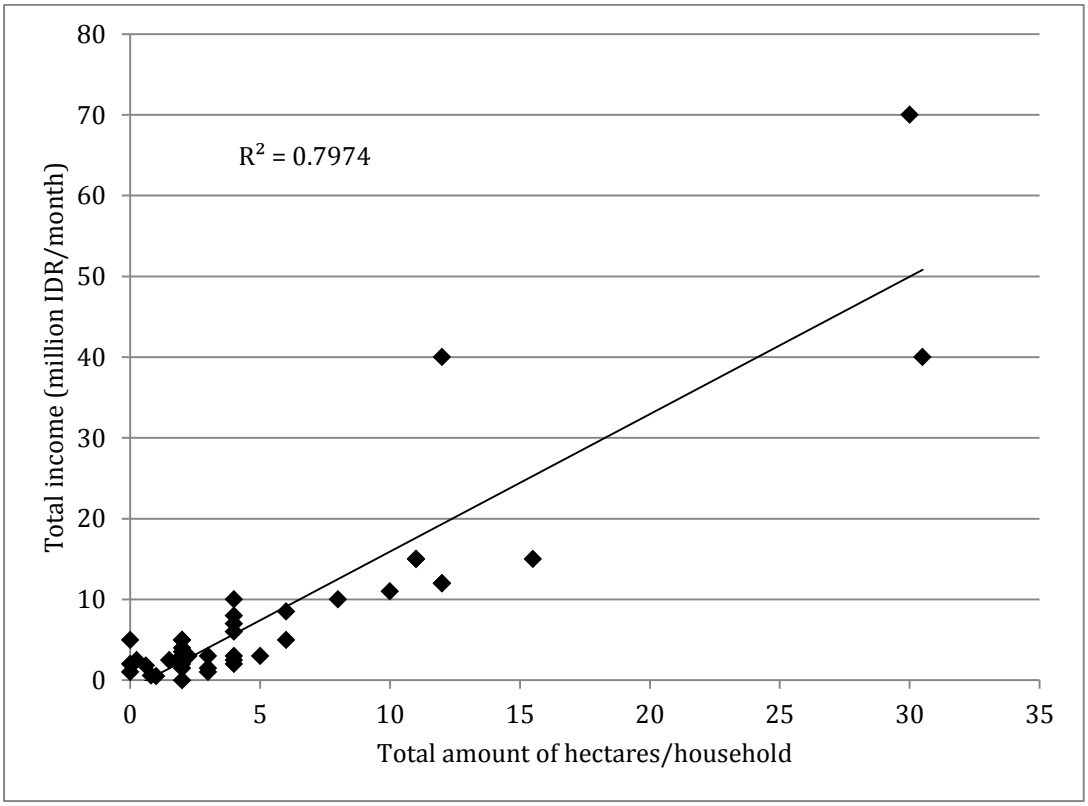

Figure 8 Total income of the household (million IDR/month) compared with the total amount of hectares each household owns (n=42. Two farmers are left out due to missing data. Another farmer is not represented in the graph and also not in the regression, due to his extremely high income and high amount of hectares owned. When this farmer was included, R^2 was higher).

As we have seen in the part on wealth differentiation, the total amount of hectares and the total income seem to correlate. When set out against each other, the total monthly income of villagers positively correlates with the amount of hectares they own (Figure 8). This implies that most income also comes from their fields.

4.8. Oil palm dependency

Income from oil palm yields in Ramin is high and accounts for the major part of the income of the farmers.

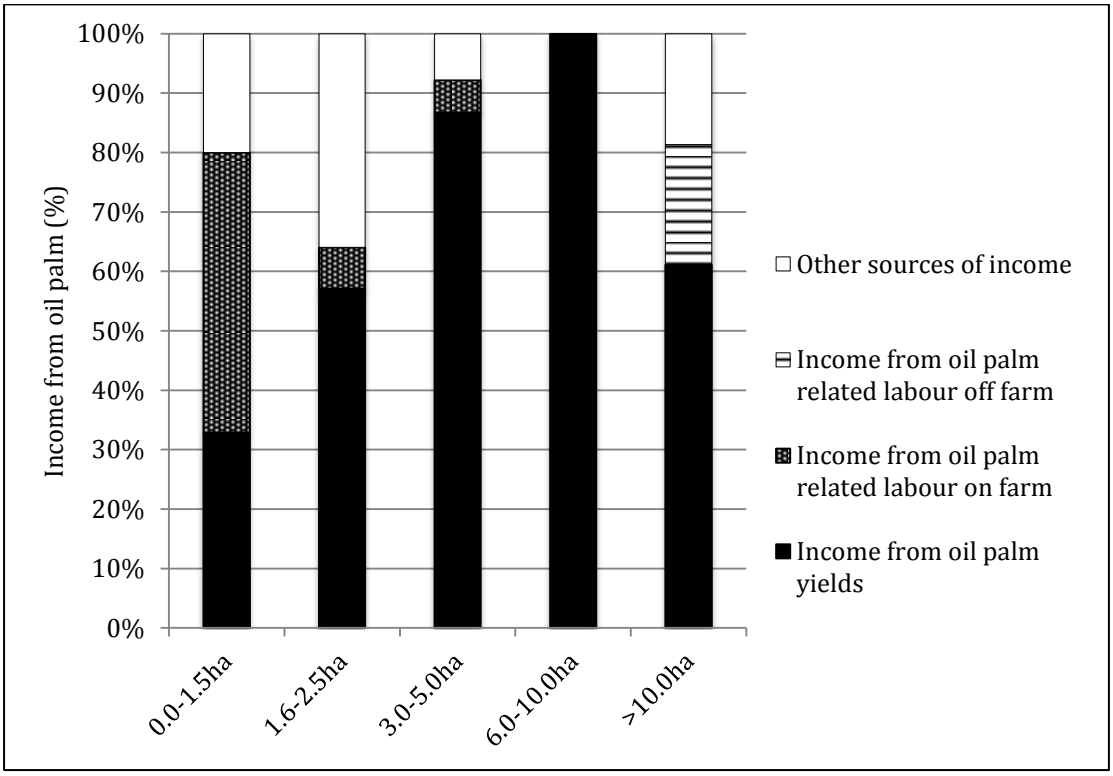

Figure 9. The percentage of the farmer's income coming from oil palm yields, oil palm related work on- and off farm or other sources. Farmers are grouped based on the land area they own (n=39).

In total, 97% of the random farmers own oil palms and 62% of them indicate that oil palm yields are the most important income source for their families. Another 23% is working in fields of other farmers and earns the major part of their income there. These are the farmers with the lowest land sizes. Because oil palm needs to be managed, brought to a mill and processed, the total production also determines the income for other people of the oil-chain. Therefore I defined oil palm related labour as either working for someone in their fields (on farm) or trading the fresh fruit bunches (off farm) (Figure 9). Farmers with the highest land sizes were engaged in oil palm transport and trade.

5. Results: Oil palm

From the total income of the random farmers (n=39), 84% comes from oil palm yields or from on-farm or off-farm labour that is in some way related to oil palm. Therefore this crop is of major influence on the livelihood of this village and demands further exploring.

5.1. Income from oil palm

When we consider income from oil palm yields and total amount of hectares of oil palm per household, a stronger relation is found than between total income and total amount of hectares. Because of this, we conclude that most income comes from oil palm (Figure 10).

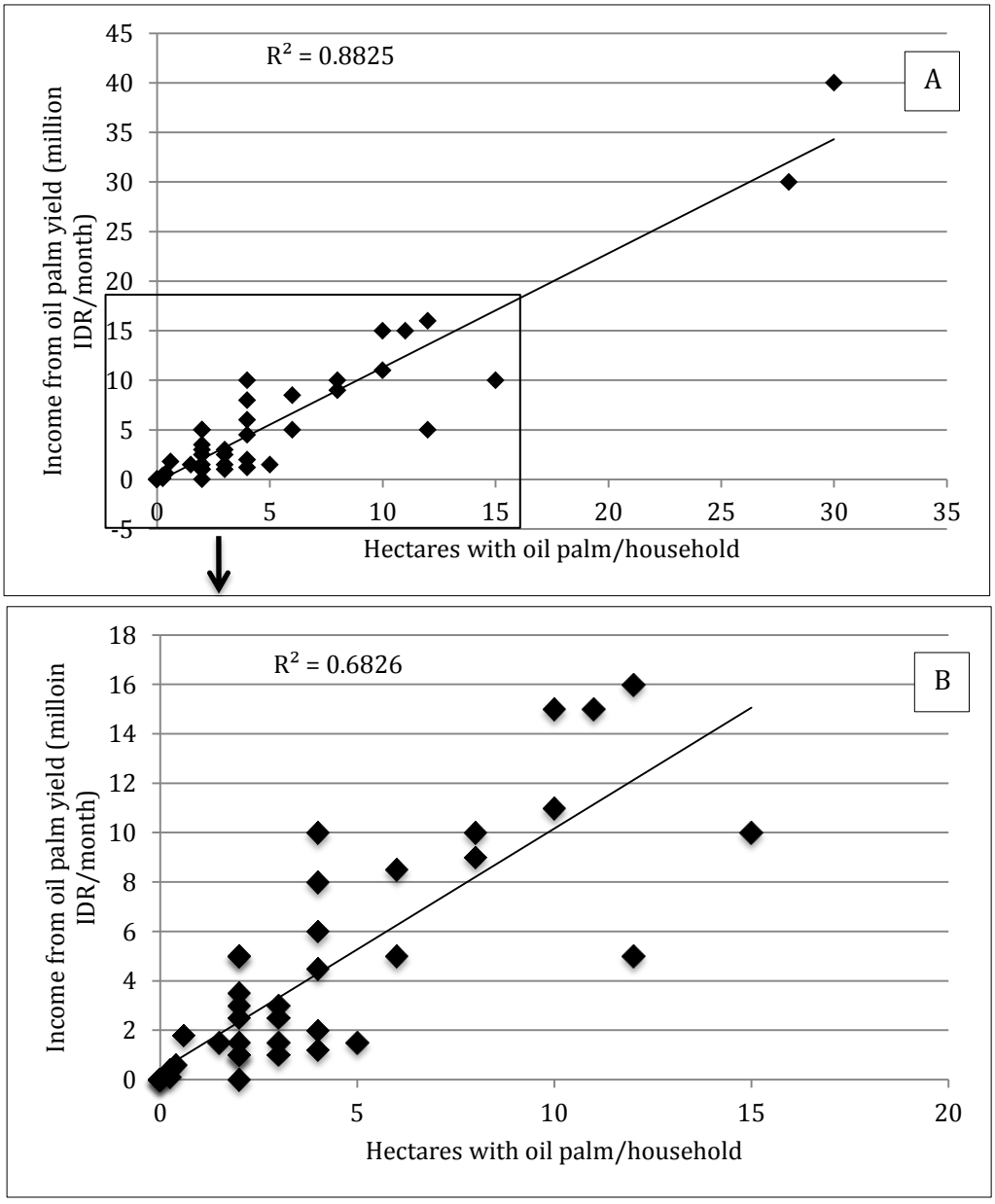

Figure 10 The correlation between monthly income from oil palm and hectares of oil palm per household for all data (n=42. Two farmers are left out due to missing data and another farmer is not represented in the graph, due to his high income and hectares owned). B. For a subset of the data (n=40), where income is lower than 16 million IDR per month.

The variation of income from the same land size can be substantial (Figure 10) and needs further exploring. The two farmers with 12 hectares each show an income difference from oil palm yields of more than 10 million IDR per month. First of all, the farmer with the lower income has 12ha of peat soils, while the farmer with the higher income has 12ha of mineral soils. Secondly, the farmer with the lower income told me he had just bought 6ha of non-productive oil palm fields. Because he only just started to manage these fields they have yet to yield a production, which clearly explains his low income (which seems incongruous when his large land size is taken into account).

Table 4 and 5 show actual practices, which are compared to recommended practices. Five classes were made: Very good, Good, Ok, Bad, Very bad. The range reaches from totally in accordance with recommended (very good) to farthest away from recommended practices (very bad).

Table 4. Here are compared: the income, soil type, tree age, drainage, weeding, pruning (where tree age is taken into account) and fertilization of the six farmers with four hectares of oil palm.

Income (million IDR/month)	Soil type	Tree age (y)	Drainage	Weeding	Pruning vs. tree age	Fertilisation
1.2	Peat	4	Good	Bad	Ok	Ok
2	Peat	14	Bad	Ok	Good	Bad
4.5	Peat	5 & 9	Good	Good	Good	Very bad
6	Mineral	4 & 12	Good	Bad	Ok	Very bad
8	Mineral	3 & 7	Good	Bad	Ok	Ok
10	Mineral	10, 15 & 22	Good	Bad	Good	Ok

Oil palm income from farmers with four hectares also shows a large range- between 1.2 and 10 million IDR per month. The soil types can explain the major difference. The three lowest monthly incomes come from peat soils, while the three highest incomes are earned from oil palm on mineral soils. For mineral soils the income differentiation seem to further increase according to better management practices and fertiliser type and amount applied. Here, also tree age plays a role in total income from oil palm yields. The way farmers fertilise on peat soils is negligible: only small amounts of NPK (15:15:15) are added, and often even more organic matter. However, pruning, weeding and a well-managed drainage can make a difference, if the age of the tree is taken into account (Table 4).

For farmers with two hectares, the right combination seems to matter the most. Farmers with mineral soils have higher income from these fields, but combined with good fertilising and good management practices the differences between the soils can be further explained (Table 5).

Table 5. The ten farmers with two hectares of oil palm are compared in regards to their income, soil type, tree age, and their relative management for drainage, weeding, pruning (where tree age is taken into account) and fertilisation. Mixed soils are both peat and mineral soils.

Income (million IDR/month)	Soil type	Tree age (y)	Drainage	Weeding	Pruning vs tree age	Fertilisation
0.0*	Peat	10	Bad	Good	Bad	Bad
0.2**	Peat	7	Bad	Bad	Ok	Bad
1.0	Peat	23	Good	Bad	Ok	Ok
1.0	Peat	10	Bad	Bad	Good	Ok
1.0***	Mixed	13	Bad	Ok	Good	Ok
1.5	Peat	18	Bad	Good	Bad	Good
2.5	Unknown	13	Good	Good	Good	Ok
3.0	Mineral	14	Good	Bad	Ok	Good
3.5	Mineral	6	Good	Ok	Ok	Bad
5.0	Mixed	13	Good	Bad	Ok	Very good

* This farmer just bought fields with oil palm from other farmers, palms bore no fruits yet.
** Income from only 90 oil palms. *** Income from only 160 oil palms.

If we focus on the part of the income that is not earned by oil palm harvest, farmers with small or no areas with oil palm have more than 65% income from other labour (Figure 11).

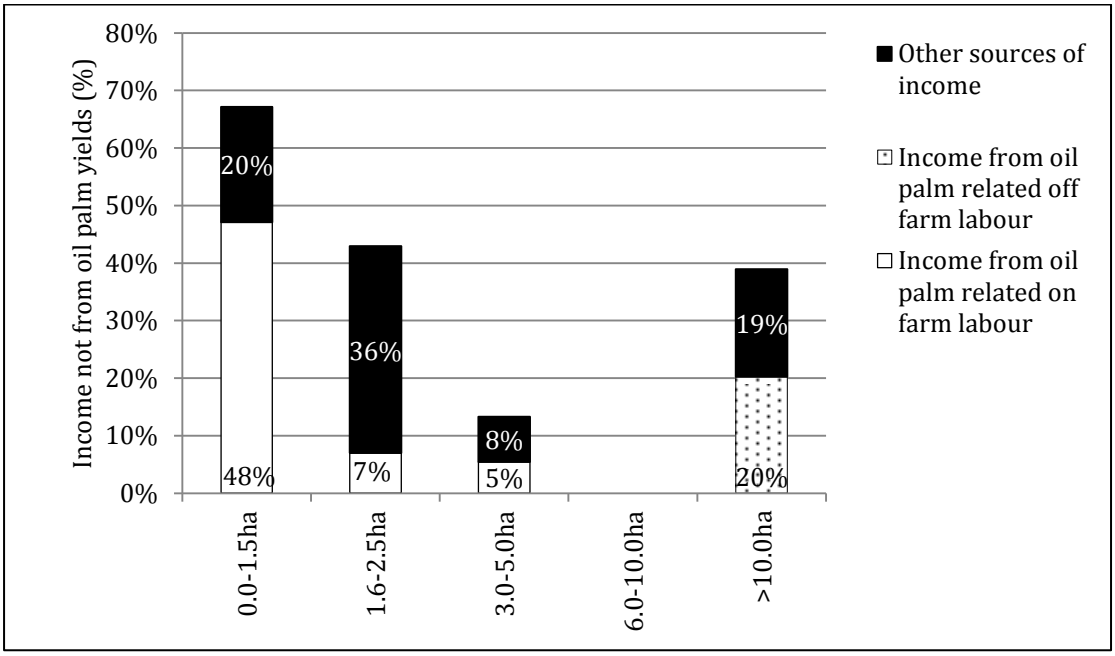

Figure 11 Average income that does not come from oil palm yields and income that comes from on- and off farm labour (n=39), divided over groups of farmers with different land areas.

Most of this labour consists of oil palm related labour (48%). Because more farmers own bigger areas under oil palm (Figure 4), the demand for labour increased and farmers with small or no fields work on fields of other farmers. For the higher end, farmers could afford to buy a truck to trade.

Table 6. The division of farmers from local and Javanese origin, over mineral, peat and mixed soils and the income of oil palm per hectare for the different soil types and origins. (n=7 for local, n=26 for Javanese, 6 other farmers had missing data)

	Locals		Javanese	
	Percentage of farmers	Income from oil palm*	Percentage of farmers	Income from oil palm*
Mineral soil	43%	58%	46%	64%
Peat soil	57%	42%	31%	16%
Mixed soil	0%	0%	23%	20%

*Income from oil palm per hectare of oil palm

Although Javanese have a higher share of the incomes (Table 3) they do not have more income from the same soil type if you compare them with local farmers (Table 6). This implies they do not necessarily use better management practices to create this higher income.

5.2. Factors affecting yields

Because the origin of farmers does not explain differences in yields, we investigated two other factors that might determine these differences: level of education and soil type.

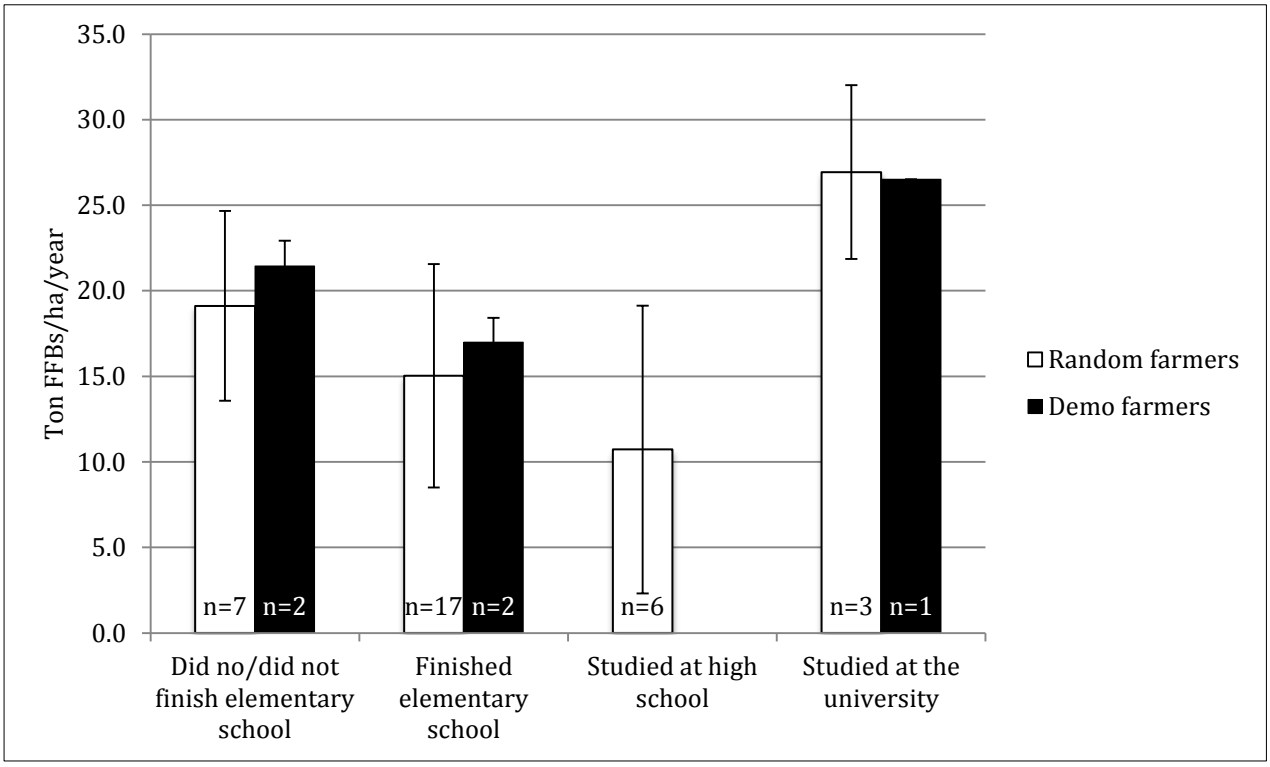

Figure 12 Average annual yield per hectare for farmers with different education levels for random farmers (n=33. Six farmers are left out due to missing data on yields) and demo farmers (n=5. One farmer is left out because he had only young oil palm trees that were not producing yet).

When we link the average yield per year to the level of education, farmers that studied at the University had on average a higher yield per hectare than people with lower education. This, however, is not significant (Figure 12). The trend suggests that farmers

with the lowest and the highest level of education produce best. Farmers who did not finish elementary school have probably more incentives and personal framing experience to produce more. Farmers that studied at the university all had an agronomic background and technical knowledge about farming, which might explain their higher production . The lowest production per hectare is associated with people who studied at high school, which might be explained by a lack of professional agronomic education and a lack of personal cultivation practice due to time spend in school instead of time spend at the farm.

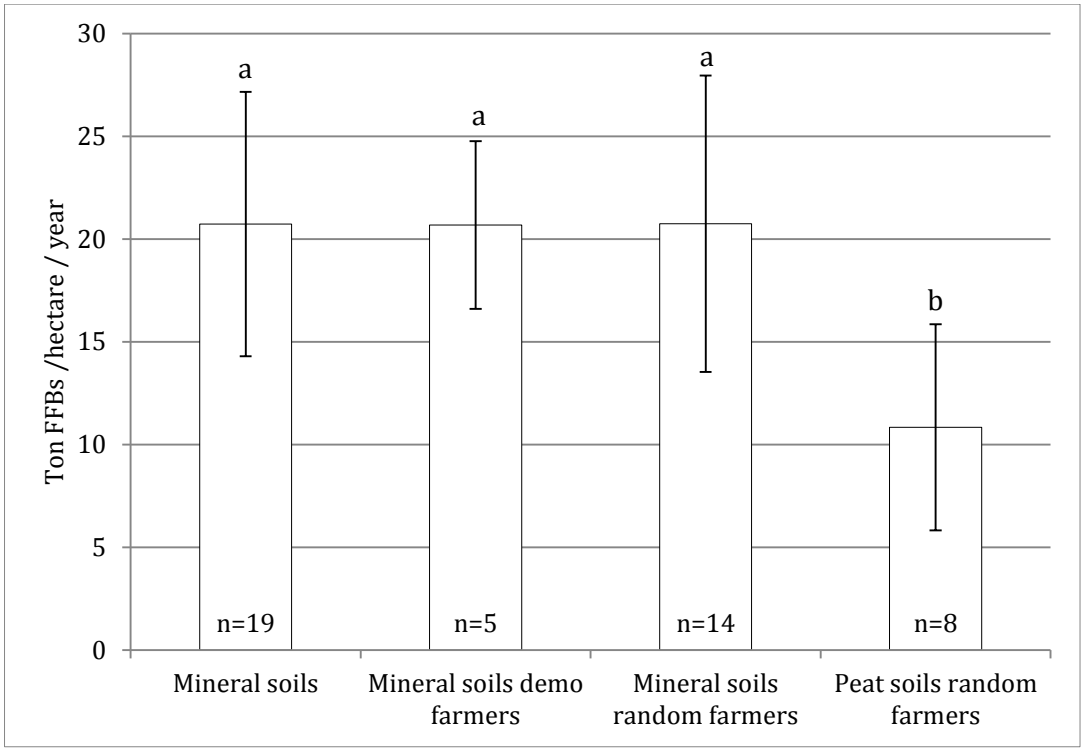

Figure 13 Ton of fresh fruit bunches per hectare per year for different soil types (n=22 for random farmers. Missing farmers have mixed soils, or no fields with oil palm. N=5 for demo farmers. One farmer is not taken into account, because he had only young unproductive oil palms). Significant differences ($p<0,05$) are indicated with different letters.

When the average annual yield is compared over different soil types, we found that production on peat soils is significantly lower than on mineral soils (Figure 13). The six demo farmers all had mineral soils, and no (significant) difference is found between the yields of demo farmers and random farmers on mineral soils (Appendix D)

5.3. Oil palm management practices

Farmers in the area never received any collective training or information on how to manage their oil palm. Most practices are copied from other farmers, neighbours or family members in the area. To evaluate these actual practices, I will first discuss the best management practices for oil palm.

5.3.1. BMP's and actual practices

The best management practices that should be applied are dependent on soil structure, age of the tree, water availability, infrastructure, labour availability and many more factors. However; some main practices can be listed as a guideline. The next summary

gives a list of these main practices, focused on the area of this study. For the full list and explanations of these practices I advise to consult the Rankine and Fairhurst (1999) BMP handbook for oil palm.

Pruning	* For trees with different ages, different guidelines are available. For each tree there is an optimum number of leaves that should be maintained: - Trees of less than 4 years: no pruning. - Between 5 and 7 years: 2-3 rings below the last ripe bunch. - Between 8 and 15 years: 1-2 rings below the last ripe bunch. - Older than 15years: 1 ring below the last ripe bunch. * Pruned leaves should be stacked in a box shape in the field. This makes the nutrients and organic matter more spread out and the leaves to decompose faster.
Weeding	* Only a clear circle needs to be weeded around the tree as well as access and harvesting paths, which are all used to improve the harvesting process. A ground cover on the rest of the field can prevent the soil from eroding and works as a safety net for nutrients. Leguminous weeds should also be left between the trees as they can be an extra source of nitrogen. * Woody weeds need to be pulled out or killed by a herbicide, which is best done for the entire plantation.
Insects and pests	* Pests and diseases should be monitored. For example: damage by rats should be kept below 20% of the FFB's.
Harvesting	* Should be done every 10 days. * Empty fresh fruit bunches should be brought back from the mill and put back in the field.
Planting material	* Tenera seeds should be planted.
Fertilisation	* The amount of fertiliser that should be applied, depends on the soil type, age of the tree and the harvested amount of fresh fruit bunches. Next to N, P and K also Mg and B should be added. K and N are the most important fertilisers to apply.

Actual management practices of the random farmers are described in Table 7. Fertiliser data are not found in Table 7, because application was widespread and more complex to describe. Therefore this will be analysed in separate tables graphs in section 5.3.2.

Table 7 Different management practices that are associated with oil palm are listed. Descriptions show the answers that were given by the random farmers and the percentage of the farmers that gave that certain answer (n= different for all specifics. Farmers missing either did not know (e.g. because hired labour executed these practices) or data were missing).

Management practice	Specific	Description	Percentage of farmers that gave this answer
Pruning	Pruned part (n=33)	Oldest leaves (yellow or death) or (second) lowest ring	55%
		1 or 2 rings underneath FFB	27%
		Small trees: 2 rings under FFB, large trees: 1 ring under FFB	18%
	Pruned fronds (36)	All collected in one direction in the field	94%
		Collected outside the field	3%
		Collected in on one pile	3%
	Pruned by whom (n=33)	Pruned by themselves	55%
		Pruned by hired labour	45%
Weeding	Weeded part (n=36)	The total plantation	67%
		Small weeds: circle around the tree, big weeds: total plantation	17%
		Circle around the tree and (harvesting) path	14%
		Does not weed	3%
	Weeded by whom (n=34)	Weeded by themselves	59%
		Weeded by hired labour	35%
		Weeded for 50% themselves	6%
Insects	Problems with ants (*Formicidae*) or beatles (*Oryctes rhinoceros*) (n=33)	Yes, does nothing about it	55%
		No problems	30%
		Yes, they use salt against ants and beetles	9%
		Yes, (unknown) insecticide used against beetles	6%
Pests	Problems with Rats (*Rattus*) or Wild boar (*Sus scrofa*) (n=34)	Yes, does nothing about it	76%
		Yes, does something about it (but doesn't use pesticides)	9%

		No problems	9%
		Yes, uses pesticides	6%
Harvesting	How often harvested (n=33)	Once every two weeks	100%
	Empty Fresh Fruit Bunches (that are left in the field after harvesting) (n=33)	Are put back in the field/around the trees	70%
		Nothing is done with the EFBs/doesn't know	24%
		Are burned to create smoke for their goats as mosquito repellent	6%
	Harvested by (n=33)	Hired labour/traders	61%
		Themselves	39%
	Fruit sold to (n=35)	Trader	91%
		Mill	9%
Oil palm characteristics	Type of oil palm (n=34)	Does not know	41%
		Mix of Dura and Tenera	29%
		Dura	18%
		Tenera	12%

Most farmers do pruning and weeding, although not always the way it should be weeded or pruned (see BMP's listed above). Most of the farmers weed the total field and prune only the yellow and old leaves.

Furthermore, most farmers have problems with beetles and ants (70%), but 79% of the farmers that have problems with these insects do nothing about it. To clear their trees from beetles or ants, they used salt or pesticides.

Even more problems are found with rats and wild boar (91% of the farmers indicate this as a problem), and even less is done about these pests; 84% of the farmers do nothing. Farmers think that rats and wild boar are not a problem or they do not know how to prevent these pests from eating fruits. However, the remaining 16% used different practices to prevent loose fruits or young oil palms from being eaten by wild boar. Loose fruits come from overripe bunches, which then fall onto the ground and the young leaves of small oil palms are tasteful and accessible for wild boars. Barn owls can be found in the area, but farmers do not know the importance of these birds as predators of rats. One of the farmers even shot a barn owl, when the bird was making too much noise in the farmyard.

Harvesting is done every 14 days and fresh fruit bunches are sold to traders most of the time (91%) (Table 7). Loose fruits are often left in the field by harvesting teams and are either collected by family members (wife, sisters) of the farmers or by children who earn money with the collected loose fruits.

Furthermore, not always the right planting materials are planted. Most farmers do not know what they plant and often they still plant Dura instead of Tenera.

Lastly, management practices are very often copied from other farmers or family. This is a main reason for farmers to execute certain management practices the way they do.

5.3.1. Fertiliser use and associated costs

Nine farmers did not use any fertilisers the past year, either because they had no oil palm fields, they did not have enough money to buy fertilisers from or they did not use fertilisers yet. Most farmers apply NPK-fertilisers.

Table 8 Fertiliser use by percentage of random farmers (n=34. Five farmers had no oil palm fields to apply fertiliser on). Amounts applied per application and per year are given per tree.

	Applied (kg) per application/tree	Applied per tree/year	Applied by (% of farmers)
NPK Phonska (15:15:15)	2.11	3.65	79%
NPK Mutiara (16:16:16)	1.80	4.08	29%
NPK Mahkota (13:8:27)	1.75	1.00	26%
Urea (46% N)	1.50	1.88	15%
ZA (21% N)	1.50	2.75	8%
TSP (45% P)	1.50	2.50	6%
SP36 (36% P)	1.00	1.25	6%
KCL (60% K)	1.73	2.38	18%
Borat (11.3% B)	0.02	0.03	15%
Dolomite (18% Mg)	2.61	3.45	47%
Petroganik (12.5% C)*	3.47	3.59	26%

*C-organic: 12.50%, C/N ratio: 15 (www.petrokimia-gresik.com/Pupuk/Petroganik.Petronik)

79% of the random farmers applied NPK Phonska (15:15:15), which is a subsidized fertiliser for annual crops farmers (n=34. Five farmers had no oil palm field to apply fertilisers on). The average amount applied is 2.11 kg per tree per application. For a year, the average application is 3.65 kg per tree. Farmers apply two other brands of NPK. These are NPK-Mutiara (16:16:16), which is applied by 24% of the farmers and NPK-Mahkota (13:8:27), which is applied by 6% of the farmers. These latter NPK fertilisers are applied by 29% of the farmers (n=34), from which 90% also apply NPK Phonska. Some of the farmers also apply N, P and K separately: Urea (46% N), ZA (21% N, 24% S), Triple superphosphate (45% P_2O_5) or KCl (60%K_2O). Though, only two farmers applied all three N, P and K together (Table 8).

Moreover, other important fertilisers are applied as well. Dolomite (18% Mg) is applied by 47% of the random farmers, but only those with lower yields (Figure 15). Boron (11.3% B) is used by 15% of the farmers. Petroganik (12.5% C) is applied by 26% of the farmers, from which the larger share (56%) have peat soils.

Table 9 The amount of nutrients that are applied on average per tree per year for different soil types. The recommended application for mineral and peat soils is given.

		Oil palm farmers that apply these nutrients		All Oil Palm farmers		
Nutrient	Soil type	N	Average application/tree/year*	N	Average application/tree/year*	Recommended application (min-max)/tree/year**
Nitrogen (kg)	Mineral	13	0.91	15	0.79	1.25-1.50
	Peat	9	0.85	12	0.63	1.25-1.50
	Mineral, peat or mixed	28	0.82	34	0.67	
P2O5 (kg)	Mineral	13	0.81	15	0.71	0.23-0.30
	Peat	9	0.67	12	0.50	0.30-0.40
	Mineral, peat or mixed	28	0.75	34	0.63	
K2O (kg)	Mineral	12	0.88	15	0.70	1.75-2.25
	Peat	9	0.67	12	0.50	2.45-3.15
	Mineral, peat or mixed	27	0.89	34	0.71	
MgO (kg)	Mineral	3	0.76	15	0.15	0.50-0.68
	Peat	7	0.67	12	0.39	0.00-0.50
	Mineral, peat or mixed	12	0.66	34	0.26	
Boron (g)	Mineral	2	3.11	15	0.41	11-22***
	Peat	1	1.13	12	0.09	11-22***
	Mineral, peat or mixed	5	3.05	34	0.45	

* Despite a consistent lower fertiliser application on peat soils than on mineral soils, this difference is not significant (Appendix E).
** Based on Rankine and Fairhurst (1999): Replacement of nutrients removed
*** Prevention of B deficiency

Compared to the recommended amounts, the amounts of N, P, K, Mg and B that are applied by the farmers show a lack in nitrogen, potassium and boron. The amounts of phosphor and magnesium that are applied are higher than needed (Table 9).
And despite a consistent lower fertilisation on peat soil compared to mineral soils, there is no significant difference between the two soils.

We divided the fertiliser application over peat and mineral soils (**Error! Reference source not found.**).

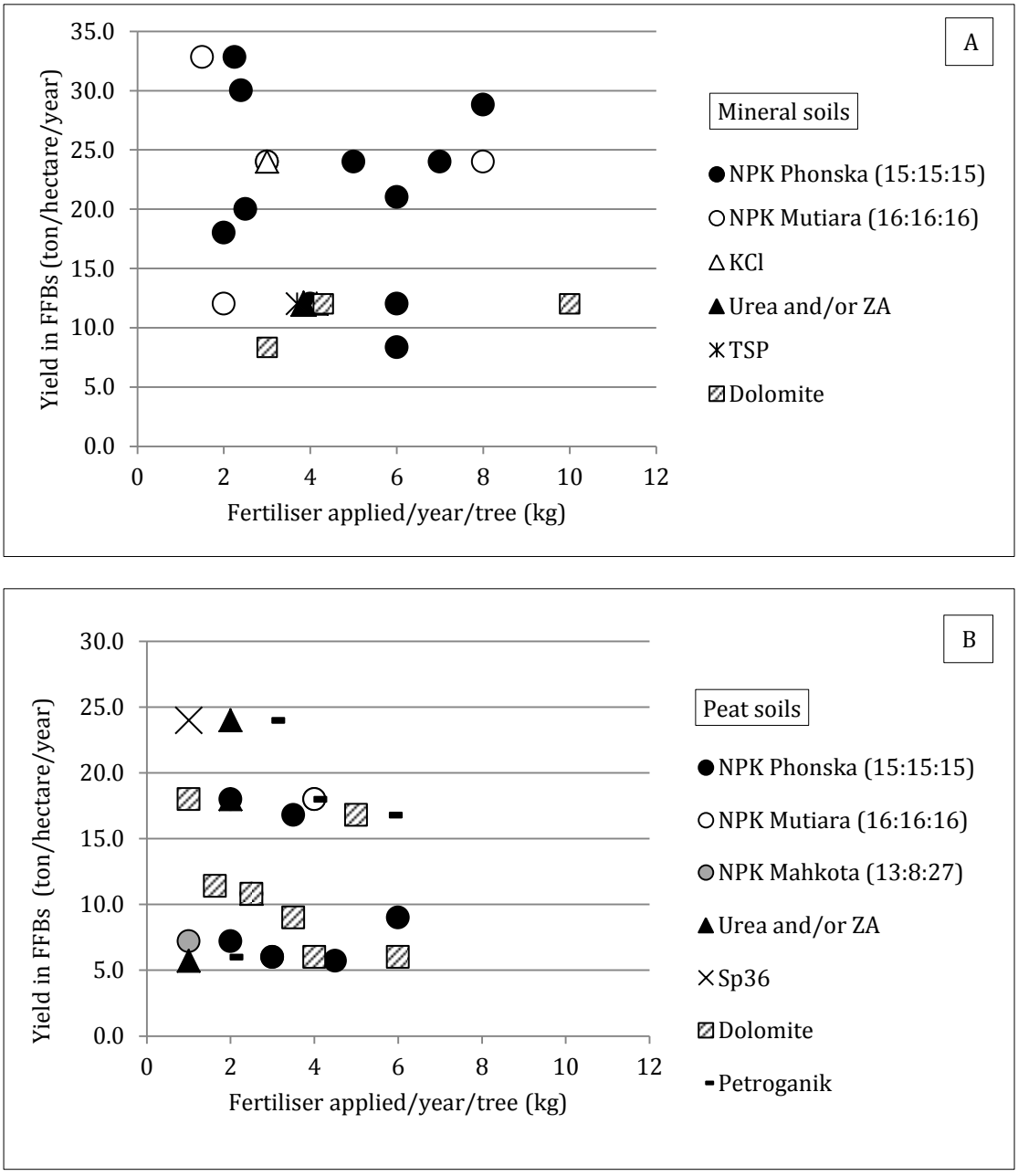

Figure 14. Fertiliser applications for a range of oil palm yields divided over peat (A) and mineral (B) soils. Boron is left out, since only small amounts are applied. A. On mineral soils, none of the farmers applied NPK (13:8:27), SP36 or Petroganik (n=14, farmers with mixed soils or missing data are left out). B. On peat soils, none of the farmers applied KCl, TSP (n=11, farmers with mixed soils or missing data are left out).

Remarkable is that organic matter (petroganik) is only added by farmers with peat soils. Furthermore, more people with peat soils apply dolomite on their fields, than those with mineral soils. Yet, farmers with peat soils do not apply KCl or TSP on their soils.

Overall, when we look at the use of fertilisers by the farmers, the variation in yields can hardly be explained by a different use of fertilisers, since no trend is seen (Figure 14, 15).

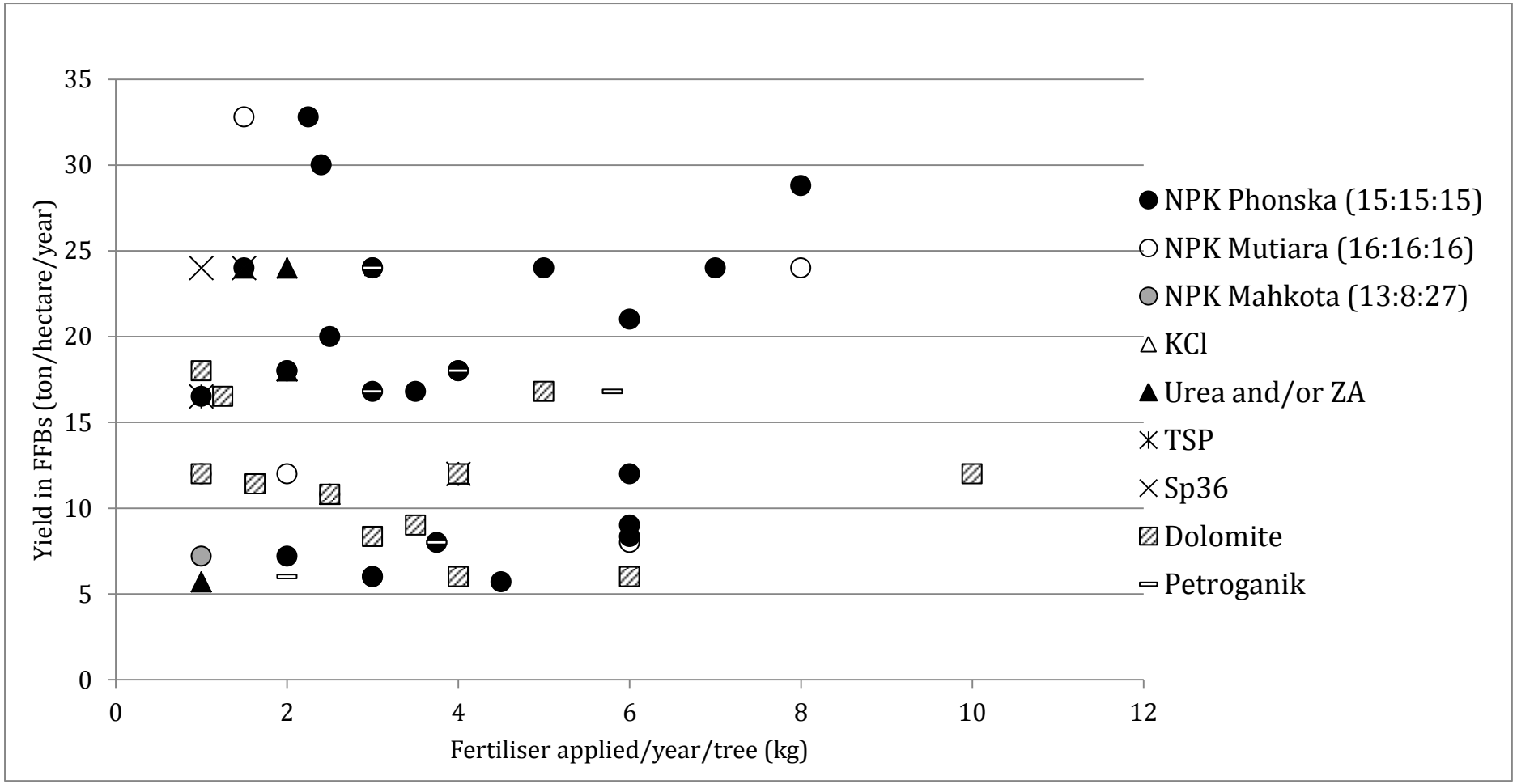

Figure 15. Fertiliser applications for a range of oil palm yields in FFBs. Boron is left out, since only small amounts are applied (n=32, rest of the farmers did not apply fertiliser, or had no oil palm)

Within the whole yield range, a similar amount of NPK is used per tree per year. Farmers that invest in dolomite are all in the lower segment of the yield range and as can be seen, only few farmers apply KCl, Urea/ZA or TSP (Figure 15).

To do triangulation, the expenses for fertilisers are determined in two different ways. Firstly, the expenses the farmer thinks he has (the 'farmers guess') were asked for and afterwards the expenses they should have were calculated ('calculated') (Figure 16).

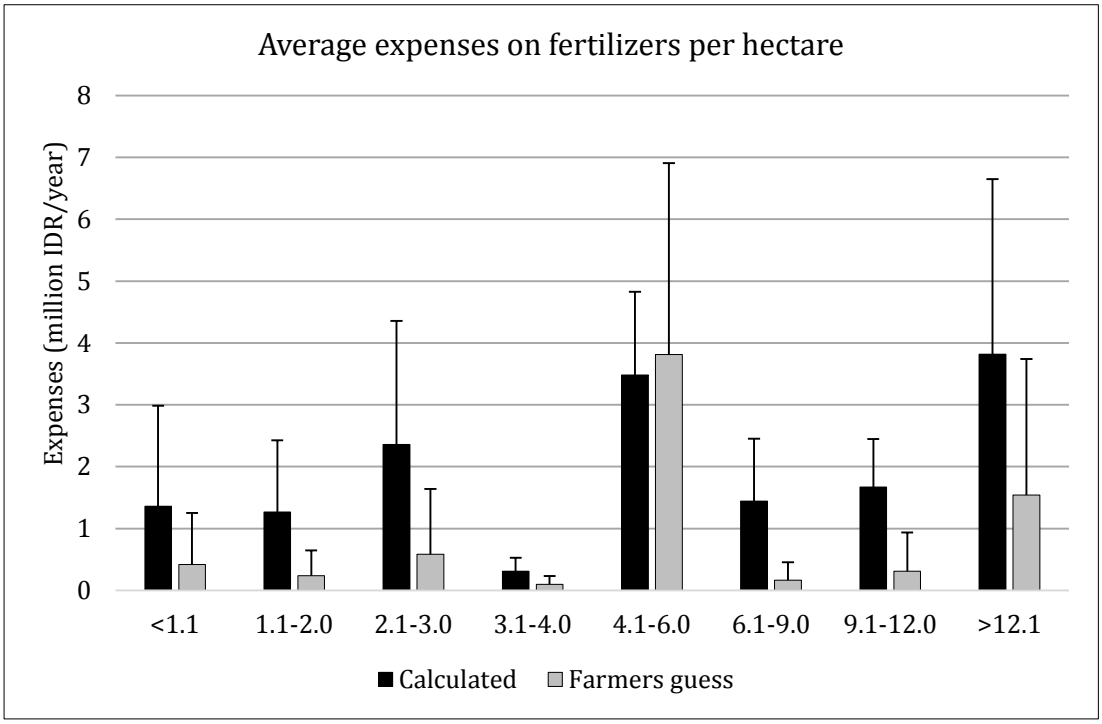

Figure 16 Average expenses (million IDR/month) on fertilisers per hectare for farmers with different areas of oil palm. Calculation is made based on information given by the farmer. The farmers guess is what they said they spent on fertilisers per year (n=34, 5 farmers with no fields are left out).

Farmers know they have to apply 'fertiliser', but they do not know which fertiliser should be applied. Therefore they often apply the cheapest fertiliser, regardless of the composition. The cheapest fertiliser available in Ramin is dolomite. Fertiliser application is copied from other farmers or traders. The major issue is money, or actually the lack of money, that keeps them from applying fertilisers that contribute to a higher yield.

Farmers guess their expenses are much lower than the expenses they make for the amounts of fertiliser applied, if applied. This can imply that farmers even apply less than they say they do.

5.3.2. Labour for BMPs

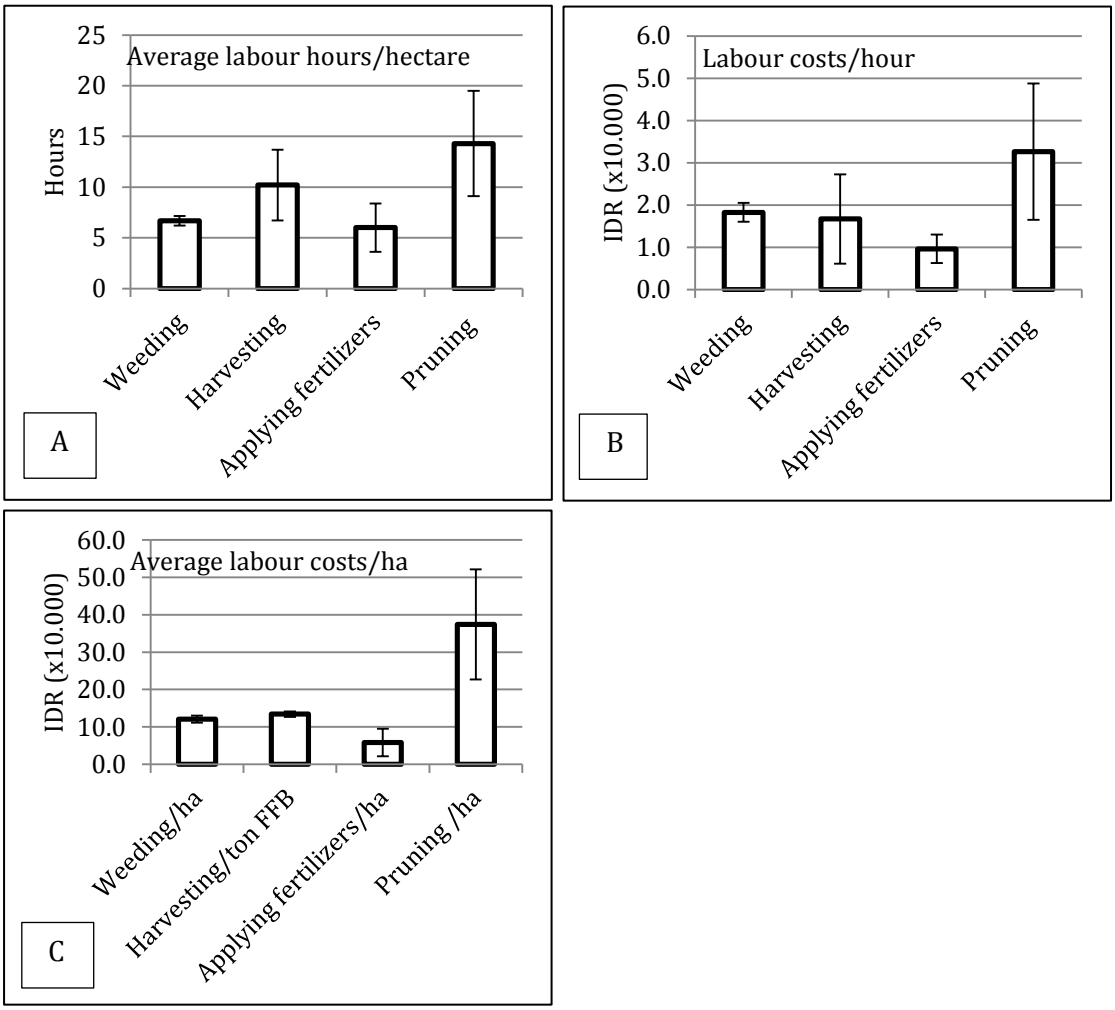

Figure 17 A. Average labour hours/hectare for weeding fertiliser application, pruning and harvesting for the demo farmers. B. Average labour costs/hour for the different management practices. C. Average labour cost/hectare or labour cost/ton for different management practices. The bar represents the standard deviation (n=6).

Labour costs per hectare are low for weeding or applying fertilisers, when compared to pruning (Figure 17C). As for the latter more labour hours are required (Figure 17A) against higher costs/hour (Figure 17 B). Average costs per hour for pruning are the highest, on average 32.619 IDR. For applying fertiliser on average 9.623 IDR is paid per hour. Costs of pruning are highly variable (Figure 17C). Pruning is often calculated per tree and is dependent on the age of the palm. This type of labour asks for a skilled labourer. If the tree is older and taller, the tree is difficult and harder to prune and pruning gets more expensive. Therefore, there is no standard hourly rate. Farmers in the subsample have oil palms with different ages. Because the trees do not have the same age also harvesting costs per hectare differ as older trees have higher yields.

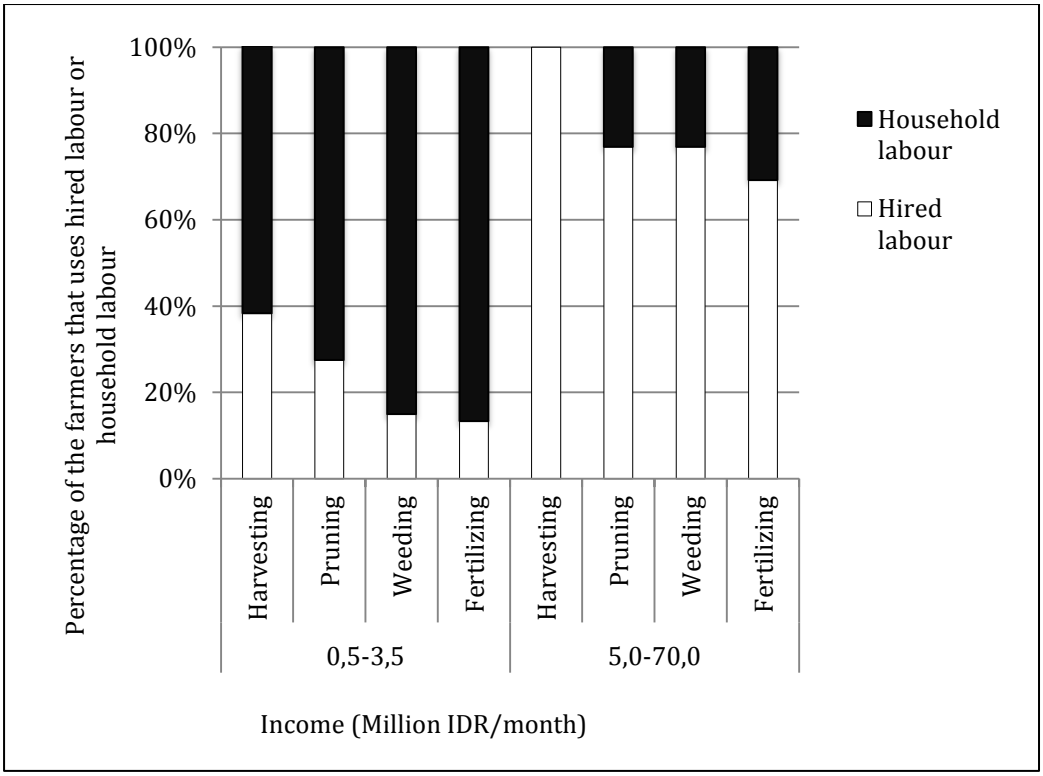

Figure 18. Average division of household and hired labour for different management practices for low (n= 20) and high (n= 13) income classes. Farmers either hire all labour, or do everything themselves for each practice, (due to missing data, n=32 for applying fertilisers and weeding. n=33 for pruning and n=34 for harvesting).

If the farmer' income is higher, more practices are done by hired labour. If the income is lower, more practices are done by household labour. A low income correlates with a smaller land size for oil palm (Figure 10) and small land sizes are more easily managed. Owners of larger land sizes however need more hired labour. Compared to the other practices, harvesting is most often done by hired labour and, fertilisers are most often applied by household labour (Figure 18). In the lower income segment, 40% of the farmers used hired labour for harvesting, while 100% of the farmers with a higher income used hired labour for harvesting.

6. Institutional environment

6.1. Cooperative and farmer organizations

As explained in the introduction under 'historical perspective', there was a cooperative in the village from 1984 until 1996. When the village cooperative was exterminated, farmers started small (unofficial) farmer organizations. These different organizations had diverse aims. I spoke to two group members of one group that consisted of farmers of one neighbourhood. These farmers traded their yields together and with the profit of the trading were able to rebuild the roads in their neighbourhood. Another group was dependent of a wealthier farmer, who facilitated fertilisers, lent money and did the trading for the farmers in the group. Most of the demo farmers were part of this group. The smallholders had in this case easy access to money and fertilisers, but in return had to sell their harvested oil palm to this wealthy farmer. Other way around, by providing

money and fertilisers, the more well off farmer secured higher income for himself as a trader. These arrangements could be found between almost all traders and the farmers they trade for.

6.2. Traders

Traders function as social control and as economic safety net for oil palm farmers in the village. Most traders started trading oil palm between 2005 and 2014. Only one out of 8 interviewed traders was not capable of providing money or fertilisers, his own income was too low. The rest of the traders all provided money to farmers they trade for. Pay back conditions are very fair; if the farmer borrows 5 million, he has to pay 5 million back. A discount on the money the farmers get for their oil palm pays back the borrowed money. This discount also depends on the yields and the total oil palm income the farmers have. Most of the time there are no time restrictions, only restrictions on the money that is lent. Farmers with more land could borrow more money than farmers with small areas. Only one trader worked with contracts and time restrictions.

For fertilisers it is slightly different. Most of the traders have good relations with cooperatives from other villages and they buy subsidized fertilisers from these organizations. To cover their transport expenses, traders ask slightly higher prices for these fertilisers when sold. Conditions for paying for the fertilisers are the same as when money is borrowed. Most of the traders do not have fertiliser stocks, but they buy the exact (amount of) fertilisers asked for by the farmers. Traders are willing to help providing fertilisers, since this also increases their own income. The subsidized fertilisers are always fertilisers that are made for annual crops. According to the traders and farmers, the fertilisers they need for oil palm are never subsidized.

Traders very often accept all FFBs from the farmers, also if they are un- or overripe. Although they know that the mill won't accept unripe or overripe bunches, most traders buy all the bunches from the farmers, often telling them which bunches are actually not right for selling. Traders also know which farmers trade with which traders and which fields are from which farmers. If farmers have another trader from which they borrowed money or fertilisers, other traders will not trade oil palm with these farmers. Furthermore, if the trader does not know from which field the FFB's comes, they do not trade with these farmers to prevent theft.

On average, these traders earn 25 million per month from trading only. Traders make schedules for FFB's pick-up, which is now every fortnight. Traders were willing to change to a scheme where FFB's of one farmer would be brought to the mill every 10 days, but this had to come from farmers themselves.

Traders are often found close to good roads, and they only pick up FFB's from roads which are passable by truck. Farmers themselves need to bring the FFB's to the road, which is not always convenient, especially when it is raining (Figure 19).

6.3. Labour market

Finding a job, working for oil palm smallholders, is easy in Ramin. Several farmers have more fields then they can manage on their own, which results in a high labour demand. Employers therefore have problems finding enough labour in time, because the supply is

not always present. Most workers also have their own fields, so they are not fulltime available. Farmers with larger estates therefore hire the same people for a longer period, to ensure their labour force. Sometimes people are hired from Java. These are often distant family or old friends.

For smaller farmers it is also difficult to hire enough labour, because most workers in the village are occupied on bigger farms. If the fields are smaller than 1 hectare, people do not like to work on these fields, because this will cost them time that they could spend on a larger estate.

6.4. Price setting

The price received at the mill is unknown by the farmers, and the price that the government sets for FFBs is also unknown. The son of one farmer I spoke to is one of the biggest traders in the village, but even he (the father) did not know the price would receive at the mill. The few people that did know these prices (often only the price they would acquire at the mill) were people with small areas covered with oil palm and small yields. They were therefore not able to bring the FFBs to the mill themselves. The traders gave 17% less to the farmers, than they received at the mill. However they also made transaction costs: (off-) loading of the truck, fees at the mill, salary and food for the driver and fuel. Per truck of 10ton of FFB's, the traders can earn around 1 million IDR.

6.5. Social and environmental conditions

More than 94% of the random farmers with oil palm fields have no forest next to their fields (Figure 19). However, when we asked them the question if a farmer should be allowed to open the forest for agriculture or that the forest, that is still left, should be protected, 81% of the farmers replied that they would open the forest. Mostly this is to get a higher income by planting new oil palm: "a forest is not productive" and "a forest is a good habitat for pests and dangerous wildlife". The farmers that would protect the forest had different reasoning: "forest can prevent the area from flooding and from environmental problems", "a forest can keep wild animal that are predators of wild boar" or "three hectares is enough, the rest is for the animals".

Environmental problems the farmers encounter are mostly smog from forest that is been burned in Riau province. Furthermore they have floods every year for at least a month, which can be of bad influence on the oil palms if it holds on for a longer period. The floods were also a major reason for ethnic people to flee the area and sell their land and properties. In the dry season, drinking water scarcity can be a problem. In the rainy season, many roads are inaccessible, which makes oil palm management very difficult.

All farmers have access to electricity. Sometimes power cuts were experienced, but this happened less than in the city of Jambi itself. The richer farmers had also power generators.

Only 8% of the random farmers (n=39) had some sort of health insurance. The rest of the farmers praised and thanked god: 'Alhamdulillah' was the most often heard phrase in this matter. When farmers do have to go to the hospital they ask family or traders for help, or sell their property. The head of the village was also able to give the poorest

people in Ramin a social health insurance for the poor, which is subsidized by the government. However, he gave this only to people with no fields, which was his definition of 'really poor people'.

Compared to 5 years ago, 79% of the farmers (n=39) say they have a better standard of living, from which 55% explicitly mentioned oil palm. From 8% of the random farmers, the standard of living is worse than 5 years ago, with mostly health related reasons.

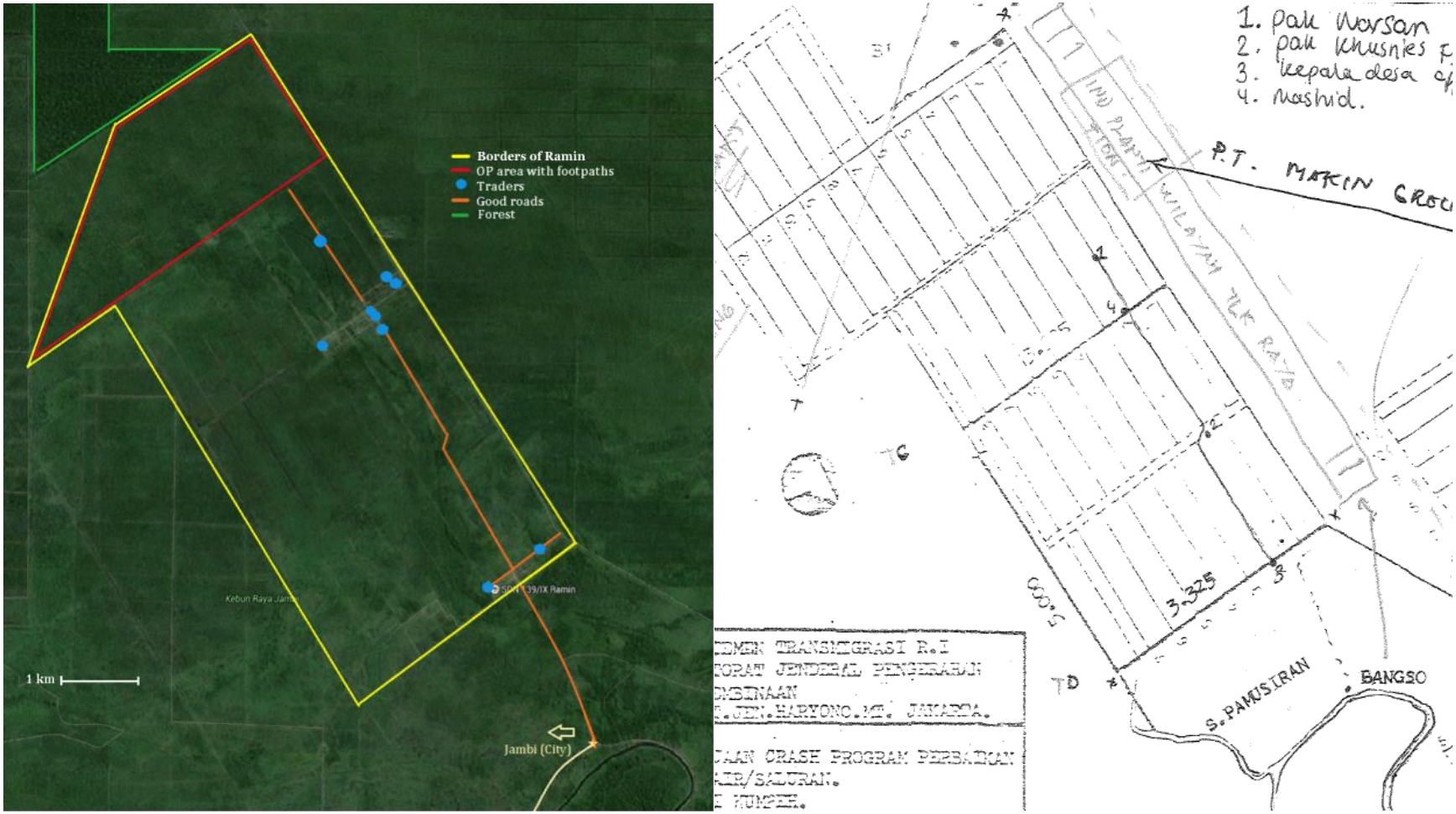

Figure 19 Satellite map of the village of Ramin and a black and white map regained at the office of the head of the village. The borders of the village are shown. A forest and an area of oil palm fields, which are only reachable by foot or motorbike, are encircled. Traders and good roads are pointed out. The black and white map shows a clearer division of the parcels.

7. Discussion

In this discussion we elaborate further on farmers livelihood and oil palm dependency and their influence on the social differentiation in the village. In the end possible constraints for implementation of best management practices will be indicated.

7.1. Demo farmers not representative

The demo farmers are not representative for the whole village (Chapter 3). Farmers participating in the project have a higher income and on average significantly more fields with oil palm. If best management practices are to be adopted in the rest of the area, this adoption is very likely to be influenced by different constraints than those of the demo farmers.

To understand these constraints, first a livelihood analysis is done, exploring the livelihood assets of the random farmers.

7.2. Farmers livelihood

A good health care system, which assures farmers good care, is lacking. This can be seen as a governmental limitation (Mahmud et al., 2010). If farmers cannot work due to physical inabilities, especially for poor farmers, this can result in long-term field problems. Poor farmers in need of care are more likely to sell their land, which brings them in a vulnerable position (McCarthy et al., 2012). Hired labour is scarce especially for smaller farmers (Chapter 6.3); the management of their fields will decrease and lag behind. And although there is a social health insurance for the poor that seems to be helping (Sparrow et al., 2013), farmers who have fields are not regarded poor enough to claim this insurance in this village (Chapter 6.5).

Although level of education and yield performance had no significant relationship, a trend could be seen where farmers with no finished elementary school or farmers with an agricultural degree from University have the higher yields (Chapter 5.2). Knowledge is lacking in the village as farmers are copying from each other and no one actually really knows what is best for their oil palm (Chapter 5.3.1). There was never any collective training in the village, which can also be seen by the way farmers fertilize their fields. However, training and demo plots showing BMP's will most likely be adopted in the village, while farmers tend to copy practices from other farmers.

A normal population would contain women and men in an equal amount. However, in Ramin this is shifted to 810 female to 905 male (Chapter 1.2.2). This can be explained by the fact that there is a labour scarcity. Labour from outside the village or even distant family is attracted to help in the farmers' plantations (Chapter 6.3). This might explain why there are more men in the village. However, research showed that smallholder productivity greatly depends on the role of women (Surambo et al., 2010). Which should be stressed more in the field, while often women are a small share of the total smallholders, but do perform better than their male counterparts (Molenaar et al., 2013).

Land is scarce in the village; 94% of the farmers have no forest close to their fields. On both the satellite map and the map of the head of the village it is evident there is no forest left in Ramin itself. (Chapter 6.5) Farmers thus can only buy from other local farmers or from people who own the land but do not live in the village. This land

scarcity can also be a reason for the shift in land possession that has been taken place the last decennium, where wealthy farmers bought land from poor farmers in the village, leaving them a short money boost, but with less land in the future (Chapter 4.2).

Some farmers do intercropping with oil palm, but most of them have oil palm as a sole and only crop. Farmers cannot provide for their own basic needs. From the random farmers only one farmer was self-sufficient. Because most farmers rely on purchased food, this makes them vulnerable (Chapter 4.4). When a disease, fungus or pest devastates their oil palms, this can bring the farmers in a poor condition (De Franqueville, 2003). The need for more diversified systems of production have long been emphasized (Belcher et al., 2004). So, although oil palm is a profitable crop, farmers should be aware of the risks they are taking by only growing oil palm.

People also fish in the area (especially during floods), but in times of drought (drinking) water can also get scarce (Chapter 6.5). Natural predators for oil palm pests and the knowledge about how to control the pests are also scarce. Rats and wild boar are a problem for almost 80% of the farmers, and they can cause severe yield losses (Wood & Liau, 1984). Providing the right knowledge can diminish yield losses.

Money, which is borrowed from the bank or from traders, is paid back by income from oil palm. A vast amount of money is invested in consumer goods or health care. Money to buy fertilisers is always coming from borrowed money; the random farmers never invested their savings in fertilisers (Chapter 4.6). This can imply that the money spend on buying fertilisers is not seen as an investment, while building a new house or children's education is. The right fertiliser input is clearly not known, while if done right, fertiliser costs are 60% of the total costs (Rankine & Fairhurst, 1999), which represent a major contribution to increase yield.

Next, an analysis is given on the importance and dependency of oil palm on the farmers' livelihood and an explanation is sought for the social differentiation in the village.

7.3. Oil palm, an important livelihood factor

When farmers first came here, they started cultivating staple crops and cash crops; none of the random farmers spoke of oil palm (Chapter 4.2). This is remarkable while the first big migration to Ramin was in the 1980's and this coincides with the government-sponsored migration schemes that focused on developing oil palm plantations (Colchester et al., 2006). This can be caused by two reasons; or the questions (and translation) were not clear enough, or farmers really did cultivate other crops.

A second wave of mostly spontaneous migration could be seen around 2000. These people were mostly looking for a job and better opportunities, which were probably created by oil palm, while an oil palm mill was build and oil palm as a crop was introduced in the same period (Cchapter 4.1). Oil palm in this way generated new livelihood strategies for people.

As Feintrenie et al. (2010) are stating: oil palm is a highly profitable alternative for traditional cropping systems and this creates opportunities for poor farmers to escape poverty (Feintrenie et al., 2010). And because this high profitability is also a reason for the government to earmark more land to cultivate oil palm (Casson, 2000) it seems logical that this was also the main reason for farmers in Ramin to change to oil palm.

Another advantage of oil palm is that farmers can harvest throughout the year (Feintrenie et al., 2010). This makes one bad harvest not responsible for the whole farmers income. When cultivating vegetable or other food crops, harvesting can be done only several times per year, or for only one part of the year, resulting in a less stable income; if a harvest is bad, this is harder to compensate.

7.4. Social and Income differentiation

If focused on the origin of the farmers in Ramin, an income differentiation can be noticed; the higher income segment consists of farmers with a Javanese background (Chapter 4.7).

However, this income differentiation can also be explained by yields coming from different soil types. Yields from peat soils were much smaller than yields from mineral soils. And because there is no absolute difference in yields between local farmers and Javanese farmers on both peat and mineral soils, Javanese must have had other ways to gain this higher income. One way is simply by rather buying mineral soils instead of peat soils. Only 31% of the Javanese farmers had peat soils, while 57% of the local farmers did (Chapter 5.2). This difference in possession of land with different soil types can explain the difference in income variation between the Javanese and the local farmers.

This differentiated agrarian landscape was also described by McCarthy et al. (2012). The first round of oil palm (PIR-Trans) schemes led to an emergence of a class of independent farmers, who bought up 'highly productive oil palm entitlements'. Ethnic farmers were invited to join these early schemes, but most of them opted out (McCarthy et al., 2012). This class of independent farmers with productive oil palm field were present in Ramin as well and most were transmigrated from Java.

The question whether oil palm cultivation is the cause for a higher social differentiation or if oil palm cultivation is an effect of a higher social differentiation is difficult to answer. As we have no baseline data from before oil palm we cannot attribute any changes in livelihood and in social differentiation for sure to oil palm alone.

However; the higher social differentiation that was present in the village might be caused by oil palm cultivation. Land profitability went up when farmers started cultivating oil palm and farmers became wealthier. Those who stayed behind also stayed behind in income. Oil palm cultivation resulted in a higher social differentiation: new wealthy farmers bought land from (already) poor farmers to expand their properties, and invested in their children's education and health, while poor farmers with small or no land kept lagging behind. Social differentiation will most probably further increase in the village when farmers keep buying fields from other farmers, which is a trend seen in Ramin and also described by McCarthy et al. (2012), where in 2009 an estimated 30% of the villagers was already landless (McCarthy et al., 2012).

Furthermore, farmers with peat land seem to be in a poverty trap, without knowledge on management practices and which fertilisers they should apply, farmers with a low income keep buying cheap fertiliser. While farmers with oil palm on peat land should especially invest more in chemical input than in labour practices to get higher financial returns (Noormahayu et al., 2009). Oil palm farmers with mineral soils earn more money due to higher yields and are able to buy more land, invest in the right fertiliser or other aspects that will improve their livelihood and income. These will all

give rise to social differentiation (McCarthy, 2010).

Diversification in respect of financial gains did increase. But diversification is also 'the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living' (Ellis, 2000 p15). The spreading of risks, by diversification of income resources can be found by the lowest and the highest incomes, but oil palm dependency is rather large in the village, especially for the middle class households. Farmers with higher income did increase their wealth by changing their income source; they became traders in oil palm. Farmers with low incomes work on fields of other farmers or still keep other crops like areca nuts (for chewing betel) or rubber (Chapter 5.1).

7.5. Constraints for best management practices

The biggest constraint for farmers to invest in best management practices is money. Farmers are willing to invest in their fields, but they do not have the incentives, assets and money to do so. Their cultural or sentimental attachment to the forest is not sufficient to prevent forest conversion (Feintrenie et al., 2010). The largest share of the random farmers (81%) would also cut the forest for other cultivation, if they had the means to do this (Chapter 6.5). Because most of the farmers have not enough money to buy (more) fertilizers, let alone new fields to plant oil palm, farmers probably will have more incentives to invest in better management practices, than in enlarging their fields.

Another problem for farmers is the condition of the roads; when it rains roads are inaccessible and slippery. Performing best management practices during the rainy season gets more difficult (Chapter 6.5). Farmers group together to improve roads, but better infrastructure is something that should be higher on the policy agenda.

Costs for pruning are the highest per hour and per hectare. Pruning costs are around 2.6 times as high as applying fertilizer, which has the lowest costs per hour and per hectare. Although applying fertilizers is relatively cheap, farmers most often apply this themselves. This might indicate that pruning is a management practice that needs skilled labour. This can also be stressed by the time that is needed for pruning a hectare (14hours on average) and applying fertilizer (5 hours on average). Therefore, when labour is considered, pruning is most difficult to practice and is constrained by the specialised labour needed and the high costs that are made. Investing in skilled labourers should be promoted, while the household members themselves should do the easier practices. This will result in a more efficient implementation of better management practices (Chapter 5.3.2).

Farmers are very dependent on traders for their income and social stability. Not only do they borrow money and fertilisers from their traders, traders can also organise FFB's to be picked-up every 10 days (Chapter 6.2). This can be beneficial for the farmers.

Variation between yields can be explained by different reasons. The most direct reasons can consist of either intrinsic properties, like soil type and palm age as well as extrinsic reasons like different oil palm densities or different management practices. Current yield variation is most probably explained by intrinsic properties. Since no real correlation is seen between fertiliser use and yields and farmers do not keep records of yields or of applied fertilisers, yields can be increased by giving the right training,

knowledge and planting material to give farmers the power to improve their yields and income.

7.6. Research evaluation

The head of the village, Mr Amin S., is in place since January 2014. The latest records with names of villagers present were from 2006, when people from the village applied for an ID card. Since then, no data were kept or they were lost, lent, but never returned. This made it difficult to do a simple random selection of farmer households in the village.

It was quite fruitful that the translator could speak English, Bahasa Indonesia and Javanese. When elderly farmers were met, who could not speak Bahasa Indonesia, this was more than necessary.

The current study is a baseline to facilitate attribution of change to the introduction of BMP's through training and demonstration plots.

8. Conclusions and recommendations

8.1. Oil palm as livelihood factor

Smallholders changed to oil palm, due to its profitability and steady income. Oil palm generated new livelihood strategies and is an important livelihood factor. Improving yields is therefore of major importance. Next to this, farmers are also more susceptible to risks, while they grow mainly oil palm. Therefore they should be more self-sufficient, in case of yield losses of oil palm in changing climate conditions.

8.2. Social differentiation

Due to the introduction of oil palm, there is a higher social differentiation, while the average standard of living increased. This higher social differentiation is related to oil palm but could also be caused indirectly by oil palm related factors like the lack of a good health care (and insurance) system. This higher social differentiation and land scarcity in their turn can be an explanation for the shift in land possession that is observed.

Furthermore, farmers with oil palms on peat soils have lower yields than farmers with oil palm on mineral soils. By only implementing BMPs in farmers' fields with mineral soils, farmers with peat soils will further lack behind. Although farmers should not plant oil palm on peat soils in the first place, they should be supported as well, because farmers with peat soils are more likely to get stuck in a poverty trap.

Javanese farmers have a higher income. This is however not caused by better management practices. Therefore, this difference in income within farmer's ethnic backgrounds should be accounted for when yields are analysed.

8.3. Best Management Practices

BMPs are very likely to be adopted, while management practices are copied from other farmers, neighbours and family members. When BMPs are creating higher yields, smallholders are likely to imitate these practices. To optimize management practices and make them more efficient, labour should be better divided: skilled labour should be promoted to be done by people from outside the household, while less skilled labour should be more often performed by the household members. And also women in the village could be stimulated more to work in the fields when labour is scarce.

Giving the right training, more knowledge and the right planting material could increase yields and income. And since most farmers have problems with pests, this is an efficient subject to discuss during trainings. Furthermore, money spent on fertilisers should be seen as an investment. This could be clarified during trainings and empirically proved after harvesting the demonstration plots.

To be able to execute the best management practices, infrastructure needs to be improved. Next to this, traders should be engaged more in the project, because they can facilitate the right fertilisers and also the right harvesting time.

9. References

Amrouk, E. mamoun, Poole, N., Mudungwe, N., & Muzvondiwa, E. (2013). *The impact of commodity development projects on smallholders' market access in developing countries* (p. 41).

Belcher, B., Rujehan, Imang, N., & Achdiawan, R. (2004). Rattan, Rubber, or Oil Palm: Cultural and Financial considerations for Farmers in Kalimantan. *Economic Botany*, *58 (Supple*, S77–S87.

Casson, A. (2000). *The hesitant boom: Indonesia's oil palm sub-sector in an era of economic crisis and political change.*

Colchester, M., Jiwan, N., Ardiko, Sirait, M., Firdaus, A. Y., Surambo, A., & Pane, H. (2006). *Promised Land : Palm Oil and Land Acquisition in Indonesia - Implications for Local Communities and Indigenous Peoples* (p. 197).

Curry, G., & Koczberski, G. (2004). *Mobilising smallholder labour in oil palm production: Results of the mobile card trial*.

De Franqueville, H. (2003). Oil palm bud rot in latin america. *Experimental Agriculture*, *39*, 225–240. doi:10.1017/S0014479703001315

Feintrenie, L., Chong, W. K., & Levang, P. (2010). Why do farmers prefer oil palm? lessons learnt from Bungo District, Indonesia. *Small-Scale Forestry*, *9*(3), 379–396. doi:10.1007/s11842-010-9122-2

Feintrenie, L., Schwarze, S., & Levang, P. (2010). Are Local People Conservationists? Analysis of Transition Dynamics from Agroforests to Monoculture Plantations in Indonesia. *Ecology and Society*, *15*(4).

Mahmud, A., Rehrig, M., & Hills, G. (2010). *Improving the Livelihoods of Palm Oil Smallholders : the Role of the Private Sector*.

McCarthy, J. (2010). Processes of inclusion and adverse incorporation: oil palm and agrarian change in Sumatra, Indonesia. *The Journal of Peasant Studies*, *37*(4), 821–850. doi:10.1080/03066150.2010.512460

McCarthy, J. F., Gillespie, P., & Zen, Z. (2012). Swimming Upstream: Local Indonesian Production Networks in "Globalized" Palm Oil Production. *World Development*, *40*(3), 555–569. doi:10.1016/j.worlddev.2011.07.012

Miettinen, J., Wang, J., Hooijer, a., & Liew, S. (2013). Peatland conversion and degradation processes in insular southeast asia: A case study in Jambi, Indonesia. *Land Degradation and Development*, *24*(4), 334–341.

Molenaar, J. W., Persch-orth, M., Lord, S., Taylor, C., & Harms, J. (2013). Diagnostic study on indonesian oil palm smallholders: Developing a better understanding of their performance and potential, (September).

Noormahayu, M. N., Khalid, A. R., & Elsadig, M. A. (2009). Financial assessment of oil palm cultivation on peatland in Selangor , Malaysia, *5*, 1–18.

Rankine, I. R., & Fairhurst, T. H. (1999). *Field Handbook: Oil Palm Series Volume 3 - Mature*. *Field Handbook: Oil Palm Series Volume 3 - Mature*. Singapore: Potash & Phosphate Institute (PPI), Potash & Phosphate Institute of Canada (PPIC) and 4T Consultants (4T).

Sparrow, R., Suryahadi, A., & Widyanti, W. (2013). Social health insurance for the poor: targeting and impact of Indonesia's Askeskin programme. *Social Science & Medicine*, *96*, 264–71. doi:10.1016/j.socscimed.2012.09.043

Surambo, A., Susanti, E., Herdianti, E., Hasibuan, F., Fatinaware, I., Safira, M., … Winarni, R. R. (2010). *The Oil Palm Plantation System Weakens the Position of Women*.

Wood, B. J., & Liau, S. S. (1984). A Long-Term Study of Rattus tiomanicus Populations in an Oil Palm Plantation in Johore , Malaysia : II . Recovery From Control and Economic Aspects. *Journal of Applied Ecology*, *21*(2), 465–472.

Appendix A - Farmers Questionnaire

April/May 2014

Name of the Respondent:			
Age of the Respondent:			
Level of education of the respondent:			Literate/illiterate
Gender: Male/Female			

A	**Household Characteristics**			
1	Total number of household members			
2	Total number of household members, working on the farm	2	A	What do these household members do on the farm?
3	Which additional labour is done next to farming, outside the farm, providing income, in the last year?			
4	Are you originally from Jambi province?	4	A	If not, where are you originally from?
			B	Are you part of a transmigration scheme or PIR/NES or KKPA?
5	Why did you stay/move here to Ramin?			
6	What was on the land before you came here? (Primary forest, secondary forest or agricultural/degraded land?	6	A	Who owned the land before you came here?
7	Since when have you been living in this area (years)?			
8	Who is making the decisions in the household?	8	A	Regarding which labour practices are done on the crops?
			B	Regarding the money spent on crop/palm/rubber management practices (or land)?
9	Do you have livestock?			
10	Which livestock do you have (cattle, chickens, goats etc.)?	10	A	How many of each?
11	Do you use animal products for subsistence or for selling?	11	A	If sold, how much income do these products generate (average monthly)?

B	**Land use properties**			
1	Which crops do you cultivate on your land?			
2	What percentage of this area do you own? (Ownership status, land title)			
3	Do you think you have a healthy soil?			What is the consistence of your soil (clay, peat etc)

C	**Land with Oil Palm**			
1	How large is the land cultivated with oil palms (in Ha)?	1	A	How far is this land from the mill? (km)
			B	Did you plant anything underneath or in between your oil palms? (Intercropping) If not, do you have cover crops (penutup

				tanah) and if yes, which?
				Type of oil palm
2	How many Oil Palms do you have?	2	A	What is/are the type(s) of your oil palm (Dura, Tenera, Pisifera)?
			B	Are the seeds hybrids with a certificate? (are they available?)
			C	What is the age of these oil palms?
3	Do you have plantations that need to be replanted soon (e.g. within the next 5 years)?	3	A	If yes, how much hectare?
4	Are you going to replant them? If yes, when?	4	A	If yes, where do you get the new palms and credit from?
5	What was on the land before you planted oil palms? (Or when you first came here: what did you cultivate?)	5	A	Why did you change to oil palms?
6	When did you start doing business in oil palms?			

D	**Management practices of Oil palm**			
1	Is the land with oil palms drained?	1	A	If yes, which percentage?
			B	Is this existing drainage managed (e.g. ditches are cleared)?
	Do you have problems with the flood?			
2	Do you prune the oil palms? (If not, why not)	2	A	How often are they pruned per year?
			B	Which part of the tree do you prune?
			C	What do you do with the pruned leaves?
			D	Which percentage of your land do you prune yourself (or any other member of your household)?
3	Do you weed your oil palm plantation? (If not, why not)	3	A	What part of the plantation do you weed?
			B	How often do you weed per year?
			C	Which type of herbicides do you use? (Kg/ha/application, which brand, which formula and costs?)
			D	Where do you get these herbicides from?
			E	Which percentage of your land do you weed yourself (or any other member of your household)?
			F	How much do you spend (monthly/yearly) on herbicide costs (Rp)?
4	Do you have problems with insects or pests?	4	A	Do you have problems with leaf-eating insects/pests, or other?
5	Do you spray pesticides/ insecticides? (If not, why not)	5	A	If yes, how often do you spray per year?
			B	Against which pests/insects do you spray?
			C	Which type of inputs are applied? (Kg/ha/application, which brand, which formula, what does it cost per unit)
			D	Where do you get these pesticides from?
			E	Which percentage of your land do you spray

				with pesticides yourself (or any other member of your household)?
			F	How much do you spend (monthly/yearly) on pesticides/insecticides (Rp)?
6	Do you have problems with other animals?	6	A	Which ones, what do you do about it?
7	Do you use chemical fertilizer? (If not, why not)	7	A	If yes, which different fertilizers do you use? (ask next questions for all fertilizers)
			B	Where do you get these fertilizers from?
			C	Which of these fertilizers is subsidized?
			D	Are you willing/able to invest in buying more fertilizers?
			E	How often do you apply fertilizer per year?
			F	How much is applied every time?
			G	What are the costs per unit (bag of 50 kilo etc.)
			H	Which percentage of your land do you spray with fertilizers yourself (or any other member of your household)?
			I	How much do you spend (monthly/yearly) on fertilizer (Rp)?
8	Are there any other management practices you apply?	8	A	If yes, which one(s)?
9	Do you harvest yourself or do you hire harvesting teams?	9	A	What are the costs of harvesting (ton FFB)?
			B	Which percentage of your land do you harvest yourself (or any other member of your household)?
10	How often do you harvest?	10	A	How long after you harvested you bring it to the mill?
11	How much do you harvest every time? (ton/harvest/kavling or Ha)	11	A	Maximum (ton/hectare/month)
				Months maximum
				minimum (ton/hectare/month)
				months minimum
			B	What is your average yearly production? (per hectare)
12	What do you do with the empty fresh fruit bunches?	12	A	How much does it cost to load the FFB in the truck?
13	How do you get your harvest at the mill?	13	A	Do you sell your bunches to a trader or directly to the mill?
			B	If with a trader, how is your relation to this trader?
			C	Do you have a choice in where you sell your bunches?
			D	If another trader or buyer offers a higher price, do you accept?
			E	What price do you get for the bunches? How much does that fluctuate?
			F	What price do you get at the mill or what is the government price (published in the papers)?
14	When do you get your money for the FFB? Immediately from the trader or the mill? Or after how long?			
1	Is the mill obliged to buy your fresh			

5	fruit bunches?			
16	How is you relation to the people of the mill?	16	A	What kind of problems do you have with people from the mill?
17	Do you think your oil palm production is high, average or low?			
18	Do you think you can increase your oil palm production?			
19	What are the constraints for production intensification?	19	A	Regarding plant management
			B	Regarding harvesting
			C	Regarding transport
20	Did you receive any help/information or training from an external party on how to manage your oil palm?	20	A	If yes, from whom? How often, When?
21	Are you planning to expand your oil palm plantations to other areas in the next year?	21	A	If yes, on which land?
22	Are you planning to expand your oil palm plantations to other areas in the next ten years?	22	A	If yes, on which land?

E	**Income and costs**			
1	What is the main income source of your family?			
2	What is the average monthly income of the household?	2	A	Is this more or less the same every month?
			B	If not, what is the maximum amount and for how many months? And what is the minimum amount and for how many months?
3	What is the average monthly income of the household from Off-farm work?	3	A	Is this more or less the same every month?
4	What is the available monthly or yearly income from remittances?			
5	What is the average monthly income of the household, from oil palm production?	5	A	Is this more or less the same every month?
			B	If not, what is the maximum amount and for how many months did it last? And what is the minimum amount and for how many months did it last?
			C	For which expenditure do you use the money gained with oil palm?
6	What is the average weekly/monthly income of the household, from rubber?	6	A	Is this more or less the same every month?
			B	If not, what is the maximum amount and for how many months did it last? And what is the minimum amount and for how many months did it last?
			C	For which expenditure do you use the money gained with rubber?
7	Do you produce staple food on the farm for subsistence? (Do you have a home garden)	7	A	What is the percentage of the total household needs of staple food covered by this production?

8	Do you have any other annual income from a different crop than Oil palm or rubber?	8	A	If yes, which crop and how much?
9	What are the average weekly/monthly/yearly costs of the household…	9	A	Spend on living? (Monthly)
			B	Health care (of the household)? (yearly)
			C	For the cigarettes (Monthly)
			D	For fuel
			E	For food and drinking water? (Monthly)
			F	For electricity? (Monthly)
			G	For children's education? (Monthly/yearly)
10	How much do you save yearly (Rp)?	10	A	How do you invest your savings?
11	Which assets do you own? (machines, type of house, livestock etc)			
12	Did or do you borrow money (from family, creditor or anyone else) for planting or managing oil palms?	12	A	If yes, from whom and how long did you get/do you have to pay it back (months/years)?
			B	What is the annual interest rate?
			C	Where do you use this credit exactly for?
			D	From which income are you going to pay it back?
13	Did or do you borrow money (from family, creditor or anyone else) for annual production cycles (fertilizer/labour/pesticides etc)?	13	A	If yes, from whom and how long did you get/do you have to pay it back (months/years)?
			B	What is the annual interest rate?
			C	Where do you use this credit exactly for?
			D	From which income are you going to pay it back?
14	Did or do you borrow money (from family, creditor or anyone else) for consumer goods (cars/motorcycles etc)?	14	A	If yes, from whom and how long did you get/do you have to pay it back (months/years)?
			B	What is the annual interest rate?
			C	Where do you use this credit exactly for?
			D	From which income are you going to pay it back?
15	Is it easy to employ workers?	15	A	Does it occur that you do not have enough labour to finish some of the practices?

F	**Social perceptions**			
1	What are the most important problems/issues in your village?			
2	Compared to 5 years ago, is your standard of living better, the same or worse?	2	A	What is the reason for this?
3	Compared to the rest of the villagers, is your standard of living better, the same or worse now?	3	A	What is the reason for this?
4	Has there been any conflict or tension during the past years in your village?	4	A	Regarding natural resources (water, energy)?

			B	Regarding Land?
			C	Regarding employment opportunities and jobs?
			D	Regarding cultural differences and/or religious issues/ indigenous people?
			E	Regarding neighbours or other households in the village?
			F	Regarding neighbouring villages?
			G	Regarding industrial facilities nearby?

G		**Other**			
	1	Do you have any environmental problems in your village?	1	A	If yes, what are they?
	2	Do you have forest nearby your plantation?	2	A	If yes, What is the status of that forest? (HCV area, government owned, company owned, community forest)
	3	What is your opinion, choose between 1. A farmers should be allowed to open forest for agriculture 2. The left over forest should be protected.	3	A	Why do you think that?

Appendix B - Traders Questionnaire

Name of the Trader: When did you start being a trader: Age of the trader: Gender: GPS coordinates

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E

A	**Trader facts**			
1	How many kavling of oil palm do you have:			
2	For how many farmers are you trading?	2	A	Which percentage is living in Ramin?
3	How many hectares do the farmers you trade for have in total?			
4	How often do you pick up FFBs (every day, once a week etc.)			
5	How much do you bring to the mill at once?	5	A	
6	How many traders are there in the village?			

B	**Marketing of FFBs**			
1	How are the Fresh Fruit Bunches brought to the mills?	1	A	Is it you own truck or do you hire it (and what are the costs?)
			B	Who is bringing it (you or another driver)? And what do they get paid?
2	To which mills do you sell the most?	2	A	How far away from here is this mill?
				What kind of relation do you have with the mills?
3	How often (which percentage) is not accepted by the mill?	3	A	Why not accepted
4	What kind of problems/constraints do you experience with these mills?			
5	What are the biggest constraints for the traders after each harvest?			
6	Do you also exclude farmers if they ask you to be their trader?	6	A	If yes, why?
7	How is the trading organised; do you pick up the FFBs on fixed dates or do the farmers call you when they are harvesting/ have harvested?	7	A	How often per farmer?
			B	would you be able to pick up FFBs more often (once every 10 days?)

C	**Farmers management practices**			
1	Do you think the farmers can increase their productivity?	1	A	How do you think they can increase their productivity?
2	Do you take all the FFBs that the	2	A	If not, why not and which FFBs do

	farmers put in the road?			you leave behind?
3	How much time and money does it take when there is a flood?			

D		Costs and credit			
	1	Do you provide credit (money) to the farmers?	1	A	For how many farmers?
				B	Against which conditions?
				C	Where do they use it for?
				D	How do they pay it back
				E	What is the maximum amount that they can borrow?
	2	Do you provide fertilizers to the farmers?	2	A	For how many farmers?
				B	Against which conditions?
	3	Which fertilizers?	3	A	Where do you buy it?
				B	How much do you buy
				C	For how much do you sell it to the farmers?
	4	How much does it cost to load the FFBs on the truck?	4	A	How many loaders work for you?
	5	When does he give the money to the farmers?			
	6	What do the farmers get for their FFBs? (Rp/kg)	6	A	Do different farmers get different prices? Why
					What do farmers get
	7	How much fuel do you need to go to the mill and back?			
	8	What do you get for the FFBs			
	9	What do you earn on average per harvest?	9	A	What is the minimum and the maximum?
	10	What is your average monthly income from trading?			
	11	What do you do with the money you earn with the trading?			
	12	How many procent of the villagers do not have land (anymore)			

Appendix C - Results of Independent T-test in SPSS

Table A10 Descriptives on differences in total income between demo and random farmers. Data are normally distributed after taking the logarithm

Descriptives Log10TotInc

	N	Mean	Std. Deviation	Std. Error
RandomFarmers	37	.5921	.45601	.07497
DemoFarmers	6	1.2092	.51349	.20963

Table A11 T-test on differences in total income between demo and random farmers. Data are normally distributed after taking the logarithm

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Log10TotInc Equal variances assumed	.121	.730	-3.026	41	.004	-.61716	.20394	-1.02903	-.20528
Equal variances not assumed			-2.772	6.346	.031	-.61716	.22263	-1.15480	-.07952

Table A12 Descriptives on differences in hectares of oil palm between demo and random farmers. Data are normally distributed after taking the logarithm

Descriptives Log10 OPHa

	N	Mean	Std. Deviation	Std. Error
RandomFarmers	34	.4740	.46724	.08013
DemoFarmers	6	1.0346	.51874	.21177

Table A13 T-test on differences in hectares between demo and random farmers. Data are normally distributed after taking the logarithm.

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Log10TotInc Equal variances assumed	.115	.737	-2.669	38	.011	-.56058	.21004	-.98578	-.13538
Equal variances not assumed			-2.476	6.514	.045	-.56058	.22643	-1.10420	-.01696

Appendix D - Results of Independent T-test in SPSS

Table A14. Group statistics of yield differences between mineral and peat soils of random farmers with mineral soils and random farmers with peat soils

Group statistics YieldRand				
	N	Mean	Std. Deviation	Std. Error
Mineral	14	20.7429	7.21470	1.92821
Peat	8	10.8375	5.01596	1.77341

Table A15. T-test on of yield differences between mineral and peat soils of random farmers with mineral soils and random farmers with peat soils

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
YieldRand Equal variances assumed	.800	.382	3.423	20	.003	9.90536	2.89407	3.86843	15.94228
Equal variances not assumed			3.781	19.020	.001	9.90536	2.61973	4.42260	15.38811

Table A16. Group statistics of yield differences between mineral and peat soils of demo farmers with mineral soils and random farmers with peat soils

Group statistics YieldDemo				
	N	Mean	Std. Deviation	Std. Error
Mineral	5	20.6840	4.07986	1.82457
Peat	8	10.8375	5.01596	1.77341

Table A17. T-test on of yield differences between between mineral and peat soils of demo farmers with mineral soils and random farmers with peat soils

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
YieldDemo Equal variances assumed	.738	.409	3.677	11	.004	9.84650	2.67781	3.95268	15.74032
Equal variances not assumed			3.870	10.018	.003	9.84650	2.54441	4.17860	15.51440

Table A18 Group statistics of yield differences between mineral and peat soils of demo and random farmers with mineral soils and random farmers with peat soils

Group statistics YieldAll				
	N	Mean	Std. Deviation	Std. Error
Mineral	19	20.7274	6.42594	1.47421
Peat	8	10.8375	5.01596	1.77341

Table A19 T-test on of yield differences between mineral and peat soils of demo and random farmers with mineral soils and random farmers with peat soils

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
YieldAll Equal variances assumed	.275	.604	3.869	25	.001	9.88987	2.55587	4.62595	15.15379
Equal variances not assumed			4.288	16.882	.001	9.88987	2.30614	5.02175	14.75799

Table A20 Group statistics of yield differences between demo and random farmers with mineral soils

Group statistics YieldMine	N	Mean	Std. Deviation	Std. Error
Mineral Demo	5	20.6840	4.07986	1.82457
Mineral Rand	14	20.7429	7.21470	1.92821

Table A21 T-test on of yield differences between demo and random farmers with mineral soils

Independent Samples Test	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
YieldMine Equal variances assumed	1.633	.218	-.017	17	.987	-.05886	3.44487	-7.32689	7.20918
Equal variances not assumed			-.022	12.953	.983	-.05886	2.65463	-5.79596	5.67824

Appendix E - Results of ANOVA in SPSS

Table A22 Amount of fertiliser applied between peat and mineral soils for oil palm farmers that apply these nutrients

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
N	Between Groups	.020	1	.020	.084	.775
	Within Groups	4.767	20	.238		
	Total	4.787	21			
P	Between Groups	7.721	1	7.721	.790	.385
	Within Groups	195.341	20	9.767		
	Total	203.062	21			
K	Between Groups	9.420	1	9.420	.930	.347
	Within Groups	192.386	19	10.126		
	Total	201.807	20			
Mg	Between Groups	.017	1	.017	.066	.804
	Within Groups	2.022	8	.253		
	Total	2.039	9			

B	Between Groups	.000	1	.000	.653	.567
	Within Groups	.000	1	.000		
	Total	.000	2			

Table A23 Amount of fertiliser applied between peat and mineral soils for ALL oil palm farmers

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
N_All	Between Groups	7.570	1	7.570	.931	.344
	Within Groups	203.215	25	8.129		
	Total	210.785	26			
P_All	Between Groups	8.394	1	8.394	1.037	.318
	Within Groups	202.418	25	8.097		
	Total	210.811	26			
K_All	Between Groups	8.304	1	8.304	1.022	.322
	Within Groups	203.187	25	8.127		
	Total	211.491	26			

Mg_All	Between Groups	.379	1	.379	2.014	.168
	Within Groups	4.704	25	.188		
	Total	5.083	26			
B_All	Between Groups	.000	1	.000	.780	.386
	Within Groups	.000	25	.000		
	Total	.000	26			