University of Copenhagen
Interdisciplinary Land Use and Natural Resource Management
April, 2016

Among People, Paddy and Pepper

- a study of agricultural livelihood strategies in Paon Gahat

Williams Patricio Apunte Calles WSK991
Line Juul Jensen DJL374
Julie Emilie Lærkegaard Nielsen KWN780
Tone Rusdal MGL596
Louise Kronborg Sørensen FZR983

Supervisors
Astrid Oberborbeck Andersen
Simon Mundus

To the people of Paon Gahat

Have no fear to go alone into the jungle.
Go down the notched steps and when you reach the jungle,
you will find you have me for company.

(Song of going out to the jungle - traditional Bidayuh hymn)

Williams Patricio Apunte Calles - WSK991

Line Juul Jensen - DJL374 -

Julie Emilie Lærkegaard Nielsen - KWN780

Tone Rusdal - MGL596

Louise Kronborg Sørensen - FZR983

Acknowledgements

This report is the finalized product of the course Interdisciplinary Land Use and Natural Resource Management (ILUNRM). The report is based on data collected from 12 days field research in Kampung Paon Gahat in the region of Sarawak, Malaysian Borneo from 1. - 12. March 2016.

First and foremost, we want to thank our four Malaysian counterparts from Universiti Malaysia Sarawak (UNIMAS) for their hard work, insights, patience, quick wits and dedicated cooperation both during and after the fieldwork. Much gratitude is also extended to our two interpreters, Imelda Markus Luak and Rebecca Saur Osaka, for creating positive and fruitful interactions with the villagers through tireless translating, explaining and facilitating.

Secondly, we want to thank the professors and coordinators, especially Dr. Wong Swee Kiong, Dr. Wee Boon Siong and Mohd. Azizul Hafiz Jamian, from UNIMAS for their efforts to make our field research run as flawlessly as possible, by giving great guidance and advice, and ensuring an efficient organization of logistics.

A great thank you is also directed to the ILUNRM team of professors and coordinators in Copenhagen, for a well organized course, helpful instructions, lectures and support. In particular a great thank you to our two supervisors, Astrid Oberborbeck Andersen and Simon Mundus who accompanied us in Malaysia, for making us feel comfortable and confident, and providing a constructive professional environment and even greater social experience.

Finally, our deepest and most heartfelt gratitude is extended to the people of Paon Gahat. The experience has exceeded our expectations in every way, and we are overwhelmed and humbled by the kindness, generosity and inspiration of the kampung people. Their knowledge, insights, energy and enthusiasm has been invaluable. A big thank you to our three cooks, who brought a smile to our face and full stomachs every day. A special thank you to our headman, Mr. Lunga Anak Gajot, for designating his valuable time to our research, and encouraging the villagers to participate. A further thank you to Mr. Michael, for the precious insights into the culture and traditions of Paon Gahat.

Work distribution		
	Main Author(s)	**Contributing Authors**
Acknowledgement	Tone	
Abstract	Line	
Introduction	Louise	
Village description	Louise	
Problem Statement	All	
Themes and research question	All	
Theoretical approach		
The Sustainable Livelihood Framework	Julie	
A Theory of Access	Line	
Methodology		
Different types of knowledge	Line	
Transect walk and forest walk	Tone	
Soil sampling	Tone	
Water sampling	Tone	
Global Positioning System (GPS)	Tone	
Semi-structured interviews	Julie	
Participatory Rural Appraisal	Julie & Williams	
Questionnaires	Julie	
Participant observation	Line	
Collaboration with counterparts	Julie & Line	
Results and analysis		
Land use	Louise	
Impact on natural resources		
Forest resources	Tone	
Soil quality	Williams	Tone
Water quality	Tone	
Decision making	Line	
Influencing factors	Louise	
Discussion		
Diversification	Julie	
Impacts on natural resources	Tone	Williams
Interrelations between land use and decision-making	Louise & Line	
Reflections of theoretical approach and methodology	All	All
Conclusion and perspectivation	Louise & Line	

Abstract

This report strives to access the interrelations between land use and decision-making in choice of agricultural livelihood strategies of smallholder farmers in Paon Gahat, a rural village in Sarawak, Malaysia. Through the sustainable livelihood framework and access theory, we assess the overall strategies of the smallholders in Paon Gahat in trying to decrease their vulnerability, and their ability to benefit from the resources available, especially in terms of natural resources and the access to resources from the government. Using a combination of different methodological approaches from social and natural science we found that several factors are influencing the decisions made over land use. The traditional adat influences the life of the villagers and how decisions are made in order to keep the harmony in the kampung. As smallholder farmers they are able to decide over their own lands and what crops to grow, and thereby they are balancing traditional practices of subsistence farming to survive while also relying on cash crops to gain a monetary income. By diversifying their land use and agricultural strategies they make themselves less vulnerable.

Keywords:
Sarawak, land use, decision-making, livelihood strategies, access theory

Table of Contents

Table of Figures

List of Tables

List of Abbreviations

Al	Aluminum
ANOVA	Analysis of Variance
BR1M	Bantuan Rakyat 1 Malaysia
DBNA	Dayak Bidayuh National Association
DOA	Department of Agriculture
FCC	Fecal Coliform Count
IADA	Integrated Agriculture Development Area
ILUNRM	Interdisciplinary Land Use and Natural Resource Management
JKKK	Committee of Development and Safety (translated)
JVC	Joint Venture companies
MOA	Ministry of Agriculture
MPB	Malaysian Pepper Board
MPOB	Malaysian Palm Oil Board
NCR	Native Customary Rights
POX-C	Permanganate Oxidizable Carbon
PRA	Participatory Rural Appraisal
RC	Reactable Carbon
SALCRA	Sarawak Land Consolidation and Rehabilitation Authority
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
SSI	Semi-structured interview
SLF	Sustainable Livelihood Framework
SWOT	Strengths, Weaknesses, Opportunities and Threats
TCC	Total Coliform Count
UNIMAS	Universiti Malaysia Sarawak
WQI	Water Quality Index

List of Appendices

1. Introduction

The life of the indigenous Bidayuh people in the Malaysian state of Sarawak in northern Borneo has changed drastically during the past 50 years. The Bidayuh have traditionally been paddy-planting communities practicing shifting cultivation and living off the jungle by hunting and collecting forest products (Chua 2012:3). With the independence in 1963, Sarawak became a part of Malaysia and the country's march to modernity, and in this optic the "native rural societies" were seen as counterproductive to the development towards a "modern society" (Chua 2014:5).

Large-scale development plans were initiated such as infrastructural improvements and a modernisation of the agricultural sector, moving from traditional and 'unproductive' subsistence farming to a commercialization of agriculture focused on cash crops such as pepper, rubber and oil palm, with the aim of reducing poverty through increase in productivity (Banerjee & Bojsen 2005:18; Meertz et al. 2005:210). Since the 1980s the agrarian development in Sarawak has been dominated by large-scale oil palm plantations. These have been established either through joint venture companies (JVC) or government schemes such as Sarawak Land Consolidation and Rehabilitation Authority (SALCRA), where the locals lease out their land for the plantations and in return receive a percentage of the profits (Cramb 2013:131). The development of the agrarian sector has thus significantly changed the land use and land cover in Sarawak.

Amidst these changes, the Bidayuh have had to adapt their previous agrarian practices to the new circumstances. It is here interesting to see which agricultural livelihood strategies are practised in light of the rapid changes, as land use decisions by rural communities are influenced by various factors (Mertz et al. 2008:1).

The focus of this study is the kampung Paon Gahat, in the Serian district in the state of Sarawak, Malaysia. It is a catholic Bidayuh village of 125 households and approximately 670 inhabitants. The kampung lies in a mountainous area by the Aping Mountain Range close to the border of Kalimantan. The kampung was settled in 1946 when people moved from the old kampung Gahat Mawang because of overpopulation, and founded the new kampung in the jungle by the Paon river where the name Paon Gahat originates from. In

1953 a longhouse was built housing 17 households and the longhouse still stand today, but is no longer inhabited.

The people of the kampung are dependent on agricultural activities and almost all of them cultivate their own lands. They cultivate hill and swamp paddy for their own consumption, they grow cash crops such as pepper, rubber and oil palm and many have vegetables and fruits in their gardens. There are a number of fish ponds in the kampung and some domestic animals such as goats, chickens and pigs.

Since the settlement of Paon Gahat there has been major changes in the land cover and land use, and the people have also had to adapt earlier practices to these overall changes. The kampung distinguishes itself from many of the nearby kampungs, by the absence of any plantations, all that is farmed is smallholder farming. It thus appears that Paon Gahat has decided to follow other agricultural practices than some of the surrounding kampungs and we were intrigued as to why this is. In this report we are therefore interested in investigating the agricultural livelihood strategies of the people in Paon Gahat, and what are the factors influencing decisions about land use.

All photos are taken by authors unless stated otherwise.

1.1 Problem statement

Assess the interrelations between land use and decision-making in choice of agricultural livelihood strategies in Paon Gahat?

1.1.2 Themes and research questions

Table 1 Themes and research questions

Land use RQ1 What are the different land use and agricultural activities in Paon Gahat?	**Natural resources** RQ2 What are the impacts of land use and agricultural activities on natural resources ?
Decision-making RQ3 How are the decisions made in regard to land use and agriculture in the kampung?	**Influencing factors** RQ4 What are the influencing factors behind choices of agricultural livelihood strategies in Paon Gahat?

2. Theoretical approach

Our theoretical approach is a combination of the Sustainable Livelihood Framework (SLF) and the theory of access by Ribot & Peluso (2003). By using both we can get a better understanding of how people make a living and how decisions are made in Paon Gahat.

2.1 The Sustainable Livelihood Framework

The SLF can be used in rural areas to create a more complex and holistic picture as it "comprises people, their capabilities, and their means of making a living including food, income and assets" (Chambers & Conway 1991:1) and not only looking at economic measurements such as GDP.

For this report, SLF offers a vocabulary and a framework in which the collected data can be understood (see figure 1).

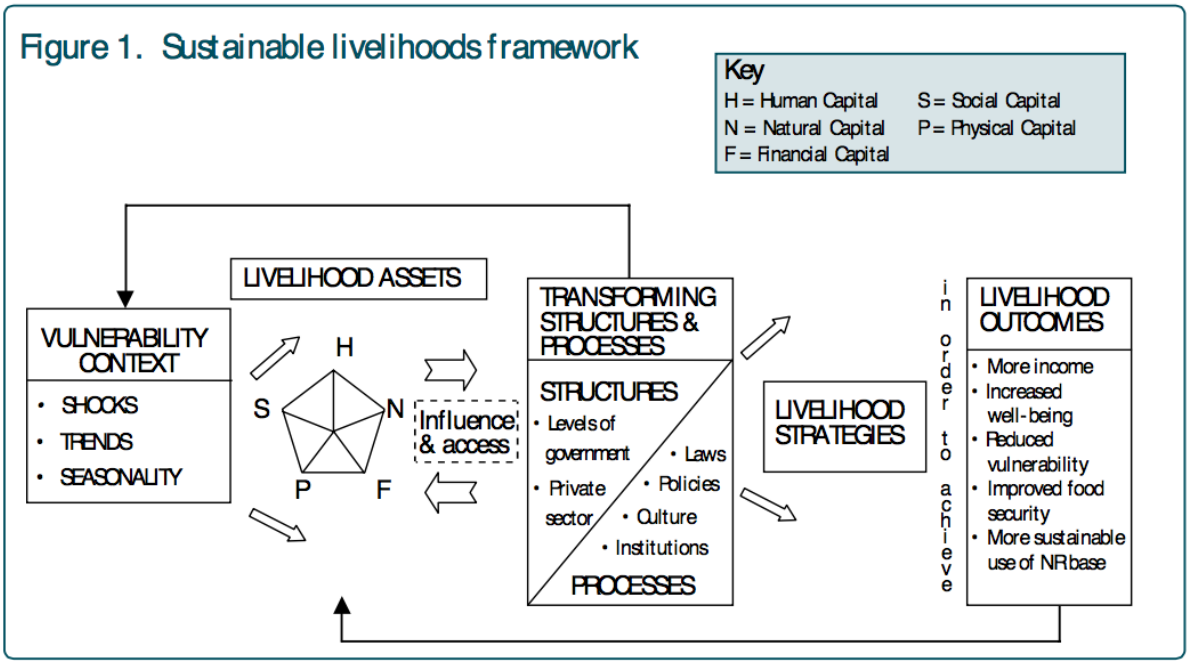


Figure 1 Sustainable Livelihood Framework (DFID 1999:1)

The livelihood assets are being used to understand what are available to the households and what kind of opportunities they have. The vulnerability context along with their available capitals are in this report used to understand the influences on the decisions regarding land use and thereby the agricultural livelihood strategies. The elements of the framework are all interrelated and we will therefore also look at the transforming structures and processes in terms of land tenure, relations to the government and how this influence the people of Paon Gahat.

2.2 Theory of access

To complement the SLF we use theory of access to get a better understanding of how people get and retain the access to resources and elaborate on how the decisions on land use are made.

The theory of access by Ribot & Peluso (2003), outlines the mechanisms of access to technology, capital, markets, labour, knowledge, authority, access through social identity or via negotiation of other social relations, and it can become more clear how the villagers use the different measures to obtain and retain access to benefits from resources (Ribot & Peluso 2003:172). The access theory offers a theoretical vocabulary to analyse the accesses to the resources available in Paon Gahat, both on a household level but also on a community level. All of the mechanisms are forms of social relations that allow us to look at potential conflicts, collaborations and the negotiation inside and outside of Paon Gahat (ibid.:173-174). This framework also helps identify gatekeepers, address power relations and furthermore look at the levels of alliances and actors influencing the decisions being made in the kampung over land use.

3. Methodology

The following section will explain which methods have been applied to collect data and will explain how and why the given method is relevant for the report. Through a triangulation of the data gathered from the different methods we will try and answer our problem statement.

3.1 Different types of knowledge

We have tried to create a dialogue between the different types of knowledge between the villagers and us as academics, as well as between the different sciences and academic backgrounds. By that we have aimed at inviting their explanations and reasonings to be a part of our knowledge, rather than building a hierarchy of knowledge between science and the informant (Watson-Verran & Turnbull 1995:116).

The farmers have a way of explaining the nature in their surroundings and act according to their notions of the nature. As a way to supplement various statements based on empirical data collected by social science methods, nature science methods gives quantifiable and qualitative data to enrich our analysis. As the two sciences in the case of this course complement each other, they do not exclude each other in methods.

3.2 Transect walk & forest walk

Figure 2 Forest walk

We did the transect walk in the beginning of our fieldwork to get an overview of Paon Gahat. The forest walk was conducted later in the fieldwork to get more in depth information about the use of the nearby forest. For both walks we did informal, walk-and-talk observational interviews, about land tenure, land use and natural resources, whilst getting a physical overview of areas of interest.

3.3 Soil sampling

In the Sarawak region the large-scale oil palm plantations are dominating the landscape, while in Paon Gahat the oil palm farms present are all smallholders. While high amounts of SOC is lost from cultivation of large-scale oil palm in the region (Wilms-Posen et al., 2014), we were interested in seeing the impact by smallholder oil palm farms on soil. Also, as pepper is broadly cultivated in the village, our analysis was also directed at seeing potential differences in impact between the two crops.

Figure 3 Soil sampling

To be able to identify and measure soil quality and fertility, we performed volume specific soil sampling from four different sites; two pepper farms, one smallholder oil palm farm, and one secondary forest said to be approximately 40 years of age. As different farming systems and crops, have different impact on soil quality (Van Vliet, N., et al. 2012), we wished to have sites which pre-cultivation had been forest, and this way be able to attribute potential changes to the related crop cultivation. As the two near lying pepper farms had, expressed by Mr. Simon Sujang (personal communication, 2016), distinctively contrasting soil qualities, we were interested in seeing the potential differences in fertilities.

The analyses have been of chemical and physical parameters. The chemical parameters are pH-value, labile carbon via permanganate oxidizable carbon and total carbon and nitrogen content. The physical parameters are texture, bulk density and color. All analyses have been carried out at the University of Copenhagen.

The data were analyzed with ANOVA using Infostat/L (version 2016) statistical software, and bar graphs were calculated using SPSS (version 17).

See Appendix 15 for site-specific data.

3.4 Water sampling

While the Paon River is the river running through the village and the river which the villagers have referred to as polluted, to be able to evaluate the isolated impact of agriculture on water quality, we needed a river where a "clean" baseline could be acquired. For this reason we chose to sample from the Ngayan River, which is source of their gravity feed water supply. This river runs immediately through an agricultural area, with both pepper farms, paddy fields and oil palm areas.

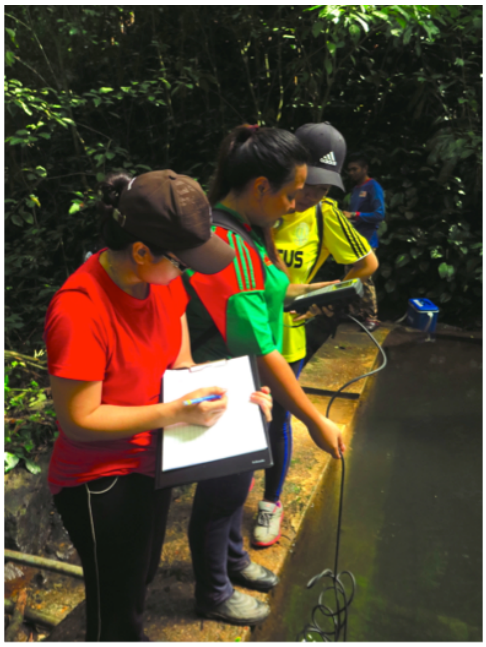


Figure 4 Water sampling

We sampled from three different stations within and surrounding the agricultural area; one station upstream by the village gravity feed, one station midstream amongst cash and subsistence crop farm areas, and one station downstream.

We were interested in finding potential fertilizer and pesticide run-off into the rivers, and pollution levels were indicated by testing and analyzing following parameters; dissolved oxygen, pH, chemical oxygen demand, biological oxygen demand, ammoniacal nitrogen and total suspended solids. By using the Water Quality Index (WQI), one can combine the six quality parameters to give one single classification value (Sánchez, E. et al. 2007).

See Appendix 12 for full values, calculations, and description of parameters tested.

3.5 Global Positioning System

We have used Global Positioning System (GPS) in order to get a visual overview, creating maps and better understanding of the relevant areas are acquired**.** We have used it whilst conducting various walks, water sampling and soil sampling, a GPS was used to mark the route and points of interest. The data was synchronized with Google Earth for creating the maps.

3.6 Semi-structured interviews

Semi-structured interviews (SSI) were conducted during the fieldwork. The SSI's gave the opportunity to get more in depth information and knowledge about subjects of interest to our research. For each of the SSI's an interview guide was prepared containing questions organized in themes. Although the frames for the interview was set, it was also conducted with an explorative view. The interviewees were different key informants, an expert on land tenure and owners of the soil sampling sites.

3.7 Participatory Rural Appraisal

Participatory Rural Appraisal (PRA) is defined as a pool of communication and learning tools (maps, models, matrices, diagrams) used to help local people assess their own reality (FAO, 1996). The PRA encourages the participants to lead the process, and the facilitators only guide them in the use of the different tools (Chambers, 1997).

Table 2 Tasks in PRA sessions

First PRA session (3/3-16)	**Second PRA session (8/3-16)**
Timeline Seasonal calendar Matrix ranking Sources of income	VENN-diagram SWOT - Strengths Weaknesses Opportunities Threats

At the first PRA session, four different tasks were executed. Conducting the seasonal calendar, the matrix ranking and the source of income-task was to learn about the land use

practices in Paon Gahat. Both in terms of the decision-making behind choice of crops, the workload of the different crops throughout a year and general overview of sources of income for the villagers. The timeline was conducted to get an overview of history and important events.

In the second PTRA session the VENN-diagram was used to identify actors and alliances, and place them in relation to the village. The SWOT-analysis gave the opportunity to ask difficult and potentially sensitive questions regarding the weaknesses of and threats to the village.

3.8 Questionnaires

We did a questionnaire to get an overview of the general trends regarding land use, decision-making, governmental initiatives and more. The questionnaires were conducted at the end of the field trip making it possible to adjust and specify the themes after learning more about the village, the villagers and the agricultural activities in Paon Gahat. The purpose of the questionnaires was to get quantitative data through a random sampling, and we took the opportunity through elaborative questions to get qualitative data as well.

3.9 Participant observation

Participant observation has been used throughout our fieldwork. This method allowed us to engage with the community members on personal level, making them comfortable with our presence and gather information about their lives (Bernard 2006:342).

3.10 Collaboration with counterparts

Our group was composed by various academic disciplines from both natural and social science. Coming from different disciplines and cultures can be challenging, but we quickly learned to use it to our advantage, especially in terms of making the methods work together. We had many discussions about how we understood things differently, but these discussions helped us streamline our research and move further in a constructive way.

Box 1 - The importance of a good laugh

From an early stage we found the importance of laughing together. During lunch and in the evening we had time to get to know each other and everyone were able to have self irony on behalf of their academic discipline which helped relieve potential tensions between the natural and social science backgrounds. To quote one of our interpreters: "I like natural science better, they don't ask so many questions. With social science it is always why? why? why?"

4. Results and analysis

4.1 Land use

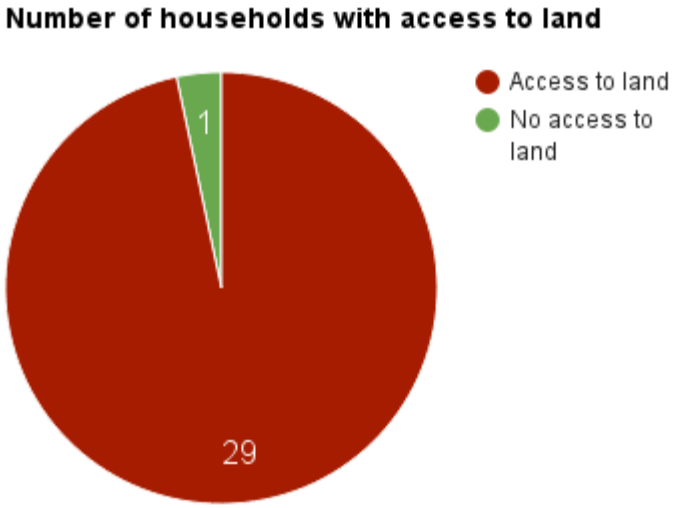


Figure 5 Number of households with access to land

The majority of the households in Paon Gahat are farmers and have access to land within the community (see figure 2). The land is inherited and passed down from generation to generation, where the land is divided between the siblings. This also means that the size of land decreases as it must be shared among an increasing number of people. The villagers farm a variety of crops, both hill and swamp paddy, pepper, rubber, oil palm, fruit trees such as durian, langsat, rambutan and jackfruit, and many villagers grow other fruits and vegetables in their gardens (QUE, TRW). The villagers also hold different kinds of animals such as chickens, pigs, cows and goats, and some have their own fish ponds.

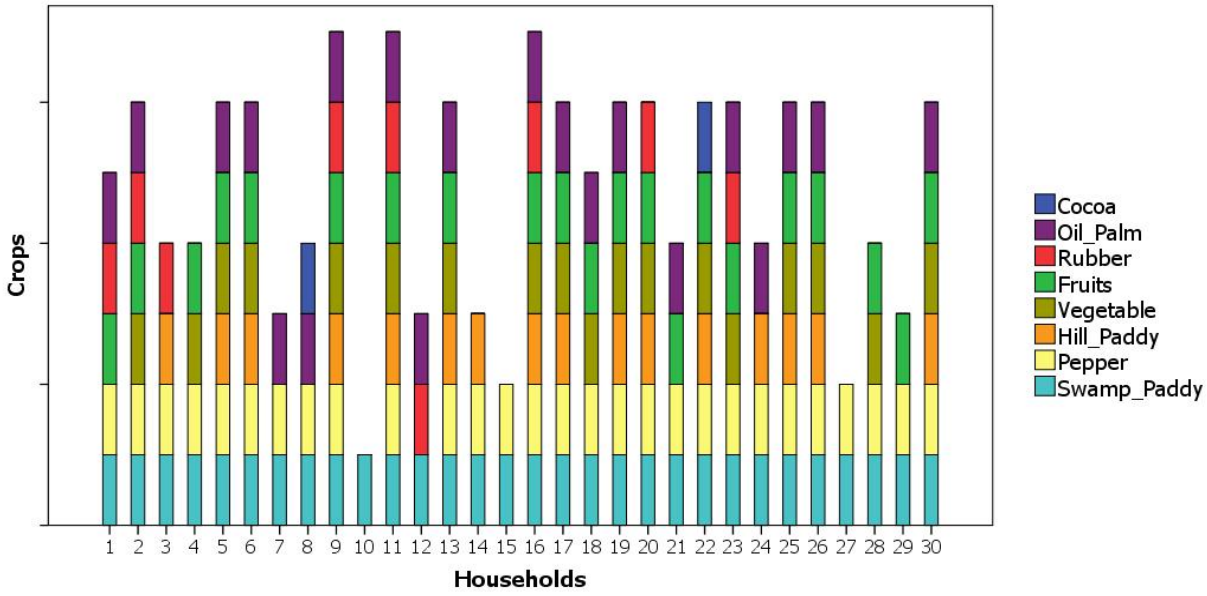


Figure 6 Crop diversification in the households in questionnaire

4.1.1 Main crops

When we asked what their most important crop is, and many told us that they could not answer only one crop (see figure 3), as the crops have different functions. Both hill and swamp paddy are grown and their reasonings for choosing it is: "for own consumption", "for eating", "a food source" and one of the households answering only paddy, said it was "for survival" (QUE). The other important crop is pepper which has a "good market price" and "can be sold and buy other things" (QUE). Two households also answered oil palm "to generate income", but this was in addition to the other crops. In our matrix ranking the the majority of participants from both groups put pepper as their most important crop. All the participants agreed that pepper has the highest market value, and they also agreed on pepper as the main source of income, with the exception of one man who put oil palm (see figure 5).

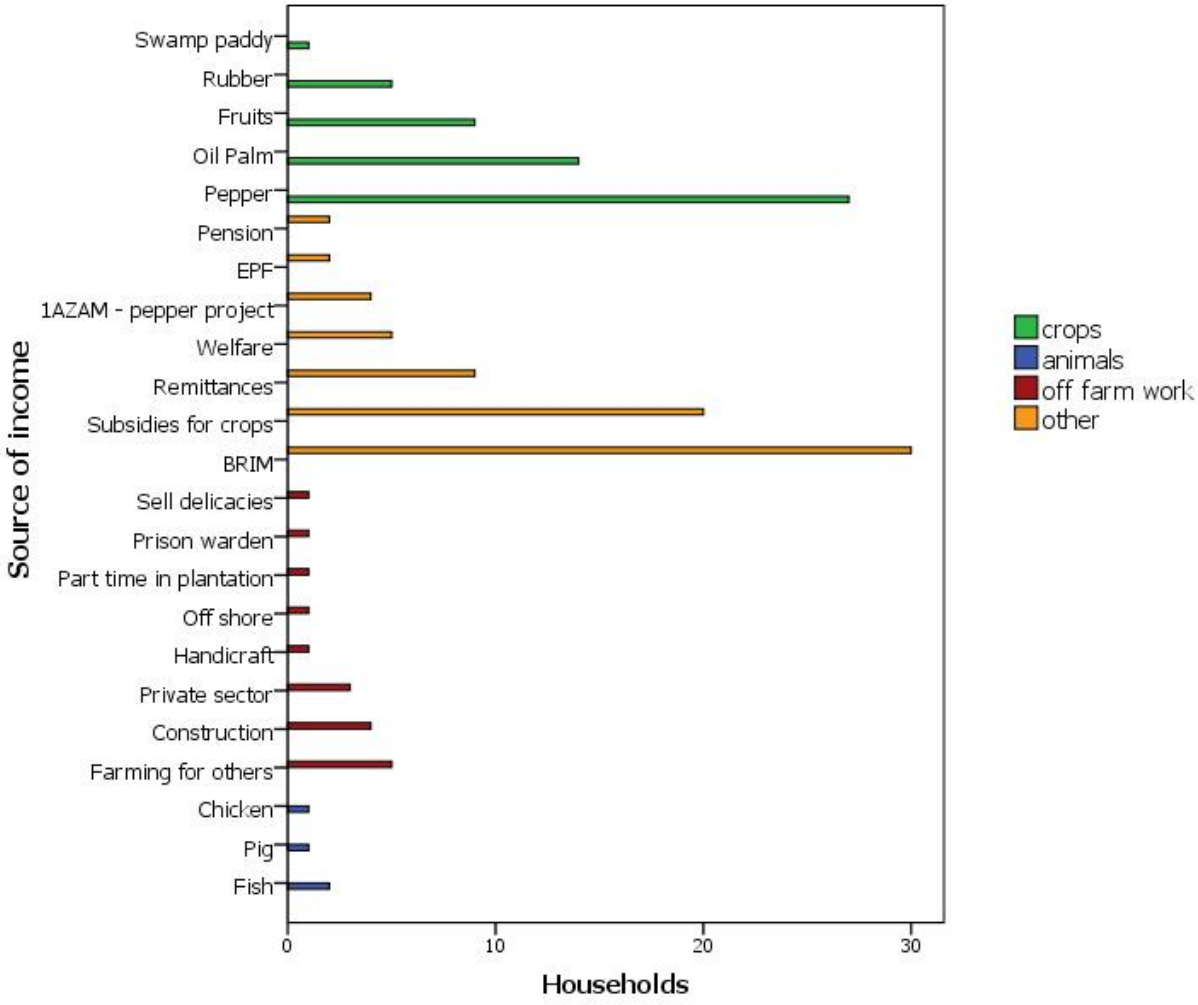


Figure 7 Main sources of income. BRIM is government support for low income households

From both the PRA session and the questionnaire is it possible to see that paddy and pepper appears to be the two most important crops. Paddy for subsistence use and pepper as a cash crop.

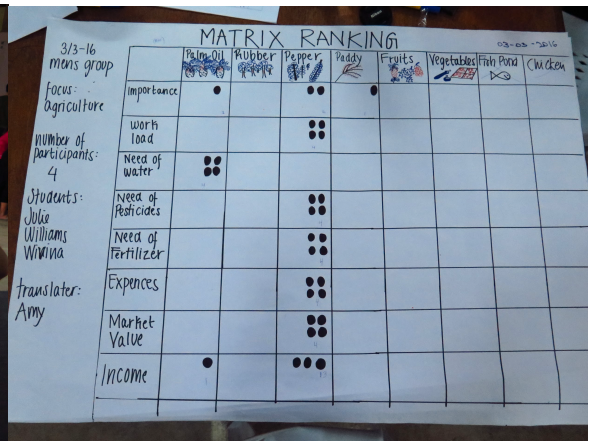


Figure 8 Execution of seasonal calendar (left)

Figure 9 Matrix ranking by men (right)

4.1.2 Paddy

Paddy is an important crop and something that the Bidayuh have been planting for generations (Chua, 2012:73). As told by Mr. Michael, who is in charge of culture and traditions in the village, "Paddy rice was something that could be eaten. Rice gives you a life. Rice can make you sustain your life and your family" (KEY3). Paddy has thus historically been essential for survival and providing for the family, but it is also closely connected to the cultural practices of the Bidayuh.

> "The Bidayuh's believe that the paddy have their own soul. That is why when we eat rice, the whole plate must be clean. We believe that if the paddy is thrown away the spirit will be crying and begging" (KEY3).

The Bidayuh's believe in a range of different spirits, where the *simangi paddy* (spirit of rice) is the most important one, as paddy enables people to survive and "grow fat", so there is a link between the wellbeing of the paddy spirit, and of the people and community (Chua 2012:71).

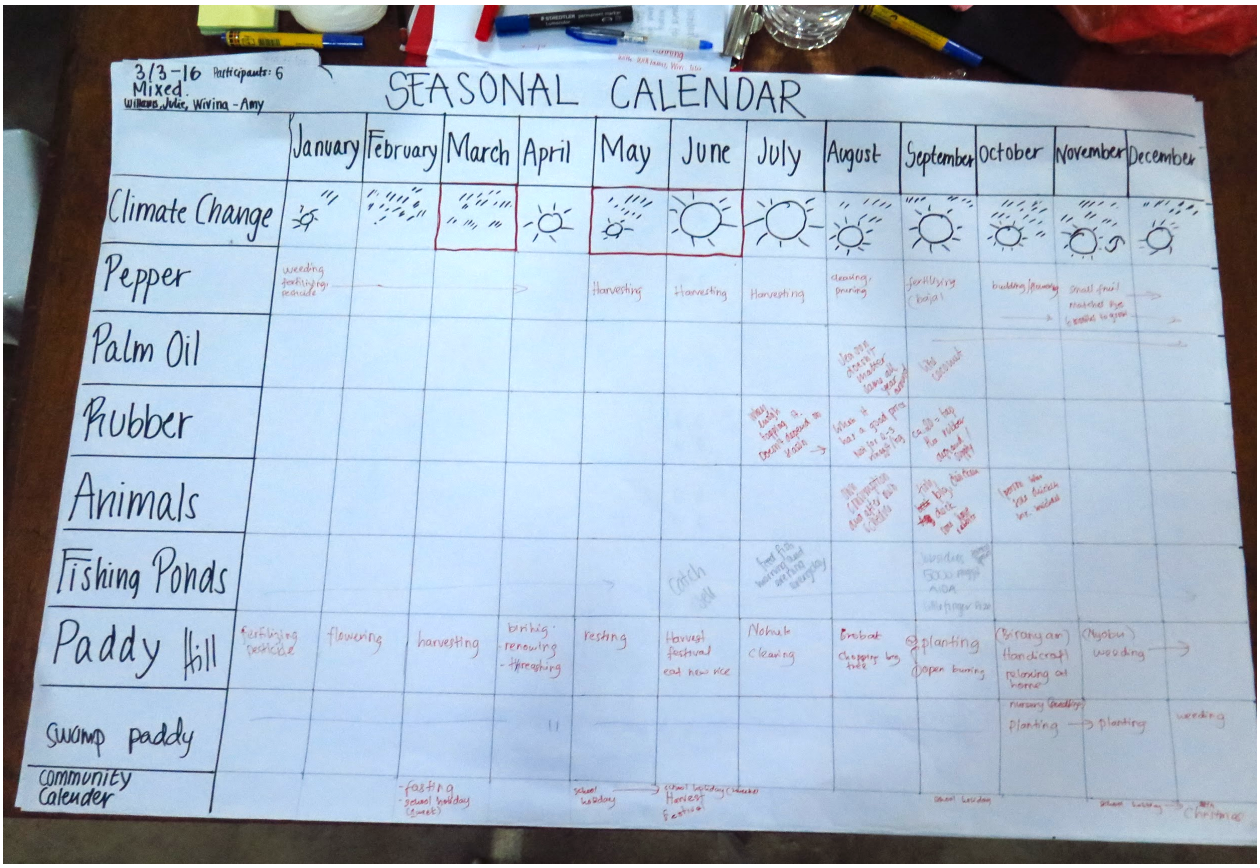


Figure 10 Seasonal calendar from PRA

.

Many cultural activities are closely linked to the cultivation of paddy and the Bidayuh calendar is said to be "following the rice year" (Chua 2012:73). From the PRA seasonal calendar we also learned that the Gawai harvesting festival is continuously an important event celebrating the harvest of paddy, where people return to the kampung for celebrations with their family (see figure 7).

4.1.3 Pepper

Pepper is the most important income-generating crop in the kampung, where 28 out of the 30 households in the questionnaire grow pepper. When people settled in Paon Gahat the main activity was shifting cultivation of paddy, where "they practised slash and burn to plant paddy" (KEY1). In the 1960's this started changing, and people slowly started growing pepper as well because "The price of pepper was good – so they could buy a lot of things" (KEY3). This was a change from traditional subsistence farming towards cash crops providing a monetary income.

> "Pepper is spicy and hot – the dayaks in the old days were paddy planters, not pepper planters. When someone started to plant pepper, the elders didn't like people planting pepper. Because pepper is hot. You can't eat pepper" (KEY3)

Back in the 1960's the price of pepper was RM2 per kg, and growing pepper gave people an income to send their children to school. The price of pepper has since experienced fluctuations in market value, at the moment the price of pepper is considered high with the price of black pepper at RM30 and white pepper at RM50 and is therefore currently profitable (KEY1).

Whilst pepper is a popular crop it is also demanding, it has a high workload and many expenses. From the seasonal calendar it shows that the farming of pepper involves a lot of maintenance throughout the year with cleaning, seeding, application of fertilizer and pesticides, weeding and harvesting as well as drying and processing afterwards. Pepper needs good quality soil to grow good yields and several times we were told (QUE, TRW, SOI) that hill soil was of the best quality due to preferable water retention properties, therefore pepper is prioritized if the owner has hill land.

4.1.4 Oil Palm

In recent years many villagers have started to grow smallholder oil palm. The first to start growing it in 2005 was the headman, and he now has the oldest oil palm farm in Paon Gahat (KEY2). In comparison to pepper, oil palm is the less demanding crop; it can grow in all types of soil, and is often planted on what would otherwise be categorised as bad soil. It does not require much work, mainly in the planting process, and are producing fruits after 3-4 years. Harvesting is normally two times a month (TRW1). The problem related to oil palm is that the harvested product is not storable, and the fresh oil palm fruits have to be processed rather quickly (Cramb & Sujang 2013:134). Therefore in order to have a production of oil palm it is necessary with developed infrastructure linking the farmer to the necessary facilities for processing the fruits. In Paon Gahat the proximity to a SALCRA mill approximately 20 minutes away by car has made it possible for the people to sell it directly to the mill (KEY1).

4.1.5 Rubber

In the past rubber has also been a popular crop, and villagers still have rubber farms, but only tap it when it is economically beneficial, with a high price being RM10 per kg. Currently, the price for rubber is too low at RM3 (KEY1). With the financial crisis in 2008 the prices on rubber went down and this caused many of the villagers to start planting oil palm on their old rubber farms. Some villagers also who keep their rubber farms in order to secure their lands (TRW1, KEY1). Rubber is easy to keep, it does not demand a lot of labour to sustain it, only when it comes to tapping.

Box 2 - A Gaharu way

In Paon Gahat the headman and his brother Mr Michael haves started growing the Gaharu tree. The Gaharu tree (Aquilaria) is a tree native to the rainforest in Southeast Asia. The trees are known for their special dense wood (agarwood) and is also used for perfume or incense (oud), as well as in traditional medicine. The tree has been listed as an endangered species, due to depletion of the wild resource, and it is considered one of the most expensive raw materials in the world.

The headman and Mr Michael imported the seedlings for the Gaharu trees through a contact in Thailand and their trees are still very young. The headman himself has about 400 trees and Mr Michael about 3000 trees. The headman explained us that the planting and maintenance of the trees is quite complex and he has had to learn a lot about it, but he hopes it will be worth it, as he has seen from others previous experience that it generates a very high profit. One of his hopes for this Gaharu-endeavour is also that he might act as a mentor and inspire the other villagers to follow.

4.1.6 Government initiatives

There are different governmental initiatives in the kampung related to agriculture. There are no large-scale development schemes in Paon Gahat, where all are smallholder farmers, instead the government schemes in the kampung are directed at supporting smallholders, providing training and subsidizing inputs, such as fertilizers and pesticides.

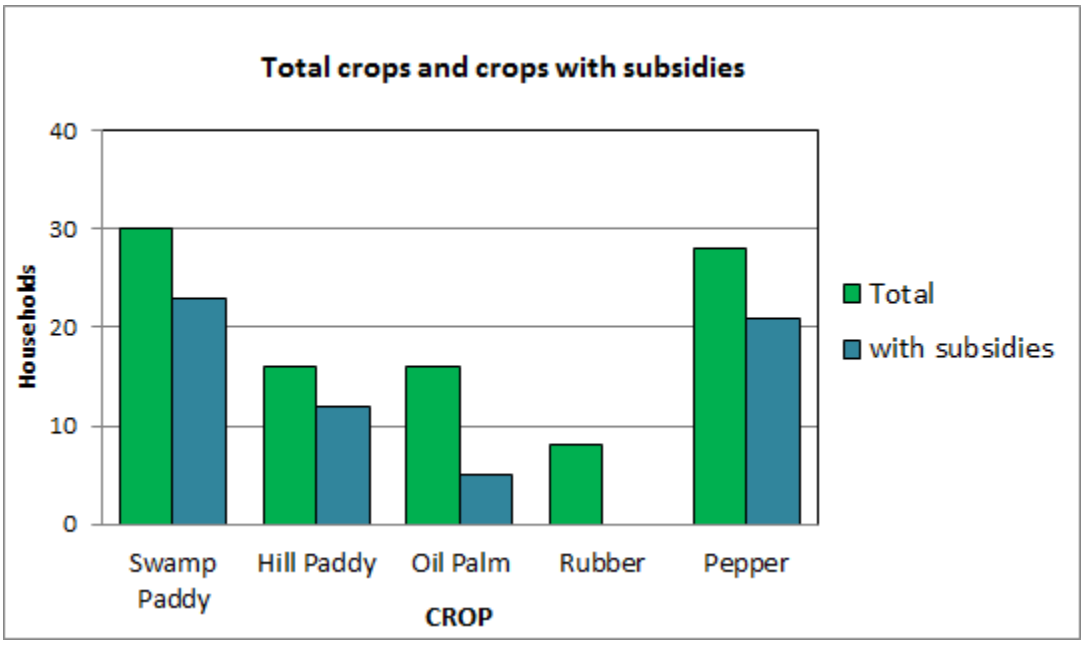


Figure 11 Households growing crops and receiving crop specific subsidies

From this graph it is clear that a majority of households receive agricultural subsidies for their crops. The VENN-diagram showed that MPB is important for the villagers as well as the scheme for paddy. In contrast the MPOB is considered of less importance, possibly due to oil palm not being as important as paddy and pepper.

It is up to the individual household to apply for subsidies, as the Headman told us: "It depends on individual interest, for example the pepper scheme, they have to go to MPB and get the application form it is also the same with oil palm and fisheries" (KEY2). The household fill out the application with information about size of land and previous experience with planting the crops, this will be verified by the headman and then the application is handed to the government office. Some households have not been successful in receiving these subsidies and are frustrated with their applications continuously being rejected. From both the VENN-diagram and the questionnaire there generally seems to be a positive attitude towards the government initiatives, because it "gives benefits", "reduce their burdens", "improve life" and "provides training, free fertilizer and pesticides" (QUE).

Box 3

Subsidies	Smallholder farmers	SALCRA
Subsidies are in this report defined as government-provided fertilizers and pesticides. It is possible for the villagers to apply for subsidies through the different government offices, under the Department of Agriculture (DOA). In Paon Gahat there are: Pepper – MPB Palm Oil – MPOB Paddy – MOA Fish ponds – Integrated Agriculture Development Area (IADA)	Smallholder farmers are defined as farmers of a small piece of land, with reliance on household labour and management, with varying degrees of engagement with agricultural markets. (Cramb & Sujang 2013: 133). In Paon Gahat we find two types of smallholders. The *independent smallholders* who are farmers who are self-financed and *supported smallholders* who receive various types of support from government agencies (Cramb & Sujang 2013:136) In this report we do not distinguish between the two types but refer to them as smallholders.	Sarawak Land Rehabilitation Authority (SALCRA) was established in 1976 with the aim of making in situ development of rural lands. Land leased out by the owners (the villagers) to SALCRA who will then be in charge of the technicalities and the labour in the development of the land by planting large-scale oil palm plantations. The owners of the land will in return receive a percentage of the profits and on completion of the development the owners are to be issued with a title to the land. (Cramb 2011).

4.1.7 SALCRA

There is no SALCRA plantation scheme in the kampung, but it has been discussed at kampung meetings. In the 1990's it was decided to not apply for SALCRA to develop their lands. In 2004 the village did apply for the SALCRA scheme, but was rejected on account that the land was too diversified with crops and topography. The headman told us "they applied because they still have many unused land. They don't want to waste the land" (KEY2). According to the headman it is not a problem for them to not participate in SALCRA as they want to control their lands and what they farm, and therefore only wanted SALCRA to develop their unused land (KEY2). Among the villagers it seem as if there is some confusion when it comes to SALCRA. This became clear in the questionnaires, where a majority of households wanted to participate in the SALCRA schemes (see figure 9).

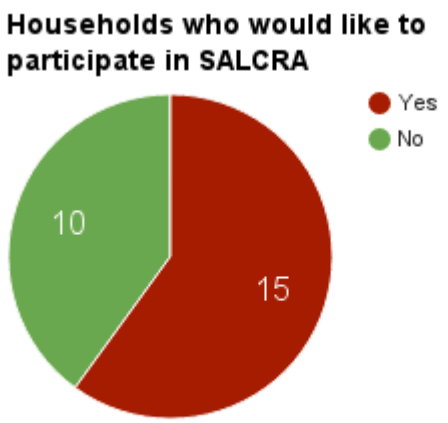


Figure 12 Based on questionnaire

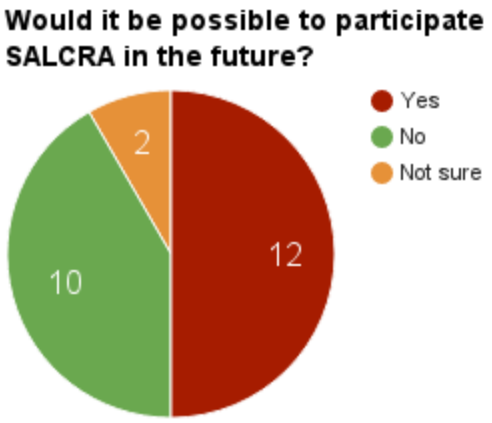


Figure 13 Based on questionnaire

When asked why they would like to participate or whether it would be possible in the future, the answers were conflicting. In one household, he answered that he wants to join in order to receive training, but afterwards he said that there was "No need for SALCRA to teach them. They have learned it themselves. Oil palm is much easier than pepper" (QUE). There seem to be an uncertainty among the villagers about SALCRA and what participation entails (see box 4), where some answers are far from what the headman explained about SALCRA, whereas others seem to correlate more.

Box 4 (QUE)

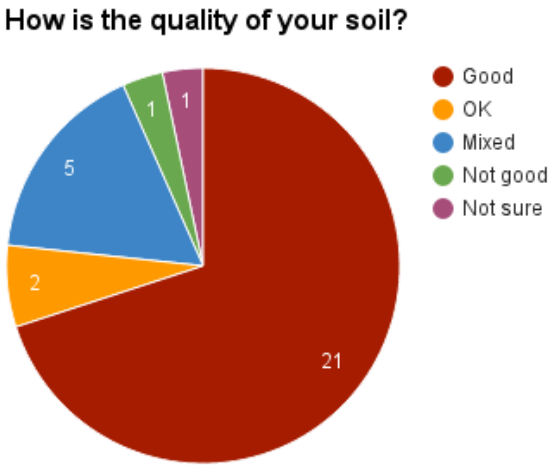
Arguments for joining SALCRA	Arguments against joining SALCRA
"To get free fertilizer" "Others will manage the land and I get dividends" "There is no place to sell oil palm" "Oil palm can be harvested all the time" "People say if you plant it you will get a bonus" "To help improve farming life" "We follow the majority"	"The profit will be divided" "Want to do own farming" "Getting old" "Not enough land" "Do not have the labour to do it" "We follow the majority"
Arguments for being able to participate in SALCRA in the future	**Arguments for not being able to participate**
"It is in the proccess, the application will be approved" "If SALCRA will rent the land yes, for sharing no" "If the government help us" "Maybe if we have workers hired to help us"	"No we do not have enough land" "Previous people did not want it" "Getting old" "Prices in oil palm is dropping"

4.2 Impact on natural resources

The livelihood of the villagers is based on their lands, making them dependent on natural resources, such as the forest, water and soil, in their surroundings. The villagers have experienced different changes to these natural resources and the way they use them. During our fieldwork our research has been guided by the villagers notions of their surrounding environment.

4.2.1 The notions of the villagers

The villagers generally see their soil as being of good quality and are able to grow a variety of crops. From the farmers interviews they told us their farming practices are with "no effect to the environment" in terms of using fertilizer and pesticides. They choose plots based on criterias each crop demand, e.g. hillsides where water control is optimal for pepper, and poorer quality soil for oil palm.



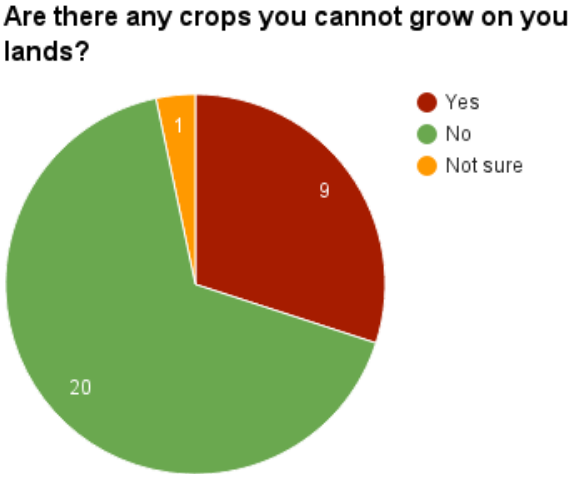


Figure 14 How is the quality of your soil?Figure 15 Crops you cannot grow?

We learned that they consider the Paon river to be polluted, changing their use of the river. The size and flow of the river has changed, there are fewer fish and people don't use it recreationally anymore (QUE). Their explanations is that there is no proper drainage system in the kampung, because the households are too scattered and that a construction

project trying to widen the river failed instead giving them problems with soil erosion (QUE).

We learned that there is a forest reserve in the Aping mountains, gazetted in 1993 after the forest had been subjected to heavy illegal logging in the 1980's and early -90's (FW). The villagers do not go hunting for animals in the forest as much as they used to, only five out of 30 households still do and all agreed that there has been a reduction in wild animals in the area. Many explained this being due to large-scale oil palm plantations in the forest taking away the habitats and the corridors of the animals (QUE). The villagers also collected forest products in the area in and around Paon Gahat, and 18 out of 30 households still collect today, but the majority stated that there has been a reduction in the forest products (QUE).

Inspired by the knowledge and notions from the villagers, we made several hypotheses for our field research. As agricultural activities dominate the livelihoods and landscape of Paon Gahat, we made the hypothesis that it would have an impact on the natural environment in the village, causing soil degradation and water pollution of nearby rivers. In regards to the forest, our hypothesis was that the forest reserve might have an impact in terms of missed opportunities for forest use and logging activities for the villagers.

4.2.2 Forest Resources

The villagers have mixed opinions on how the forest reserve affects their livelihood; While some people appreciate the forest reserve, and "(...) would preserve it ourselves if the reserve was not there", others recognize the missed opportunities for logging and selling the timber (FW, TRW2). The villagers however still use the the timber and other resources in the forest for subsistence use, and often log whatever they need for subsistence use. The reason for this is that the regulations for the reserve are not strictly enforced when it concerns subsistence use, and if caught they will be let off with a warning (Mr. Simon Sujang, personal communication, March, 2016). The village still has areas of forest which are not a part of the reserve, and these areas consists of a mixed geography of forest and plots of agriculture.

4.2.3 Soil Quality

To be able to scientifically measure the impact of agricultural activities on soil quality, the sampled soils were tested for physical and chemical parameters. See appendix 13 for full plot results from the laboratory analysis.

Texture and color

The soil color is a good indicator of mineral weathering, organic matter and soil-aeration (Chesworth, 2008). The soil-color was tested based on the Munsell color charts. The results show four predominant colors (Appendix 13 y 14): Dark yellowish brown (10YR3/4), Brown (10YR5/3), Brownish yellow (10YR6/8), Yellowish brown (10YR5/6). The presence of soils with colors between yellow to brown are indicators of well-aerated soils, with low to moderate fertility, and moderate contents of organic matter establishing good conditions for plant growth (Missouri Center for Career Education, 2012).

Soil texture influences nutrient retention. For example finer (silt, clay) textured soils tend to have greater ability to retain soil nutrients. The texture was estimated using a field method based on the appreciation of the person who evaluates the soil; so that the texture values determined (Appendix 13 y 14) is an approximation of the real value. Based on the evaluation the results show soils with high percentages of clay with textures that range from loam to clay.

Bulk density

Soil bulk density directly affects water infiltration, aeration, root development, and plant growth (Throop, et al., 2012). The mean bulk density of the different sampling sites are depicted in figure 13. For clayey soils, the ideal value for plant growth is < 1.10 g/cm^3, while values > 1.47 g/cm^3 implicate soil compaction problems that restrict root growth and cause reduced crops yields (Arshad M.A., et al. 1996). As the values measured range from 1.1 to 1.38 g/cm^3, it implies that bulk density is not an affecting factor in the sampling sites. Finally the increment in the bulk density in the bottom horizons is attributed to the contents of clay (Stockdale, 2016).

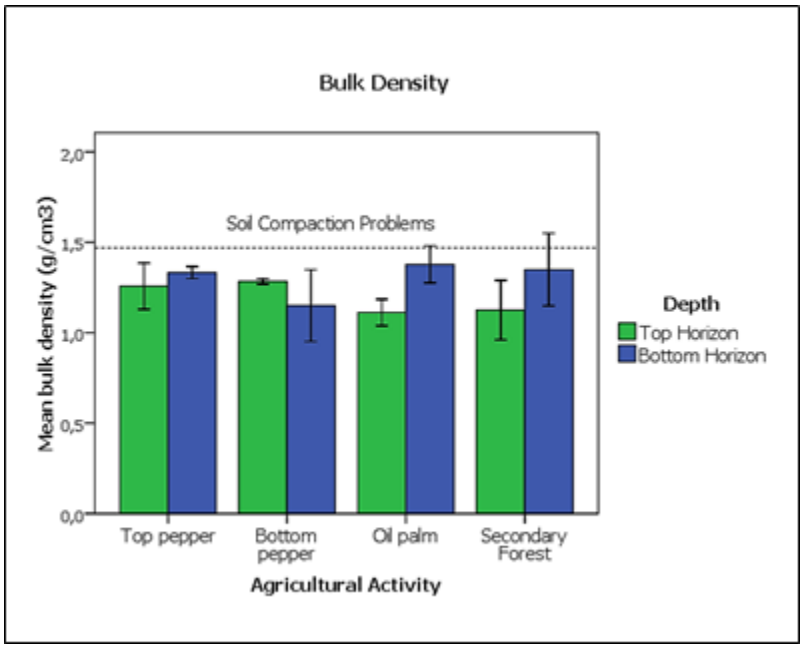


Figure 16 Bulk densities from 4 different land uses at 2 soil depths

pH

The pH is an important parameter that directly influences crop yields, plant nutrient availability, and soil micro-organism activity (USDA, 2013). The soils sampled can be defined such as acid soils due to most of the pH values (Figure 14) being below 5.5 (FAO, 2016). Acid soils are common in tropical regions where the high rates of temperatures, rainfall and the high aluminum (Al) content in soils influence the low values of pH, and its fertility is considered low causing limitations for agricultural production. However, the results suggest pH is not a limitation for the pepper and oil palm plantations tested, as the suitable soil pH for pepper growth is 5.5 to 7.0 (Zu, et al., 2014) and for oil palm is 4.0 to 6.0 (ACIAR, 2015).

The low pH-values found in the secondary forest are a consequence of constant production of organic acids and CO_2 from the decomposition litters on the forest soils (Towhid, 2013).

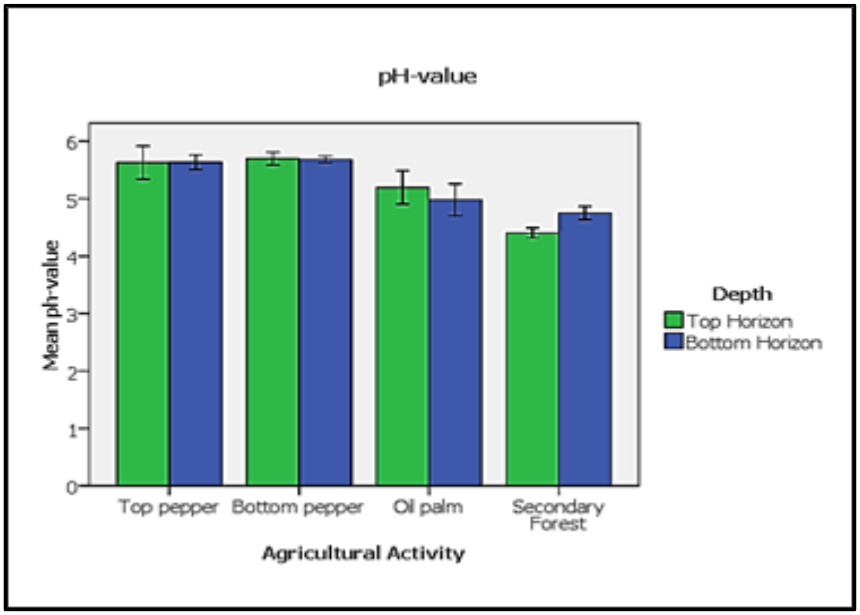


Figure 17 pH-values from four different land uses at two soil depths

Total Carbon (% C)

The results show that the differences in the content of carbon are small between the crops and the secondary forest (Figure 15). Although, according to Guo and Gifford (2002), a reduction in carbon stock of 42 percent when the land use changes from forest to crop is expected. The carbon content is higher in the top horizon than in the lower horizons. This is because organic matter accumulates in the top layer.

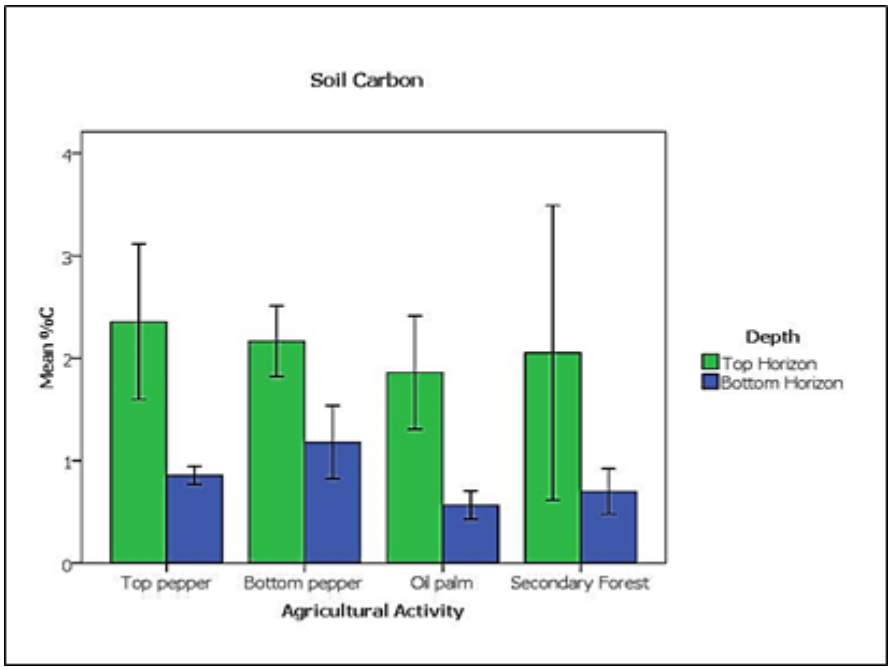


Figure 18 Soil Carbon from four different land uses at two different depths

Permanganate oxidizable Carbon

The variations in the reactive carbon (RC) concentrations are directly linked to changes in land use, and the reduction in the RC-rates could be used as an indicator of changes caused by agricultural activities (Culman, 2012). The results show higher reactive carbon values in average in the top horizons than in the bottom horizons in all cases (Appendix 13 y 14), this result is corroborated by Heiderer (2009) who argue that the levels of RC tends to decrease with soil depth, which is due to the concentration of organic materials and the processes related with carbon are more active on the top soil layers (Heiderer, 2009).

Total Nitrogen (%N)

Nitrogen is the main nutrient for plants, which have a strong impact on soil fertility and crop yields. The nitrogen available for plants is generally low, from 1 to 5% (Sadej & Przekwas, 2008). Contents under 0.2 percent are considered low (Hill Laboratories, 2009), so based on this the contents of nitrogen in the secondary forest (<0.16%) are low and in the farming fields are low to medium (0.17-0.25%) The content of nitrogen tends to be higher in the farming lands than in the secondary forest, due to the constant application of fertilizer in the farming land (Figure 16).

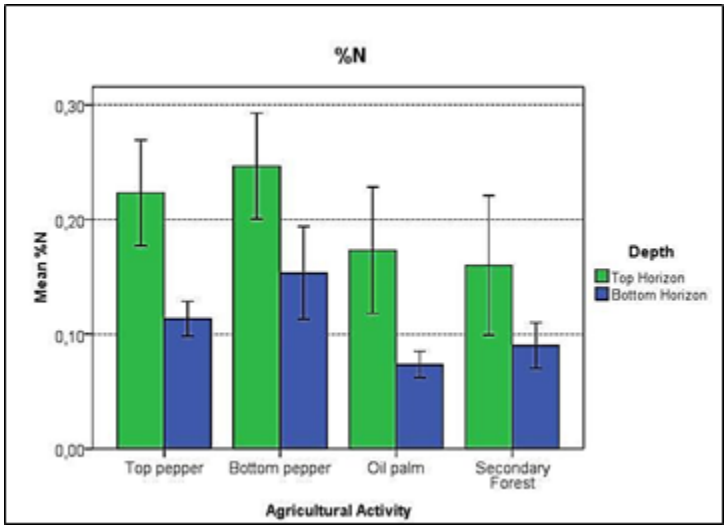


Figure 19 %N from four different land uses at two different depths

The values of nitrogen tend to be higher on the top horizons, and this finding is confirmed by Sadej & Przekwas (2008). In the case of pepper, the probable reason for the different values between the top pepper farm (site 1) and bottom pepper farm (site 2) is that factors

such as erosion have more effect on top soils than in flatlands influencing the movement of nutrients, in this case nitrogen, from the top sites to the bottom sites (Weintraub, Taylor, Porder, Cleveland, Asner, & Townsend, 2015). Another possibility would be that fertilizers were applied more recently (in December) in the bottom pepper farm (site 2) in comparison with the other fields.

The ratio of total organic carbon and total nitrogen (C/N) values below 24 indicate high rates of organic matter decomposition which will result in a temporary nitrogen liberation (mineralization) (USDA, 2011). The results range from 7.25 to 11.80 (Appendix 13 y 14).

4.2.4 Water Quality

After several voiced concerns from the villagers regarding water pollution, a surprising factor was that no one mentioned agriculture as a potential reason for pollution. The Paon River is according to the villagers severely polluted, and is no longer used for drinking, washing or fishing. Making their skin itch if they swim in it, can imply it is a grade III or lower. Reasons expressed by the villagers were poor drainage systems, rubbish in the river and tuba roots, which are to some degree toxic. Table # shows an overview of the classification system and categories the river can be evaluated as, and Table 2 and 3 show results from our analysis of the chemical and biological parameters.

Table 3 Water Quality Index

Class	WQI	Designated Uses
I	> 92.7	Excellent quality. Undisturbed
II	76.5 - 92.6	*Class IIA* - Good water quality, suitable for human use *Class IIB* - Protect sensitive species. Recreational use - body contact.
III	51.9 - 76.4	Moderate water quality. Protect common and moderately tolerant species. Need extensive treatment for water supply
IV	31.0 - 51.8	Poor water quality. For irrigation purposes
V	<31.0	Very poor water quality. Not suitable for any use

Table 4 Results from chemical parameters

Station	Value	WQI Class
1	93.91186	I
2	94.50044	I
3	86.86273	IIA

Table 5 Results from biological parameters

	Station	Volume of sample	Dilution factor	Number of colonies	mpN/100 ml	Class
Fecal Coliform Count (FCC)	1	6 ml	10	0	0	I
	2	6 ml	10	2	333.00	IIB
	3	6 ml	10	3	500.00	III
Total Coliform Count (TCC)	1	6 ml	10	5	833.00	IIA
	2	6 ml	10	7	1166.00	IIA
	3	6 ml	10	9	1500.00	IIA

The chemical parameters show that the agricultural activities only have a minor impact on the water quality in the Ngayan River, downgrading it from Class I at station 1 and 2, to Class IIA at station 3 - downstream from the agricultural area. The water is still suitable for human use, but needs conventional treatment first; boiling.

Results from the biological tests show that for the Fecal Coliform Count (FCC), the lowest classification of the river is III, which means the river would need extensive treatment before being used for water supply. The number of colonies however are low, and results from Total Coliform Count (TCC) show that the total bacteria count is rather low, finally classifying all three stations in Class IIA.

4.3 Decision making

There are several factors influencing the decisions made on land use in Paon Gahat. When analysing how decisions are made by villagers we define them as “village based” smallholders to emphasise that they are operating within a village territory, and working as

a local community (Cramb & Sujang 2013:136). The decisions made over land use in the kampung are complex and work on many levels. We will try to outline different levels as well as the different actors involved.

4.3.1 Kampung law

"(...) adat as "simply their way of doing things"*"* (Chua 2012:62).

The traditional way of organising around the longhouse and the adat is continuously influencing how the villagers make decisions. During our fieldwork we experienced that the feeling of being one unit was quite crucial for the villagers. Here the adat, the traditional kampung law, had a central role in providing rules and guidance. Both the headman and Mr. Michael, explained that the adat is everything (KEY2). The adat can be seen as working on different levels and "In Bidayuh societies, *adat* is broadly understood to maintain harmony within the community and to preserve its general well-being" (Chua 2012:62).

Harvesting of paddy is, as also mentioned earlier in the report, guided by the adat. The Bidayuhs take turns in helping with farming in each other's paddy fields and they all gather for ceremonial and festive events (Chua 2012:73). This communal feeling also transcends into other aspects of kampung life, for instance in communal projects such as renovating the community house where all the villagers will partake (KEY3).

Besides from being guidelines to the harvest and other practices, the adat also include a set of taboos. The taboos in the Bidayuh culture should be understood as written or unwritten rules of do's and don'ts that guide the social life in the kampung. When interviewing Mr. Michael he gave an example of how fining people can help maintaining the harmony in the village (see box 5).

Box 5 - Taboos and the feeling of shame

"When it comes to fining people, the whole kampung will know. It is the feeling of "malu" (shame). No Bidayuh like to be fined, even if it is one ringgit. […] Young guys they drink but once they start a quarrel, one punch, there is no excuse for not paying the fine.[…] A punch or a slap is a taboo in the kampung, because if the fellow don´t want to pay for the fine, the whole kampung will have bad luck. We want to keep the peace you know. Once you do not fine them a lot of things may happen. Crops don't grow well, people get sick and that may happen many many times in one year. So people will say, you know what? Three, four, five, six, seven people died this year because this guy refused to pay the fine" (KEY3)

By not adhering to the taboos, a bad decision made by one person in the village can affect the whole village, bringing about the bad spirits and disturbing the harmony. Through the adat and the taboos, there is thus a necessity of collaboration among the villagers, in order to prevent bad things to happen to the kampung.

4.3.2 One for all and all for one in making decisions

In 2008, the headman introduced a committee JKKK (Committee of Development and Safety) with the aim "to unite the village so that they can live harmony in this village in terms of safety and development" (KEY2). The JKKK include different members from the kampung in charge of an area e.g. health or agriculture.

Whenever there is an issue to discuss in the kampung the JKKK meet and try to come to an agreement, and if it is an issue of special interest to the whole kampung they will call for a community meeting. Here decisions will be made by majority vote and according to Mr. Michael the Bidayuh's are sometimes too democratic (KEY3).

Whenever there is a disagreement there seem to be a certain type of negotiation taking place. As an example Mr. Michael explained:

> "We built a new dam for the new pipe. One says that a part of his land will be involved. You don't agree, but the road to your land is my land – so what. If you refuse to give the land for the dam, you are not going through my land to get to yours" (KEY3)

From this example it appears that a negotiation is taking place at the community meeting, where mutual obligation also becomes a mutual dependency, in the search for the best solution for the whole kampung.

Regarding gender there is only one woman in the JKKK and that is Mdm. Irene, the head of the Women's Committee. She explained that men are best represented both in the JKKK and in the community meetings as they are head of the households and "whatever is good for the men is also good for the women" (KEY4)

The level of collaboration and common agreement in the kampung is interesting in analysing how they get access to resources. Through organising as one unit they can obtain more benefits from the government.

4.3.3 The Gatekeeper

The headman has a central role in access to resources, both in terms of relations to actors outside the village, but also in guiding the traditional law in the kampung. The headman is given the authority to act on behalf of the interests of the kampung. Given that he is the one representing the kampung to the outside, he is also the link that knowledge and social relations go through.

As head of the kampung he is the one being invited to meetings on government initiatives, subsidies and agricultural programs. Thereby he obtains all the knowledge on how to apply for the subsidies, how the programs work and why they are beneficial. This puts him in a position where he can distribute knowledge and filter what is going in and out of the kampung. It is through the headman that the villagers get access to knowledge and government initiatives.

The headman is also guarding and guiding the traditional law in the kampung. When there are questions or uncertainties in regards to the adat and the traditional law in the kampung the villagers go to the headman. It is also him who is settling disputes in the kampung.

4.3.4 Mutual benefits

In relation to the negotiation of access via other social relations, the headman participate in meetings with the local politicians, and especially through the district politician YB Martin has a good connection to the government. It appears to be a mutually beneficial relationship, where the villagers get help from the government, in terms of building facilities and providing subsidies. and in return the government gets loyal support from the kampung as "the headman already promised to this government that all the people will vote for the government side" (KEY4).

It can be argued that by organizing themselves under the headman, the villagers can obtain access to more resources and that it might be crucial to how decisions are made within the kampung. It appears that by making alliances through the headman with outsiders such as politicians, each household get the opportunity to decide how they want to use their land, while benefitting from the access to the resources such as subsidies.

The decision-making in Paon Gahat is on many levels shaped by the adat and taboos, where collaboration is an essential part of keeping the harmony in the kampung. The decision-making in the kampung in relation to land use work both on a household level, community level but also through the headman functioning as a gatekeeper to the outside. We have tried to analyse the willingness and the benefits of working together as one unit and negotiating within a political system, where the headman gives access to different government initiatives and in that way the villagers have access to different resources.

4.4 Influencing factors

The decisions of the villagers are conditioned by a variety of factors that all interrelate and influence the choices of land use. We have identified a number of key influencing factors to the choice of agricultural livelihood strategies, even though it is not possible to say that these factors are all of equal importance to the villagers or households.

In the above part we described how the adat and the community might influence the decision-making, so in the following we will elaborate on other influencing factors.

Figure 20 Influences to choice of crops

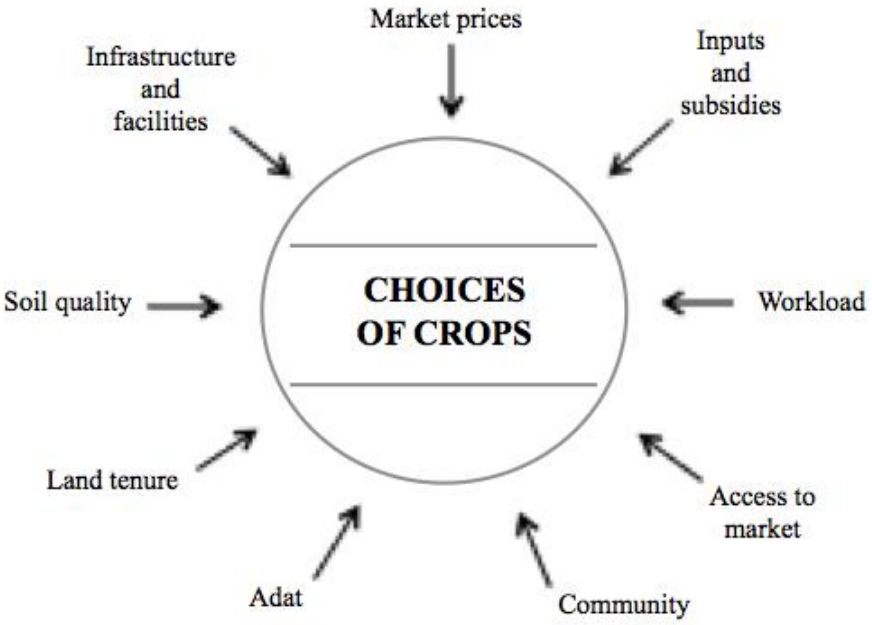


Figure 21 Influences to choice of crop

4.4.1 Market prices

Market prices influence which types of cash crops the villagers farm and also show how vulnerable the villagers are to fluctuations in market prices. We were told by the headman that "range in income is not consistent and moves up and down, it depends on economic market prices" (KEY1). Therefore when there is a change or sudden drop in trends, their vulnerability might increase, which was seen in the case of the sudden drop in rubber prices, where the villagers stopped tapping the rubber or shifted to oil palm.

4.4.2 Land tenure

Land is important to the villagers, as it is from the access to land that they derive their livelihood. The Bidayuh have a tradition as farmers, and the land holds great value, as land provides a security for the household and for the future. From Prof. Gabriel we learned that the land holds a greater value to the Bidayuh than money, as their ties to the land are also affected by their cultural heritage and sentimental value.

The Bidayuh as natives hold a special customary right to the Native Customary Rights (NCR) land, through their status as natives in Sarawak which can be understood as an access through social identity.

Box 6

Land Tenure	NCR	DBNA
Land tenure is understood as the relationship, whether legally or customarily, with respect to land. The rules of tenure define how property rights to land are to be allocated within societies, individually or collectively. They define how access is granted to rights to use, control, and transfer land, as well as associated responsibilities and restraints (FAO, 2002).	Native Customary Right land is a classification of state land that has been used by native people before 1958. There are two types of NCR land, the first is with a title where the natives have proved that the land was used by them before 1958 and therefore they hold the right to it. The other type is without a title, which is the majority of NCR land in Sarawak. Without a title the land is state land and the natives can risk government interference (EXI).	Dayak Bidayuh National Association is supporting the documentation of the NCR land. DBNA assist the Bidayuh villagers that want to document their land, by helping them measure it. DBNA use the same method as the Land and Survey Department. The documentation is then used to apply for the land title and the Land and Survey Department will then confirm the data before the issue of the land title. Paon Gahat have done their land survey through DBNA (EXI)

Insecurities about land tenure are often a reason for participating in JVC's or large-scale governmental schemes such as SALCRA, where a part of the agreement is that the villagers will receive titles to their lands after leasing it out (Prof. Gabriel, interview).

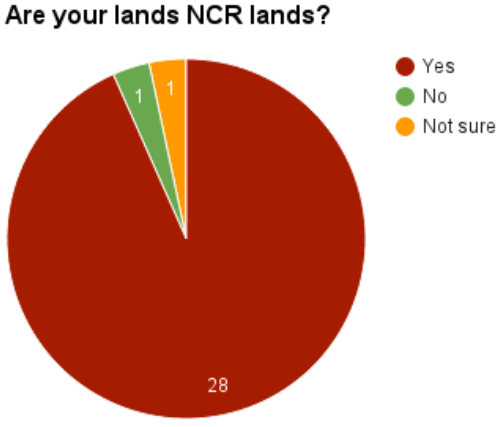


Figure 22 NCR lands

In Paon Gahat we found that the villagers were generally not concerned about land tenure. Rather we found that the villagers felt secure about their lands (QUE) even though some told us they keep their rubber trees as a safety and to prevent their lands from being taken away. A reason for why they

feel secure about their lands, might be because they have had access to a survey, as the lands has been surveyed by the DBNA. Many villagers explained that they are in the process of getting the titles through the headman. The reasons for not worrying might therefore be, that they believe that they have access to getting the titles through the headman and the DBNA. This might be one of the reasons, that they are not trying to get land titles through any schemes.

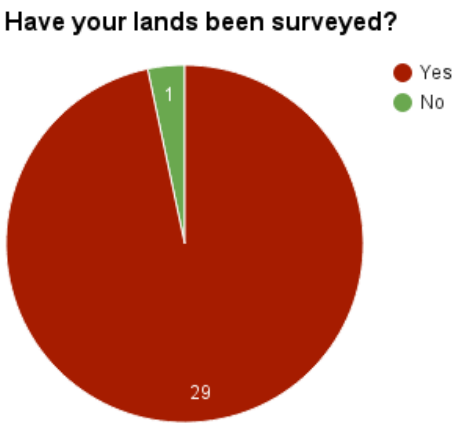


Figure 23 Land survey

From the headman we learned that the process of getting the titles is long. The status now is that half of the kampung land has been proved as NRC land whilst the other half is still in the process. There can be different explanations to this. First of all it is a possibility that some of the land might not have been used before 1958, seeing as the population of the kampung has grown from 16 households in 1953 to 125 in 2016. It is not uncommon that people have been cutting down the forest to clear lands for farming.

Another reason can be difficulties in proving that the land has been utilized prior to 1958. All of the land needs to be declared as NCR land for the villagers to be able to get titles to it.

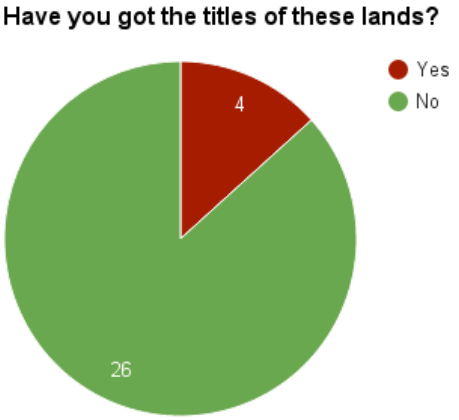


Figure 24 Land titles

4.4.3 Infrastructure and facilities

Infrastructure is crucial in terms of land use possibilities. Getting road access to Paon Rimu in 1977 allowed for easier access to a market where they could sell their crops. Since 1999 they have had a tar sealed road which provides a quicker and more stabile access to markets, schools and medical facilities. The road can be said to provide opportunities, it is thus an improvement of their physical capital.

The road has also made it easier for them to access some of their fields further away by motorbike, thereby increasing their mobility within the kampung area. This allows them to

grow a variety of crops further away, such as oil palm, since it is also easier to access the field for farming and to transport the products afterwards. Their farming practice on these plots of land has thereby become less laborious, whilst at the same time increasing their productivity.

Through a government programme they have received blue water tanks, providing them with water-access year round, making them less vulnerable to periods of drought. This way they also have access to water for agriculture, increasing their chances of harvesting high yields.

4.4.4 Access to market

Access to markets is another important factor in terms of choice of land use, as it affects the ability to benefit from the natural resources. To be able to profit from it, one must be able to sell it.

Access to a market can also be seen in the form of a middleman who buys the products. The middleman functions as the link to the market, and from the VENN-diagram the participants ranked him highly. Another way to gain access to a market is through participating in the different governmental schemes as they provide training and subsidies, and in return expect the villagers to sell their crops to them.

We learned from the Headman that the villagers are often hesitant to engage with farming new crops, *"*the culture of Bidayuh is they see first other people do it, and if the crop give good income then the villager follow it*"* (KEY2). Thus the headman was the one to start farming oil palm, and when people saw that he did well they followed him. In the same way he hopes it is possible to find a market for the Gaharu (See box 2).

4.4.5 Inputs and Subsidies

The villagers use inputs such as fertilizer and pesticides for most of their crops, and as we learned from the matrix ranking this is especially for paddy and pepper. The inputs can be expensive and they need financial capital, to buy these inputs in order to grow the crops. When the villagers are a part of development schemes such as MPB they can receive subsidies in the form of fertilizer and pesticides, thereby relieving their economic burden. By use of these subsidies they might increase their yields and natural capital, which can

lessen their vulnerability. The access to subsidies is therefore also a factor to be considered in relation to land use. In the first PRA they also mentioned subsidies as one of the most important sources of income.

4.4.6 Soil quality

The villagers are very aware of the fertility of their lands and it plays in important part in why and how they choose to farm it (FAI+TRW). The primary reason for choice of crop is based on the quality of the soil. Where pepper is grown in the most fertile soil, oil palm can grow in any type of soil. So if the villagers have a piece of land where the soil is too poor for crops such as pepper or paddy, it will be an option to grow oil palm instead. They consider themselves rich in natural capital in terms of availability of favourable soil and that the have good opportunities to grow the types of crops they want to.

4.4.7 Workload

Work also plays a role in terms of land use and this is mainly in terms of labour. The individual households farm crops, where workload correlates with availability of labour. It is therefore dependent on the number of members in the households who can contribute to the farming or the availability of help from others.

The farming can be subject to customary rules of labour exchange to coordinate farming activities where they are helping each other in the fields (Cramb & Sujang 2013:136). This we learned applies to the way the villagers farm paddy, and during our fieldwork we saw, how they were helping each other with the harvesting of paddy in the fields. In this way there is a communal support system, where they all partake in the farming of paddy, which decreases their individual vulnerability. It show a strong social capital in the form of a communal network. An interesting observation was that pepper is considered to be the most heavy in terms of workload, but it doesn't seem to matter as the profits derived from the crop are high.

5. Discussion

5.1 Diversification

According to the questionnaires it is not uncommon for the households to have members living away from the household. From what we learned through the sources of income-task, this would mostly be because of either education or work. Diversification in this section in terms of income "can act both as a safety valve for the rural poor (…) and as a means of accumulation for the rural rich" (Ellis 1998;2) We have identified three consequences of migration that might affect agricultural decisions. Firstly having a member living away affects the labour available for farming – the same workload for fewer people. Secondly on the other hand sending a member to live away from the mamba is one mouth less to feed. Finally if one is leaving the mamba to work, remittances in terms of money may be sent back to the mamba.

As can be seen on figure 3 several respondents had multiple types of crops. In relations to the livelihood framework growing subsistence and cash crops (either one or both) will reduce the vulnerability. Growing subsistence crops will make you independent from the monetary market for the basic survival in terms of food, but can still be vulnerable towards natural disasters and seasonality regarding draughts and heavy rain which the villagers identified as threats (see PRA8). Growing cash crops will create an income for the household but will make you vulnerable to fluctuating market prices.

Growing either multiple subsistence or cash crops will make you less vulnerable to a bad yield or the price drop of a certain crop – then you will have other crops to rely on.
Whereas a mix of having the subsistence crops for basic survival, makes it possible to generate an income from the cash crops. The income from cash crops (this also goes for the remittances) will increase their financial capital. The larger financial capital can allow them to buy new crops, additional food, going to a health clinic, education and to buy cars or motorbikes and the gas it requires. Basically it can allow them to accumulate money for unforeseen expenditures, for investment in the members of the household and for future investment in regards to agricultural practices. But all this comes down to what resources are available to a given household in the village in terms of land, soil quality, knowledge on how to grow the crops and the financial capital to support it.

5.2 Impacts on natural resources

In a rural community as Paon Gahat the natural capital is as important, if not more, as financial capital in choice of agricultural livelihood strategies. Without this capital, the means to create a livelihood are severely limited.

Forest resources had before we left Copenhagen been stressed as an important topic in Paon Gahat. Information from villagers pointed towards it not being such a big issue. Some of this can be explained by their relatively secure current livelihoods, with paddy for subsistence, and rather profitable prices on pepper. With oil palm slowly emerging as a new cash crop, the missed opportunities for logging does not stand out in the community. This might also be due to mixed understandings of how the terms and regulations around the reserve actually function. Several villagers risk the punishment by entering the forest and using what they need, while some villagers believe they are allowed to utilize the forest for subsistence use. There might be misconceptions and knowledge gaps that downscale the importance of forest debates.

As the villagers' own view of their soil quality was that it was good, our results concluded that the soil is of moderate quality. This can also be confirmed by the low to moderate yields. The pepper yields in Paon Gahat of 600-1200 kg/ha (FAI1+FAI3) are low in comparison to the average pepper yield of 1850 kg/ha reported in Sarawak (Rosli, et al., 2013). For oil palm, the yield is also low compared to the average in Malaysia, 1.42 tons/ha in Paon Gahat versus 3.9 ton/ha nationally (Yuen, 2012). Whether or not the villagers are aware of normal average yields is unknown.

While we were expecting to find a correlation between longer cultivation of crops and soil degradation, our results show no correlation. The reasons for this can be that the villager's farming practices might take into consideration environmental impact of the cultivation, in terms of tillage and fertilizer use. Also, as for oil palms, one of the major issues with nutrient degradation is due to soil erosion, where the most nutrient rich top layer of the farm is eroded, misplacing the nutrients (Lord, S. & Clay, J., 2006). There was no sign of current erosion in the oil palm farm we collected samples from, as the topography was not of the steepest kind.

Figure 25 Map over oil palm soil sampling site, with topographic values

This might be one of the reasons why the results from our POX-C analysis did not show lower values of labile carbon from the oil palm site. The pepper sites showed higher values of nutrients in the site located at the foot of the mountain in the flat lands, than the site situated higher in the hill side. This is explained by soil erosion, where according to literature (Atucha, A., et al., 2013), the nutrients experience a slide from top of the hills to the bottom. An additional explanation can be the fact that the two sites were fertilized at different months; the top site with lower values was fertilized last September, almost 6 months prior to sampling, while the bottom site was fertilized in December, 3 months prior (SOI1+SOI2, March 2016), causing higher nutrient values in the latter. Both pepper farm sites have higher values for all analyzed parameters than the oil palm and the forest. This can as well as being attributed to fertilizer application, also show signs of the assertion that the villagers choose better quality soil for their pepper cultivation, and soil of lesser quality for their oil palm cultivation.

As for the baseline value from the forest, the nutrient levels are low, which are both expected and unexpected. Higher SOM would imply bigger amounts of SOC, than cultivated plots. The forest had the lowest value for POX-C and %N, which corresponds with literature saying tropical soils have more acidic soils, limiting nutrient amount (see pH-results, appendix 13). The forest had higher content of %N in the bottom horizon than in the same horizon at the oil palm site. This can be explained by disturbance in the oil palm soil, from pre-planting tillage and terracing (Tan, C., et al., 2015).

Parameters such as color, texture, bulk density have not been affected by the agricultural activities, since these parameters are more influenced by soil components such as silt, sand and clay. However, the ANOVA analysis ($p>0.01$) show statistical differences in parameters like %N and pH. Based on the results of the different parameters assessed the soil fertility could be defined as moderate.

While the Paon River is perceived as severely polluted, we were expecting the agriculture to have a higher impact on the nearby rivers. The results show that the agriculture only have a minor effect, downscaling it from class I to IIA according to the WQI-classification. This could be explained by efficient farming practices, but also by the fact that it was not season for clearing, weeding, application of fertilizer and pesticides in the agriculture - several of the polluting elements. The time of sampling was also in heavy rain season, and could also impact results, especially at station 2 and 3, in terms of wash-off and dilution of samples. Research done at different months could show very different results (Bau, J., et al., 2003).

5.3 Interrelations between land use and decision-making

From our analysis we can argue that the decision-making on agricultural livelihood strategies of the villagers in relation to land use is influenced by several factors. Most importantly it is aimed at decreasing their vulnerability and strengthening their ability to benefit from their access to resources. Trying to make themselves less vulnerable each household use the land available to them to grow the most suitable crops, whilst considering factors such as soil quality, expenses, workload, access to government subsidies and market prices among other factors mentioned in the report.

Land is of great importance to the villagers both in terms of them as being farmers but also in terms of their cultural heritage. The traditional adat influences how decisions are made in order to keep the harmony in the kampung. By not partaking in large-scale government schemes as otherwise encouraged by the government, they have had to follow different livelihood strategies. The villagers seem satisfied with being smallholder farmers. In that way they can decide what to grow (they have access to natural capitals), they feel secure about their lands (they have access to land), they are able to generate an income to support their households (they have access to markets and economic capital) and they have a good access to benefit from resources through the headman. It thus appears that there are no major reasonings, or specific vulnerabilities, that would incline them to participate in SALCRA or any other large-scale plantation schemes. The independence connected to smallholder farming seems to be of value, as they have the ability to decide over their own lands and land use.

In creating a livelihood the villagers put great value on their lands. We have assessed their agricultural strategies by looking at their assets and types of access, and searched to identify the interrelations between the agricultural strategies and the decision-making on land use incorporating the different influencing factors.

5.4 Reflections of theoretical approach and methodology

In this section are reflections of the report's theoretical approach and methodology.

Given the length of the report and the short time to conduct research it has not been possible to reach the full scope of the sustainable livelihood framework. Optimal would be interviewing more people and tried to further elaborate the different elements of the framework.

We haven´t been able to go more into depth with the access theory, instead we have been able to use the concepts from the theoretical approaches to guide and frame our analysis.

For the PRA sessions only a few people compared to the population of the kampung attended and they might not be representative of the whole kampung - and it also turned out several of them were closely related and they might have been in the elite of the kampung since some of them were in the JKKK committee. Finally there are uncertainties regarding the data collected from the women's matrix ranking. On some of the variables only eight of the ten participants have ranked.

In the questionnaires it became apparent that not all of the questions had been clear enough in the way they were phrased which resulted in some inconsistent data. Through all of the methods used the language barrier might have influenced the data, since we have not been able to understand the translation or if words and concepts might have gotten lost in translation. The times we have not prepared the interpreters before interviews, they might not have been sure of what kind of data we were looking for and thereby have left out important information or the other way around not translated things they thought were irrelevant.

Uncertainties from the soil sampling method are diverse. As neither of the group members had extended background from soil sampling, the method might not have been conducted completely according to protocol. Also information about sampling sites have several times shown to be incorrectly stated by the landowners, due to translation and conception errors. The results from the POX-C test show high standard deviation values caused by the low number of samples used for the analysis, and due to the sensitivity of the test. We also obtained a negative value (-72 ±124.71) in the bottom horizon from the bottom pepper field, which could be attributed to a mistake in the samples processing during the analysis in the laboratory. Another laboratory mishap is the loss of one horizon sample in the C/N test, where the aluminum foil was broken.

To be able to conclude on real fertility state of the soil further sampling would be needed to get the statistical average of each site. Also, analysis of phosphorus and potassium would be needed to get a more total depiction of nutrient content in soil.

As for water sampling the time of sampling might show a skewed result, as it being rainy season might cause a high wash-off from the fields into the rivers. The river also only runs

through a limited agricultural area, and does not reflect the agriculture in Paon Gahat as a whole. As fertilizing season for most crops are in the fall, it might also not reflect the full impact.

6. Conclusion and perspectivation - Navigating in a developing world

Paon Gahat has not been isolated from Malaysia's march to modernity and the modernisation of the agricultural sector. The life of the villagers has changed tremendously since they settled in the jungle in 1946 and so has their agricultural practices. Though the improvements in infrastructure they have moved from isolation to an interconnectedness, not only on a local level by being able to reach the market in Serian, but also in terms of being a part of the global market and thus also vulnerable to global shocks and trends. Their most basic decisions, such as what to farm, are conditioned by global demands and fluctuations in market prices. At the same time we see that their agricultural practices are still influenced by traditional adat and a communal feeling. There seems to be a clash between the development of a globalised world contra the traditional ways of the longhouse-bidayuh culture. In Paon Gahat they seem to be balancing between these two opposites in their agricultural livelihood strategies. The subsistence farming of paddy, fruit and vegetables enables them to survive, whilst the farming of cash crops such as pepper, rubber and palm oil provides them with a monetary income to cover expenses. In recent years the government has promoted oil palm as the crop of the future, especially through the establishment of large scale oil palm plantations, but here Paon Gahat have adapted to this development, by growing it independently as smallholders. There is a vulnerability connected to leasing all the land to a scheme and solely growing one crop, because if it fails, the villagers will be left with no other agricultural options for securing their livelihoods. Instead the villagers of Paon Gahat are holding onto their lands and diversifying their land uses, in order to decrease their vulnerability. They are aware of the possibilities of farming different cash crops and interested in generating an income, whereby they are able to provide for themselves and contribute to the economy of Malaysia. In their agricultural livelihood strategies they have a freedom to decide themselves over what crops to grow and they have been able to farm in a manner that is without damaging effects to the natural resources in their surroundings.

References

ACIAR, 2015. *Sustainable Management of Soil in Oil Palm Plantings.* [Online] Available at: http://aciar.gov.au/files/pr144-web.pdf .[Accessed 28 03 2016].

Arshad M.A., Lowery B., and Grossman B., 1996. *Physical Tests for Monitoring Soil Quality.* In: Doran J.W., Jones A.J., editors. Methods for assessing soil quality. Madison, WI. p 123-41.

Atucha, Amaya, et al., 2013_,*Soil erosion, runoff and nutrient losses in an avocado (Persea americana Mill) hillside orchard under different groundcover management systems*. Plant and Soil 368.1-2 : 393-406.

Banerjee, Nina & Kristina P. M. Bojsen., 2005. N*egotiability and limits to negotiability - land use strategies in SALCRA Batang Ai Resettlement Scheme, Sarawak, East Malaysia.* Geografisk Tidsskrift, Danish Journal of Geography. 105.1

Bau, J., Henriques, J. D., Ferreira, J. L., & de Oliveira Raposo, J., 2003. "*Integrated approaches to water pollution problems*". CRC Press.

Bernard, H. Russel., 2006. *Research methods in anthropology: qualitative and quantitative approaches 4th. ed.* Oxford: AltaMira Press.

Chambers, R. & Conway, G. R., 1991. *Sustainable rural livelihoods: practical concepts for the 21st century*. IDS Discussion Paper 296.

Chambers, R., 1997. *Chambers, Robert: Whose Reality Counts? Putting the First Last.* Intermediate Technology Group, London.

Chesworth, W., 2008. *Encyclopedia of Soil Science.* [Online] Available at: http://link.springer.com.ep.fjernadgang.kb.dk/book/10.1007%2F978-1-4020-3995-9.
[Accessed31 03 2016].

Chua, L., 2014. Gifting, Dam(n)ing and the Ambiguation of Development in Malaysian Borneo. Ethnos. [Online] Available at: http://www.tandfonline.com/doi/full/10.1080/00141844.2014.986152. [Accessed 27.2.2016].

Chua, L., 2012. *The Christianity of Culture - Conversion, Ethnic Citizenship, and the matter of religion in Malaysian Borneo*. Palgrave Macmillian.

Culman, S., 2012. *Permanganate Oxidizable Carbon Reflects a Processed Soil Fraction that is Sensitive to Management.* [Online] Available at: (http://www.oardc.ohio-state.edu/culman/wp-content/uploads/2013/10/Culman-et-al-2012-Permanganate-Oxidizable-Carbon-Reflects-a-Processed-Soil-Fraction-that-is-Sensitive-to-Management.pdf) [Accessed 01 03 2016].

Cramb, R & Patrick S. Sujang, 2011. *'Shifting ground': Renegotiating land rights and rural livelihoods in Sarawak, Malaysia,* Asia Pacific Viewpoint, vol. 52, no. 2, August 2011.

Cramb, R. A. & Patrick S. Sujang, 2013. *The mouse deer and the crocodile: oil palm smallholders and livelihood strategies in Sarawak, Malaysia*, The Journal of Peasant Studies, 40:1, 129-154.

DFID, 1991. *Sustainable livelihoods guidance sheets*.
Ellis, F., 1998, *Household strategies and rural livelihood diversification*, Journal of
Development Studies, 35:1, 1-38.

FAO, 2002. Land Tenure and Rural Development [Online] Available at: http://www.fao.org/3/a-y4307e/ [Accessed 27 03 2016].

FAO, 2016. *FAO Soils Portal.* [Online] Available at: http://www.fao.org/soils-portal/soil-management/management-of-some-problem-soils/acid-soils/en/ [Accessed 28 03 2016].

Guo, L., & Gifford, R., 2002. *Soil carbon stocks and land use change: a meta analysis.* Available at (http://onlinelibrary.wiley.com/doi/10.1046/j.1354-1013.2002.00486.x/full). [Accessed:5.4.2016].

Heiderer, R., 2009. *Distribution of Organic Carbon in Soil Profile Data.* [Online] Available at:
http://eusoils.jrc.ec.europa.eu/ESDB_Archive/eusoils_docs/other/EUR23980.pdf.
[Accessed 1.4.2016].

Hill Laboratories. 2009. *Assessing Soil Quality The organic Soil Profile.* Available at (http://www.hill-laboratories.com/file/fileid/15505). [Accessed: 4.6.2016].

Lord, S., & Clay, J., 2006. Environmental impacts of oil palm practical considerations in defining sustainability for impacts on air, land

and water." *International Planters Conference on Higher Productivity and Efficient Practices for Sustainable Agriculture, Putrajaya, Malaysia.*

May, C. Y., 2012. Malaysia: economic transformation advances oil palm industry. *AOCS (American Oil Chemists' Society)*.

Mertz, O., Reed W., & Christensen, A., 2005. Local land use strategies in a globalizing world: Subsistence farming, cash crops and income diversification, Agricultural Systems, vol. 85 p. 209-215

Mertz, O., Reenberg, A., Bech, T., & Birch-Thomsen, T., 2008. *Land use decisions in smallholder rural communities in developing countries.* Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 2008 3, No. 043

Missouri Center for Career Education, 2012. *Soil Color.* [Online] Available at (http://www.missouricareereducation.org/doc/soilsci/SRLesson3.pdf) [Accessed 30.03.2016].

Osman, K., 2013. *Forest soils: properties and management*. Springer Science & Business Media.

Plant & Soil Sciences eLibrary. 2016. *Soils - Part 2: Physical Properties of Soil and Soil Water*. [Online] Available at (http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1130447039&topicorder=6&maxto=10&minto=1) [Accessed: 30.3.2016].

Ribot, C., & Peluso, N., 2003. "*A Theory of Access**". Rural Sociology 68(2):153-181.

Rosli, A., Radam, A., & Rahim, K. A., 2013. Technical efficiency of pepper farms in Sarawak, Malaysia: an application of data envelopment analysis. *International Journal of Business and Social Science*, *4*(7).

Sadej, W. & Przekwas, K., 2008. *Fluctuations of nitrogen levels in soil profile under condition of long-term experiment.* [Online] Available at: http://www.agriculturejournals.cz/publicFiles/01326.pdf. [Accessed 01 04 2016].

Sánchez, E., et al., 2007. "*Use of the water quality index and dissolved oxygen deficit as simple indicators of watersheds pollution.*" Ecological Indicators 7.2. :315-328.

Stockdale, E., 2016. *Fact Sheets Making Sense of Physical Indicators.* [Online] Available at: http://soilquality.org.au/factsheets/making-sense-of-physical-indicators. [Accessed 30 03 2016].

Tan, Chunjian, et al., 2015. "*Effects of Long-term Conservation Tillage on Soil Nutrients in Sloping Fields in Regions Characterized by Water and Wind Erosion.*" Scientific reports 5.

Throop, H. L., Archer, S. R., Monger, H. C., & Waltman, S., 2012. "*When bulk density methods matter: Implications for estimating soil organic carbon pools in rocky soils*". Journal of Arid Environments, *77*, 66-71.

USDA., 2011. *Carbon to Nitrogen Ration in Cropping Systems.* [Online] Available at: soils.usda.gov/sqi [Accessed 04 05, 2016].

USDA, 2013. *Soil pH.* [Online] Available at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053293.pdf. [Accessed 29.03.2016].

Van Vliet, N., et al., 2012. "*Trends, drivers and impacts of changes in swidden cultivation in tropical forest-agriculture frontiers: a global assessment*." Global Environmental Change 22.2 :418-429.

Weintraub, S. R., Taylor, P. G., Poet al., 2015. *Topographic controls on soil nitrogen availability in a lowland tropical forest*. Ecology, *96*(6), 1561-1574.

Wilms-Posen, Nico, et al., 2014. *Land-Use and Livelihoods-A Malaysian Oil Palm Scheme and its Social and Ecological Impacts.* The Journal of Transdisciplinary Environmental Studies 13.2 : 2.

Watson-Verran, H & Turnbull, D., 1995. *Science and Other Indigenous Knowledge Systems*, in Sheila Jasanoff & Gerald E. Markle & James C. Peterson & Trevor Pinch (Eds.) Handbook of Science and Technology Studies, Sage, London.

Zu, C. et al., 2014. *Acid Soil is Associated with Reduced Yields, root Growth and Nutrient uptake in Black pepper (Piper nigrum L.).* [Online] Available at: http://dx.doi.org/10.4236/as.2014.55047. [Accessed 30.3.2016].

APPENDIX 1. Reference codes for methods

Reference code	Subject	Description	Influences (Biases)
PRA 1	Timeline -1st PRA session	PRA task involving six people creating a timeline of important event that has happened in the village	Knowledge Translation Communication
PRA 2	Seasonal calendar – 1st PRA session	PRA task involving five people to get a general understanding of weather, the crops and the work related to them throughout a work	Knowledge Translation Communication
PRA 3	Matrix Ranking (women) – 1st PRA session	PRA task involving four women ranking different crops in terms of importance, what they require and what might influence the decisions of which crops to grow	Knowledge Translation Communication
PRA 4	Matrix Ranking (men) – 1st PRA session	PRA task involving four men ranking different crops in terms of importance, what they require and what might influence the decisions of which crops to grow	Knowledge Translation Communication
PRA 5	Sources of Income (women)	PRA task involving ten women to get an understanding of how people generate money in the village	Knowledge Translation Communication
PRA 6	Sources of income (men)	PRA task involving ten men to get an understanding of how people generate money in the village	Knowledge Translation Communication
PRA 7	VENN-diagram – 2nd PRA session	PRA task involving ten people	Understanding the scope of the task Translation Communication
PRA 8	SWOT analysis – 2nd PRA session	PRA task involving ten people outlining strengths, weaknesses, opportunities and threats to the village	Knowledge Translation Communication
TRW 1	Transect walk to the forest	Walk towards the forest getting information and overview of natural resources along the way	Translation
TRW 2	Transect walk to the fields	Walk towards the farming fields getting information and overview of natural resources along the way	Translation
FOW	Forest walk	Walk to the forest learning about the use of the forest	Translation Geography (forest reserve was too far away)
COW	Community walk	Informal walk around the town learning about what the village physically consists of and meeting the villagers	Translation
QUE	Questionnaire	Questionnaire of 30 households about land use and agricultural activities	Translation Phrasing of questions Conduction (by various students)
EXI	Expert interview with professor Gabriel on NCR	Interview regard land tenure	In situ interview
KEY 1	1st interview with headman	Interview introducing us to basic knowledge about the village	Translation Setting (in his living room)
KEY 2	2nd interview with	Interview to close any gap of knowledge	Translation

	headman		Setting (in community hall)
KEY 3	Interview with Mr. Michael	Interview regarding culture and traditions connected to the village	Setting (in his living room)
KEY 4	Interview with Madame Irene	Interview regarding the role of the womens committee	Setting (in kitchen with the other cooks) Translation
FAI 1	Farmers interview with Mr. Alfred	Interview regarding land use and agricultural activities	Translation Definitions of terms
FAI 2	Farmers interview with Mr. Francis	Interview regarding land use and agricultural activities	Translation Definitions of terms
FAI 3	Farmers interview with Mr. Rolland	Interview regarding land use and agricultural activities	Translation Definitions of terms
SOI 1	Soil sampling interview with Mr. Nelson	Interview regarding land use and soil sampling site	Translation Definitions of terms
SOI 2	Soil sampling interview with Mr. Wally	Interview regarding land use and soil sampling site	Translation Definitions of terms
SOI 3	Soil sampling interview with Mr. Headman	Interview regarding land use and soil sampling site	Translation Definitions of terms

APPENDIX 2. Methods used during the fieldwork

Method	**Times used**
Transect walk	1
Transect walk forest	1
Forest walk	1
Community walk	1
PRA sessions	2
Semi structured interviews (SSI)	9
Informal walk with at library	1
Questionnaire	1
Water sampling	1
Water analysis	1
Soil sampling	1
Soil Analysis	1

APPENDIX 3 . Household Questionnaire

Interviewer:
Observer:
Translator:
Date:
Recording number:
Respondent:
Household number:

System for filling out tables in the questionnaire:

√ = Yes
% = No
/ = Existing but not of relevance

Briefing
We are a group of students who are here to learn about the life and land use in Paon Gahat, and this is for study purpose only.
We will ask you about your household, your land use, what crops you grow and about your life in this kampung. Please just give a brief answer, that is as short and simple as possible. If there are some questions that you don't want to answer, just let us know and we will skip it. The interview is anonymous and only us and our teachers will be able to read it.
We are very thankful that you want to participate, it is of great value to us and our study.

General:
Gender: M □ F □
Were you born in Paon Gahat? YES □ NO □
If no – when did you move here?

May I ask how old you are?

How many members belong to this mamba (household)? *(In numbers -Be aware that people might answer differently)*

How many are here everyday? (*including yourself)*

How many members live away from the mamba?
(living elsewhere, but coming back for weekends or festivals)

Land use:

Do you have access to land? YES □ NO □

What do you use this land for? *(See table 1)*

1. What crops are for subsistence?
2. What crops are cash crops?
3. How many plots do you have for each crop?

4. What is the size of land area for each crop? *(estimated measure in hectars/acres)*
5. Do you use any subsidies?

Table 1.

Crops	1. Subsistence *(own consumption)*	2. Cash crop *(for selling)*	*3. S*ubsidies
Swamp Paddy			
Hill Paddy			
Oil Palm			
Rubber			
Pepper			
Fruit			
Vegetables			
Others			

What is your most important crop? Why?

Have you always been planting these crops? YES □ NO □

If no - What other crops have you planted? When and Why?

Income:

What are the main sources of monetary income in this mamba (household)? *(See table 2)*
Table 2.

□ Crops	□ Animals	□ Off farm work	□ Other
□ Swamp Paddy □ Hill Paddy □ Oil Palm □ Pepper □ Rubber □ Fruits □ Vegetables □ Other	□ Chicken □ Fish □ Pig □ Cow □ Goat □ Other	□ Construction □ Police □ Teacher □ Army □ Engineer □ Medical/health □ Shops □ Private sector □ Other	□ Remittances □ Pension □ EPF □ BRIM □ Welfare □ Subsidies for crops □ Other

If other - what other sources of monetary income does this mamba (household) have?

Profit:

These questions are about profit of your different crops *(fill out table 3)*

1. How many harvests do you have per year?

2. What is the market price of the different crops?

3. How many kilos/tons do you get per harvest?

4. Where do you sell your crops?

Table 3.

Crop	1. Harvests per year	2. Market price?	3. Quantity of harvest in kilo/tons	4. Where are the crops sold?
Swamp Paddy				
Hill Paddy				
Oil Palm				
Rubber				
White Pepper				
Black Pepper				
Fruit				
Vegetables				
Others				

Comments to table:

Land tenure:

How did you get your areas of land? *(fill out table with numbers and comments)*

Inherited	
Bought (for money)	
Rented (for money)	
Borrowed (for free)	
Other	

Are your lands NCR land? YES □ NO □
Is it all of your lands that are NCR?

Have your lands been surveyed? YES □ NO □

Have you got the titles of these lands? YES □ NO □

If no – have you tried to gain titles to these lands? YES □ NO □

How have you tried to gain titles to these lands?

Governmental development schemes:

Are you a part of any governmental development schemes? YES □ NO □
(If yes move to A if no move to B)

A. What are the governmental development schemes you are a part of?

What are the reasons or benefits of participating in these schemes?

Would you like to participate in any other governmental development schemes?
YES □ NO □ Why? Why not?

B. Why are you not a part of any governmental development schemes?

Would you like to be a part of it any governmental development schemes?
YES □ NO □
Why? Why not?

If they have not already mentioned SALCRA, then continue with next question.

SALCRA
Do you know about SALCRA? YES □ NO □
Why? Why not?

Would you like to participate in SALCRA schemes? YES □ NO □
Why? Why not?

Would it be possible for you to participate in SALCRA schemes in the future?
YES □ NO □
Why or why not?

Animals
Do you go hunting in this area? YES □ NO □
(If yes move to A if no move to B)
A. Where do you go hunting?

□ In Paon Gahat area
□ In nearby areas

□ In forest reserve
□ Other:

Are these animals reducing? YES □ NO □

If yes - Why do you think it has been reducing?

B. Did you go hunting in the past? YES □ NO □

When did you go hunting?

Where did you go hunting?

□ In Paon Gahat area
□ In nearby areas
□ In forest reserve
□ Other:

Why don't you go hunting anymore?

Would it still be possible? YES □ NO □

Forest Products
Do you collect forest products (not hunting animals)? YES □ NO □
(If yes move to A if no move to B)

A. Where do you collect forest products?

□ In Paon Gahat area
□ In nearby areas
□ In forest reserve
□ Other:

Are these forest products reducing? YES □ NO □

If yes - Why do you think it has been reducing?

B. Did you collect forest products in the past? YES □ NO □

When did you collect forest products?

Where did you collect forest products?

□ In Paon Gahat area
□ In nearby areas
□ In forest reserve
□ Other:

Why don't you go collect forest products anymore?

Would it still be possible? YES □ NO □

Water
For what purposes you use the river? *(Look at table)*
What are the reasons of why you have stopped using the rivers it? *(Look at table)*

Purpose	Current use	Past use	Reason
Drinking			
Washing			
Fishing			
Irrigation			
Swimming/recreation			
Other			

Soil:
How is the quality of your soil on your lands?

Are there any crops you cannot grow on your lands? Which crops? And why?

Has the quality of your soil changed over time? YES □ NO □
If yes – why has the quality changed?

If the quality of the soil has changed what are the effects?
(different crops, different yields, different quality of crops etc?)

Thank you very much for participating in our interview, we are very grateful and it will be of big help in our studies. This information you have shared with us, will only be used by us, in our university project and not for anything else.
Terimah kasih!
Thank you!
Mange tak!

APPENDIX 4. Data from First PRA session

Planning the workshop:

- We went to the headman the day before our first PRA session to show respect and ask for permission to do the workshop
- We then asked around town for people to come and for them to bring friends.

Before arriving to Paon Gahat we had planned four tasks:

- Resource mapping
- Community mapping
- Timeline
- Matrix Ranking

At the ceremony the first day of our field trip in Paon Gahat we received a community map from the headman. It was a detailed map including the Paon River, the roads, the church, the community house, the longhouse, the ponds and every house in the village was mapped with a number etc. We then decided to leave out that task, simply because we would rather use that time in the workshop for something we could get new data from.

When we went to the headman to ask for permission for doing the workshop, he showed us a detailed resource map of the kampung. After that we decided to leave out the resource mapping task as well and included the sources of income instead. We were five student, who spent all day (WHAT DAY?) to prepare the PRA session. We planned the workshop, brainstormed the tasks and prepared the A0 papers.

Plan for the workshop

- Start 6pm (after advise from headman)
- We decided to start with the mixed

Part 1:

Group 1 (mixed)	**Group 2** (mixed)
Timeline	Seasonal Calendar

Part 2:

Group 1 (women)	**Group 2** (men)
Matrix ranking	Matrix ranking
Sources of income	Sources of income

Group 1: Line and Jennifer
Group 2: Julie, Williams and Wivina

Timeline:
Duration: approximately 35 minutes.
Number of participants:

The point of doing the timeline was to get an understanding of the important events that has happened in Paon Gahat. All we did to prepare this task was to draw a line. We did not want to put on a start date – and we did not want to put 2016 at the end of it if they wanted to include future planning. If they had difficult to get started we had prepared some events

to suggest (the tarsealed road, the longhouse, the community house, the church etc.). We handed out pens and post-its so they could add to the timeline themselves. The task went better than expected and we did not need to help them get started. Since they wrote it themselves we have had to put aside time to get it translated into English. The timeline is kept open for us during the fieldwork so that we can add on event later on if needed to get an understanding of the history and development of the village.

Seasonal Calendar
Duration: approximately 40 minutes
Number of participants:

The point of doing the seasonal calendar is to get a general understanding of the weather and the crops throughout a year.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Climate												
Pepper	Weeding fertilizing pesticide	Weeding fertilizing pesticide	Weeding fertilizing pesticide	Weeding fertilizing pesticide	Harvesting	Harvesting	Harvesting	Cleaning Seeding	Fertilizing	Flowering	Need six months to grow	growing
Palm Oil												
Rubber												
Animals												
Fishing Ponds						Catch/ Sell			Receives subsidy from government			
Hill paddy	Fertilizing Pesticide	Flowering	Harvesting	????	Resting	Harvest festival – eat new rice	Clearing	Chopping and making ready for new season	Open burning Planting	Time to do handycraft and to relax at home	Weeding	Weeding
Swamp paddy	Fertilizing Pesticide	Flowering	Harvesting	????	Resting	Harvest festival – eat new rice	Clearing	Chopping and making ready for new season	Open burning Planting	Planting	Planting	Weeding
Community Calendar			Fasting			Harvest festival						Christmas

The figure above was the starting point of this task. We had left two rows open if they wanted to add anything. They wanted to seperate the paddy into swamp- and hill paddy. When we did the task we decided to add on a community calendar, which did not really give us any important data.

Important finding:
Climate:
- most rainy months: February and March
- most dry months: June and July

Pepper:
- Needs a lot of attention throughout the year with both weeding, fertilizer and pesticides.
- Has the size of matches in november.

Palm Oil:
- Season doesn't matter. It is the same all year around. Harvesting is not tied to a certain time of the year. It was compared to farming coconuts.

Rubber:
- Rubber is not tied to a certain season. Tapping whenever the tree are ready.
- But rubber is strongly connected to the market prices (demand/supply). Therefore they only tap the tree when the market prices are ”good enough”.
- Example given by villager: it is not a good price for 2-3 ringgit/kg. A good price is 20 ringgit/kg – and then he will tap it.

Animals:
- Own consumption and after own schedule.
- They have: fish, pigs, chickens, ducks and a few have rabbits.
- 1 person sells chicken in the village – Mr. Michael.

Fishing Ponds:
- They catch and sell in June
- They feed the fish twice every day – morning and evening
- They receive 5000 ringgit worth fish food once a year in september.
- They have several species in the village
- They are the size of the little finger in september

Hill paddy:

Swamp paddy:

Overall:

We got a lot of usable data out of this task. It gives us a great understanding of what the different crops requires in term of workload, weeding, fertilizier and pesticides. It help to give an overview of the livehoods connected to agriculture in this village.

Matrix ranking:

We decided to divide the participants into men and women when doing this task. We thought it would be interesting to see if the men and women had different perceptions of the different variables they are presented to in this task. The point of matrix ranking we did was to get and understanding of which crops are important, what they require and what might influence the decisions of which crops to grow.

The men's matrix ranking:
Duration: approximately 20 minutes.
Number of participants: 4

	Palm Oil	Rubber	Pepper	Paddy	Fruits	Vegetables
Importance	●		●●	●		
Workload			●●●●			
Need of water	●●●●					
Need of pesticides			●●●●			
Need of fertilizer			●●●●			
Expences			●●●●			
Markets value			●●●●			
Income	●		●●●			

Unfortunately only four men showed up to the workshop(approximately 10 men were expected). The biggest difference among the men was which crop is the most important. And one had the highest income through palm oil where the others had the highest income on pepper. Even though pepper has the highest workload, and is of the most need of both fertilizer and pesticides, and all in all is the most expensive it makes sense in terms of it also has the highest market value and generate the highest income according to three out of the four participants. The matrix gives a great understanding of the decision making of which crops to grow.

But even though we only had four men and it might not be representative for the village it has given us a basic introduction and understand to and of the crops, what they demand, and why people choose them.

Date: 03.03.2016 Venue: Paon Gahat Community Hall Interviewee: Village Community

Matrix Ranking (Womens Group)

Time	Questions	Explaination
1.10	What are the most importance crops?	• **Pepper** • Pepper because pepper can be sold to buy paddy and other susbsistence food like fruits and vegetables • They can buy rice • Paddy is not expensive to buy • For them everything is important
3.50	Which one demands more work?	• **Pepper and oil palm** • **Pepper.** Demands more work because need to spray and trim. However, both work demands are the same, but working on pepper is much more complicated because need to maintain every month. • **Paddy** is easy for them. But it is harder to do in traditional ways as compared to using machine. • **Rubber** is easy. Starting with spray and take the latex. Rubber is compared with oil palm because of the market price. Long time ago the market price for rubber drop and low cause them to change rubber to oil palm. They said rubber do not have a lot of care, once in awhile maintenance, it can still survive.

7.27	What is the most need of water?	• **Vegetables** • Get water from the rain, however need more "extra" water. • **Paddy.** Paddy planted in swamp and get the water from the rain. • **Pepper.** Pepper need water from the rain incase of wilt/die.
13.43	Which one need a lot of pesticides?	• **Pepper** • If there is pest and fungus (on pepper) then they will spray with pesticides on grass. Pepper, first they spray on the grass. If they want to maintain the leaves, they spray on the leaves using (Pesticides: cobox) then the leaves will fall. Spray cobox once a week (every week). • **Vegetables and fruits.** Once in a while spray vegetables and fruits only when it is still in a growing process but from their point of view it is dangerous for consumption. • **Paddy.** Spraying pesticides on paddy when they flower, otherwise the insect will feed on it.
19.30	Which one need the most fertilizer?	• **Pepper** • If they put more fertilizer, the quality is good. They put fertilizer three times/stages, first planting they put in fertilizer, the middle growth stage add in fertilizer in small amount (one palmful/handpalm), lastly when add in fertilizer when its fruiting. When the pepper tree is getting older, they need 1 kg for one tree 3 times, for best quality. • **Palm oil.** Once in a month or every three months. • **Rubber.** Never use pesticides because it is easy to maintain and grow. • **Paddy.** They put in fertilizer twice a year.
23.39	Which crops need more expenses?	• **Pepper** • Pepper because they need to buy a lot of fertilizer and pesticides.
25.00	Market Value.	• **Pepper** • White pepper, RM50 per kg. • **Oil Palm**. RM0.30 per kg but now is going down. • **Rubber**. when it is a lot in the market, but the demand is low, no market value/price. • **Paddy.** They never sell paddy • **Fruits.** They sometimes sell fruits especially during fruiting season. • **Vegetables.** Seldom because mostly they use as for own consumption.
27.14	Income	• Pepper • Pepper once in a year, oil palm every month, however in terms of price they are the same. • Pepper = 1 year = 12 sacks • A lot pepper meaning a lot income, RM50,000.00 per year (sell only once a year) • **Oil palm** = 1 tonne = RM300 (every two weeks) • The demand of **rubber** is high but "no price"

Sources of income

The point of this task was to get an understanding of how people generate money in Paon Gahat and which income sources are important to them.

Men:
We asked them to write on post-it's all the different kind of activities that creates an income in the village. After they finished that, we put them into different groups:

- Agriculture
- Remittances
- Work in the public and private sector
- Shops
- Government subsidies
- Fish Ponds

When they had been organized we asked them to rank the top three of highest/most important income for the village.

1. Agriculture
2. Work in public and private sector
3. Subsidies

It was interesting that they mentioned subsidies as one of the most important groups. This might imply that the government subsidies may be taken into account when choosing which crop to grow and by that is an important factor of the decision making process.

Methodological uncertainties:

- We have to keep in mind that the participants might not be representative of the kampung, they were related many of them.
- Also the women might have felt under time pressure during the last exercise(sources of income) since the men finished first and waited outside.
- When the men waited outside, they told us it was because they waited for their wives to finish. This information can affect the day since it might not be as representative as wanted.
- They might only represent the elite of the kampung, since they were all connected to each other and we know that several of them are in the committee.
- We asked some of our first acquaintances from the first day to bring people who would like to participate. We invited people in groups, like we asked Irene and she found some other women, so it was through her.
- Some people might state pepper, but that could be because they only grow pepper. Same could go for other crops.
- The headman was present at the workshop. He did not participate actively but walked around observing and adding to the discussions. Although he was present it did not seem to affect the participants and the atmosphere throughout the session was good, people laughed and seemed to have a good time.

Uncertainties regarding the data collected from the women's matrix ranking (number of participants and the amount of stones divided onto pepper and paddy regarding importance).

APPENDIX 5. Data from Second PRA Session

For the second PRA session we had prepared two tasks: a Venn-diagram and a SWOT analysis.

SWOT analysis

None of us had used the SWOT analysis as a part of a workshop before. But we discussed how we could use it as a tool to get even more knowledge from the villagers. Hiding behind the SWOT analysis allowed us to get more information on the more difficult questions to ask like weaknesses and threats to Paon Gahat. This analysis gave us some really interesting data and gave us an even better understanding of the village.
When we presented it, we presented we told the

Strengths	Weaknesses
- Good road; easy access - Strong + good relationship with each other (but also for special events, e.g. burial, chrismas caroling, gawai, wedding) - Happy to be able to grow: Durian trees, rambutan, langsat, mangosteen, curangi. Because they can harvest them once a year and get an income from them. - Gravity feed - Hill soil - Swamp land (paddy)	- Draught season (3 months; aug-oct) - Water pollution (rubbish in river) - No wild animals (all oil palm) - No place for garbage (easy way) - Illegal logging activities
Opportunities	**Threats**
- Opportunity for big plantations (individual) (have a lot of land) - Academic Club - Health Screening/services/clinic - Sportscenter - Sports Club - NGO - Education - Youth club	- Robbery/theft - Drugs - Headhunters - Quarrels and alcohol (people from other villages) - Indonesian strangers - Flood - Climate change(always raining, draughts; two extremes. Affect crops) No more crops, children dehydrating in draughts, every year (draughts), they can not adapt to incontrollable things, paddy dies too much; rain this year: less yield

Now we have been some times in Paon Gahat and learned a lot about the kamoung. But we are really interested in learning more about how you perceive Paon Gahat and life in the kampung.

Venn- Diagram

The participants distributed the different organizations, institution, important people, programs in four levels .In the First level, the participants identified the group of institutions that actually are working close to Paon Gahat . The institutions identified are explained as follows:

Institution	Description	Origin
Malaysia pepper board (MPB)	Government agency that promotes pepper production, gives training to farmers, distributes subsidies (products) related to	Government

	pepper farming. It is located in Serian and only the people who has transportation can sell to MPB	
Skin-Padi Bukit/ Paya Skim-Lada Skim-Kelepa Semit	Provides fertilizers and pesticides for the production of rice	Government
Pertubuhan Paladang kawasan [ppk]	It is a farmer's association Sell agriculture products to the members at lower prices. The farmer pay for the membership. Buy the production of the farmers	Government
Ketua Kampung/ headman		
Concrete road-transportation		Government
Mr. Martin Ben	Kedup assemblyman Politician.	Government
SESCO (Sarawak electricity company)	Provide electricity	Government
Scheme (Gravity feet)	Provide clean, untreated water.	Government

In the second and third level the participants identified the institutions with a distant-relationship with the community.

Institution/person	Description	Origin
Businessman / middleman	Identified four middlemen • Kim Him • Engene • Kim Piao • Ah Kiam MPB gives them the license to buy agriculture products They compete for prices, and Kim Him offers the best price. They are located nearby Paon Gahat, and the farmers prefer to sell to them due to the lack of transportation**.**	
Bugak Ak Rinah **Treasurer**	The person responsible of the community money management provided by the government, NGOs	Community
Biru Wanita **Women Bureau**		Community
Biro Kesihatan **Health Bureau**		Community
Transportation		Government

Third level

Institution/person	Description	Origin
Youth Community		Community
Mr. Roland Anak Agriculture Bureau		Community
Malaysian Palm oil board (MPOB)	Government agency looking after oil palm production, give training to farmers, distribute subsidies(products) related to pepper farming.	**Government**
Safety Bereau		**Community**
Skim Tong 1 Malaysia water tank	It provides a tank to each house in order to people be able to collect water	**Government**
Jkkk	Village committee	**Community**

In the fourth level the participants identified

Institution/person	Description	Origin
1Azam	Government scheme The mission is to support poor people through productive activities such as • Azamtani =to promote agriculture production (rural people) • Azamniaga=to promote small business • Azamkerja= employment agency • Azamkhidmat= to provide servicing such as kinder garden school	**Government**

- The government has a strong presence in the village through different programs.
- The perception of the participants in general is positive respect the work of the different programs.

APPENDIX 6. First and Second Headman Interview guide for SSI

First Interview

A. Personal

- How old are you?
- What kind of education have you recieved? When?
- How many members are there in your household?
- And family? (Parents, siblings, children and grandchildren)

- Does all of your household members live in Paon Gahat?
- Does all your family live in the kampong

B. HEADMAN

- How long have you been the headman?
- What did you do before you became the headman?
- How did you become the headman?
- Who were the previous headmen?
- What are your duties as the headman of Paon Gahat?
- Where do you get your income from?
- Do you recieve any benefits from the state as a headman?

C. HISTORY

- When did people start to settle in Paon Gahat?
- Who owned this land before? How did you get permission to settle here?
- Why did the migrate here?
- Who were the first households?
- Did they stay in a longhouse?
- What was the original pre-cultivated state of the land? (Forest, swamp etc.)
- What kind of agricultural activities did they practice?

D. PAON GAHAT

- How many people live in Paon Gahat now?
- How do people separate or divide their land? For housing or farming?
- How is life in the kampung?
- What are the main work activties and occupations of the people in the kampung?
- What other sources of income do people have?
- Do some people migrate away from the kampung? Why do they migrate? And for how long?
- What are the differences in the range of income for people in the kampung?
- What is the organisational structure of the village?
- What are the functions of the committees? How did they start?

E. LAND USE

- What are the main land use in the kampung? Is it subsistence or cash crops?
- What are the main crops in the kampung?
- Why are these crops produced in the kampung?
- Have you had changes in land use in Paon Gahat?
- Why has there been changes?
- When did the kampung start to grow cash crops? What types?

F. LAND TENURE

- What land tenure arrangements exists in the village?
- How is the land divided between the people?
- Is land tenure something the people of the kampung worry about?
- How can you secure your lands?
- Do you have problems with illegal logging?
- How does it affect the kampung that there is a forest reserve?
- Is it still possible to use the forest?

G. GOVERNMENT SCHEMES, SALCRA AND PRIVATE COMPANIES.

- Do you have any government schemes in the kampung?
- Why? / Why not?
- If yes – how many people are involved?
- If no – would they like to have it?
- Has there been debates in the kampung, about whether or not, they should participate in government schemes?
- If yes – what were the arguments pro and con in the debate?

H. DECISION MAKING

- If there are big decisions to be made in the kampung (such as government schemes) how will they make a decision?
- Who will participate?
- Is there any kampung meetings? And how often?
- Who are a part of these meetings? Is it only the main commitee or does it involve all the villagers of the kampung?

I. ENVIRONMENT

- How is the natural environment in and around Paon Gahat?
- Has there been changes in the environment?
- Has there been a loss of biodiversity? Maybe not as many wild animals? Why?
- Have you experienced any pollution in the kampung? Why?
- How is the soil quality?
- Have you experienced any changes in soil quality?
- If yes – has it influenced what crops you can grow?
- How is the water quality?
- Have you experienced any changes in water quality?
- If yes – How? Why?
- How will you get your water supply in dry season for this kampung?
- Have you experienced any natural disasters, such as floods or land slides ?
- Have you experienced any changes in climatic patterns?
- If yes – What?
- Why do you think these changes have occured?

J. DEVELOPMENT

- How has the changes been from life in the longhouse to life in single houses?
- Why will the longhouse be torn down? How was it decided?
- When did the kampung get a paved road? Has it changed the life of people in the kampung?
- What type of facilities do you have in this kampung?
- What facilities would you like to have in the future in the kampung?
- How can you recieve (monetary) support for future facilities?
- What do you wish for the future of this kampung?

Second Interview

Decision Making

- Can you explain us more about JKKK and the functions of JKKK?
- Can you explain us more about village meetings? How often do you have them? Who participates and how do you come to agreements?
- Can you explain us more about the role of the committee?
- How do you become a member of the committee?

- What topics do you discuss in the committee? (any examples?)
- How do you solve problem in the village?
- Are there any other committee in village?
- Can you explain us more about kampung law?

Subsidies

- Can you explain us the difference between subsidies and government development schemes?
- Can you explain us more about how people apply for subsidies?
- What subsidies do they apply for?
- How do they get information about subsidies?
- What are the criteria for getting subsidies? Are there different criteria for the different subsidies?
- What are the benefits or reasons for getting subsidies?
- How long do they get the subsidies for?
- Are there other aids other than subsidies and governmental development scheme?

SALCRA

- We have understood that there has been discussions about whether or not Paon Gahat should participate in SALCRA? Could you explain us more about this?
- Would it be possible for SALCRA to come
- Why do the villager ask for SALCRA back then?

Your Choice of cash crop

- Can you explain us more about why you mainly plant oil palm?
- Was it after the rejection from salcra that you started the oil palm yourself?
- When did you start growing it?
- Were you the first person start planting oil palm?
- Did other people in the kampung start growing it at the same time?
- Are there any problem to your oil palm plantation back then?
- Are some people don't want to grow oil palm because it's hard to get subsidies?
- If u did not get help from MPOB from where you get seedling?
- Can you explain us more about why you have sarted growing Gaharu?
- When did you start?
- Will other people start planting it?
- What is you plan for this Gaharu plantation?
- Why did you start?
- What are the uses of gaharu?
- Can gaharu tree be alternative cash crop in the village?
- Do u need special land for gaharu

Role as a headman

- How would you like to be remembered as a headman in the future?

APPENDIX 7. Interview guide to the the head of women's committee Madame Irene.

General.

- Where you born in Paon Gahat?
- How many children do you have?
- What is your educational background?
- May I ask how old you are?
- What are your daily activities?
- Are you a part of other groups or committees in Paon Gahat?

History of the womens committee.

- Why did the womens committee start?

Head of the womens committee.

- How did you become the head of womens committee?
- What is your role/duties in the womens committee**?**

Organizational level.

- Who is a part of the womens committee?
- How often is the womens committee meeting?
- What do the women discuss?
- What do the women get out of being part of the womens committee?
- What is the role of the womens committee in Paon Gahat?
- Do they have a saying in terms of the decisions being made in Paon Gahat?
- Are there any outsider influencing the womens committee? (state, ngo, other?)
- What could a good influence be?
    - Have they always supported this government?
    - Is the government also supporting this kampung?
    - Are there good ties to the government?

Gender role.

- Is there a traditional woman role in the community or in bidayuh (culture)? eg. Work or activities.
- Are there any obstacles for the women in the community?
- What do you wish for the future of the womens committee?

APPENDIX 8. Interview guide to Mr. Michael - Head of culture/traditions

Topics and Questions

- **Kampung/traditional law -What is it?**
- Fines, taboos and bad luck
- Hunting
- Decision in the kampong
- What happens, do they gather? or how does it work?
- Big decisions
- Example of a decision
- If you take a decisions and someone disagree is it then the majority?
- New dam
- Longhouse
- Moving on
- Sentimental value
- Young people Born in the 50´s
- Transition period
- Internet.
- Education and religion
- What were you before?
- Old religion
- Why did your father become a christian on his dead bed?
- Spirits.
- Is there something in the forest you have to take care of?
- Have you always been planting paddy in this area?
- What more would you eat?
- Jungle products
- Why are there no more fish?
- (pollution and chemicals)
- Corruption
- Who breaks the rules?
- History of pepper/paddy.
- Mostly paddy
- Pepper
- Paddy

APPENDIX 9. Interview guide Professor Gabriel

• What is DBNA and its role?
• What does it mean by there are some part of the area have been confirm meanwhile there are some part are not yet confirm?
• How do you know they have been using the land?
• The headman explain that they have divided the land into few lot numbers part of it has been declare as NCR land and have of it is in the process of declaring into NCR land
• There are NCR land with title and NCR land without title
• Do SALCRA have the land for 60 years after the land have been rent to SALCRA by the village people? Is the title be given to the people after the period of agreement end?
• If your land are NCR land without title what can happen?
• If they already have the land, why joining the SALCRA scheme?
• Is it the recent development that people worry about land tenure?
• Paon Gahat area in early 90s
• Do they have any specific reason to not joining the SALCRA?
• There are people who chop down forest tree to claim the land and it will cause loss in biodiversity, so how does this work? Are there any problem like this?
• Extra information on Paon Gahat (not to be write in the report)
• What are the reason of moving from the other village?

APPENDIX 10. Soil sampling interview guide.

Focus of interest
• Where is the plantation?
• How long has he been growing oil palm on the location?
• What was on the land before he started growing oil palm?   • If forest, what kind of forest?
• What needed to be done to the land before he could plant the oil palms?   • Burn/clear the land?
• How is the soil, good or bad?
• Is the soil the same everywhere on the plantation?

• Does he use fertilizer and pesticides?
  • What type? Chemical/compost?
  • How often does he put it in?
  • How much?

• How often does he harvest? • What is the marked price per kg?

• Does he irrigate it?
  • How?
  • Where does the water come from?
  • How often?
• Does the soil hold water?
• Does he have a drainage system on the plantation?

• Is there different topography on the plantation?

APPENDIX 11. Soil Analysis Protocols

Samples have to be air dried and crushed to a fine powder prior to the chemical analyses.

Total C and N

Will be conducted by Isotope-Ratio Mass Spectrometry (IR-MS) at Department of Plant and Environmental Science

An introduction in how to weigh the samples prior to analyses will be arranged upon return from the field.

Permanganate Oxidizable Carbon

Determines how much Carbon is oxidized in a solution of 0.02 M $KMnO_4$ in 0.1 M $CaCl_2$ at pH 7.2 by determining the bleaching of the purple $KMnO_4$ solution by a handheld spectrometer. You can read more about the method in Weil et al. (2003) available in the 'Soil and Water' folder.

Equipment

Permanganate reagent: 0.2 M $KMnO_4$ in 0.1 M $CaCl_2$ at pH 7.2
A glass beaker for the $KMnO_4$ solution
2 l glass bottles for Mili Q water
25 ml graduated cylinder
Milli Q water

1-5 ml pipette + tips
200-1000 µl pipette + tips
Racks for 50 ml Falcon tubes
Plastic flasks for Mili Q water
Plastic pipettes

Spectrometer
50 ml Falcon tubes
Plastic container for waste

Analysis

1. Weigh 2.5 g of crushed soil to 8 Falcon tubes.
2. Add 18 ml of milli Q water to each tube and then 2 ml of the permanganate reagent.
3. Shake for 2 minutes.
4. Leave to settle for 10 minutes.
5. Label 8 new Falcon Tubes for subsampling and add 19 ml of Mili Q water (equal to a 20 fold dilution) – These are the solutions that you will use for measuring $KMnO_4$ concentrations.
6. When the samples have settled for 10 minutes use an electronic pipette to transfer 1.00 ml of the supernatant to the tubes with 19 ml of Mili Q water
7. Pour about 10 ml of the diluted solutions into the spectrometer glass vial (to the mark). Put on the cap, measure and note the reading. Measure the 8 samples as fast as possible.

*It is very important to maintain consistent procedural timing (pre-shaking, shaking and settling). This means that once you have added the $KMnO_4$ you have to very strict with the time control.

Waste handling

Pour the permanganate solution into a plastic container and use a plastic bottle to get most of the soil out of the Falcon tubes and into the plastic container. The 'almost empty' Falcon tubes can be disposed of in the normal waste bins. Use a permanent marker to label the plastic container 'O1' + Thilde Bech Bruun.

Calculation

The bleaching of the purple $KMnO_4$ (reduction in absorbance) is proportional to the amount of oxidizable C in the soil (the greater the colour loss the lower the absorbance reading) the greater the amount of oxidizable C in the soil. To estimate the amount of oxidized C it is assumed that 1 mol MnO_4 is consumed (reduced from Mn^{7+} to Mn^{4+}) in the oxidation of 0.75 mol (9000 mg) of C.

MnoxC (mg/kg) = [0.02 mol/l – (a mol/l)] * (9000mg C/mol) * (0.02 l solution/0,0025 kg soil)

0.02 mol/l is the initial solution concentration

'a' is the concentration measured in the supernatant

9000 mg is mg C oxidized by 1 mol of MnO_4

0.02 l is the volume of $KMnO_4$ solution reacted

0.0025 kg is the weight of the soil being used

pH in water

Measurement of pH in a 1:2.5 soil:water solution

1. Weigh 10.0 g of soil in a 50 mL Falcon tube
2. Add 25 mL of milliQ water
3. Shake for 20 minutes
4. Leave for 30 minutes – for the sediment to settle
5. Calibrate the pH meter using the pH 4 and pH 7 buffer solutions (See manual)
6. Clean the electrode with milliQ water between each measurement. Collect the liquid in a glass.

When all samples have been measured the Falcon tubes (with content) and the milliQ water in the glass are collected in a plastic bag.

Physical analyses

Soil bulk density

Collect samples with 100 cm^3 soil cores, air dry samples and weigh them. If a sample contains more than 5% stones these have to be removed and weighed. The weight of the stones must be subtracted from the weight of the entire sample and the volume of the stones must be subtracted from the volume of the sample. When calculating the volume of the stones you can assume that stones have a bulk density of 2.6 g/cm^3.

Ex:

The weight of a sample collected with a 100 cm^3 soil core is 125g

The sample contains 25g of stones

Real weight of soil sample is 100g

The volume stones collected in the 100 cm^3 ring is: 25g/2.6 g/cm^3 = 9.6 cm^3

The bulk density of the soil sample is: 100g/(100 cm^3-9.6 cm^3) = 1.1 g/cm^3

Texture analysis

Remember to collect extra samples if you want to determine soil texture. The extra samples do not have to be volume specific.
Soil texture can be estimated by field methods - such as the 'feel method' presented below. The soil has to be moist when determining soil texture by 'feel methods'.

TABLE 25
Key to the soil textural classes

				–% clay
1	Not possible to roll a wire of about 7 mm in diameter (about the diameter of a pencil)			
1.1	not dirty, not floury, no fine material in the finger rills:	sand	S	< 5
	• if grain sizes are mixed:	unsorted sand	US	< 5
	• if most grains are very coarse (> 0.6 mm):	very coarse and coarse sand	CS	< 5
	• if most grains are of medium size (0.2–0.6 mm):	medium sand	MS	< 5
	• if most grains are of fine size (< 0.2 mm) but still grainy:	fine sand	FS	< 5
	• if most grains are of very fine size (< 0.12 mm), tending to be floury:	very fine sand	VFS	< 5
1.2	not floury, grainy, scarcely fine material in the finger rills, weakly shapeable, adheres slightly to the fingers:	loamy sand	LS	< 12
1.3	similar to 1.2 but moderately floury:	sandy loam	SL (clay-poor)	< 10
2	Possible to roll a wire of about 3–7 mm in diameter (about half the diameter of a pencil) but breaks when trying to form the wire to a ring of about 2–3 cm in diameter, moderately cohesive, adheres to the fingers			
2.1	very floury and not cohesive			
	• some grains to feel:	silt loam	SIL (clay-poor)	< 10
	• no grains to feel:	silt	SI	< 12
2.2	moderately cohesive, adheres to the fingers, has a rough and ripped surface after squeezing between fingers and			
	• very grainy and not sticky:	sandy loam	SL (clay-rich)	10–25
	• moderate sand grains:	loam	L	8–27
	• not grainy but distinctly floury and somewhat sticky:	silt loam	SIL (clay-rich)	10–27
2.3	rough and moderate shiny surface after squeezing between fingers and is sticky and grainy to very grainy:	sandy clay loam	SCL	20–35
3	Possible to roll a wire of about 3 mm in diameter (less than half the diameter of a pencil) and to form the wire to a ring of about 2–3 cm in diameter, cohesive, sticky, gnashes between teeth, has a moderately shiny to shiny surface after squeezing between fingers			
3.1	very grainy:	sandy clay	SC	35–55
3.2	some grains to see and to feel, gnashes between teeth			
	• moderate plasticity, moderately shiny surfaces:	clay loam	CL	25–40
	• high plasticity, shiny surfaces:	clay	C	40–60
3.3	no grains to see and to feel, does not gnash between teeth			
	• low plasticity:	silty clay loam	SICL	25–40
	• high plasticity, moderately shiny surfaces:	silty clay	SIC	40–60
	• high plasticity, shiny surfaces:	heavy clay	HC	> 60

Note: Field texture determination may depend on clay mineralogical composition. The above key works mainly for soils having illite, chlorite and/or vermiculite composition. Smectite clays are more plastic, and kaolinitic clays are stickier. Thus, clay content can be overestimated for the former, and underestimated for the latter.
Source: Adapted from Schlichting, Blume and Stahr, 1995.

From: FAO (2006): Guidelines for Soil Description (available in the 'Soil and Water' folder)

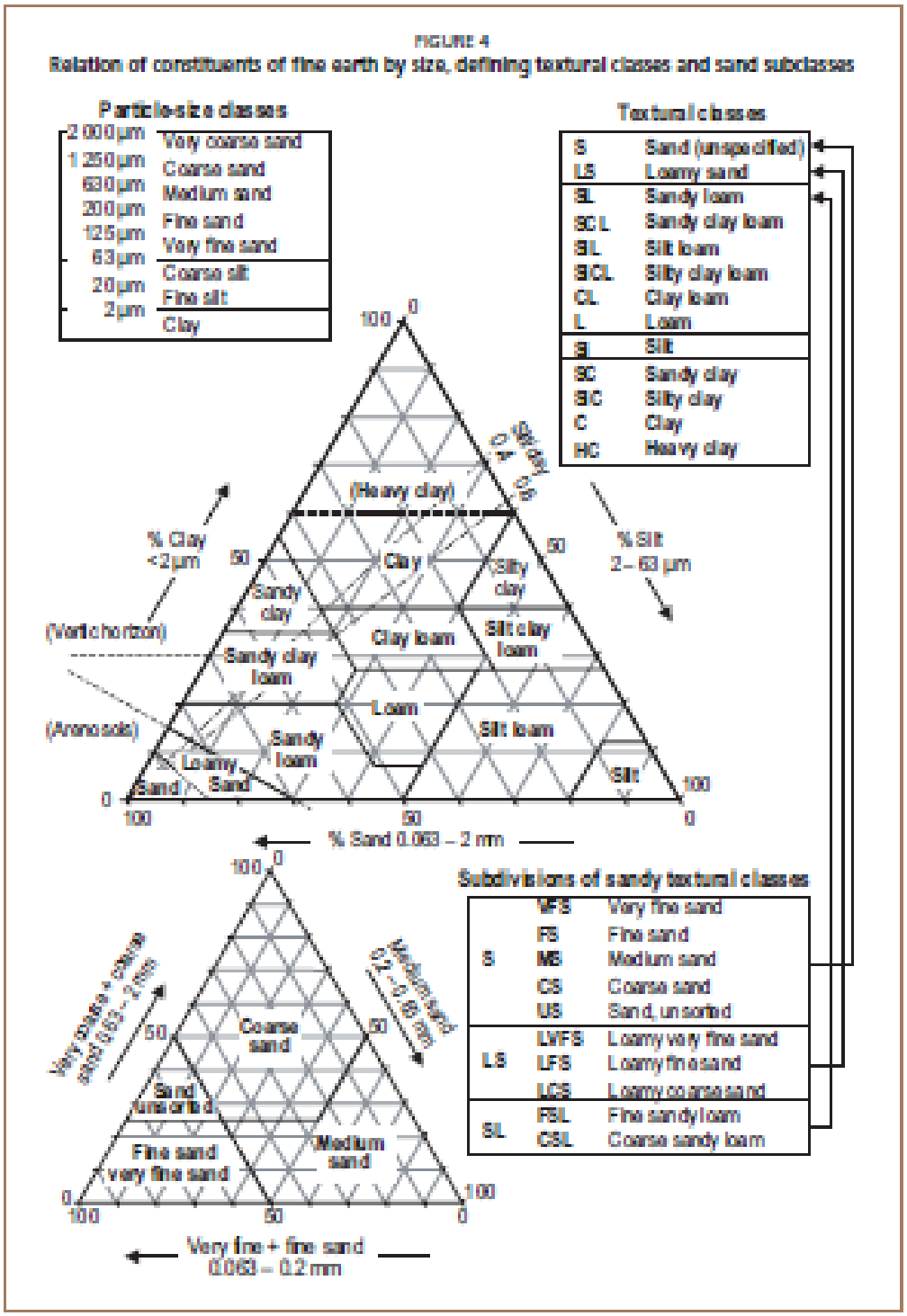


FIGURE 4
Relation of constituents of fine earth by size, defining textural classes and sand subclasses
Particle-size classes
2 000 µm
1 250 µm
630 µm
200 µm
125 µm
63 µm
20 µm
2 µm
Very coarse sand
Coarse sand
Medium sand
Fine sand
Very fine sand
Coarse silt
Fine silt
Clay
Textural classes
S Sand (unspecified)
LS Loamy sand
SL Sandy loam
SCL Sandy clay loam
SiL Silt loam
SiCL Silty clay loam
CL Clay loam
L Loam
Si Silt
SC Sandy clay
SiC Silty clay
C Clay
HC Heavy clay
% Clay <2 µm
% Silt 2 – 63 µm
(Heavy clay)
Clay
Silty clay
Sandy clay
Clay loam
Silt clay loam
Sandy clay loam
Loam
Silt loam
Sandy loam
Loamy Sand
Sand
Silt
(Vertichorizon)
(Aronosols)
% Sand 0.063 – 2 mm
Subdivisions of sandy textural classes
S
VFS Very fine sand
FS Fine sand
MS Medium sand
CS Coarse sand
US Sand, unsorted
LS
LVFS Loamy very fine sand
LFS Loamy fine sand
LCS Loamy coarse sand
SL
FSL Fine sandy loam
CSL Coarse sandy loam
Very coarse + coarse sand 0.63 – 2 mm
Medium sand 0.2 – 0.63 mm
Coarse sand
Sand unsorted
Fine sand very fine sand
Medium sand
Very fine + fine sand 0.063 – 0.2 mm

APPENDIX 12. Water Quality Summary

Date: 08th March 2016

The water quality parameter include:

In situ analysis	1. pH: Measuring acidity of the water body
	· temperature
	· Dissolve oxygen: amount of oxygen dissolve in water
	· Conductivity: ability conduct electivity of water
	· Total dissolve solid: amount of particle dissolve in water
	· Salinity

Ex situ analysis	1. Total suspended solid: amount of insoluble solids suspended in the water
	· Biochemical Oxygen Demand: amount of oxygen needed by microorganisms to biodegrade the organic matter in water.
	· Chemical Oxygen Demand: amount of oxygen needed by strong acid to degrade the organic matter in water.
	· Ammonical Nitrogent content: HACH method
	· Phosphate content: HACH method
	· Nitrite: HACH method
	· Nitrate: HACH method

Classification of river water quality

Water quality of a river can be classified into five (5) classes according to their Water Quality Index (WQI).The WQI is a method of combining six water quality parameters into one concise and objective value representing the state of the water quality trend. The six parameters used for the evaluation of the WQI values include:

1. Dissolved Oxygen (DO)
2. pH
3. Chemical Oxygen Demand (COD)
4. Biological Oxygen Demand (BOD)
5. Ammoniacal Nitrogen (AN)
6. Total Suspended Solids (TSS)

Calculations were performed not only on the parameters themselves but also on their sub-index whose values were obtained from a series of equations shown in Table 1.

Water quality index equation

Parameter	Sub-index Formula	Condition
DO	SIDO = 0	for $x \leq 8$
	SIDO = 100	for $x \geq 92$
	SIDO = $-0.395 + 0.030x^2 - 0.00020x^3$	for $8 < x < 92$

BOD	SIBOD = 100.4 - 4.23x SIBOD = 108e-0.055x - 0.1x	for $x \leq 5$ for $x > 5$
COD	SICOD = -1.33x + 99.1 SICOD = 103e-0.0157x - 0.04x	for $x \leq 20$ for $x > 20$
TSS	SISS = 97.5e-0.00676x + 0.05x SISS = 71e-0.0016x - 0.015x SISS = 0	for $x \leq 100$ for $100 < x < 1000$ for $x \geq 1000$
pH	SIpH = 17.2 - 17.2x + $5.02x^2$ SIpH = -242 + 95.5x - $6.67x^2$ SIpH = -181 + 82.4x - $6.05x^2$ SIpH = 536 - 77.0x + $2.76x^2$	for $x < 5.5$ for $5.5 \leq x < 7.0$ for $7 \leq x < 8.75$ for $x \geq 8.75$
NH_3-N	SIAN = 100.5 - 105x SIAN = 94e-0.573x - 5 $\lvert x-2 \rvert$ SIAN = 0	for $x \leq 0.3$ for $0.3 < x \leq 4$ for $x \geq 4$

These were best-fit equations obtained from rating curves. The sub-indices for the chosen parameters are named SIDO, SIBOD, SICOD, SIAN, SISS, SIpH and the formula used in the calculation is:

WQI = 0.22SIDO + 0.16SICOD + 0.15SIAN + 0.16SISS + 0.12SIpH + 0.19SIBOD

Based on the WQI value, a river segment can fall under any of the class listed in the table below.

Water quality index classes

Parameter	Unit	Classes				
		I	II	III	IV	V
Ammonical Nitrogen	mg/l	<0.1	0.1-0.3	0.3- 0.9	0.9- 2.7	>2.7
Biochemical Oxygen Demand	mg/l	<1	1-3	3-6	6-12	>12
Chemical Oxygen Demand	mg/l	<10	10-25	25-50	50-100	>100
Dissolve Oxygen	mg/l	>7	5-7	3-5	1-3	<1
pH	mg/l	>7.0	6.0-7.0	5.0-6.0	<5.0	>50
Total Suspended Solid	mg/l	<25	25-50	50-150	150-300	>300
Water Quality		>92.7	76.5-92.7	51.9-76.5	31.0-51.9	<31.0

Table 3: Definition for each class of river

Class	WQI	Designated used
I	>92.7	Excellent quality. Undisturbed
II	76.5-92.6	Class IIA : Good water quality, suitable for human use Class IIB: Protect sensitive species
III	51.9-76.4	Moderate water quality. Protect common and moderately tolerate species. Need extensive treatment for water supply
IV	31.0-51.8	Poor water quality. For irrigation purpose
V	<31.0	Very poor water quality. Not suitable for any use

RESULT

1. Physical and Chemical Parameter

GPS	Station 1 N 00° 56. 022' E 110° 40. 353'	Station 2 N 00° 56. 399' E 110° 40. 247'	Station 3 N 00° 56. 562' E 110° 40. 441'
Temp (°C)	24.6±0.0500	25.5±0.0500	26.57±0.0409
DO (mg/L)	9.15±0. 1476 106.4	9.07±0.0512 107.98	7.39±0.2594 90
Conductivity (mS/cm)	0.092±0.0005	0.08±0.0005	0.073±0.0000
Salinity (mg/L)	0.04±0.0000	0.04±0.0000	0.03±0.0000
TDS (mg/L)	60.45±0.0000	52.00±0.0000	46.15±0.0000
pH	7.80±0.4014	8.16±0.1314	8.19±0.0648
BOD (mg/L)	2.41±0.0282	2.86±0.1414	3.2±0.1272
COD (mg/L)	6.5±3.5355	0.000±0.0000	12.5±0.7071
NH_3-N (mg/L)	0.02±0.0111	0.000±0.0000	0.05±0.0187
PO_4^{3-} (mg/L)	0.31±0.0071	0.26±0.0269	0.30±0.0165
TSS (mg/L)	14±2.8284	20±0.0000	64±0.0000
Nitrate (mg/L)	0.035±0.0071	0.05±0.0000	0.095±0.0071
Nitrite (mg/L)	0.0035±0.0021	0.0035±0.0021	0.0045±0.0035

Water Quality Index

STATION 1

Parameter	Subindex Formula	Calculation
DO	SIDO= 100	100
BOD	SIBOD = 100.4 - 4.23x	90.206
COD	SICOD = -1.33x + 99.1	90.455
TSS	SISS = 97.5e-0.00676x + 0.05x	89.396
PH	SIpH = -181 + 82.4x - 6.05x^2	93.638
NH_3-N	SIAN = 100.5 - 105x	98.4

WQI = 0.22SIDO + 0.16SICOD + 0.15SIAN + 0.16SISS + 0.12SIpH + 0.19SIBOD

= 0.22(100) + 0.16(90.455) + 0.15(98.4) + 0.16(89.396) + 0.12(93.638) + 0.19(90.206)

= 93.91186

STATION 2

Parameter	Sub-index Formula	Calculation
DO	SIDO= 100	100
BOD	SIBOD = 100.4 - 4.23x	88.3022

COD	SICOD = -1.33x + 99.1	99.1
TSS	SISS = 97.5e-0.00676x + 0.05x	86.170
PH	SIpH = -181 + 82.4x - 6.05x^2	88.541
NH_3-N	SIAN = 100.5 - 105x	100.5

WQI = 0.22SIDO + 0.16SICOD + 0.15SIAN + 0.16SISS + 0.12SIpH + 0.19SIBOD

= 0.22(100) + 0.16(88.3022) + 0.15(99.1) + 0.16(86.170) + 0.12(88.541) + 0.19(100.5)

= 94.50044

STATION 3

Parameter	Sub-index Formula	Calculation
DO	SIDO = -0.395 + 0.030x^2 - 0.00020x^3	96.805
BOD	SIBOD = 100.4 - 4.23x	86.864
COD	SICOD = -1.33x + 99.1	82.475
TSS	SISS = 97.5e-0.00676x + 0.05x	66.457
PH	SIpH = -181 + 82.4x - 6.05x^2	88.046
NH_3-N	SIAN = 100.5 - 105x	95.25

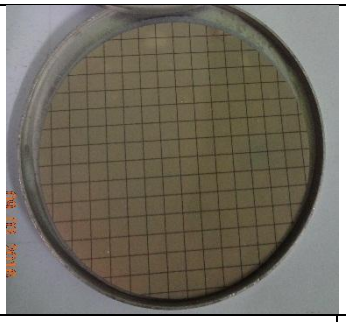
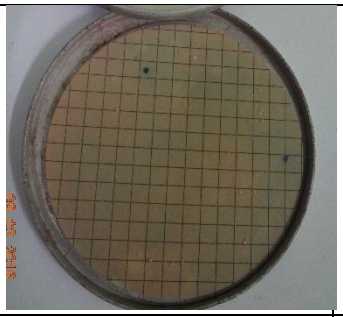
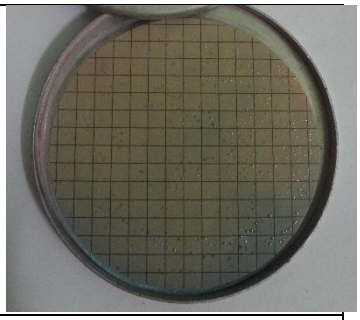
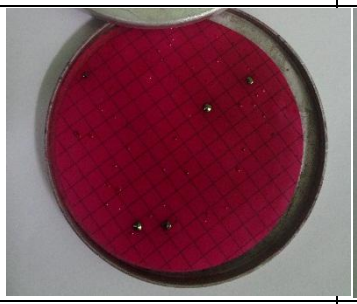
WQI = 0.22SIDO + 0.16SICOD + 0.15SIAN + 0.16SISS + 0.12SIpH + 0.19SIBOD

= 0.22(96.805) + 0.16(86.864) + 0.15(82.475) + 0.16(66.457) + 0.12(88.046) + 0.19(95.25)

= 86.86273 →

	Station	Volume of sample	Dilution factor	No of colony	mpN/100ml	Class
FCC Plate	1	6	10	0	0	I
	2	6	10	2	333.00	IIB
	3	6	10	3	500.00	III
TCC Plate	1	6	10	5	833.00	IIA
	2	6	10	7	1166.00	IIA
	3	6	10	9	1500.00	IIA

2. Biological Parameter

FCC mpn/100 ml			
	0	333.00	500.00
TCC mpn/100 ml			
	833.00	1166.00	1500.00

APPENDIX 13. Summarized Results from Soil Analysis.

	Color	pH-value	Bulk density (g/cm3)	Pox C (mg/Kg)	%C	%N	C/N
Top Pepper (S1)							
Top horizon	Dark yellowish brown (10YR3/4)	5.63 ±0.29*	1.26 ± 0.13	336 ± 362	2.36±0.76	0.22 ±0.05	10.63 ±1.96
Bottom Horizon	Dark yellowish brown (10YR3/4)	5.63 ± 0.13	1.33 ± 0.03	-72 ±124	0.86 ±0.09	0.11 ±0.02	7.58 ±0.21
Bottom Pepper (S2)							
Top horizon	Dark yellowish brown (10YR3/4)	5.70 ± 0.11	1.28 ± 0.01	552±149	2.17 ±0.34	0.25 ±0.05	8.91 ±0.26
Bottom Horizon	Dark yellowish brown (10YR3/4)	5.68 ± 0.06	1.15 ± 0.20	168 ±109	1.18 ±0.36	0.15 ±0.04	7.71 ±0.29
Oil Palm (S3)							
Top horizon	Brown (10YR5/3)	5.20 ± 0.29	1.11 ± 0.07	432 ±190	1.86 ±0.55	0.17 ±0.06	10.95 ±0.42
Bottom Horizon	Brownish yellow (10YR6/8)	4.98 ± 0.28	1.38 ± 0.10	48 ±41	0.57 ±0.14	0.07 ±0.01	7.25 ±0.87
Secondary Forest (S4)							
Top horizon	Yellowish brown (10YR5/6)	4.40 ± 0.09	1.13 ± 0.16	360 ± 190	2.05 ±1.44	0.16 ±0.06	11.80 ±4.02
Bottom Horizon	Brownish yellow (10YR6/8)	4.75 ± 0.12	1.35 ± 0.20	48±41	0.70 ±0.22	0.09 ±0.02	7.58 ±0.76

*First value represents the media and the second the standard deviation