

# **Analysis and characterization of farming systems in West Kalimantan**

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## **Introduction :**

Sumatra and Kalimantan are experiencing massive deforestation. It is likely that the forests will be replaced largely by monocrop plantations of oil palm and rubber because they seem to be more profitable. As deforestation is continuing, the jungle rubber agroforests are becoming increasingly important as a reservoir of forest diversity, but they are less productive. These facts raise the problematic of diversification for tree-crop smallholders.

Indonesia has the highest surfaces planted in rubber trees. Approximately 2 million hectares are made up of agroforestry systems where smallholders tap their trees intensely, with a low productivity.

Rubber is Indonesia's most important agricultural export commodity, and 75% of national rubber comes from smallholder's jungle rubber.

Moreover the sustainability of agriculture is becoming a major concern. The main questions concerning "ecological sustainability" are linked to the problem of degraded environment and fragile soils and thus fertility, biodiversity, and the protection of watersheds. Several farming systems offer potential solutions to these problems: agro-forestry, permanent vegetal cover cropping systems, etc. Crop diversification and rapid technical change characterise the evolution of existing farming systems. The history of these innovations and innovation processes are key elements to analyse and understand, and thus be in a position to make viable recommendations for development.

The survey I mean to do, is part of the project SRAP/CFC lead by CIRAD (Centre International de Recherche et d'Aide au Developpement, France) and ICRAF (International Center and Research for Agroforestry, Indonesia). It will consist in an analysis and a characterisation of farming rubber systems in 6 villages in Kalimantan. The fieldwork will be based at Sanggau in the province of West.

## **Project and research presentation**

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### **SRAS Project: Smallholder Rubber Agroforestry Project**

The Smallholder Rubber Agroforestry Project (SRAP) in Indonesia has identified the components of several improved rubber agroforestry systems (RAS) that maintain the economically and ecologically advantageous aspects of jungle rubber, with indications that the level of rubber productivity will be comparable to that of monoculture rubber gardens. Considerable research experience with these systems has been developed in the past ten years. The components of the improved rubber agroforestry systems (RAS) require only low to medium input levels but will elevate and diversify farm income through the use of rubber clones and associated perennial crops (viz. timber, fruits, pulp trees and rattan). Biodiversity and environmental concerns are addressed as well because these alternative systems very close to the highly biodiverse jungle rubber systems that of farmers currently practice.

RAS systems are currently under experimentation through participatory on-farm approach with farmers involved in the project. SRAP is validating an alternative model for rubber development projects to the current rubber monoculture development approach. A network of on-farm trial plots and budwood gardens has been established and will be augmented to fully document the best management practices for rubber agroforestry systems, obtain comprehensive financial analyses of their costs and benefits, enable farmers to have access to IGPM and evaluate and demonstrate the prospective advantages of these improved systems to smallholders in major rubber producing areas in Sumatra, West Kalimantan in Indonesia, and in Thailand with emphasis on timber/rubber association. The on-going trials enable the development and release of technical recommendations that fit a wide range of non-project farmer situations and strategies. The target is the population of poor farmers still relying on existing jungle rubber with a low productivity, facing the problem of replanting their plots with little capital and low labour.

### **The software Olympe**

INRA/ESR, IAMM and CIRAD have developed the Olympe software to model and simulate how farming systems function. The model is linked with a socio-economic analysis and takes all contextual situations into account. It enables identification of farmers' strategies and trajectories. Simulations permit prospective analysis based on the volatility of prices and/or the impact of climatic events. This software was first developed in close cooperation with a number of researchers from research institutions involved in tropical agriculture. Farming systems modelling provides reliable quantitative economic data on the different sources of income (from farming and off-farm activities), net return to investment, return to labour, and margins per activity.

Tools for farming systems analysis based on simulation and modelling like the software Olympe enable a comprehensive understanding of how a given farming

system functions, as well as provide a tool to model prospective technical choices, price scenarios, and even ecological scenarios.

Tools of this type that are based on the use of primary data collected during surveys for the characterisation of farming systems are essential to provide decision-making tools to key stakeholders in terms of development, adaptive research, project orientation...

### **Type of data required for farming systems modelling using Olympe**

Olympe is based on the characterisation of farming systems using a systemic approach. Consequently all the standard information that qualifies the structure and components of production factors of the farm is required. This information can be obtained by means of a traditional survey. In addition, as Olympe focuses on the origin of the different sources of income and provides an economic analysis, all this information should be collected at least at 4 levels:

**>cropping systems:** crops are divided into annual crops, perennial crops (minimum 5 years) and multi-annual crops (typically banana, pineapple and cassava, between 1 and 5 year cycles).

**>livestock systems:** whatever type of animal.

**>off-farm activity:** all activity that is not directly linked with agricultural or livestock production, including processing of primary products...

In these three systems, information concerning the cost of production, inputs and outputs and yields should be included here, i.e. all operational costs. If externalities can be quantified, they should also be included at this level. Labour requirements also have to be identified in order to calculate return to labour, which is a very important factor in making decisions for farmers.

**>production system:** at the "farm level" including the decision maker (the producer) and a strategy for the combination of production factors.

All non operational costs are considered here. So all sources of capital (income, including off farm, credits, loans), and all other expenses should be included here. Family accounts and business accounts can be separate but should be recorded.

All commodity prices should be collected, in particular taking into account local variations as well as international historical series of prices that will enable the building of potential scenarios.

## **Objectives and expected outputs**

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### **Objectives of using Olympe**

Olympe is based on the systemic analysis of farming systems. The overall objectives of using Olympe are the following:

- To test the economic impact of a technical choice (of a particular rice cropping systems for instance) for different types of farms.
- To compare economic results in various farm environment of a technical choice (or a technical pathway...).
- To identify smallholders' constraints and opportunities in a rapidly changing environment in preparation for the adoption of new cropping systems or any other organisational innovation.
- To assess their ability to adapt to changing economic conditions, price crises and technological change.
- To understand farmers' strategies and their capacity for innovation and to understand the farmers' decision-making process.
- To do a prospective analysis according to climatic events or prices volatility.
- To test the robustness of a technical choice according to climatic or economical uncertainties (effect of a drought, an "el nino » year , or price volatility...).
- To put information about farming systems in the social and economic context (through a regional approach).
- To calculate externalities, positive or negative, on the environment.

The research I want to do aims also to provide guidelines for agricultural and development policies for institutions or donors. Olympe can be used in a variety of situations and with different methodological approaches: comparison of cropping systems, the economics of farming systems and resources management ("farm management counselling"), prospective analysis, a regional approach.

### **Expected outputs:**

There are more and more problems in which several different stakeholders are involved, who often have different interests. The aim is not to find an optimal solution but to create models that lead to acceptable compromise between the different

stakeholders. Such problematic is so frequent that it is not possible to answer all these demands personally. The expected outputs are to develop methods and instruments, usable at local level, to facilitate discussion between the stakeholders involved as well as the emergence of acceptable compromise.

Another main outputs of such an approach is the assessment of the impact of technical alternatives or choices at the level of the farming system, both from an economic and environmental point of view. Olympe is feed with data from appropriate farming systems surveys and can then provide key information in terms of diagnosis and, later, in terms of prospective analysis.

These **results and outputs** are the following:

- Annual and perennial cropping patterns and technologies (technical pathways for monoculture, intercropping, agro-forestry systems etc.).
- A comparison between the different cultivation systems: costs, incomes and long term effects.
- An operational typology of situations and farmers leading to the identification of "topics of recommendations".
- A global overview of the possible adoption of rubber technology as a function of farmers' strategies and local conditions.
- An ongoing and dynamic data base on farming systems using Olympe software.
- The clear identification of the conditions required to ensure future projects are viable at the decision-making level.
- To provide better support for technical choices made by decision makers with respect to agricultural policy.

## Description of the research site

### Sanggau district

The study area of Sanggau district in the province of West Kalimantan have been identified by SRAP as representative of the traditional jungle rubber farming system developed by local farmers over the last 90 years.

The district of Sanggau is located in the central area of Kapuas River, between 1° N and 0°6' S and between 109°8' O and 11°33' E. The district is divided in 20 sub-districts and recovers 18 302 km<sup>2</sup>, 13 % of the province. The experiments describes in this study were located in the villages of Embaong, Kopar, Trimulya, Engkayuk, Sanjan and Pana (figure 1).



Figure 1: Map of the Kabupaten Sanggau

## **Physical and biological aspects**

- Climate : rainfall and temperature

In the district of Sanggau, annual rainfall varied from 2500 mm to 3500 mm (155 days per year). Annual temperature is on average 26 degree Celsius. Generally the dry season occurs from April/May to September, the rains starting in September and becoming heavy from November until February.

- Soils :

Soils in the province of Kalimantan are Acrisols associated with Ferrallic soils. These soils have good physical characteristics but poor chemical characteristics and become acid.

Four types of soils are present:

- alluvial deposits
- organosols
- podzols
- latosol

The agronomic importance of the rubber in this area is because rubber can content with poor soil.

- Vegetation :

The landscape of this area is dominated by logged-over forest, secondary forest and mosaic of smallholder rubber with secondary forest regrowth. Large scale logging activities have been taking place at the expense of primary forest. At present, the forest only exists in the hilly area and is very limited. Oil palm plantations and *Acacia mangium* plantations, in extension, have gradually limited the forest area.

- Population :

In 2003, the population of the entire district of Sanggau was 400 000 inhabitants. Population dynamics tend to be quite stable now but the annual population growth was very important between 1990 and 2003.

In West Kalimantan, we note the presence of 5 human groups: Dayaks, Chinese, Javanese, Madurese and Malay.

In my research villages, I will study only 2 ethnic groups who are the Dayaks (Embaong, Sanjan, Pana, Engkayuk and Kopar) and the Javanese (Trimulya).

# Methodology and research Schedule

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## Methodology

Tools for farming systems analysis based on simulation and modelling like the software Olympe enable a comprehensive understanding of how a given farming system functions, as well as provide a tool to model prospective technical choices, price scenarios, and even ecological scenarios.

Tools of this type that are based on the use of primary data collected during surveys for the characterisation of farming systems are essential to provide decision-making tools to key stakeholders in terms of development, adaptive research, project orientation...

Thus the field study will take place in many stages:

- Description and analysis of the main cultivation systems: Monoculture, RAS systems, Oil Palm...
- Description and diagnosis on local rubber based farming systems ( classical systemic analysis) .
- Analysis of the constraints and opportunities on the farms.
- Modelisation with the software « Olympe » of the farms of the SRAP farming systems reference network.

The **methodology** is based on the following stages for the diagnosis:

---> A preliminary diagnosis based on the study of all available information (bibliography, data collections, key-informants), and an exploratory survey.  
Survey of the characteristics of the farming system

---> To understand the constraints, opportunities, income and labour productivity of each cropping system and farm activities. The data analysis should provide an operational typology and a clear identification of constraints and opportunities.

An agronomic and socio-economic approach provides suitable technical pathways or improved cropping systems for farmers as well as ensures adequate conditions for the adoption and appropriation (of innovations) by farmers as a function of the different situations encountered in terms of further rubber development.

## **Research schedule**

The internship will take place between May and December 2005.

*From 15.05.2005 to 15.06.2005:*

### **Bibliographical study and training with Olympe.**

The first step of the training consists in collecting data about Indonesia. The bibliographical study insists especially on SRAS project and on the province of Kalimantan Barat. Files about SRAS / CFC project allow to understand the situation of the region and the objectives of the programme. Books about Indonesian History and Economy are also very useful, they are essential tools in order to understand the assets and the constraints in the country.

The Olympe training is necessary and very enriching. A good knowledge of the software is the basis of a successful, interesting and particularly correct study. The training gives a good idea of the possibilities of the software.

*From 15.06.2005 to 30.06.2005:*

### **Language courses.**

This training aims to give basic notions of Bahasa Indonesia. Two weeks are sufficient to acquire basis vocabulary and structures. The training focuses on the forestry aspects, that is very useful. Of course, this training does not last enough in order to become linguistically independent. The first surveys have to be achieved with somebody from the country.

*From 01.07.2005 to 15.07.2005:*

### **Analysis of the previous surveys.**

Preliminary surveys give a good idea of the situation, but also allow to define better the subject. Thus the study focuses on the missing data and the assertion or contradiction of hypothesis previously made must be a topic of interest too.

The surveys based on rubber growth data are very useful tools. They bring valuable information about the cultural itineraries and practises. The description of the cultivation systems start with the analysis of these data.

*From 15.07.2005 to 30.08.2005:*

### **Characterisation of the cultivation systems.**

The first step of the research on the field consists in an inventory of the main cultural itineraries and practices for each type of cultivations: RAS 1, RAS 2, RAS 3, RAS sendiri, Rubber Monoculture with project, Rubber Monoculture sendiri, Oil palm, Jungle Rubber, Ladang, Sawah, Tembawang...

To each different type of cultivation systems corresponds a precise questionnaire. The modelisation with the software Olympe follows the collect of the data.

From 01.09.2005 to 30.10.2005:

**Characterisation of the farm systems.**

This characterisation uses the inventory realized during the previous step. This time, the questionnaire takes into account the whole farm, with all the cultivation systems it includes. So the research results in determination of assets and constraints related to the farming systems.

From 01.11.2005 to 30.11.2005:

**Analysis of the results.**

Some days are planned in order to tackle precise questions raised by the surveys. The presentations to the farmers and then to Icrاف follow the analysis of the results. That enables to assert the results.

From 01.12.2005 to 31.12.2005:

**Editing of the report in France and presentation.**

## **Results and Discussions**

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### **RAS : CONSTRUCTIONS AND INTERPRETATIONS OF THE MODELES**

A particular attention has been given to the RAS (Rubber Agroforestry Systems) analyses, here are their different characteristics.

- RAS 1 reminds of the jungle rubber system. However clonal material is used instead of local rubber trees. The maintenance just concerns rubber trees, natural vegetation grows in the inter rows till the rubber trees begin to produce.
- RAS 2 associates timber and fruit trees in the inter rows. Their productions aim to complete the incomes from rubber.
- RAS 3 is an « anti Imperata » strategy, cover crop and fast growing trees are planted in inter rows to avoid the colonization of "*Imperata cylindrica*".

After 10 years experimentations and 3 years cloned rubber production, first data are available. This paragraph deals with economic analyse of RAS. First, we will describe the construction of the models and the problems rose. Then the economic results will be presented. Finally the attention will focus on RAS perspectives.

### **Construction of the models and problems raised**

#### **The collect of the data**

This is a two step procedure. First the data available in the Icrاف Office in Sanggau have been analysed and then missing data have been collected directly with the farmers.

Icrاف has all the experimentations protocols of RAS. In each type of RAS, different sub groups can be defined, depending on the level of maintenance, the soil quality and the type of vegetation in the inter rows.

- RAS 1– High maintenance during the immature and mature period
  - Low maintenance
- RAS 2- Good soil conditions
  - Bad soil conditions (Trimulya)
- RAS 3- Cover crop in inter rows
  - Fast growing trees in inter rows

Many data have been collected in the research center; the maintenance of the RAS plot during the immature period has been planned by Icrاف. Moreover, data about rubber production are regularly realised, thus the yield are easily available.

The surveys with farmers focused more on the missing data:

- ◆ The maintenance of the plot during the mature period
- ◆ The labour needed for the tapping and the others activities
- ◆ The farmers' impression about RAS

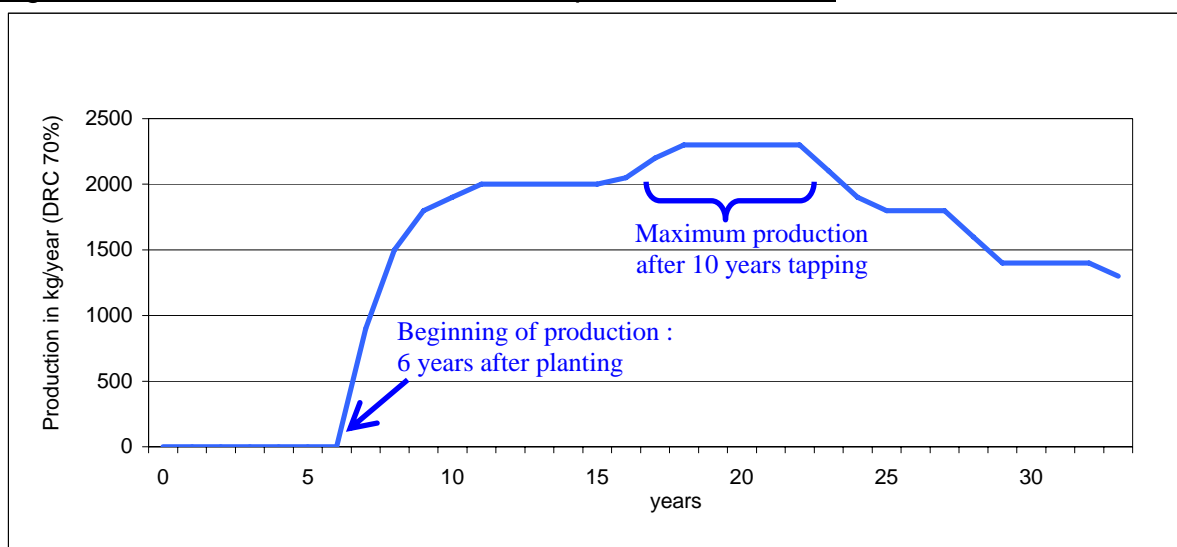
## Cultivations' life cycle and modelisation

The modelisation with the software Olympe necessitates precise knowledge about the cultural practises and the yields of the system throughout its life cycle. But currently no data are available concerning the future yields of the RAS. Moreover, their production began 3 years ago, so it remains difficult to estimate the possible differences of yield between the systems. Finally there are many factors influencing the production: tapping quality, disease, soil fertility... , it is difficult to accurate the modelisation without hind sight.

Considering these hindrances, an hypothetic evolution of the production of latex has been realised. Its building has been based on several elements:

- The yield of the different systems during the 3 first years of production
- The evolution of the yield of older cloned rubber systems
- The behaviour of the clones PB 260 in research station

Figure : Estimated evolution of the RAS' production of latex



This curve has been chosen for each RAS in spite of the inaccuracies it contains. Knowing that, the analysis will focus on the immature period.

A problem raised by the modelisation concerns the beginning of the production of latex. Different treatments have been applied on the plot: vegetation in inter rows and fertilization influence the growth of the rubber trees. In theory, the tapping begins when the trees' circumference reaches 40 cm; the more the trees grow fast, the more the tapping can begin early.

As the plots received different treatments, they should start to produce at different moment. In fact, the current data are not sufficient now to confirm such hypothesis.

- For a same treatment, 2 plots can give different results: disease, soil fertility,...
- For technical reasons the tapping starts at the same time for all the farmers for the village considered. Some farmers have had to wait till the others were ready.

But the estimation that RAS 1 begins to produce on year after because of the competition in the inter rows is not far from reality.

Finally for practical reasons, we considered that the planting occurred at the beginning of the year 1 and that the soil preparation (slash and burn) took place in year 0.

### Adaptation of the modelisation to the first results of the experimentations

In some cases, the results of the experiments did not fit to the expectations of both farmers and Icrat. So we decide not to modelize the systems that were not satisfying. The study does not exclude them, but they were modified a little so that they correspond more to the expectations and considering the results of experiments.

RAS 2' experiments show the limits of trees association, such as timber trees or fruit trees. Some die and some others do not produce any fruits. This is partly due to the high density of associated trees. Thus the density chosen for the modelisation is lower than the one applied in reality. On the other hand, some trees species are not adapted to association with rubber trees, such as ramboutans and mangles. They have been replaced by Jengkol and petai in the model. (More detailed presentation in the following part).

Finally, RAS 3 experiments aimed to find efficient way to fight Imperata and other weeds without using chemical products. The idea was to plant cover crops or fast growing trees in the inter rows. The study only deals with the systems that have been the more efficient: Acacia for the fast growing trees and the association Flemingnia-Gamal for the cover crops.

### Presentation of RAS and economics outputs

The analysis insists on the economic aspects and particularly deals with the immature period as all the data are not available for the moment concerning the mature period.

All the models share some characteristics:

- The cloned seedling are supplied in the form of polybags, which costs 2500 Rp per unity (price 2005).
- The type of the clones is PB 260, because they are considered as more efficient.
- The planting density is equal to 550 trees par hectare.
- The planting occurs at the beginning of the year 1 whereas the soil preparation takes place the year before (in June year 0).
- Usually the farmers have 0.5 ha of RAS, the tapping of the trees takes 4 hours (1 person) in the morning, 2 to 4 times a week depending on the weather.

In this part, we will work with constant prices, reference 2005. We also consider that the prices of inputs and paid labour do not increase outside inflation.

## RAS 1, Cloned rubber trees and natural vegetation in inter rows

The plots of RAS 1 are characterized by the lack of maintenance in the inter rows. However, when the trees become mature (after 7 years), the farmers clean completely the inter rows. This aims to avoid the competition in order to increase the yield of rubber.

During the immature period, the maintenance (weeding and fertilization) of the trees are carried out in groups: Kelompok from SRAS project. When the rubber trees begin to produce, the labour only comes from family.

The felling and the weeding of the inter rows occurs in year 8, the farmer employs paid labour. It represents 12 mandays, it costs 20 000 rupiahs per manday, so be it 240 000 Rp.

### *RAS 1 « extensiv », regular maintenance, control of the costs*

This system is qualified as “extensive”, considering the inputs. Therefore, the fertilization is reduced but regular during the immature period. Moreover the use of chemical products is also reduced as the weeding of the rubber trees is manual during the first years.

Tablor : Maintenance calendar

Years	Immature period				Production period					
	1	2	3-4	5+	8	9	10+	18+	23+	28-33
<b>Fertilizations</b>	1	1	2		Once every 2 years					
<b>Weeding</b>										
<i>Manual</i>	2	2	3	2	1	1	1	1	1	1
<i>Chemical</i>	0	0	0	1	1	1	1	1	1	1

Fertilization : During the immature period :

**Urea** 50g /tree so **27.5 kg /ha**

**TSP** 40 g /tree so **22 kg /ha**

**KCI** 25 g /tree so **13.75 kg /ha**

The work is carried by the kelompok: 2.5 mandays per ha

During the production time, there is a fertilization of 50 kg Urea every 2 years.

It takes 0,5 manday / ha, the products are thrown.

Weeding :

*Manual* : Rows only during the immature period : 5 mandays /ha, otherwise 10 mandays

*Chemical* : 2 L of Round Up used per going past

Each going past corresponds to 1 manday / ha

Tablor : Need of money and time during the immature period : RAS 1 « extensiv »

Years	0	1	2	3	4	5	6	7	
<b>Costs</b> (in K Rp)	Inputs	0	1 588	113	226	226	100	100	100
	Labour	0	0	0	0	0	0	0	0
	<b>Total</b>	<b>0</b>	<b>1 588</b>	<b>113</b>	<b>226</b>	<b>226</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Labour needed</b> (in mandays)	<b>110</b>	<b>53</b>	<b>13</b>	<b>20</b>	<b>20</b>	<b>13</b>	<b>13</b>	<b>13</b>	

## RAS 1 « intensive »

This system is qualified as « intensive », considering the inputs. The fertilization is very high during the 2 first years. After it is quite regular since the trees produce. However, concerning the maintenance or the rows, use of chemical products is preferred to manual work. This may mean that there is a lot of weeds or that there is not a lot of worker available: chemical weeding is more expensive but need less labour.

Tablor : Maintenance calendar

Years	Immature period				Production period					
	1	2	3-4	5+	8	9	10+	18+	23+	28-33
<b>Fertilizations</b>	4	4	1		1	1	1	1	1	1
<b>Weeding</b>	1	2	1	0	1	1	1	1	1	1
<i>Manual</i>										
<i>Chemical</i>	1	2	2	1	2	2	2	2	2	2

Fertilization : During the immature period :

**Urea** 50g /tree so **27.5 kg /ha**

**TSP** 40 g /tree so **22 kg /ha**

**KCl** 25 g /tree so **13.75 kg /ha**

The work is carried by the kelompok: 2.5 mandays per ha

During the production time, there is a fertilization of 60 kg NPK every year.

It takes 1 manday / ha, the products are buried.

Weeding :

*Manual* : Immature period: Rows only, 5 mandays /ha

Production time: rows and inter rows, 10 mandays/ ha

*Chemical* : 2 L of Round Up used per going past

Each going past corresponds to 1 manday / ha

Tablor : Need of money and time during the immature period : RAS 1 « intensive »

Years		0	1	2	3	4	5	6	7
<b>Costs (inK Rp)</b>	Inputs	0	2 139	651	313	313	100	100	100
	Labour	0	0	0	0	0	0	0	0
	<b>Total</b>	<b>0</b>	<b>2 139</b>	<b>651</b>	<b>313</b>	<b>313</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Labour needed (in mandays)</b>		<b>110</b>	<b>56</b>	<b>22</b>	<b>10</b>	<b>10</b>	<b>1</b>	<b>1</b>	<b>1</b>

Thus, each type of RAS 1 corresponds to different constraints. When there is a lot of labour, the use of inputs can be reduced. This allows saving but the maintenance has to be regular.

On the other side, when the labour available is limited, it remains possible to decrease the labour time using chemical products.

Although there are different types of RAS 1, these systems do not require a lot of inputs, as there is no maintenance of the inter rows during the immature period.

## RAS 2, Cloned rubber trees and associated trees

Timber and fruit trees are associated in RAS 2, these plantations aim to complete the incomes from the rubber production. But the experimentations show the limits of such systems.

According to the experiments in the field, the density should not exceed 100 trees per hectare in order to avoid competition with the rubber trees. Moreover, experiments show that some kind of trees grow better in association. Ramboutans and mangles, if they do not die, do not produce any fruit when they are associated with rubber trees. On the other hand, durian, petai and jengkol trees give good results. Timber trees such terindak and nyatu also show good aptitudes to grow in agroforestry systems. These trees have been chosen for the modelisation. Thus, in a plot of one hectare we consider that there are 80 associated trees: 60 fruit trees and 20 timber trees.

During the immature period, maintenance (fertilization and weeding) are carried out in groups: Kelompok from SRAS project. When the rubber trees begin to produce, the labour only comes from family.

### *RAS 2 in good soil conditions*

Paddy cultivation is realised during the 2 first years after the opening of the land. Fertilization is brought the second year in order to get a quite good yield. In this case, the soil conditions are quite good, the fertilization of the rubber trees is not very high. Furthermore, there is no big risk of Imperata's invasion, manual weeding is enough to prevent weeds. The costs in money and labour are quite big, because of the regular maintenance that is needed to reach the objectives of production.

Tablor : Maintenance calendar

Years	Immature period				Production time					
	1	2-3	4-5	6	7	8+	10+	18+	23+	28-33
<b>Fertilizations</b>	1	1	2							
<b>Weeding</b>										
<i>Manual</i>	2	3	1	1	2	2	2	2	2	2
<i>Chemical</i>	1	1	1							

Fertilization : During the immature period :

**Urea** 50g /tree so **27.5 kg /ha**

**TSP** 40 g /tree so **22 kg /ha**

**KCI** 25 g /tree so **13.75 kg /ha**

The work is carried by the kelompok: 2.5 mandays per ha

No fertilization during the mature period.

Weeding :

*Manual* : Rows and inter rows, 10 mandays /ha

*Chemical* : 2 L of Round Up used per going past  
Each going past corresponds to 1 manday / ha

Tablor : Need of money and time during the immature period : RAS 1 « extensive »

Years		0	1	2	3	4	5	6
<b>Costs (inK Rp)</b>	Inputs	0	2 341	241	241	254	254	28
	Labour	0	0	0	0	0	0	0
	<b>Total</b>	<b>0</b>	<b>2 341</b>	<b>241</b>	<b>241</b>	<b>254</b>	<b>254</b>	<b>28</b>
<b>Labour needed (in mandays)</b>		<b>118</b>	<b>125</b>	<b>56</b>	<b>56</b>	<b>15</b>	<b>15</b>	<b>30</b>

### RAS 2 in bad soil conditions and risks of Imperata

This systems corresponds to specific soil and vegetation conditions. The culturam practices are adapted to the low fertility of the soil and to the high risks of *Imperata cylindrica*. The degree of fertilization is high and the use of chemical products remains systematic to fight weeds. Moreover, paddy is being grown during the 2 first years, fertilization is needed every year to get a good yield.

Tablor : Maintenance calendar

Years	Immature period				Production time				
	1	2-3	4	5-6	7	8+	10+	18+	23-28
<b>Fertilizations</b>	1	3	2	1	2	2	2	2	2
<b>Weeding</b>									
Manual	3	2	1	1					
Chemical	1	1	1	1	2	2	2	2	2

Fertilization : During the immature period :

**Urea** 50g /tree so **27.5 kg /ha**

**TSP** 40 g /tree so **22 kg /ha**

**KCl** 25 g /tree so **13.75 kg /ha**

The work is carried by the kelompok: 2.5 mandays per ha

During the production time, there is a fertilization of 50 kg Urea 2 times a year.

It takes 1 manday / ha, the products are buried.

Weeding :

Manual : Rows and inter rows, 10 mandays /ha

Chemical : 2 L of Round Up used per going past

Each going past corresponds to 1 manday / ha

Tablor : Need of money and time during the immature period : RAS 1 « extensive »

Years		0	1	2	3	4	5	6
<b>Costs (inK Rp)</b>	Inputs	639	2 530	546	466	354	341	341
	Labour	0	0	0	0	0	0	0
	<b>Total</b>	<b>639</b>	<b>2 530</b>	<b>546</b>	<b>466</b>	<b>354</b>	<b>341</b>	<b>341</b>
<b>Labour needed (in mandays)</b>		<b>113</b>	<b>173</b>	<b>106</b>	<b>19</b>	<b>13</b>	<b>14</b>	<b>14</b>

A quick analyse show that there are 2 different types of RAS 2. But the management can vary between the 2 systems described according to the conditions

of each plot. The main advantage of RAS 2 remains to create a new source of income. This is quite adapted to farms that do not have tembawang (kind of orchards). But often in Dayak villages (Sanjan, Pana), farmers have access to old tembawang, that are very productive.

Otherwise plantation of associated trees with a long life cycle can be transmitted to the next generation, it is a kind of natural capital.

### RAS 3, Fast growing trees or cover crops

These systems have been created in order to develop cultivations on plots that were taken up by *Imperata cylindrical*. It also aims to find new ways to fight against weeds without using chemical products. Cover crops or fast growing trees are planted in the inter rows in order to avoid the growth of weeds here. But this is only efficient during the first years, after the plot is managed as a monoculture.

Paddy cultivation is realised during the first year, a high fertilization is brought in order to get a quite good yield.

#### *RAS 3, Fast growing trees*

According to the field experimentations, Acacia are the more efficient fast growing trees. But they have to be cut the fourth year, since they begin to create competition with rubber trees.

The density in inter rows is equal to 550 trees per hectare. The felling occurs in the year 4 and calls on external and paid labour, it costs 200 000 Rp for one hectare.

The fertilization and the weeding are important in spite of trees in inter rows.

Table: Maintenance calendar

Years	Immature period					Production time					
	1	2	3	4	5-6	7	8+	10+	18+	23+	28-33
<b>Fertilizations</b>	RP	3	3	2							
<b>Weeding</b>											
<i>Manual</i>	3	1	1	1	1	1	1	1	1	1	1
<i>Chemical</i>	0	2	3	1	1	1	1	1	1	1	1

Fertilization : During the immature period :

**Urea** 50g /tree so **27.5 kg /ha**

**TSP** 40 g /tree so **22 kg /ha**

**KCl** 25 g /tree so **13.75 kg /ha**

The work is carried by the kelompok: 2.5 mandays per ha.

No fertilization during the mature period.

Weeding :

*Manual* : Rows only till the year 3: 5 mandays /ha, otherwise 10 mandays /ha.

*Chemical* : Each going past corresponds to 1 manday / ha.

2 L of Round Up used per going past the first years.

2L of Round up and 2 L of gramoxan per going past.

Table: Need of money and time during the immature period : RAS 1 « extensive »

Years		0	1	2	3	4	5	6
<b>Costs (inK Rp)</b>	Inputs	639	1 753	538	638	406	180	180
	Labour	0	0	0	0	200	0	0
	<b>Total</b>	<b>639</b>	<b>1 753</b>	<b>538</b>	<b>638</b>	<b>606</b>	<b>180</b>	<b>180</b>
<b>Labour needed (in mandays)</b>		<b>119</b>	<b>74</b>	<b>15</b>	<b>16</b>	<b>31</b>	<b>11</b>	<b>11</b>

### RAS 3, cover crops

According to the field experimentations, the association *Flemingia / Gamal* is the more efficient. These cover crops die after 5 years of growth. Then the maintenance is more intensive and the weeding occurs in the rows and in the inter rows.

Tablor : Maintenance calendar

Years	Immature period					Production time					
	1	2	3	4	5-6	7	8+	10+	18+	23+	28-33
<b>Fertilizations</b>	2	3	1	1							
<b>Weeding</b>											
<i>Manual</i>	3	1	1								
<i>Chemical</i>	0	2	1	2	2	2	2	2	2	2	2

Fertilization : During the immature period :

**Urea** 50g /tree so **27.5 kg /ha**

**TSP** 40 g /tree so **22 kg /ha**

**KCI** 25 g /tree so **13.75 kg /ha**

The work is carried by the kelompok: 2.5 mandays per ha.

No fertilization during the mature period.

Weeding :

*Manual* : Rows only: 5 mandays /ha.

*Chemical* : Each going past corresponds to 1 manday / ha.

Year 1 to 4

2 L of Round Up used per going past the first years.

Since year 5: there is no more cover crop in inter rows

1.5 L of Round up and 1.5 L of gramoxan per going past.

Dés herbages :

*Manuels* : Rangs seulement, 5 mandays /ha

*Chimiques* : Chaque passage de dés herbant correspond à 1 manday/ha

Années 1 à 4

Utilisation de 2L de Round Up /ha à chaque passage

A partir de l'année 5 : plus de plantes de couverture en interligne

Utilisation d'un mélange Round Up Gramoxan, avec 1,5L de chaque produit /ha

Tablor : Need of money and time during the immature period : RAS 1 « extensive »

Years		0	1	2	3	4	5	6
<b>Costs (inK Rp)</b>	Inputs	639	2 004	538	213	313	270	270
	Labour	0	0	0	0	0	0	0
	<b>Total</b>	<b>639</b>	<b>2 004</b>	<b>538</b>	<b>213</b>	<b>313</b>	<b>270</b>	<b>270</b>
<b>Labour needed (in mandays)</b>		<b>123</b>	<b>74</b>	<b>15</b>	<b>9</b>	<b>5</b>	<b>2</b>	<b>2</b>

The fast growing trees and the cover crops are only efficient during the first years. The use of chemicals products is reduced only during this period.

### **RAS and development perspectives**

The RAS show a high variety of systems, considering both the costs and the labour. The RAS have been producing for 3 years. Although it is still too early to make hypothesis for the future productions, it is already interesting to go further in some observations.

First we will study the framers' reactions to RAS and the adoption ways of agroforestry systems. Then, we will see some ideas of development and finally we will analyse the diversity of RAS systems facing the variety of the situations.

#### **First observations after 3 years rubber production**

##### *Adoption and sharing of the knowledges*

The Dayak farmers already knew the running of rubber trees via 'jungle rubber' systems. Rubber trees were introduced in the beginning of the 20<sup>th</sup> century in Indonesia. The traditional system consisted in planting local rubber trees after ladang. This system did not need a lot of maintenance, that constitutes a quite important difference with cloned rubber trees.

Many SRDP projects (Smallholder Rubber Development Project) have been undertaken in the 80's and 90's, in particular in the area of Sanggau. The knowledge about cloned material's maintenance began to spread at that time but there was no real following up, that limited the process of adoption.

SRAS farmers benefit from the knowledge and the advice from Icraft, they learnt rather quickly the know-how of such systems. Some of them undertook to plant cloned rubber trees on their own initiative, of course when they have the financial, land and logistic means. Moreover the development of nursery also shows the good impacts of the project in the villages. However in some places only a minority of farmers have access to such knowledge (this will be developed later).

Finally the systems the farmers undertake on their own also show the spread of the knowledge: agroforestry systems are preferred to monoculture. That can be partly related to SRAS activities even if there is a long and old tradition of agroforestry in Kalimantan. The analysis of these systems "sendiri" is very interesting since it shows the farmers' expectations.

### *Limits of the systems*

However the observations in the fields highlight the limits of the RAS systems too. Thus RAS 3 reaches only partly its objectives; the use of chemical products is reduced during the first years, after the system quickly turns in monoculture. Moreover the cover crops used are not as efficient as the ones used in industrial plantations (LCC).

Concerning the planting of fast growing trees, the results show a mixed picture; In one hand Acacia trees grow fast enough to avoid significantly the development of weeds in the inter rows. On the other hand, after 3 years they become too big and begin to make competition with rubber trees, they have to be felt down. At that moment the wood is too young to be used.

Moreover farmers are not keen on cultivations in inter rows, especially when they are invasive. Cloned rubber trees are more sensitive to disease and need more maintenance, but the yield is higher. The farmers try at the most to avoid competition with the rubber trees. All the more so since they depend a lot on the rubber plot: main source of incomes, necessity to enter in production as soon as possible because of the constraints of the farming systems (credit repayment, end of production of another plantation,...)

Finally it remains essential to consider the system in its whole context and environment; if one type of cultivation is adapted in one place, it may not suit to other expectations and constraints in another place. The production of fruits and timber in the RAS 2 provide complementary incomes but also requires more maintenance (costs and labour).

For example: the durian season occurs in December and the fruits have to be harvested quite quickly. This represents additional work in a short while, labour has to be available. Moreover this activity is profitable only if there is outlet for the production: First, demand and second, infrastructures. Generally infrastructures are missing: bad road conditions, transport long and uneasy...

The running of a RAS 2 plot requires high investment in terms of time and money, thus it is adapted to precise conditions.

### Ideas of development

#### *Limitation of the costs*

One of the main assets of RAS compared to monocultures systems remain the limitation of the costs at least during the immature period. But some other expenses can also be reduced.

At the first sight the question of the profitability of the fertilization of rice in RAS 2 and 3 can be raised. There is fertilization the year before planting the rubber trees in RAS 3 and RAS 2 “bad soil conditions”, and also the year after for both RAS 2 (“good soil conditions” and “bad soil conditions”). The fertilization of one hectare paddy costs 640 000 rroupiahs. This represents a big expense.

One kg paddy costs 2000 roupiahs (price 2005), so the increase of the paddy production due to the fertilization should reach at least 320 kg to make the fertilization profitable. But it is not generally the case, so economically considered these input is often not useful.

Moreover, the purchase of the inputs for the fertilization takes place in a difficult moment. The farming system has already to buy cloned seedling and fertilizers for the rubber trees. The farmers do not have the means for such an investment.

Another expense can also be reduced; the models take into account the purchase of polybags, which costs 2500 roupiahs per unity. These kind of seedlings better resists to the planting , the mortality rate is lower. Nevertheless, the farmers generally do not buy such polybags, they prefer budded stamps. The mortality rate is higher and but they only cost 1000 roupiahs per unity.

### *Adaptation to the demand*

Many cloned rubber trees plantations are undertaken on the farmers' own initiative around Sanggau. More and more of these plantations are agroforestry systems: generally timber trees are associated to rubber trees, the planting density is more or less important. Timber trees need only low maintenance. The felling requires a lot of labour, but just for a short while compared to harvesting fruits. The lack of infrastructures has already been evocated to explain partly this choice.

The association timber trees and rubber trees is worth studying. For the moment, farmers do not take into account the minimum spacing between the trees to avoid competition, generally by lack of information.

### Diversity of the systems for various situations

Even if a system seems to be very efficient, it has to be adapted to the context in order to be satisfying. The diversity of RAS allows choosing the system the more adapted to the farm's situation. The following paragraph illustrates this idea.

### *RAS 1 and accumulation in kind*

RAS 1 aims to reduce the costs during the first years, thanks to the limited use of chemical products. Natural vegetation grows in the inter rows, thus rubber trees grow less quickly and begin to produce later.

Let us consider the case of farmers that already have a cloned rubber trees plantation, which is still producing. RAS 1 is particularly adapted; it does not need lot of maintenance and the trees do not have to produce quickly. The plot also establishes the private property and constitutes an accumulation or capitalisation in kind. The farmers can also intend this plot to the children.

The idea of capitalisation in kind is largely widespread in the area of Sanggau. Many farmers keep on planting cloned rubber trees even if they have enough surface area to permit the renewal of the rubber production.

## *RAS 2 and labour in abundance*

RAS 2 costs a lot in labour and money. However the costs (in money) can be reduced and the consumption of chemical products can be decreased using more manual labour. Here the idea is to use labour in abundance while the land is the limiting factor.

This situation corresponds quite well to the ones of transmigrants farmers in Trimulya, but can be extended to all farming systems whose limiting factor is the land.

## **CHARACTERIZATION OF THE VILLAGES**

### **Pana : a traditional village in conversion**

#### History of the village

Nearly all the area of Pana is sloping, the road from Sanggau remains passable even if in bad conditions. The access to the village is uneasy, this element should be considered carefully as it influences the possibility of marketing.

Pana is a traditional Dayak village, the population comes from the village or from the ones around. Generally at least one member of the household is a native of Pana and the new farm gets land from the parents (gift, sale or lending). Nowadays there are usually only 2 children per family, whereas in the past the number of children reached 4 or 5. This is partly due to the priority given to education. The schooling costs are high and the parents can not afford them for many children.

Since the introduction of rubber trees in Indonesia at the beginning of the 20<sup>th</sup> century, farmers have been exploiting these trees in jungle rubber. In Pana the area planted with local rubber trees are extensive. All the plots available in one farm are or were not tapped at the same time, the farmer can choose the most efficient place (accessibility, trees density, production, distance)

The productions from ladang were essentially intended to self consumption, the surplus of vegetables was sold in the market and the money was used for daily expenses as the incomes from rubber were. These incomes were insufficient to consider any investment.

In 2002, the population of Pana welcomed the SRAS project with enthusiasm. Then the farmers got organised in order to get the support from Disbun in order to create new plantations of cloned rubber trees. Each family in the village takes part to this project and will get 0.5 ha of clones. The Disbun's contribution of clones solved the problem of initial investment. Moreover, the acquisition of knowledge was very quick as the development of nurseries shows it. The projects gave solutions to the small possibilities of investment but also to the lack of access to knowledge and vegetal material.

## The main groups of farming systems

### Abundance of land and traditional system in conversion

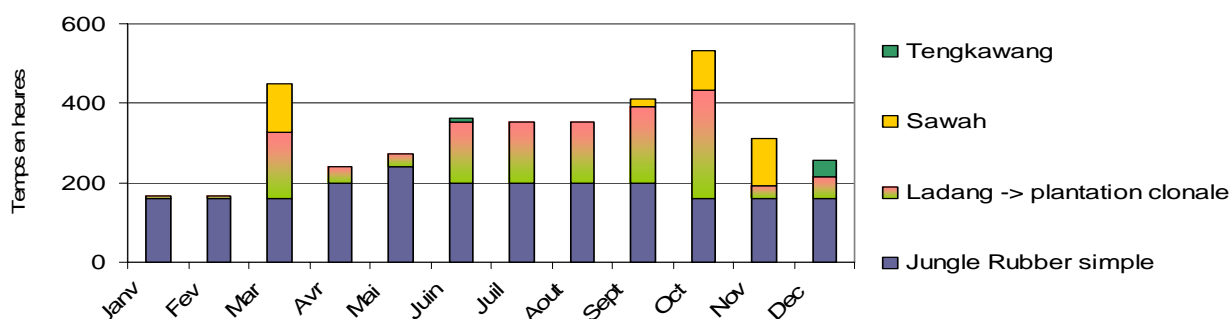
#### History of the farm:

In relief, abundance of land  
 Traditional Dayak system :  
 • Old practice of ladang and sawah  
 • Jungle Rubber  
 Undergoing a transformation:  
 • Adoption of cloned rubber trees  
 (SRAS, Disbun)

#### Ressources:

2 workers available  
 18 ha:  
 - 6 ha jungle rubber, 2 ha tapped  
 - 1 ha sawah, 0,5 ha planted  
 - 8 ha bawas, 1 ha ladang each yera  
 - 3 ha tembawang (family and private)  
 Simple material (parang, sabit, cankul)

#### Calendar labour :



#### Economical results :

	Margin /ha ( Rp /ha)	Area on the farm	Margin on the farm ( Rp/an)
Jungle Rubber	4 100 000	2 ha	8 000 000 Rp / year
Ladang	1 500 000	1 ha	1 500 000 Rp / year
Sawah	1 300 000	0,5 ha	650 000 Rp / year
Tembawang	15 000 000	0,06 ha	900 000 Rp / year
Fowl			324 000 Rp / year
Pigs			480 000 Rp / year
<b>Total Margin on the farm:</b>			<b>11 854 000 Rp / year</b>

#### Incomes :

<b>Gross Product:</b>	<b>12 100 000</b>	<b>Rp / year</b>
- Intermediate consumption:	250 000	Rp / year
<b>= Margin:</b>	<b>11 850 000</b>	<b>Rp / year</b>
<b>Agricultural Revenu:</b>	<b>11 850 000</b>	<b>Rp / year</b>
<b>A R /a. agricole:</b>	<b>5 800 000</b>	<b>Rp / year /a. agri</b>
+ Off farm activities:	0	Rp / an
<b>Disposal ressources</b>	<b>11 850 000</b>	<b>Rp / year</b>
<b>Disposal ressources/ worker</b>	<b>5 800 000</b>	<b>Rp / year/ actif</b>

## Agricultural and off farm activities

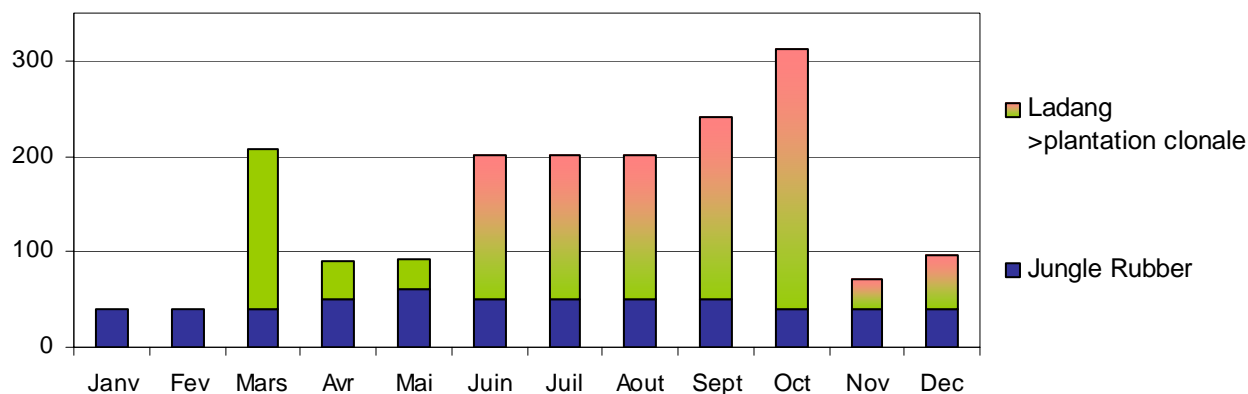
### History of the farm:

In relief  
 Lucrative off farm activities  
 Traditional system with ladang and local rubber trees  
 Plantation of clones rubber trees with Disbun

### Ressources:

1 agricultural worker available  
 Area used:  
 - 0,5 ha jungle rubber  
 - 1ha ladang each year  
 Simple material : parang, sabit, cankul

### Calendar of labour :



### Economical results :

	Margin /ha ( Rp /ha)	Area on the farm	Margin on the farm ( Rp/an)
Jungle Rubber	4 100 000	0,5 ha	2 000 000 Rp / an
Ladang	1 500 000	1 ha	1 500 000 Rp / an
<b>Total Margin on the farm:</b>			<b>3 500 000 Rp / an</b>

### Incomes :

<b>Gross Product:</b>	<b>3 550 000</b>	<b>Rp / an</b>
- Intermediate consumption:	50 000	Rp / an
<b>= Margin:</b>	<b>3 500 000</b>	<b>Rp / an</b>
<b>Agricultural Revenu:</b>	<b>3 500 000</b>	<b>Rp / an</b>
<b>A R /a. agricole:</b>	<b>3 500 000</b>	<b>Rp / an /a. agri</b>
+ Off farm activities:	15 000 000	Rp / an
<b>Disposal ressources</b>	<b>18 500 000</b>	<b>Rp / an</b>
<b>Disposal ressources/ worker</b>	<b>9 200 000</b>	<b>Rp / an / actif</b>

## **Embaong : Projects of cloned rubber trees plantations and inequalities**

### **History of the village**

Embaong lays very near from Sanggau, the access to the village is quite easy, moreover a new road is being built. The relief is undulating and the path leading to the center of the village remains difficult especially when it is raining.

For a long time, there were many projects in Embaong thanks to its localisation near Sanggau:

- SRDP (Smallholder Rubber Development Project) or PPKR (Proyek Perkebunan Karet Rakyat) in 1988-1989: 200 ha of clones rubber trees were planted, each family received 1 hectare.

- The Project "CU" was supported by Credit Union in 1990. 75 farmers only received 1 hectare cloned rubber trees each.

- In 1996, SRAS project developed 10 ha cloned plantation more. All the participants are related and belong to the same group of farmers: They have a lot of land and take part in all the projects in the village.

- There was also an oil palm project supported by a protestant NGO, it covers 45 ha. It aimed to develop lands infested by *Imperata cylindrical*. The members of the kelompok have to work one day per week for the project, they are payed 20 000 roupiahs par day (as farm workers). The production is very low due to the lack of inputs, thus the project is not very profitable.

- In 2005 some farmers got organised in order to get support from the government (Disbun) for new cloned rubber trees plantations. The main beneficiaries of this project are the farmers that already have a lot of cloned plantation (same as project CU), the other farmers were not well informed.

### **Main groups of farming systems:**

## Plantations of cloned rubber trees in projects, sawah and ladang

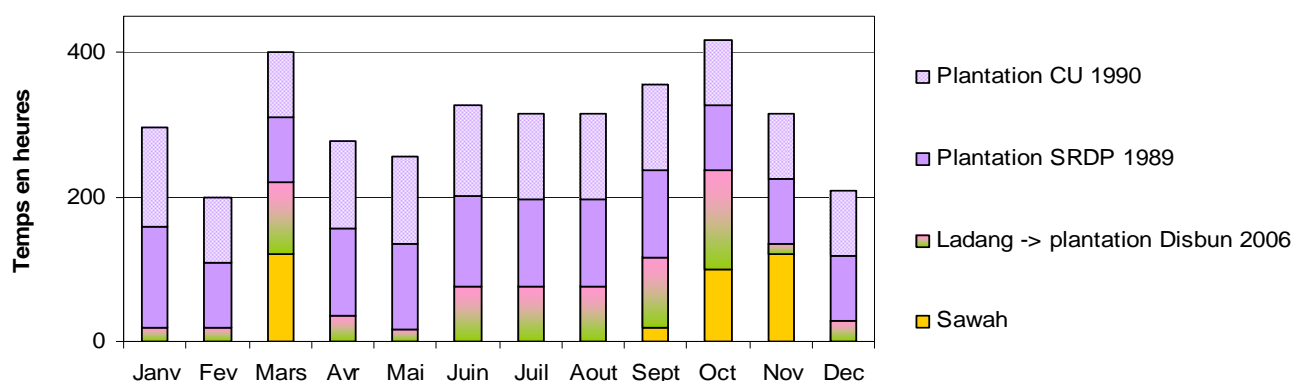
### History of the farm:

Projects SRDP and CU in 1988-1989  
 -> 2 ha of cloned rubber trees  
 Interruption of the tapping of jungle rubber when the clones are ready  
 Persistent running of traditional systems:  
 Ladang and sawah  
 Project supported by Disbun in 2006  
 -> 1 ha cloned rubber trees in association

### Ressources:

2 workers availables  
 Limited area, 5 ha:  
 - 1 ha SRDP plantation in 1989  
 - 1 ha CU plantation in 1990  
 -  
 0,5 ha sawah  
 - 1 to 2 ha bawas, 0.5 ha ladang each year  
 - 1 ha jungle rubber not used  
 Simple material and spreader

### Calendar of labour :



### Economical results :

	Margin /ha ( Rp /ha)	Area on the farm	Margin on the farm ( Rp/year)
<b>Plantation SRDP 1989</b>	14 200 000	0,6 ha	<b>8 500 000 Rp / year</b>
<b>Plantation CU 1990</b>	14 200 000	0,6 ha	<b>8 500 000 Rp / year</b>
<b>Ladang</b>	1 500 000	0,5 ha	<b>750 000 Rp / year</b>
<b>Sawah</b>	1 300 000	0,5 ha	<b>650 000 Rp / year</b>

**Total Margin on the farm: 18 400 000 Rp / year**

### Incomes :

<b>Gross Product:</b>	<b>18 900 000</b>	<b>Rp / an</b>
- Intermediate consumption:	400 000	Rp / an
<b>= Margin:</b>	<b>18 500 000</b>	<b>Rp / an</b>
<b>Agricultural Revenu:</b>	<b>18 500 000</b>	<b>Rp / an</b>
<b>A R /a. agri:</b>	<b>9 300 000</b>	<b>Rp / an /a. agri</b>
+ Off farm activities:	0	Rp / an
<b>Disposal ressources</b>	<b>18 500 000</b>	<b>Rp / an</b>
<b>Disposal ressources/ worker</b>	<b>9 300 000</b>	<b>Rp / an / actif</b>

## Project SRDP and traditional system

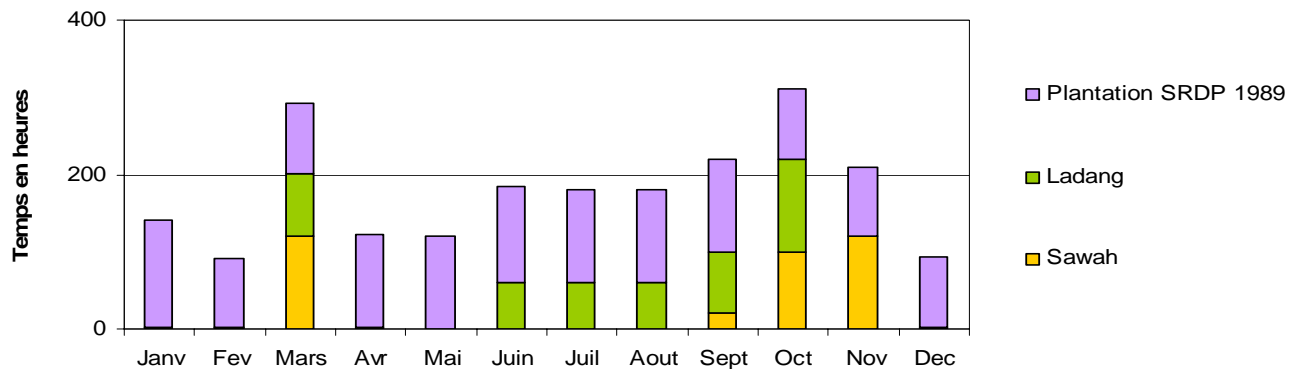
### History of the farm:

SRDP in 1989  
 -> 1 ha of cloned rubber trees  
 Interruption of the tapping of jungle rubber when the clones are ready  
 Persistent running of traditional systems:  
 Ladang and sawah  
 No other participation to project  
 -> Local rubber trees for renewal

### Ressources:

2 workers  
 Limited area, 4 ha:  
 - 1 ha SRDP plantation 1989  
 - 0,5 ha sawah  
 - 1 à 2 ha bawas, 0,5 ha ladang each year  
 - 1 ha jungle rubber not tapped  
 Difficult access to knowledge  
 Simple material

### Calendar of labour :



### Economical results :

	Margin /ha (Rp /ha)	Area on the farm	Margin on the farm (Rp/year)
<b>Plantation SRDP 1989</b>	14 200 000	0,6 ha	<b>8 500 000 Rp / year</b>
<b>Ladang</b>	1 500 000	0,5 ha	<b>750 000 Rp / year</b>
<b>Sawah</b>	1 300 000	0,5 ha	<b>650 000 Rp / year</b>
<b>Total Margin on the farm:</b>			<b>9 900 000 Rp / year</b>

### Incomes

<b>Gross Product:</b>	<b>10 150 000</b>	<b>Rp / year</b>
- Intermediate consumption:	250 000	Rp / year
<b>= Margin:</b>	<b>9 900 000</b>	<b>Rp / year</b>
<b>Agricultural Revenu:</b>	<b>9 900 000</b>	<b>Rp / year</b>
<b>A R /a. worker:</b>	<b>5 000 000</b>	<b>Rp / year /a. worker</b>
+ Off farm activities:	0	Rp / an
<b>Disposal ressources</b>	<b>9 900 000</b>	<b>Rp / year</b>
<b>Disposal ressources/ worker</b>	<b>5 000 000</b>	<b>Rp / year / worker</b>

## **Engkayuk / Kopar : Oil palm projects**

### **History of the villages**

Engkayuk and Kopar show many shared characteristics, this is due to the massive adoption of oil palm project in the 90's. Engkayuk lays on the road leading from Bodok to Bonti, it is quite good. Kopar is not far from Bodok too and the private society PT Sime Agro set up there in 1995-96. There is a new road , which was built by the company, thus the access to Kopar is quite easy.

Engkayuk and Kopar are essentially Dayak villages. Before the implementation of the oil palm society, the traditional system consisted in cultivations of ladang and sawah for the rice and running of jungle rubber to get supplementary incomes.

The private company Pt Sime Agro set up in Kopar in 1995-96. The people from Engkayuk and Kopar adopted massively the project, nearly all the households gave lands to the society to get at least one kapling of oil palm (2 hectares): 95% of the family in Engkayuk and 100 % in Kopar. The land exchange was very unequal: the farmer had to give up 7,5 ha in order to get 2 ha "ready to be ran": In Engkayuk, it represents 290 ha for the society and 160 for the farmers and in Kopar it reaches 500 ha for the company and 280 for the farmers. Therefore, nowadays nearly all the households of these villages have at least 2 ha, and now they have to work about 10 days and get 1 millions roupiahs a month.

The area of ladang has considerably decreased in the past years by lack of time and space. Land is now the limiting factor, the young households have few lands only because the parents are no more able to supply them with. They are an important source of labour especially for the oil palm company.

Finally in 2005, the population of Engkayuk asked for the support of Disbun to plant cloned rubber trees. 75 farms will benefit from 0.5 to 1 ha clones, according to the possibilities of the disbun. On the contrary, in Kopar the plantations of cloned rubber trees are due to the farmers' own initiative.

## Oil palm and Cloned rubber trees Projects

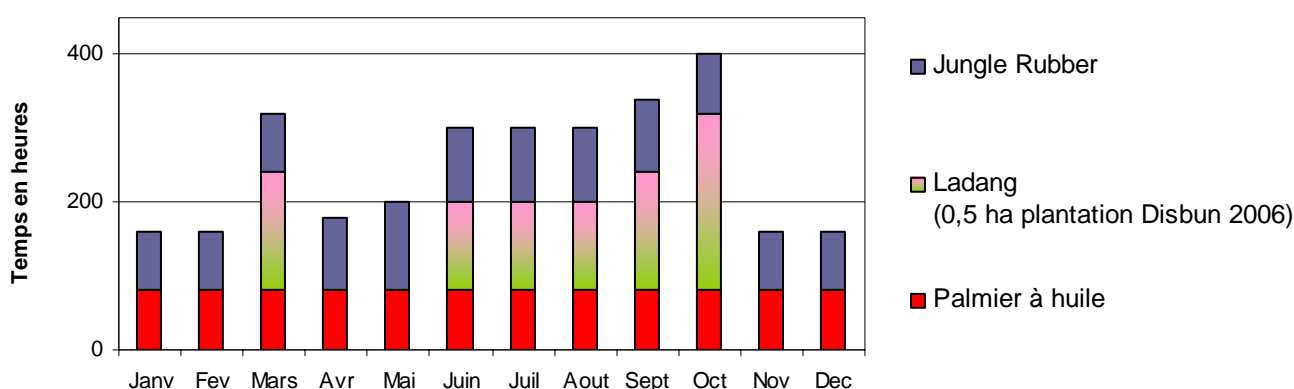
### History of the farm:

Oil palm's planting in 1998  
 Acquisition/inheritance of 2 ha oil palm  
 Beginning of the production in 2002  
 Persistent running of traditional system (ladang and sawah)  
 Cloned rubber trees plantation in 2000-2005 (disbun or own initiative)

### Ressources:

2 workers and 7 ha available :  
 - 2 ha oil palm  
 - 1 ha rawa not used  
 - 3 ha bawas, 1 ha ladang each year (bad soils and rats)  
 - 1 ha jungle rubber  
 - 0,5 ha cloned rubber trees (immature)  
 Simple material : parang, sabit and cankul

### Calendar of labour :



### Economical results

	Margin /ha (Rp /ha)	Area on the farm	Margin on the farm (Rp/year)
<b>Oil Palm</b>	6 000 000	2 ha	<b>12 000 000 Rp / year</b>
<b>Ladang</b>	400 000	1 ha	<b>400 000 Rp / year</b>
<b>Jungle Rubber</b>	4 000 000	1 ha	<b>4 000 000 Rp / year</b>
<b>Total Margin on the farm:</b>			<b>16 400 000 Rp / year</b>

### Incomes

<b>Gross Product:</b>	<b>28 500 000</b>	<b>Rp / year</b>
- Intermediate consumption:	12 100 000	Rp / year
<b>= Margin:</b>	<b>16 400 000</b>	<b>Rp / year</b>
<b>Agricultural Revenu:</b>	<b>16 400 000</b>	<b>Rp / year</b>
<b>A R /a. agri:</b>	<b>8 200 000</b>	<b>Rp / year /a. agri</b>
+ Off farm activities:	0	Rp / year
<b>Disposal ressources</b>	<b>16 400 000</b>	<b>Rp / year</b>
<b>Disposal ressources/ worker</b>	<b>8 200 000</b>	<b>Rp / year / actif</b>

## Oil palm and off farm activities

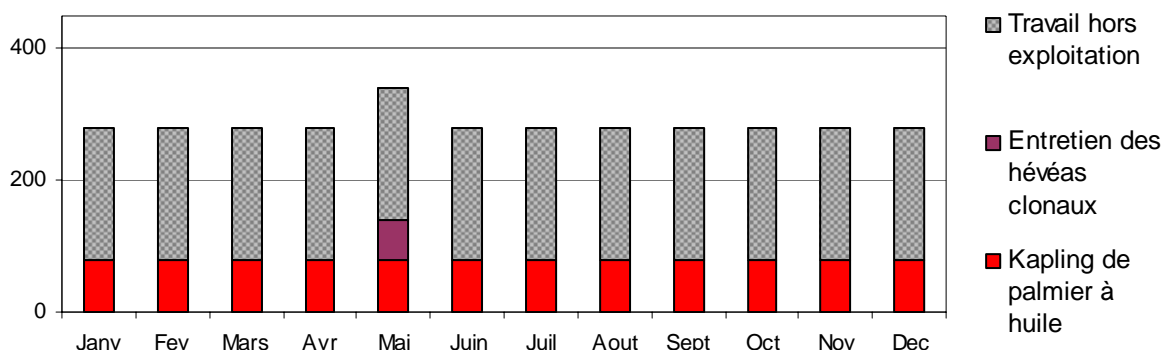
### History of the farm:

Oil palm planting in 1998  
 Acquisition/inheritance of 2 ha oil palm  
 Beginning of the production in 2002  
 Few other lands available  
*Stop traditional system : ladang and sawah*  
 Beginning of the production in 2002  
 Access to innovations  
*Cloned rubber trees planting*

### Ressources:

2 workers available, only 1 farm worker  
 3 ha:  
 - 2 ha oil palm: 1 kapling "plasma"  
 - 0,5 ha bawas  
 - 0,5 ha cloned rubber plantation  
 (disbun or sendiri)  
 Off farm activities : 1 worker  
 Simple material and spreader

### Calendar of labour :



### Economical results

	Margin /ha ( Rp /ha)	Area on the farm	Margin on the farm ( Rp/year)
<b>Oil Palm</b>	6 000 000	2 ha	<b>12 000 000 Rp / year</b>
<b>New Rubber Plantation</b>	- 250 000	0.5 ha	<b>-250 000 Rp / year</b>

**Total Margin on the farm: 11 750 000 Rp / year**

### Incomes :

<b>Gross Product:</b>	<b>24 000 000</b>	<b>Rp / year</b>
- Intermediate consumption:	12 250 000	Rp / year
<b>= Margin:</b>	<b>11 750 000</b>	<b>Rp / year</b>
<b>Agricultural Revenu:</b>	<b>11 750 000</b>	<b>Rp / year</b>
<b>A R /a. worker:</b>	<b>11 750 000</b>	<b>Rp / year / a. worker</b>
+ Off farm activities:	6 000 000	Rp / year
<b>Disposal ressources</b>	<b>17 750 000</b>	<b>Rp / year</b>
<b>Disposal ressources/ worker</b>	<b>9 000 000</b>	<b>Rp / year / worker</b>

## **Analysis and conclusion**

This project will finish at the end of November and all the data are not yet analysed. The analysis is still in process. All the data concerning the comparison between different systems, and the possible issues in the future are not available for the moment.

## **ANNEXES**

## **The Rubber Agroforestry Systems: RAS**

A particular attention has been paid to the RAS.

There are three different types of RAS:

- RAS 1: The environment is similar to jungle rubber where unselected seedlings are replaced by adapted clones. Usually the trees in interrows are cut down at the beginning of the rubber production, to avoid competition.
- RAS 2: Rubber trees are associated with food crops, principally upland rice and various fruits or timber trees. The density of fruit and timber trees must not exceed 100 trees per hectare. Otherwise it affects the rubber trees growth.
- RAS 3: It has been set up in *Imperata* grasslands, it promotes the use of cover crops and fast growing trees to reduce or eliminate weeding requirement. The interrows are cleaned after three years to avoid the competition with rubber trees' growth.

But in each type of RAS, different types of management are possible. There are more or less "intensiv". That means that the quantity of fertilizers during both the immature and mature period can be adapted to the possibilities of the farmers. Moreover the weedings can use chemicals or can be realised manually.

The research shows that 6 different types of RAS can be distinguished:

- RAS 1 "intensiv": Important use of chemicals and fertilizers.
- RAS 1 "extensiv": The manual labour is preferred to the use of chemicals.
- RAS 2 with bad soil conditions in Trimulya.
- RAS 2 with normal soil conditions.
- RAS 3 associated with cover crops during the first years.
- RAS 3 associated with fast growing trees (*Accacia*).

The technical data sheets that follows aim to describe these different cultivation systems.

### **Note:**

The labour required is expressed in mandays: 8 hours of the work of one man. It represents the time needed to manage the cultivation system.

**Cultivation System: RAS 1, High maintenance**

<u>Previous soil occupation:</u>	Secondary Forest
<u>Immature period:</u>	Paddy (1 year)
<u>Clones used and density:</u>	PB 260, 550 trees /ha
<u>Interrows:</u>	
<i>Plants:</i>	Natural vegetation
<i>Maintenance:</i>	No maintenance during rubber immature period Felling and weeding during rubber mature period
<i>Use:</i>	No use

**Work Organisation:**

<u>Soil preparation:</u>	Family
<u>Rubber maintenance:</u>	
<i>immature period</i>	Kelompok (SRAS)
<i>mature period</i>	Family
<u>Interrows maintenance:</u>	Family
<u>Paddy management:</u>	Gotong-Royong and Kelompok

**Main Activities:**

		<b>Costs (in K Rp/an)</b>	<b>Labour required (in mandays/an)</b>
<b>Immature Period</b>	<u>Year 0:</u>	Slash and Burn Paddy: sowing, weeding	375 110
	<u>Year 1:</u>	Rubber: planting and manual weedings Paddy: harvest	2170 56
	<u>Year 2:</u>	Rubber: fertilization and manual weedings	<b>680</b> 22
	<u>Year 3 - 4:</u>	Rubber: fertilization and manual weedings	120 18
	<u>Year 5 - 6:</u>	Rubber: Chemical weeding	<b>100</b> 1
<b>Mature Period</b>	<u>Year 7:</u>	Rubber: Tapping and chemical weeding	<b>981</b> 109
	<u>Year 8 - 25:</u>	Rubber: Tapping Fertilization and chemical weeding	1000 200

**Cultivation System: RAS 1, Regular Maintenance**

<u>Previous soil occupation:</u>	Secondary Forest
<u>Immature period:</u>	Paddy (1 year)
<u>Clones used and density:</u>	PB 260, 550 trees /ha
<u>Interrows:</u>	
<i>Plants:</i>	Natural vegetation, Jengkol
<i>Maintenance:</i>	No maintenance during rubber immature period Felling and weeding during rubber mature period
<i>Use:</i>	Jengkol: harvest and sale

**Work Organisation:**

<u>Soil preparation:</u>	Kelompok
<u>Rubber maintenance:</u>	
<i>immature period</i>	Kelompok (SRAS)
<i>mature period</i>	Family
<u>Interrows maintenance:</u>	Family
<u>Paddy management:</u>	Gotong-Royong and Kelompok

**Main Activities:**

		<b>Costs (in K Rp)</b>	<b>Labour required (in mandays)</b>
<b>Immature Period</b>	<u>Year 0:</u>	Slash and Burn Paddy: sowing, weeding	<b>0</b> <b>110</b>
	<u>Year 1:</u>	Rubber: planting and manual weedings Paddy: harvest	<b>1588</b> <b>32</b>
	<u>Year 2:</u>	Rubber: fertilization and manual weedings	<b>121</b> <b>12</b>
	<u>Year 3 - 4:</u>	Rubber: fertilization and manual weedings	<b>240</b> <b>20</b>
	<u>Year 5 - 6:</u>	Weeding	<b>100</b> <b>12</b>
<b>Mature Period</b>	<u>Year 7:</u>	Rubber: Tapping Interrows: Trees felling	<b>500</b> <b>87</b>
	<u>Year 8 to 25:</u>	Rubber: Tapping Chemical weeding	<b>335</b> <b>147</b>

**Cultivation System: RAS 2, Bad soil conditions**

---

Previous soil occupation: Secondary Forest

Immature period: Paddy and peanuts (2 years)

Clones and density: PB 260, 550 trees /ha

Interrows:

Plants: Associated trees  
( Durian, Jengkol, petai, tengkawang, terindak, nyatu)

Maintenance: Weeding with rubber trees and fertilization (year 1)

Use: Fruit trees: harvest and sale, wood trees: sale

**Work Organisation:**

---

Soil preparation: Family

Rubber maintenance:

*immature period* Family

*mature period* Family

Interrows Family

maintenance:

Paddy management: Family

**Main Activities:**

---

		<b>Costs</b>	<b>Labour</b>
		<b>(in K Rp)</b>	<b>required (in mandays)</b>
<b>Immature Period</b>	<u>Year 0:</u>	Slash and Burn Paddy: sowing 1, weeding 1, fertilization 1	<b>675</b> <b>113</b>
	<u>Year 1:</u>	Rubber: planting and manual weeding Paddy: harvest 1, sowing 2, weeding 2, fertilization 2 Peanuts: planting, fertilization, weeding, harvest Associated trees: planting and fertilization	<b>2570</b> <b>172</b>
	<u>Year 2:</u>	Rubber: fertilization and manual weeding Paddy: harvest 2 Peanuts: planting, fertilization, weeding, harvest Associated trees: fertilization	<b>565</b> <b>106</b>
	<u>Year 3:</u>	Rubber: fertilization and manual weeding Associated trees: fertilization	<b>490</b> <b>19</b>
	<u>Year 4:</u>	Rubber: fertilization and manual weeding Associated trees: fertilization	<b>370</b> <b>13</b>
	<u>Year 5-6:</u>	Weedings Associated trees: fertilization	<b>350</b> <b>13</b>

<b>Mature Period</b>	<u>Year 7:</u>	Rubber: Tapping Fertilizations and chemical weedings	<b>440</b>	<b>124</b>
	<u>Year 8 - 20:</u>	Rubber: Tapping Fertilizations and chemical weedings	<b>600</b>	<b>244</b>

**Cultivation System:** **RAS 2, Good soil conditions**

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<u>Previous soil occupation:</u>	Secondary Forest
<u>Immature period:</u>	Paddy vegetables and maize(2 years)
<u>Clones used and density:</u>	PB 260, 550 trees /ha
<u>Interrows:</u>	
<i>Plants:</i>	Associated trees ( Durian, Jengkol, petai, tengkawang, terindak, nyatu)
<i>Maintenance:</i>	Weeding with rubber trees and fertilization (year 1)
<i>Use:</i>	Fruit trees: harvest and sale, wood trees: sale

**Work Organisation:**

---

<u>Soil preparation:</u>	Kelompok
<u>Rubber maintenance:</u>	
<i>immature period</i>	Kelompok (SRAS)
<i>mature period</i>	Family
<u>Interrows maintenance:</u>	Family
<u>Paddy management:</u>	Gotong-Royong and Kelompok

**Main Activities:**

		<b>Costs (in K Rp)</b>	<b>Labour required (in mandays)</b>
<b>Immature Period</b>	<u>Year 0:</u>	Slash and Burn Paddy: sowing 1, weeding 1, fertilization 1 Vegetables: planting 1	<b>0</b> <b>118</b>
	<u>Year 1:</u>	Rubber: planting and manual weedings Paddy: harvest 1, sowing 2, weeding 2, fertilization 2 Vegetables: harvest 1, planting 2 Associated trees: planting and fertilization	<b>1380</b> <b>125</b>
	<u>Year 2:</u>	Rubber: fertilization and manual weedings Paddy: harvest 2 Vegetables: harvest 2, planting 3 Associated trees: fertilization	<b>250</b> <b>55</b>
	<u>Year 3:</u>	Rubber: fertilization and manual weedings Vegetables: harvest 3 Associated trees: fertilization	<b>250</b> <b>28</b>
	<u>Year 4-5:</u>	Rubber: fertilization and manual weedings Associated trees: fertilization	<b>270</b> <b>15</b>
	<u>Year 6:</u>	Rubber: manual weeding Associated trees: fertilization	<b>28</b> <b>30</b>
<b>Mature Period</b>	<u>Year 7:</u>	Rubber: Tapping and manual weedings	<b>90</b> <b>134</b>
	<u>Year 8 - 25:</u>	Rubber: Tapping and manual weedings	<b>200</b> <b>228</b>

**Cultivation System: RAS 3, Cover Trees**

<u>Previous soil occupation:</u>	Young forest with <i>Imperata</i>
<u>Immature period:</u>	Paddy and vegetables (1 year)
<u>Clones used and density:</u>	PB 260, 550 trees /ha
<u>Interrows:</u>	
<i>Plants:</i>	Acacia, 550 tree/ha
<i>Maintenance:</i>	Felling year 4
<i>Use:</i>	No possible use

**Work Organisation:**

<u>Soil preparation:</u>	Family
<u>Rubber maintenance:</u>	
<i>immature period</i>	Family
<i>mature period</i>	Family
<u>Interrows maintenance:</u>	Family
<u>Paddy management:</u>	Family

**Main Activities:**

		<b>Costs (in K Rp)</b>	<b>Labour required (in mandays)</b>
<b>Immature Period</b>	<u>Year 0:</u>	Slash and Burn Paddy: sowing, weeding, fertilization Vegetables: sowing	<b>675</b> <b>119</b>
	<u>Year 1:</u>	Rubber: planting and manual weedings Paddy: harvest Acacia: planting	<b>1753</b> <b>73</b>
	<u>Year 2:</u>	Rubber: fertilization and manual weedings	<b>560</b> <b>14</b>
	<u>Year 3:</u>	Rubber: fertilization and manual weedings	<b>660</b> <b>15</b>
	<u>Year 4:</u>	Rubber: fertilization and manual weedings Acacia: Felling	<b>430</b> <b>31</b>
	<u>Year 5-6:</u>	Rubber: Weedings	<b>90</b> <b>11</b>
<b>Mature Period</b>	<u>Year 7:</u>	Rubber: Tapping Manual and chemical weedings	<b>190</b> <b>105</b>
	<u>Year 8 - 25:</u>	Rubber: Tapping Manual and chemical weedings	<b>300</b> <b>200</b>

**Cultivation System:** **RAS 3, Cover Crop**

<u>Previous soil occupation:</u>	Secondary Forest
<u>Immature period:</u>	Paddy and vegetables (1 year)
<u>Clones used and density:</u>	PB 260, 550 trees /ha
<u>Interrows:</u>	
<i>Plants:</i>	Flemingnia and Gamal
<i>Maintenance:</i>	Growing during 5 years
<i>Use:</i>	Gamal: fodder for livestock

**Work Organisation:**

<u>Soil preparation:</u>	Family
<u>Rubber maintenance:</u>	
<i>immature period</i>	Kelompok (SRAS)
<i>mature period</i>	Family
<u>Interrows maintenance:</u>	Family
<u>Paddy management:</u>	Family

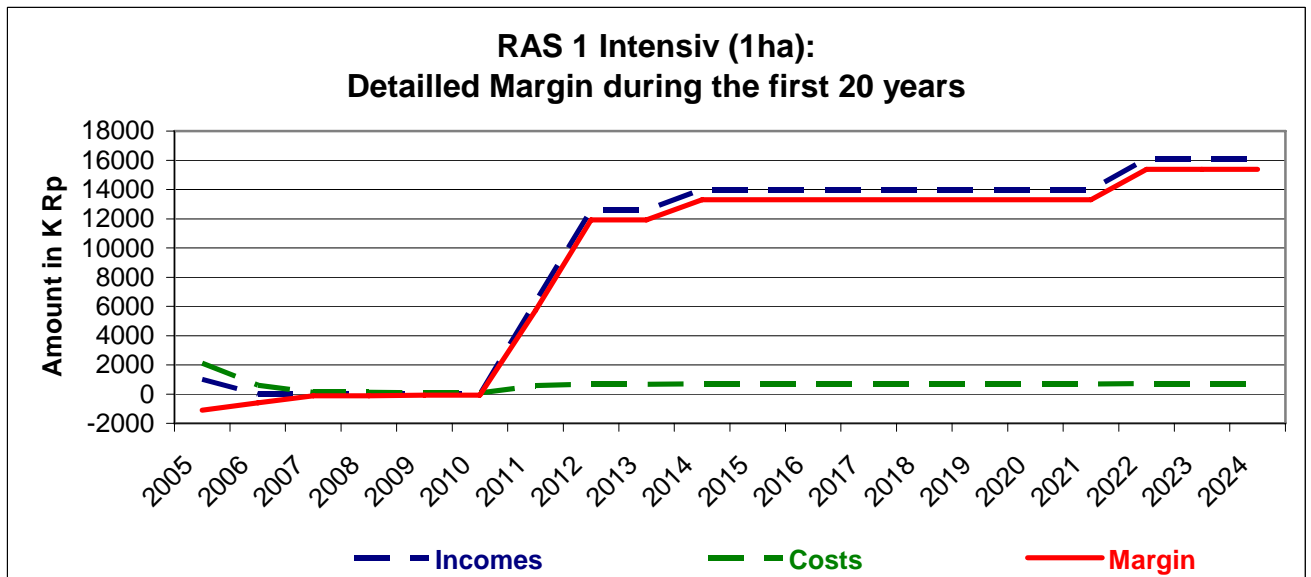
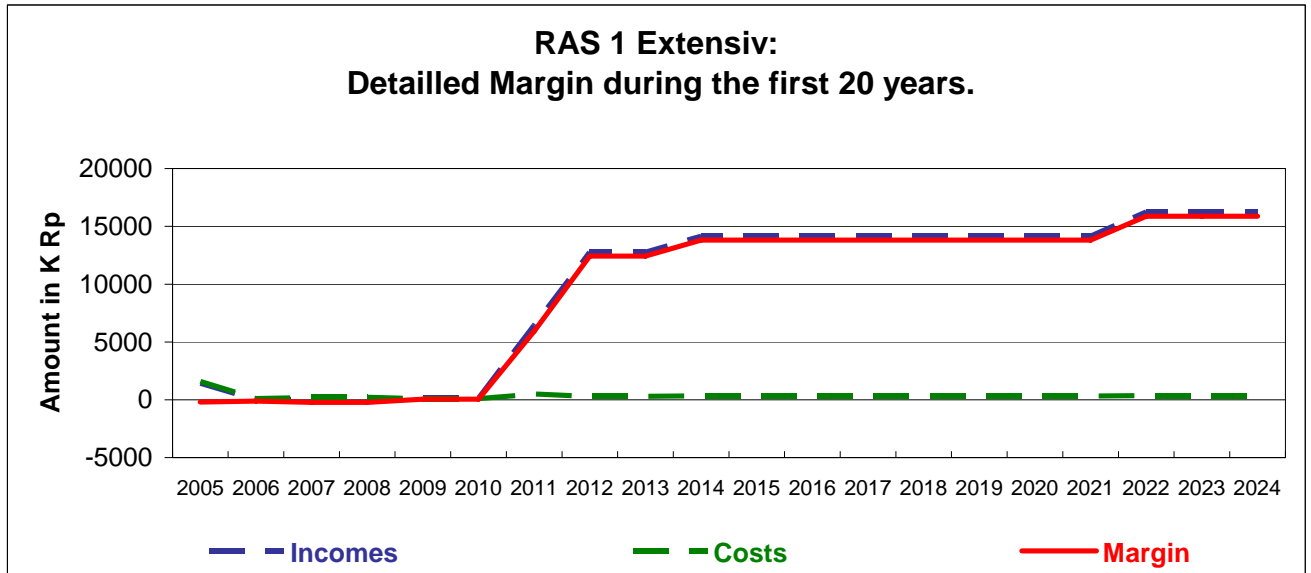
**Main Activities:**

		Costs (in K Rp/an)	Labour required (in mandays/an)
<b>Immature Period</b>	<u>Year 0:</u> Slash and Burn Paddy: sowing, weeding, fertilization Vegetables: sowing	<b>675</b>	<b>122</b>
	<u>Year 1:</u> Rubber: planting and manual weedings Paddy: harvest Cover crop: Planting and fertilization	<b>2020</b>	<b>75</b>
	<u>Year 2:</u> Rubber: fertilization and manual weedings	<b>560</b>	<b>14</b>
	<u>Year 3:</u> Rubber: fertilization and manual weedings	<b>320</b>	<b>9</b>
	<u>Year 4:</u> Rubber: fertilization and chemical weedings	<b>320</b>	<b>5</b>
	<u>Year 5-6:</u> Weeding	<b>200</b>	<b>2</b>
<b>Mature Period</b>	<u>Year 7:</u> Rubber: Tapping and chemical weedings	<b>360</b>	<b>96</b>
	<u>Year 8-25</u> Rubber: Tapping and chemical weedings	<b>475</b>	<b>190</b>

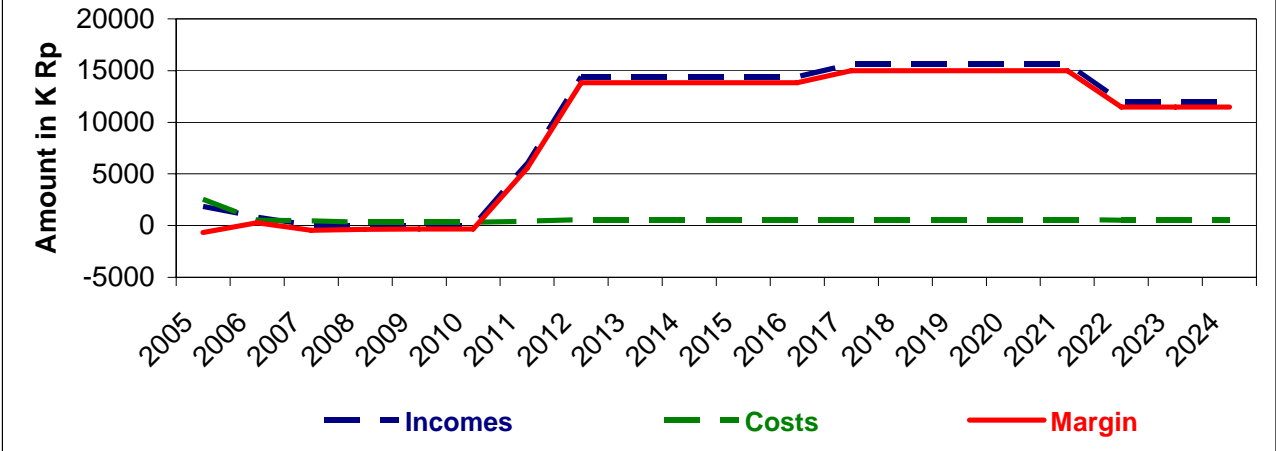
## Incomes of the main cultivation systems

A detailed research has focused on the economical aspects of the different cultivation systems.

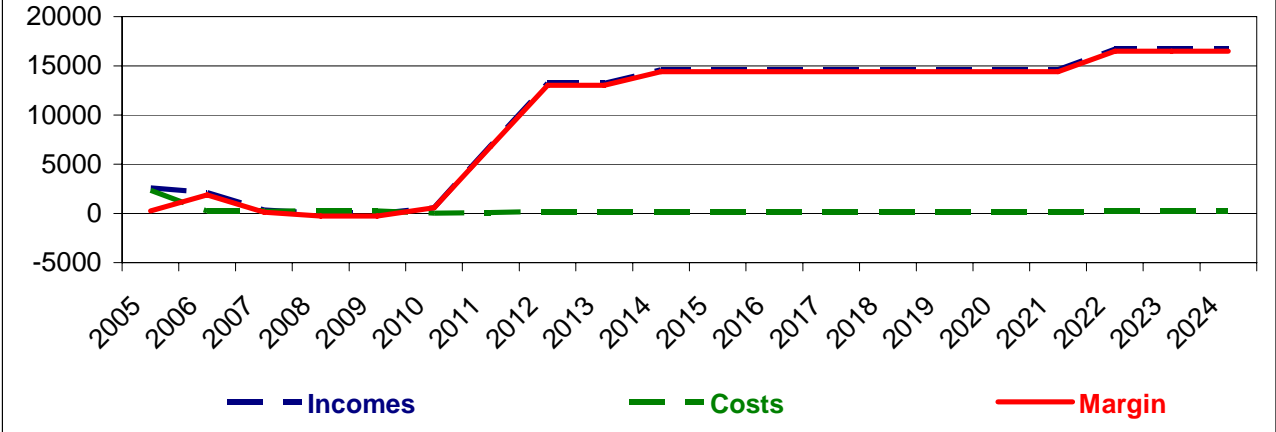
The following graphs show the margin, detailed in incomes and costs during the 20 years following the plantation.



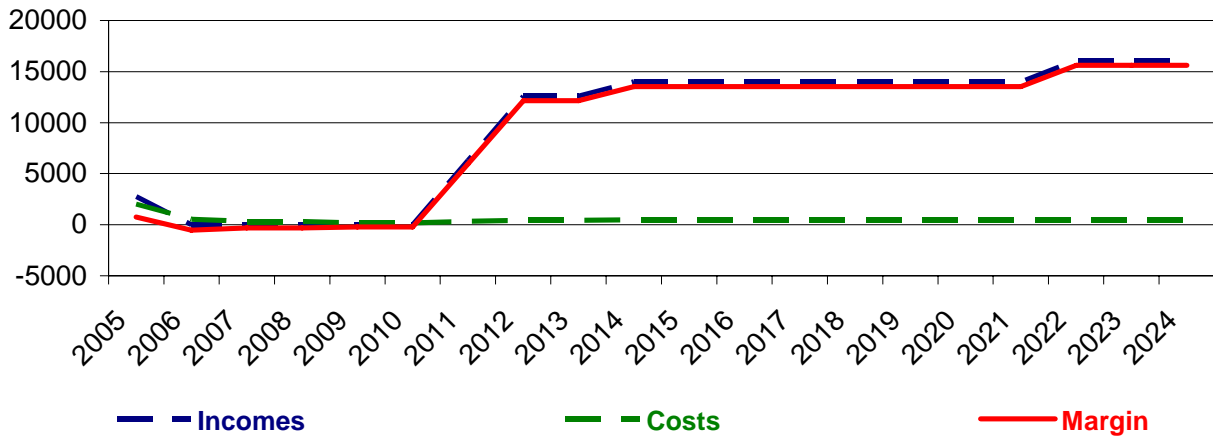
**RAS 2 Bad soil Conditions (1ha):  
Detailed Margin during the first 20 years**



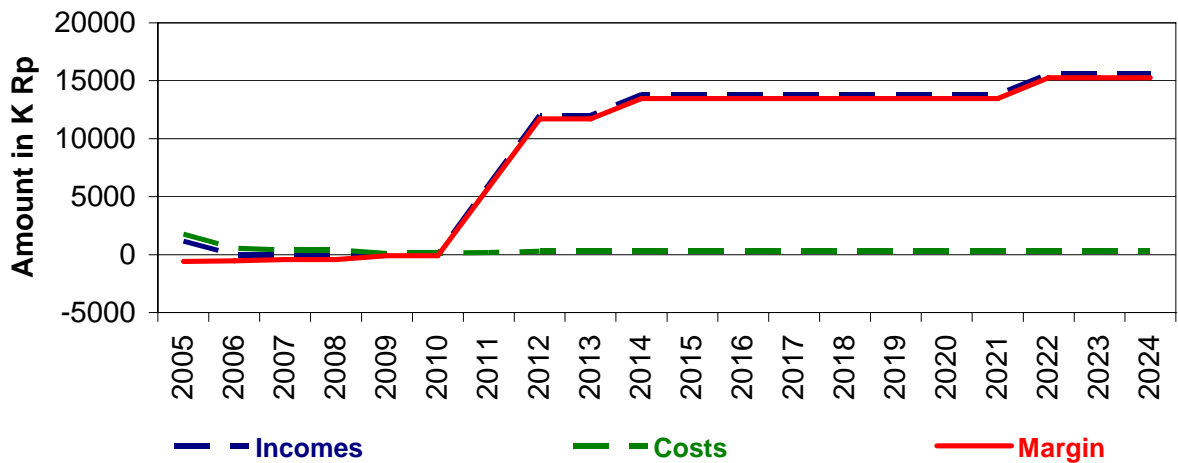
**RAS 2 Good Soil Conditions (1ha):  
Detailed Margin during the first 20 years**



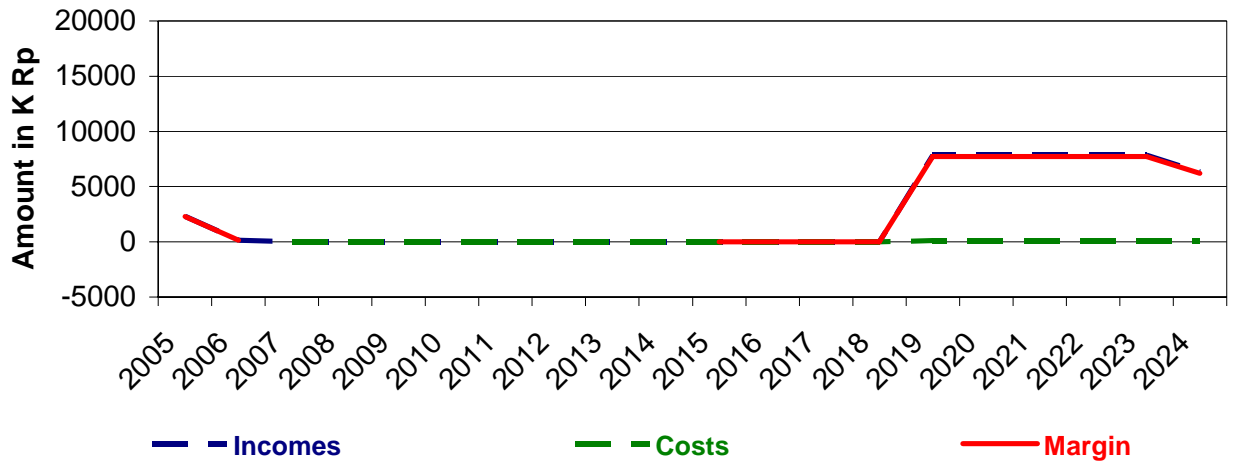
**RAS 3 associated with cover crops (1ha):  
Detailed Margin during the first 20 years**



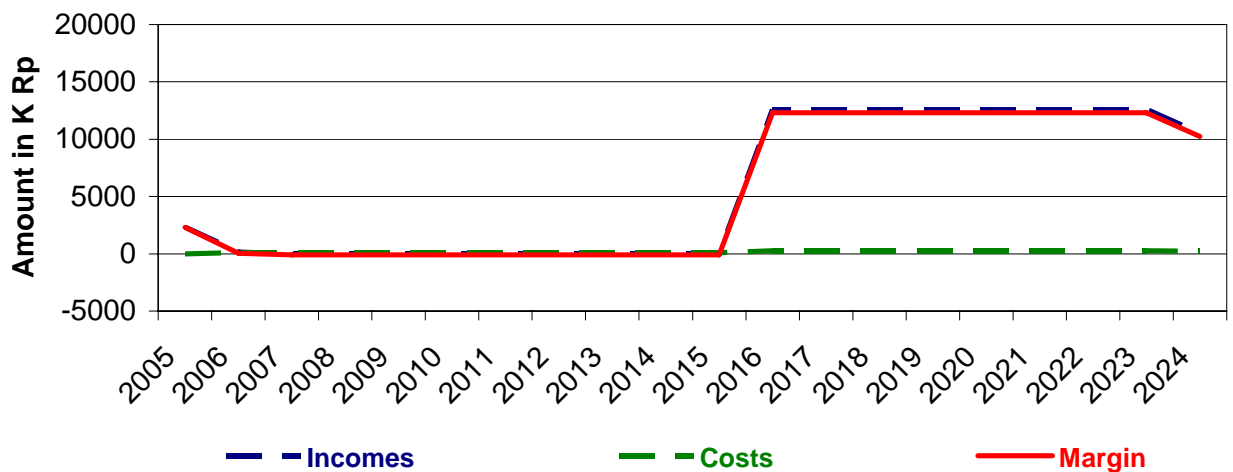
**RAS 3 associated with fast Growing Trees (1ha):  
Detailed Margin during the first 20 years**



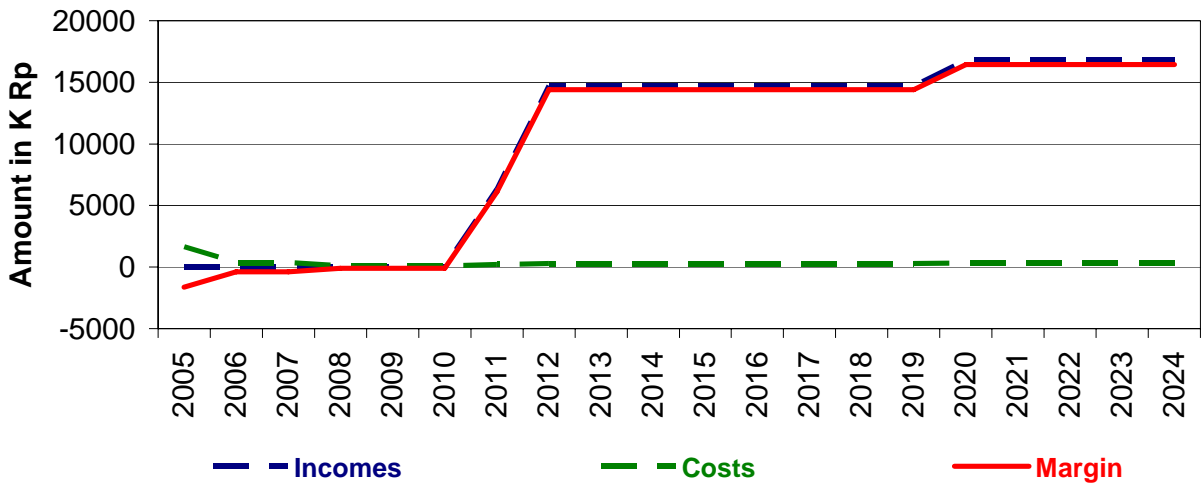
**Jungle Rubber (1ha):  
Detailed Margin during the first 20 years**



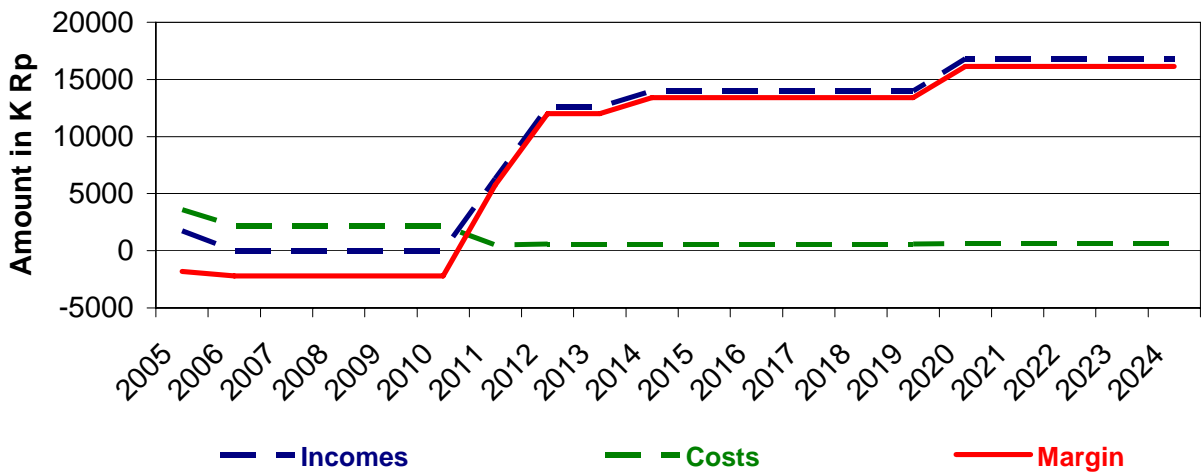
**Kebun Karet (1ha):  
Detailed Margin during the first 20 years**



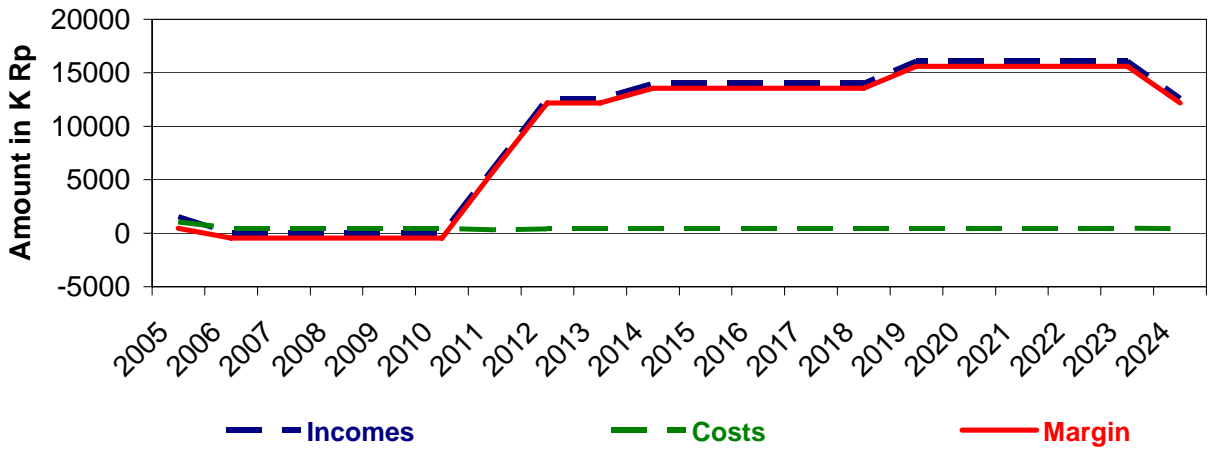
**Project Rubber PPKR 1988 (1ha):  
Detailed Margin during the first 20 years**



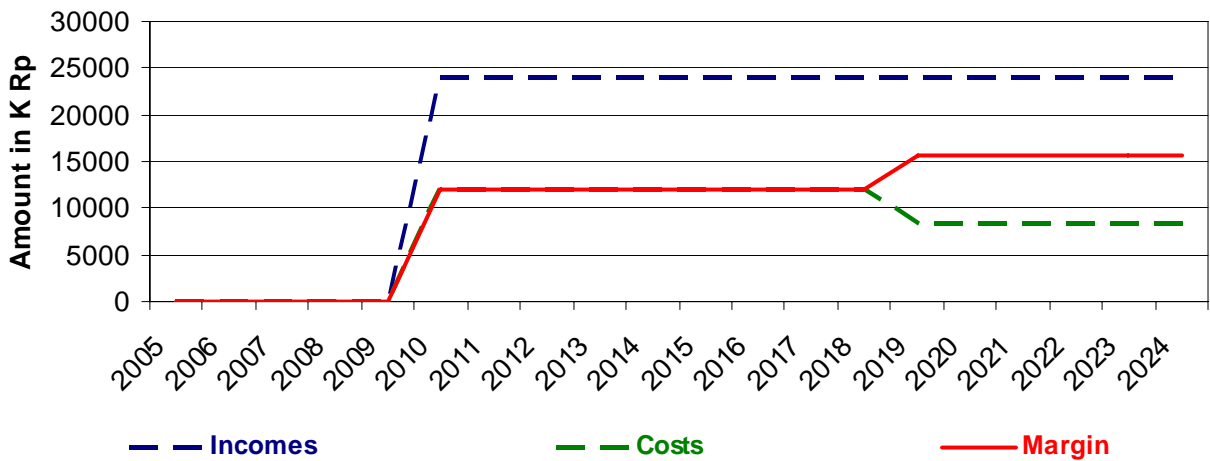
**Project SRDP 1982 (1ha):  
Detailed Margin during the first 20 years**



**Monoculture Sendiri (1ha):  
Detailed Margin during the first 20 years**



**Plasma Oil Palm (2 ha):  
Detailed Margin during the first 20 years**



## **Analysis and conclusion**

This project will finish in November and all the data are not yet analysed.

The analysis is still in process.