Assessment of the sustainability of the rubber farms in Centre-east Thailand using IDEA method

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Abstract

This study was conducted to compare the sustainability of the farms of three types (family business farms with or without family workforce and family farms) in the Muang Rayong, Wang Chan, Klaeng and Nikompattana districts, Rayong Province, Thailand. The main objective was to assess the sustainability of the rubber farms and to determine whether it is possible to differentiate the three types of farms according to their sustainability and characterize them depending on their strengths and weaknesses. In order to answer this question, the French quantitative methodology of "Indicateurs de Durabilité des Exploitations Agricoles" (IDEA) was used. Based on interviews with 25 farmers, percentages of sustainability were calculated on three scales: the agro-ecological scale, the socio-territorial scale and the economical scale.

For all the farms, the socio-territorial scale is the less sustainable because of the lack of local flows, the use of non-local resources and non-collective local activities, and because most of the production is dedicated to the export. It is the economic scale that presents the best assets, due to the relative low need of inputs and the diversified income for most of the farms.

According to the statistical tests of ANOVA, the factors that differentiate the most the three types of farms are, in increasing order: the agro-ecological scale (60.52% of variability), the diversity component (50.35%) and the socio-territorial scale (23.59%). For the economic pillar, there is no difference between the different kinds of farms. The Newman-Keuls test proved that family business farms without family workforce are less sustainable than the other two farm types for the agro-ecological scale and for the diversity component. For the socio-territorial scale, business farms without family workforce are less sustainable than business farms with family labor and the family farms cannot be differentiated from them. The family business farms without family workforce appear to be the least sustainable type of farms on the three factors on which a difference was proven.

Another typology of the farms would be also interesting. Indeed, the diversification of the activities (on and off farm) from which the families get their income is also meaningful. Instead of a typology of farms considering the labor use, it could be relevant to make a typology according to the diversification of the households' activities, that is to say the farms with only rubber production based income, the farms with rubber and fruit production based income and the farms with rubber production only as a side income, the main income coming from off-farm activities.

Key words

Sustainability assessment, IDEA method, rubber tree production, global changes, strengths and weaknesses of the farms, family agriculture.

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All the pictures in this report come from personal sources.

Prologue

To ensure the sustainability of plantation systems such as rubber trees, environmental and socio-economic conditions should remain favorable during several decades. How can such conditions be ensured when the environment is changing? A project named HEVEADAPT aims to evaluate the wide array of inter-related risks induced by global changes, i.e. climatic changes and socio-economic changes, on rubber-based family farms. Rubber tree-based system in Thailand is used as a model of tropical family plantations integrated in a major global commodity channel. The final aim of HEVEADAPT is to analyze how tree-based family farms can adapt and remain sustainable while facing variable climatic conditions, deep changes in their socio-economic context, and environmental issues (HEVEADAPT, 2014). The following study will use information from HEVEADAPT as a basis.

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1. Introduction

1.1. Global context

1.1.1. The rubber production in Centre-eastern Thailand

In Thailand, around 36,188,000 people are living in rural areas, which represents 53 % of the total population. Approximately 40 % of the Thai labor forces are working in the agricultural sector (World Bank, 2012). A wide range of crops is grown in Thailand, and rice represents the most important one in quantity and surface area covered. The other main crops grown in Thailand are cassava, corn, sugarcane, oil cops, rubber trees and fruit trees. Small family farms represent the major source of agricultural production. Recent surveys from the FAO (2015) show that on an average, farmers grow mostly rice on less than 4 hectares.

Rubber is a major economic crop for Thailand. Since 1991, the country has been the top producer and exporter of natural rubber in the world. For instance, in 2014 Thailand rubber farms produced an amount close to 4.3 millions of tons (RRIT, 2015), which represents 35% of the world production (IRSG, 2015). The total amount produced has been constantly increasing. This rise is due to the extension of the cultivated areas and the increase in rubber yields. Thanks to the government support and the favorable economic conditions, planted area doubled and the total production increased by 13 times in less than a half of century (Chambon et al, 2016). There are around 1.5 million rubber producers. Like rice farms in Thailand, most of the rubber plantations (around 90%) belong to smallholders owning less than 8 hectares, with an average of 2 hectares (RRIT, 2013 cited by Somboonsuke and Wettayaprasit, 2013).

The area studied in this report is Rayong province in the Centre-eastern region of Thailand. This is one of the historic rubber growing areas, where farmers started to grow rubber at the turn of the XXth century. In the province, 12% of the planted surface (which represents around 633,000 rai[1] or 101,000 ha), are rubber plantations. The landscape of this area is characterized by high trees, planted in rows (around 80 trees per rai or 500 trees per hectare) and by a dense canopy.

Picture 1. Example of a rubber tree field in a family business farm with family workforce

[1] 1 rai = 0,16 ha

From our interviews, the rubber farmers in Rayong keep one generation of rubber trees from 25 to 30 years, after what trees are cut down and sold. They harvest the latex starting from the fifth to the seventh year after plantation. The harvesting season lasts from 7 to 10 months per year. Considering that rubber trees are deciduous trees, the harvesting period generally does not occur at defoliation/refoliation time. The rainy season is another factor, which also affects harvesting, preventing tapping activities some days.

1.1.2. Typology of farms considering the workforce characteristics

In Thailand, most of the rubber plantations belong to family farms. Family farming is means of organizing agricultural, forestry, fisheries, pastoral and aquaculture production, which is characterized by an organic and structural relationship between the productive assets and the family patrimony. They are managed and operated by a family and predominantly reliant on family labor, including both women's and men's (FAO and Belières et al 2015).

Based on the classification proposed by Belières et al (2015), Chambon et al (forthcoming) proposed to separate three categories of family farming:

- The **family farms** are characterized by the fact that the workforce used is only from the family, with maybe temporary employees but no permanent employees.

Other farms employ and pay at least one permanent worker who is not part of the household. Those agricultural holdings are named as family business farms (Belières et al 2015). In the case of Thai rubber farms, rubber tappers usually have a long-term oral agreement with the owner of the plantation. Therefore, even though they often work 7 to 10 months a year, Chambon et al (forthcoming) considered rubber tree tappers as permanent workers. Family business farms are often farms, which employ at least one tapper. Chambon et al (forthcoming) distinguished two different kinds of family business farms:

- The **family business farms with family labor**, in which the family workforce is still involved in the agricultural tasks.
- The **family business farms without family labor** are characterized by family workforce who is only involved in the management and organization of the farm, but not in the agricultural tasks.

Table 1. Distribution of the family workforce depending on the type of farm

Type of farm	Family workforce involved in agricultural tasks	Permanent non family workforce (including rubber trees tappers)
Family farms	X	
Family Business farms with family labor	X	X
Family Business farms without family labor		X

The modalities of employment of the people who take care of the rubber trees is often the same. For a plot (around 20 rais or 3.2 ha), the owner buys inputs and employs a couple who will take care of the plantation during 7 to 10 months of the year (tapping, fertilizing…). The salary of the employee family depends on the production: the owner shares the incomes by giving the employee the value of 40 to 50% of the rubber income obtained on the land that they took care of.

1.2. Global changes

Rubber is a cash crop produced by small farmers for the international market. Because it is a long-term crop that requests rather high investment, once the trees are planted, the farmers have to cope with the global changes: climate, land use and socio-economy (Heveadapt project, 2014). They are described below with a focus on Rayong province.

1.2.1. The climate changes

The population of Rayong province can feel that the climate has changed over the past 10 years. Indeed all the farmers interviewed testified that the temperature has risen in the last decade, which is consistent with the average temperature graph from *worldweatheronline* below. According to this graph, the highest average temperature recorded in 2016 (33°C) was 2°C more than the one in 2009 (31°C).

Figure 1. Evolution of the average temperature in Rayong province (2009-2016)

Moreover, the seasons and the rain patterns are harder to predict. The unreliability of the weather may lead to a shorter time of rubber harvesting and thus to a lower annual production. Farmers noticed an increase of frequency of storms over the last past ten years, which causes devastation of crops. In addition, rains seem to be more intense in a short time, which might lead to more runoffs on the lands.

Finally, from the point of view of the farmers, the air quality is getting worse year after year due to the pollution, certainly caused by the presence of industrial areas in the province. They also claimed that more and more chemicals seem to be mixed with the rain leading to acidic rainfall.

According to most of the farmers, the climate was more appropriate to grow rubber trees 10 years ago than it is now.

1.2.2. Agricultural land use in Rayong

- An historical rubber production area

Rubber was introduced in Rayong around the XXth century. All along this century, the rubber tree has always been quite popular and the area of the province dedicated to this crop has always been important.

- Recent land use evolution

The climate of Rayong province is very appropriate for some fruit crops (durians, longans, mangosteen and betel nuts) and the fruits of the region are well known for their good quality. In addition, fruits are more difficult to grow than rubber but they can be sold at a higher price per area unit. That may be one of the reasons why considering the fluctuation of rubber prices, some farmers switch from rubber production to fruit production. Most of the farmers who own family farms or family business farms with family labor are interested by switching rubber crops to fruits crops. On the opposite, the family business farms without family labor, which usually have rubber production just as a side income, are not considering the option, since they usually have rubber trees because it is an easy crop if you have employees.

Picture 2. From the left to the right, durians and longans

Another recent change concerns pests and diseases, which affect the trees. More and more farmers complain about their recent development and diversification during the last decade. Farmers have to struggle harder against these pests and diseases since they seem to be more resistant. In particular, some farmers complain about the spread of *Corynespora*, which causes leaf fall. *C. cassiicola* is a fungus, which causes abnormal leaf fall and affects the growth of rubber trees. This disease is more particularly spread in southern, eastern and northeastern region of Thailand (Manju M.J., 2011).

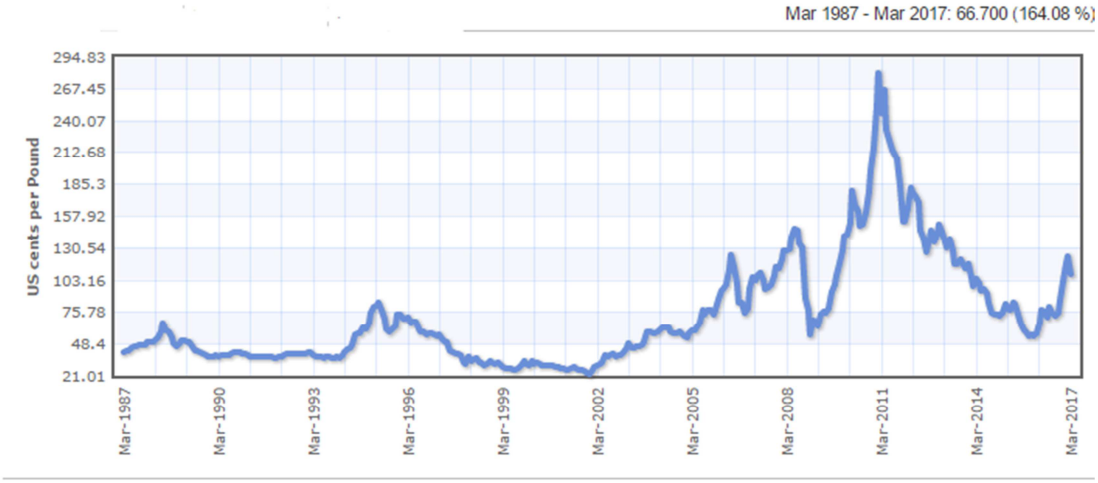
1.2.3. Social and economic changes

- Market uncertainties

The prices of rubber production are unstable. They have been globally decreasing, from 280.79 US cents per Pound in February 2011 (highest price) to 107.35 US cents per Pound in March 2017.

Figure 2. Rubber Monthly Price (Singapore Commodity Exchange)

from http://www.indexmundi.com/commodities/?commodity=rubber&months=360



The farmers suffer from these price changes since they do not store the rubber and they cannot adjust their production quickly because the production cycle lasts from 25 to 30 years. Also, most farmers sell their rubber to a very low number of buyers which makes them even more vulnerable. In addition, some farmers claimed to be worried about the government support too, since the amount of government subsidies is globally decreasing, whereas the farmers depend on these aids only when they start producing rubber trees (planting material, money, and fertilizers).

- Industrial development

The industrial sector has increased fast in Rayong province, with numerous petrochemical manufacturing factories. The number of industrial estates and factories has increased by both domestic and foreign investments. The economic structure has extremely changed from the agricultural sector to industries. Many people have migrated from other provinces to Rayong province (Jampanil, 2012). However, it seems to be harder for some farmers to hire employees since, in the context of low rubber price, workers could find job with a better income in the industry.

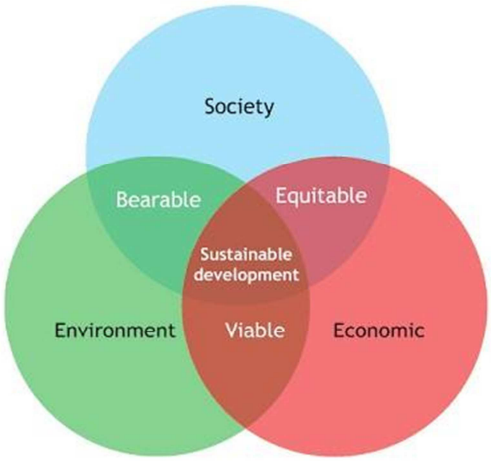
Since the economic situation is globally slowly changing concerning the rubber tree growing, farmers seem to be worried about the future of this crop.

1.3. Sustainability

According to the Brundtland report (1987), the definition of sustainability is the “Way of development that meets the needs of the present without compromising the ability of future generations to meets their own needs.”

All the global changes mentioned in the previous paragraph affect the farms, and that is why the sustainability and the resilience of the farms may be challenged. In this study, we propose to analyze the farms' sustainability with a specific method, which takes in account the three pillars of sustainability: Environment, Society and Economy.

Figure 3. The three pillars of sustainability (Brundtland, 1987)



1.4. Research questions

The aim of this study is to assess and compare the sustainability of the three types of rubber farms present in Rayong province, according to the different pillars and indicators of sustainability. We will answer the questions:

- Are there any differences between the three types of rubber farms in terms of sustainability?
- What are the possible strengths and weaknesses of each type of farm from a sustainability point of view?

1.5. Participants

CIRAD is the French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions. Its activities concern the life sciences, social sciences and engineering sciences, applied to agriculture, the environment and territorial management. Its work focuses on six main topics: food security, climate change, natural resource management, reduction of inequalities and poverty alleviation. In Thailand, CIRAD develops all the research activities on rubber sector in the framework of the Hevea Research Platform in Partnership (HRPP) gathering French and Thai research institutions and universities.

The Agro'nautes (http://www.lesagronautes.org/?lang=en) is a French student association, which aims at discovering innovative agricultural systems, reflecting their diversity, and assessing their sustainability to study their strengths and weaknesses. The first part of our project is to collect data on the field (in South-East Asia) to realize several diagnostics of sustainability in farms. Then, we will give the results to all the actors interested, both on the field and to larger organizations. Finally, we will gather our results with the association, in order to show the sustainability and diversity of innovative agricultural practices through the world.

2. Material and methods

2.1. The region and the interviewed farmers

Figure 4. Geographical distribution of the four studied districts in Rayong province

The study area is Rayong province, the largest rubber area in the Centre-eastern part of the country according to spatial suitability assessment (Narong). All the 25 farmers that we interviewed were located in the districts of Muang Rayong, Klaeng, Wang Chan and Nikompattana. To facilitate fieldwork, we selected farmers from a sample of 106 farmers interviewed in Rayong in 2014 (Chambon and Dao, 2014). The classification of each farm in the typology based on labor had been identified, which also facilitated sampling. Initially in 2014, the farmers were contacted through a government organization in charge of rubber extension, the Office of Rubber Replanting Aid Fund now included in the Rubber Authority of Thailand (RAOT). For our study, the fact that most of the farmers interviewed belong to a rubber association, maybe because of the initial sampling method, might be a bias in the farmers sampling.

Figure 5. Distribution of the farmers interviewed depending on labor based typology and districts

	Muang Rayong	Klaeng	Wang Chan	Nikompattana	Total
Family farms	5	1	0	0	6
Family business farm with family labor	4	5	0	1	10
Family business farm without family labor	1	3	4	1	9
Total	10	9	4	2	25

The two criteria used to select the farmers were firstly, the type of farm identified by Chambon et al (forthcoming) and secondly, the location of the farm (district). We tried to balance the different types of farms in the

different districts in order to have a sample well distributed and avoid eventual bias linked to relations between close farms. Nonetheless, in the table it appears that the farms of the same type are grouped by location. Indeed, it was very hard to find family farms outside of the Muang Rayong district or family business farms without family workforce outside the Wang Chan and the Klaeng districts. Details of all farms interviewed are described in annex 1.

Only rubber farmers were selected for the interview, but we took into account all the additional agricultural activities, such as annual crops or fruit trees, for the IDEA method. The interviewee was always the head of the farm, sometimes with his or her family members who were there to participate to the discussion. It is noticeable that several heads of farms were women.

2.2. Sustainability assessment of the farms: the IDEA method

2.2.1. Origin of IDEA

Although the definition of sustainable development from Brundtland Report is now generally accepted, its application in agricultural operations still raises many scientific questions. Since the United Nations Rio Conference (UNCED, 1992), the European Union has been working to integrate the concept of sustainable development into its policies in all the different sectors of activity, including the agricultural sector.

However, these political objectives raise the question of the conception of new indicators to evaluate the degree of sustainability of an agricultural production system. In this context, in 2003, a French multi-disciplinary research team elaborated the IDEA method (Indicateurs de Durabilité des Exploitations Agricoles or Farm Sustainability Indicators method, Zahm 2016).

2.2.2. Functioning of IDEA

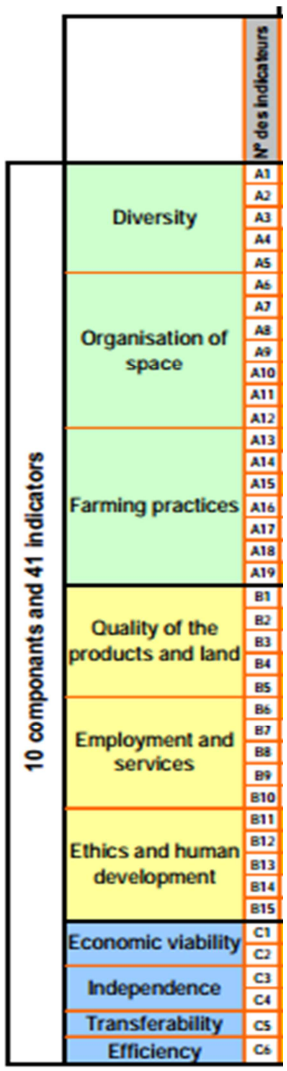
IDEA method is structured around three sustainability scales:

- Agro-ecological sustainability scale
- Socio-territorial sustainability scale
- Economical sustainability scale

Each of these three scales is subdivided into three or four components (making 10 components), which are themselves divided into indicators (for a total of 41 indicators). The detail of those scales and the components and indicators related are detailed on the next figure.

The components take into account all the aspects of the farm in order to assess its sustainability with as many details as possible. That is to say all the productions (rubber, fruits, annual crops…), all the land (cultivated plots, water catchment, not used areas…) etc.

Figure 6. The different components: in green the agro-ecological scale, in yellow the socio-territorial scale and in blue the economical scale



Each indicator has a way to be graduated. The detailed grading scale, with the explanation related to each indicator, is in Annex 2. All the indicators are summed up to get the grades of the components and the pillars. In this report, we always compare the scales or components sustainability with grades brought to 100 points; that is why we name them “sustainability percentages”. A grade of 100 would be for an ideal sustainable farm according to the vision of sustainability of the IDEA methodology.

However, "A diagnosis of farm is always linked to the point of view and to the referential of the person who does it" (Bonneviale et al. AGEA, 1989). The IDEA method takes in consideration this principle. Even if the assessment is quantitative with indicators calculated according to a common rule, some of them relate to personal observations and qualitative interpretation. For instance, there is not an official way to evaluate if a farm is well integrated in its environment (indicator B6). However, those assessments are always graded on low grading scales and we have settled basic agreements within our group to make sure those interpretations are uniform.

We can highlight the fact that “sustainability” is a subjective concept, depending on the point of view of each person. Indeed, sustainability is hard to assess because it depends on many elements, difficult to quantify. The IDEA method is an innovative tool to assess the sustainability. Nonetheless, it would be not relevant to say if a farm is sustainable or not. We can assess the sustainability of one farm to know its scores and strengths/weaknesses in the

different scales (agro-ecological, socio-territorial and economical scale) or we can compare the sustainability relatively to other farms, as in our case. This study can only conclude to a difference (or not) of sustainability between the studied farms. It is only possible to evaluate if a farm is more or less sustainable than another, and to try to understand why.

2.2.3. Our version of IDEA

We used the third version of IDEA, which has been modified by our predecessors in the Agro'nautes association, after a common feedback based on their studies in South East Asia, Latin America, the USA, etc. Some adaptations were made in order to apply the components outside of the European context (detailed grid in Annex 2).

2.3. Data collection in the field

2.3.1. Technical organization

In the field, we were divided into two groups of two, plus an interpreter for each. For one group, we could conduct two interviews in a day, one in the morning and one in the afternoon (as one interview took approximately 2 to 3 hours). We alternated full days of interviews and mid days to take the time to process the data collected on the farms.

2.3.2. Materials

Data were collected through individual interviews, always with the head of the farm. In order to fill the IDEA grid (Annex 2), we used a questionnaire to get the information about the three scales: agro-ecological, socio-territorial and economical scale. We also added some questions to understand more the farmers' situation and the global changes of the area.

2.4. Data analysis: ANOVA and Newman-Keuls test

In order to compare the different types of farms, we compared the variability of the means of each type of farms for the different pillars or components. We did variance analysis ANOVA followed by Newman-Keuls tests, to determine if there was a significant difference between the means of the different groups studied. The statistical significance is α=5%.

Validation hypothesis for the ANOVA analysis:

- All the observations made in the field are supposed random and independent (according to the selection of the farmers interviewed explained in 2.1.).
- The three populations studied (the types of farms) have sustainability means for the three pillars that follow a normal distribution (verified by the normal probability plot of Henry).
- The homoscedasticity (equality of variances) is always verified with the Bartlett test.

3. Farm sustainability results

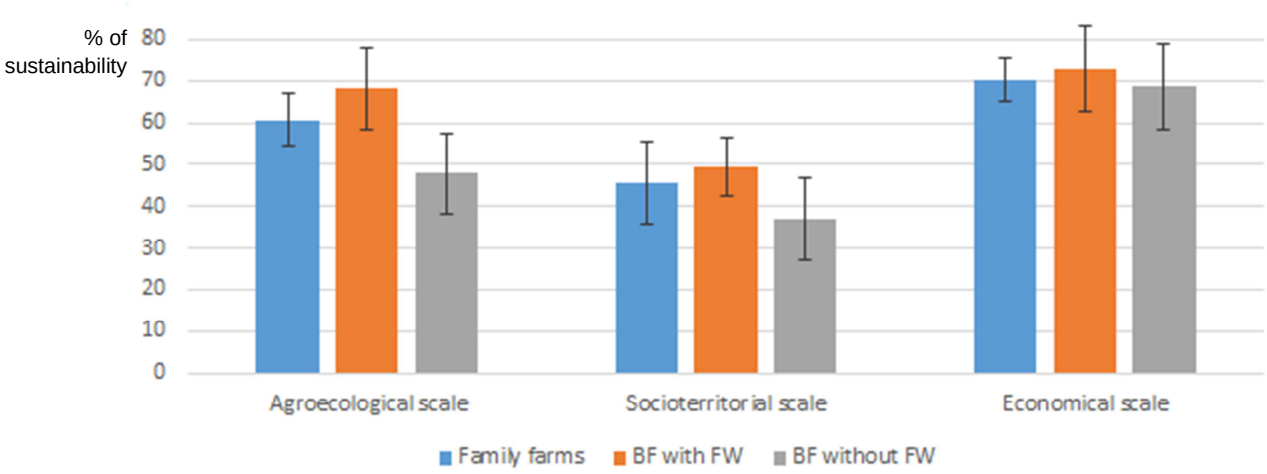
3.1. Comparison per farm type

For the following graphs, the abbreviation BF stands for "Family Business Farm" and FW stands for "Family Workforce".

3.1.1. Bar diagram analysis of the three scales: global overview and statistical comparison

To evaluate the differences between the types of farms, we adopted a zoom in movement, from the scales to the component. The following bar diagram with the three scales displays the sustainability percentages of the three pillars of sustainability of the Brundtland report.

Figure 7. Comparison of the farms according to the sustainability scales



Global overview:

In Rayong province, the socio-territorial scale is clearly the weak point of the rubber farms. This can be explained by the facts that there are not any local flows of local resources. Indeed, there is very little use of local organic fertilizer (since there is no significant animal production in the area) and no self-energy production nor use of renewable energy. In addition, most of the rubber and fruit production are exported outside of the province or the country (DOA). Moreover, there are no collective activities that energize the local interactions and no cultural traditions maintained. Finally, no initiative is put in place to valorize the specific quality of the products (labels, certifications).

Opposite, the economical scale is the relatively best asset of all the farms. We have come across a very wide range of family income, but all had enough resources to live decently. This might be explained by the fact that rubber and fruit crops are cash crops that have relative low input needs, but mostly because most of the farms have a diversified based income, as it was explained above (1.2.2).

Statistical comparison between the types of farms:

Table 2. Statistical comparison between the types of farms for the agro-ecological scale

ANOVA				NEWMAN-KEULS TEST
Groups	Number in the sample	Mean	Variance	No difference between BF with FW and FF.
Family farms	6	60.67	38.27	
BF with FW	10	68.20	97.73	Difference between BF without FW and the two other types of farms.
BF without FW	9	47.89	27.11	
Variability of the factor "type of farms":		η^2=	60.52%	

The variability of the factor “type of farms” influences at 60,52% the score of the agro-ecological scale. It is the scale with the highest variability factor, which means that it is the pillar that differentiates the most the three types of farms.

For this pillar, the farms fall in two distinct categories according to the Newman-Keuls test:

- on one hand the family business farms without family workforce (BF without FW);
- on the other hand the family farms (FF) and family business farms with family workforce (BF with FW).

The mean of the agro-ecological score is lower for the BF without FW (47,89%) than for the two other kinds of farms (60,67% and 68,20%, with no significant difference).

The BF without FW have a lower crops diversity than the others types of farms (we will prove this fact in the next part with the components comparison). They commonly only grow rubber trees, not annual crops (as vegetables for self-consumption) or fruits to sell on the local market, because the rubber tree production is not their main income and they do not need to diversify their incomes coming from the agricultural production. In addition, they do not try to improve the agricultural practices of their workers (in order to have more agro-ecological practices) as for example: reasoned pesticides treatment or good natural resources management (energy saving, water management, soil protection) and they do not try to improve the spatial organization as ecological buffer zones.

Table 3. Statistical comparison between the types of farms for the socio-territorial scale

ANOVA				NEWMAN-KEULS TEST
Groups	Number in the sample	Mean	Variance	No difference between FF and the other types.
Family farms	6	19.00	10.80	
BF with FW	10	20.30	10.01	Difference between BF without FW and BF with FW.
BF without FW	9	15.22	33.69	
Variability of the factor "type of farms":		η^2=	23.59%	

The variability of the factor “type of farms” influences at 23.59% the score of the socio-territorial scale. This variability factor is around 3 times lower than for the agro-ecological factor, which means that the differentiation for

this pillar is less significant.

For this pillar, we have the following differences according to the Newman-Keuls test:

- the family business farms without family workforce (BF without FW) and the family business farms with family workforce (BF with FW) are different;
- the family farms (FF) are similar to the two other farms.

The mean of the socio-territorial score is lower for the BF without FW (15.22%) than for the two other kinds of farms (20.30% with a significant difference for the BF with FW and 19.00%, with no significant difference for the FF).

The owners of BF without FW do not work in the field. This fact could explain the lowest socio-economical score for this type of farm. Indeed, the owners are less involved in farming than in their off-farm activities. For instance, they seem less concerned by the farmers' networks, as the rubber tree organization. They generally do not attend to trainings and do not open the farm for consumer visits. The BF without FW show a lower social implication than the other types of farms. However, because they need workers, they contribute well to the employment (local or not).

Table 4. Statistical comparison between the types of farms for the economical scale

ANOVA			
Groups	Number in the sample	Mean	Variance
Family farms	6	70.33	91.47
BF with FW	10	72.90	98.77
BF without FW	9	68.78	108.69
Variability of the factor "type of farms":		η^2=	3.58%

The variability of the factor "type of farms" influences at 3.58% the score of the economical scale. This variability factor is very low. In addition, the comparison of the F factor to its critical value confirms that there are no significant differences in that pillar.

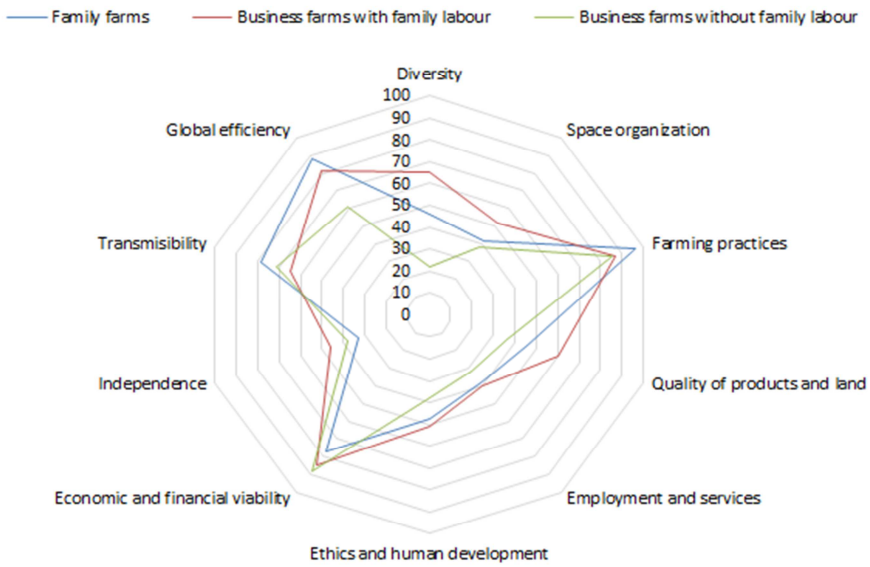
The economical sustainability is quite similar for all the three types of farms. Indeed, even though they do not always have the same quality of life and wealth, none of them seems to have huge economic difficulties. It is explained by the fact that most of the farmers have incomes from other sources than rubber production. Also, the independence (diversity of products sold, diversity of clients, off-farm income) of the farms does not depend on the kind of farms.

However, by rearranging the grading scales, it might be possible to conclude to some differences. This is explained in the discussion part (4.3.3. IDEA grid adaptation to the studied context). In the opposite, the lack of economical information could lead to a homogenization of the grades of economical scale for the three types of farms. We also explained that in the discussion.

3.1.2. Star plot diagram analysis of the components

The star plot diagram is well suited to see the strengths and weaknesses of the farms according to each component. All the components are quantified in percentages of sustainability. We chose the star plot representation because it appears easier to understand the situation of each type of farm in order to compare them. In Figure 8, diversity, space organization and farming practices correspond to the agro-ecological scale. Quality of products and lands, employment and services and ethics and human development belong to the socio-territorial scale. Finally, economic and financial viability, independence, transmissibility and global efficiency correspond to the economical scale.

Figure 8. Comparison between the three types of farms for each component



The shape of the star plot is quite homogenous for the 3 types of farms. This can be easily explained by the fact that (i) all the farms have the rubber crop in common and are in the same area (same climate, same input and output market etc.), thus a similar global organization and (ii) the farmers usually have the same agricultural and social practices since they get knowledge about rubber cropping with the same kind of trainings organized locally by the rubber associations. Only diversity and global efficiency components show a notable difference between the different types of farms.

About global efficiency component, which evaluates the gross efficiency of the agricultural system and the sobriety in inputs, there might be a bias. Indeed, maybe the owners of the family business farms without family workforce do not always know how much inputs their employees really apply on the fields, even if the owners pay for fertilizers.

Statistical analysis of the variance of diversity score:

The most obvious difference between the three types of farms would be the score of diversity (of agricultural production). That is why we have decided to make a comparison test for this component.

Table 5. Statistical comparison between the types of farms for diversity component (agro-ecological scale)

ANOVA				NEWMAN-KEULS TEST
Groups	Number in the sample	Mean	Variance	No difference between FF and BF with FW.
Family farms	6	15.17	48.57	
BF with FW	10	21.50	61.83	Difference between BF without FW and the two other types of farms.
BF without FW	9	7.11	21.11	
Variability of the factor "type of farms":		η^2=	50,35%	

The variability of the factor “type of farms” influences at 50.35% the score of diversity component. This variability factor is close to the variability factor of the agro-ecological pillar (60.52%), which is quite important.

For this pillar, the farms fall in two distinct categories according to the Newman-Keuls test:

- on one hand the family business farms without family workforce (BF without FW);
- on the other hand the family farms (FF) and family business farms with family workforce (BF with FW).

The mean of diversity score is lower for the BF without FW (7.11 points on 33) than for the two other kinds of farms (15.17 points for the FF and 21.50 for the BF without FW with no significant difference in between them).

Indeed the value reaches almost 70% for family business farms with family workforce while the score is no more than 25% for the family business farms without family workforce. This gap might be due to the fact that most owners of family business farms without family workforce have another activity beside their farm. So they consider more their farming as an additional income and do not really try to take benefit of several crops.

Statistical analysis of the global efficiency

The result of the test on the economical pillar shows that the different types of farms is not a factor to explain the differences for that pillar. However, it is one of the component with the widest gap on the star plot diagram.

The statistical analysis reveals that the homoscedasticity of the variances is not verified, which means that the difference of the variances intra-group are too high to compare the differences between the groups. It can be explained by the fact that, for that component, the IDEA grid was not well suited to assess the global efficiency of the farms in this context. When it came to assess qualitative results, our answers were not all uniform for the different farms. For instance, the evaluation of the C11 indicator “Sobriety in inputs” is:

Consumption in input per hectare of the TAC:

Very high……. 0

High…….. 2

Medium……..4

Low ……..6

This point is discussed more widely later, in 4.3.3. IDEA grid adaptation to the studied context.

3.2. Strengths and weaknesses of rubber farms

The previous graphs give an overall sight of the farms by components. To have a specific idea of why they got these grades, it seems essential to detail them with the ideas that stand out of the assessment. The following

tables provide a more qualitative analysis.

The strengths and weaknesses presented in table 6 were deducted from the general trends identified from the results of the interviewed farms, but sometimes there could be exceptions. However, these exceptions never exceeded 3 cases per statement (12% of the farms studied). If there were exceptions, we considered that the strengths and weaknesses depended on the farms and could not be generalized, thus the column "exceptions".

Table 6. Strengths, Weaknesses and Exceptions for the three types of farms

Scale	Component	Strengths	Weaknesses	Exceptions
AGRO-ECOLOGICAL SCALE	Diversity	Good diversity of perennial crops (fruit trees) when it is not rubber tree mono-cropping	No animal production No annual crop No agroforestry practice No initiative to promote different varieties for one specie, nor local or underrepresented variety	Actually there are rare cases of chicken production (3 farms) and annual crops for sale (3 farms)
	Space organization	Size of the plots adapted to a correct management (around 25 rai or 4 ha) Irrigation water coming from their own water catchment (free access, not in the plots) Good organic matter management (organic matter input added annually to all the cultivated area)	No rotation (since there is no annual crop) Low diversity of water sources and ecological buffer zones Fertilizers are not produced on the farm, nor locally (no animal production in the farms)	
	Farming practices	No rollover of the soil (except for planting) Very little irrigation needed for the rubber trees Good practices allowing water conservation in the soil (organic matter and soil cover: trees and grass) Low energy dependence (only fuel for tractors if have any and electricity for the water pump) Organic fertilization	No use of renewable energies Chemical fertilization to complement the organic fertilization	Some farms have a dedicated space to the pesticides storage Some farms leave the grass to cover the soil under the rubber trees, but other use herbicides Once, we saw the use of solar energy to dry fruits

	Quality of products and land	For durian production: good quality due to the territory and the climate (Rayong is known for its durian quality)	Low production of food (rubber is the main production of the farms) Families are not food self-sufficient (need to buy all the staple food) No labels or certifications to testify when the production has a good quality Fruit production losses (fruits are left on the ground) No initiatives to improve the link with the consumers No pedagogy or initiatives to communicate good agricultural practices The farmers qualify their soil not really fertile	Some farms have their own vegetable garden to improve their food sufficiency Some farmers give away some fruits to avoid food losses
SOCIO-TERRITORIAL SCALE	Employment and services	The fields have public access (the paths can be used by everyone) The inorganic wastes (bottles of pesticides, fertilizer bags) are collected and sold Part of the fruit production supports the short value chain (fruits sold on the local market or to the neighborhood) The trees provide important environmental services (prevent natural bioclimatic risks: anti erosion, flood limitations, drought limitation, carbon storage...) The farms have a nice environment, the houses are well integrated in the environment The rubber tree production allows to employ people during almost all the year	The rubber tree production does not enhance the short value chain (crop for the exportation and very few secondary rubber processing factories in Rayong) No planting material autonomy No services for the local area (no agro-tourism, no pedagogical farm...) No sharing of agricultural equipment nor work	Some farms are prettier than others (surrounded by flowers for instance) The workforce can be local or foreign There are both long term (more than 5 years) and short term employments

		(the tappers work 7 to 10 months per year)		
	Ethics and human development	The farmers all belong to a rubber tree organization The farmers are passionate by their job The farmers appreciate their life (average of all farms 6,3/7) The farmers do not feel isolated on their farms, because they have social links with relatives and neighborhood (average of all farms 3,7/4)	The farmers find their job quite tiring No special communication about their practices to the consumers Practices exposing the workers to pesticides No diversified training	
ECONOMICAL SCALE	Economic and financial viability	The farmers all consider that they have a sufficient global income to live The creation of wealth is higher than the net annual minimum wage No debt		Some of the farmers (in the three types of farms) have a very insufficient creation of wealth in their farm
	Independence	Low dependence to the government aids (they just give money the first years after the plantation and some inputs)	Low diversification of clients and products sold No contract with the clients (low income security)	
	Transmissibility	The farmers think that their farm will still exist in 10 years. The average age of the farmers is around 60 years old. The farmers are owners of their land, thus they can easily pass it to their children Coherent plot organization (plots close from one another, close to the house) to make transmissibility when the successor is identified		

	Global efficiency	High global efficiency (reasonable quantity of inputs used compared to the surface and good efficiency of the agricultural system that is to say the expenses for the inputs compared to the farmers' income)		

The strengths and weaknesses presented in table 7 were deducted from the general trends identified from the results depending on the three types of farms.

Table 7. Strengths, Weaknesses for selected components depending on the type of farm

Type of farm	Scale	Component	Strengths	Weaknesses
BF with FW	AGRO-ECOLOGICAL	Farming practices		Use of chemical pesticides
	SOCIO-TERRITORIAL	Employment and services	Quite good contribution to employment (local/permanent tappers, for more than 5 years)	
	ECONOMICAL	Independence	Significant income from pluriactivity	
BF without FW	AGRO-ECOLOGICAL	Farming practices		Use of chemical pesticides
	SOCIO-TERRITORIAL	Local development, circular economy and employment	Quite good contribution to employment (local/permanent tappers, for more than 5 years)	
	ECONOMICAL	Independence	High off-farm income	
Family farms	AGRO-ECOLOGICAL	Farming practices	Reasoned organic treatments	

3.3. To another farm typology: based on the diversification of the families' activities

From the previous analysis, we showed that there were some significant differences in terms of sustainability between the three types of farms studied. However, not all the sustainability components permitted us to differentiate the three types. There is a great diversity in the Rayong's rubber farms according to their activities to generate an income. This diversity of activities is shown in Annex 1. All the farms studied have in common that they produce rubber, but the share of the rubber in the total income of the families varies widely. Here are the possible diversifications:

- **Farms with only rubber production based income:**

They are very rare.

- **Farms with rubber and fruit production based income:**

These farms have an agricultural diversification, but no off-farm income. The majority of the farms have this double production. The fruits crops like durian and mangosteen have different labor force requirement, in terms of time amount and seasons, thus when the rubber and fruit productions coexist, the cultural calendar of the family is more efficient. These crops are quite complementary in terms of income and labor force needs.
However, other farming productions are represented but in a lesser extent, for instance:

- Chicken production (for eggs, meat or fighting)
- Annual crop production: for sale or self-consumption. For instance peanuts and corn have been shown as other crops grown for cash.

- **Farms with rubber production only as a side income:**

The income from rubber is very often a small part of the total income, the owners having a full time job or a business to run. The off-farm incomes come from different kind of activities, for instance: government officer, retired with a pension, owner of a factory (biscuit factory) or worker (mechanical parts factory), chef in a noodle restaurant, worker in a financial business. They most of the time have only rubber plot, and in fewer cases fruit tree plot. This category might represent 8 farmers out of 25 (Annex 1).

4. Discussion

4.1. Answers to the research questions

Through this report, we tried to answer the following questions:

- Are there any differences between the three types of rubber farms in terms of sustainability?
- What are the possible strengths and weaknesses of each type of farm from a sustainability point of view?

As explained in *2.2.2.2. Functioning of IDEA,* it is not possible to conclude whether a farm or a type of farm is sustainable or not, since it is always relative to other farms. There is not a ceiling grade upon which you consider the farm sustainable. Nonetheless, what is possible is to compare the sustainability grades between each type rubber farm to see which one is more or less sustainable than the others.

The statistical analysis permitted us to compare the three types of farms according to the three different scales and the diversity component of sustainability. The factors studied in increasing range of influence to differentiate the types of farms are:

- The **agro-ecological scale**, with 60.52% of variability.

The mean of the agro-ecology score is lower for the BF without FW (47,89%) than for the two other kinds of farms (60,67% and 68,20%, with no significant difference).

- The **diversity component**, with 50.35% of variability.

As for the agro-ecological scale, the mean of the diversity score is lower for the BF without FW (7.11 points on 33) than for the two other kinds of farms (15.17 points for the family farms and 21.50 for the BF without FW with no significant difference).

- The **socio-territorial scale**, with 23.59% of variability.

As for the two other factors, the mean of the socio-territorial score is lower for the BF without FW (47.89%) than for the two other kinds of farms (20.30% with a significant difference for the BF with FW and 19.00%, with no significant difference for the FF).

- The **economical scale**, with 3.58% of variability.

There are no significant differences between the three types of farms.

The family business farms without family workforce appear to be the least sustainable type of farms on the three factors on which a difference was proven.

IDEA method is a good basis to develop a qualitative analysis, that is to say the strengths and weaknesses diagnostic, which we made in the part 3.3.2.

4.2. About rubber farming in Rayong province

After studying the sustainability components of the farms and their strengths and weaknesses, some suggestions that would improve the farms' sustainability appear. It would increase their resilience to the global changes they are facing.

4.2.1. Agro-ecological suggestions

Diversity

It appears that this component has a quite low value. Indeed, the farms usually have only crop production, most of the times just perennial crops and just one variety per crop. The farms which scored the highest in diversity are the ones with fruit production and, very rarely, annual crops or chickens. Having a wider range of productions would increase their sustainability by compensating the unstable prices and the production risks (bad rubber years etc.) and possibly reaching better food self-sufficiency. Moreover, the area lacks of interactions between animal and crop production, which could improve sustainability by organizing the flows for food and fertilizers. Interactions between perennial and annual crops could be also valorized, in order to take advantage of the ecosystem services possible with their association.

For the area, the diversifications to an exclusive rubber farm seem to be, in decreasing order:

- Fruit production (durian, mangosteen, jack fruit, ramboutan…);
- Annual or pluriannual crops (pineapple, cassava, vegetables);
- Animal production (chicken for eggs or meat, pigs).

Space organization

The production being mainly rubber and fruit trees, there is neither interesting rotation nor fodder area possible. It weakens the soils by always exporting the same nutrients throughout the years, forcing the farmers to bring chemical fertilizers and can also lead to root disease development (especially for the rubber trees).
Nonetheless, the space organization could be improved by implementing agro-forestry systems of two kinds:

- Increasing the intra-plot mixity (some farmers plant pineapples or banana trees between the rows of the young rubber trees only at the beginning of the cycle and there are a few examples of mangosteen with rubber trees during all the production cycle, Stroesser, 2016);
- Associating animal production (pigs or chicken) with the rubber production. This diversification takes advantage of the space available in the rubber fields to breed animals. A farmer told us that this kind of farm was present in the Rayong district, but unfortunately, we were not able to get in touch with any of these farms.

Farming practices

The farming practices are quite homogenous in the area, which could be explained by the fact that they almost all attend to trainings given by rubber producers associations.

To make those practices more sustainable, we thought about:

- Supporting and explaining to the farmers how to make their own organic fertilizer (a practice which is also supported by the government, who distributes free compost enhancers), in order to reduce the use of chemical fertilizers and to have a better soil composition;
- Supporting the mulch or grass cover of all the perennial crops (this could be done by sharing experiences between the farmers who do and the farmers who do not);
- Thus, reducing the use of herbicides in the rubber field.

4.2.2. Social and territorial suggestions

Quality of products and land

There is no specific label which attests the quality of the agricultural products due to the territory or the process. We met farmers with very good practices but they cannot be differentiated from the others on the market because there is no certification. The development of a label would encourage the farmers to improve their practices (sustainable and organic practices) for both fruits and rubber thus the conservation of their environment. It would also allow selling at a better price, if there is a market of this kind of product.

Also, the contribution of the farms to the global food balance is quite low, since they do not produce other food crops than fruits. Producing more animal products or protein based food would improve the independence of the area relative to the food.

Employment and local services

The rubber farms play a major role in the local employment and services. Indeed, they employ families to take care of the production and represent an important part of the area cultivated of the province. In the district, the Thai workforce prefers to work in other sectors than the rubber production, since they can get a better wage.

Nonetheless, it could be improved by:

- Increasing the productivity of the workforce in the rubber fields to make the tapper job more attractive in terms of wage;
- Enhancing collective work, since the rubber farmers usually have no other interactions than chatting about the production (it could be sharing agricultural tasks, material etc.);
- Using more local supplies like locally made organic fertilizer or locally grown or selected fruit trees. Since it does not exist at this time, it would be necessary to create such a local market ;
- Contributing to the quality of the local heritage (cultural, landscapes etc.).

Ethics and human development

All the farmers belong to at least one rubber tree association, which is a good thing to attend to trainings and improve their production. However, it would be interesting to encourage, within the existent associations, the collective work and the share of equipment and/or labor force to enhance the interactions between the farmers.

The fact that all the farmers interviewed belong to a rubber tree association might be a bias of the farmers sampling. Indeed, it was easier to get the farmers contacts through an organization. So this situation cannot be

generalized for all the districts studied.

4.2.3. Economical suggestions

Independence

It appears necessary to have an economical independence for the rubber producers, since they are dependent on the rubber prices (according to the share of rubber sales in their total income).

Being more independent for a rubber producer means:

- Having a diversified production to sell to face the instability of price or production (it means for instance to have a lower share of the rubber tree production, thus a diversified panel of products to sell);
- Having a wider range of selling opportunities, to compare the selling prices and choose the best option, and not selling the products by habit to the same retailer;
- For some of the farms, having an external financial contribution makes the income more stable.

Economic and financial viability, transmissibility and global efficiency

It is harder to make suggestions for those components, partly because they are dependent on the other components. We do not have any suggestion about those components.

4.3. About the IDEA method

4.3.1. In the field

IDEA method is interesting because it is quite complete and it considers a wide range of sustainability indicators. But this can be drawback in the field since it requires a lot of information from the farmers, and thus a long and extensive interview (from 2 to 3 hours). Despite the length of the interviews, we were surprised that the 25 farmers were very patient with us. We felt very comfortable and we never had the feeling to disturb them. They really seemed happy to see our interest in their work and to enjoy sharing their experience and knowledge with us.

The farmers offered us time and generosity. They were very welcome and they often offered us fruits and drinks during the interviews. They also helped us to find others contacts of farmers to have more interviews. However, unfortunately we did not give any feedback of the interviews to the farmers. We could have discussed with them about the strengths and weaknesses diagnosis but i) due to our little knowledge of the rubber tree context in Rayong, it seemed difficult for us to give them an overview of the farms' situation and potentially some advices and ii) we needed time to process the results of the interviews and we should have come back to give to the farmers this feedback, which was impossible with the means of our study. Giving a feedback to the farmers is very important for us and this point deserves to be thought before going to the field.

Also, some of the information required is quite precise, and some of the farmers do not really know how to answer to some questions. All the exact quantitative data is quite hard to obtain, for instance, the rubber yields, the quantity of inputs or the economic data. Nonetheless, by chatting a bit more it is possible to have a better idea of this missing data.

Of course, the exchanges were conducted by translators, which possibly lead to some distortion of the message or loss of information.

4.3.2. The results

All the data collected was used to fill up the grid. Most of the time, we considered that the information was correct, but sometimes it may have diverged from the reality. To explain this idea we will give two examples:

- About the self-assessment by the farmer of the quality of his/her life:

The B17 indicator (intensity and quality of work) is the following:

Item 1: pleasure and satisfaction at work
Self-assessment on a scale of 0 to 4
Item 2: time and mental load
Number of weeks per year where the farmer is feeling overloaded
If more than 8 weeks: 0
4-8 weeks: 1
1-3 weeks: 2
Zero week: 3 points
Item 3: days off
In absolute terms, do you need to take rest days? Are you taking some?
If Yes to the two questions: 3
If no to both questions: 3 If answer yes/no: 0
Item 4: hardship at work
Self-assessment of fatigue on a scale 0 to-4 (hard work)

Of course, the answer is very subjective since the farmers do mostly self-assessment. In addition, they may answer according to the interviewer, thinking she or he could be judged.

- About some economic data:

In order to get the farm's global turnover, there are many things to take in account (all the purchases, the farm income, the external incomes…). Since for some of the farmers, there is no record of the sales and purchases, it is a challenge to get a coherent number for the turnover, as well as aids and gross efficiency.

Even if the farmers seemed comfortable talking about their economic situation, some parts were more delicate to approach. For example, the sensitive subjects were the debts, the loans or for the external income (the amount and where it comes from). Indeed for the business farm without family workforce, the amount of the external income is often quite high.

- About the global efficiency component:

As it was explained before, it evaluates the gross efficiency of the agricultural system and the sobriety in inputs and there might be a bias. Indeed, the farmers do not have a precise idea of the inputs quantity put in the fields, especially the owners of the family business farms without family workforce do not always know how much inputs their employees really apply on the fields.

4.3.3. IDEA grid adaptation to the studied context

The purpose of the IDEA methodology is to compare the sustainability of farms in any context. However it brings some difficulties to compare farms within the same context. Indeed, in this study, the grades of each component or pillar are very close for every type of farms. This could be improved by modifying the IDEA grid used with more specific grading indicators more adapted to the context of hevea cultivation in Rayong province. Another study with such precisions would be a lot more specific and might show more differences between the farms. However, to do so, it would be necessary to make two kinds of interviews in the same area: one to adapt the grid and another one to collect the data. This would be a huge amount of work on the field and to process the results.

The indicators that we thought would be interesting to modify to make the evaluation more specific would be:

- Component “farming practices”: adapt the quantity of inputs applied by surface unity, for the fertilizers (differentiating the organic and chemical fertilizers) and pesticides.
- Indicators “social and solidarity implications” (B15) and “trainings” (B21): compare their trainings and implication within the rubber associations.
- Indicator “economic viability” (C1): modify the item 1 in order to distribute in a wider range the economic data.
- Indicator “economic transferability” (C8), “gross efficiency of the agricultural system” (C10) and “sobriety in inputs” (C11): establish the average yield and quantity of inputs applied per rai for the rubber production, to compare the efficiency of the farms (which is very hard since a lot of farmers do not really know their exact production nor quantity of inputs used).

5. Conclusion

Sustainability previously defined as the “way of development that meets the needs of the present without compromising the ability of future generations to meet their own needs” was the element of comparison in this report. The French quantitative methodology of Indicateurs de Durabilité des Exploitations Agricoles, a comparator of sustainability, was chosen to evaluate the sustainability of the rubber farms in Rayong province in a context of global changes. Sustainability is a key notion for both resilience and mitigation to face major changes such as climate changes, land use changes and socio-economical changes.

During the survey, a specific typology of farms was used considering the workforce characteristic. This classification was proposed by *Belières et al* (2015) and adapted by *Chambon et al* (forthcoming). Three categories of family farming have been put forward: family farms, family business farms with family labor and family business farms without family labor.

For all the rubber farms studied, the socio-territorial scale is the least sustainable pillar of sustainability and the economical scale appears the most sustainable.
The statistical analysis proved that the types of farms can indeed be differentiated by the agro-ecological pillar, the socio-territorial pillar and the diversity component, whereas no difference was established for the economic pillar. On the three factors on which a difference was proven, the farms which appear to be the least sustainable are the family business farms without family workforce. Also, the strengths and weaknesses of the rubber farms of Rayong are quite similar for the three types of farms, since they are all in the same context.

However, another typology of the farms would be interesting in the Rayong context: not according to the workforce, but according to the families’ activities (rubber production alone, or completed with other agricultural productions or off-farm activities) and the share of the rubber production in the total income of the family.

The sustainability of the farms depends on their ability to still exist in the next years. In addition to the IDEA diagnostic, we wanted to collect the farmers' opinion about their future. The farmers had two different points of view. One part was worried about the changes that might worsen a lot. Most of their anxiety concern climate changes, political change, increase of foreign investors on Thailand lands. The second part was confident in their adaptation skills and affirmed that whatever might happen, they will figure out how to adjust to those changes.

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Annexes

Annex 1. Details concerning the farmers interviewed during the survey

Farm number	District	Type of farm	Age and Sex	Main activity of the owner	Surface area (rai)
1	Mueng Rayong	Business farm with family workforce	52, M	Government officer (specialist of agriculture)	18 (10 fruits + 8 rubber)
2	Mueng Rayong	Business farm with family workforce	70, M	Rubber and fruit farmer	5 (3 fruits + 2 rubber)
3	Mueng Rayong	Family farm	62, F	Farmer	6
4	Muang Rayong	Business farm without family labour	61, M	Owner retired	23
5	Nikompattana	Family business without family workforce	69, M	Rubber tree farming	80 (rubber: 23+18+31+8)
6	Nikompattana	Family business farms with family labor	52, M	Farmer owner	78,5
7	Muang Rayong	Business farm with family labor force	60, M	Farming (rubber and fruits)	25 (15 rubber + 10 fruits)
8	Muang Rayong	Family farm	66, F	Farming	20
9	Muang Rayong	Family business without family workforce	51, F	Owner of a factory	20
10	Klaeng	Business family with family workforce	54, M	Farming	60
11	Klaeng	family farm	54, F	Farming	30
12	Klaeng	Business farm without family	37, M	Rubber farming and biscuits factory	150

		workforce			
13	Klaeng	Business farm without family workforce	56, M	Chef of his own restaurant	52
14	Klaeng	Business farm without family workforce	47, F	Finance business	20
15	Klaeng	family business farms avec family labor	58, F	Farming	50
16	Klaeng	Family farm with worker family workforce	74, M	farming	20
17	Wang Chan	Business farm without family workforce	62, M	Retired	70
18	Wang Chan	Business farm without family labor	81, M	Owner	100 (90 Rubber + 10 Fruits)
19	Wang Chan	Business farm without family labor	74, M	Retired	20 owned and 30 rented
20	Wang Chan	Business farm without family labor	70 F	Retired	40
21	Muang Rayong	Family farm	54, M	Farmers	40
22	Muang Rayong	Family farm	65, F	Farmer	18
23	Muang Rayong	Business farm with family workforce	46, M	Farmer	331 (300 Rubber + 31 Fruits)
24	Klaeng	Business farm with family workforce	80, F	Farmer	60 (400 Rubber + 20 Fruits)
25	Klaeng	Business farm with family workforce	40, F	Farmer	337 (325 Rubber + 12 Fruits)

Annex 2. IDEA grid with indicators, means and variance for each type of farms

Component	Indicator		Criteria	Grading scale	Family farms		BF without FW		BF with FW	
Agro-ecological scale					Mean	σ	Mean	σ	Mean	σ
Diversity /33	A1	Diversity of annual/temporary crops	By species cultivated: 2 pts • If more than 6 species cultivated : 2 pts • If presence of legumes in the rotations: 5 to 10 % : 1, 10 to 15% : 2, +15% : 3	14	0,33	0,82	0,44	1,33	3,90	4,58
	A2	Diversity of perennial crops	• Permanent or temporary pastures of more than 5 years : – less than 10 % of the Total Cultivated Area (TCA) : 3 – more than 10 % of the TCA : 6 • Fruit trees and other perennial crops: – by specie : 3 - if more than 6 species : 2 • Agroforestry, crops or pastures associated to trees or fruit trees: – between 5 and 10% of the TCA: 1 – between 10 and 20 % of the TCA : 2 – more than 20 % of the TCA : 3	14	10,50	4,81	6,67	4,12	13,00	2,11
	A3	Animal diversity	3 points per specie 2 points per additional breed (=nb breed*2pts - 1)	14	1,00	1,55	0,00	0,00	0,90	2,02
	A4	Enhancement / conservation of the genetic heritage	• Per specie or breed in its original region : 3 • Per specie or breed rare or in danger: 1 (It must be because of their choice, not because they lack choice)	14	3,33	5,43	0,00	0,00	4,00	4,71
	TOT COMPONENT			**56**	15,17	6,97	7,11	4,59	21,80	8,39
	FINAL GRADE		CEILING	33	15,17	6,97	7,11	4,59	21,50	7,86

Space organisation	A5	**Rotations**	Area of the main annual Crop/Total of the area than can be cultivated • If : - < 20 % : 8 – < 25 % : 7 – < 30 % : 6 – < 35 % : 5 – < 40 % : 4 – < 45 % : 3 – < 50 % : 2 – > 50 % : 0 • Significant presence (> 10 %) of a crop in intra-plot mixity : 2 • Plot in monocropping since 3 years (except pasture, alfalfa) : – 3	8	0,00	0,00	0,89	2,67	2,40	3,50
	A6	**Dimension of fields**	• No « spacial unity with the same crop » of a dimension superior of: 6 ha : 6 8 ha : 5 10 ha : 4 12 ha : 3 14 ha : 2 16 ha : 1 • If average dimension ≤ 8 ha : 2 • If only natural pasture, grazing routes : 6	6	6,00	0,00	5,00	1,80	4,70	2,50
	A7	**Organic matter management**	• Annual input of organic matter – on more than 10 % of the TCA : 2 – on more than 20 % of the TCA : 4 • At least 50 % of the inputs are composted or other transformation : 2 (Do not take in account the weak C/N contributions like liquid manure)	6	5,67	0,82	4,22	2,54	5,20	1,93
	A8	**Ecological buffer zones**	Evaluation on 0 to 4 of the area dedicated to the water area (0 = no area, 4 = important area) Diversity of the ZRE : Ceiling at 6 pts • Water access, wetland : 2 • Permanent pasture on submersible land (which are not drained or enriched) : 3 • Terraces, small rocky walls maintained : 2 •Non mecanizable routes : 2	10	2,00	2,28	2,33	1,58	4,90	2,38

	A10	Space valuation	The farm uses part of her area for animal food : -No pasture : 0 -No livestock farming : 0 -Part of the area is used for pasture, but it could be extended : 2 -Maximal use of the pasture, which is not enough for self sufficiency (<75%) : 3 -Maximal use of the pasture, which is enough for self sufficiency : 5	5	0,00	0,00	0,00	0,00	0,00	0,00
	A11	Fodder area management	• No fodder : 0 • Alternating cutting + pasture : 1 • Permanent pasture superior to 30 % of the TCA : 2 • Pasture with pasture rotation : 1 pt • Area for corn ensilage : – < 20 % of the TCA : 1 – between 20 and 40 % of the TCA : 0 – > to 40 % of the TCA : – 1	5	0,00	0,00	0,11	0,33	0,00	0,00
	TOT COMPONENT			40	13,67	2,07	12,56	3,32	17,20	3,61
	FINAL GRADE		CEILLING	33	13,67	2,07	12,56	3,32	17,10	3,60
Farming practices	A12	Fertilization	Self-sufficient system in a good fertility context : 8 Organic fertilization : 6 Chemical and organic fertilization : 4 Reasoned chemical fertilization : 2 If no fertilization when it needs it : 0 Unreasoned chemical fertilization : -2 Use of catch crops or green fertilizer to cover the soil and restore fertility : +1	8	4,00	0,00	3,56	0,88	4,00	0,47
	A13	Effluent processing	• No organic liquid effluent : 3 • Individual organic treatment aerobical of the effluents put on the farm with authorization : 2 • Compost : 2 • Collective treatment with an authorized input plan : 2 • No treatment of the effluents : 0	3	3,00	0,00	3,00	0,00	3,00	0,00
	A14	Pesticides	• No treatment and no need for it : 13 All the treatments are reasoned, in biological control : 10 If copper or sulfur treatments : 8 Organic treatments and chemical if necessary : 5 Reasoned chemical treatments : 3 Unreasoned chemical treatments : 0 • Products storage If good management of the stock of the products and the waste: 2 If bad management: - 2	13	10,00	3,95	6,89	4,14	5,30	2,91

	A15	Veterinary products	Over treated : 0 Sufficient and adapted treatment : 3 Existing but not sufficient treatment :1 No treatment but if would be necessary : 0 Use of natural and alternative medicine : bonus +2	3	1,00	1,55	0,00	0,00	0,60	1,26
	A16	Soil resource protection	• Labor without breaking the soil: on 30 to 50 % of the TAC : 1 on 50 to 80 % : 2 on more than 80 % : 3 • For annual crop : Permanent pasture or vegetal cover at least 11 month on 12 -on less than 25 % of the TAC : 0 -on 25 to 40 % : 1 -on 40 to 60 % : 2 -more than 60 % : 3 • Installations and practices anti-erosion (terraces, small walls...) : 2 • For perennial crop Mulch or grass cover of the perennial crops : 3 • Straw burning : – 3	5	3,50	1,97	4,22	1,92	4,60	0,84
	A17	Water resource protection	• No irrigation : 4 • Local irrigation – on more than 50 % of the TAC : 4 – between 25 and 50 % of the TAC : 2 – on less than 25 % of the TAC : 0 •Irrigation system (and anti-frost fight) – on less than 1/3 of the TAC : 1 – from a water catchment : 1 • Irrigation with central-pivot or with lateral move : 1 • Rotation of the irrigated plots : 1 • Individual debit (well, river...) not declared and/or not equipped with a counter: : – 2 ; Practices allowing water conservation in the soil (organic matter input, soil cover, crop disposition) : +2	4	3,33	1,21	2,78	1,86	3,80	0,42
	A18	Energy dependence	Major dependence on fuel oil : 0 Use of different energetic sources : between 2 and 6 according to the fuel oil % Low or non-existent dependence on fuel oil : 10 Energetic saving ways to dry (solar, barn, open air...) : 1 Solar panel, wind turbine, biogaz : 2 Pure vegetal oil : 2 Production or use of wood to heat : 2 Animal traction and labour : 3	10	8,50	1,76	8,44	2,30	8,10	2,38
	TOT COMPONENT			**46**	33,33	4,23	28,89	5,16	29,40	4,27

	FINAL GRADE		CEILING	33	31,83	2,86	28,22	3,93	28,70	2,98
	TOTAL SCALE			100	60,67	6,19	47,89	5,21	68,20	9,89
Socio-territorial scale										
Quality of products and land	B1	**Food production of the farm (FPF)**	Item 1 : % of the TAC used for human alimentation FPF = area used for food production / TAC FPF ≥ 85 % : 5 0% < FPF < 85% : 3 FPF = 0% : 0 point Food self-sufficiency of the family if >30% : +1pt and if >50%: +2pts Item 2 : legumes production on the farm OR fruits and vegetable production destined to human consumption... 2 pts Item 3 : farm with battery farming ... 5 pts	5	2,83	2,48	2,11	2,32	5,00	0,00
	B2	**Contribution to the global food balance**	Item 1 : For the livestock breeding farms Import ratio (IR) ..... /5 IR = imported area/TAC IR< 10 % : ..... 5 10 < IR < 20% : ..... 4 20 < IR < 30 % : ..... 3 30 < IR < 40% : ..... 2 40 < IR < 50 % : ..... 1 IR> 50 % : ..... 0 Item 2 : For farms without livestock Production of food rich in protein if more than 30 % of the TAC : 5	5	0,00	0,00	0,00	0,00	0,80	1,75
	B3	**Quality of the production**	Item 1 : Food quality linked to: · the territory : 3 · the process : 3 Item 2 : Nutritional quality ..... 3 (Milk production from grazer systems (milk enriched with omega 3), flax seeds meal in the animal ration) Item 3 : Global quality ..... 5 Organic farming certified.	5	1,83	2,14	0,67	1,32	2,60	1,51

			Organic farming practices not certified because of label nonexistent or too expensive in the country.							
	B4	**Loss and waste**	If waste and no action : 0pt If no wastes: 5 pts Actions put it place: 1 pt per method * Presence of an adapted and quality storage capacity on the farm * Social action to limit the leftovers in the field (free picking etc.) * Participation to an association of prevention of food wastes * Donation to food assistance structures * Food valorization of the products not compatible to the buyer standards * Processing and valorization of the secondary products for food * Donations or exchange of some products	5	3,67	2,16	4,11	1,76	3,00	2,16
	B5/5	**Social, hedonistic and cultural links with food**	1 pt per procedure, with a ceiling at 3 pts Some specific procedures can be added according to the farm. Item 1 : Procedures improving the link between the consumer and the farmer * Opening of the farm to the consumer for sales or visits * Participation to events about food * All kind of restoration on the farm * Fair trade * others Item 2 : Procedures improving learning or culture around food * Pedagogic farm with food processing workshops * Communication by the farmer of recipes from her/his products (written, oral, flyers...) Item 3 : Significant production of species little represented on the common market to contribute to the diversity of tastes of the consumer	3	0,83	1,17	0,44	1,01	0,60	0,70
	TOT COMPONENT			**23**	9,17	4,79	7,33	2,50	12,00	3,86
	FINAL GRADE		CEILING	20	9,17	4,79	7,33	2,50	12,00	3,86

Employment and services	B6	**Valorisation and quality of the heritage: Built, landscape and local knowledge and natural resources**	Qualitative assessment between 0 and 4 on the quality of preservation of the landscape, natural resources and the environment. Overall assessment of the indicator according to the context. Examples: Item 1: quality of the buildings • maintenance or restoration of older buildings (heritage and rural quality) • quality and typicality of architectural and landscape integration of recent buildings • quality of the surroundings of the farm Item 2: quality of the landscape • Arrangement of the landscapes in the cultivated areas and near the farm • Implementation of measures to enhance the local landscape (flowering contests, flowery fallows, commitment of local landscapes...) • Contribution by the cultural or breeding practices to maintain the cultural landscape (rice terraces, cevenol terraces, walls stone dry,...) Item 3: contribution to the maintenance of local knowledge (cultural or productive) Item 4: maintain/develop the natural gene pool: Presence of breeds or crop varieties with low yields entering in the act of production.	4	2,17	0,98	1,11	1,05	2,11	1,05
	B7	**Accessibility of space**	Item 1: in rural areas Access to the paths to other people and users (hikers, mountain biking, leisure horses, balloons, paragliders, etc.) Item 2: in urban area Free access on private in paths urban or peri-urban areas Item 3: Maintenance of the paths for hiking or road of access	2	2,00	0,00	1,78	0,67	1,70	0,67
	B8	**Management of inorganic waste**	• Recycling and reusing at the local level: 3 • Waste sorting and collective collection: 2 • If no sorting: 0 • Burning, landfills: -3 • Plasticulture, wrapping: -3	5	2,17	1,60	2,56	1,01	1,40	0,97

	B9	**Short-chain valuation**	Item 1: valuation by direct sales or short circuit... 4 1 point by 5% of the ratio Direct sales /(Agricultural turnover) Item 2: development of the proximity area... 4 Proximity sale to the final consumer or short circuit of proximity Item 3: Contract with the local canteens or local restoration or local public markets... 6	6	3,00	2,76	1,33	2,24	3,10	2,56
	B10	**Valorization of local resources**	Item 1: local supplies (purchase or all forms of exchange) Item 1.1: Feed * More than 50% of the purchases of cattle food (in quantity or value) are from the local area... 2 * Less than 50% of the food purchases for the cattle are from the local area:... 0 Item 1.2: Organic fertilizer * Less than 20% of supply (value or quantity) are produced on the local territory: - 1 * If exchanges straw/ manure or equivalent: 1 Item 1.3: Purchases of animals produced on the local territory:... 2 Item 2: varietal selection approach Reproduction and/or exchange of seeds to develop seed autonomy... 2 Item 3: energy... 4 Use or production of energy from agricultural or forestry resources from the territory (other than 1st generation agrofuels and solar farms with panels on the ground) Item 4: effluents Reuse of water station or food processing water for irrigation: 2 Valorisation of sludge of station: 2 Item 5: water	6	1,50	1,22	0,33	0,71	1,10	0,88

			Recollection of rainwater: 1 Reforestation in order to help the water resource: 1							
	B11	**Territorial and global environmental services**	Item 1 : farm committed in an environmental quality process (with or without label), with involves the non-use of chemical inputs _ between 20 and 50% of the TAC : 3 - for at least 50 of the TAC: 6 Item 2 : process who prevents a natural bioclimatic risk (anti erosion, flood limitations, drought limitation...)... 6	6	3,00	0,00	3,00	0,00	3,60	1,07
	B12	**Market services and pluriactivity**	Commercial services for the local area · Agrotourism : ……..…….. 2 · Pedagogical farm : ……..…… 2	4	0,00	0,00	0,22	0,67	0,00	0,00
	B13	**Contribution to employment**	At least one permanent worker (employee or family): + 2pts Seasonal labor: + 1 pt. If presence of an employee for more than 5 years: + 2pt. If workers are local (seasonal or permanent) + 1pt If willingness to employ within the year + 1pt	6	2,67	1,63	4,00	1,58	4,80	1,03
	B14	**Collective work**	Item 1: Participation in networks of knowledge... 3 Work or participation in networks of test, knowledge, management, collective learning or design of environmental innovative practices Item 2: Sharing of materials equipment buildings/services... 3 Item 3: Pooling of labor... 3 Bank working...1 Mutual help + 10 j per year...1 Group of employers... 1 CUMA material that offers a service full of Labor (more equipment)...1 Item 4: Pooling of productive projects... 6 (crop rotation in common, common project diversification, points of sale shared. etc...)	6	0,83	1,17	0,00	0,00	0,30	0,95
	FINAL GRADE		CEILING	**45**	17,33	3,88	14,33	4,61	17,90	4,18
	TOTAL SCALE			40	17,33	3,88	14,33	4,61	17,10	3,60

Ethics and human development	B15	**Social and solidarity implications**	Item 1: Involvement in professional structures (limited to three structures) (ceiling at 2) -Associate Member (regardless of the number of structures) 1 -With responsibilities (regardless of the number of structures): 2 Item 2: Involvement in structures (not agricultural) associative and/or elective off professional fields in the territory (ceiling at 2) -With responsibilities (regardless of the number of structures): 2 -Associate Member (regardless of the number of structures): 1 Item 3: Working with structures within the field of the social economy and solidarity and practical insertion and/or social experimentation... 2 Item 4: Involvement of citizens in the work or life of exploitation... 2 Item 5: Volunteer host of public... 2	7	0,83	0,41	0,67	0,71	1,80	1,14
	B16	**Transparency approach**	Item 1: - Communication of the farmer practices with certified procedures, individual or collective: 4 - Others 2 (justify: example sharing practices without certification or charter) Item 2: Membership in a participative system ... 2	4	0,00	0,00	0,00	0,00	0,00	0,00
	B17	**Intensity and quality of work**	Item 1: pleasure and satisfaction at work (/4) Self-assessment on a scale of 0 to 4 Item 2: time and mental load (/3) Number of weeks per year where the farmer is feeling overloaded If more than 8 weeks: 0 4-8 weeks: 1 1-3 weeks: 2 Zero week: 3 points Item 3: days off (/3) In absolute terms, do you need to take rest days? Are you taking some? If Yes to the two questions: 3 If no to both questions: 3 If answer yes/no: 0		4,83	1,60	2,56	3,13	4,40	2,17

			Item 4: hardship at work (/4) Self-assessment of fatigue on a scale 0 to-4 (hard work)							
	B18	Quality of life	How do you appreciate you quality of life on a 0 to 7 scale?	7	6,00	0,89	6,22	0,67	6,40	0,70
	B19	Isolation	Self-assessment of the isolation feeling (geographical, social and cultural) Isolation = 0 and no isolation = 4 pts	4	3,67	0,52	3,67	0,50	3,70	0,67
	B20	Health, Hygiene & Security	Item 1: Quality of reception and accommodation of the temporary labour and interns... 2 estimate of 0 to 2 Item 2: Security of facilities Yes (electricity, protection... manure pits)... 1 Item 3: Contact with pesticides -Meets local recommendations regulations... 2 -Practices exposing individuals to the pesticides... -2 -No plant phytosanitary product (expect organic ones)... 2	4	1,33	1,37	1,00	1,22	1,00	0,00
	B21	Training	Item 1 : Training 1 point per type of training up to 5 Item 2 : Reception of professional, students or interns groups 1 point/group up to 2 groups	5	1,67	1,51	1,11	1,36	2,80	1,87

	B22	Animal wellbeing	Item 1: Put 1 point for each correct answer the following questions: -reply to the physiological needs of animals (Absence of thirst, hunger and malnutrition) -Response to the health needs of animals (Absence of illness and injury) -Response to the psychological needs of animals (Absence of fear or anxiety) -Response to the behavioural needs of animals (possibility to express normal behaviour of the species) -Response to the environmental needs of animals (Presence of appropriate shelters and the comfort of the animal-keeping) -No no curative action (dehorning, docking). Item 2: initiatives or personal commitments: + 1 if the breeder has a good relationship with its animals. Item 3: Remove: -2pts if no pasture, -1 for each practice of the type dehorning, docking...	7	0,67	1,63	0,00	0,00	0,40	1,26
	TOT COMPONENT			**38**	19,00	3,29	15,22	5,80	20,50	3,21
	FINAL GRADE		CEILING	40	19,00	3,29	15,22	5,80	20,30	3,16
	TOTAL SCALE			100	45,50	9,73	36,89	10,46	49,40	6,80
Economical scale										
Economic and financial viab	C1	Economic viability	Item 1 : economical data …… 20 Creation of wealth (WC) =Gross Operating Surplus GOS / Labor Unit not employed WC < 0,6 net annual minimum wage : ……. 0 0,6< WC < 1 : 8 pts 1 <WC< 1.4 : 12 pts 1.4 <WR< 1.6 : 16 pts 1.6 <WR < 2.5 : 18 pts WR> 2.5 net annual minimum wage: 20 pts Item 2 : farmer's evaluation..... 5 * What evaluation have you on the economical capacity of your farm? (on a scale from 0 to 5) or * Do you think your farm has a sufficient income on a 0 to 5 scale?	22	11,67	7,76	16,89	7,88	15,70	7,38

ility	**C2**	**Debts**	Item 1: Weight of the refund =(amount of the annuities + final costs) / GOS - <30%:... 6 - between 30 and 50%:...3 - ≥ 50%:... 0; Item 2: Estimate between 0 and 6 by the farmer of the debt situation, taking into account the amount borrowed at first, its ability to repay the loan, and his feeling about borrowing. Item 3: Ability to repay How the producer considers her/his ability to repay its debts, on a scale of 0 to 4.	16	16,00	0,00	16,00	0,00	15,20	1,93
	TOT COMPONENT			**38**	27,67	7,76	32,89	7,88	30,90	7,45
	FINAL GRADE		CEILING	35	27,17	7,03	31,00	6,56	29,80	6,37
Inde pen den ce	C4	**Diversification of production**	Item 1: the share of the major production in the farm's turnover -less than 25% ... 8 -from 25% to 50% ... 4 -of 50% to 75% ... 2 -more than 75% ... 0 Item 2: diversification of the number of raw or processed products sold Number of products representing more than 20% of turnover: -More than 3 products:... 4 -From 2 to 3 products:... 2 -1 only product that exceeds 20%: 0	10	2,33	2,94	0,78	2,33	3,00	1,94
	C5	**Diversification of contract. relationships**	Item 1: Diversity of the clients (/6) The major customer represents * less than 33% of the turnover... 6 * 33 to 66% of the turnover... 3 * more than 66% of the turnover... 0 Item 2: Quality of the contracts relationship (/6) For the main production * No contract:... 0 * Conventional contract of simple type joining a co-op:... 3 * Presence of production on a contracts long term:... 6 * all forms of "solidarity" contract (type AMAP or other forms with the same level of confidence to the producer price (and amount):... 6 Workshop in integration and work full:... - 2	10	2,00	1,55	1,67	2,18	3,30	2,63

	C6	**Sensitivity to aid**	Sensibility to aids from the government (AS): AS = Σ aids /GOS < 25 % : …… 5 25 to 50 % : …… 3 50 % to 100 % : …… 2 > 100% : …… 0	5	4,67	0,82	5,00	0,00	5,00	0,00
	C7	**Contribution of external incomes to the sustainability of the farm**	Is there a significant income from outside the farm or from a pluriactivity of the farmers Yes : 5 No : 0	5	0,83	2,04	3,89	2,20	2,50	2,64
	TOT COMPONENT			**30**	9,83	4,07	11,33	4,85	13,80	4,39
	FINAL GRADE		CEILING	30	9,83	4,07	11,33	4,85	13,80	4,39
Transmissibility	C8	**Economic transferability**	Bigger capital than the majority of the farmers in the area : low yield per person (0), medium (5), high (9) Normal to weak capital for the area : low yield 5 ; medium 9 ; high 15	15	8,33	1,63	7,22	2,11	7,00	2,11
	C9	**Probable perenniality**	Item 1 : existence though by the farmer (on 5pts) • Existence almost-certain of the farm in 10 years : 5 • Existence possible : 4 • Existence wished if possible : 1 • Disparition possible of the farm in the farm : 0 Item 2 : property, structure et projects (on 3 pts) - Access to the property and ways to value it : 3 - Protected (with property or long term contracts or stable collective agreements or other) 2 - Presence of projects of futures developments (irrigation, tree plantation ...) or future extension of the property : 1 - Plots structure: coherent / far, divided in small plots, not continued... : 2	8	7,33	1,21	7,00	1,22	6,00	2,49
	TOT COMPONENT			23	15,67	1,75	14,22	2,99	13,00	3,77
	FINAL GRADE		CEILING	20	15,67	1,75	14,22	2,99	13,00	3,77
Global efficienc	C10	**Gross efficiency of the agricultural system**	Gross efficiency = GE GE =(Production - Inputs / Production) in monetary value GE < 0,1: …… 0 0,1 ≤ GE < 0,2: …… 3 0,2 ≤ GE < 0,3 : …… 6 0,3 ≤ GE < 0,5 : …… 9 0, 5 ≤ GE < 0,6 : …… 11 GE ≥ 0,6 : …… 14	14	13,50	1,22	9,25	4,59	12,10	2,81

y	C11	**Sobriety in inputs**	Consumption in input per hectare of the TAC: Very high…… 0 High…… 2 Medium……..4 Low ……..6	6	4,17	1,33	4,00	1,41	4,20	1,14
	TOT COMPONENT			20	17,67	1,51	12,22	4,52	16,30	3,37
	FINAL GRADE		CEILING	20	17,67	1,51	12,22	4,52	16,30	3,37
	TOTAL SCALE			100	70,33	9,56	68,78	10,43	72,90	9,94