

Veronika Fendel

Perceptions of intercropping and the natural undergrowth in rubber plantations

Master's Thesis

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Natural Rubber Studies

Veronika Fendel

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Master Thesis

Preface

The series 'Natural Rubber Studies' aims at popularizing studies, assessments, observations related to natural rubber which would otherwise fall into oblivion although they could contribute to a better understanding and probably management of natural rubber. Due to the strict formal and methodological criteria for scientific publications many of such information would never find its way to a wider audience, despite its basic validity. Therefore, this series encourages everybody with valuable and trustworthy - that is comprehensible and documented – information dealing with natural rubber to make it accessible to a wider audience.

'Perceptions of intercropping and the natural undergrowth in rubber plantations' addresses an aspect in rubber plantation management which is largely ignored in the general discussion, the farmers' point of view. While it is undoubted that the commonly practiced clean-weeding is physically and ecologically detrimental it stays dubious why farmers still practice it despite all the opposing arguments. A commonly used explanation is the fear of snakes. But, interestingly, there is hardly any study supporting this assumption. Quite the contrary, own observations and discussions in rubber plantations of SW China suggest that snakes are not at all perceived as a noteworthy problem. This case study in Malaysia aims therefore at a better understanding of farmers' perception and motivation to keep their plantations clean.

Gerhard Langenberger

Abstract

Farmers' perception is crucial for agricultural projects in terms of technology adaptation. However, this is often neglected which results in a knowledge gap, leading to failed projects of implementing ecologically friendly agricultural systems. Furthermore, perceptions vary strongly with context, are highly complex, and difficult to comprehend and retrace. This indicates the fundamentality of mutual understanding. Therefore, the discovery of different perceptions was the main motivation of this research.

The objective of this study is to represent those perceptions. To be more precise, the perception of natural undergrowth and intercropping from stakeholders in the rubber cultivation. An insight opens the possibility to involve farmers' desires. This may provide a path to the aim of creating sustainable systems and make an implementation meaningful. This goal is aimed at the future design of rubber plantations. The reason for this is that rubber is planted in monocultures and occupies a large area in order to meet the huge international demand of a growing world population. Nature and farmers are affected. This indicates the need for action towards an alternative and sustainable planting system. Several studies show the advantageousness of intercropping and diversified systems. Nevertheless, initial intercropping is applied, but long-term intercropping hardly ever is. Furthermore, in this case natural undergrowth is frequently minimized on big-scale farms and partially, in general before manuring, on small scale farms. This research investigates these decisions. It is conducted in order to recognize potential possibilities of implementation opportunities for sustainable systems.

To approach rubber cultivating stakeholder's perception, a case study was conducted in Northern Malaysia. The method of 30 interviews in a semi-standardized oral survey included pre-interviews, group discussions, ongoing conversations and expert interviews. Institutional representatives, as well as large-scale and small-scale farmers, were considered. High complexity and diversity of perceptions result in the need for an interactive investigation. Furthermore, the context changes with time and place. Therefore, this study does not aim to provide a generalization. However, similarities can be found with other cases, as it is with a missing bridge between scientific research and farmer's perception.

The tendency of preference shows overwhelming argumentation against intercropping and against maintaining the natural undergrowth than in favour of it. A strong focus on social and economic factors and a neglect of ecological/agronomic factors appeared.

Ecological/agronomic advantages are obvious for farmers but of inferior importance. Traditional values and living style, bad experiences with former projects, financial aspects like risk and profitability, more work, a focus on rubber and a lack of interest in intercropping of the estate farmers were reasons for the majority to not apply intercropping. An additional finding is that ethnic communities form a difficult environment for selling fruits and vegetables and therefore decide market possibilities. Particularly, the preference of having a clean plantation makes natural undergrowth undesired. This is a result of pressure from society which unintentionally sets unofficial rules through the connection to a good character and image for all stakeholder groups. Other concerns are the fear of animals, ghosts and competition for fertilizer. The latter relates also to rubber trees being perceived as extremely valuable by smallholders who are often dependent on high yields. Estate owners additionally wish to create an attractive working environment due to labour shortage. There are nearly no reasons to keep it. Furthermore, spraying is much cheaper and less time-consuming than cutting. For this reason, herbicides are usually sprayed. On small-scale farms in this case, natural undergrowth partially remains, even though it is not desired. Small farmers initially plant cash crops and estate farmers cover crops for mulching. Initial is preferred to long-term intercropping. Explanations, amongst other things, are the need for better income, already existing experiences, reduced risk, economical profitability, less work for weeding and trustworthy advice. A change in the lack of the need to do so is seen as a motivation for long-term intercropping. Additionally, personal attitude and consciousness of its advantages, which are influenced by society's recognition and economic proof, improved soil conditions and the preference of agroforestry to fruit trees were advocating reasons for the majority.

An implication is that it does not lead far to convince farmers in keeping natural undergrowth or applying long-term intercropping, which is not precisely investigated. Research-based proof on market situations and profitability must be traceable for the farmers. Due to transforming costs, proof of a profit is needed for estates, that is higher than that achieved with initial intercropping. Working together with institutions through the already existing seminars might be a way to gain trust and to promote ecological consciousness for a positive attitude towards new systems. Additionally, acceptance for intercropping with native wood trees exists. This has potential for estates due to affordability. Financial support and implementation advice and help might include other farm systems as well. Furthermore, this support might be a possibility for smallholders to grow cover crops. This is positively connected to successful systems, which are

visible on estates. The need for good experiences of other systems might be provided through a model. Among other reasons, for gaining society's recognition, certification systems might be a motivation for financially strong large-scale farms. This should not compete with the production of smallholders. A changing agricultural pattern expects an increase in the amount of estate farms. Nevertheless, due to the big part of small farmers in Malaysia they remain important. Consequently, different farming systems should be addressed simultaneously for implementations of sustainable systems. Currently, Thailand is the biggest rubber producer worldwide, which makes this country another starting point. The gain of this study is, in particular, the visible importance of the perception of farmers when implementing new agricultural technologies. It shows a large complexity and the need for understanding the centre, which should be included in any further research projects. A wrong path would be to ignore it, which leads to the following conclusion:

(Small-scale) farmers are the centre of agricultural production and can no longer be pushed out of this position and replaced by agricultural projects.

The quotations are largely reproduced in their original form and were minimal linguistically smoothed in order to maintain the reading flow.

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Abbreviations

FSC	Forest Stewardship Council
MRB	Malaysian Rubber Board
RISDA	Rubber Industry Smallholders Development Authority

1. Introduction

1.1 Background and problem statement

“Try to see the world out of different eyes” [18]



Figure 1 Rubber cub

Natural rubber can be obtained from the para-rubber tree *Hevea brasiliensis* (Willd. Ex A. Juss.) Müll. Arg., which is an important renewable resource and fundamental in modern industrialization. Its origin is located in the Amazon basin. From there it was distributed to the African and Asian continents. In this way, rubber plantations caused a conversion of forests on a large scale in the early 1900s in Malaysia (Ratnasingam et al., 2015). Malaysia's rainforest is recognized for a high diversity and one of the most complex ecosystems along with twelve other countries around the world (Jusoff, 2008). However, natural forests declined quickly while, in particular, oil palm plantations grew (FAO, 2011) and thus turning Malaysia into an agricultural-based country.

A large area of land is occupied in order to meet a growing international demand for rubber (Warren-Thomas, Dolman, & Edwards, 2015). Though in total, rubber plantations decline as well in Malaysia (FAO, 2011), due to low profitability and unstable prices (Gouyon, 2003; MRB, 2017). Nevertheless, rubber is still important to the Malaysian economy and the livelihood of approximately 200.000 smallholder families managing approximately 95 percent and estate farmers approximately five percent of the rubber plantations (*Rubber Plantation & Processing Technologies*, 2009). The dependency of rubber farmers on a good rubber price points to an unsteady situation and contributes to a rural depopulation trend, in particular of young people. An increasing

unpopularity of agricultural work creates a labor shortage (Freske, 2013; Gouyon, 2003) on the country side.

Rubber plantations are usually planted in monocultures, which cause ecological effects. Climate change, scarcity of resources, increasing world population as well as forest and species extinction are increasingly gaining attention. Smallholders apply initial intercropping with cash crops, while estate farms plant cover crops. Besides, sustainable long-term intercropping systems like agroforestry are not practiced in Malaysia. A similar relation in rubber intercropping systems can be observed worldwide, which was highlighted by a respondent of this study ^[10]. This stands contrary to scientific research assessments about suitable alternatives and sustainable systems, which indicates a lack of mutual understanding.

Malaysia is a land of diversity, which can be seen in the natural ecosystem as well as the society with a high percentage of minorities and various cultures and religions. This enrichment shows the need to deal with complexity for comprehension. Furthermore, different rubber-cultivation-connected stakeholders make it necessary to consider various perceptions in order to retrace decisions.

Consequently, alternative agricultural systems, in order to spare environmental impacts for reaching a sustainable working balance between agriculture and nature and to improve farmers' situation, are fundamental.

1.2 Research field and research question

The background idea of this case study is to picture the perception of different stakeholders in the rubber cultivation. Many studies deal with ecological/agronomic issues, which often do not consider the perception of farmers. This includes: what they experience in praxis, how they perceive the rubber management and, in particular, what is important to them. Understanding the perception and situation creates a foundation for better communication and makes an implementation meaningful. This might be a possibility to create a sustainable approach towards environmentally friendly systems.

This study was carried out in Northern Malaysia, mainly in the states Kedah and Perlis. The view of two stakeholders from Southern Thailand, closed to Hat Yai were included due to the lack of long-term intercropping systems in Malaysia.

This work illuminates the perception from people who work in rubber cultivation related **institutions** as well as from **estate** farming representatives. The opinions from an estate owner, estate manager and tapper are included. Likewise, the arguments of stereotyped and exceptional **smallholders** gained attention.

An overview on various opinions in order to understand the perception of different stakeholders in terms of intercropping and the natural undergrowth is consequently provided in the results. By taking a broad view on the current situation, the aim is to answer the following questions:

1. What are the perceptions?
2. What are different and similar perceptions among the categorized groups?
3. What are important arguments for the majority?
4. Whom to address and where is it better not to intervene?
5. What are possible incentives and approaches?
6. Where is further research needed?

1.3 Structure of the thesis

The results of the thesis are structured according to the different stakeholder groups. Beginning with institutions, it leads to the results of estate representatives and ends with findings from typical and exceptional smallholders. Within those groups, their reasons for and against intercropping and natural undergrowth are illuminated. Frequently appearing arguments as well as a contemplation of all groups together can be found in the summarized results. Based on these deliverables, the discussion will focus on the above-listed questions, including an outlook on possibilities and further research.

2. Methodology

In the following section, the methodological foundations of the scientific knowledge gained in this thesis are described. In doing so, the approach of the work and the theory of applied methods are described.

2.1 Research method

The research method consists of a case study approach. This is chosen to study the research questions. Case research could be defined as a *“research method that involves investigating one or a small number of social entities or situations about which data are collected using multiple sources of data and developing a holistic description through an iterative research process”* (Easton, 2010, p.119) *“The key opportunity case it has to offer is to understand a phenomenon in depth and comprehensively”* (Easton, 2010, p.119). This allows the researcher to analyse a *“complex set of factors and relationships, albeit in one or a small number of instances”* (Easton, 2010, p.119). Nevertheless this approach is criticized for providing little basis for scientific generalization (Yin, 2003).

“Indeed, the case study is probably best understood as an ideal type rather than a method with hard and fast rules. Yet the fact that the case study is fuzzy round the edges does not mean that it doesn't have distinctive characteristics” (Gerring, 2009, p.346).

During the interview process, more and different questions arose, which significantly influenced, added and changed the structure towards new insights. As the interviews were conducted, the question of *“how and why”* was focused on, which offers advantages, compared to other research methods, in understanding complex social phenomena (Yin, 2003).

This thesis does not aim to be generalized and follows an approach of exploration during the investigation. Therefore, and for letting the perception of farmers decide the results, this approach is assessed to be suitable.

2.2 Data collection and interview conduction

The data was collected through 30 **interviews**. Pre-meetings, group discussions, on-going conversations and expert interviews were conducted (table 1). The pre-meetings were crucial for structuring the questionnaires. Furthermore, they enabled contacts options for interview partners. A “snowball effect” started, which means that there were increasing possibilities of connecting with interview partners. Each interview took around one to two hours. They included a start in conversation and continued in following the structure of the question guide. Often the conversation continued for several more hours. In order to gain the perception of stakeholders it is more suitable to use qualitative open-end interviews in a small amount than many short-structured interviews (Hubermann & Miles, 2002). Therefore, different interview types were conducted, according to the situation provided.

Table 1 Interview types and the amount of all conducted interviews

Interview type	Number of interviews
Pre-interviews	3
Group interviews	1
Ongoing conversations	5
Expert interviews	21
Total	30

A **semi-standardized** oral survey was chosen in order to provide the possibility for the experts to express their opinion and perception (Gläser & Laudel, 2010). This is called a guideline interview, which is part of the qualitative data collection (Gläser & Laudel, 2010). In this way, the structure was maintained, which kept a focus on the hypothesis and results comparable, but left explorative space for new findings simultaneously. This open nature of the study allowed interactive investigation into new insights. Key questions that reflect the central questionnaire as well as eventual questions, which can be asked depending on the conversation history, were included (Schnell, Hill, & Esser, 2011).

A main structure for the **guiding questions** was prepared with little differences in the eventual questions for the different stakeholder categories. The questionnaire begins

with general introduction questions about the background of rubber cultivation and continues with questions about management and motivation for growing rubber in monocultures. Then, the perception about mixed cropping is illuminated. Furthermore, it continues with the management and opinion about natural undergrowth and biodiversity. Relationship and connection questions to other stakeholder groups are included. Finally, space is given for further suggestions, wishes, concerns and topics that were not addressed. Additionally, a small closed questionnaire followed for completion. Those were taken for the possibility to connect the results to clusters.

Some interviews were not **recorded**, due to the fact that some felt insecure or insulted, making them feel that their input was untrusted. However, the information was noted during the interviews and used for the analysis. Ongoing conversations took all day, for which reason a recording was excluded as well. During the conversation, due to language barriers, gestures and facial expressions improved the mutual understanding. A word-for-word transcription would therefore lead away rather than towards the core. In this case, notes can represent a more realistic image. Eleven recordings were used to verify the transcription. The transcription was performed through documenting notes during all interviews. The statements were directly used as results. In another study, it was argued that individually focused interviews, which *“replace audio transcriptions with a combination of simultaneously taken and jointly produced notes can be done without affecting reliability, validity and transparency”* (Clausen, 2012, p.1).

The author of this thesis strongly agrees with the statement that it is difficult to gain deep insight in less than an hour (Silverman, 2013). Therefore, **all information** given by the interview partners, even when they were out of the official interview time borders were included.

2.3 Stakeholder group definition

The first focus was to cover a wide range of stakeholders. This included representatives from institutions, estate farming and smallholding.

Smallholdings accounted for 95,7 percent in 2007 of the planted area in Malaysia, meanwhile the other part is occupied by **estate farms** (*Rubber Plantation & Processing Technologies*, 2009). Smallholdings are defined to occupy an area less than 100 acres (approximately 40 hectares) (RISDA, 2017). However, most smallholder respondents

of this study said that the majority of them own a plantation area of approximately two hectares ^[1].

A relatively large amount of **typical Malay smallholders** were integrated, since this is most representative in Malaysia (*Rubber Plantation & Processing Technologies*, 2009). The definition, from own observations for a typical smallholder, is as followed:

- Malay origin
- Retired
- Translation into English is needed for the author
- Small plantation (approximately two hectares)
- No long-term intercropping experiences
- Self-supporter characteristics with a traditional fruit yard

In order to not have a biased and rather diverse view, data was selected additionally, following an “**extreme pattern**”. This means that farmers with different features were chosen. Essential features were:

- Ethnic origin
- Gender
- Age
- Education
- Farm size
- Intercropping experience

The ethnic diversity in Malaysia led to the inclusion of Indian, Chinese and additionally Thai smallholders. Translation was necessary for approximately half of all interviews. This was one of the criteria, related to education, which served to include English-speaking and non-English-speaking stakeholders in the interview sample.

Estate farming in this survey was included by representatives from three different occupations. Estate owner, estate manager and tapper were considered. It is common that employees live on big scale farms, which also have small plantation villages. The weeding gang was not included, due to minimal decision power and their need of payment orientation ^[E1]. They are mainly foreigners and hired by estate farms ^[E1].

The **institution** category included the “*custodian of the rubber industry in Malaysia*”, the Malaysian Rubber Board (MRB) (MRB, 2017). Furthermore, Rubber Industries

Smallholder Development Authority (RISDA) was considered, which communicates directly with smallholders and is in charge of replanting in this sector. This includes providing items and advice for them (RISDA, 2017). Currently, the institutions support smallholders in poverty with subsidies and give fertilizer to smallholders who are registered with RISDA for the first 6 years (RISDA, 2017). RISDA and MRB interact less with estate farms. Additionally, this study included the opinion from employees of a company, which provides tools for rubber cultivation and from a university representative, who is focusing on rubber ecology and integrates a scientific view.

Beyond that, the survey also included the perception of a villager and a town dweller, who were not themselves participating in rubber cultivation but connected with it through their family. Other **extensional cases** were two Thai representatives, who were included due to long-term intercropping experiences.

In the following tables one is able to recognize number and distribution of the interview partners (table 2). Furthermore, the anonymization is traceable for institution (table 3), estate farming (table 4) and smallholder representatives (table 5).

Table 2 Number of interview partners and their category

Category of interviewed person	Number of persons
MRB	7
RISDA	1
University, Hat Yai	1
Company for rubber cultivating items	2
Estate farmer	1
Estate manager	2
Estate tapper	1
Typical Malay small farmer	8
Exceptional Malay small farmer	7
Others	2
Total	32

2. Methodology

Table 3 Interview details and anonymization of interview partners from the category of institutions

<i>[Reference – cursive and elevated]</i>	Function of the interviewed <i>Type of interview – cursive</i>	Trans- lator
MRB ^[10]	<i>Group discussions</i>	No
Pre-meeting		
1 ^[1]	Head of the department	
2 ^[2]	Employee	
3 ^[3]	Employee	
4 ^[4]	Employee	
5 ^[5]	Employee	
Second official meeting		
1 ^[1]	Head of the department	
2 ^[2]	Employee	
3 ^[3]	Employee	
5 ^[5]	Employee	
6 ^[6]	Retired; had been invited to provide expert knowledge	
7 ^[7]	Employee	
Prince of Songkla University Hat Yai	<i>Ongoing conversation</i>	No
8 ^[8]	Head of Department for Ecology	
RISDA	<i>Expert interview</i>	Yes
9 ^[9]	Head of the office in Baling	
Company Greenyield Berhad	<i>Ongoing conversations</i>	No
10 ^[10]	Retired from MRB, works since then for the company; visited many rubber producing countries.	
11 ^[11]	Retired from MRB, works since then for the company	

2. Methodology

Table 4 Interview details and anonymization of interview partners from the category of estate farming

Function of the interviewed	Note	Trans- lator
<i>[Reference – cursive and elevated]</i>	<i>Type of interview – cursive</i>	
Estate owner	<i>Expert interviews</i>	No
Pre-information ^[E1]		
Pre-interview ^[E1]		
Second official meeting ^[E1]		
Estate manager	<i>Expert interviews</i>	
2 ^[E2]		Yes
3 ^[E3]		No
Estate tapper	<i>Expert interview</i>	Yes
4 ^[E4]		

Table 5 Interview details and anonymization of interview partners from the category of small farmers

Small farmer category	Note	Intercropping	Trans- lator
<i>[Reference – cursive and elevated]</i>	<i>Type of interview - cursive</i>		
Typical Malay small farmer	<i>Expert interviews</i>		
1 ^[S1]		Yes – Initial	No
2 ^[S2]		No	Yes
3 ^[S3]		No	Yes
4 ^[S4]		No	Yes
5 ^[S5]		Yes – Initial	Yes
6 ^[S6]		Yes – Initial	Yes
7 ^[S7]		Yes – Initial	Yes
8 ^[S8]		No	No
Exceptional cases	<i>Expert interviews</i>		

2. Methodology

9 [S9]	Indian origin	No	No
10 [S10]	Chinese origin	No	Yes
11 [S11]	Young farmer (Age: 34 years)	Yes – Initial	Yes
12 [S12]	Long-term intercropping applying Thai farmer in Thailand	Yes – Long-term	Yes
13 [S13]	Alone managing female farmer	Yes – Initial	Yes
14 [S14]	Alone managing female farmer	No	Yes
15 [S15]	From University graduated farmer	Yes – Initial	No
Others	<i>Ongoing conversation</i>	N.a.	No
1 ^[O1]	Villager		
2 ^[O2]	City dweller		

2.4 Analysis

The analysis and evaluation of the expert interviews were achieved with the help of a written version (Fuß & Karbach, 2014). This transference is described by the social research as transaction (Friebertshäuser, Boller, & Richer, 2010).

The summary **transcript** documents shortened the most important statements, whereby the exact wording does not have to be reproduced. In the journalistic transcript, the colloquial expressions are smoothened and transferred into a written language. (Fuß & Karbach, 2014). Interviews were transcribed with written notes and partly by the sound of audio records in a Microsoft Word document. This type of transcription corresponds to the two described transcript types. The interview guide was used as an orientation in order to achieve the aim of a comparable text design.

The interview statements were assigned to categories in a Microsoft Excel-based system. Later they were anonymised to ensure an impossible allocation.

2.4.1 Microsoft Excel-based analysis

The data was evaluated through an Excel-based analysis (figure 3). **Categories** and subcategories were defined and the interview content was assigned. The same argu-

mentations were clustered and then summarized in a category. This analysis is supposed to uphold the content and show the exact perception of the experts. This was conducted separately for institutions, estate farms and smallholdings.

Orientation was the method of **Mayring** (Mayring, 2015), who distinguishes three basis forms of qualitative content analysis: The summary, explication and structuring through a category system of the interview material (Mayring, 2015). Following this method, categories were deductive and subcategories were mainly developed inductively (Mayring, 2015). A content-based structuring was carried out for the work, so that certain information could be summarized from the material and only non-content-relevant text passages were filtered out (Mayring, 2015).

Within these categories and subcategories of the analysis **additional allocations** were carried out. Three categories made the results facilitated accessible and graphical. This assignment makes it possible to provide an image and overview of the perceptions, despite a wide range of responses.

Social arguments are in the first line those who are characterised through society, personal preferences, culture, religion and character. Furthermore, examples are culture, religion, fear, attitude, motivation, tradition and focus with a social explanation.

Economic arguments were most closely related to financial aspects, efficiency, output and the return. Furthermore, time and work aspects were, depending on the way of argumentation, frequently assigned here as well.

Ecological/ Agronomic arguments were related to agricultural, environmental and ecological aspects. Additionally, nature elements, such as animal concerning issues were included.

Those three categories are often closely related to each other (figure 2). But due to the mentioned simplified representation, arguments are assigned mostly to one category.

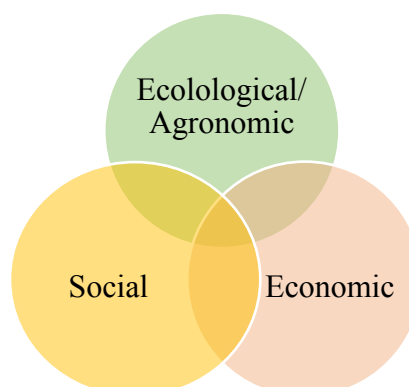


Figure 2 Three categories and their interfaces

2. Methodology

UC 5	Reasons against initial intercropping		
UC 5.1	I: How about governmental support? P: Government encourage us for pineapple. I don't know how.	missing know how	S9
UC 5.2	Those days they used cover crops. Beans, peanuts. Nowadays they don't. Now they are willing to put vegetables. They are not encouraged for cover planting. It is not popular	got unpopular encouraged for vegetables	S9
UC 5.3	People come to pick up the cup lumps.(This might give options towards selling intercropping or makes it more difficult. It depends if there are customers and if the transportation option is given and easy)	Transportation options for intercropped plants	S5
UC 5.4	We have chickens also for the reason of income lack, before the rubber is tappable.	Alternative possibilities	S1
UC 5.5	It is a time, that is much too short. It is not a long term investment. You get back only once... (one time harvest for some plants)	short time investment	S2
UC 5.6	If it is easy to maintain cover crops? We don't plant them and we don't see a reason in doing that. I cannot see the economic value.	Cover crops - cannot see the economic value	S2
UC 5.7	Anyway intercrops are very expensive to grow. We need funding for that. We do not have initial capital to grow watermelon or chilli.	Initial costs - need funding	S2
UC 5.8	I take papaya because of the market value. At the same time it also means more work.	papaya experience more work	S7
UC 5.9	Normally people are not holding banana, because the quality goes down and "it becomes a C or a D-Banana." Only in the first 3 years!	Bad banana quality	S7
UC 5.10	Watermelon and chilli are cash crops. But a problem is, that you also have to wait until it is mature, to sell it.	time till harvest	S9
UC 5.11	Cover crops. It's a lot of work. The seeds are costly. That's why nowadays not many do it.	expensive seeds work	
UC 5.12	With banana we have problems with pest and diseases.	Diseases and pest	

Figure 3 Screenshot of a part of the smallholder analysis. On the left, the category is counted. On the upper end, it is described. Beneath, the sentences are given in the original shape. Blue coloured sentences are used as quotes. Own thoughts are in brackets. Colours stand for allocations of the cluster: Yellow=social; red=economic; green=ecological/agronomic. If a statement is allocated to more than one category, it is noted (not visible in this example). On the right side, statements are anonymized.

Furthermore, the arguments were counted to gain a general overview of the preferred direction of arguing. The numbers were depicted in **diagrams**. This method does not pay focus to the exact number but rather towards the trend.

2.4.2 Mind maps

Additionally, mind maps were created. The results are very complex and connected in various ways. For this reason, the mind maps are part of the analysis. It is essential to see the perception structured and allocated to make it accessible. All statements given in the interviews are included in order to give a representative view. These mind maps are simultaneously table of contents for the reader's orientation. In the written part, the details explain the motivation for clustering the arguments this way. The scheme of

colours stays consistent with all methods. Yellow lines refer towards social, red lines to economic and green lines towards ecological/agronomic aspects.

Stars are used to make the frequency of mentioned arguments visible within the mind maps. The relation is always considered within a depicted mind map. Three stars [***] are used if an argument is used by many respondents in relation. With less frequency, the number of stars decreases to [**] and [*]. If it is not marked, it means it was mentioned relatively seldom, and in most cases only once. The star assessment is also used if an argument is only mentioned by a few people, but with an extraordinary focus. In this case, the stars are marked additionally with the specific number of people in brackets. For instance, ***[1], means one respondent mentioned this argument very often. Another mark added is [i]. This means the argument is said by a Thai farmer who applies long-term rubber agroforestry and maintains wild undergrowth.

The exact numbers of people referring to an argument were not written, due to the large amount of material. If the exact number was written the picture would become even more complex and the focus on gaining an image of the perception would be lost. Furthermore, this survey is not about precise numbers. It was assessed to be negligible if nine or ten people referred to an argument, however a comparison of one to ten people was seen to be meaningful.

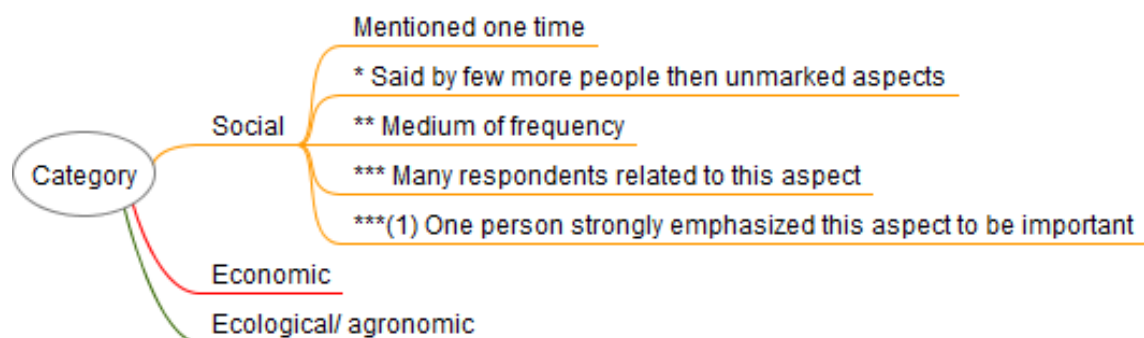


Figure 4 Description of the mind map structure with an example for frequency in the yellow social line.

2.5 Limitations of the research

Understanding the perception of others is a complex and time consuming process and requires an intense confrontation with people and their environment. Time was limited to three months, for which the regional exploration towards interviews was restricted.

Therefore, this research focused on the north of Malaysia, also due to this area being the “rubber zone” with the biggest area of planted rubber plantations. Additionally, the research focused on a limited number of interviews, trying to have a broad insight into the perception of intercropping and inter-weeding of rubber.

3. Results

3.1 Institutions

3.1.1 Perceptions of reasons for and against intercropping

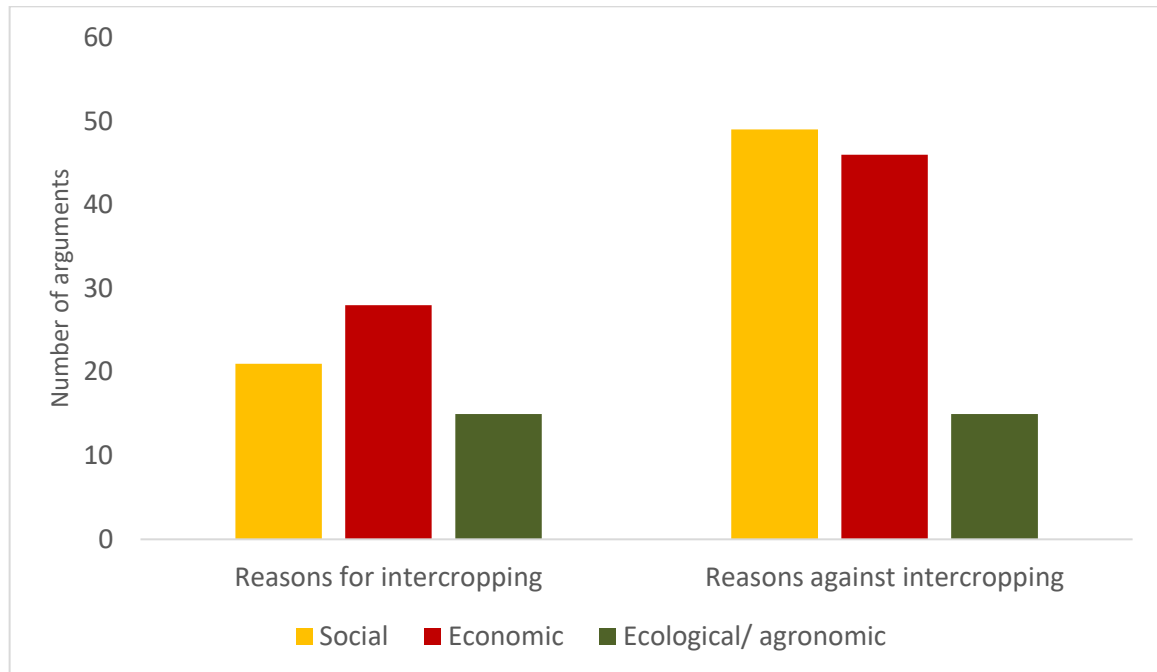


Figure 5 Numbers of arguments from institutions about intercropping

Figure number 5 shows a tendency of the given arguments by representatives of institutions. The arguments against intercropping were stronger in number and, here in particular, those that stress social and economic aspects. Ecological issues did not hold much importance. Reasons for intercropping were more comparable in number in terms of social, economic and ecological related answers.

Figures 6&7 [The images had to be removed due to privacy reasons by the editorial staff.]

3.1.2 Perceptions of reasons for intercropping

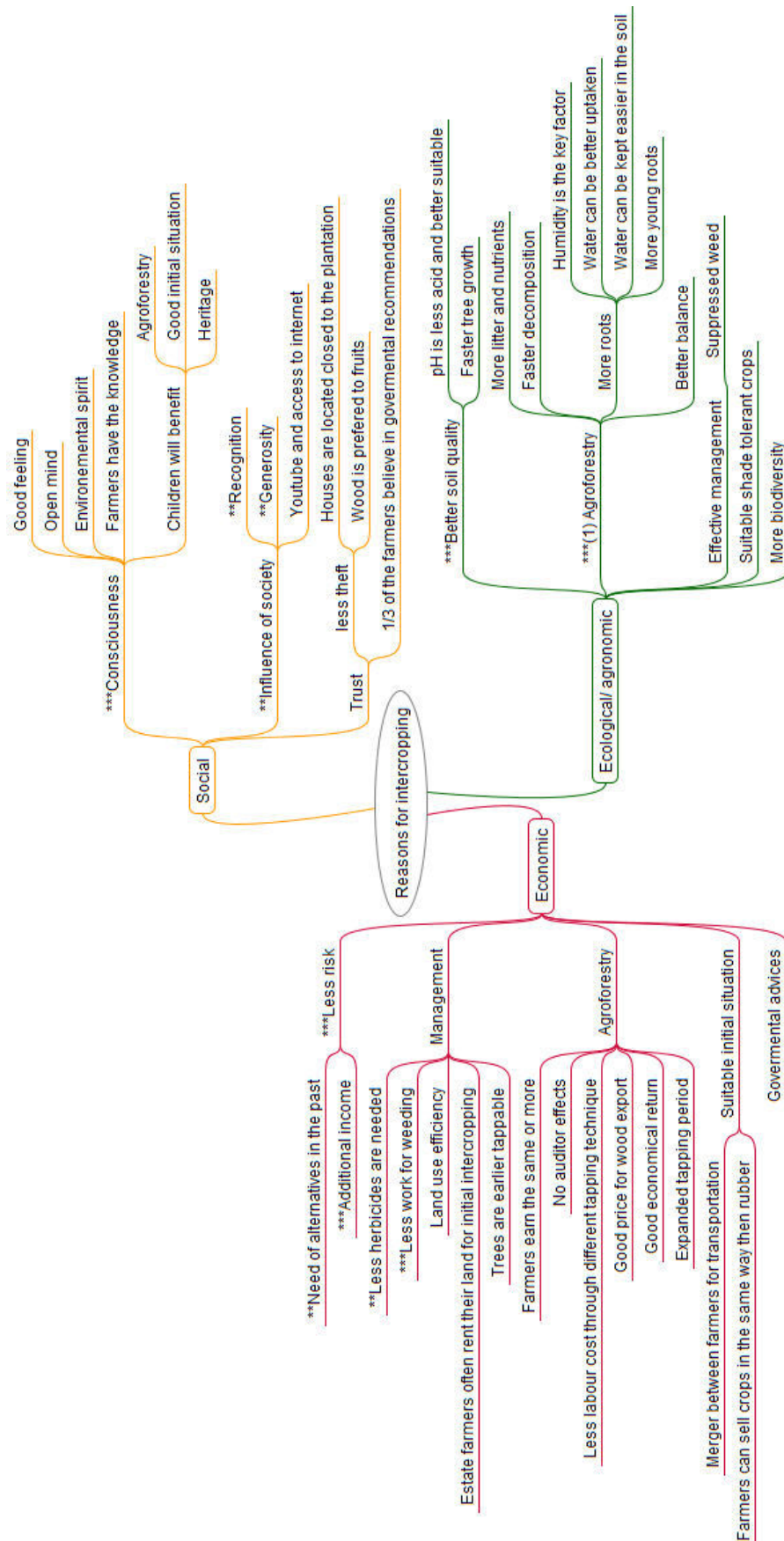


Figure 8 Reasons of institutions for intercropping (Relation of frequency of argument: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments; (1)= if mentioned by only one respondent)

These results include the opinions of the representatives of institutions. These opinions are strongly based on a scientific point of view. Social, economic and ecological/agro-nomic arguments were all included, with a greater emphasis on the economical ones. **Social** answers were strongly driven by the opinion that farmers' consciousness plays an important role. This was expressed through statements such as farmers tend to do intercropping if they have an “*environmental spirit*” or an “*open mind*”. Another reason mentioned was the awareness that children might benefit from long-term agroforestry systems, which would then be a heritage for them.

“This farmer does intercropping because he has an environmental spirit in his mind. He does not talk about money. This is the way people start with those alter-native systems.” [18]

This was strongly connected to society, the pursuit of social appreciation, recognition and the feeling of belonging to society and being accepted in order to feel proud, happy and good.

“The recognition of their heart is more important than money.” [18]

Furthermore, access to the internet opens the possibility to use YouTube (<http://www.youtube.com>) and to exchange expert knowledge within farmer societies. This maximizes on popularity and could increase the rate of adaptation to intercropping systems.

“Farmers can grow everything; they are experts” [18]

Trust is another factor that influences the adaptation of intercropping, since theft occurs less if the house is close to the plantation and if wood trees instead of fruit trees are planted in between the rubber rows. Trust in recommendations, either from the government or in those given by other farmers, exists partially.

From an **economic** view, intercropping was supported by many respondents with the argument of lowering the risk of an unsteady income, since the price of rubber is low and unstable. In the case of smallholders, the need for additional income in the initial period was pointed out. The management aspect was also stressed and mentioned frequently by the institutions, meaning less work, less costs for herbicides and more output due to an expanded tapping period. In the case of estate farming, land is sometimes leased out in the initial phase to maintain the land. Consequently, a third party produces cash crops in the first years.

Many scientific economic arguments based on scientific papers were addressed by the institutions. One Thai respondent emphasized that agroforestry has a good economic return. Further examples for this argumentation were the good price for wood export and that no negative economic impacts for farmers were found with these systems.

"In terms of agroforestry, rubber wood is not allowed to be exported in order to keep local prices affordable. The price for rubber wood is low. Growing other wood trees in agroforestry systems could be beneficial." [11]

Furthermore, very few respondents referred to farmers' associations for transportation in Thailand. This excludes the need for middle men and was seen to make the situation for intercropping suitable. In terms of Malaysia, intercropping was seen to be economically appropriate since the Malaysian Government gives support and advice through MRB and RISDA. A recommendation from MRB and RISDA is to grow cover crops, in particular legumes in the initial phase of the rubber cultivation. Cover crops are applied by estate farmers in the immature phase. This possibility is restricted to farmers who have enough financial resources because of the high investment cost.

Ecological/ agronomic arguments were, in particular about the improved soil quality. In initial intercropping systems, weeds are suppressed, which influences the management and the need for herbicides. For agroforestry systems, many scientific arguments were mentioned by one Thai respondent: such as better balance, faster decomposition, more nutrients, litter and roots. Considered particularly important was the better root growth, since water is a key factor in rubber production, and more water can be kept in the soil. Those systems contain more young roots, which lead to more water uptake.

"More foliage increases decomposing. It goes 1.5 times faster. The ecological system is more balanced." [18]

The existence of suitable shade tolerant plants and an increased biodiversity were noticed by very few respondents.

3.1.3 Perceptions of reasons against intercropping

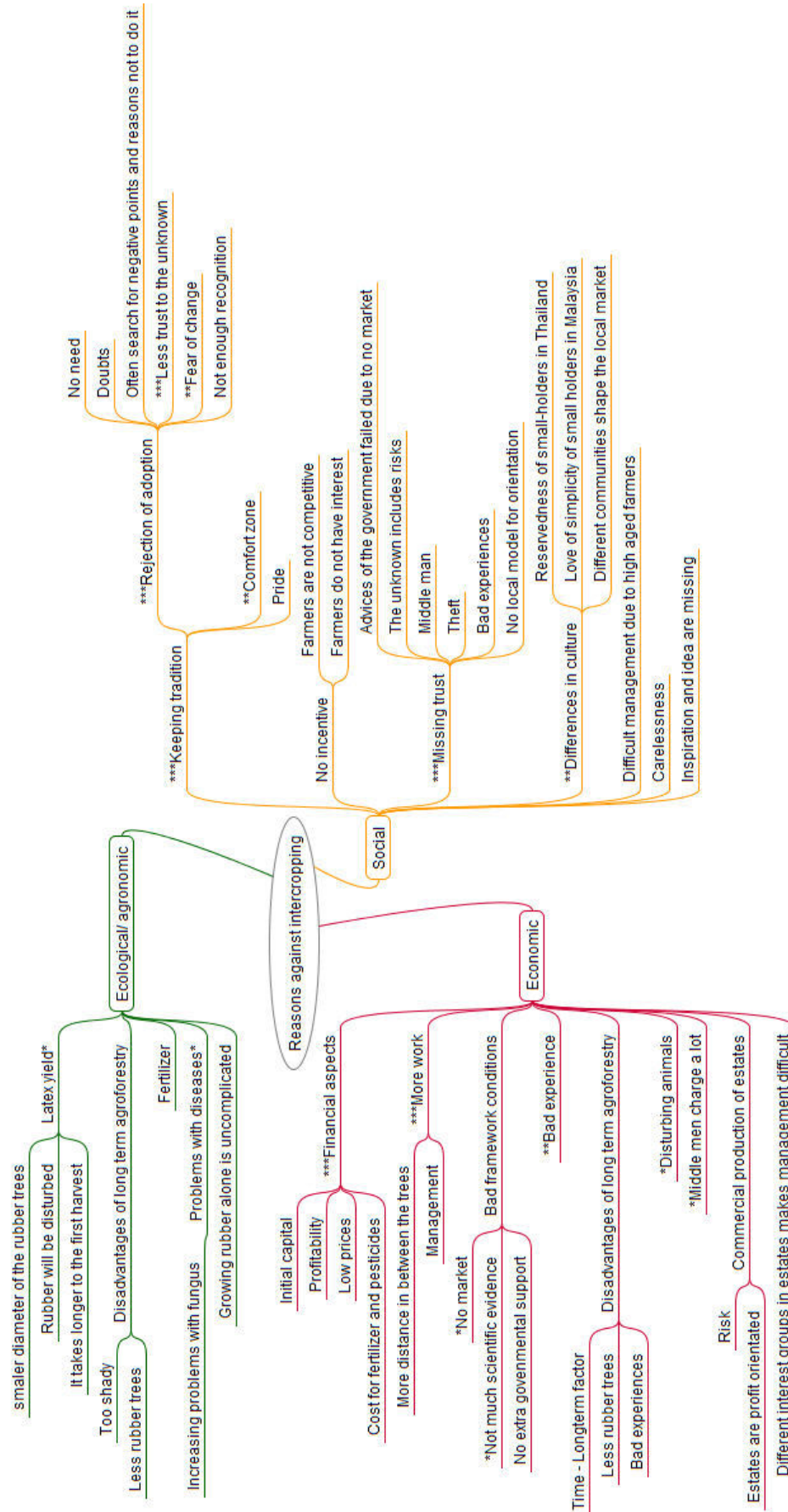


Figure 9 Reasons of institutions against intercropping (Relation of frequency of argument: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments)

Many **social** reasons were given and often the importance of tradition was addressed (figure 5). This was connected with rejection of adaptation, which was explained by farmers not getting enough recognition for these systems, having doubts, fear of change and in particular that they do not see the necessity for it. Pride and remaining in a comfort zone supported the argument of tradition as well. The opinion is that farmers do not have enough incentives for a change, and therefore prefer to handle their plantations in a conventional way.

"It always worked. Why should they change it? People change if necessary. Before that they tend to stay in a comfort zone." [18]

Missing trust was also a significant argument, which was frequently mentioned by the respondents. It includes the unknown, which is connected to risk, failed governmental advice, theft, distrusted middle men (who are needed by smallholders for transportation due to the location) and bad experience with failed projects. In this category, it was highlighted by one respondent that there is no model for orientation, which is necessary for the adaptation of another system.

Different cultures have different argumentations. Even though Thailand and Malaysia are neighbours, there are differences in behaviour. The farmers in Malaysia openly share information about rubber yield with other farmers, whereas farmers in Thailand are more reluctant to do so. Furthermore, Malay farmers prefer simplicity. Many respondents explained that cultural characteristics are important factors for the rejection of adaptation of a new system.

Farmers in Thailand do not talk about the yield. This is a very private topic. Only the price is mentioned to anyone. [18]

It was often mentioned that ethnic communities shape the market and provide barriers for certain smallholders, dependent on the location and their access to different communities.

"The Market is controlled by communities. Chinese, for example, they won't buy from Indian or Malay because they have their own supply." [10]

Many smallholders are old, which sets restriction for intercropping, in that it makes the management more complicated and challenging. Furthermore, carelessness and lacking inspiration were arguments that were mentioned peripherally.

The **economic** arguments were nearly as many as the social ones (figure 5). The majority of respondents explained the financial aspects, including additional cost for fertilizer, missing capital and not sufficient profitability.

"If the price is low and the land is occupied, it would be a waste of time. Inter-cropping is recommended, but important is the question which is the best plant, in order to gain the highest return of money." [10]

Several respondents indicated that investment costs for cover crops are a barrier for smallholders. Many smallholders cannot afford to grow legumes as cover crops. Besides, smallholders often prefer crops which provide a direct income.

A common reason provided by several respondents for bad experiences and failed recommendations of the government, was the market. The crops used for intercropping had worse prices than rubber.

"With coffee and rubber, it happened that the prices of coffee decreased during the harvest time of coffee." [16]

It was profitable and the better income came from rubber. They removed the coffee. [11]

Rubber together with chicken, goats...even birds. The problem is the same. The price is low." [10]

"During my time with Rubber Research Institute, we carried out integrated farming with rubber but failed miserably. We can only cultivate other crops on the land planted with rubber for the first two years after replanting." [10]

These reasons are strengthened by the lack of sufficient scientific evidence, which was highlighted by some respondents. More investigation is needed to make sure that intercropping, in particular long-term agroforestry is profitable.

The aspect of having more work was mentioned frequently as well. Agroforestry systems especially, have greater distances. Therefore, more time is needed to tap the trees.

"It is a boring job and nobody wants to spend more time there than necessary. Maybe they even have to jog with those distances!" [10]

Animals were mentioned sometimes to play an important role from an economic point of view. Farmers have to protect, or share the food crops with other living beings. If animals are a disturbing factor on the plantations or not, depends on the location of the plantation,

"Elephants are always hungry and angry and like to eat the intercropped bananas. Meanwhile they are destroying the plantation and leave it together with the frustrated farmer behind". [10]

It was said by a few respondents that middle men are untrustworthy because they are accused of charging too much. Less of a concern but still mentioned, was that estate farmers are more profit-orientated for a commercial production and consequently will not risk something uncertain. Another point of one respondent related to estate farming was that many different interest groups are involved and often do not see a benefit in intercropping.

"They need a middle man, what makes the prices worse. This is necessary because they are selling on a small scale. They often do not have the transportation possibilities and own only a motorcycle." [19]

Ecological and agronomic reasons were far less used compared to social and economic ones. There were as many ecological arguments against intercropping as there were in favour of it (figure 5). The broadest concern given by some respondents was the impairment of the rubber yield. It was said that the rubber growth is decelerated, delaying the first harvest.

"There is the concern that the rubber plant will be disturbed" [16]

"Rubber together with other plants have a smaller diameter after 4-5 years." [10]

Regarding initial intercropping, it was also said by very few that farmers do not want to lose the subsidised, valuable fertilizer to less valuable crops.

"They get a certain amount of fertilizer. They don't want to share these subsidies with lower income plants." [16]

"Rubber trees do not get enough fertilizer" [118]

Some described problems with pests for intercropping in the initial phase. Concerning long-term agroforestry, it was said that with regular tree distances it simply gets too shady. Consequently, the number of rubber trees had to be reduced. Fungal problems appeared, due to a higher humidity.

Marginally, it was mentioned by one respondent that more maintenance is necessary and this reverses the advantage of an uncomplicated rubber which can easily be left alone.

"The advantage of rubber is that it can be left alone. One does not have to take care much" [10]

3.1.4 Perceptions of reasons for and against natural undergrowth.

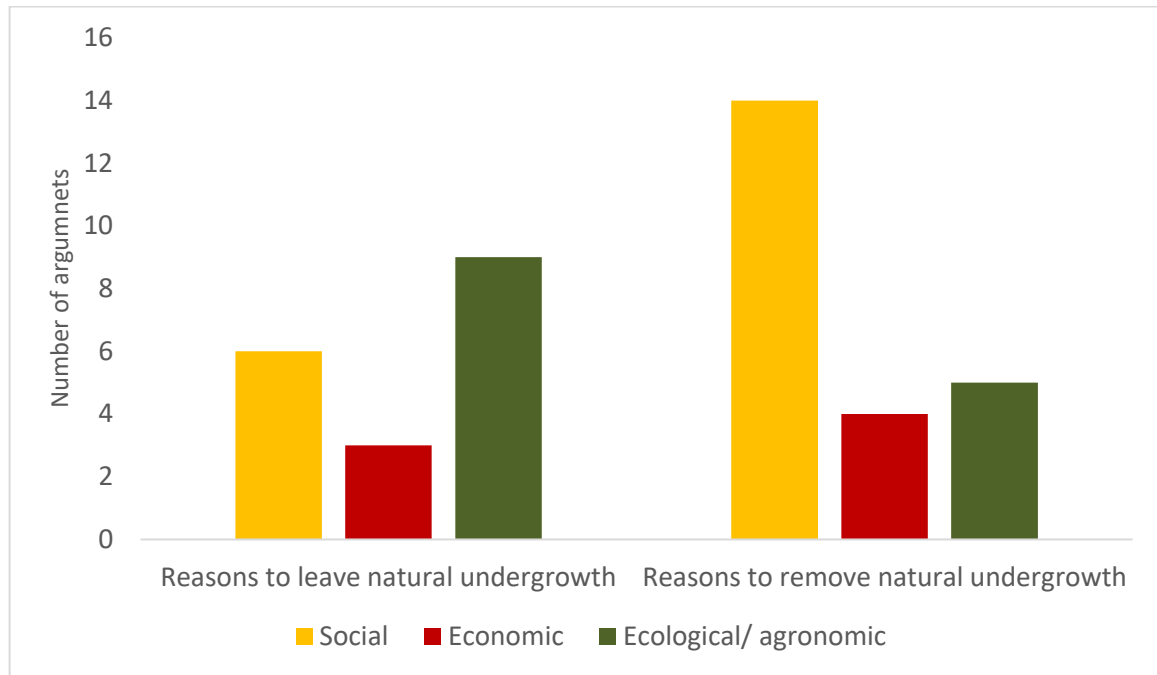


Figure 10 Numbers of arguments of institutions about the natural undergrowth

According to the number of arguments, leaving natural undergrowth is mainly justified ecologically by the representatives of the institutions, whereas removing it is explained with a focus on social reasons (figure 10).

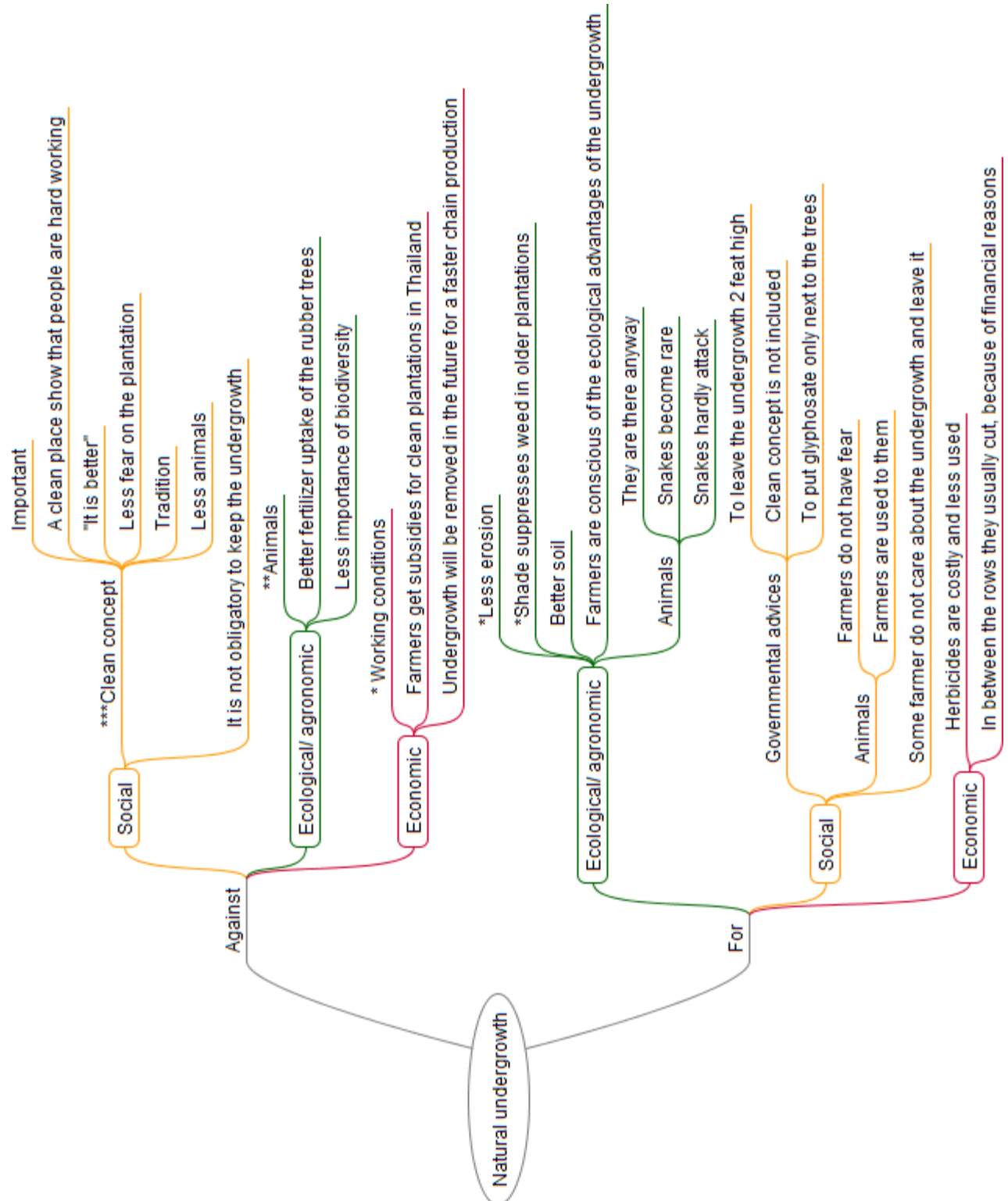


Figure 11 Reasons of institutions for and against leaving the natural undergrowth in the rubber plantations (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments)

3.1.5 Perceptions of leaving the natural undergrowth

The arguments that focused on **ecological/agronomic** reasons for leaving the natural undergrowth got the highest attention in the interviews with the representatives of institutions. Still, the attention was not high, compared to the amount of answers that were given against leaving the undergrowth. Within this category there was an agreement by a few respondents that natural undergrowth leads to less erosion and contributes to a better soil quality. Especially in the immature phase there should be some weeds for those purposes.

"For the young rubber, it is good to leave some weeds." [16]

"Weeds are needed to moisture the soil and to avoid erosion. More are for those reasons better." [15]

It was slightly highlighted as well that in the mature phase there is no need to think about this issue since the trees have closed branches that do not give enough light for weed to grow. Then there is no need for farmers to remove the natural growth anyway.

"Anyway, it is just left naturally if the rubber is mature." [10]

The farmers are ecologically conscious that chemicals, especially in a huge amount, have adverse effects also on the trees.

"Smallholders do not like to apply chemicals because they believe that this is not good for the roots on the top." [10]

On the topic of animals, it was said that snakes are there anyway and it does not make a big difference especially since they are not present in large quantities. Previously, there were more accidents with snakes, however in general, they only attack if they feel threatened and nowadays workers use boots, which means serious snakebites have also become rare.

"Snakes hardly attack" [10]

From the category of **social** explanations, it was mentioned that there is no advice given, which recommend the total removal of the natural undergrowth. The official recommendation is to leave at least two feet and to put glyphosate only next to the trees.

"The concept is not to have clean weeding. The concept is not a clean concept." [19]

Furthermore, it was explained that farmers do not care much if there is undergrowth or not. Very few representatives of the institutions have the opinion that farmers are not

scared of animals, since they are raised in the countryside. They claim that this is more a fear from people, who are not raised in the countryside.

„Some people are scared of snakes and animals, but those people are used to all sorts of things, la. They are so much used to work in the bush, so they will work in the bush.“ [110]

One respondent mentioned that this is a topic which does not appear to be important for some smallholders and that they do not care if natural undergrowth is growing or not.

Economically it was said by one respondent that herbicides are costly. Therefore, farmers try to reduce the application to the immature phase of the rubber trees and try to cut weeds mechanically in between the rubber rows.

3.1.6 Perceptions of removing the natural undergrowth

Social arguments were strong in representation. Above all, the social aspect of having a “clean” or “clear” plantation was seen to be important. It was mentioned frequently and was underlined by arguments such as: it shows that people are hard-working, disciplined and not lazy. In general, it is regarded as “better”. Another reason was to maintain the tradition and peripherally it was mentioned that there are less animals if the plantation is not too “wild”.

“It is good to keep it clean. Cutting is good as well. Farmers like it this way.” [19]

“If there is a jungle, nobody wants to go in.” [110]

The MRB and RISDA give recommendations. For example, to apply herbicides next to the trees. It was stressed that these are only given as advice and not rules. The decision stays with the farmer.

From an **economic** view the most important point was to provide a good working condition. Either on estate plantations for the tappers (since nobody wants to do this job anyway) or for the own pursuit of the smallholders making work easier and more enjoyable.

An additional point was that in Thailand it is important to remove the undergrowth since subsidies will not be provided for a “wild” plantation.

For the future, the representatives from institutions assume that the image of farms will change in general and this will bring a change towards an even more “clean concept” in order to have a commercial and profitable production.

“The conservative ones will be passed away soon and I guess educated ones will be the next farmers. The children of the farmers will not continue this job. It will be further disconnected and money will gain more and more importance. I guess plantations will not look this wild with herbs in between of the rows. There will be a faster chain production and farms will become bigger.” [18]

Ecologically/agronomically speaking, the argument against keeping the natural undergrowth was explained mainly with the reason that the rubber trees, in particular young ones, do not get enough fertilizer.

“Herbicides are used to benefit the young trees, because otherwise they cannot take up the fertilizer.” [19]

The argument about wild animals coming more often to the plantation was very contradictory. Some representatives saw it as a reason against intercropping, but just as many assessed it not to be a problem. It was pointed out that different locations deal with different animals. In some regions, elephants and tigers were seen, whereas in other places farmers never saw these animals. Connected to the ecological side of things, animals could be a problem and cause economic problems. In very wild plantation, where one cannot see far animals can cause anxiety, which is part of human nature.

“Sometimes there are a lot of animals, even elephants and tigers.” [16]

“Only leaches will be there” [10]

When asked about the perception of farmers concerning biodiversity, it was the opinion of the representatives of institutions, that they do not focus on this issue and it is less important to most of them.

3.1.7 Perceptions of the use of herbicides in comparison to cutting mechanically

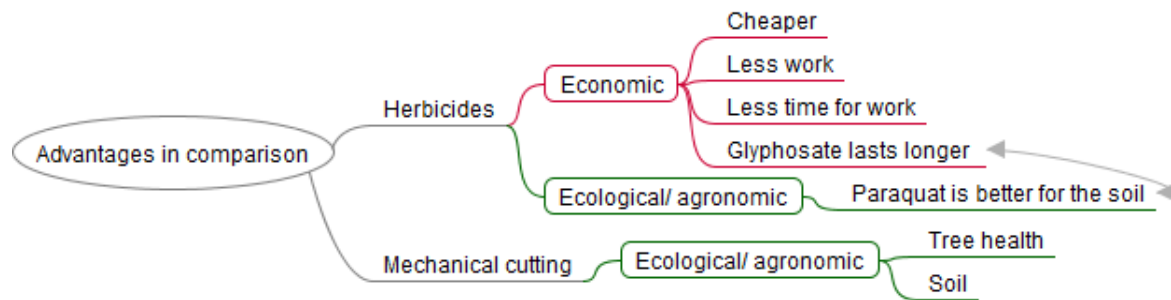


Figure 12 Summarized advantages of herbicides and cutting in comparison from the view of institutions

Table 6 Numbers noted during one expert interview ^[18]

	Herbicides	Mechanical cutting
Frequency of application	→ Around 4 times per year → 1-6 times per year from the 1.-9 th Year → 1 time per year from the 9 th year	→ 2 times per year
Duration of work	→ 2 hours	→ 1 – 1.5 days
Continuance	→ “Glyphosate” lasts longer than “Paraquat”, which only lasts 2 months	
Cost	→ 12€ per hectare per spray	→ 60€ per hectare per cut → 2-3 times more expensive
Usage	→ 60% in Thailand → Cover spray on estate farms	→ In between the rubber trees, farmers often cut

Many farmers use “Glyphosate” as herbicide. In between the rubber trees they might cut mechanically. Still, in particular on estate farms herbicides are preferred. This can be mainly explained through the economic aspects. It takes less time, is less work and because it lasts longer, is cheaper, even though the herbicide is expensive. Alternatively, “Paraquat”, also a herbicide, is used. It is less damaging for the natural environment but also does not last as long as “Glyphosate” does.

Compared, to the usage of herbicides, mechanical cutting is more environmentally friendly and includes a better health for the trees and soil. However, for farmers this does not compensate the economic disadvantage.

“Three months of maintaining versus the effort of doing it once.” ^[10]

3.2 Estate farms



Figure 13 Collection place for latex on a rubber estate farm in Sungai Petani, Malaysia



Figure 14 Estate farm with oil palm and rubber. The steep plantation is going to be prepared for rubber in intercropping with cover legumes closed to Sungai Petani, Malaysia

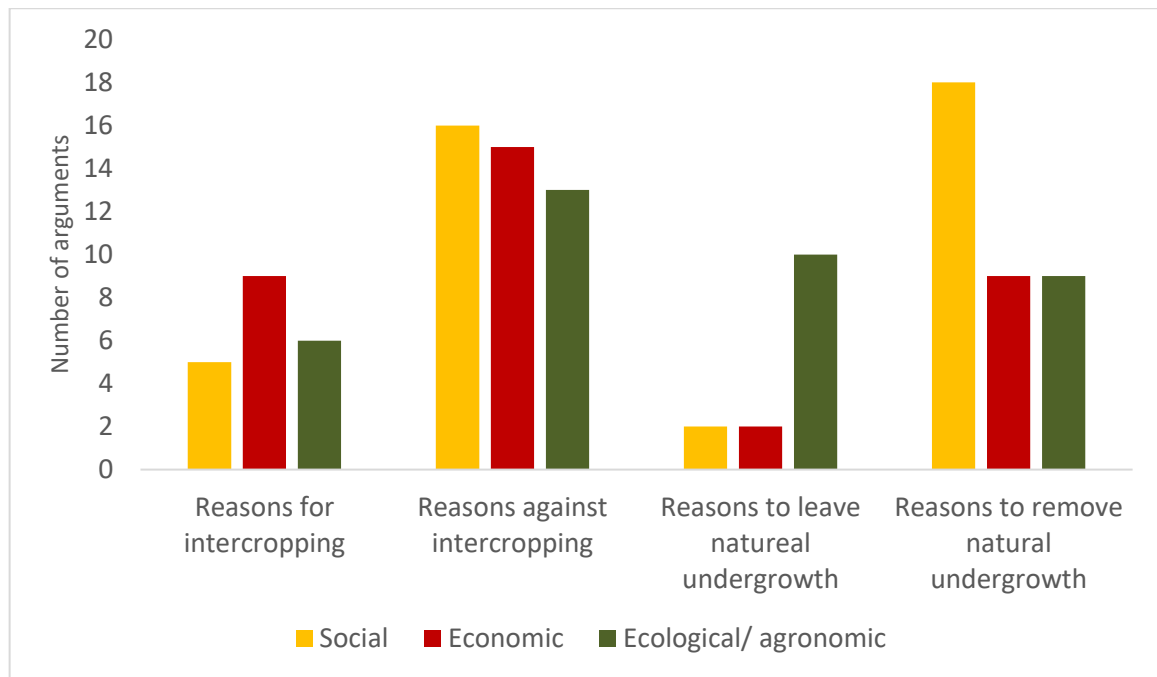


Figure 15 Numbers of arguments of estate owner, manager and tapper about natural undergrowth and intercropping

As is visible in figure 15 (above) and figure 16 (below), the point of view of the estate owner, the manager and the tapper (all estate farming representatives together) do not differ much from the point of view of the estate owner. A considerable degree of common attitude can be seen in those answers. This occurs due to a closed and good communication within an estate farm and throughout the different stakeholders. An exception is the view on reasons against intercropping, which has a strong economic focus for the estate owner, and is regarded more from a social and ecological/ agronomic view by the manager and the tapper. The estate owner is the decision maker, for what those arguments were illustrated separately. Any implementation will only work through the affirmation of the estate owner.

3. Results

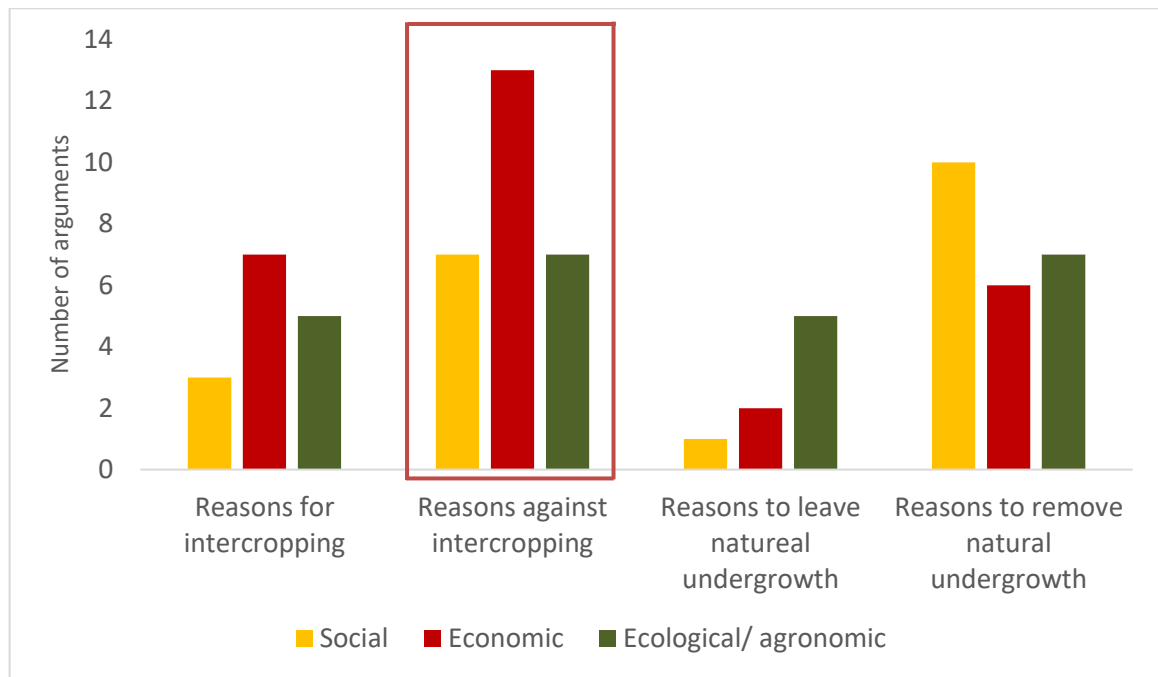


Figure 16 Numbers of arguments of estate owner about natural undergrowth and intercropping

3.2.1 Perceptions of reasons for intercropping

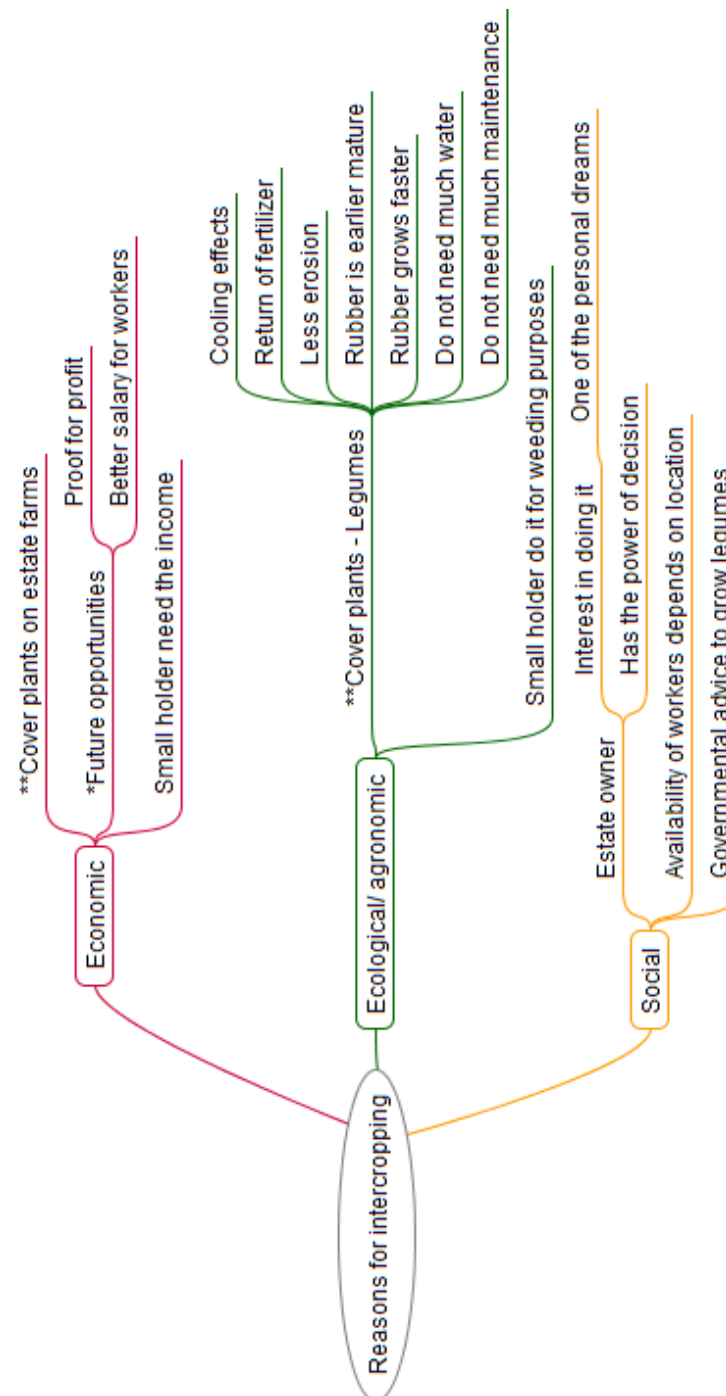


Figure 17 Reasons of stakeholders of estate farming for intercropping (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments)

Economically, it was highlighted that cover crops are profitable and a good investment. The initial investment restricts the possibilities mainly to the estate farmers. This opinion was represented by an estate owner and a manager.

"Cover plants are often used on estate farms. Cut the cost is the reason" ^[E1]

Smallholders were mentioned to do intercropping with cash crops, because of the need of income. In order to grow a long-term intercropping system in the future, it was emphasized that an increased profit is needed, in order to exclude risk. This would provide the basic to pay higher salaries to the workers, which would motivate them to work with intercropping. The importance of economic aspects is apparent through the high frequency of arguments (figure 15 and 16).

“Yes, I would do intercropping if it increases the profit. But now I don’t have it in my mind. There is no plus visible.” [E1]

The **ecological/ agronomic** arguments of several respondents were almost all regarding legumes in use as cover crops. In particular, the cooling effect, the return of the fertilizer, decreased erosion, the faster rubber growth and therefore an early maturity and also the low maintenance and low need of water were mentioned. Furthermore, it was said that for smallholders weeding purposes are reasons for cash crop intercropping.

“Cover crops are planted because the rubber gets nitrogen, grows faster and is earlier mature. For this it is worth it.” [E3]

Reasons for intercropping found the smallest attention in **social** explanations (figure 15 and 16). The interviews revealed a general interest, which was explained by one respondent to be a dream.

“My dream is to do long term intercropping with pepper, because of the bad price for the rubber and the good price for pepper. I don’t know if it is possible or not.” [E1]



Figure 18 Rubber intercropped experimental with pepper on a plantation closed to Hat Yai, Thailand.

An important point in this category is that estate owners make all the decisions and there are no incentives from the employees. Also, the tapper did not see an advantage in intercropping on the rubber plantation. The availability of workers is dependent on the location and the possibilities, of alternative employments. If there are only a few possibilities it is easier to find workers for the plantations. Another point in this sector was the governmental advice for growing legumes as cover crops.

"The government encourages people to grow legumes. I do it because of that. It is not related to the MRB." [E1]

3.2.2 Perceptions of reasons against intercropping

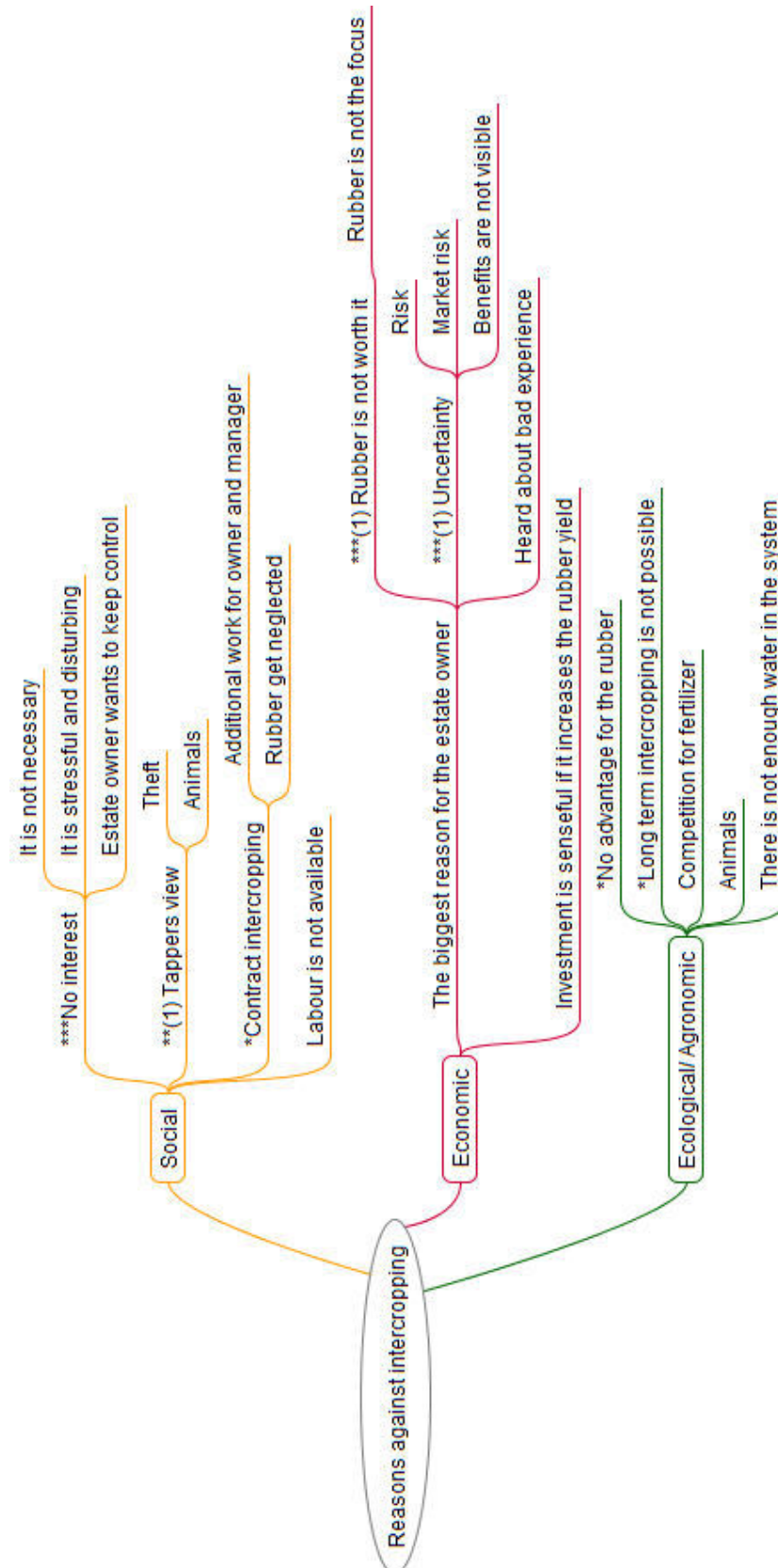


Figure 19 Reasons of stakeholders of estate farming against intercropping (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments; (1)= if given by only one respondent)

Figure 19 shows reasons which were given against intercropping. In figure 15 and 16 is visible that the estate farmer focused on the economic argumentation, whereas estate managers and tappers paid more attention towards social aspects. Additionally, the ecological/ agronomic arguments against intercropping were strongly correlated with economic aspects. The ecological/ agronomic effects were mentioned because it gives an economic disadvantage. This additionally, shows that ecological/ agronomic aspects are subordinate.

In **social** aspects, several respondents mentioned that there is no interest in intercropping. Short-term intercropping is mainly done by smallholders. Estate farms do not see a necessity to do it.

"We do not do it. Big farms never do it. I can cover my costs. Intercropping provides too much trouble." [E1]

An explanation from an estate owner was that it is stressful and that it would mean a loss of overview and control.

"Control! For me, myself, it is about control!" [E1]

The arguments from a tapper were based on personal experiences and did not include economic reasons. The main problems with intercropping were explained to come with theft and animals, showing the importance of the location and the distance from the plantation to the living area.

"At home I grow lemon trees and pandan leaves for my own consumption. I wouldn't plant them here, because cows come and eat everything. Always the problem with cows, everywhere. The area is too big for a fence and people could still steal anyway. Next to the house other plants are ok. Here it is needless." [E4]

"Sometimes there are monkey on the plantation and steal the food of the worker"
[E1]

Figure 20 [The images had to be removed due to privacy reasons by the editorial staff.]

Figure 21 [The images had to be removed due to privacy reasons by the editorial staff.]

In the initial phase, some farmers lease the land. It is then used by others for intercropping. Some respondents indicated that this tends to stop, because the leasing provides additional work. Another negative correlated point related to this was that the rubber was neglected by the workers during the intercropping.

“We tried intercropping. The rubber got affected, because it got neglected by the worker. We lease the land and the worker do not care about the rubber. Now we don’t do anymore contract intercropping.” [E3]

A lack of labour was mentioned by very few respondents to be a problem. This depends on the location and the availability of alternative employment. Those factors decide the possibility to employ tappers, which has also an economic impact. It was placed in the

social category because of the preference of people, even without considering the economic aspect to not work as a tapper, due to prestige.

“Another point is that nobody wants to do this work.” [E1]

“Even better salary would not improve the availability of labour. It is not a desirable job and it is a matter of prestige.” [E1]

The social arguments are strong because the tapper and managers argued this way. The estate owner showed a strong focus on **economic** aspects (figure 15 and 16). The main arguments of one estate farmer were that the rubber is not worth it and not the focus of production.

“Rubber is a sunset business. Change the crop to oil palm. Hilly area will be the only one, covered by rubber.” [E1]

“We have a wood factory which is the main focus. The second focus goes to the oil palm.” [E1]

The other big argument was the uncertainty. There is a big risk, since the economic benefits are not visible and the market is difficult to access. This is the reason for the estate owner to *“totally not think about”* [E1] selling intercropped plants.

“We do not have the know-how. It would be dangerous and risky.” [E1]

Consequently, it was indicated by this respondent that for the long-term intercropping, the proof of benefit is missing and for the initial intercropping it is not worth it in relation to the additional work. This opinion of prudence, underlined by experience often lead to failure of the system.

“Intercropping in mature plantations never succeed. The crop must be very valuable to success.” [E1]

The economic aspect decides the change in this view. The increased advantage in this aspect must be clearly visible, otherwise the focus is on the improvement of the common production.

“We have monocultures to have high yield. We invest in the yield only.” [E3]

Ecological/ agronomic argumentation was closely related to economic aspects. The lack of an advantage for the rubber from an intercropping system, compared to monocultures was mentioned by several respondents.

“The rubber does not profit from watermelon in contrast to cover crops.” [E3]

An important point mentioned by a few respondents in terms of long-term intercropping was that it is doubted generally to be possible.

“If the sun doesn’t reach the ground anymore, other plants won’t grow.” [E4]

There is also an economic relation in terms of fertilizing. The concern was sometimes mentioned that the fertilizer will be taken by other plants in competition. It will affect the output of rubber.

“The fertilizer is for the rubber. It is not good if other plants are cultivated, because fertilizer is invested into the latex, which is not meant to be shared with other plants.” [E2]

This statement is related to common distances and the systems as they currently exist. Another point mentioned already under social aspects was a loss through animals eating the intercropped plants, which is also dependent on ecology and geography and which has economical/agronomic impacts. Furthermore, wild pigs and cows damage the rubber trees when they are small and even more could be attracted to the plantation if intercropping is practiced. *“Water as well is the main issue” [E1]*, which gives a problem statement, comparable with that one of the fertilizer. The defined problem was that resources are shared. However, the undivided usage of the resources by the rubber plants is preferred.

3.2.3 Perceptions of leaving the natural undergrowth

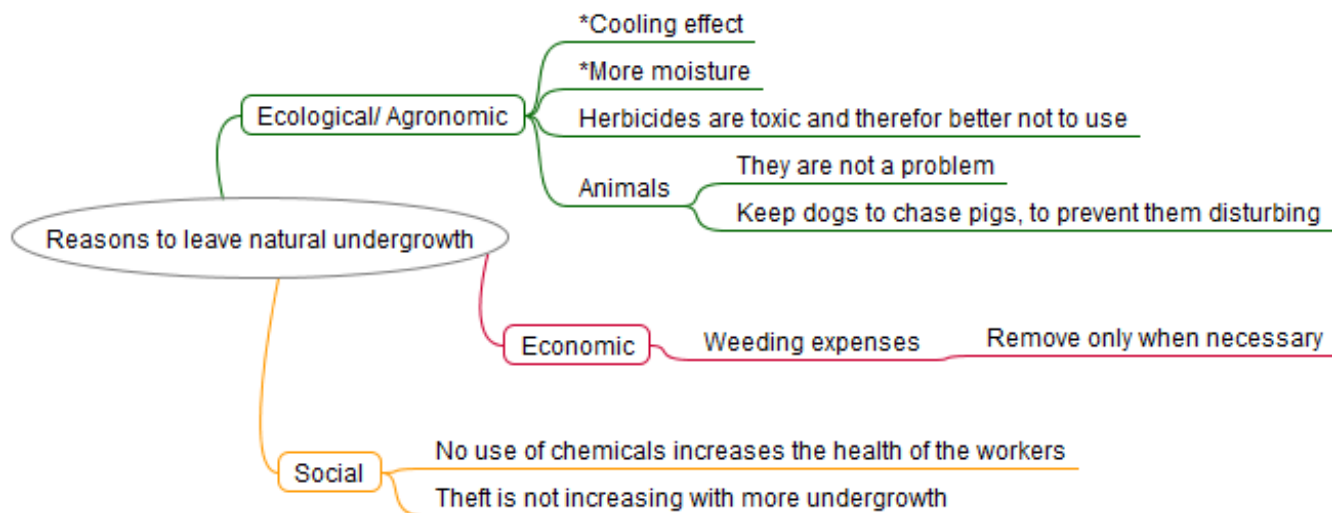


Figure 22 Reasons of stakeholders from estate farming for leaving the natural undergrowth in the rubber plantations (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments)

The different participants of estate farming have similar opinions on inter-weeding. Leaving the natural undergrowth was mainly seen as something positive from an **ecological/ agronomic** point of view (figure 15 and 16). Most frequently, by slightly more respondents than for the other arguments the cooling effect and an increase in moisture was mentioned. Therefore, natural undergrowth was purposefully left, which also helps to prevent fire in the dry season.

"If it is too dry, the weeding gang is not hired in order to prevent fire, what could be quite dangerous." [E1]

"It is good if it is a bit green because of the water and the cooling effect." [E2]

Very few respondents said that herbicides have a toxic side effect and for a healthy environment it would be better to use less of them. The fear of animals can be neglected, since there is not the perception of having more animals if there is more natural undergrowth. Wild pigs, if they occur, can be averted with dogs, which will chase them. This is suitable for dog lovers. Nevertheless, some respondents said they would not like to keep dogs due to religious beliefs.

"We keep dogs and they chase the wild pigs away. Many people poison the dogs." [E2]

From an economic perspective, it is only worth it to spend money on inter-weeding if it is necessary. This reduces the expenses of weeding.

3. Results

*"1-2 months later, grasses grow again and the weeding gang has to come again.
This is expensive. If there is less rain, less is spent on inter-weeding."* ^[E1]

Socially it was considered that the herbicides influence the health of the workers. Spraying can have an effect on health, due to carelessness of the workers.

"The weeding gang is not wearing their protection masks, while they are spraying herbicides, because they find it too hot. They should do it, but they do not care."
^[E1]

Furthermore, more natural undergrowth does not promote more theft. This shows that the preference of removing it is not correlated with this concern.

3.2.4 Perceptions of removing the natural undergrowth

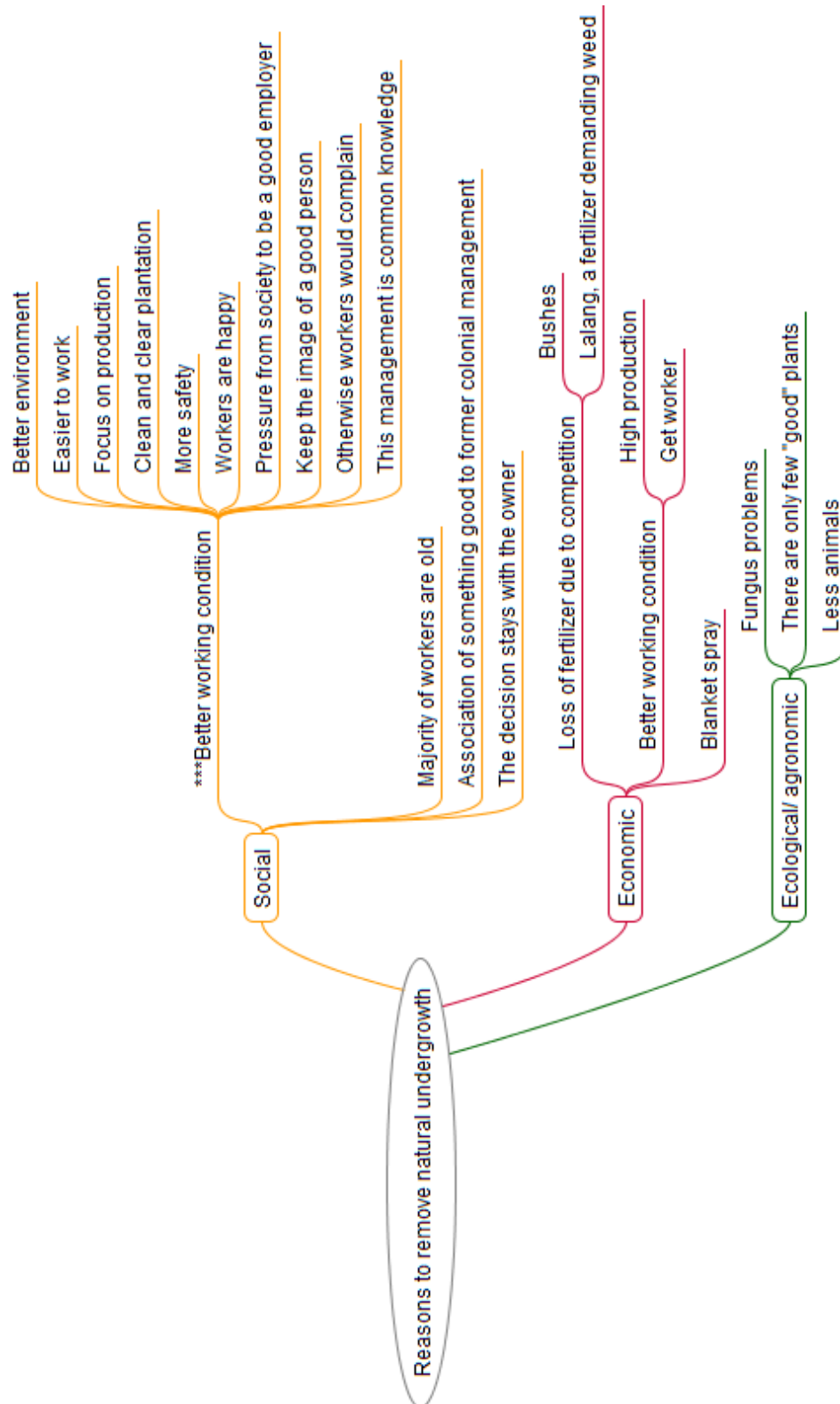


Figure 23 Reasons of stakeholders from estate farming against leaving the natural undergrowth in the rubber plantations (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments)

Reasons against the conservation of the natural undergrowth were in particular emphasized with the **social** aspect of working conditions which were given by the majority of respondents. This was much more important for the estate farming representatives than the advantages of leaving the natural undergrowth and other explanations for removing it (figure 15 and 16).

Arguments categorized in the section of better working conditions were as followed: A good working condition and environment is provided through a plantation that is kept clean and clear. This is the common opinion of the estate owner, manager and tapper. Additional points mentioned related to the working conditions, were, that it is important to provide a safe and improved environment to make work easier and to keep a clear focus on the production. Happiness of the worker was related to a removal of the natural undergrowth as well. Another point was to keep an image of a good employer that comes along with pressure from society. Moreover, to handle the plantation like this is indicated as common knowledge and prevents complaints from the workers.

"We put the chemicals everywhere to improve the working conditions for the worker. If you come to my plantation you can see it is very clear. In other plantations, you cannot see each other and I am even scared to go in. They don't want to spend money on that. You can come to my estate and will find them all happy." [E1]

"It should be clean because then it is accessible for the tappers. The main focus is the production that workers can walk. It shouldn't be blanket either, but if there is too much undergrowth we have to spray." [E3]

"I don't like the plants in between of the rubber, because it is difficult to walk." [E4]

It also was mentioned by very few respondents to be an impossibility for the old workers to have a wild working environment. Nearly all workers are above 60, which supports this point. It was mentioned that it was clean and the ways were better, when the English were there, which refers to a connection to colonisation and the practice applied at that time.

Another point mentioned by one respondent is that all the decision power stays with the owner and that managers and tappers act close to the orders given. The answers from an estate manager were formulated with the perspective of others. An example is that most of the sentences started with: "One ought to..." The response to the question if the manager thinks the plantation should be free from natural undergrowth was:

"The estate owner wants it clean. If I don't know something I ask the estate owner." [E2]

In the **economic** view, there were more arguments against the natural undergrowth than for it (figure 15 and 16). One explanation was the loss of fertilizer to other crops and the financial aspect of this. Especially bushes and Lalang (*Imperata cylindrica*) are fertilizer demanding plants, which are feared.

Additionally, it was mentioned by very few respondents that the aspect of good working conditions is connected to the economic view on production. High production output is said to go hand in hand with good working conditions. Furthermore, it is difficult to hire tappers if the plantation appears wild and unordered. An improved environment, with less wild appearance, increases the attractiveness of the tapper job and provides a higher possibility to obtain workers. Hiring the weeding gang and applying blanket spray are commonly practiced due to economic advantages.

More reasons mentioned from very few respondents from **ecological/ agronomical** point of view are problems with fungus, the fact that there are only a few good plants and, marginally, that insects and animals occur more frequently and that they can be disturbing for the workers.

"Only a few weeds are good for the plantation" [E1]

"Too much of undergrowth brings the problem of snakes and others. The way next to the rubber trees should be kept clean. Also because of the "lipans" – the centipedes." [E4]

"If it was too wet and the natural undergrowth was left, they got fungus on the plantation." [E1]

3.3 Smallholdings



Figure 24 Expert interviews with small farmers, Malaysia (two photos had to be removed due to privacy issues)

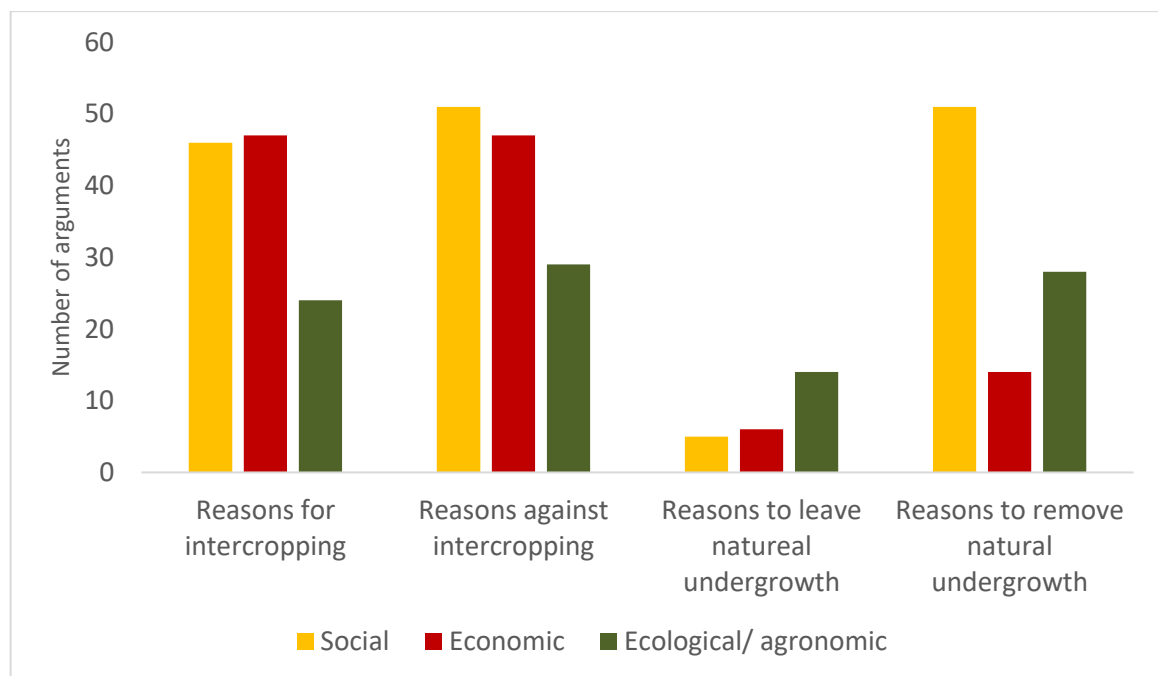


Figure 25 Numbers of arguments from smallholders about natural undergrowth and intercropping

The arguments counted show that for smallholders there is a tendency of neglecting ecological/agronomic aspects and focusing on social ones. The social aspects are more influential on their decision-making compared to those of institutions and estate owners. In terms of intercropping, the economic aspect also gains attention from the farmers since here investment is needed. For them, the higher positive economic jus-

tification for intercropping refers to the initial phase, when they need alternative income, since the rubber is not harvestable then. Regarding the arguments to leave or remove the natural undergrowth, answers of social, economic and ecological/agronomic arguments are proportionally similar to the ratio of arguments of estate farmers and institutions. Leaving the natural undergrowth is mainly explained with ecological/agronomic advantages and removing it with social ones.

3.3.1 Perceptions of economic reasons for intercropping

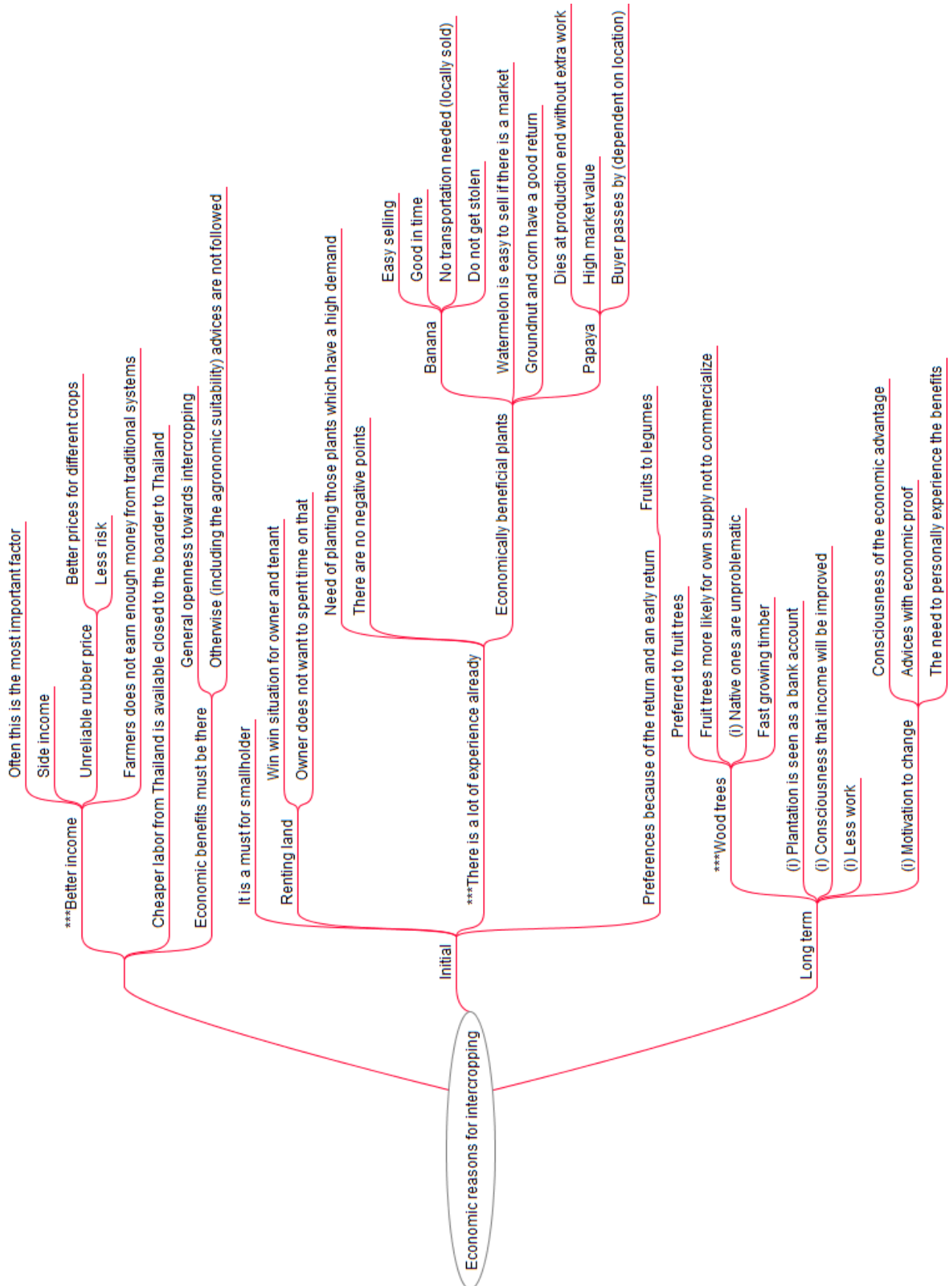


Figure 26 Economic reasons of smallholders for intercropping (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments; (i)= if given by a Thai respondent, who applies long term intercropping ^[S12])

A high variety of arguments was given for the explanation to apply intercropping. **Economic** reasons gained high attention since the improved income is, especially in the initial phase of rubber cultivation, necessary for small farmers to earn more money.

*“1 kg Scrups today in Baling: 2 Ringgit
Several years ago 1 kg scrups: 7 Ringgit
1 kg fish: 10 Ringgit
1 kg Durian: 20 Ringgit” [S3]*

Traditional systems, as they often still exist, only give very little output and farmers try to find alternative systems.

“We have 2000 trees and bees but the money from the system as it exists is not enough. From one bottle of bee nectar one earns 50 Ringgit.” [S4]

For this reason and in order to minimize risk and dependency on the rubber price, small farmers either have additional jobs or think about other possibilities of managing the plantation.

“Still, we cannot relate on the rubber price. I will decide how to manage the plantation related to the economic benefits.” [S15]

The argument of an improved income was highlighted by many small farmers and is thus assessed to be one of the most important factors for them, when it comes to the decision of implementing intercropping. It was said that it is possible to get better prices from different crops, that there are several plants suitable and there is an openness towards those systems.

“There are some plants suitable, I would use. I would probably plant something.” [S15]

Local differences were disclosed during the interviews. For example, it was considered important that farmers with a slightly bigger land (in this example the farmer has about seven hectares farm land) with need of labour for the plantation prefer tappers from Thailand since the labour is cheaper. This is easier if the farm is located close to the border with Thailand. This might be important since tappers could also be hired for managing intercropped plants.

“Here many tappers are people from Thailand. They are more willing to do it and they are cheaper labour.” [S9]

Very few respondents mentioned that there is a general openness to apply intercropping if there is an economic benefit and it is ecological suitable. Otherwise, advice for changing the system would not be considered.

"For example, it is advised to put every 4 months, manure. We put it every month. The reason is we have a shortage of labour and cannot put that much manure because of the weather." [S9]

Economic advantages were seen in particular in the **initial** phase of the rubber plantation.

"Intercropping, you simply have to do it. Otherwise you have a long time without income." [S9]

Small farmers tend to rent their land out in order to create a "win-win situation" and also to be in favour of the time factor, since they do not want to manage it themselves and spend time on this issue.

"After chopping the trees, we will lease it to other people and their crops. One year more or less and then they planted banana, cover plants, groundnut or chilli. I always lease out. I do not have time for that things and don't want to have a headache on that. Therefore, it is a win-win situation" [S11]

Another point that was frequently mentioned by the majority of respondents was that there is already a lot of experience and distributed knowledge and people trust and practice those systems. Farmers in general see intercropping as something positive and they are aware of the economic advantages of several plants and their market situation. The economic benefit of banana, watermelon, groundnut and papaya was highlighted

"I call it supporting farming. I do it." [S5]



Figure 27 Initial intercropping of rubber with papaya. Papaya was said to be three and the rubber less than five years old. The location is close to Sungai Petani, Malaysia

Part of this common knowledge of farmers is that certain fruits are preferred because of the economic value on the market. The majority is aware of economic advantages and disadvantages of specific plants, and choose in particular according to the current market situation. Therefore, their preference depends on the economic return including the consideration of the time component. This mainly explained that the majority prefers fruits to legumes in the initial phase.

The economic reasons that spoke for **long-term** intercropping are shaped by the preference of planting wood trees. It was emphasized by some respondents that wood trees are preferred compared to fruit trees. Fruit trees are more connected to the own use instead of a commercialization. In addition, there is positive experience with native wood trees, being unproblematic and offering the possibility of using fast-growing timber.

"There is fast growing timber that grows up in 5 years." [S15]

"If you try it with rambutan..., this amount could not be commercialized. This is only suitable for the own supply. There is always an effect with the mixing process" [S8]

"The shade leads to less management effort." [S12]

"One do not have to take care of native wood trees. One have to take more care on fruit trees. I feel that fruit cannot compete as well as wood trees. For this reason, I would mainly grow it to eat myself. I also have a garden next to the house with fruit trees to eat." [S12]

The Thai farmer, who applies intercropping with trees to sell the wood emphasized strongly the good return and an easier unproblematic management compared to fruit trees. For this respondent, the time factor, to receive a late return was not negative. Additional arguments, which spoke for the application of long-term intercropping were that the plantation is seen as a bank account and that there is the need of a certain consciousness that income will be improved, as well as less work will be necessary.

"You withdraw when you need it." [S12]



Figure 28 Agroforestry - Rubber and various wood trees, close to Hat Yai, Thailand

The economic aspect was seen by one respondent as the main issue in terms of providing motivation to change to an intercropping system. The consciousness, which could come out of advice from visible proof, is essential for this process. The respondent himself *“did not think about it, until he saw that the wood is usable”* [S12].

“Neighbours wouldn’t care what I tell them but if I talk to them about the economic aspects they care. I have two bottles my friend has only half (latex yield).”
[S12]

Interviewer: “How about diversity how important is this to you?”
Interviewed: “I have not been concerned about this. I just realized I can use the wood.” [S12]

3.3.2 Perceptions of social reasons for intercropping



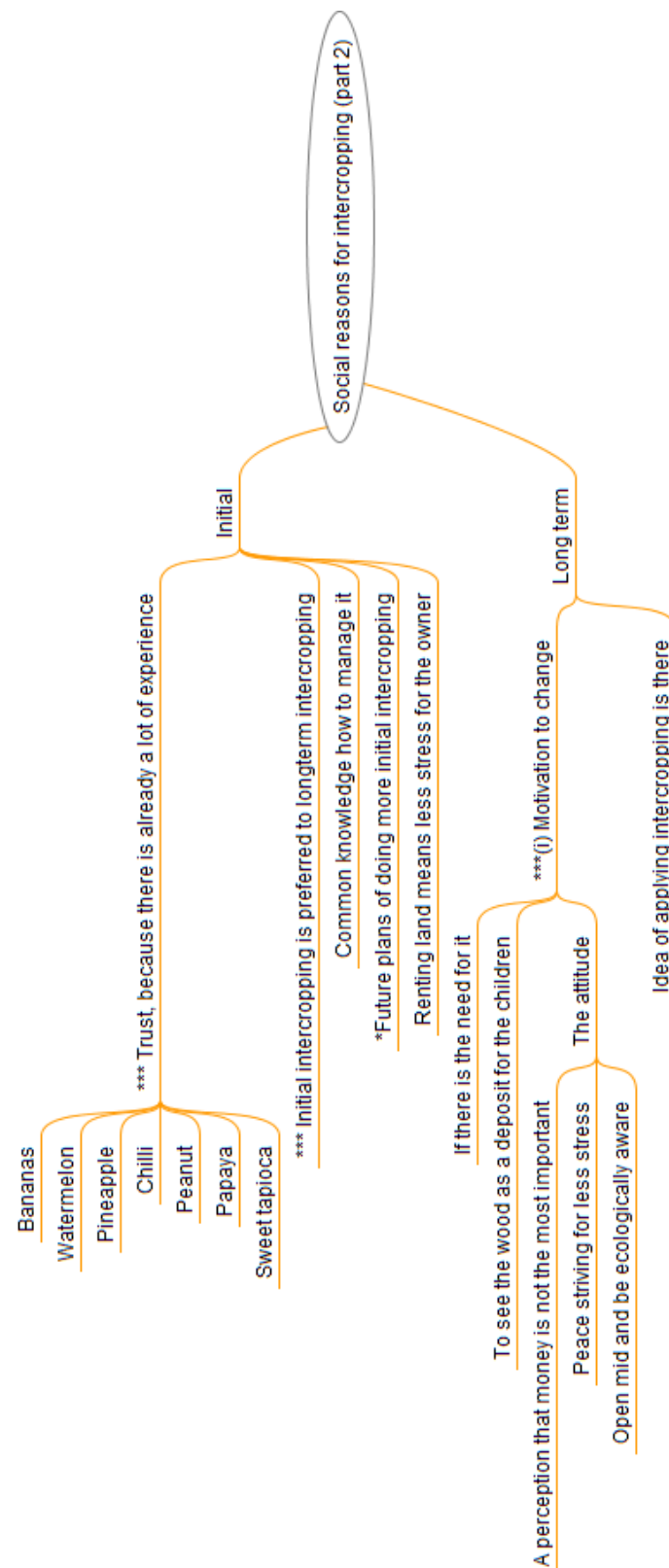


Figure 29 Social reasons of smallholders for intercropping part one and two (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments; (i)= if given by a Thai respondent, who applies long term intercropping ^[S12])

Social arguments were mentioned nearly as often as economic ones (figure 25). From a social point of view, the perception of nature and self-sufficiency as a strong contributor to happiness, as well as the attitude of being satisfied, without striving for more was seen to be very important. The last argument was connected to a cultural thinking due to the religion of Buddhism. Those arguments that outline a very strong importance of personal attitude was strongly emphasized by one Thai Buddhist respondent, who applies intercropping in Thailand.

"I built my house around a tree, because I didn't want to chop the tree down just because of me wanting a house." [S12]

"I used to work in chemistry, but stopped. I have everything I need. Also, some paddy fields. I am mainly self-sufficient. This is something important for me. My farm has everything." [S12]



Figure 30 *"The tree should not be chopped down, just because I build a house"*^[S12] - attitude and house of an intercropping applying smallholder close to Hat Yai, Thailand

If advice is followed or not was explained mainly by many respondents with the appearance of sympathy and trustable sources. Therefore, it varies if advice from higher institutions, as MRB and RISDA, is taken or not. A reason that strengthens the acceptance of such recommendations is in particular, to get subsidies and the fear of not receiving them. Advice is there, but the problem is partly that the "know-how" is missing, as well as long-term advice. Advice is only given when the trees are small. One respondent said that he would, once in a while follow advice from a book. Neighbours'

advice might be taken, but it is much more likely to be taken if it comes from an educated person. Furthermore, various respondents emphasized that visible success, which encloses the creation of interest, would change the attitude towards intercropping in the future.

Interviewer: "MRB and RISTA do they influence you in your decisions?"

Interviewed farmer "Sometimes, la." [S8]

(Note from author: "La" – typical Malay style to talk)

"We have to create an interest." Show that you get that much or this much. This should be done by showing, sample of holdings and plot demo." [S1]

Moreover, it was said several times that it is important what kind of market and which ethnic communities are located close by in order to sell agricultural products. This opens and closes possibilities of selling, depending on the ethnic origin of the seller. For Malay-Malay farmers, it seldom is a problem, regarding this aspect. Chinese-Malay have their own market, where Chinese-Malay are selling and mainly Chinese-Malay are buying the products. The ethnic origin splits and decides the structure of the society and was mentioned by many respondents to have a big influence on possibilities to sell.

"The middle man is honest and there is no problem with him. He is a Chinese middleman. We sell on the Chinese village, where it gets away easily." [S10]

"It is easy to sell fruits simply next to the street." [S11]

Furthermore, theft was considered to be a negligible issue. Even though it was said to happen frequently, farmers have a relaxed attitude about it. Connected to this issue, it was mentioned that there is not more theft if the plantation is further away. On the other hand, one respondent said that bananas are preferred for cultivation, because they would not get stolen. By another respondent, it was mentioned that a feared ghost, called Pontianak, prefers to hang at banana trees. Additionally, one respondent reported that some people believe that people can own ghosts, which protect them from theft. If one would steal, the thief could get killed by it. A connection could be seen in between the easy-going attitude towards theft and the living ghost culture.

"Yes, it happens I even saw one stealing. He told them that they can eat but the problem is they even sell it. It doesn't matter we live together and we don't want to have any problems. We just assume they want to eat and let them eat." [S7]

"Hantu Raya, a Malay ghost is raised up by a person to protect an area. It has to be fed. For example, with 7 eggs a day and sticky rice. Like this people protected the rubber plantation. The ghost is disturbing or killing foreign people that steal."

But nowadays people do not believe, that other people have them, for what they are less afraid to steal. There is an area where the owner passed already. It is said that he had a Hantu Raya once. Nobody now takes the fruits even though it is fruit yards full of good fruits. The reason is he did not have children and he could not inherit the ghost. Now the ghost is searching for a new owner. Anyway, people have a traditional thinking. They do not trust and are scared. Even me, I avoid, to pass by this area.” [O1]

The following reasons were visually summarized in the mind map for the motive that they were not mentioned frequently. It is emphasized by one respondent that for the farmers it is important to “*keep care on the tappers*” [S9], since it is difficult to find labour nowadays in this working area. This means that the requirement of having labour and workers available for intercropping is given. Therefore, the circumstances for the tappers have a priority. If intercropping means a better situation for the workers, it is more likely to succeed. A rarely mentioned aspect in the smallholder category, which should be considered is that only few owners do not tap themselves.

“For me to be honest the most important thing, is to look after my tapper that they do not run away.” [S9]

Another reason mentioned by one respondent was the coincidence of a meeting with a stubborn cow on the plantation. The farmer described that the cow was a disturbance. The respondent wanted to prevent it from walking across the plantation. The farmer let the natural undergrowth grow wild and discovered ecological and economic advantages of covering the inter-rows with plants. This was a personal story about the beginning of applying intercropping.

“If the cow was not there I wouldn’t know what and how to do it. Thanks to the cow.” [S12]

Farmers referred to the importance of social media and the possibility of this tool to create interest, motivation and knowledge about intercropping. It was said that more and more farmers use social media, networks and in particular YouTube (<http://www.youtube.com>) to collect new ideas. At the same time, the restriction of trust was stressed. There is the opinion that there is “*much of a makeup and fake in those clips*” [S12].

Another point is that farmers tend to separate, whether the plant is grown for commercialization or for own consumption. It is more suitable to grow plants together with rubber that are sold as well. Also, the matter of task was mentioned. It depends on who is taking care and has the decision power on intercropping if it is done or not.

"The matter is if you want to do it on your own or let someone else take care on it. It is a matter of task. Sometimes somebody else handles the intercropping. Do it yourself!" [S1]

Regarding social aspects in particular towards the **initial** rubber growing period, it became obvious that there is already a lot of experience and knowledge, which shows that the small farmers are experts in initial intercropping. A majority of the respondents said that they feel secure with initial intercropping due to a high level of experience with several plants. Highly popular in initial intercropping cultivation are banana, watermelon and pineapple. Less, but still preferred crops on the second position, are groundnut, chilli and papaya. Furthermore, mentionable on the third place are ladyfinger and corn (table 7). Farmers are aware of the different advantages of different plants and have their preferences according to this insight. This is one of the reasons that the majority of respondents prefer initial intercropping to long-term intercropping. How to grow and handle the plants is common knowledge and there are further plans to apply it. Some farmers prefer to rent the land out in the initial period, in order to have less stress on maintaining the land, which is a common practice in Malaysia. This practice increases the application of initial intercropping.

"Previous we had 100 bananas, before the plantation got too old." [S5]

"Most people prefer banana to papaya." [S7]

"When the rubber is young they intercrop with maize, watermelon. Watermelon is the number 1 crop to plant in between of rubber. It is a creeper. It doesn't destroy. Number 2 is chilli. Number 3 is ladyfinger." [S9]

"This is my second focus: Renting the land. Especially if they have the experience. If you rent the land, you won't have much headache on that". [S9]

3. Results

Table 7 Number of different people, mentioning a crop for initial intercropping during all interviews conducted and during the interviews with smallholders only

	Number of all respondents	Number of smallholders
Banana	16	9
Watermelon	11	5
Pineapple	10	5
Groundnut	7	5
Chilli	7	4
Papaya	5	2
Ladyfinger	2	1
Corn	2	1

The strongest mentioned reason for **long-term** intercropping from a social view was the motivation to change. This was highly emphasized by one Thai respondent, who implemented intercropping. This motivation in turn occurred out of the need to change. An open mind, the ecological awareness and the will to provide wood as a deposit for the children were factors that motivated the respondent further. Striving for less work and stress, more peace and not for an immediate monetary return were drivers of motivation as well. Furthermore, it was mentioned by very few respondents that the general idea of applying long-term intercropping is present.

“For me this wood is like a deposit for my kids.” [S12]

3.3.3 Perceptions of ecological/agronomic reasons for intercropping

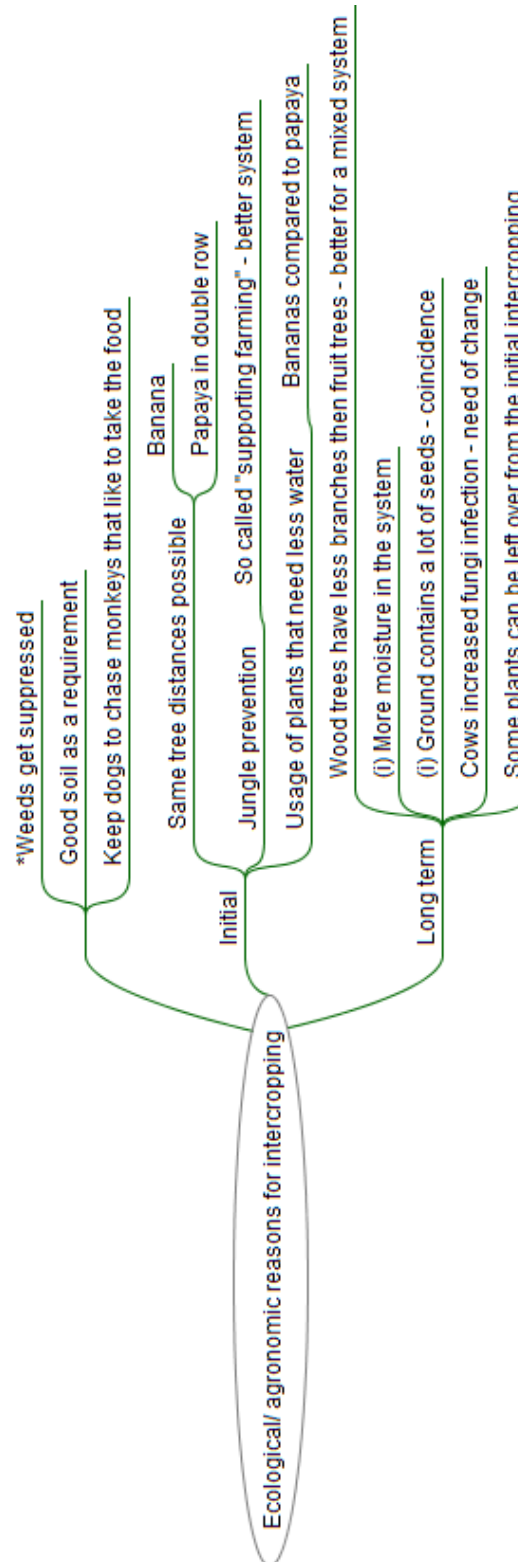


Figure 31 Ecological/agronomic reasons of smallholders for intercropping (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments; (i)= if given by one Thai respondent, who applies long term intercropping ^[S12])

From the economic, social and **ecological/agronomic** point of view, ecological/agronomic explanations are used the least (figure 25). It was mentioned by some respondents that awareness about the advantage of having less weed, in order to “*prevent a jungle*” ^[S9] is there, but not assessed to be as important as issues from the previous categories. Good soil was said to be a requirement for intercropping, and keeping dogs to chase monkeys reduces the possibilities for monkeys to take away fruits or vegetables, which makes intercropping management easier. In particular, regarding **initial** intercropping there is the perceived advantage by very few respondents of the possibility of keeping the same distances in between the rubber trees, while planting other plants in between. Through their expert knowledge farmers choose plants which need less water, if water is scarce. An example was banana which needs less water than papaya. Taking a look at **long-term** intercropping, a farmer indicated the advantage of wood trees having less branches than fruit trees. A further positive impact indicated by the respondent, who applies intercropping, is that there is more moisture in the system. More reasons for adapting to intercropping were based on a coincidental run in with a cow, which led the smallholder to realize the ecological advantages. The respondent had the concern that the cow damages the roots and therefore could make the rubber more sensitive to fungi infection, which made a change necessary. The next coincidence was that there were many seeds of usable plants naturally in the ground. This made the respondent realize the further advantage of using other plants in between the rubber trees.

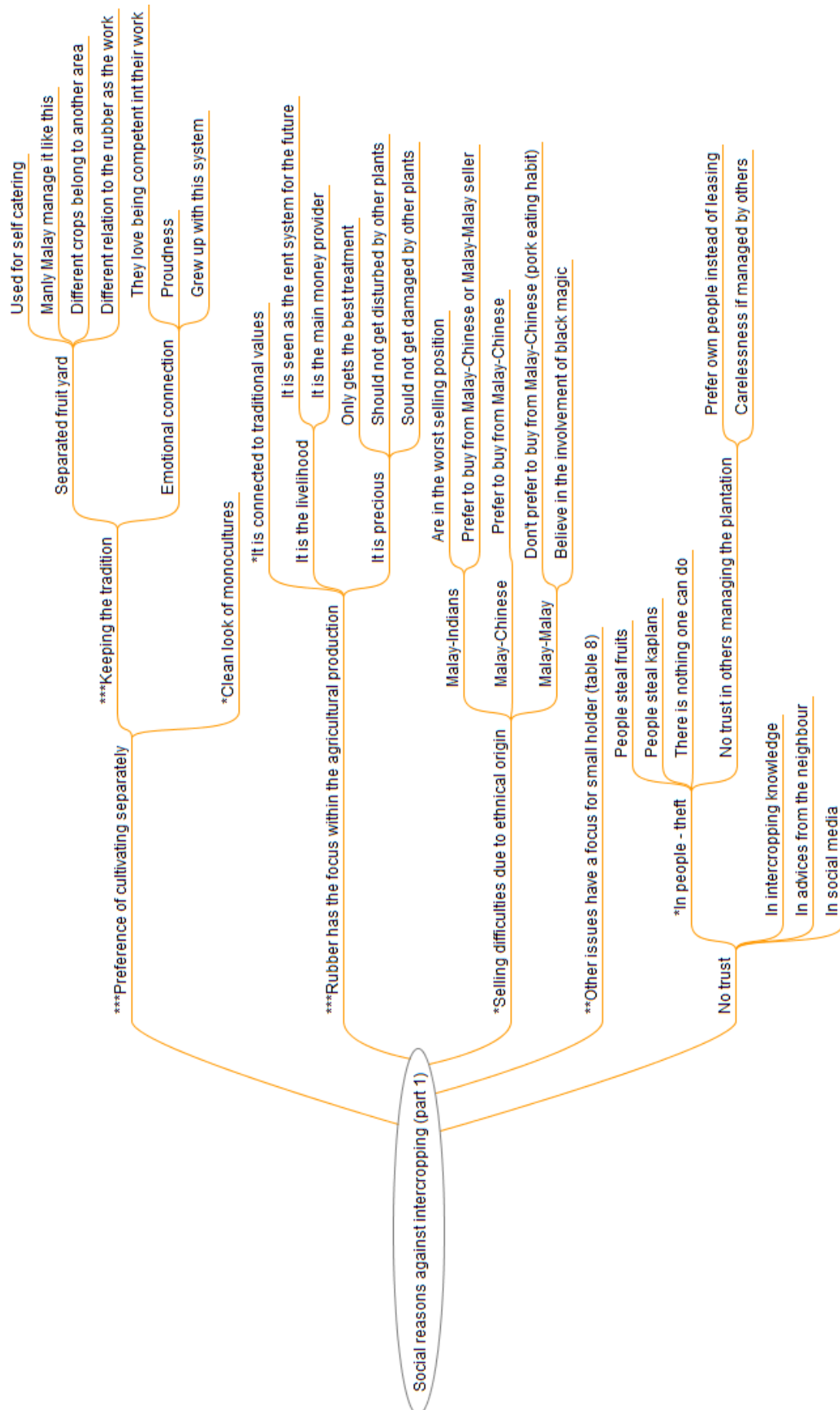
“I thought nothing. My neighbour has cows and they used to come to my plantation. This disturbed me because they brake the roots of the trees and could make it more sensitive for a fungi infection, as my concern. Therefore, I thought about a solution how to stop it. 26 years ago, I planted the wood in between to supress the weed and because I saw that it was effective with the natural undergrowth. I kept doing it.” ^[S12]

Very few respondents mentioned that some plants can survive in between the rubber, longer than assumed. An example was a few banana trees that are kept and used for this very purpose.



Figure 32 Old rubber plantation with a banana tree from the initial intercropping closed to Sungai Petani, Malaysia

3.3.4 Perceptions of social reasons against intercropping



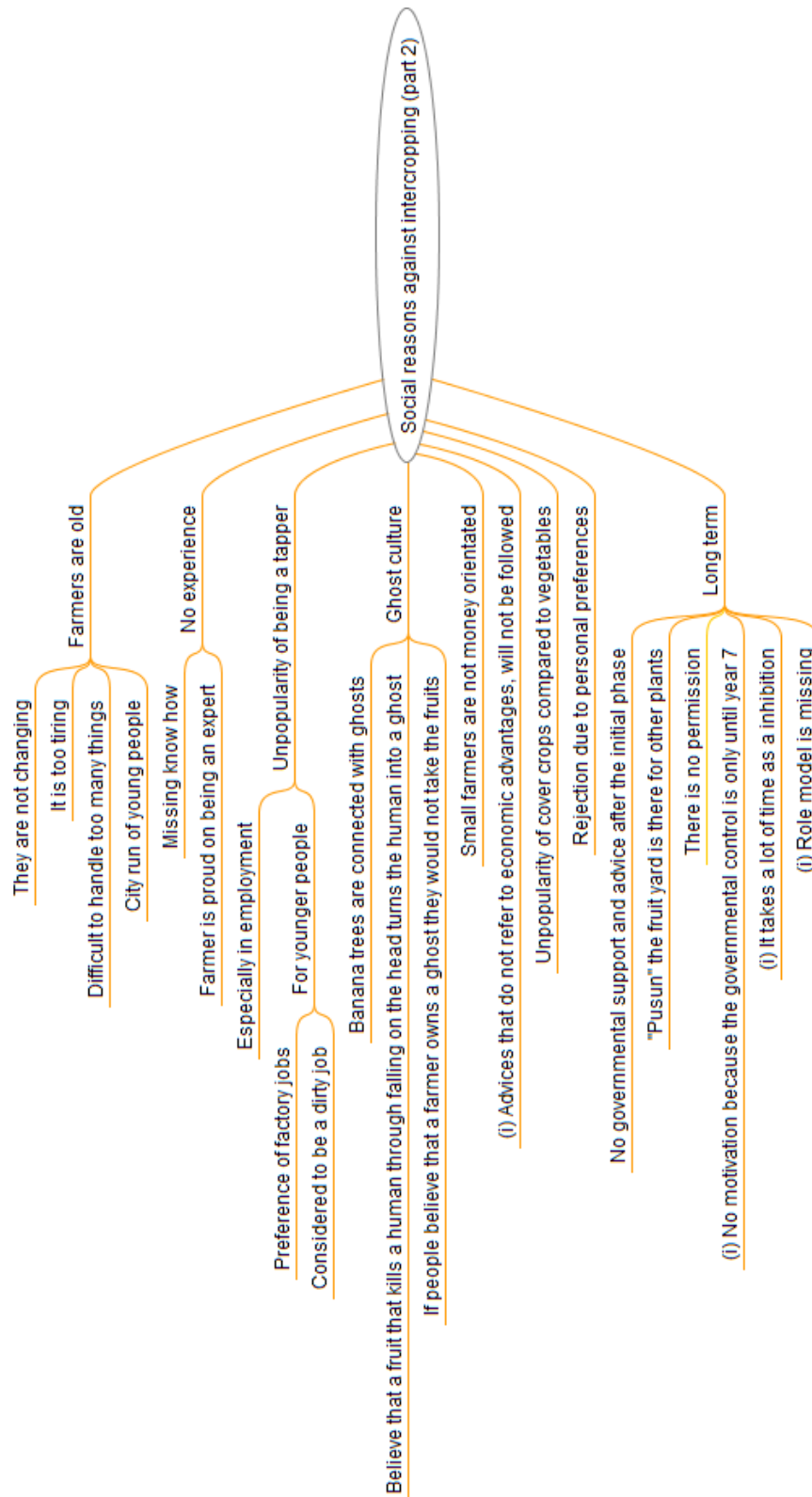


Figure 33 Social reasons of smallholders against intercropping part one and two (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked arguments; (i)= if given by one Thai respondent, who applies long term intercropping ^[S12])

Compared to other explanations, social reasons receive much attention from the smallholders. The majority of farmers expressed their preference of cultivating rubber separately from other crops. This is mainly connected to traditional values and systems that already exist. It is a Malay tradition to keep a separate fruit yard, the so called “pusun”, which is used for self-catering (figure 34). This is a common practice connected to perception that different crops belong in a different space. Some respondents said that other plants than rubber do not belong in the rubber field, and that it is cleaned up this way, since different plants are something else. It was mentioned that there is a different relation to the rubber trees, which are considered to be the work required, in contrast to fruits that are used for the own consumption.

“My parents did it like this. This is our tradition. It is traditional. I work every day and always were working with rubber.” [S8]

“I like to have fruits separately. I do not like to mix.” [S10]

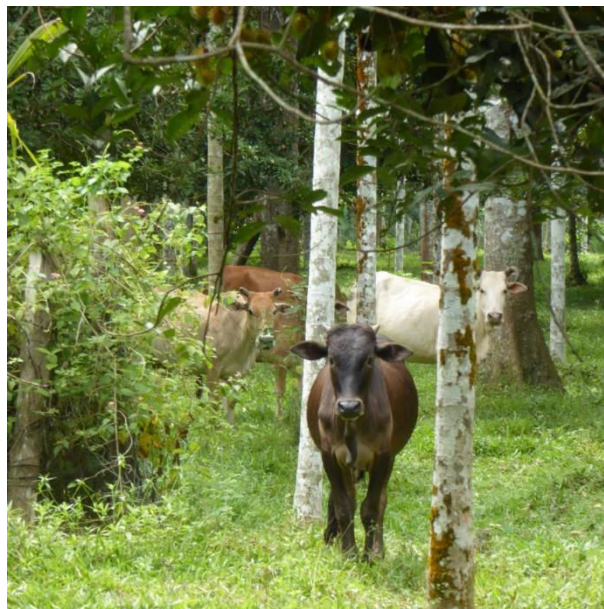


Figure 34 Traditional Malay fruit yard (so called “pusun”), which is used for self-catering. Here are several fruit trees kept together with cows. [S6]

This preference of the traditional system formed, for the majority of respondents, an emotional connection. Most of the farmers grew up with the rubber cultivation. They know that they are experts in this field and they feel proud of their work.

“Yes, I do rubber, because I am with it since I am a child. It is our tradition, the way it is.” [S13]

Some respondents mentioned that monocultures look more beautiful and, in particular, cleaner than mixed systems.

“Less variety looks clean.” [S1]

Another big argument of the majority of respondents was that rubber is the focus within the agricultural production. This point was strongly connected to traditional values. It is the rubber that provides a future with a constant output and livelihood. Many explained rubber to be the main money provider and some kind of a rent system for smallholders. For this reason, it is seen by the majority to be precious, which explains that it is worth it to receive the best treatment, with attention and attentiveness. This opinion includes that the rubber plants should not get disturbed or damaged by other plants.

“For a smallholder rubber tree are something precious. They take care of us. They are our future, our only livelihood. Fruits are seasonal, palm oil is monthly and rubber daily!” [S2]

“The fruit yard we have for our own consumption. We are self-catering in a big amount, mainly. Many Malay manage the plantation like this. In the traditional way. They provide a lot for their own and have rubber as THE income and money provider, like a rent system”. [S6]

From time to time respondents referred to difficulties due to different ethnic origins. This was emphasized in particular from people who have a different ethnic origin than the Malay-Malays. The opinions varied. Different people see different people being in a disadvantaged position. Examples are that one responder sees the Malay-Indian sellers in the worst selling position. Indians themselves would prefer Malay-Chinese or Malay-Malay sellers. It was said by a few respondents that Malay-Chinese are famous for good quality. This is the reason for them to prefer Malay-Chinese sellers if this possibility exist. In some areas, Malay-Chinese have their own communities, where they buy and sell. In a Malay-Malay relationship, one respondent from another ethnic origin said that nobody would dare to mess with them, since one never knows who is involved with black magic. Malay-Malays would prefer others than Malay-Chinese sellers, due to the habit of eating pork. All in all, it was obvious, due to the amount, of respondents, that this is not the most important factor, but also that if there are possibilities, certain preferences are held and people differentiate between people's ethnic origins.

“If there is a Malay, a Chinese and an Indian, all selling bananas, Malay people would buy always from the Malay, secondly from the Indian, thirdly from the Chinese. The reason is, that Chinese eat pork and Malay are Muslims. Indian prefer to

buy from the Chinese, because they are well known for better quality. Chinese are very biased. They will buy from Chinese. And they also eat at the Chinese restaurant. Our society is multicultural and separated in the same time. Nobody dares to mess up with the Malay because you never know, who is using black magic.” [03]

An argument against intercropping that was mentioned by some respondents was that the focus of the rubber production is elsewhere than in creating a sustainable, alternative mixed cropping system, which includes different crops (Table 9). In fact, none of the respondents referred to intercropping systems or biodiversity aspect as a focus of rubber plantations.

Table 8 Focus of interest from smallholders on rubber plantations. Smallholders named up to three different foci.

Focus of rubber production	Number of smallholders
Optimal fertilizer management	6
High yield and income	4
Having a clean plantation and the weed cut	4
Quality of rubber	2
Tapping management	1
Good growth direction of the tree for an opt. tapping area	1
Reduce cost through soil fertility and humidity	1
Make work easier	1

There were some arguments of some respondents that were related to trust. Here, a few more respondents mentioned that there is no trust in the theft of people and there is no point in working against it since there is nothing to do anyway. The distance from the plantation to the house was said to not be an influential factor for the theft rate. Another argument was that if the plantation was managed by others for the initial intercropping, these workers were accused of not working carefully and being careless, which damaged the rubber trees.

“There is theft from drug addicts. They collect the cup lumps and sell them. We have the same problem with fruits. One cannot do anything. The plantations are next to the house.” [510]

"The matter is if you want to do it on your own or let someone else take care on it. It is a matter of task. Sometimes somebody else handles the intercropping." [S1]

"You can take a Malaysian proverb to describe human behaviour of stealing and manipulating the harvest. Just take a look at your hand. You have one hand, but different fingers. All people are humans having different character and thinking." [S9]

Furthermore, it was mentioned by only one respondent that there is no trust in the own knowledge, as well as in the advice from neighbours and in social media.

It was said by very few respondents that a reason against intercropping is that the common picture of smallholders is represented by the old generation. Older people were said to be less likely to adapt to other managing forms. Another point, said by one small farmer was that it is too tiring for many and that it is difficult because then they would have to handle too many different things at once. This aspect is essential since the situation is shaped by the rural depopulation of young people.

"It is the same as it is with oil palm. Intercropping is too tiring for old people." [S5]

"We are the last generation protecting the rubber production. Younger than us...Sorry, la!" [S8]

The lack of experience and lack of access to easy, accessible know-how was expressed to be a barrier from very few small farmers. Another point that makes it even more difficult to overcome these reasons against intercropping is that smallholders are proud of being experts. Even if there is access to knowledge there is not necessarily openness to adopt to it.

Interviewer: "How about governmental support?"

Interviewed: "Government encourage us for pineapple. I don't know how." [S9]

"I am a businessman I do not have much experience with cash crops." [S9]

Emphasized by one respondent was that, in general, there is a trend that the tapper's job is getting more and more unpopular and undesirable. This is even stronger for an employment, if tappers are not already involved. Less tappers means also less workers available for the agricultural production. This is visible through young people, who instead of the plantation work, which is considered dirty, prefer to work in factories.

"This is a very sensitive question and a very sarcastic one as well. It is a dirty job first of all. Youngsters do not want to do it. There are a lot of mosquitos in the rubber field. It is not hygienic. It is better to sit next to the air conditioner. For example, in the factory, where boys and girls are mixed what leads to a healthy social

life. This causes labour decline. They bring the tappers from Thailand. I have Thai-land rubber tappers. They tap and weed.” [S9]

“There is a stigma on this job. It’s the drop box of the society. People look down on you.” [I10]

Several times it was highlighted that the ghost culture plays an influential role in the Malaysian society. The actions people take is sometimes connected to this. A few people mentioned the connection to the belief of ghosts in association with intercropping. Many stories, rumours and beliefs were told. Banana trees were said to be associated with ghosts and the fear of having a fruit drop on one’s head during work, since this turns the person into a ghost who has to stay with the particular tree that caused the accident. If people believe that a farmer keeps a ghost, they would not dare to steal fruits from the ghost keepers’ plantation. The feared ghost is called “Hantu Raya” and people believe that they are able to kill people in order to protect the plantation. It was said as well that in former times it was common to keep ghosts, but that it is now less so.

“People believe that there are many ghosts in banana trees. There are some tales, like for example if you walk under a jackfruit tree and the fruit falls on your head and kills you, you will turn into a ghost and stay with the tree. That happens with many trees.” [O4]

One smallholder (and some respondents, who are not small farmers but from the institutional rubber sector), mentioned that a characteristic of small farmers is that they are not strongly orientated towards money. It was expressed that sufficiency provides satisfaction for several smallholders.

The Thai smallholder who applied long term intercropping highlighted that advice that only refer to social or ecological/agronomic advantages, without the prospect of an improved economic situation, would not be followed anyway.

Moreover, it was expressed by one smallholder that cover crops are far less popular for them than planting vegetables for the initial intercropping. Another rejected the idea because of personal preferences.

“Those days they used cover crops. Beans, peanuts. Nowadays they don’t. Now they are willing to put vegetables. They are not encouraged for cover planting.” [S9]

“I don’t like mushrooms.” [S8]

MRB and RISDA do not give advice towards **long-term** intercropping. It is limited to the initial rubber phase. Another point that was connected to long-term intercropping

possibilities was that there is additional space available for fruit trees. One respondent said that fruit trees are supposed to be grown in a different area, since they are considered to be something else than rubber. The respondent also referred to management advantages of keeping other crops in the locally separate fruit yard.

Interviewer: "How about durian?"

Interviewed: "Can, but you need a big distance. I wouldn't do it. The reason is that the purpose is to grow the rubber. Durian is sort of something else. We have a "pusun" This is a land full of fruit trees. Durian should be grown over here. It should be kept separately. It is easy to manage it this way." [S6]

Another respondent expressed the problem of not obtaining permission for managing the plantation long-term together with other crops.

"I would consider mixed cropping with other wood trees. It is better than fruits because it grows well. I did not do it yet because I did not get permission." [S10]

The small farmer who applied intercropping said that there is no motivation, because the governmental control is only done until year seven in Thailand. Afterwards, farmers would not care anymore since there is no pressure from institutions. Furthermore, this farmer indicated that farmers are not likely to adapt because of the long-term factor. It takes a lot of time and the openness for a system that does not directly provide a return is often not available. These farmers also highlighted that a role model for orientation is lacking and that there would be a need for a pilot system.

3.3.5 Perceptions of economic reasons against intercropping

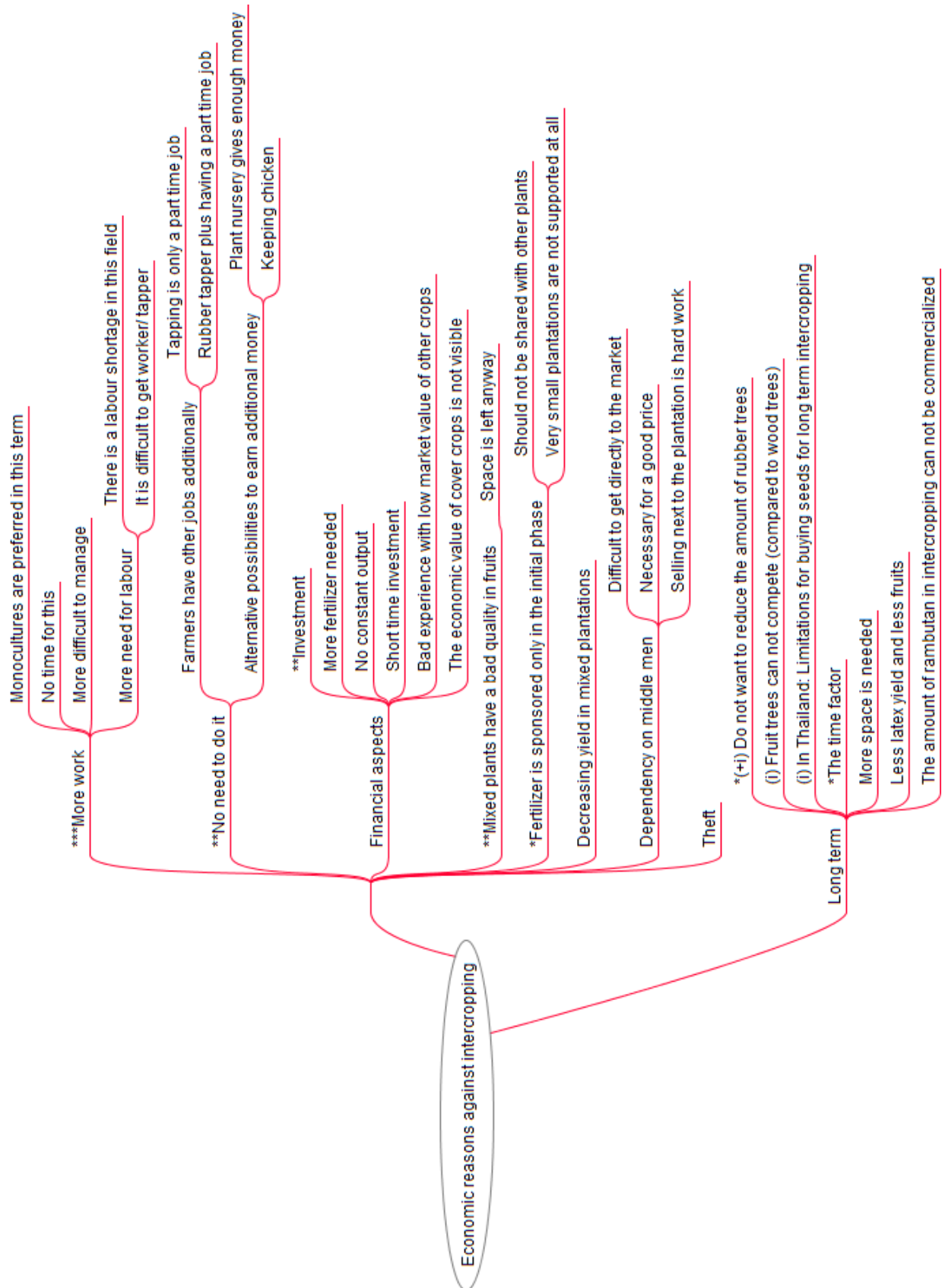


Figure 35 Economic reasons of smallholders against intercropping (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked; (i)= given by the Thai long term intercropper ^[S12]; (+i) argument of long term intercropper and others)

The economic explanations were only slightly less frequent than the social ones. A strong factor given by many respondents was that intercropping is connected with more work, for which they prefer monocultures in order to save time. Intercropping was connected to higher difficulties on managing the plantation and the need for labour. It is difficult to find tappers and workers, since there is a shortage in this field. Another frequently mentioned reason was that there is no need for the smallholder. They often have other additional jobs and describe tapping to be their part time job. There are enough other possibilities for earning additional money, like for example, to keep bees, chicken or to have a nursery farm.

Interviewer: "Why other people do not plant intercropping systems?"

Interviewed: "I guess monocultures are always better. Otherwise it is too much work." [S15]

"To mix is not good because to have two plants together is complicated and they are for their own complicated already." [S10]

"Once a week I go for tapping. Otherwise I built houses." [S5]

"I grow rubber alone. I have enough income anyway, because I manage a nursery meanwhile. In fact, I first had the nursery. I got that much income that I decided to get rubber additionally. In order to invest. I grew big from small." [S10]



Figure 36 Bee holding, chicken holding and a nursery farm in combination with rubber, different locations in Malaysia

Various financial aspects were mentioned by several respondents, in particular regarding the investment. Often, small farmers do not have sufficient financial resources. Furthermore, some individuals stated that reasons against intercropping are that money must be spent on more fertilizer, the output is not constant and often only one-time return. In terms of initial intercropping in particular, it is a short-term investment

which was also explained by a respondent as being a demotivating point. One respondent mentioned that the economic value of cover crops is not visible and that they had bad experiences in the past with the market value of other crops. For example, with durian, pineapple and rambutan, which are preferably grown in monocultures.

"The fertilizer is taken by both plants. Rubber needs 50 kg, timber needs another part and I need another side income to effort this. Fertilizer is very expensive." ^[S8]

"Nowadays rambutan do not have a price at all." ^[S10]

Yet another point that was given by some smallholders was that the quality of fruits decreases if the fruit trees are grown together with rubber trees. Enough land is available to grow fruit trees separately anyway.

"The quality of the intercropped bananas and the other fruits is bad. They have C or D quality. Why should we have worse quality of fruits if there is other space left anyway for those fruit trees?" ^[S6]

"I like to separate fruits from rubber. The quality gets worse in mixed cropping." ^[S10]

A point that was explained by few respondents was that the fertilizer is only sponsored in the initial phase. It is precious and therefore not supposed to be shared with other plants. Very small plantations are not supported and thus smallholders try to use as less fertilizer as possible. Additionally, one respondent said that the yield decreases for the individual plant in mixed plantations and it means a loss of harvest.

"If rubber stays alone then it has 100% of production. To have it together with other plants means that both decrease in their production. It is better to keep rubber alone, also because of the fertilizer. One cannot mix. It creates a fight. Plants are not helping each other." ^[S7]

Moreover, it was highlighted by one respondent that a middle man is necessary which creates dependency. Otherwise, without the middle man, it is difficult to get direct access to the market and a good price for the crops. The alternative of selling the crops directly next to the plantation on the street is hard work. Another point that was mentioned by one respondent was the loss through theft.

"To get the market is difficult. One gets to a contact trough a middle man. This is it. You first need the contact. He could ask for an "under cut price". For a better price, you need a middle man." ^[S9]

In particular, for the **long-term intercropping**, it was said by some respondents that they are not willing to reduce the amount of rubber trees in order to plant other crops. This point was also mentioned by the smallholder who applies intercropping.

Interviewer: "Would you like to widen the distance?"

Interviewed: "No, I prefer to have more rubber trees. They provide a stable income for the long-term use." [S1]

The Thai farmer that applied intercropping, gave the reason that fruit trees cannot compete on the market, as compared to trees used for lumber. Another point related to Thailand, was that there are only severely limited possibilities of buying seeds for long-term intercropping.

"I feel that fruit cannot compete as well as wood trees. For this reason, I would mainly grow it to eat myself. I also have a garden next to the house with fruit trees to eat. Favourable fruit trees would be durian, longkong and banana." [S12]

The time factor was addressed by few respondents. One must wait a long time until getting the return. This, matters because in the future, children will not overtake the plantation anyway.

"I could only harvest wood trees in 20 years." [S15]

"With agroforestry one has the long-term aspect. It takes long time to grow, so to get profit takes long as well. I am more towards fast income. My children do not want to overtake the plantation anyway." [S10]

It was also mentioned by a smallholder that there is need of leaving more space in between the rubber trees for intercropping, which means a reduction of the number of rubber trees.

"Space! You have to leave more space for long-term intercropping. That's why I wouldn't do it." [S9]

Further points given by one respondent were the disadvantage of having less latex yield and less fruits and also that, for example intercropping with rambutan would offer too small of an output to commercialize it.

3.3.6 Perceptions of ecological/ agronomic reasons against intercropping

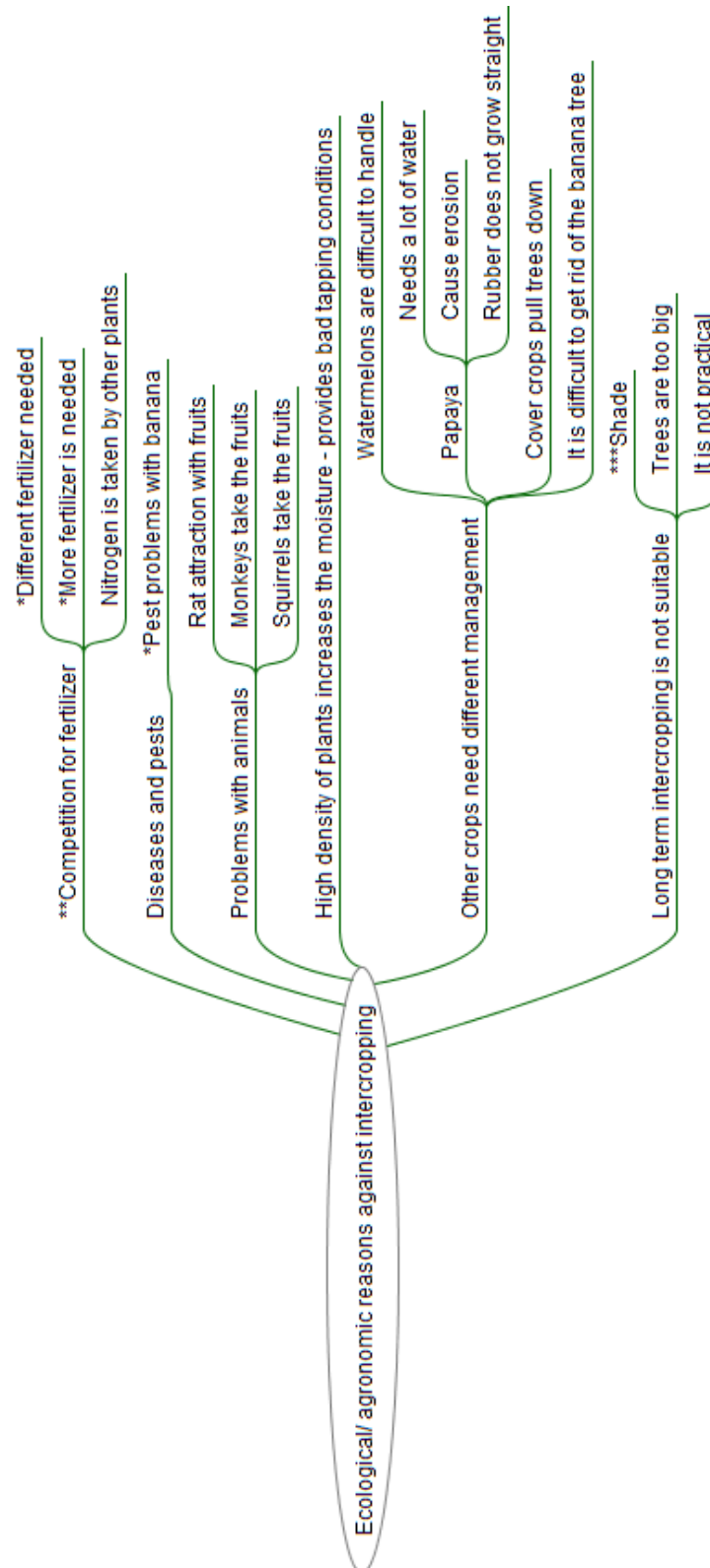


Figure 37 Ecological/ agronomic reasons of smallholders against intercropping (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger than unmarked; (i)= if given by one respondent, who applies long-term intercropping ^[S12])

The much less common explanation against intercropping was based on ecological/ agronomic reasons. Within those arguments, the most frequently mentioned were related to the fertilizer. The need of more and different fertilizer was emphasized. Furthermore, it was said that the competition for fertilizer, in particular for nitrogen, is a disadvantage.

“Durian? Can, but another reason is that different fertilizer is needed.” [S6]

“With wood tree intercropping, more fertilizer is needed. This is a point.” [S15]

It was explained by a few respondents that diseases and pests are a problem. More than one said that especially bananas have a lot of pest problems.

Problems with animals were varying strongly. Some mentioned troubles, but the kind of trouble with animals depends on the region. One smallholder expressed fear of rat attraction through fruit crop cultivation. The reason is that a disease in that particular area exists, which can be transferred from rats to human beings. Other farmers referred to monkeys and squirrels, taking the fruits.

“With durian, we have monkey problems. They always attack the fruits. To mix is not good. I experimented short term mixed cropping. Than the monkeys came and damaged a lot and I gave up. I also tried bananas 1 to 2 years and again the monkeys came. We take the dog to chase them, what reduces the problem.” [S10]

“It doesn’t matter if you like animals or not they will come. It is nature. In my wife’s area, there are durians and squirrels tasting the durians, before we taste the durians. – cannot do anything.” [S9]

The higher density of plants increases the moisture, which was said by one respondent to provide bad conditions for tapping, since it should be dry for that practice. Different examples of ecological/ agronomic disadvantages were given with regards to intercropping management. Examples were that watermelons are difficult to handle and papaya needs a lot of water which causes erosion through the irrigation and effects the rubber growth. Cover crops were accused with pulling down trees in the initial stage and to ending the intercropping with banana is complicated due to the difficulty to remove the banana trees from the plantation.

“We need to water the papaya which is a problem for the rubber. It is more difficult in this way to keep the earth and with some wind sometimes rubber tend to grow not straight. Papaya needs a lot of water and we need a sprinkler water systems. Rubber roots cannot hold themselves in the ground anymore and then they fall.” [S7]

In the case of long-term intercropping, it was most frequently said by many respondents that it is not possible because of the shade. Further explanations by individual respondents were that the trees are too big for this system and that it is not practical in the application.

3.3.7 Perceptions of leaving the natural undergrowth

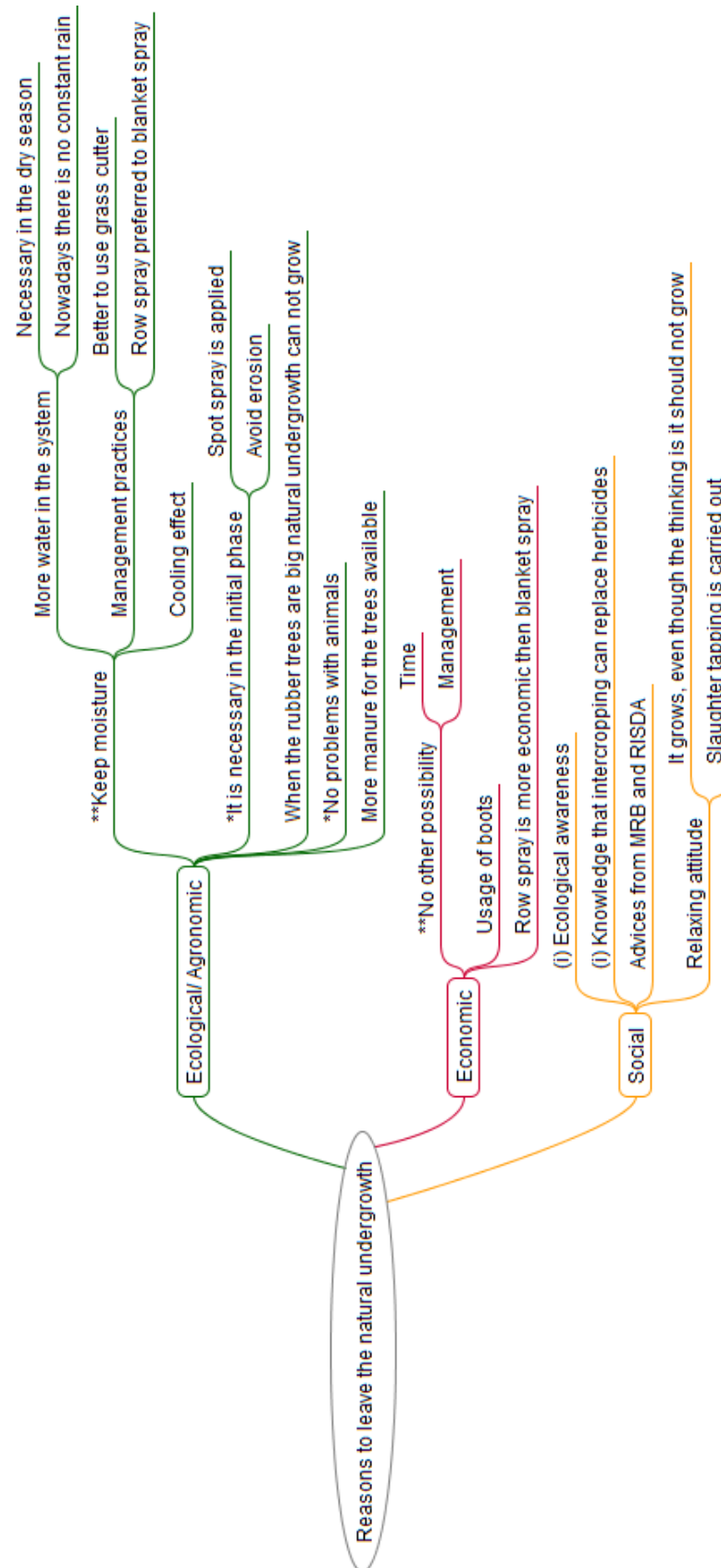


Figure 38 Reasons of smallholders to leave the natural undergrowth (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger than unmarked; (i)= if given by one Thai respondent, who keeps very wild natural undergrowth^[S12])

Only very few arguments were given regarding the advantage of leaving the natural undergrowth. Many smallholders leave it, but have the idea that it should not be left. Within the very few explanations, most advantages were seen in ecological/ agronomic aspects.

From an **ecological/agronomic** point of view, the most frequently mentioned explanation by several smallholders were that it is helpful to keep natural undergrowth in order to keep moisture/water in the system. It was explained to be necessary and that it is not advisable to have a cleared-up plantation, particularly in the dry season. Furthermore, the rain was said to change its pattern and that nowadays it does not rain constantly anymore. Therefore, and also to reduce the wash out of fertilizer and nutrients grass cutters are used and row instead of the blanket spray is applied. Included in the argument of increased moisture in the system was an elevated cooling effect.

"Blanket spray has its big disadvantage with heavy rain. Row spray is more economic. More moisture is kept and less is washed out. One must have water in the rubber plantation!" [S9]

"Nowadays it doesn't rain so much anymore. To keep the water in the system, we use the grass cutter." [S9]

Some respondents mentioned that it is necessary to keep some natural undergrowth in the initial phase. This avoids erosion which protects the ground and roots. This and the reason of not hurting the young rubber trees were the explanations for applying spot spray.

"The weeding gang uses spot spray otherwise young rubber trees get hurt. So, when the trees are small they avoid the trees and as they grow higher they simply spray everywhere." [S11]

Very few respondents said that in later stages when the trees grow higher there is not enough sunlight in between the trees for the natural undergrowth to grow. In favour of leaving the natural undergrowth were animal-related arguments as well. It was said that it does not matter that there are animals since they belong naturally into the nature and that there are no problems with elephants or snakes. There is nothing one could do against them anyway. Additionally, one individual said that there is more manure for the trees.

Interviewer: "Are you scared of animals?"

Interviewed: "No, I am immune against this fear. This is normal. People from the countryside have a different relation to this then people from the city." [S6]

The **economic** arguments in this category were related with the highest frequency towards the lack of alternative possibilities. It was emphasized that it is grown because of the lack of time and the extra effort that would be needed to invest in the management.

“Even though the role model of a plantation is an estate, it is difficult for farmers to manage it that way. Also because of the time.” [S7]

“We let it grow but actually it need to be cut.” [S2]

One respondent explained this with the possibility to utilize boots nowadays, which would reduce the possibility of snake accidents. Another referred to an economic advantage in using row spray instead of blanket spray, which is also called cover spray.

Very little attention was given towards the **social**-based explanations by the smallholders in order to explain reasons for leaving the natural undergrowth. The Thai intercropping-applying smallholder, who also has a plantation with very wild natural undergrowth, sees ecological awareness as well as the knowledge that intercropping can replace herbicides as important factors.



Figure 39 Managed plantation with wild-growing natural undergrowth and a drop irrigation system; Thailand ^[12]

Individuals answered that advice from the MRB and RISDA is a driving force and - that the so called - “slaughter tapping” is actually carried out and sometimes applied. “Slaughter tapping” means that the natural undergrowth grows wild on the unmanaged

plantation but it is at times tapped. Furthermore, it was said that theft is there anyway and that this is not a reason for removing the undergrowth.

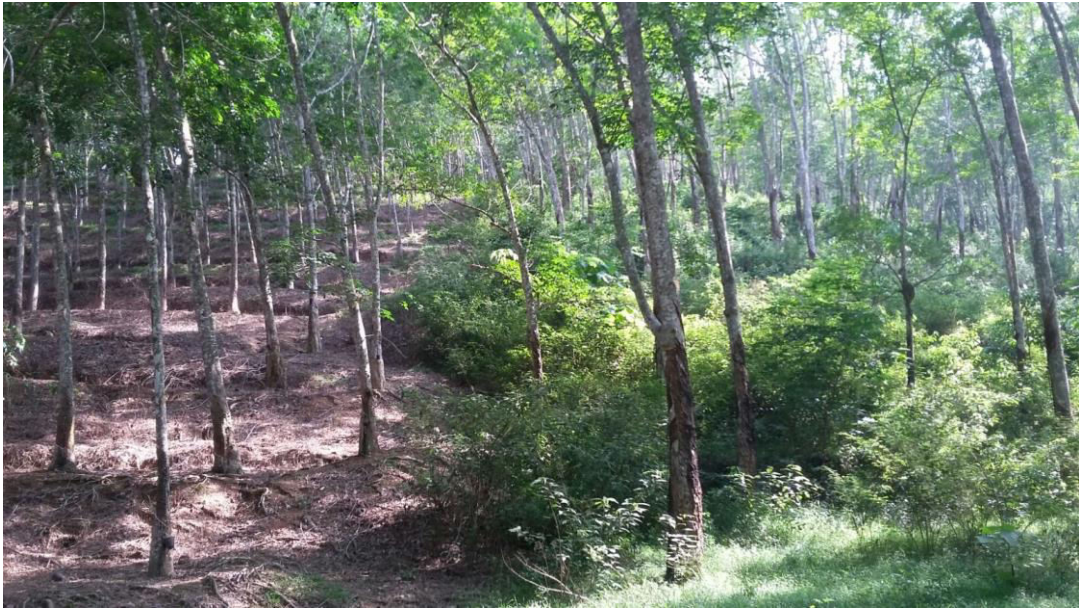


Figure 40 On the left-hand side is an estate farm that applies blanket spray with the weeding gang. On the right-hand side is an unmanaged small holding with natural undergrowth for, which at times is used for “slaughter tapping”.

Natural undergrowth remains partially on small-holdings. It grows even though the attitude of the smallholders is often that it should be removed. Overall the relaxed attitude of small farmers was mentioned by far less than the lack of feasibility.

3.3.8 Social perceptions of removing the natural undergrowth

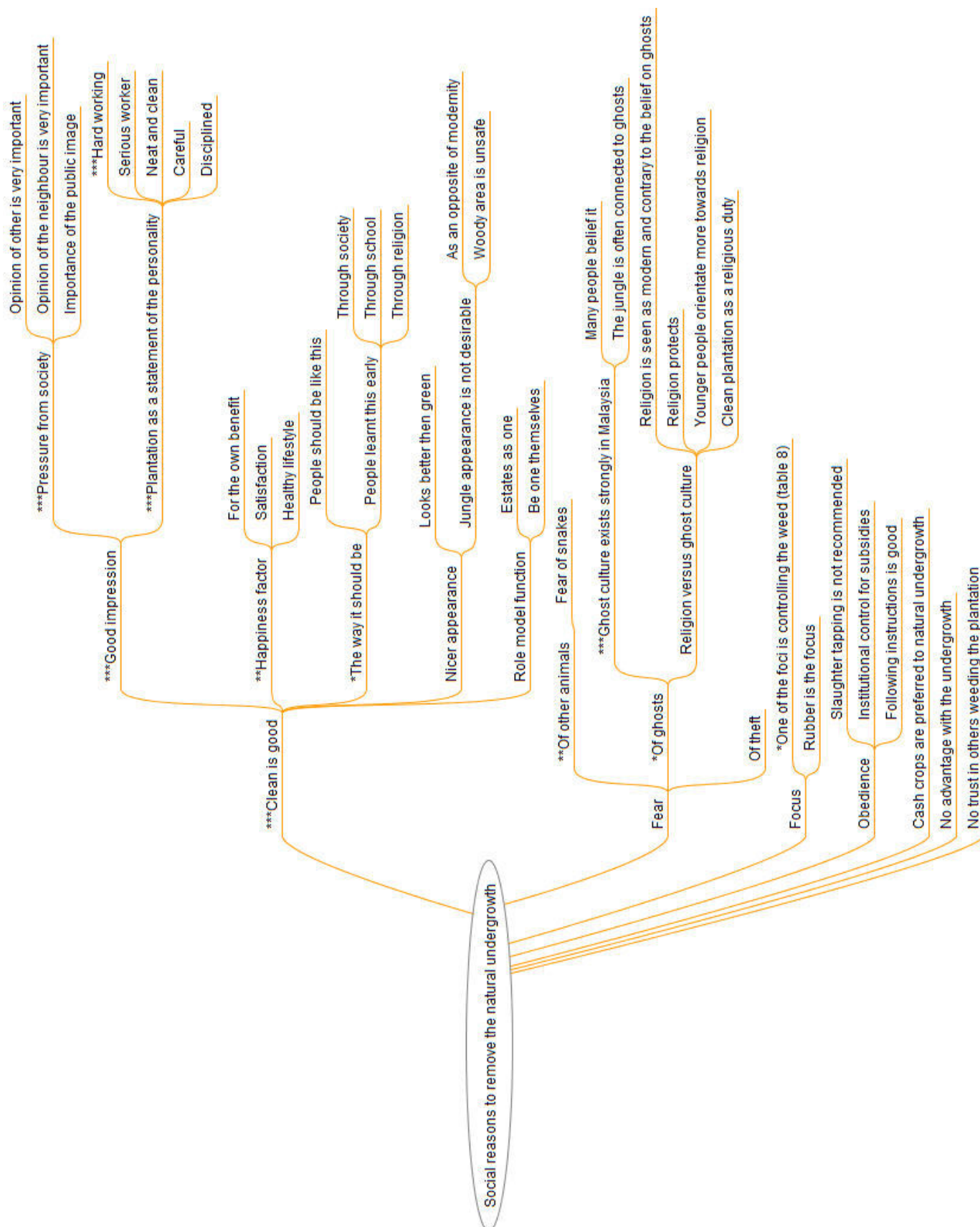


Figure 41 Social reasons of smallholders to remove the natural undergrowth (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked)

A majority of the smallholders explained, with various arguments, reasons against having natural undergrowth from a **social** perspective. Many ecological/agronomic reasons were given while the economic argumentation, in relation found the least attention.

The most frequently given explanation by the majority of smallholders, was the opinion that a clean plantation is considered to be a good plantation. Within this explanation, providing a good impression was seen to be very important. There is pressure from society, due to the opinion that satisfaction of others including one's of the neighbour is seen as very important. The public image should look decent. The plantation is seen as a release label that reveals a lot about the owner to the public, in particular to the neighbours. It shows whether the plantation owner is a hardworking, neat, careful, disciplined and serious worker. This is the way most smallholders want to be seen and this is the possibility to claim and prove that they are like this.

"A wild plantation provides a bad impression. It is related to the person. They are then not managing it rightly. Also, there are more animals. Those people are lazy. If I see a clean plantation I feel some kind of a relief. It shows seriousness and that the people are hard working." [S13]

"It is important what other people think. It is important for everyone. Also for me." [S13]

"The opinion of the neighbour is important. Neighbours complain, if the plantation is messy. Their feedback will request me to clean up. It is important to clean up." [S13]

"She prefers the plantation to be clean, because she is old. If she would see another plantation that is not clean she would think how it can be possible for them to do their work." [S14]

During one interview two plantations of one same smallholder were visited. The plantation that was easy visible for the public was very clean and tidy, without much natural undergrowth. The one that was more hidden, located far from the main street and living area, looked wilder. Still, both plantations were presented (figure 42). Other visitors made jokes from this fact and everyone, including the plantation owner were heartily laughing. On a relaxed way, the public picture is important to this smallholder, who stated the following quote:

"It is important what other people think about my plantation. It shows that I am disciplined and hard working." [S11]



Figure 42 Two plantations of the same owner with different management preferences in Baling, Malaysia

The happiness factor through having a clean plantation was another point that was mentioned by several smallholders. They referred to the own benefit and satisfaction as well as to the connection of a healthy lifestyle.

“Happiness in the holding. If it is bushy you don’t like it. Happiness! You feel lazy if it is not clean, like for example it is with the house also.” [S1]

“You must clean, it is a healthy lifestyle. One feels open.” [S10]

By some respondents, the point was emphasized that a plantation is supposed to be clean. This is, in a way, an unofficial rule. Furthermore, respondents said that people should be like this. This way of thinking was explained to be a result from education and impacts of society, school and religion.

“We let it grow but actually it needs to be cut” [S2]

“It is Muslim thinking that one should be clean outside and inside for praying. Only then one can feel happy. Of course, it is connected to the thinking that something should be and look clean. I am only happy if my plantation is clean.” [13]

Interviewed: “You learn that the house needs to be clean since you are small. If you see that the plantation is clean, then it shows that the house is most probably clean as well. This is part of the religion. Of course, I am Muslim. Everything needs to be clean, tidy and disciplined. This is part of the religion.”

Interviewer: “Would it be against the religion if the plantation is kept wild and messy?”

Interviewed: “Yes we learn it like that.” [S11]

A further point related to the aspect of a clean plantation being a good one, was that it is a preference in appearance. It was said by individuals that it looks nicer, if it is not too green and a few farmers stressed that it is not desirable if the plantation looks like a jungle and that the neatness shows a certain part of modernity. Wildness is connected with danger and the opposite of modernity. Wildness is not liked. It is trimmed, like in the garden, the head and life.

"I want it clean for 100%. If I sees another unclean plantation I would think the person is lazy, he does not care and wants to save costs. I prefer it clean, because it looks better. I do not like it green." ^[S10]

"If someone is lazy, you can see that also the elephant can get in. If someone is hard working it will be like this: A clean plantation." ^[S9]

We must have a limit. Otherwise it will be a jungle. Below 0.5 m it is safe. If it grows higher it is called woody area." ^[S9]

Another point that was said by two respondents was the function of a role model. One referred to the aim of being a role model with one's own plantation and the other sees estate farms as one.

In terms of safety, it was said by several small farmers that there is fear of other animals, in particular of snakes. On the other hand, one respondent mentioned that this is more a fear of people who are not brought up on the countryside.

"It is highly dangerous. Snakes, tigers. In one case tappers were attacked by a tiger. In Kelantan, at the boarder to Thailand. There they have heavy jungle. The tiger hurts people. It happened just recently. If the grass is too high it is dangerous." ^[S9]

"I am not scared of animals. I am immune against this fear. This is normal. People from the countryside have a different relation to this then people from the city." ^[S6]

Another point that was mentioned by many people is the presence of a strong ghost culture. Even though there is not an official commitment to this status, it still influences the thinking and fears of the people. There are many stories that connect ghosts to the jungle and wilderness.

"I am less afraid of ghosts if it is clearer, but if you don't disturb them they won't disturb you. I prefer not to think about it. The more you think about it the more probably you could see them." ^[S10]

Religion is seen by a few respondents as the opponent towards the ghost belief. One respondent expressed that strong religious faith protects against ghosts. Especially the younger farmer would strongly orientate in this direction. One learns from early years

that it is important to keep everything clean. Oneself, the house, the surrounding and the plantation. This is part of the religion for some smallholders and at times it is seen as a religious duty.

"A ghost touched me at the shoulder. I screamed I only believe in god." [S14]

Furthermore, a small argument, mentioned without focus by only one respondent, was the fear of theft due to a worse overview of the plantation.

Another explanation from some respondents was that one of the first three foci of most respondents was to control the weeds (table 9) and that the focus is said to be towards the rubber and not towards having wild undergrowth.

"I prefer to put my focus on rubber." [S1]

Rules are followed. This was said by very few respondents. Those referred to recommendations of the MRB or RISDA as an explanation of managing the plantation the way they do. One respondent explained that the obedience is due to controls of the institutions and that the preference of a clean plantation is to be sure to obtain the subsidies. Another point of statement was that it is considered good to follow instructions.

"Younger trees are affected in the growth of their roots. For this one should follow the instruction. This is just positive." [S1]

Each one said, that if the plantation is combined, there would be the preference of using cash crops instead of natural undergrowth. That there are no advantages seen in keeping the natural undergrowth and it would be preferred to not let others manage and weed the plantation due to a lack of trust.

"If I want to combine rubber with something else, I use plants, cash crops." [S1]

3.3.9 Ecological/agronomic perceptions of removing the natural undergrowth

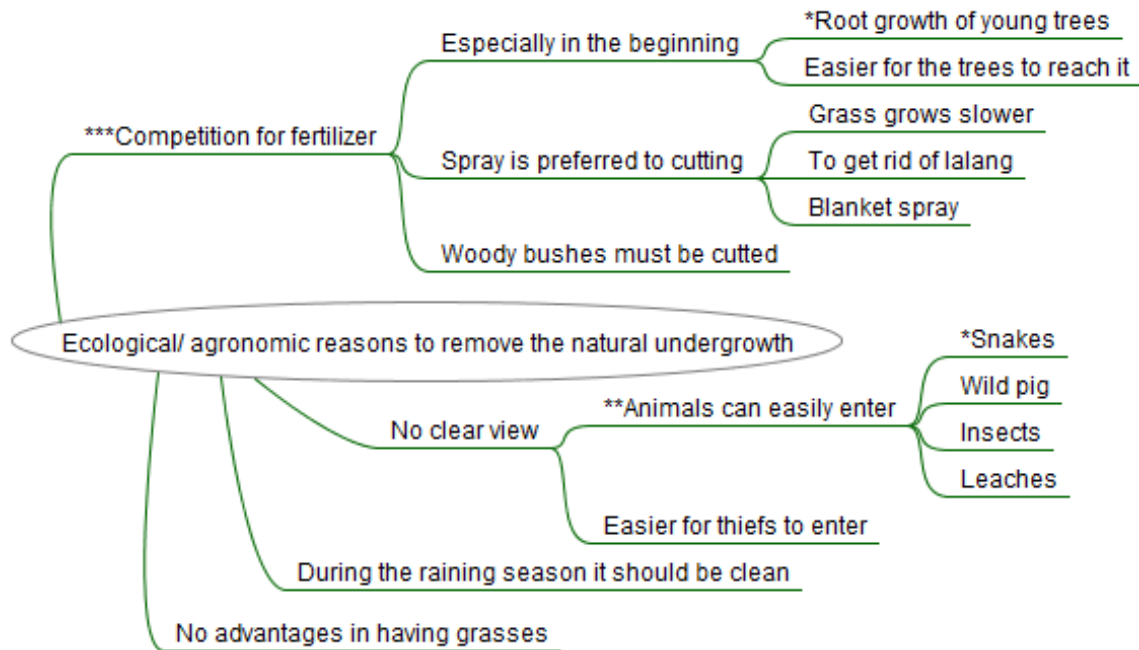


Figure 43 Ecological/ agronomic reasons of smallholders to remove the natural undergrowth (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked)

Ecological/agronomic explanations found less attention than social ones but more than economic ones. Still within these explanations a strong focus was given of several smallholders to the competition of fertilizer. The loss of it to other plants is disliked. For this reason, especially in the beginning farmers often look for a clear space in order to not disturb the root growth of the young trees and to make it easier for the rubber to reach the fertilizer. Generally, before manuring smallholders clear the land. In particular, Lalang is a weed that takes a lot of fertilizer and which is often seen as a threat. A respondent said that this makes it necessary to spray glyphosate at least every two to three months. Lalang, as well as other fertilizer-demanding weeds, are one of the main reasons that spraying is preferred towards cutting. It is said by some farmers that the grass grows slower afterwards than it does if it is cut. It was said that the weeding gang is hired, but this is more a management practice of bigger farms. Additional cutting was said to be necessary for woody bushes in order to get rid of them.

"Lalang is an unpopular weed. We weed it." [S1]

"You must have discipline if it comes to the grass management. Only in the beginning. Otherwise rubber do not grow, because it does not get enough fertilizer. Afterwards there are no problems anymore." [S15]

"I spray herbicides all over. Basta 15. It doesn't matter if the rubber is small or big. I spray everywhere. Only not on the forage when the rubber is still small. But anyway, it is not very harmful. I tried different managements, but not grass cutting. The reason is that grass grows faster and I have more work to do. I put Basta 15 once per month, always, only not if it rains because than it gets washed out of course." [S10]

Another aspect that was mentioned by several respondents was that there is not a clear view. The problem with this is that one cannot see animals and also that they can easily enter unrecognized into the property. Most frequently, the snake was mentioned within the animal sector. The wild pig was also mentioned as entering the plantation, which is undesirable and furthermore, insects and leeches are not companions of preference of the smallholders which are increasing in amount through a wild natural undergrowth. Additionally, very few respondents said that an unclear view could favour thieves.

"Nobody likes snakes" [I3]

"Snakes, unwanted people and animals. The plantations become their home if we cannot see it clearly." [S2]

The following arguments were given by one respondent each. In contrary to the dry season, it is preferred to have less undergrowth during the rainy season. Furthermore, it was expressed that there are no ecological advantages in having grasses.

3.3.10 Economic perceptions of removing the natural undergrowth

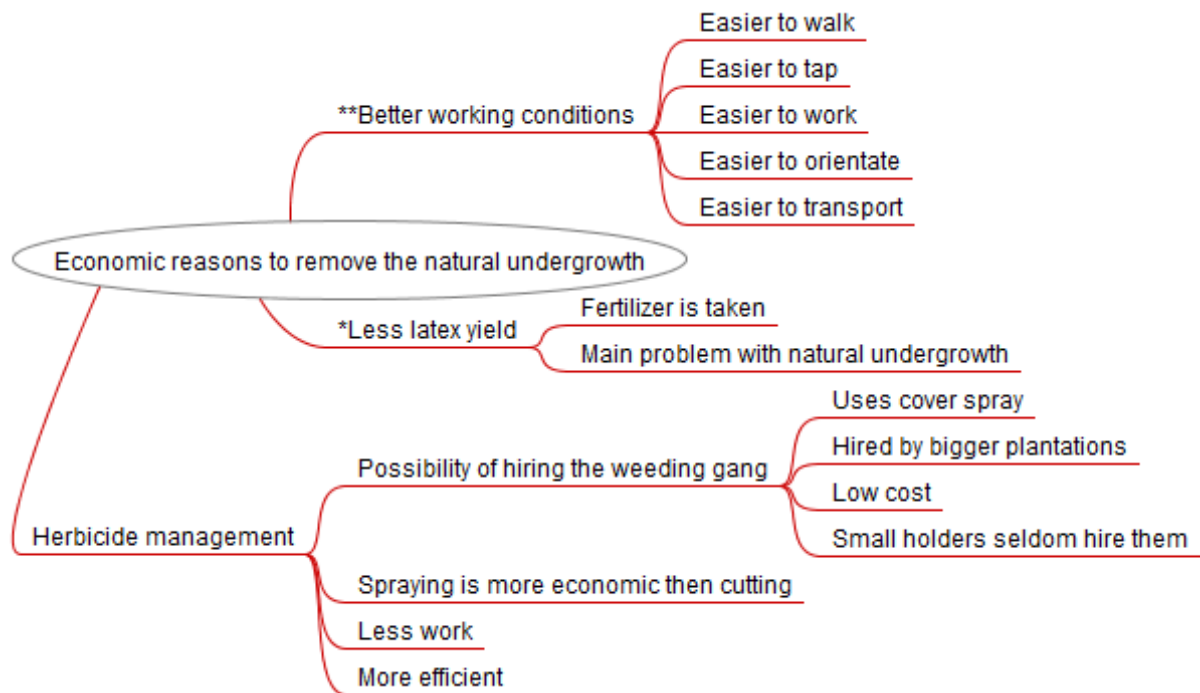


Figure 44 Economic reasons of smallholders to remove the natural undergrowth (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked)

This category found the least attention within the reasons to remove the undergrowth. Within the economic explanations most smallholders referred to the advantage of improved working conditions. It is easier to walk and work and therefore it is more effective, also in regard to the time aspect. Table 9 shows that the reduction of work is one of the farmer's goals. Due to subsidies, the price factor of inputs is neglected, compared to the view of the estate farmers. About the frequency of applying herbicides and cutting the weeds, different answers were provided. It depends on the grass growth which itself depends on the amount of perception.

"It is easy to work if it is clean." ^[511]

A main problem that was mentioned by some smallholders was that the latex yield decreases, due to the fertilizer taken by other plants. Fertilizer is applied in the beginning directly next to the tree and later when the trees are bigger, in between the rows, due to far-outgoing roots. For this reason, it is important to keep the grasses short in between of the rows.

The possibility of hiring the weeding gang makes it, in particular for bigger and older plantations, economical to remove the natural undergrowth completely through the application of cover spray. Another way used at times is the application of row spray. It is perceived not to be expensive and an opportunity to reduce the amount of work. Smallholders often do not use the weeding gang. They often combine cutting and spraying practices. When the trees are small, they do either cutting or spot spray. Woody bushes are cut, since there is often a need. With cutting, one old small farmer said that there is a dependency on help from children and grandchildren.

"I am using the weeding gang." [S13]

It was said that spraying herbicides is more economical than cutting. Reasons are, in particular the reduced amount of work and the higher efficiency, since the grass takes longer to grow again.

3. Results

Table 9 Comparison of cutting grasses and using herbicides. Numbers noted during one expert interview from an institutional representative. Information given by smallholders is framed. ^[18].

	Herbicides	Mechanical cutting
Frequency of application	→ Around 4 times per year → 1-6 times per year from the 1.-9 th Year → 1 time per year from the 9 th year → Every 2-3 months on bigger plantations ^[S7] → Once every 6 months, depending on the grass growth ^[S14] → 2 times a year cover spray ^[S9] → Every 2-3 months with additional cutting ^[S6] → 3-4 times per year glyphosate is applied for the lalang challenge ^[S1] → Every 2-3 months sometimes more, sometimes less ^[S15] → Once per month ^[S10]	→ 2 times per year → Once per month before applying herbicides ^[S5]
Amount	→ 1 acre takes 3 bags, 50 kg ^[S8]	
Duration of work	→ 2 hours in comparison to 1-1,5 days for the same area	→ 1 – 1.5 days in comparison to 2 hours for the same area.
Continuance	→ “Glyphosate” lasts longer than “Paraquat”, which only lasts 2 months	→ Grass grows quicker after cutting then after applying herbicides ^[S10]
Cost	→ 12€ per ha per spray	→ 60€ per ha per cut → 2-3 times more expensive
Usage	→ 60% in Thailand → Cover spray on estate farms	→ In between the rubber trees, farmers often cut

4. Summary and comparison within the results

4.1 Intercropping

The consensus of all interview participants was that there are many more arguments against intercropping than for it. There were many agreements, which were even more pronounced for institutions and smallholders focusing on subsistence economy whereas estate farmers tried to optimize production. Even though in absolute numbers, the reasons for intercropping were far less than those against it, various advocating arguments were frequently mentioned, for what they are considered to be important. Here, the most frequently given arguments are summarized in order to represent the most common attitude and opinion. This is an overview to address further approaches towards changing the system from monocultures into alternative systems.

Common statements of all stakeholders against intercropping were the economic profitability and the risk that comes along with not enough proof for success. In particular, for long-term intercropping, this was seen as an obstacle. Furthermore, a common focus on social aspects was visible. However, explanations within this category were different. Smallholders mainly referred to aspects related to traditions, whereas estate farmers pointed to a lack of interest due to a lack of need.

A common statement between all stakeholders for intercropping was the focus on economic arguments. The institutions and the smallholders saw improved income, existing economic proof due to available experience and reduced risk as reasons for initial intercropping. Estate representatives argued differently since they grow cover crops instead of cash crops in the initial rubber phase. Another common point of view was the ecological consciousness and the need for implementation, which is also seen as a motivation for long-term intercropping.

4. Summary and comparison within the results

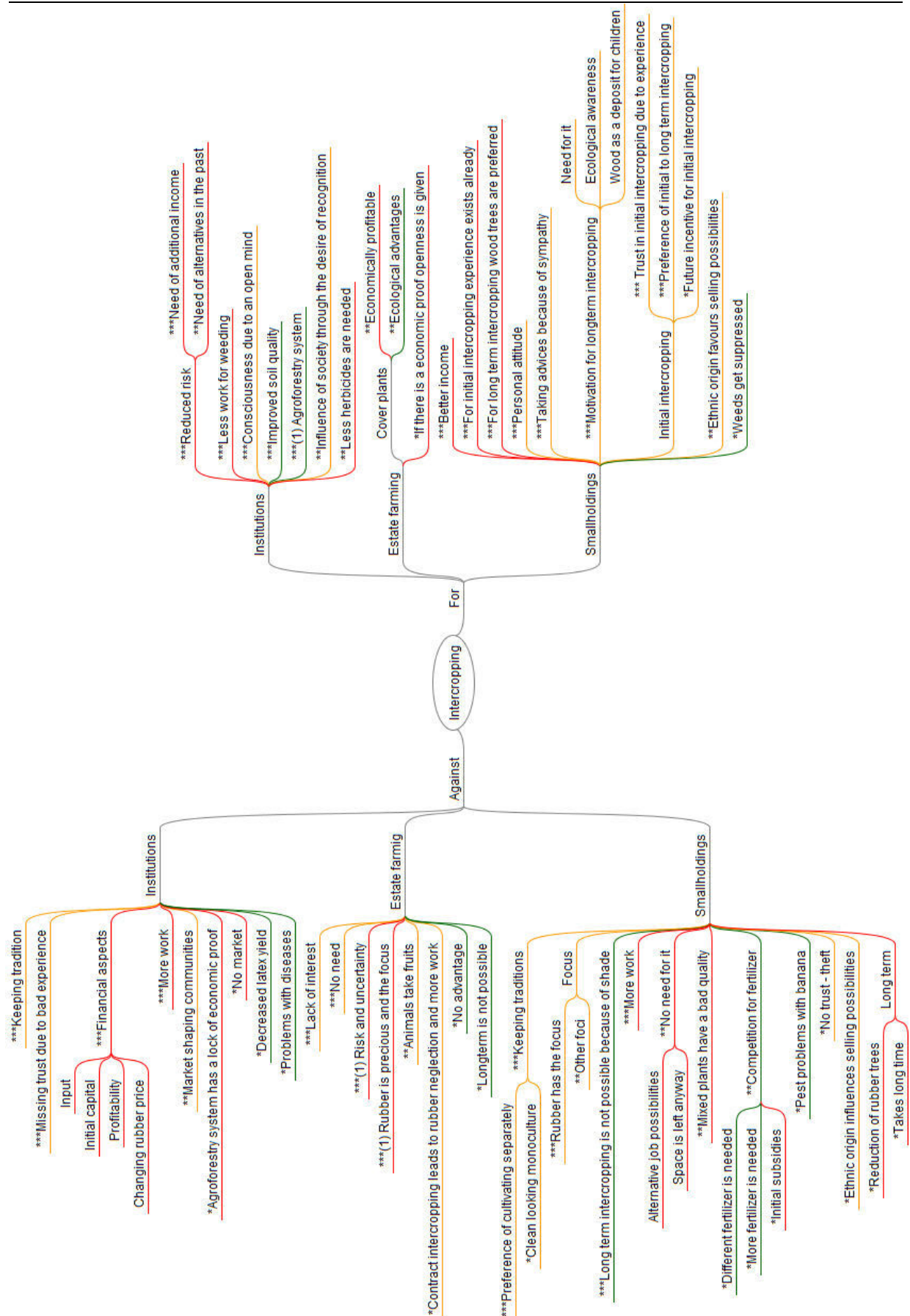


Figure 45 Most frequently mentioned reasons for and against intercropping of all stakeholder respondents (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger then unmarked; Category: yellow=social; red=economy; green=ecologic/agronomic)

4.1.1 Reasons against intercropping

Institutions mostly argued socially, closely followed economically and less significantly, ecologically/agronomical. The most important reasons for the majority were keeping the tradition and a lack of trust due to bad experiences, the financial aspects regarding input, initial capital, the profitability and the changing rubber prices, as well as the additional work load. Communities that shape the market, as a result of a big variety of cultures, are seen as a problem of implementation by many. Few more respondents referred to the missing economic scientific proof and the unreliable missing market. The disadvantage of decreased rubber yield and problems with diseases were also mentioned.

For representatives of **estate farming** the most frequently mentioned arguments against intercropping were socially and, in particular by the estate owner, economically argued. Ecological arguments found more attention by all estate representatives together compared to the other stakeholder groups, but were far less important within the estate representing group for the estate owner. Contrary to the institutions reasons were not explained with traditions but rather with a lack of interest due to the missing necessity. Risk and uncertainty strengthen the arguments against intercropping and are most important for the estate owner. A few respondents mentioned the point that contract intercropping provides additional work and furthermore, the fear exists that the rubber gets neglected. This is closely related to the reason emphasized by the estate owner that it is not worth it to burden the focus of the rubber production, the rubber trees, with competition and destruction. Furthermore, estate owners often have their focus on other businesses. The perception that animals take the fruits was highlighted particularly by the tapper. From an ecological standpoint, it was argued that there is no advantage for the rubber and that long-term intercropping is not possible, due to the shade.

The view and perception of smallholders was closer to that of the institutions compared to the estate representatives. Social arguments, closely followed by economical ones with a neglected ecological view, were used for reasoning against intercropping as well. Most frequently, the traditional aspect as it was mentioned by institutions as well was highlighted. It was related to the preference of cultivating separately which is also connected to the common practice to have a fruit yard and, by a few farmers, to keep a clean monoculture. Furthermore, the focus on rubber as mentioned by estate repre-

representatives was important. The focus of the interview partners was more towards fertilizer management, high yield and income from the rubber as well as keeping the plantation clean through weeding. Frequently mentioned was the increased amount of work and secondly, that there is no need for intercropping due to alternative additional job possibilities and enough available land area for farming. Furthermore, the negative impact of mixed plant systems on the quality of fruits, just as the competition for fertilizer due to the need of more and varying fertilizer was also highlighted by some farmers. Another concern of some representatives was that fertilizer is only sponsored in the initial phase and that it is too valuable to share it with other plants. Very few smallholders referred to pest problems, especially in terms of intercropping with banana, as well as to a lack of trust, for example due to theft. Reduced selling possibilities due to communities which are based on various ethnic origins were also mentioned by few respondents, and even less by those from the institutions. Another argument against long-term intercropping stood the frequent perception that it is not possible due to shade, whereas a few farmers expected problems in regard to the reduction of rubber trees or that it takes longer to harvest.

4.1.2 Reasons for intercropping

Arguments that found high attention by respondents of the **institutions** were strongly related to economic and social reasons and less so to ecological ones. Reduced risk and the need of additional income for a financially safe situation, as well as the reduced work amount due to weeding were expressed frequently as an influence on adaptation. Another driving force of change was and is the need of alternatives, which is observed by some respondents. Furthermore, most institutional representatives found consciousness due to an open mind and some of them found the influence of society through receiving recognition reasons which increase the motivation for applying intercropping. The improved soil quality was expressed to be an important driving force as well. One respondent emphasized the high potential of agroforestry systems. The reference to the advantage of less needed herbicides was also mentioned at times.

Reasons for intercropping defined by **estate farming** representatives focused on economic arguments and included, by some respondents, the importance of cover plants having a big potential from an economic and ecological point of view. Many advantages that favour the development of rubber were pointed out. Another point mentioned by

few representatives was that if there is proof for profit then there is a general openness for future application.

From the perspective of smallholders, many used economic reasons for intercropping, closely followed by social ones. Better income, already existing initial intercropping experience and the preference for attempting intercropping with wood trees in case of long-term intercropping implementation were frequently mentioned. Further importance for the majority of smallholders in applying intercropping systems was the personal attitude related to nature perception, self-sufficiency and the willingness of taking advice, which was strongly dependent on the sympathy related to the advice giver. More frequently mentioned points from many respondents with regards to the motivation to apply long-term intercropping were that the need for it must exist, farmers should be ecologically aware and the profitability should be visible, for example, by looking at it as a deposit for the own children. Restricted to initial intercropping, a majority of smallholders said that the trust into this system exists, since there is already a lot of experience, which provides security and that this is preferred to long-term intercropping. Some respondents were open to further initial intercropping application. Some smallholders saw that ethnic origin could favour sellers, depending on the location, as a point that speaks for intercropping. The advantage of suppressed weeds was mentioned by few respondents, whereas it was said by many institutional respondents that connected this aspect to less work.

4.2 Natural undergrowth

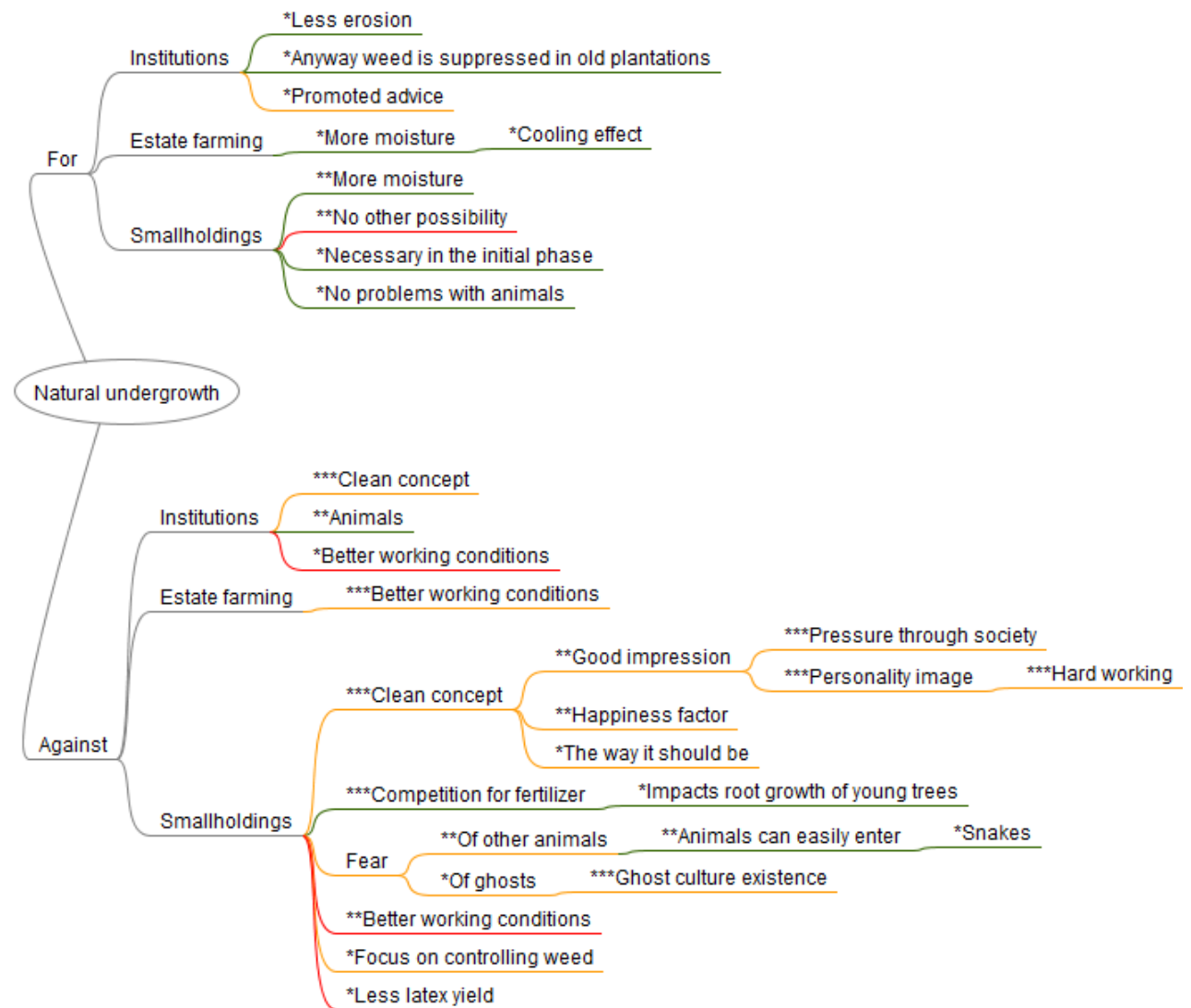


Figure 46 Most frequently mentioned reasons for and against leaving the natural undergrowth of all stakeholder respondents (Relation of frequency of arguments: ***= strong; **= middle strong; *= slightly stronger than unmarked; Category: yellow=social; red=economy; green=ecologic/agronomic)

4.2.1 Reasons of removing the natural undergrowth

Reasons against leaving the natural undergrowth overwhelmed in number those that spoke to retain it. Reasoning to remove the natural undergrowth was extremely similar in all stakeholder groups in regard to the importance of having a clean plantation, and the perception that to have something clean is a good concept. Estate representatives related this perception to good working conditions in order to provide an attractive environment for the employee, whereas smallholders saw this to be important in order to

provide a good impression towards society, which itself is a measure for this perception to be right. This makes it an unofficial rule with an assumption that it should be like this. Furthermore, it is seen to be related to personal happiness. The image of being a hard-working and disciplined person is motivating for all representatives and goes through all social groups. All in all, results show that the perception of a trimmed natural undergrowth being good and safe is strongly defined by and integrated in the society. Therefore, social pressure plays a big role for weeding purposes. Moreover, animals as a disturbance factor are categorized here, since it was mentioned more frequently as a reason against leaving the undergrowth, with a strong reference to snakes. Ghost beliefs, which is strongly integrated in the Malaysian culture promote the natural fear of humans in an obscure environment. Ecological/ agronomic argumentation generally found medium attention. However, smallholders strongly referred to the competition of fertilizer, its loss to weeds and the resulting impact on the growth of young roots. This is one of the reasons that herbicides are seen to be necessary. Even though economic reasons found the least attention in number, the advantages gained a strong consensus of improved working conditions and the profitability of applying spot, row or blanket spray. Regarding the last aspect, the application of herbicides provides a strong economic advantage compared to cutting, which explains this management decision. Moreover, small farmers were concerned about decreased latex yield. This lead their focus stronger into a rubber favouring management, for which controlling weed is a very important management point.

4.2.2 Reasons of leaving the natural undergrowth

Reasons to keep natural undergrowth showed a similar picture in argumentation. One deviation, however, was a slightly higher focus towards social aspects of institutions. All three stakeholder groups were aware of ecological/agronomic benefits and targeted those in order to advocate natural undergrowth. The knowledge about more moisture that is kept in the system was the main reason for smallholders and estate farming participants. Institutional respondents argued mainly with the advantages of reduced erosion and weed that is suppressed anyway in older plantations, which makes it needless to think about removing it. Economic arguments were not given much attention by all stakeholders, although smallholders partially have to maintain the undergrowth due to a lack of time and management effort possibility, which is the same reason for estate farmers to only remove it if necessary. Few smallholders referred to the ecological

necessity of leaving it to some extent in the initial phase. Furthermore, social aspects gained nearly no attention by the respondents, with exception from the representatives of institutions, who referred to their promoted advice of leaving two feet high natural undergrowth. Moreover, it was visible that arguments for leaving natural undergrowth did not receive much attention.

Smallholders and institutional respondents did not see a point in thinking about this issue since it is handled by nature and is less about an own choice. There are not many reasons for the farmers to leave it. However, economically a removal is not always possible for small farmers. For this reason, it remains and is nearly never completely cleared up, sometimes even very wild in the so-called “slaughter tapping”-style. The perception of the small farmers is that it should be removed, despite the evident ecological advantages. However, this is only partially done, due to of additional work, time and effort.

5. Discussion and a critical reflexion

5.1 Understanding of other perceptions

Sometimes there is a gap between scientific research and the perception of farmers. This leads to misunderstanding and communication problems and creates an unsafe initial position for adaptation. More collaboration is desirable instead of individual projects crashing on cones like bowling balls.

For agricultural adaptation it is necessary to understand the situation and the perception of those who are supposed to implement them, since the perception often differs from researchers to farmers (Douthwaite, Manyong, Keatinge, & Chianu, 2002; Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis, 2014). Studies showed that scientific work failed in the applicability of agricultural technologies due to a lack of not taking the perception of the farmers into account (Sood, Paul, Head, Sood, & Mitchell, 2004), which lead to misunderstandings.

Overall, it became obvious during the investigation that there are similar arguments in terms of intercropping and natural undergrowth by all three representatives of stakeholders, which was also observed in other studies (Jassogne, van Asten, Wanyama, & Baret, 2013). In this study, the similarity in particular, was based on the overwhelming arguments against applying intercropping and retaining the natural undergrowth. Nevertheless, differences within the stakeholder groups also occurred. Understanding the perception and preference as precisely as possible gives a good foundation for communication, understanding and implementing new technologies (Douthwaite et al., 2002; Meijer et al., 2014).

5.2 Perceptions of intercropping

Reasons given against intercropping are overwhelming compared to those that speak for it. Social reasons against intercropping found a high attention closely followed by economic reliability, with exception of the estate farmer who focused on the economic aspects. The social arguments though, have a different background in explanation. Estate farmers were mainly referring to a **lack of interest**, whereas for smallholders and institutions (who often argued similarly, due to a closely connected working environment and strong communication) keeping their **traditions** is significant, as it was also observed by others (Jassogne et al., 2013). In regard to the disinterest of estate farmers it is investigated that the probability of a sustained adaptation increases with

the farm size (Nnadi & Nnadi, 2009), showing the potential of a sustainable changed system once the adaptation took place for farms on a big scale. Next to the preference of having a traditional fruit yard, small farmers often prefer a separated cultivation of rubber for keeping it in focus. The concern of an **impact** on the main culture, which is also connected with this preference was observed in a coffee-banana intercropping system in Uganda as well (Jassogne et al., 2013). Furthermore, the preference of keeping fruit yards, here as so-called home gardens (approximately 41 percent of the respondents) instead of planting intercropping systems (approximately 31 percent of the respondents), could also be seen in agroforestry systems in Panama (Fischer & Vasseur, 2002)

Contrary to a research study (Jassogne et al., 2013), and despite limited land space, in particular in Peninsular, Malaysia (*Rubber Plantation & Processing Technologies*, 2009), interviewed small farmers do not feel **land pressure** on small scale farms. For them there is no sense in making the management more complicated if land is available and more easily managed. Coffee-banana intercropping smallholders in Uganda have an additional food supply as a motivation for mixed systems (Jassogne et al., 2013), whereas it is not motivating for small farmers in Malaysia, since they have separated fruit yards and no concern about **food shortage**.

Institutional representatives referred strongly to a lack of trust, due to failed projects and negative experiences, as an obstacle to continue or try these practices again, which is strengthened by another example (Jassogne et al., 2013). This leads to the following statement that profitability is important for the majority of the farmers in terms of a decision for intercropping, which is confirmed in further cases (Nnadi & Nnadi, 2009; Rajasekharan & Veeraputhran, 2002). Connected to this was the risk that comes along with insufficient proof for success, which was, in particular for long-term intercropping seen as a barrier. One of the problems is that the economic security is not transparent for the adaptors (Glover, Sumberg, & Andersson, 2016). The lack of secure and transparent economic profitability was one of the main reasons for failed intercropping projects with rubber in Malaysia, which led to mistrust and rejection of further adaptation, which is also seen in another example (Jassogne et al., 2013). On the other hand, nearly all representatives referred to **financial aspects**, when advocating intercropping. Frequently, smallholders referred to the need of initial intercropping. Initial intercropping, before the main crop is harvestable in order to overcome the lack of income, is applied also in other regions (Jassogne et al., 2013). The institutions and

the smallholders saw improved income, existing economic proof due to available experience and reduced risk as reasons for initial intercropping. The perceived advantage of reduced risk and improved income were not only a motivation for smallholders in Malaysia (Jassogne et al., 2013). Furthermore, initial intercropping is applied, due to having less work for weeding. The decreasing amount of appearing weeds was also outlined in another case (Jassogne et al., 2013). Furthermore, weeding takes 25% of total immature cost into account, which could be decreased by occupying the land by other plants (*Rubber Plantation & Processing Technologies*, 2009). Small farmers are aware of ecological/agronomic and economic advantages of initial intercropping due to their experiences for what they also apply it, if they need it. Initial intercropping is applied, either through renting or self-application, but at times also just ignored due to other job opportunities. Simultaneously, financial aspects are the main motivation for long-term intercropping for all farmers. The lack of access to investment possibilities and capital was said to be a problem for the application of intercropping (Jassogne et al., 2013), which is one of the obstacles for growing cover crops in the initial phase or planting crops for long-term intercropping for smallholders in Malaysia. As in another case study (Jassogne et al., 2013), the perception differs from smallholder and institutions who try to minimize risk to estate farmers who are orientated towards a maximized latex production.

Market availability is an important aspect (Zubair & Garforth, 2006). Market failure was at times mentioned from respondents in this study to be guilty for failed intercropping projects in Malaysia, as it also happened with agroforestry projects in Panama (Fischer & Vasseur, 2002). Therefore it is recommended to carefully investigate and communicate market information to the farmers (Zubair & Garforth, 2006).

Incentives for long-term intercropping are **suggestions**, for instance to plant durian, mango, rambutan and cocoa with described examples on planting patterns, which are accessible through a MRB publication (*Rubber Plantation & Processing Technologies*, 2009). It should be considered that one respondent of the smallholders said to read the book recommendations. Furthermore, advice taken is strongly influenced by sympathy and trust, which were expressed to exist for smallholders towards MRB and RISDA. This phenomenon of trust and relationship influencing the acceptance of advice is observed also in another study (Swol & Snizek, 2005). This includes the potential to overcome mistrust of intercropping systems due to negative experience and shows that implementations for smallholders might include working together with those

institutions. The willingness to accept institutional advice shows that it is possible to introduce alternative management of smallholders through an institutional way. Furthermore, smallholders also apply initial intercropping because of trust in the system due to experiences with it, which might signify that once positive experience is gained, further projects could face less inhibitions.

Personal attitude is seen to be important in terms of applying intercropping. Similar to this, it was observed that adaptation is influenced by the personal character (Krause, Uibrig, & Kidane, 2007). Smallholders advocated initial intercropping due to increasing self-sufficiency and happiness. A study in Tanzania observed that there was a low tolerance of waiting two years, before receiving benefit from the system (Matata & Ajay, 2010). This could be connected to the impatience that was expressed by respondents of this study about long-term intercropping, in particular in terms of return through timber. Otherwise, an easy going attitude of smallholders is said at times and is underlined by the statement that adaptation of modern technologies is slowly (*Rubber Plantation & Processing Technologies*, 2009).

Pressure from **society** and the desire for recognition was identified as an important factor for many respondents in their decision. Similar results were seen, in particular in family members, owners, fellow farmers and village elders influencing the decision of growing trees in Pakistan (Zubair & Garforth, 2006). If the system is socially accepted and highly recognized, farmers might be motivated to receive this acknowledgement (Zubair & Garforth, 2006).

A largely common point of view is that **ecological consciousness** is seen as a motivation for long-term intercropping. Described as ecological friendliness this revealed importance for intercropping application in another study as well (Nnadi & Nnadi, 2009).

Even though farmers are aware of ecological/agronomic advantages, these are neglected by all in the decision. This shows that other advantages must be visible for farmers in order to adapt. **Animal** theft problems were expressed as a concern of many farmers. Similar perception of animals and people causing damage as an obstacle to plant trees was observed (Zubair & Garforth, 2006). In addition to loss and fear, animals, for instance monkeys, squirrels and elephants actively damage the rubber (*Rubber Plantation & Processing Technologies*, 2009). Pest problems were seen as a main disadvantage by 28 percent of respondents in an agroforestry study (Fischer & Vasseur, 2002). A reason against intercropping in another study was the concern of

having poor **soil conditions**, which make the ground unsuitable for intercropping (Jassogne et al., 2013). Contrary to this statement, institutions were focusing on the improved soil conditions through the application of intercropping. Furthermore, problems with diseases were also described by the MRB (*Rubber Plantation & Processing Technologies*, 2009), which increased the concern when mixed with other plants. Other frequently mentioned obstacles of intercropping were the worry about competition for fertilizer, which was the main concern of intercropping of farmers in another case (Jassogne et al., 2013), which would mean extra input and investment or a decreased yield. The latter is also seen in an agroforestry project in Panama (Fischer & Vasseur, 2002).

Alternative job possibilities reduced the willingness of smallholders for intercropping. This is seen as a possible explanation of farmers to focus on those activities in another investigation (Rigg, 2005). In this case study, an estate farm owner focuses on another business, a wood factory, which makes it unnecessary to focus on rubber intercropping. The consequence of **more work** as an aversion of implementation was observed also for an increased effort for organic technologies (Tiraieyari, Hamzah, & Samah, 2017), whereas it was mentioned by another study to be a main advantage in having less work through the combination of banana and coffee, due to less work for mulching (Jassogne et al., 2013).

In particular, in Malaysia, the location seems to be important towards selling possibilities for smallholders because of **communities**, due to a large variety of different cultures and middle-man necessities. Preference of buying products due to a certain ethnic origin, including the possibilities depending on the location, might be considered. A majority of smallholder respondents saw this rather negative than positive. Furthermore, the aspect of **contract intercropping** antipathy of estate farmers results in a restraint of leasing land in the initial phase. Those aspects could not be found to be considered in other investigations in a similar specific context, but was frequently mentioned in this research. This might be due to the high complexity, difference of all individual cases and impossibility to include everything.

Cover cropping was preferred by estate farmers due to the visible economic and ecological advantages. Several ecological advantages and an economic potential from mulching with cover crops were described in another study (Erenstein, 2003). This was said to be not applicable for smallholders yet, due to a lack of investment possibilities.

Small farmers in particular **prefer** cash-crop-initial to long-term intercropping and if respondents showed an openness towards long-term agroforestry they preferred wood to fruit trees. Beneath this study, it was observed that a combination of a **continuous and inconsistent** harvest was willingly applied (Jassogne et al., 2013). The **need** to plant an agroforestry was seen important in order to move people to actually doing it, as was similar observed by another (Rigg, 2005).

5.3 Perceptions of the natural undergrowth

Overall, the perception is that the disadvantages of weeds overwhelm the advantages (*Rubber Plantation & Processing Technologies*, 2009). Disadvantages and advantages are identified in the **publication** for official recommendations from the MRB (*Rubber Plantation & Processing Technologies*, 2009). The described advantage of more **moisture** that is kept in the system is perceived by the respondents. Erosion is another point (*Rubber Plantation & Processing Technologies*, 2009), which makes some undergrowth in the initial phase necessary. Even though the MRB recommends protective clothing for safety reasons while spraying (*Rubber Plantation & Processing Technologies*, 2009), it was said by respondents that this is hardly ever done. This shows, as the statement given by farmers that advice is given and accessible but only followed at times. Depending on increasing trust and the relationship (within other factors) between the advisor and farmer (Swol & Snizek, 2005) **recommendations** are taken. This is connected to the potential in distributing trustworthy information and promoting adaptation, which is assessed to be high in this case since the majority of small-holders mentioned to trust advice from MRB and RISDA, given frequent communication.

The concept of the institutions is not stated to be a **clean concept** (*Rubber Plantation & Processing Technologies*, 2009), which shows that they do not intend to have 100 percent weeding. However, the trend of a clean plantation is preferred by the majority of farmers in Malaysia, as it is also observed elsewhere (ABRAHAM & JOSEPH, 2016; Schroth, Coutinho, Moraes, & Albernaz, 2003). Estate farmers clean the plantation with cover or row spray, by hiring the weeding gang. This is important in order to create an attractive **working environment** for the employee (ABRAHAM & JOSEPH, 2016). Since nowadays working as a tapper on plantations is unpopular, it is difficult to find labour, resulting in **labour shortage** (Freske, 2013; Gouyon, 2003), thus raising the

significance for estate owners to remove natural undergrowth. One of the main obstacles for the implementation of organic farming (as an example for agricultural technology adaptation) was labour shortage, due to a higher demand for more work, which increased the dependency on foreign workers (Tiraieyari et al., 2017). Foreign workers have to be employed by the government for controlling purposes (Tiraieyari et al., 2017). Even though they are needed, the government makes efforts in creating more job opportunities for locals in the agricultural sector (Tiraieyari et al., 2017). Tappers themselves see good working conditions in a clean plantation and related this to good **colonial management** of former times. This positive link to colonial structures was also seen by other authors in terms of giving monocrop recommendations (Jassogne et al., 2013). A clean plantation is important for smallholders due to the thinking that it is “good” to have something neat. This unofficial rule creates social pressure, which can indeed heavily affect decisions (Zubair & Garforth, 2006). Moreover, it was connected to various aspects, such as increased **happiness**.

Many smallholders targeted the disadvantages of weeds **competing** with the rubber for nutrients and causing decreased yield. Moreover, competition for fertilizer was expressed to be a concern, as it is recognized by other papers as well (Langenberger, Cadisch, Martin, Min, & Waibel, 2016). On the other hand, another study indicated that competition in a mature plantation would not lead to nutrient deficiency (ABRAHAM & JOSEPH, 2016). The concern of having **less yield** through non-weeding techniques appeared within smallholders (*Rubber Plantation & Processing Technologies*, 2009). A study observed that a ten years no-weeding practice does not affect the rubber yield negatively (ABRAHAM & JOSEPH, 2016). Nevertheless, the most deciding factor was that there is no choice for many. Weeding is **costly** (*Rubber Plantation & Processing Technologies*, 2009) for which it is often sparsely applied by smallholders. Many do not have another possibility.

More reasons for explaining the aversion of natural undergrowth were fear of **animals**, in particular snakes, which is supported by a study that shows the frequency of snake bites in the Amazonian Brazil forest (Warrell, Paulo, & Theakston, 1912). There is also a fear of **ghosts**, due to a ghost culture in the Malaysian society (Nicholas, 2009), which influences the dislike of wild plantations. This fear is not always openly discussed since the ghost culture is sometimes seen to stand contrary to **religious beliefs**. Furthermore, cleanliness is connected to religious faith. There is no other literature describing this aspect.

The comparison between **herbicides and mechanical cutting** showed the preference of herbicide use of the majority. This is due to cost and time saving factors (*Rubber Plantation & Processing Technologies*, 2009), which makes it difficult for manual cutting to compete.

Beyond this, a study observed that mixed rubber plantations with the **integration of animals** could be beneficial (Tajuddin, 1986). Sheep would decrease the cost for controlling weeds by 21 percent (Tajuddin, 1986). Respondents of this study, however, emphasized a preference of separation and cleared-up looking plantations, which might be considered and change the implementation possibility.

Overall, controlling weed only applied to a limited extent by smallholders. Nevertheless, weeding is strongly preferred over leaving the natural undergrowth, although respondents are aware of the ecological/agronomic advantages.

5.4 Changing agricultural pattern - who to address for future adaptation approaches?

In Malaysia, planted area of natural rubber of estate farms counts approximately 53.000 hectares and of smallholdings approximately 1.195.000 hectares in 2007 (*Rubber Plantation & Processing Technologies*, 2009), which shows that most of the rubber area is still managed by small farmers.

The trend of changing agricultural patterns from small scale to **large scale farms**, which can be observed in different parts of the world, also in Southeast Asia, especially in land abundant regions (FAO, 2011), was also recognized by various respondents of the study. Furthermore, young people especially migrate to cities with a rapid urbanization and abandoned farmland (Xie, Wang, & Yao, 2014), which could result in a changed farm image of less traditional and more **graduated agrarian entrepreneurs** (Rigg, 2005). The increasing sustained adaptation rate that comes along with better education and bigger farm sizes was something that was observed (Nnadi & Nnadi, 2009). Many smallholders are old. Compared to **young** smallholders it is less likely that they will adapt to and, in particular sustain alternative agricultural systems (Nnadi & Nnadi, 2009). In this study, it became visible that the attitude of the young and educated farmers differ in particular in terms of economic importance and profitability to those of retired, traditional farmers. This indicates, that different farming systems should be addressed for implementations of sustainable systems.

Farmers might need to change from subsistence to **commercial agriculture** in order to invest into alternative systems to optimize production (Jassogne et al., 2013). Even though rubber production is commercial, smallholders put less concentration towards maximising profit than estate farmers do. This is often not possible for smallholders, due to a lack of capital, which is seen also as an inhibited factor for other smallholders to change an agricultural system (Jassogne et al., 2013). Future implementation for long-term intercropping approaches might address therefore mainly estate farming. With the right incentives and support, it might be also desirable for smallholders, in particular for young untraditional ones. This is important since the major rubber plantation area is still managed by smallholders.

Thailand is the largest producer and exporter for natural rubber and contributes significantly to the world's production (OEC, 2017; *Rubber Plantation & Processing Technologies*, 2009), which could lead to the assumption that investigation in alternative systems in Thailand might be meaningful for the future. This would again need an investigation on the perception of stakeholders in the rubber cultivation in Thailand, since settings strongly differ from each other and cause interventions to fail due to neglecting the needs of the farmers (Bernet, Ortiz, Estrada, Quiroz, & Swinton, 2001).

5.5 Opportunities for approaches

Understanding the perception is an important element in creating further policy approaches (Rajasekharan & Veeraputhran, 2002). This study might support them.

Currently, the institutions support smallholders in poverty with subsidies and give fertilizer to smallholders who are registered with RISDA for the first six years (RISDA, 2017). However, many of them buy additional fertilizer. Legumes could be an alternative possibility or substitute instead of fertilizer for smallholders, since it seems profitable for estate farmers. Institutions mentioned that cover crops are only applied from estate farmers and that it is not known if smallholders are aware that trees can be tapped earlier with the application of cover plants. However, it should be considered that a general preference of cash crops to cover crops exists for smallholders. Insufficient **financial support** by the government, due to the goal of maximizing production (Tiraieyari et al., 2017), is effective in not failing the market, but a main problem for small scale farmers with limited capital for implementation, in particular for long-term intercropping. Without financial support, many are not able to apply new technologies.

For **long-term agroforestry projects**, for smallholders, financial support to compensate the lack of capital, knowledge transfer, proof for the economic profitability and market investigation is needed. These should be oriented to the direction of preference of planting native wood trees. Long-term agroforestry systems might be interesting for estate farms as well. Beneath the last three mentioned factors above, for estate farmers the profitability must exceed a certain added value, otherwise the effort will not be worth it. High value timber, for instance for export could therefore be a possibility. This needs further research.

A participatory approach, such as **farmer field schools** (Nnadi & Nnadi, 2009) with a **model/pilot project**, which makes the benefits visible and trustable could be a driving factor for a change towards alternative systems. A lack of training in technical knowledge was an obstacle in implementation (Tiraieyari et al., 2017), which is also said by respondents of this study. Emphasized was long-term intercropping for which experience is missing. Using a demonstration project was assessed to have a high adaptation possibility, since it was said by many that visible experience is important. Another case mentioned that faster adaptation is likely if a technology is introduced in a pilot project to motivate farmers in need of it (Douthwaite et al., 2002). A possibility for implementation provides the already existing seminars of the MRB and RISDA, the so-called "Transfer of Technology".

Currently there is no **certification** system for rubber products (Gouyon, 2003). However, for timber and agroforestry large international certification programmes exist to get forest management certification (including timber or non-timber products), as for example the Forest Stewardship Council (FSC), including the non-given insurance for discrimination between products from agroforestry and monoculture (Gouyon, 2003). The Rainforest Alliance certification program could be a possibility, since they assess the biodiversity (Gouyon, 2003). A Malaysian organic certification program (Sijil Organik Malaysia) was launched in 2003 (Tiraieyari et al., 2017). From 2.000 small farmers in the Cameron Highlands, 13 land owners adapted to organic farming (Tiraieyari et al., 2017). The Malaysian organic certification process was criticized for being expensive, complex and taking long in execution (Tiraieyari et al., 2017). As a result, only a few farmers participated, despite their ecological awareness (Tiraieyari et al., 2017). Moreover, it is recommended to provide more assessable information and to facilitate certification process systems (Tiraieyari et al., 2017). Certification for small farmers is critical, since they often face a lack of investment possibilities.

5.6 Further research

There are not many studies that focus on how agricultural adaptation projects are perceived by farmers (Meijer et al., 2014) and even less for the perception on intercropping projects. Results differ considerably with aspects that could have a negative influence on adaptation in one case, whereas it could have a positive influence in the other (Meijer et al., 2014). This shows that it is difficult to generalize, due to a high complexity of context. People are different everywhere. Every situation for every project might get investigated carefully on the perception of the people who are involved in the implementation. This makes it more realistic to target the preference and conditions of farmers for a higher possibility of adaptation and sustainability (Meijer et al., 2014).

A high adaptation rate could be expected if the technology received a higher spoken value than the traditional gains (Nnadi & Nnadi, 2009). This shows the importance of ensuring the economic profitability and investigating the market carefully, with a particular reference towards long-term agroforestry projects including fast growing native wood species. Timber might be considered for export as well.

A focus on rubber intercropping in Thailand or oil palm intercropping in Malaysia, might be due to the so-called “sunset business” of rubber in Malaysia meaningful.

6. Conclusions

Even though it seems as though we are living in one world, there are many more within. Those differences are often underestimated, but are important to understand for compatibility. This recognisability of complexity and profundity in various perceptions is the conclusion drawn from this case study. Individuality as well as generalization are part of it.

The most important contribution of this study to the literature is the recognisability of including stakeholders' and in particular farmers' desires for reaching the aim of creating sustainable systems. The expressed perceptions show that it is unlikely to have wilder undergrowth as a desire of farmers at the moment. Initial intercropping will most probably sustain for small holdings, due to the need and suitability. Long-term intercropping agroforestry systems have a potential in terms of a combination with wood production but are still far from implementation. An openness towards this is often available, if the economics are transparent and risk-free adaptation is clearly demonstrated and proven. A first step therefore might be a model, which is designed in the existing possibilities of either an estate farm or a smallholder. Different stakeholders with different desires should be taken into account since it is an interplay and none exist on their own. Approaches for intercropping implementations therefore differ for estate farms and smallholders. Even if there are similar perceptions, a rubber plantation has another meaning for a "tradition-connected-smallholder", then for "striving-for-maximal-production-estate-owners".

Furthermore, an interesting result from this case was the importance of society driven influences. Unofficial rules are shaped through a general social acceptance. The perception is deeply rooted, which makes it difficult to ignore. Due to this enormous complexity, perceptions are impossible to understand completely. However, an insight, as provided here, is a necessary step towards mutual comprehension. An example for influencing factors are norms and beliefs, which influence decisions. These lead to influencing aspects, previously neglected in the literature, such as religious faith, ghost culture, or ethnic communities, which give individual colours to this context. A personal, emotional and traditional connection to the rubber trees, which are seen by many old smallholders as a pension system, is an aspect that explains, among other things, the preference of separating.

It can be learned generally from this case study that there is a need to understand others' perceptions for intercultural action and communication. Small farmers are experts in agricultural production and have reasons for acting the way they do. Understanding them might lead to the possibility to work together on implementing alternative agricultural systems. Without this fundamental understanding, sustainability approaches might have a negative impact on farmers, which would not be sustainable in the end. The question therefore remains if it would be better to not interact at all, since a lack of mutual understanding and egoistic motivations of international actors might create an inefficient and/or unfair environment in the end.

Overall, this study focused on the perception of farmers and other stakeholders closely related to the rubber cultivation. The results might serve to support more effective implementations or promotions for long-term agroforestry systems with a regard to the preference of the stakeholders. A focus should be paid to the one in the centre, which leads to the following conclusion:

(Small scale) farmers are the centre of agricultural production and can no longer be pushed out of this position and replaced by agricultural projects.

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Appendix

Questionnaire:

Aim:

This interview is part of a rubber research project at the University of Hohenheim. It aims to understand the perception of the natural undergrowth and additional integrated plants in rubber plantations. Although many studies already focus on this topic, rarely any papers exist that investigate the perception of stakeholders on this issue. In order to understand reasons for the management of farmers this interview is conducted. I highly appreciate your time and effort and I am looking forward, to learn something from experts in this area.

Signed documents for data:

All these data will be collected for research purpose. I will not use what you don't want me to use or write! I am going to additionally record the interview. With the sign of this document, you would allow me to write down the knowledge I got from you. Thank you for your cooperation! Please do not hesitate to contact me at any time.

Structure:

This interview is supposed to take around 1 hour. It will start with first general questions, coming to the main focus on intercropping and natural undergrowth in rubber plantations and will end with some space for open wished and suggestions from you side, what will give you the opportunity to say what haven't been said during this interview and you consider as important.

Guiding questions:

- 1) What is your background of cultivating rubber?
 - a. Did you always cultivate rubber and your parents as well? (a tradition?)
 - b. Would you like to continue growing rubber?
 - c. Will your children continue this work?
 - d. Is rubber cultivation your main source of income?
 - e. Are there additional sources of income?
 - f. Is rubber something like the income of retired people? Is it for you like this?
- 2) How do you plant rubber? Do you grow rubber alone, without other plants on the same area?
 - a. What are the reasons for this decision?
 - b. Will you continue this management? Would you like to change it?
- 3) What is your perception about planting rubber with different plants together on the same area of land? (Others?)

- a. What are the reasons for not planting more than one type of plant on the same area? (Why do other people not do it?)
- b. Would you say there are advantages in planting different plants on the same area? (Why do other people do it)
- c. Would you like to plant other plants together with rubber?
 - i. What kind of plants?
 - ii. Permanent or initial intercropping?
 - iii. Cash crops?
 - iv. Legumes and cover crops?
 - v. Watermelon, banana, papaya, chilli, ladyfinger, durian the sleeping cat
 - vi. Would it be profitable and easy to sell the intercropped plants?
 - vii. Easier to sell if you are closer to Kuala Lumpur or any other big city?
 - viii. Energy demanding, worth it?
 - ix. Management – difficult?
 - x. Quality of the intercropped fruits?
 - xi. Theft?
- d. Are there different tasks in terms of intercropping for men and women?
- e. Rubber and animals?
- f. Experience with integrated systems?
- g. How does it influence the distance to Thailand or KL? (selling, prices, transport...)
- h. What would motivate you for intercropping? (permanent and initial)

4) What do you think about natural undergrowth? (Others?)

How & Why?

- a. How do you handle it?
- b. What are the reasons for this decision?
- c. What kind of herbicides do you use?
- d. What kind of pesticides do you use?
 - i. How much do you apply and why?
- e. Do you apply it everywhere?
- f. Does this management cause also problems?
- g. What are the problems with leaving the natural undergrowth?
- h. Would you say leaving the natural undergrowth has advantages?
- i. Would you like to change the management?
- j. Are there different tasks in terms of weeding for men and women?
- k. Do you hire a weeding gang? Higher position then tapes?
- l. Do you have experience with other methods in handling the natural undergrowth?
- m. Is it important to you to have it clean?
 - i. What do you think if you see a clean plantation? What do you think about the owner? What do you think about an owner of a wild plantation?
 - ii. Is it important what other people or neighbours think and why?
 - iii. Do you think the plantation shows also the inside of the owner?

- n. Leaches?
 - o. What would motivate you to leave more natural undergrowth?
- 5) Is it important for you to maintain many different species of plants and animals on the plantation?
Why?
- a. Into what, in terms of management of the rubber plantation, do you put most effort in? (order please)
 - b. Why wouldn't you prefer to plant rice?
 - c. How does a good plantation look to you?
 - d. Is it important what neighbours think and why?
 - e. Superstitious/Ghost stories as an influence? (Are other people superstitious?)
 - i. Bananas?
 - ii. Hantu Raya (suddenly clean plantations)
 - iii. More ghosts/scary in wild plantations?
 - iv. Believes and traditions on the plantation?
- 6) MRB and RISTA. How do you get information from them?
- a. Does it influence you in management decisions?
 - b. The book published by the MRB, does it influence you in management decisions?
 - c. Do they check the plantations?
 - d. Is their recommendation or that one of the family more important?
- 7) Suggestions and wishes concerning rubber cultivation, natural undergrowth and intercropping.
- a. What do you think about the future of natural rubber?
 - b. What else is it you would like to mention, because it is important to you?
 - c. Any "rubber wisdom"?

Closed Questions:

- 1) Working Position of the surveyed
- 2) Age
- 3) Retired
- 4) Gender
- 5) Spoken languages
- 6) School graduation
- 7) Religion
- 8) Origin
- 9) Family size
- 10) Farm size
 - a. In total (ha)
 - b. How many ha is used for the rubber cultivation
 - c. Yield
 - d. Dry or liquid
 - e. Distance of trees
 - f. Are higher plants in between/ lower plants/ cleared
- 11) How many people work on the rubber plantation
- 12) Female representation in the rubber
- 13) Additional income sources
- 14) Age of the plantation
- 15) Location of the plantation
- 16) Place of living
- 17) Source of contact recommendation

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