



Rubber agroforestry Breeding Initiative for Smallholders (RUBIS)

A participatory breeding initiative for resilient rubber cultivation systems for smallholders in a context of global change

Synthesis concept note

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1 Introduction

The rubber sector in Indonesia: a critical context for sustainable rubber cultivation in Indonesia

Indonesia is the world's second largest producer for many years, with 3.4 million tons in 2017, representing 25% of the world's natural rubber production. Small family farms very quickly and spontaneously adopted this crop in the 1920s, reaching now 85% of the country's total area [30, 38]. In the 1960's some of the large plantations were nationalized to form the state-owned company "PTP" (PT Perkebunan Nusantara III). The State implemented concession policies promoting the development of oil palm in the 1990s, contributing to massive deforestation [13, 26] between 1990 and 2015. Over the last decade, natural rubber production has increased at an average rate of 2.4% per year, with a slight slowdown in growth since 2013. Meantime, rubber areas decreased as most jungle rubber plantations are partially disappearing replaced by clonal rubber and oil palm plantations.

Yields in Indonesia are reported to be lower than in other producing countries, mainly due to the use of unproductive material of trees in jungle rubber, the ageing of the trees and the competition with oil palm for replantation. BPS statistics mix up jungle rubber plantation with a yield of 500 kg/ha/year with clonal plantations (average yields between 1.2 and 1.8 ton/ha/year). Therefore the average yield generally presented for Indonesia does not reflect the reality of two types of co-existing plantations.

Industrial plantations represent only 14% of the area planted with rubber trees [16], but are decreasing in favor of village plantations, but also industrial plantations of *Acacia mangium* and oil palm trees. These industrial plantations are often owned by the state-owned PTP and/or local or foreign-owned private plantations (from China, Singapore, Indonesian etc.). Most private plantations are between 1500 up to 10 000 ha. Private areas can also be very large: 35,000 hectares for Michelin (Jambi and Kalimantan) and 24,000 hectares for Bridgestone, 16 000 ha for Goodyear in North Sumatra. The private plantations associated with smallholder plantations mainly follow the hybrid planting model called NES / PIR (NES = Nucleus Estates and Smallholders which has its Indonesian equivalent PIR = Perkebunan Inti Rakyat), i.e. an industrial plantation feeding a factory, with a crown of family plantations.

The possibilities to increase the area of industrial plantations are currently quite limited as the policy of concessions initiated in the 1980's under Suharto's area ended in 2015). Some private plantations may consider taking over concessions that have fallen into the public domain or planting in areas that are still untouched but difficult to access. Access to land is strongly dependent on policies, which are not as favorable to major concessions as in the past. In 2021, the Indonesian government does not wish to open new concessions, but it is not impossible that this will change in the future. GAPKINDO, the association of Indonesian rubber producers, has developed a policy to improve rubber quality in the 1990's. Actions to improve quality are implemented by private companies themselves with success [22].

In Indonesia as in Malaysia, the replacement of rubber by oil palm is encouraged by the governments [8, 61]. Indeed, if land productivity (Gross margin per ha) is higher for rubber (+40%) than for oil palm, labour productivity (Gross margin per man-day) is much higher for oil palm (+258%) [26, 61]. In addition, the return on investment is faster for oil palm. If the economic data presented do not change, this trend of replacement of the rubber tree by the oil palm is likely to continue.

2 The RUBIS project

2.1 Presentation

The RUBIS project combines all relevant new technologies in a bid to create a three-level paradigm:

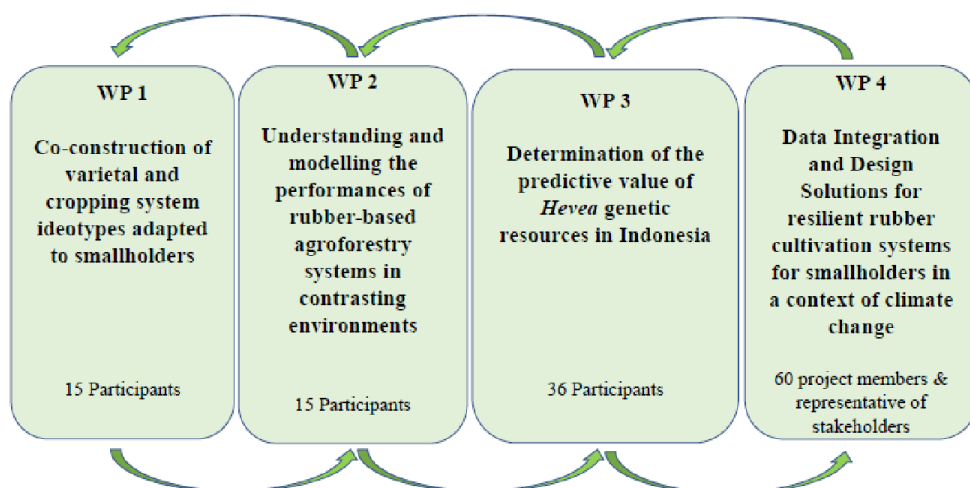
1. Breeding program for smallholder's plantations
2. Multidisciplinary approach integrating socio-economy analyses, modern technologies for the analysis and adaptation of complex cropping system facing fast-changing climate change
3. Participatory approach
4. Participatory science for agriculture-based solutions
5. Co-construction of solutions with stakeholders including national and local authorities

2.2 The objectives of RUBIS

1. Developing a network of stakeholders
2. Fostering the organization of smallholders
3. Providing knowledge from socio-economic, agronomic and genetic studies
4. Co-constructing solutions with stakeholders based on scientific and stakeholders' knowledge
5. Identifying new scientific questions
6. Offering a proof-of-concept for further regionalization in South-East Asia

2.3 Organization in WP (Working packages)

RUBIS Project Workpackages



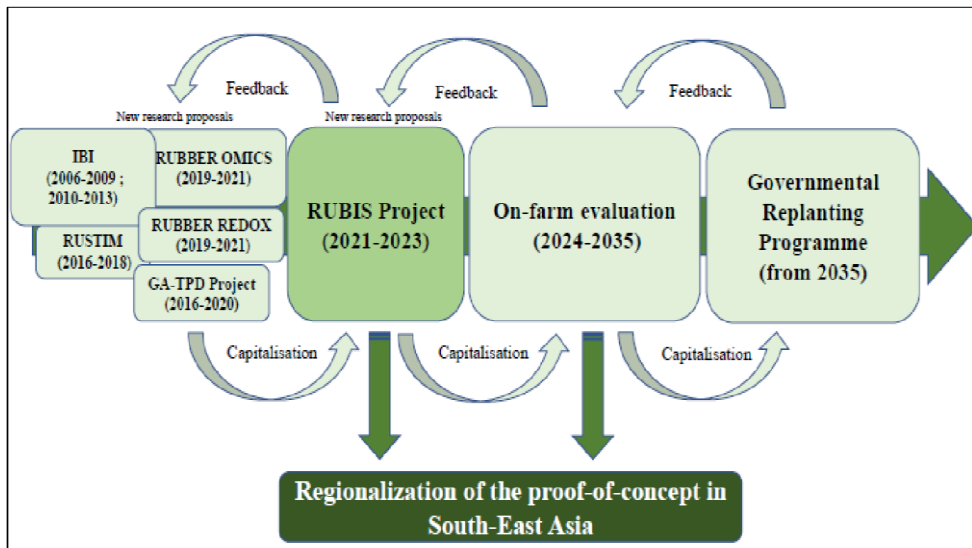


Fig. 1 and 2: the Rubis project

3 Main overviews about RAS

The presentation of Dr Meine van Nordwick and Gede Wibawa have shown a wide and broad overview of rubber place and role in the economy, in Indonesia and the main challenges of today's situation. Also some presentations of the workshop have presented a wider perspective with Land-use problems in Laos, AF in peat soils, RAS in Nigeria, policy issues in India.

Meantime, it is always interesting to compare situation and in particular countries with RAS: Indonesia, Thailand, China, Sri Lanka, India, Columbia... and also to try to understand why in some countries such as Cambodia, Laos, Vietnam, Malaysia, Guatemala, République de Côte d'Ivoire, Cameroon, farmers rarely developed RAS at large scale:

What do farmers expect from rubber agroforestry in terms of sustainability?

1. Income diversification (rubber , fruits , timber ...) for a better economic resilience
2. Agroforestry practices have so far according to farmers' opinions and surveys (SRAP) no impact on rubber production but potential impact in systems with reduced number of rubber trees. There might be an impact with double spacing systems and lower rubber planting density (400 instead of 550 trees/ha).
3. RAS are reservoirs of local biodiversity with a « forest effect » on climate if largely used in the landscape
4. Possibility to mitigate climate change...
5. Less soil erosion and better use of water
6. Soil fertility maintenance or improvement if soil is covered by weeds
7. rubber is generally already « bio compatible » requiring little chemical treatments
8. Better valorization of their production thanks to a future certification? This point is still questionable for most farmers.

Each context will generate an issue for specific RAS types;

1. Markets are triggering RAS types: for rubber and associated products.
2. RAS with products for self-consumption could be adapted as well in specific isolated situations
3. Rubber wood sales are essential to generate capital for replanting. Associated timber trees would also contribute...
4. Quality of rubber is an issue but not correctly priced

4 Session socio-economic of rubber-based agroforestry systems

4.1 The main socio-economics issues

Smallholders is the main rubber sector with 2.5 million of smallholders that account for 85% of NR production (3.1 of the total Indonesian area of 3.6 million ha). In 2021, 90% of these smallholders are non-organized farmers, however a new cooperative sector is emerging since the 2010's.

The main characteristic of smallholders' sector in the 1990's is the low domestic productivity due to high jungle rubber proportion of rubber area (almost 3 million ha) and low quality of planting material (seedlings in jungle rubber). In Indonesia, today's exact proportion of jungle rubber is still unknown: probably between 1 and 1.5 million ha partly converted to oil palm (probably 70 %) and new clonal rubber plantations (30 %), mostly outside development projects as SRDP/TCSDP ended up in 2002. Most rubber farmers have diversified their farming systems mainly with oil palm as access to oil palm planting material was offered to local planters in exchange of land within the concession accorded to private oil palm companies. Mostly, it was 5 ha given to the oil palm company and 2 ha of planted oil palm provided to farmers with full credit to be reimbursed. The "mirage" of oil palm has been a reality for hundreds of thousands of local farmers. Oil palm provided an alternative to the poverty trap for those relying on jungle rubber. Diversification occurs with progressive partial conversion of ageing rubber plantations (jungle rubber) to other perennial crops (oil palm, fruit trees,).

In 2021, the replanting of most old SRDP/TCSDP plantations is a real problem as these plantations reached the end of their lifespan. Income diversification, inside rubber systems such as RAS or inside farming systems with other crops is a key issue

Key objectives are;

1. Crop diversification inside RAS
2. Intercropping during immature period as temporary agroforestry practices
3. Rubber-based agroforestry practices during the mature period (fruit trees, timber).

4.2 Impact of the rubber price volatility

Since the early 2000s and until the financial crisis of 2008, the price of natural rubber has risen steadily, reaching a value of USD 3,000 per ton in 2008. At the beginning of the financial crisis, prices collapsed, then soared to a record high of USD 5,500 per ton in 2011 (Figure 3)



Fig. 3. Price of Natural Rubber (Grade SMR20) in Kuala Lumpur from January 2000 to May 2019 (Malaysian Rubber Board, 2019)

Then the price of natural rubber gradually declined to around 1,200 to 1,400 USD/t (FOB price for SMR 20) since 2015, leading to a 5-year period of low prices very similar to that observed in the period 1999/2006 with very similar constraints as today.

Rubber prices volatility has a significant negative impact on farmers' income for farmers relying mainly on rubber, and is a key element to understand current actors' strategies

4.3 Rubber and quality

Further, down the chain, processing plants are one of the main drivers of rubber value creation. For a long time, factories were integrated into industrial plantations. The model that is developing most today is that of independent factories in the middle of small producers' plantations. The factories then contract with the growers or traders to buy all or part of the production from them. Most companies do not internalize the entire supply chain but keep a few plants under their own management for the reasons mentioned above. Large manufacturers have very diversified policies on this subject.

4.4 Agroforestry practices and RAS (Rubber Agroforestry Systems) today

For a very long time in Indonesia, agroforestry was linked with jungle rubber and considered as a non-modern cropping system with no future compared to clonal rubber monoculture seen as the only way to modernize the rubber sector. The development of clonal rubber monoculture plantations for smallholders has been the key message of the government through the implementation of SRDP/TCSP and NES/PIR projects from 1970 to 2002. Meantime, in West Kalimantan for instance, an estimated 20 % of these projects farmers decided on their own to reintroduce agroforestry practices, mainly Dayaks farmers (according to B Chambon 2001) with up to 250 fruits and timber trees/ha (surveys results have been published in 1997). That was the base for the development of the SRAP research program in the 1990's (CIRAD/ICRAF/IRRI project) that tried to promote RAS through on-farm trials in Kalimantan and Sumatra (1994/2007).

Jungle rubber is now clearly economically obsolete and cannot compete in terms of margin/ha to oil palm or clonal rubber plantations as it is based on rubber seedlings. From

the 3 million ha of the 1990's, it remains probably today 1 to 1.5 million ha according to PBS statistics, which are not precise enough to separate clonal plantations from jungle rubber.

Most farmers have largely adopted clonal rubber but access to good quality clonal planting material remains today a major constraint in Indonesia. The proportion of farmers' plots with agroforestry practices is still unknown today. RAS are very limited in Sumatra and are probably more developed in West-Kalimantan.

Another important point is the profitability of agroforestry (AF). Budiadi shows that profitability was lower for AF than monoculture when other studies (Chambon, Penot and et al) showed the opposite with an average increase in margin/ha of 30 % in Thailand and Kalimantan. Other sources in India and Sri Lanka also show a significant increase in margin/ha for RAS.

The last point is the future of double spacing RAS types for smallholders. These systems are not currently developed but several trials were conducted by IRRI in Indonesia. Some other countries have established large double spacing plots in particular in China and Sri Lanka with tea. With regard to food security, the use of food crops in RAS emerges as a crucial question. Given Indonesia is not self-sufficient in rice, adaptation of rice varieties to AF systems was implemented by the Indonesian Centre for Rice Research. Studies have to be initiated to determine if there is an economic interest for farmers to grow in good conditions and high yield upland rice in double spacing RAS. IRRI will at least verify that it is technically possible to optimize such RAS type with adapted trials using as well adapted rice varieties. We still need discussions and possibly experimentations with interested smallholders about double spacing tree/crop rubber combinations that could be interesting for them.

5 RAS and agronomy

From the agronomic point of view, the first question people often raise about RAS is about the productivity of the plantation in terms of natural rubber yield by ha. Looking at broad data from Indonesia, one can say that RAS produce less rubber than mono-specific plantations (MS plantations). The presentation by F.Oktavia from IRRI showed that is mainly due to the use of seedlings instead of clones budded on stumps. When RAS are planted with improved high-yielding clones, they reach the same rubber yields than MS plantations, and even more. Esekhadé et al. also showed us that young rubber trees grew faster during the immature phase when intercrops are grown between the tree lines instead of natural vegetation or cover crops such as *Pueraria spp.* These results suggest that the benefit of RAS on the performances of the rubber trees can overcome the competition for resources (water, nutrient, light) they can induce on the first step. In some cases, the explanation is simple. In intercropping systems, trees can take advantage of the additional fertilizers the farmers brought to the intercrops. Several studies (like Andriyana et al. comparing Rubber-Bamboo association to a similar MS plantation) reported that this positive effect can be due to improvements of the soil properties (organic matter, macro-porosity). Indeed, according to Justes et al., sustainability and resilience of rubber plantations rely in the implementation of an agro-ecological management of the soil at the different steps of the life cycle of a rubber plantation, from the planting to the felling of the plantation.

Implementation of RAS raises questions on the way rubber plantations are designed and managed. Sahuri et al. showed us the benefits of the double row plating systems to extend the number of years intercropping can be practiced before the trees shade the ground. Double row can also be used for rubber – timbers association (Boulakia et al.). The presentation of Nazri about rubber forest plantation in Malaysia (which is not an agroforestry system) shed the light on the need to consider the balance between wood/timber production and latex production in the context of low and fluctuating price. Similarly, tapping systems must be

adapted to the constraints of RAS, especially in terms of labor requirement. In this situation, adoption of good tapping practices, such as reducing frequenting combined to ethylene stimulation (Aryani et al.), by smallholders is of the utmost importance.

Research on RAS should develop methods and tools to help design and evaluate RAS. In this respect, the Land Equivalent Ratio (LER) is a useful indicator to compare the productivity of a monospecific plantation to that of a RAS. In its keynote presentation, Van Noordwijk introduced a new version of the LER, called the Land Equivalent Ratio for Multi-functionality (LER_m) that includes an evaluation of other ecosystem services other than provision. Appropriate calculation of LER would need setting up trials to compare RAS with monospecific plantation and even the associated specie/crop alone. There are few examples of such trials in the literature. On-farm trials are possible but as stressed by Andriyana et al. the significance of their results is limited by the lack of repetition. In this condition, the use of soil-tree-crop model can be a solution (keynote of Van Noordwijk). Dorleon et al. showed that the WaNuLCas model (for f Water Nutrient and Light Capture in Agroforestry Systems) is probably one of the best simulation tool to study existing RAS or evaluate foreseeable alternatives.

Main points

1. Existing tools for a better knowledge on RAS: Walnucas, Land Equivalent Ratio (LER) for multifunctional land use...
2. Existing rice varieties tolerant for shade with losses varying from 15% to 35% depending on the varieties and light treatments.
3. Severe problems of white root diseases in former SRAP RAS plots in both Jambi and West Kalimantan (after jungle rubber or forest)
4. A real effect of fertilization during immature period : questionable for mature period, depending on soil/climate conditions
5. How to boost ecosystemic services of RAS?
6. Latex/timber trade-off for breeding
7. Double spacing: there is low adoption of this system except in Sri Lanka and China (rubber-tea). There is potentially problems with wind damage (may be adapted clones might be required), New trials at IRRI Sembawa and implementation of promotion plot in South Sumatra are implemented. IRRI reported that some rubber clones are more adapted to specific crops (sugar cane, banana and rice). Today, there is an interest for specific crop (chilli) id access to market (vicinity of Palembang and bid cities for instance ...

6 Rubber breeding

To date, rubber breeding has been devoted to promoting latex and latex/timber clones for monoculture. Apart from jungle rubber, RAS are established with conventional planting material not specially adapted to these systems. For that reason, intercrops should be adapted to rubber conditions. On the one hand, annual crops can be cultivated during the immature period when shading is not too high. On the other hand, intercrops should be adapted to the shading during the mature period.

The development of the double row system with wide spacing has been tried to generate sufficient space to maintain the intercrop cultivation during the immature period even for crops requiring sunshine. However, the sustainability of this system raises new questions in terms of the adaptation to competition for resources as well as the susceptibility to wind damage favored by the wide spacing.

This International RUBIS Workshop addressed the question of the necessity to have specific clones for RAS. Various types of new superior rubber clones have been produced by the Indonesian Rubber Research Institute, namely IRR 112, IRR 118, IRR 220 and IRR 230 with a potential latex yielding about 2.5 - 3 ton / ha / year. These clones were evaluated in large-scale clone trials and are currently recommended in Indonesia. IRRRI is also experimenting these clones for RAS at the Sembawa Research Centre and in on-farm trials. According to Sahuri and coll., some clones are well-adapted to the double row system with wide spacing. Clone RRIM 600 is also well adapted to RAS with a lower shading (60 %) compared to other clones. Interestingly, some Brazilian clones may have some advantages with small leaves and lower shade.

Beyond the promotion of rubber clones with canopy structure enabling intercrop cultivation, Eric Justes and collaborators showed that adaptation to climate change and agroforestry systems is a need. A diversified intercrop community addresses questions related to the competition for light, water, nutrients, etc. Socio-economic studies also revealed the role of income diversification. In addition to rubber and intercrop products, Vincent Gitz highlighted the role of rubber wood as an additional source of income. Breeding with multicriteria phenotyping calls for a strong interaction between different disciplines (breeding, agronomy, ecophysiology and socio-economy) to determine proper traits for RAS in order to make these cropping systems sustainable.

Genetic resources

1. Erosion of genetic resources (deforestation of the Amazon basin, difficulties to establish new collections and to maintain germplasm collections)
2. Difficulties for breeding adapted rubber clones
3. Quality of the planting material
4. Breeding for high-yielding and disease-resistant rubber budded clones for monospecific plantations
5. Replacement of jungle rubber with seedlings by rubber clones
6. Certification of budwood gardens and production of recommended budded clones

7 Rubber and other topics

7.1 Main points

The main points were:

1. Rubber triggers land use conflict in Laos (and Cambodia), as a source of inequity for some local actors.
2. Rubber is in competition with oil palm, gold/coal companies...that lead to a significative change in most existing land-use (in particular Kalimantan and Sumatra in Indonesia but also southern China).
3. Multiple forms of evolution do co-exists: can diverse land use systems co-exist as well? Estates vs smallholders, type of factory/smallholders association, contractualization etc ;.....
4. Rubber agroforestry is one of the planting patterns that is commonly found in Forest Management Unit (FMU) in Indonesia (case of Lampung Province). A particularity of forest policy in Indonesia
5. Promoting carbon trading scheme for natural rubber plantation as a potential way for having a better environmental conservation and sustainability
6. Building Institutional and Innovation Capacities for Enhancing the Socio-economic Impacts of rubber-based agroforestry systems In India and Sri lanka

7.2 Environmental issues

The “Jungle rubber” system was a fantastic system in terms on positive externalities, biodiversity conservation and globally environmental issues; however jungle rubber is today economically obsolete and cannot compete with clonal rubber, oil palm or other crop alternatives. The progressive but constant disappearance of jungle rubber to the profit of oil palm and clonal rubber monoculture raised the issue of the move to more conventional monoculture systems. Rubber production use very few inputs in particular with smallholders (fertilizers and pesticides) and can be considered generally as a bio-product. The environmental issues are the following:

1. Biodiversity issue
2. C stock
3. Soil conservation
4. Water conservation in soils
5. Reducing inputs (fertilizers and herbicide) in large estates
6. Adaptation to new leaf and root disease

7.3 Climatic effects

1. Fast-changing climate in specific areas (monospecific plantations, not adapted rubber clones, new diseases, etc.)
2. the different ecosystem services of various types of rubber cropping systems (carbon sequestration, biodiversity, soil erosion, etc.)
3. Risk to have non-adapted rubber cropping systems
4. Adoption of “good” agricultural practices
5. Quality of tapping,
6. Harvesting system (tapping, ethephon stimulation, upward tapping)
7. Low tapping intensity systems

8 The more global determinants for improving the Indonesian rubber factor beside RAS

8.1 Access to improved planting material and clonal improvement

Since the selection and dissemination of rubber clones was the subject of much work at the end of the 19th century, research has made it possible to propose new varieties that have a comparative advantage in terms of yield per hectare, compared to unselected planting material such as the one used in jungle rubber. At that time, the system that governed most plantations had allowed the rapid spread of the ten most planted clones to most countries in Southeast Asia. Today, varietal improvement could have two major objectives to improve yields and sustainability of production: resistance to disease and reduction of the immature period. It takes about 25 years to recommend new clones.

The main problem for smallholders for replanting, beside the choice of the right clones at the right place, is access throughout the country to good quality clonal planting and mainly through access of good quality clonal budwood gardens for nursery-men. Meantime, farmers need more information about new clones or those more adapted to RAS, climate change etc.

8.2 Tapping practices and techniques

Good tapping practices, and reduction of tapping frequency linked with stimulation could increase rubber production, or at least labor productivity and/or land productivity. At the industrial level, the conditions for good production is based on a planting density between 500 and 550 trees/ha. The same planting density is used by smallholders. Most RAS are based on the same “normal” planting density. The difference with smallholders lies mainly in the type of tapping practiced. The most common technique currently used is D2 6D/7, i. e. one tapping every two days, which requires a lot of work and even D1 when rubber prices are very low.

The main potential innovation is the adoption of new low tapping frequencies, namely the D3 or D4, i.e. one tapping every 3 or 4 days for an equivalent annual production linked with stimulation (the number of stimulations depend on the type of clone). There is, in Indonesia where it is not developed, a large reservoir of productivity in order to raise return to labor to a level similar to that of oil palm.

The most significant priority is also to boost adoption of good tapping practices through tapping schools for instance. Improving the quality of tapping can improve the duration of the productive life of the tree.

Globally, there is no pricing policy for quality and no real incentive for smallholders so far. Most factories have adapted the rubber process to adapt to low quality rubber raw material.

9 Session: Agroforestry, food crops and food security

The main points are:

1. There is no possible pricing policy as rubber price is not controlled by producers. Therefore RAS appears as a viable alternative for income diversification and maintenance
2. Impact of Standards? Impact certification in relation with the rubber value chain.
3. Renewable products: RAS & wood? latex - timber clones?
4. Food crops and fruit trees (breeding of adapted rice varieties to shading). Questions related to water and nutrient competition

10 Session: Ecosystem services and Environment issues

The main point are:

1. Biodiversity, ecosystem services (externalities for socio-economists because smallholders are considered to not be aware about it)
2. Climate change: resilient cropping system (RAS vs monoculture)
3. Erosion of genetic resources especially on rubber with regard to other crops

10.1 Rubber and Biodiversity

Rubber plantations are less rich in terms of biodiversity than natural forests (like all other commodities such as coffee coca...). Thus, forest degradation or deforestation causes a loss of biodiversity [40, 28, 53]. In addition, the development of industrial plantations increases the hunting pressure on animal biodiversity in non-degraded forest located in periphery of the plantation and can disturb wildlife corridors used by primates or elephants [51].

However, the impact of rubber plantations expansion is different in relation of (i) the previous land-use and (ii) the cropping system. Rubber plantation in agroforestry can have a positive effect on biodiversity [26, 55, 40, 54, 28]. Indonesia was historically the country where jungle rubber was developed at a very large scale and still remains in 2021 with a minimum of 1 million ha however it is disappearing very rapidly. In most other countries such as Malaysia and Thailand, jungle rubber disappeared very rapidly after the 1950's as local governments did develop large development policies based on the use of clones.

Therefore, the development of RAS is today the only way to restore partly at large scale part of the biodiversity. Biodiversity conservation is not a priority for most smallholders and even generally considered as a positive externality. But de facto, most smallholders do consider biodiversity as part of the system right from the beginning as a provider of eco systemic services that contribute for an easier exploitation of rubber and long term stability and resilience compared to monoculture. Such trend is more visible in Kalimantan with Dayak farmers (as shown by exploratory surveys in Sanggau area with former SRAP/SRDP farmers) (Penot, 2021) than in Sumatra with Malayu farmers. The analysis of the evolution of former SRAP plots in Rantau Pandan/Seppungur (Ratna 2021) show clearly a lack of interest for agroforestry in a context of strong pressure of the oil palm industry.

The most important points are the following:

1. Existing trade-offs between biodiversity value, ecosystem function and rubber-based livelihoods.
2. how agroforestry practices can help support biodiversity long into the future ?
3. Timber have a future in RAS: Teak and *Dalbergia* spp (Cambodia), Mahogany (Thailand), tembesu, Nyatoh, keledan... In Indonesia, it could be developed for both sales and self-consumption for housing.
4. Biodiversity contributes to eco systemic services in the long run

For most smallholders, biodiversity is always interesting for at least 3 main reasons:

1. providing other products for sale or self-consumption that contributes significantly for local population to satisfy economic as well as other needs (medicinal plants, timber for housing etc ...) of livelihoods.
2. providing eco-systemic services that contribute to a better resilience of the cropping system : and that is generally not an "externality" (as considered by external economists) but as a full component of the system right from the beginning and part of the strategy to reduce costs and uncertainty.
3. providing as well positive advantages such as control weeds, less weeding in the inter rows etc ... that limit maintenance costs. In Kalimantan, RAS developed by SRAP reduces maintenance costs of 30 to 50 % for the first 5 years.

10.2 Rubber and climate change

There is a lot of uncertainty about the effects of climate change on NR production in the future

1. Economically speaking, RAS are reported to contribute to the resilience of rubber smallholders by diversifying their source of incomes.
2. Ecologically speaking, there are less evidence that RAS are better adapted to climate change than traditional monospecific plantations.
3. there is a need to design agro-ecological practices for the sustainable management of rubber plantations that will be adapted to climate change and contribute to mitigation.

11 Conclusion

Proposals for RAS in the very next future

1. the strategy is to promote rubber agroforestry with reducing the number of rubber trees per hectare and planting more commercially interesting trees, such as fruit or timber species (Suyanto).
2. Rubber is profitable in the long term: RAS with normal planting density (fruits/timber +++) has a key role in most rubber areas and are easy to implement (Penot,2021).
3. Intercropping in immature period is key for poor smallholders or those with limited land but can be limited by labor availability...
4. What is the future of double spacing RAS for smallholders? Double spacing RAS have a potential interest in specific economic context.
5. What is the future of RAS in rubber plantations with hired labor for tapping? Impact of the labor contract on the adoption of RAS
6. What future for timber production in RAS?

Other factors to consider beside RAS

1. Main impact of oil palm in Indonesia
2. Low price decrease interest for rubber
3. Labor availability may be a constraint for the adoption of RAS
4. Rubber still planted for income diversification
5. Same problems in Indonesia as in the 1990's: poor access to clonal planting material, no training on tapping frequency and AF practices: large possibilities of productivity increase beside agroforestry practices...
6. dissemination of technologies is still a problem
7. Still large reservoir of productivity (labor) if use of stimulation and reduced tapping frequency: D4 or D6 will create a return to labor close to that of oil palm.
8. High development of monoculture with no RAS in booming rubber countries (Vietnam, Cambodia, China, RCI etc ...)
9. Rubber price volatility has a major triggering effect on local farmers' strategies and income diversification within rubber systems or within farming systems is becoming a priority for most smallholders.
10. Markets for associated products are essential (timber, fruits, shadow tolerant plants, spices, gaharu, bamboos).
11. Still many research questions on agronomy , biodiversity, externalities and eco systemic services
12. Knowledge and know-how for AF practices are very diverse according to countries
13. Dissemination of technologies (AF and non AF) is still a problem in many countries
14. Identify the best-bet AF technologies according to local contexts and markets to boost AF adoption: need of OFT (On farm trials), demo plot networks and Farming system reference network to monitor changes...
15. Socio-economic surveys to be implemented everywhere to record farm trajectories , technology adoption , innovation processes and evolution of local constraints
16. The set-up of local Innovation platforms (IP) with producers, processors, tyre industry, research, extension and administration could help in boosting AF adoption.

Key messages

The key messages concerning Rubber production in Indonesia are the following:

1. Rubber production and planted areas are sharply increasing for one decade in the world. Smallholders are responsible of most of the production (85%), but industrial plantations are not negligible, 15 % in Indonesia. In Indonesia the rubber sector is in transition with the disappearance of old jungle rubber to the profit of clonal rubber plantations and oil palm. The production level is maintained as Indonesia is the second largest rubber world producer but rubber area decreases. Yield increases as more clonal rubber replaces ageing jungle rubber.
2. Rubber is facing fierce competition from oil palm in terms of land and labor allocation due to difference in productivity. We can speak about an “oil palm/rubber complex” with many areas with both crops in competition but sometimes also in complementary situation
3. In order to ensure sustainable development of the rubber sector, still in expansion, public authorities should be more involved especially by supporting smallholders (access to clonal planting material, tapping quality and techniques....), contract farming, and promoting and improving diversified systems such as agroforestry.

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List of communications of the workshop