# *Abstracts of LMI-LUSES*

# Impact of agricultural practices on soil biological functioning in Rubber tree plantations

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Perennial crop plantations expend quickly in South-East Asia, stimulated by a rising demand on their deriving resources. Rubber plantations lead to an important land use changes over ecologically fragile areas in the North-Eastern part of Thailand. In this context, the sustainability of these tree plantations remains questionable. In this study, we hypothesize that more sustainable agricultural practice could buffer the adverse soil ecological conditions find in the NE Thailand. We measured the occurrence of three major groups of soil organisms (macrofauna, nematofauna, microorganisms), submitted to a gradient of intensity of land management practices. These 3 groups are considered as reliable bio-indicators of physical or chemical perturbations induced by agricultural practices. Sampling was made on 12 representative plots in Khon-Kaen region, that have shown similar pedo-climatic statements, within (i) two levels of agricultural practices intensity, high (with intercropping, mechanical weeding, pesticides) and low, and (ii) two different plantation's age , (immature <5-6 years old, mature > 6-10 years old). Mature plantations with low practices' intensity was characterized by a significant increase of soil engineers' density (termites, earthworms) and activity (earthworm casts, skeletonized litter). High intensity of practices tends to homogenize the structure of soil macrofauna community. Bacterivorous nematodes were the most dominant trophic guild in immature high managed plantations, contrasting with fungivorous which dominates in mature low managed plantations. Substrate induced respiration showed more microbial activity in mature low intensity managed plantations. Interestingly taxonomical index such as Macrofauna taxa's richness or evenness were not impacted neither by plantations' management nor age. Functional diversity seems to be distinguished the high and low agriculture practices while metabolic profile seems to be distinguished the age of the plantations. These first results clearly show the positive impact of more sustainable agricultural practices on soil biodiversity in rubber plantation. It's also demonstrating a long lasting effect of intensive practice in immature stage on soil biodiversity and activities in rubber mature stage. Another interesting result originated from this study is that functional index of macrofauna activity (ex: cast density), nematofauna (trophic affiliation) or bacteria (metabolic fingerprint) seems a much better indicator of soil perturbation, than ecological index based solely on taxonomical affiliation. Identifying functional groups in different taxa able to respond differently to a range of stress, constitute a promising approach in soil ecology.

***Keywords:*** *Rubber, ecosystem sustainability, land management, soil biodiversity, soil fauna, nematodes, microorganisms*

# Impact of rubber plantation on soil biodiversity

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Compared to other world areas, SE-Asia is characterized by the rapidity of the agrarian transition. Rubber plantations illustrate this paradigm as they are replacing other farming systems such as traditional subsistence agriculture or commercial crops (e.g. cassava or sugarcane) in the Greater Mekong Subregion. Despite the importance of this agricultural shift, the environmental and ecological consequences of this land conversion remain unknown. Our study investigated the impact of the land use transition from cassava (as a model of an annual crop) to rubber trees (as a model of a perennial crop) on the soil biodiversity, which deliver key soil functions such as nutrient cycling and organic matter degradation. The main question of this study was to determine how land use change and plantation age affects and drives the soil microbial compartment. To address this question, we selected a rubber chonosequence of four different ages (1-3, 5-7, 9-12, and > 23 years old) located 150 km East from Bangkok in Chachoengsao Province. An experimental block design with three replications was used along the chonosequence and compared with cassava fields as the previous crop. We investigated soil physico-chemical characteristics, soil microbial biomass (Substrate Induce Respiration, SIR), functional diversity (Microresp™), genetic diversity (high throughput DNA Pyrosequencing), and soil macrofauna (Tropical Soil Biology and Fertility, TSBF). The conversion from cassava to young rubber plantations resulted in a reduction of the overall microbial biomass, soil DNA and soil respiration rates, but did not affect bacterial and fungal genetic and functional diversity. The main driver of the changes in microbial community was the age of the plantation, as we observed a clear shift of all the microbial parameters investigated. Hence, old rubber plantations (> 23yr) harboured a more active microbial community with a higher biomass than younger plantations. Interestingly, this microbial community was metabolically more diverse than that of cassava plantations. Multivariate data analyses showed that soil of old rubber plantations represent, in terms of diversity and metabolic capacities, a highly specific microbial environment in comparison to the others plantations ages or land use. The following phylum: Firmicutes, Verrucomicrobia, WS3 and TM6 were mainly associated with older plantations, while Cyanobacteria, Gemmatimonadetes, Proteobacteria and Actinobacteria phylum characterized cassava and young rubber plantations. This first study of the soil microbial community in rubber plantation demonstrates: (i) a highly selective evolution of the microbial community along the age of the rubber plantation,(ii) that land use change (from cassava to rubber) affected only the metabolic activities of the community but not its genetic diversity. This high specialization of microbial community diversity and function in older rubber plantations represent a potential problem for soil sustainability.

*Keywords: Hevea brasiliensis*, tree plantations, perennial crop, Bacteria, fungi, metagenomics, microresp™, soil physiological profiles, cassava

# Impact of Long Term Rubber Plantation on Soil Functioning

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Forests are the most important repositories of terrestrial biological diversity. Severe disturbances on forest may generate permanent and irreversible shifts if those disturbances reach a critical threshold (Lawrence *et al*., 2008). Since 2009 to 2014, forest encroachment in Thailand have found at 34,500 hectares each year which mainly caused from the rapidly increased of rubber plantation area (Royal Forest Department, 2015).The general objective of this study is to assess the long term impact of rubber monocropping on soil sustainability with specifically focuses on the impact of soil biodiversity and related functions. We studied on the impact of successive rubber tree rotations (1st rotation / 2nd rotation / 3rd rotation) in Bannasan district, Suratthani province, Thailand. Within each rotation, we distinguished and sampled both in young plantations (3-6 years old) and old plantations (18-22 years old) and compared with the forest. Results were revealed that after 50 years or second rotation of rubber monoculture affected soil fertility and biodiversity. While, the organic matter concentrations and cations content obviously decreased after the deforestation. Deforestation also significantly affected total macrofauna abundance with a decrease of nearly 50% of total individuals. Long term impact of heveaculture on nematofauna is detected in the old stage of third rotation with a reduction of richness characterized by a loss of 6 taxonomical families. And the continuous loss of microbial biomass and basal respiration were found along the successive rotations.

*Keywords: rubber, monocropping, deforestration, sustainability, fertility, biodiversity*

# Dynamic of litter degradation and soil fauna assemblages along a chronosequence of rubber plantation

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Litter degradation plays a critical role in nutrient cycling and carbon storage in soils and constitutes an important issue for soil sustainability. Despite the economic importance of rubber and ecological relevance, litter degradation has not yet been studied in this agrosystem. Litter degradation depends on plot scale mainly on two factors: the activity of soil macrofauna and litter quality. The aim of this work was to determine the respective importance of these two drivers (litter quality versus soil fauna composition) on litter decomposition. We set up a litter bag experiment in a chronosequence of rubber plantations in Chachengsao province. The chronosequence was constituted of different plantation ages (6, 15 and 25 year-old) with 3 replicates by age. To determine the impact of soil fauna on litter decomposition, leaf litter was put in litter bags of 2 mesh sizes: one excluding macrofauna (2 mm) and one allowing macrofauna (10 mm). To determine the effects of tree age on litter quality, we characterized the litter composition at 2 different tree ages. To determine the effect of litter quality on decomposition yield, we did a transplant experiment of litterbags between 6 and 25 years old plantation. . Litter decomposition was followed during one year by collecting litter bags every 45 days. The activity of soil fauna was also monitored using humus index. Soil macrofauna biodiversity survey was also characterized in forest patches, close to the plantations, used as a reference site. The results showed that decomposition yield of litter decreased with plantation age, but it was only significant with large mesh size. Litter of young rubber tree contains more labile carbon and less lignin than litter from old tree but this difference was not statically significant. However, this pattern seems to influence the yield of litter decomposition as litter decomposition was higher with young litter (6 year-old) than with old litter (25 year-old). In addition, we monitored a change of soil fauna composition and activities between young and older plantation age. Young plantations (6 year-old plantation) was more diverse and dominated by mesofauna activities (higher density of skeletonized leaves) while mature and old plantations were less diverse, dominated by termites and to a less extend by earthworms. Thus, soil fauna composition (switch from meso to macrofauna) is likely to be the main driver of litter decomposition in rubber plantation.

*Keywords: rubber, litter decomposition, soil fauna, litter quality*

# SituRespires: an *in situ*, rapid and cheap method to measure the soil $CO_2$ respiration

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Soil respiration is a key component of the carbon cycle. This $CO_2$ emission stands as one of the main pathways for the carbon moving from the ecosystem to the atmosphere. Different methods allow measuring these fluxes to assess the impact of a disturbance on the soil system. The technics used remains however expensive, time and labor consuming as well as sometime far from the reality as the soil is disturbed before analysis. In this study, we propose a completely open and cheap method, inspired by the MicroResp™ methodology (Campbell *et al.*, 2003), which measures the *in situ* fresh soil basal respiration. The SituRespires method is developed through (1) a calibration step, (2) a validation process by comparing the method with two other (Solvita and titration) and finally (3) an application in the field. Results of the calibration shows a strong link ($R^2$ = 0.95) between the $CO_2$ injected and the color change of the gel. The *In Situ* spectrophotometer can assess the $CO_2$ concentration reflected through the color of the gel. The validation part reveals a high correlation of between SituRespires and both the titration and Solvita methods over a wide range of soil characteristics (only preliminary results, titrations *still in process…*). The amount of $CO_2$ released from the soil respiration can be evaluated through the color change of the SituRespires gel. Finally SituRespires method shows the same trends as the Solvita results when applicate to a farmer plot field experiment in Phatthalung, Thailand. However, compared to Solvita methodology, SituRespires method is less variable and allows the discrimination of treatments not distinguished by Solvita. The SituRespires tool gives an integrated measure of the interactions between the soil physicochemical property and the biological activity. Soil carbon transformation function is thus described and can be integrated within a soil quality assessment framework.

*Keywords: Soil Basal Respiration, In Situ measurement, Soil quality*

# "BIOFUNCTOOL": A framework based on soil functions to assess the soil quality

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The assessment of soil quality is a concern that has been widely developed in the literature over the last twenty years. According to Karlen *et al.* (1997), the soil quality can be defined as the "the capacity of the soil to function". However, most indicators of the soil quality are based on the evaluation of soil characteristics rather than soil functions. This leads to some discrepancies such as the high productivity of some tropical soils despite their status of "poor soil" conferred by these indicators. Kibblewhite *et al.* (2008) proposed a theoretical framework to study soil functions related to the major ecosystem services. This framework underlines the need to consider the interactions between soil physico-chemical properties and its biological activity. Based on this concept, we aimed at developing a set of functional soil indicators to assess three central soil functions: carbon transformation, nutrient cycling and soil structure maintenance. We intend to integrate all indicators within the "Biofunctool" package, i.e. a set of easy, cost, time-effective *in situ* measurements to assess the soil functions. The Biofunctool package is currently being developed in the context of rubber plantations in Thailand. It will be then tested in a plantation network along a gradient of pedo-climatic and agronomic conditions. In each situation, Biofunctool measurements will be completed with soil biota diagnosis in order to better link soil functions and biological assemblages. The approach and outputs developed will be used to evaluate the impact of agricultural practices on agro-ecosystem performances and sustainability. Biofunctool framework will thus potentially complete existing one, such as the regional agronomic diagnosis (Doré et al., 2008) or the Life Cycle Assessment.

*Keywords: soil functions, soil quality, indicator, in situ assessment*

# Are agricultural practices different between rubber-based agroforestry and rubber monoculture?

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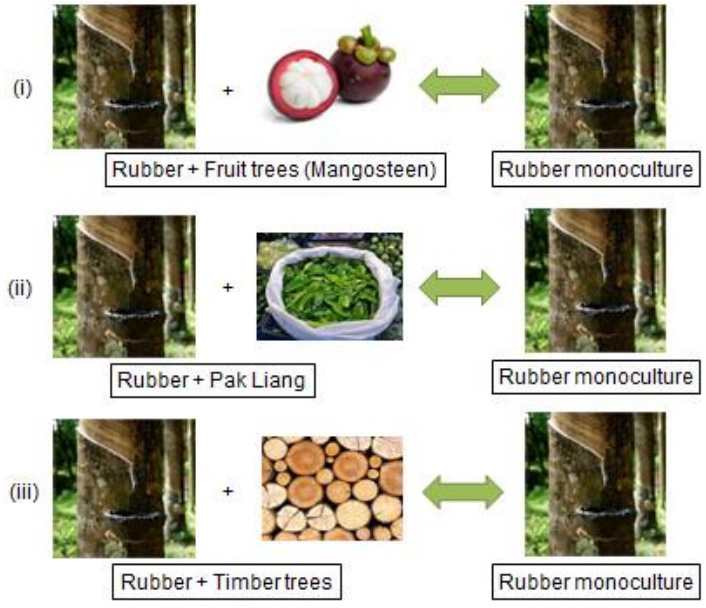
*Keywords: rubber, agroforestry, soil, agricultural practices*

Thailand is actually facing several problems of soil degradation, soil quality and global system sustainability, due partly to intensive agricultural practices and long-term monoculture such as rubber. Indeed, with more than 3.5 millions ha of rubber monoculture plantations (OAE, 2012), rubber represent a potential threat for the soil environment. To counter adverse effect of monoculture on soil, agroforestry could represent an interesting alternative since it has been shown to improve biodiversity (Warren Thomas et al., 2015) and carbon sequestration (Xu, Grumbine & Beckschafer, 2012). However, there is a lack of integrative studies on the impact of rubber-based agroforestry on soil sustainability. The goal of this study was to point out the impacts of rubber agroforestry practices on both biophysics properties and soil functionning in comparison with rubber monoculture. This goal could be reached if agroforestry and monoculture have no significant difference in terms of agricultural practices. To do so, we selected 18 plots in Phatthalung province in the south of Thailand, based on a previous socio-economic study. We choose to work on three main models, which represent around 50% of rubber-based agroforestry system in this area, each of them was compare with the closer monoculture with the same age of rubber tree, (i) rubber trees + fruit trees (Mangosteen) (ii) rubber trees + Pak Liang (iii) rubber trees + timber trees  In each three cases, we have investigated 3 replications. The first study was to assess if agroforestry and monoculture have the same agricultural practices to be sure that the differences in biophysical measurement will only originate from agroforestry practices. For that purpose we made an agronomic surveys with farmers, focusing on previous crops, fertilization, weeding, pesticide and diseases. The results showed that the agricultural practices of the farmers did not distinct agroforestry and monoculture sites and that the plots pairs (agroforestry/monoculture) were indeed homogeneous. Therefor we could assess that the following observed add-ons in terms of soil functioning and biodiversity will be a consequences of agroforestry practices.



# Impact of vermicompost and compost on soil aggregation

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Application of organic waste on agricultural land as a soil amendment has now promoted widespread in Ratchaburi province, Thailand. This study will conduct to determine the effects of vermicompost compare to compost applications (5% w/w) on physical characteristics of soils especially on soil aggregation by using 2 different soil textureal classes (Sanpatong soil series (sand 73%, silt 17% and clay 10%) and Kompaengsean soil series (sand 43%, silt 40% and clay 17%))., under control conditions during August 2016 to July 2017. The experiments will conduct at the Khao Changum Royal Study Center for Land Degradation Development in Ratchaburi province. The best quality of vermicompost will be select from the previous studied and the effect of vermicompost and compost application on soil aggregate and associated soil microbial activity. The experimental design is Randomized Complete Block Design (RCBD) with 5 replications and 5 treatments consist of no organic matter, compost and vermicompost apply in 5% by weight in 2 types of soil; Sanpatong and Kompaengsean. The soil samples will collect for analyze soil aggregate, soil fertility and associated soil microbial activity every month for six months. The hypothesis of the research question is do the vermicompost can improve soil quality better than compost. The benefits are expected to use local materials waste to produce the high quality of vermicompost and to know the interaction between soil microorganisms and soil aggregate.

*Keywords: vermicompost, soil aggregate, soil fertility, soil microbial activity*

# *Abstract of JEAI*

# Soil water and nutrients removal by rubber tree

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The economic plants always have negative effect to the soil by consume water and nutrients from the soil. In the case of water using, the tree loss water by transpiration process. Thus, several works paid on the amount of tree transpiration investigation. For 9-11 years old rubber tree clone RRIM600, it has the tree transpiration around 45-50 L tree$^{-1}$ day$^{-1}$ or 2.3 mm day$^{-1}$ (Isarangkool Na Ayutthaya et al., 2011). The three years old rubber tree in the same clone, tree transpiration ranged from 5 to 9 L tree$^{-1}$ day$^{-1}$ (Puangjumpa et al., 2016). If calculate the yearly tree transpiration of 9-11 years old rubber tree, it showed that the rubber tree need the water from soil around 840 mm year$^{-1}$. However, this value is not including the soil evaporation.

Moreover, the comparison of water consumption in many species can consider from the crop coefficient (Kc) of each plant. For example the Kc of sugar cane is around 1.2, while Kc of rubber tree is around 0.95. The meaning of this information indicated that sugar cane consume the water in the soil higher than rubber tree.

In a case of nutrient removal, rubber tree takes out of nutrients mainly by tapping. The dry rubber yield of rubber tree clone RRIM600 and RRIT251 has 0.40% Nitrogen, 0.14% Phosphorus and 0.50% Potassium (Nhean et al., 2016). It means, if the yield in northeast area is 250 kg rai$^{-1}$ year$^{-1}$, the nitrogen, phosphorus and potassium are removed from soil around 1.0, 0.4 and 1.25 kg rai$^{-1}$ year$^{-1}$ or 6.25, 2.2 and 7.8 kg hectare$^{-1}$ year$^{-1}$.

Lastly, the compensation of water and nutrients to the soil need to be the under consideration of farmer for make a sustainable of the plantation.

# Microbial biomass and activity under different ages of rubber tree plantations

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Soil microorganisms are important in the cycling of almost all the major plant nutrients, particularly so in natural and agricultural ecosystems with low inputs. A number of soil microbiological parameter, notably microbial biomass carbon and basal respiration, have been suggested as possible indicators of soil quality. Soil microbial biomass can be an important pool of plant nutrients and is often highly correlated with the organic matter content of soil. This study aims to investigate microbial biomass and respiration as an indicator of microbial activity in soil which turnover and accumulate nutrient from rubber tree plantations and the relationships between the microbial biomass to depth and season. Three treatments were conducted, including rubber tree 4-5 years-old, 12 years-old and 22-23 years-old. Soil samples were taken from randomly selected location in each plot at two soil depths of 0-5 cm. and 5-10 cm. Physical and chemical properties of soil were observed. The result showed that soil microbial biomass carbon were influenced by season, depth and soil organic carbon content (SOC). The highest carbon dioxide emission and soil organic carbon was examined in 27 years-old for 8.95 $mgCO_2kg^{-1}day^{-1}$ and 0.35%, respectively. The highest microbial biomass carbon were found in 11 years-old both in dry and rainy season. In addition, the result of microbial biomass carbon rubber tree plantation showed low activity at 0-5 cm soil depth when compared to 5-10 cm in dry season. These findings suggested that microbiological activity were responsive to age of rubber tree plantations.

# Swidden transformation to rubber plantation and its impact on smallholder farmers: A Comparison between swidden based system and rubber based system in LuangNamtha province, Northern Lao PDR

Avakat phasouysaingam, Anan Polthanee, Arunee Promkhambut, Satit Aditto, Isabelle Vagneron

The study on Swidden transformation to rubber plantation and its impact on smallholder farmers: a comparison between swidden based system and rubber based system in LuangNamtha province, Northern Lao PDR aims to describe the context of rubber plantation and shifting cultivation in the selected villages; compare the economic and social performance of rubber-based agriculture system and swidden agriculture based system and to identify the farmers' perception on agriculture transition in the selected villages. The study will be conducted in two villages in Nalae district of Luang Namtha province, located in the northern part of Laos. The study will separate into two parts of primary data gathering for qualitative and quantitative data. The study will use stratify random sampling method to select the respondent for interview. The preliminary study shows that Nalae district is one of the poorest district in Luang Namtha province. The livelihood of the people in the district was mainly subsistence by practicing swidden agriculture for food security. Rubber tree was grown in the district since 2004 promoted by government agency. It was boom in 2006 when the private company have supported the local village to grow rubber tree under contract farming system. The latex harvesting has just started for four years ago. The livelihood has changed from subsistence to semi-subsistence livelihood. The farmers still grow rice for subsistence. tapping latex have become part of their incomes. The result of preliminary survey on economic performance shows that income of the farmers has diversity sources. In the condition of low prices of rubber, farmers just manage the time of latex tapping integrated with NTFPs and other economic crops. For the social performance shows that in the traditional swidden agriculture, the village has a well-being system to maintain food security in the village level. When a household has rice shortage problem, other villagers would help to share some production. In the rubber based system.

*Keywords: Swidden agriculture, rubber plantation, social and economic performance*

# Impact of organic amendment on plant development and resistance to water stress

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**Abstract:** To increase the production of cultivated plants, organic matter seems a promising amendment with benefits at short and long term that helps improving the soil chemical, physical and biological characteristics. Using compost and vermicompost could be an option to limit the plant water stress and to maintain soil productivity in drought periods. Our objective was to make an experiment (i) to confirm the specific effect of vermicompost *vs* compost on plant resistance to water stress, and (ii) to get a better understanding of the processes involved in this resistance. To control the soil physical characteristics, the experiment was conducted in PVC column (h=60 cm, d=20 cm), filled with a sandy loam soil. The experiment consisted in 5 replications with 6 treatments (control, compost and vermicompost x 2 levels of irrigation). The compost or vermicompost were mixed to the top layer (0-10 cm) at a rate of 20 t/ha. Chemical fertilisers were added to avoid the soil poor chemical characteristics that could limit the plant development. In half of the columns, daily irrigation maintained the matric potential (Ψ) around -150 hPa; for the remaining columns, irrigation were reduced to impose a small and constant water stress with Ψ <-500 hPa. The plant development (height, leaf number and length) were measured in daily. After 8 weeks, the experiment will be stopped; soil and plant will be collected and will be analysed physical and chemical characteristic, plant nutrient uptake, plant biomass in above and under the ground. Our poster will present the current results on plant development and the benefit provided by organic amendments.

# Effect of climate on transpiration rate per sapwood area of 5 rubber tree clones

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Effect of climate on transpiration rate per sapwood area on rubber tree in 5 clones, e.g. RRIM600 RRIT408 RRIT251 BPM24 and PB260, were studied.The experimental design was a randomized completely block design(RCBD) with three replications.This investigation was done in 3 years old rubber tree planted in NongKhai Rubber Research Center, Rattanawapi district, NongKhai Province. The period of this study was well watered in soil (October 2015) which the range of soil moisture tension was -0.23 to -0.32 MPa. The tree transpiration was measured by single probe with transient thermal dissipation method (Do et al., 2011) and calculated tree transpiration according to Isarangkool Na Ayutthaya et al. (2010). The data were recorded by data logger (Campbell CR1000) in every 30 minutes. Also, the climate data were recorded by mini-weather station which was set up in the experimental field. The result showed that the daily sap flux density in each clone were 22.8 L $dm^{-2}$ $day^{-1}$ for RRIT408, 23.1 L $dm^{-2}$ $day^{-1}$ for RRIM600, 23.7L $dm^{-2}$ $day^{-1}$ for RRIT 251, 29.4 L $dm^{-2}$ $day^{-1}$ for BPM24 and 29.6 L $dm^{-2}$ $day^{-1}$ for PB260. The relationship between daily sap flux density and climate had fluctuated pattern. It is a positive tendency. The high transpiration rate occurred when the vapor pressure deficit and solar radiation increased. It meant that the transpiration rate was logically higher in sunny day than in cloudy day.

# Soil chemical properties changes in chronosequence of rubber plantation in NE of Thailand

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Rubber tree (*Hevea brasiliensis*) is a major importance economic crop in Thailand as it represents a substantial source of income for small holders. Expanding of the rubber tree to the marginal area in NE of Thailand which was sandy texture, low soil fertility and nutrient leaching often resulting in low yield of production. However, many soil properties change as a soil becomes progressively older - especially with regard to mineral depletion – which can have a profound effect on soil fertility. To monitor this question, a chronosequence of 5, 11 and 22 year old plantations was identified with 3 replication in each ages. The aim of this study was to understand how this chronosequence evolves to soil properties over time, especially with regard to fertility. The experiment was located at Kranuan District. Khon Kaen Province. Plantations were selected by RCBD (Randomized Complete Block Design). Each soil was described in the field and sampled for 2 depths to represent the average rooting depth of rubber. (0-15 and 15-30 cm) and analysis for basic soil chemical properties. Results showed significant differences for phosphorus in rubber aged 22 compare to the other ages. The older age seem to provide more phosphorous compare to the young rubber, but did not show a significant impact of the age of the plantations for other soil chemical properties (pH, OM, EC, total N and K)

*Keyword: chronosequence, rubber, soil chemical properties*

# Factors affecting farmers' practices in rubber production: A case study at Kranuan district, Khon Kaen province, Northeast of Thailand

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The research aimed to study factors which affect farm management at mature stage of rubber farmers in Kranuan district, Khon Kaen province. One village with largest planted area of rubber will be selected. Thirty sampled farmers will be selected based on their farm activities; rubber farmers with only rice, rubber farmers with rice and sugarcane, rubber farmers with rice, sugarcane and cassava etc. Face to face interview using Semi-Structured Interviewed will be used to understand 5 main factors which may affect farmers' decision making on rubber farm's practices including physical factors, biological factors, economics factors, social factors and technical factors. Data will be analyzed by using content analysis and descriptive statistics. It is expected that results of this research will be useful for extension officers in order to find the best technology fitting with different groups and conditions of farmers to increase yield of rubber.

*Keywords: rubber farm management, decision making, rubber productivity*

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# Soil and leaf nutrient status of rubber tree in northeast Thailand for development of soil and leaf nutrient standard related with high productivity

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The aim of this study was to 1) survey the soil and leaf nutrient statuses of rubber tree clone RRIM600 in northeast Thailand and 2) develop of soil and leaf nutrient standard related with high productivity. The representative rubber tree plantations located in 5 provinces: Nong Khai, Sakon Nakhon, Chaiyaphum, Khon Kaen and Buriram. In each province, 10 representative plantations were selected (total = 50 plantations) with 10 sampled trees in each plantation. The soil, leaf and dry rubber yield collecting were done in 3 periods: May, August and November 2014. The comparing of leaf nutrient in 3 periods showed a significant difference of nitrogen, phosphorus, calcium and boron in leaves according to leaf age. According to the previous works, the soil and leaf nutrient standard was developed from the data of soil and leaf nutrient and dry rubber yield in August 2014. The result showed that the possible leaf nutrient standard were 2.43-3.24 % N, 0.20-0.25 % P, 0.84-1.16 % K, 0.54-0.67 % Ca, 0.44-0.53 % Mg, and 12-27 mg/kg B. These values had related with the maintaining of possible maximum yields higher than 40 g tree$^{-1}$ tapping$^{-1}$ or 300 kg rai$^{-1}$ year$^{-1}$. In addition, the possible soil nutrient standard were 0.04-0.08 %N, 0.94-4.71 mg/kg P, 106-611 mg/kg K, 46-76 mg/kg Ca, 22-77 mg/kg Mg and 0.33-2.32 mg/kg B.

# Effect of tapping systems on yield and nutrients content in rubber tree

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This investigation aims to optimize an appropriate tapping system for rubber production management. The study was conducted in rubber clone RRIT 251 plantation of farmer located in Khaen Dong district, Buriram province during May 2014 to February 2016. The trees were planted in 2007 and the tapping was started in July 2014. The experimental designed was randomized completed block design (RCBD) with 3 replications comprised 2 treatments; conventional tapping system (Farmer's method, S/3 d2) as control and double cut alternative tapping system (DCA, 2 x S/3 d2). The results displayed that DCA was able to increase latex yield about 16% compared to Farmer's method. However, compared macro-nutrients content in leaf and tapped bark of both tapping systems, there were not significant difference. In conclusion, either Farmer's method or DAC tapping system was not effect on nutrient content in rubber tree. Moreover, DCA had a potential to improve latex productivity.

# Assessment of soil quality in different management of rubber plantation by using nematode as bio-indicator in Khon Kaen province

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It has been over a hundred years since the rubber tree was first introduced in the South of Thailand. The plantation areas are up to now widely spread over the country. However, little is aware of the effect of intensive agricultural practices on nematode communities and soil quality. Therefore, in this study aims to determine the relevance of using nematodes as a bio-indicator for assessing the impact of different agricultural practices on soil quality in rubber plantations. Soil samples were collected from two different plantation stages (immature stage with the age of 5-7 years and mature stage with the age of 8-10 years) with two different intensities of agricultural practice (high and low) in Khon Kaen province, Thailand. The results showed that nematode abundance and taxa richness were significantly different among plantation ages and practices. The immature plantation had higher number of bacterial-feeding nematodes than mature one. On the other hand, the abundance of fungal-feeding nematodes was higher in lower practice intensity. The ecological succession of soil community was also measured in this experiment through Maturity Index (MI). In the mature plantation with lower practice intensity showed larger values of MI which indicated a less disturbed environment. Therefore, based on these overall results we can concluded that the agricultural practices and age of rubber plantations are the main drive way to lead to a higher level of soil ecological stability and nematodes can be a good tools for assessing the quality of soils.

*Keywords: Hevea brasiliensis, nematode, agricultural practices, soil quality*

# *Contact list*