


2014 International Conference on Rubber (2014 ICR)

" Small rubber farms in a changing environment : meeting the challenges of a sustainable development in various contexts "

Proceeding of Abstracts

August 28 - 30, 2014

Organizer :

- Faculty of Technology and Community Development, Thaksin University,Phatthalung campus, Thailand

Co-Organizers :

- Faculty of Science, Thaksin University, Phatthalung campus, Thailand
- Faculty of Health and Sports Science, Thaksin University, Phatthalung campus, Thailand
- Research and Development Institute, Thaksin University, Thailand
- Rubber Research Institute, Thailand
- Office of the Rubber Replanting Aid Fund, Thailand
- Centre de Coopération Internationale en Recherche Agronomique pourle Developpement, France
- Institut de Recherche pour le Developpement, France

2014 International Conference on Rubber

"Small rubber farms in a changing environment: meeting the challenges of a sustainable development in various contexts"

Thaksin University, Phatthalung campus, South of Thailand

August 28-30, 2014

Welcome address

On behalf of Thaksin University, I am delighted to welcome you to the 2014 International Rubber Conference (2014 ICR), which is the first time organized by our university. It will be held during 28-30th August, 2014 at Thaksin University, Phatthalung Campus with the collaboration of Rubber Research Institute of Thailand (RRIT), Office of the Rubber Replanting Aid Fund (OFFAF) from Thailand and Agriculture Research Centre for International Development (CIRAD) and Institute of Research for Development (IRD) from France. The theme of the conference is "Small rubber farms in a changing environment: meeting the challenges of a sustainable development in various contexts", which focuses on 4 aspects of rubber: Biology and Agronomy of Rubber Production, Socio-Economics, Rubber Technology and Environmental and Public Health issues. In this conference, we have invited the special keynote speakers, together with oral and poster presentation. The conference will give the opportunities for researchers, scientists, policy makers and other stakeholders involved in the rubber industry to get together and share their experiences relevant to the conference theme. The discussion and exchanging knowledge of rubber will also contribute to strengthening a rubber research network and academic collaboration among the participants, scholars, and people in the region at large. In addition, the best selected full papers will be published in the Journal of Thaksin University and the Thai Rubber Journal.

I would also like to take this opportunity to express my special thanks and sincere appreciation to all participants, speakers, exhibitors, delegates, visitors, partners, and those who directly and indirectly involved in making this conference possible and successful. I faithfully hope that this conference will act as a catalyst to support growth on the rubber plantation sector as well as promote further developments in the manufacturing sector. Moreover, it will result in the creation of boarder perspectives in Rubber and promote fruitful academic collaboration among all sectors in the near future.

Assoc. Prof. Dr. Wichai Chumni
President of Thaksin University
Office:
140, Moo 4, Khoa-Roob-Chang sub-district, Mung District, Songkhla Province, 90000
Tel. 0-7431-7600 http://www.tsu.ac.th/

In view that Thailand will be the rubber production and marketing hub of ASEAN in 2015, Rubber Research Institute of Thailand (RRIT) is tasked with the responsibility to help increase the value of rubber and support rubber smallholders to gain a better living status. The generation of new knowledge and the cooperation on development-oriented rubber research are the major obligations of the RRIT to enable the Thai rubber to gain a dominant share in the world market, particularly the ASEAN market.

The RRIT is pleased to join hands with Thaksin University in organizing the 2014 International Conference on Rubber (2014 ICR). This conference will be a platform for exchanging ideas among rubber researchers all over the world. The conference will also providea great opportunity for our researchers to share their experiences with other participants, and hopefully will lead to a collaboration between our researchers with those from other institutes. This will strengthen the rubber research network in the ASEAN region.

On behalf of Rubber Research Institute of Thailand, I would like to express our sincere gratitude to Thaksin University in organizing the 2014 International Conference on Rubber, and giving us a chance to be the organizing committee. I am certain that this collaboration will continue, and will lead to further achievements of both of our institutes inresearch and development for supporting the rubber industry of Thailand.

Mr. Suwit Ratanapong
Director, Rubber Research Institute of Thailand
Office:
Department of Agriculture, Ministry of Agriculture and Cooperative, Phaholyothin Road, Chatuchak, Bangkok, 10900
http://www.rubberthai.com/

The Office of the Rubber Replanting Aid Fund (ORRAF) of Thailand was established on 5 December 1970 by the Rubber Aid Fund Act as a non-profit state enterprise. The responsibility of the ORRAF is to promote the replacement of traditional rubber varieties with improved varieties or other economic wood trees by small rubber-holders. Financial support and technical training are provided to farmers as well as assisting them in forming rubber farmer-groups. Supports are also given to new rubber-growers, providing them a cropping alternative. The program has been implemented in areas suitable for rubber planting. Funding of the ORRAF comes from the annual government budget.

The aim of Thailand to be the rubber hub of ASEAN has posted a challenge to the ORRAF in performing its task of promoting rubber growers to improve their productivity. The 2014 International Conference on Rubber (2014 ICR) will provide a great opportunity for our staff to gain new knowledge which will be useful in improving their work.

On behalf of the ORRAF, I would like to say that we are pleased to cooperate with Thaksin University in organizing the 2014 International Conference on Rubber, and to be a member of the organizing committee. We wish that the Conference is carried out with success and the outcomes are fruitful.

Mr. Prasit Meadsen
Acting Director, Office of the Rubber Replanting Aid Fund, Thailand
Office:
67/25 Bang Khun Non Road, Bang Khun Non sub-district, Bang Kok Noi district, Bangkok ,10700
Tel. 0-2433-2222 Fax. 0-2423-0229
http://www.rubber.co.th/

Natural rubber is a strategic product. Not a single plane could land without natural rubber to make its tires. And who is producing this unique product? Millions of family farmers, mainly in tropical Asia. Therefore, this commodity is one of the best examples of interdependency between family farming and global industry.

However, ahead of global changes, how can an individual farmer bet to invest its limited resources in land, money and manpower in a tree-crop that has to remain profitable for more than 20 years? How can he forecast the changes in the environmental conditions as well as in the market, and how can he adapt to such changes?

These questions are the real challenges for rubber scientist from every discipline, from human and social sciences to chemistry and technology, through environmental sciences, agronomy and biology. This is why CIRAD and its partners from the Hevea Research Platform in Partnership (HRPP) strongly support the organization of the first International Conference on Rubber of Thaksin University, Patthalung campus. This young campus is located in the heart of the main rubber producing area of the first word producing country. We are then looking forward at sharing knowledge that will help the farmers and the natural rubber sector to face the challenge of global changes.

Dr Philippe GIRARD
CIRAD Regional Director for Continental South East Asia
CIRAD Office:
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On behalf of the Institute of Research for Development (IRD) France and as the director of a network on the environmental impact of land uses changes on soil Ecosystem services in SEA (LUSES) its my pleasure to have the opportunity to co-organize with Thaksin University in Phatthalung campus this international Rubber conference. This International meeting will tackle a very important issue, the sustainability of rubber plantation. If sustainability refers in ecology to the question of how biological systems remain diverse and productive, in fact this word must be taken here in a broader meaning, including economical, social, politics and cultural. Sustainability is not just a smart word for researchers; it also includes a social dimension. A Thai farmer in NE Thailand where rubber expansion occurs in non-suitable soils will face this challenge on a daily base. How long will my plantations last? Will my production meet my expectations? Can I diversify my income with intercropping without affecting my latex production? These questions are crucial and must be answered by the scientific community. This is why I deeply support this initiative of Dr. Uraiwan Tongkaemkaew and accept with pleasure to be member of the organizing committee.

Dr. Alain Brauman.
Position IRD expert in Soil Ecology, head of LMI LUSES
Office:
IRD, UMR Eco&Sols LMI LUSES, Land Development Department, Bangkok, Thailand
www.luses.ird.fr

Rapid expansion of rubber plantations into non-traditional rubber growing areas has been a prominent trend in many parts of mainland Southeast Asia, as influenced by the world regional and global markets. Hence, rubber promotions in the Southeast Asia is the advantages of ASEAN Economic Community (AEC) to the world rubber industry. Thailand which is well known for a large number of rubber plantations in Southeast Asia has also increased rubber areas. This will be the opportunity of rubber smallholders to generate high income from rubber production. Rubber, however, the price has not stable including Thai rubber products is still very less development. In addition, rubber extension would impact on such food diversify and portfolio a due to rubber replaced other cash crops and low income activities. Those reasons, the research and development on rubber impact especially on rubber farming systems is the one of my commitment by the target to attempt increasing the living status of rubber smallholder along with seeking the cooperation on the rubber research to gain my opportunity and acknowledge.

The 2014 international conference on rubber (2014 ICR) is the first of my organizing on international conference. Also, the first collaboration conference with two international research institutes from French and two Thai rubber institutes. The conference is the platform for exchange rubber knowledge, experiences and discussion of participants which its lead to collaboration on rubber research in the further. On the behind with the achievement of this conference, I would like to special thanks to who are support and advise me on the work including Assoc. Prof. Kasem Asawatreratanakul (TSU), Dr. Philippe Thaler, Dr. Benedicte Chambon, Dr. Regis Lacote, and other who are not mention. Moreover, I would like to thanks due to the representative of coordinator from co-organizers including Dr. Philippe Girard (CIRAD), Dr. Alain Brauman (IRD), Mr. Suwit Rattanapong (RRIT), Mr. Suthee Intraskul (RRIT), Mr. Prasit Meadsen (ORRAF) and Mr. Jamrean Ousaratniwas (ORRAF). Besides, sincere appreciations are expressed to the reviewers from other countries work on papers for the 2014 ICR. Finally, I would like to express my great pleasure to all participants to make 2014ICR of Thaksin University successful.

Dr. Uraiwan Tongkaemkaew
Administrative Chaiman of Conference, Faculty of Technology and Community Development, Thaksin Univesity

Committee

Organizer

Faculty of Technology and Community Development, Thaksin University, Phatthalung campus, Thailand

Co-Organizers

1. Faculty of Science, Thaksin University, Phatthalung campus, Thailand
2. Faculty of Health and Sports Science, Thaksin University, Phatthalung campus, Thailand
3. Research and Development Institute, Thaksin University, Thailand
4. Rubber Research Institute, Thailand
5. Office of the Rubber Replanting Aid Fund, Thailand
6. Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France
7. Institut de Recherche pour le Développement, France

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Co-Chairman

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Dr. Alain Brauman	LMI LUSES Director, IRD
Dr. Philippe Thaler	HRPP Coordinator, CIRAD
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Dr. Wallapa C. Kochapakdee	Dean, Faculty of Health and Sports Science, Thaksin University
Mr. Prasit Meadsen	Acting Director, Office of the Rubber Replanting Aid Fund, Thailand
Mr. Suwit Rattanapong	Director, Rubber Research Institute of Thailand

Administrative Chairman

Dr. Uraiwan Tongkaemkaew

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Dr. Frédéric Bonfils	Structure of natural rubber
Dr. Gede Wibawa	Agronomy and Socio-economy
Dr. Gerhard Langenberger	Environmental impact
Dr. Hans Overgaard	Health in rubber plantations
Dr. Henri Robain	Soil physics
Dr. James Jacob	Ecophysiology
Dr. Jérôme Sainte Beuve	Rubber technology
Dr. Laurent Vaysse	Biochemistry and Structure of natural rubber
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Mrs. Noparat Wichitchonlachai	Rubber industries
Miss. Adthiwee Dangkanich	Marketing and Well Being

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Mrs. Pornthip Leeraphan

Technical Programme

THURDAY 28th AUGUST 2014	
08.30-09.20	Registration: Thaksin University Hall, Phatthalung campus
09.20-10.30	Opening Ceremony
10.30-10.50	*Coffee break*
10.50-11.20	Plenary session 1: **Opportunities and Capabilities for Thailand Rubber Industries Towards AEC** Keynote Speaker: **Mr. Suthee Intraskul**
11.20-12.00	Plenary session 2: **Can Family Rubber Farms Match Global Challenges?** Keynote Speaker: **Dr. Bénédicte Chambon**
12.00-13.00	*Lunch*

Session	***Biology and Agronomy of rubber production***		***Rubber Technology***
Room	**Srinakharin**	**Sribanphot**	**Khuankhanun**
Chair person	**Prof. Dr. Sompong Te-chato** **Assist. Prof. Dr. Samak Keawsuksang**	**Dr. Alain Brauman** **Dr. Anisara Pensuk Tibkaew**	**Assist. Prof. Dr. Orasa Patarapaiboolchai** **Dr. Peeranat Kiddee**
13.00-13.30	Can Rubber Cultivations Serve as Wildlife Habitat? A Case Study from Tai Rom Yen National Park, Thailand ***F. K. Harich***	Does Afforestation of Arable Land with Rubber Tree Improve Soil Functioning? A Case Study in a Chronosequence of Rubber Plantation in Thailand ***B. Alain***	Homogeneous of Natural Rubber Coagulum under Outdoor Maturation ***J. Intapun***
13.30-14.00	Deep Rooting Patterns of Rubber Trees: Results from a Regional Survey Along a Pedo-Climatic Gradient in Southeast Asia ***A. Pierret***	Impact of Rubber Plantations on the Soil Microbial Community: Case Study of a Rubber Trees Chronosequence in Chachoengsao Province, Thailand ***P. Monrawee***	Properties of Polymer-Modified Cement and Coated Para Rubber Shell Concrete ***D. Raksritong***
14.00-14.30	The Study on Growth and Yield of Rubber in New Planting Area of Thailand ***N. Sangchanda***	Impact of Agricultural Practices on Soil Biological Functioning in Rubber Plantations ***K. Vladislav***	Selection of Antioxidants from Natural Rubber and Development of Clean Extraction Method ***J. Chaiyut***
14.30-15.50	*Coffee break*		
15.50-16.20	Effect of Leaf Age and Tree Age on Nutrients in Leaves of Rubber Tree Clone RRIM600 ***A. Prakobmee***	The Use of Nematodes as Bio-Indicator of Different Agricultural Practices Impact on Soil Functioning in Rubber Plantation ***P. Treenuch***	Optimization of Protein Extraction from Different Latex Samples of *Hevea brasiliensis* ***S. Srisomboon***
16.20-16.50	Hydraulic Traits Quantification for Drought Tolerance Consideration in *Hevea*: Analysis of the Performance of Two Clones ***K. Sangsing***	Evaluation of Trichoderma spp. for Biocontrol of Rigidoporus microporus White Root Disease in Rubber ***N. Ninsuwan***	Study of the Rubber Particle of Latex from *Hevea brasiliensis* by a Biomimetic Approach in Langmuir Films ***K. Wadeesirisak***
16.50-17.20	The Recovery of Fine Roots in Rubber Plantation After the Installation of Minirhizotron ***J. Sopharat***	Impact of Long Term Rubber Plantation on the Nutrient Status of Soils and Leaves: the Case of Immature Rubber in the East Coast of Upper Part of Southern Thailand ***P. Suchartgul***	
18.30-20.30	*Welcome party: Chaikanathani Hotel*		

FRIDAY 29th AUGUST 2014		
09.30-10.20	Plenary session 3: **Occupational and Environmental Health Situations: Impact of Rubber Production and Transformation on Health and Environment** Plenary Keynote Speaker: **Assoc. Prof. Chalermchai Chaikittiporn**	
10.20-11.00	Coffee break/Poster presentation	
Session	***Socio-Economics***	***Environmental and Public Health Issues***
Room	**Srinakharin**	**Khuankhanun**
Chair person	**Mr. Suthee Intraskul** **Dr. Bénédicte Chambon**	**Prof. Virasakdi Chongsuvivatwong** **Assist. Prof. Bhunyabhadh Chaimay**
11.00-11.30	Development of Natural Rubber Products for the Natural Disasters Relief in Thailand ***N. Wichidchonlahai***	Scaling-up Upflow Bio-Filter Circuit (UBFC) for Sulfate-Sulfide Rich Treatment from Rubber Sheet Process Wastewater ***C. Sukkasem***
11.30-12.00	The Study of Rubber Smoked Sheet Price Forecasting Model ***A. Daengkanit***	Risk of Vector-Borne Diseases in Relation to Rubber Plantations in Lao PDR ***J.A. Tangena***
12.00-13.00	*Lunch*	
13.00-13.30	Social Security of Smallholders which Practice Associate Crops in Rubber Plots in Southern Thailand ***V. Jongrungrot***	Eronomic Design of Rubber Tapping Knife ***C. Jaitwijitra***
13.30-14.00	Farm Trajectories and Recent Changes in the Rubber Farms in Southern Thailand ***C. Kongmanee***	Musculoskeletal Disorders among Rubber Tappers: Case Study Paprayom district Phatthalung Province ***S. Inraksa***
14.00-14.30	Agriculture Practices of Rubber Plantation in Northeast Thailand and Its Challenge for Sustainability ***A. Promkhambut***	Evidence – Based Interventions to Promote Functional Ability and Working Performance for Aged Para Rubber Farmers with knee osteoarthritis ***K. Hounsri***
14.30-14.50	*Coffee break*	
14.50-15.20	Impact of Rubber Plantation on Daily Time Spent of Small Holders in Northeast Thailand ***U. Tongkaemkaew***	Safety Behavior for Rubber Workers in Kho Tao Sub-District, Paprayom District, Phatthalung province ***T. Buacharoen***
15.20-15.50	*Closing Ceremony*	

General Information

Conference Venue

Thaksin Univesity, Phatthalung campus hall, 22 M. 2 Ban-Prao sub-district, Pa-Pra-Yom district, Phatthalung province, Thailand 93110.

Oral Presentation

Oral sessions are held 2 days on Thursday 28th August around 13.00-17.20 in 3 rooms as Sribanphot, Srinakharin and Khuankhanun; and Friday 29th August around 11.00-15.20 in 2 rooms as Srinakharin and Khuankhanun.

All oral presentations, only data projection (Power Point) will be available for use by speakers. The presentation files can be only accepted as *. PPT, or *PPTX. The presenters should be giving the data of presentation contact to registration desk.

The presentation will take 20 minutes and 10 minutes for discussion (including 30 minutes). Therefore, the presenters should be strongly on the time presentation and give the audience the opportunity to ask questions. The answers should be clearly for understanding of who is asked.

Poster Presentation

Poster sessions are held on Friday 29th August around 10.20-11.00 in Thaksin University hall. Each poster presenter will be scheduled to stand by his/her poster to be available for questions and discussion by participants

All the posters can be pinned to the walls on 28th August after finished registration in the front. It will be present for the whole time. Equipment for the posters to the boards will available on site. The posters must be no greater than 90 cm wide 120 cm high. Posters will be adhered to the boards using push that will be provided. Poster presentations should incorporate illustrative materials such as tables, graphs, photographs, and large-print text. All illustrative materials should be clearly readable from a distance of three feet. Do put contact information at the bottom, to allow others who are interested to contact you afterwards.

Conference Desk

The participants will register and receive the conference documents and name badge on Thursday 28th and Friday 29th August, 08.30. The conference desk will be available on the front of Thaksin University hall on Thursday 28th and Friday 29th August, 08.30-17.30.

For any specific questions on the conference, please contact: +66(0)81 9655583.

Content

Keynote Speakers

Mr. Suthee Intraskul

Rubber Research Institute of Thailand

Topic: Opportunities and Capabilities for Thailand Rubber Industries Towards AEC

We are living in the fast changing world today whereas the world's massive economic power has shifted to Asia far more with the rising stars of China, India, the Association of Southeast Asian Nations (ASEAN), and so on. There is no doubt that ASEAN is currently playing a key role in the world's economic activities including the upcoming ASEAN Economic Community (AEC) in 2015, In terms of rubber industry, the AEC will lead to both opportunity and competition with the real challenge for all rubber industry including its upstream, midstream and downstream level as a whole.

Dr. Bénédicte Chambon
Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France

Topic: Can Family Rubber Farms Match Global Challenges?

Family farms play an important role in natural rubber production and rubber is known to present many advantages for the smallholders. Thus, rubber is a long term crop. To ensure the sustainability of plantation systems, environmental and socio-economic conditions should remain favorable during several decades. However, farmers evolve in a changing environment; they face several challenges. How smallholder's tree plantations can adapt and keep sustainable whereas they face variable climatic conditions and deep changes in their socio-economic context? This big issue needs a multi-disciplinary approach to be addressed.

Assoc. Prof. Chalermchai Chaikittiporn
Occupational and Safety Department, Mahidol University

Topic : Occupational and Environmental Health Situations: Impact of Rubber Production and Transformation on Health and Environment

Intermediate products from natural rubber industries of Thailand include ribbed smoked sheet, air dried sheets, block rubber, crepe rubber, and concentrated rubber latex. Many environmental problems include air, water, and order pollutions arise through these production. The risk of hazardous or toxic chemicals exposure in the process, and some may be listed as a carcinogen, increase risk of occupational disease. On the other hand, in the primary process of rubber production is the tapping process. The regular tapping has caused health problems among rubber tapping workers. It varies from simple musculoskeletal disorders to more serious and complicated structural damage to bone, muscles, tendon and nerve of musculoskeletal system. The other health problems varied from allergic from fresh latex, acids used for coagulation, and pesticides used in the plantation and spread of fever and Malaria fever based health issue during rainy day or semi rainy day. Handling and processing of rubber created both occupational and environmental health and safety concerns.

Biology and Agronomy of rubber production

OP-01 *Biology and Agronomy of rubber production*

Can Rubber Cultivations Serve as Wildlife Habitat? A Case Study from Tai Rom Yen National Park, Thailand

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ABSTRACT

Expanding rubber plantations and diminishing natural forests pose great challenges for wildlife conservation throughout Southeast Asia. In addition to habitat loss, arising conflicts with wildlife coming into farmland in search for food and water further jeopardize people's tolerance towards wild animals. Elephants (*Elephas maximus*) in particular can cause substantial damage to crops. Using the example of Tai Rom Yen National Park, Southern Thailand, we investigate the wildlife presence in the transition zone between the park and its surrounding plantations. We used sign-based occupancy surveys and camera trapping and assessed damage caused by wildlife through interviews with 180 farmers around the Park and through direct observations. Squirrels (*Sciuridae* spec.), rats (*Rattus* spec.) and elephants were the most common visitors to the farmland (reported by 56%, 47% and 42% of respondents, respectively). Preliminary data showed elephant presence in 17% of cameras installed at the farm-forest boundary and on 33% of transects within cultivations compared to almost 70% in protected forest. While elephants seemed to frequently visit farmland, signs of their presence were hardly found further than 600 meters from the forest boundary and generally wildlife signs were few in the farmland. Although elephants were mentioned to be the species causing most damage (18% of farmers experiencing crop losses), they only caused damage in less than half of all their visits to farmland and mainly on young rubber trees (78% of damaged trees were not yet tapped). Diseases, insects or rain were perceived as larger threats than wildlife. Our results show that plantations were used by wildlife, albeit by fewer individuals and species than in forests. Hence, rubber plantations might have the potential to provide mitigating buffer zone habitat if managed appropriately. Additional protection of particularly young rubber plants can help reduce conflicts and facilitate a joint utilization by wildlife and humans.

Keywords: Buffer zone, Conflicts, Elephants, Wildlife conservation, *Heveabra siliensis*

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OP-02 *Biology and Agronomy of rubber production*

Deep Rooting Patterns of Rubber Trees: Results from a Regional Survey Along a Pedo-Climatic Gradient in Southeast Asia

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ABSTRACT

In order to clarify the extent of the root system of rubber trees at depth and its variability depending on pedo-climatic conditions, we investigated the fine rooting patterns of rubber trees (*Hevea brasiliensis* Muell.-Arg.) at three Southeast Asian locations, namely Northeast Thailand (Buriram province), Southern Thailand (Songkhla province) and North Sumatra (South of Medan). These locations encompass a wide range of climatic and soil conditions, from clay to sandy soils and mean annual rainfalls of less than 1,200 to more than 2,200 mm.

Roots manually separated from soil samples collected along soil profiles were measured using image analysis. Fine roots were found at soil depths of at least 2-3 m at all surveyed locations; this result indicates that, in rubber tree, deep rooting patterns are likely to be primarily related to a genetic determinism, even though environmental factors may modulate such determinism.

The cumulative fine root biomass at depths of more than 1 m made up, at all locations, between 30 and 50% of the total fine root biomass. Such an amount of fine root biomass is of the same order of magnitude as the biomass corresponding to coarse woody roots.

This research confirms that rubber trees have deep roots, which extent far beyond the first meter of soil, regardless of climate and/or edaphic conditions. Further studies are needed to clarify the functional role of these deep roots, although it can reasonably be hypothesized that they play a role in the extraction of scarce/poorly mobile nutrients and of deep water resources during the driest periods of the year. The deep root system of rubber trees would therefore represent, at least for part, a "safety net" to cope with pedo-climatic variability. This result has important implications for the selection of new genetic material.

Keywords: Deep and fine roots, Rubber tree, Root biomass, Safety net, Water resources.

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OP-03 *Biology and Agronomy of rubber production*

The Study on Growth and Yield of Rubber in New Planting Area of Thailand

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ABSTRACT

The traditional area of rubber tree is in the southern part of Thailand, and nowadays the rubber tree plantations are extended to the northern and northeastern. These extended areas have the climate different from the traditional area. Thus, the aim of this work was to study on growth and yield of rubber tree clone RRIM600 in the new planting area of Thailand. The 7 years old rubber tree plantations (first year tapping) in 4 provinces; Nongkhai, Chaiyaphum, Khon Kaen and Buriram, were selected. The girth, latex yield and dry rubber content (DRC) were measured in each month during the period of July to December 2013. The result showed that the girth of rubber tree planted in Nongkhai was the highest while the girth of rubber tree planted in Burirum was the lowest. The daily latex yield in all plantations exposed the increasingly trend according to the month of tapping. The DRC exhibited high value in the month of yearly started tapping (July 2013) and was seemly stable around 25-30% during the period of September - December 2013. Moreover, the relationship between girth and latex yield was a positive linear tendency.

Keywords: *Hevea brasiliensis*, Girth, Yield, Dry rubber content

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OP-04 *Biology and Agronomy of rubber production*

Effect of Leaf Age and Tree Age on Nutrients in Leaves of Rubber Tree Clone RRIM600

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ABSTRACT

Nowadays, the leaf nutrient standard is more interested for fertilizer management. However, the nutrients in leaves can variable depend on soil, climate, plant variety, leaf age and tree age. Therefore, this work was to evaluate the effect of leaf age and tree age on nutrients in leaves of rubber tree clone RRIM600. Two experiments were conducted on the rubber tree plantations in Khan-Dong district, Buriram Province. Firstly, the effect of leaf age on nutrients in leaves was assessed in 7 years after planting (first year of tapping) on rubber tree clone RRIM600. The sampled leaves were collected each month from 2 months old until leaves started yellowing (9 months old). The result showed that nutrient contents such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), Magnesium (Mg) and Boron (B) changed according to leaf age. This experiment indicated that the optimum age for collecting the leaves for nutrient analysis should be 5-6 months old, before the second leaf flushing of the year. Secondly, effect of the tree age on the nutrient contents in leaves was assessed on 7 ages (3, 5, 7, 9, 11, 16 and 20 years old) of the rubber tree clone RRIM600, planted in the same area. In all trees, the leaves were sampled at the same leaf age, 6 months old. The result indicated that the nutrients in leaves fluctuated depending on tree age. Therefore, to develop nutrient standards from leaf analysis, 3 groups of tree age should be considered: 1-6 years old after planting (before tapping), 7-15 years old after planting, and more than 15 years after planting.

Keywords: *Hevea brasiliensis*, Leaf age, Tree age, Nutrients in leaves

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OP-05 *Biology and Agronomy of rubber production*

Hydraulic Traits Quantification for Drought Tolerance Consideration in *Hevea*: Analysis of the Performance of Two Clones

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ABSTRACT

Hydraulic trait is a key indicator closely correlated with local soil water condition and associated with the capacity of plants to survive extreme drought events. The mechanism for plant with regulation of water status results from avoidance of drought induced hydraulic failure via stomatal closure as representative of a hydraulic safety margin. The purpose of this study was to quantify and compare the safety margins value based on hydraulic traits of two popular rubber (*Hevea brasiliensis*) clones for drought tolerance consideration. We re-assessed data from Sangsing *et al*. (2004a) on drought response of two rubber clones grown in pots. Hydraulic traits data, i.e. stomatal conductance (g_s), leaf water potential (Ψ_{leaf}) and percent loss of xylem conductivity (PLC; *P*) were used. An estimate of xylem pressure at which embolism begins or 12% loss of conductivity occurs (P_{12}), embolism causing 50%loss of conductivity occurs (P_{50}), critical embolism level or 88% loss of conductivity occurs (P_{88}), xylem pressure at which50% of stomatal closure (g_{s50}) and safety margins were quantitative output results. Vulnerability to xylem embolism curves of both clones showed typical sigmoid fits (R^2>0.99) .RRIT 251 was more vulnerable to embolism than RRIM 600 as shown by less negative P_{12}, P_{50} and P_{88}. However, from P_{12}, the degree of embolism of RRIM 600 increased faster than that of RRIT 251. Both clones showed similar behaviors of water saving reducing stomatal conductance (g_s) by 50% at xylem pressure about -0.8 MPa. However, a difference of g_s slope was found between the two clones. RRIM 600 closed stomata faster than RRIT 251. Consequently, the safety margin was also higher in RRIM 600 than in RRIT 251. In the preliminary result from this study, the clone RRIM 600 was slightly more drought tolerant than clone RRIT 251when grown in pots.

Keywords: Stomatal conductance, Leaf water potential, Xylem embolism, Safety margins, *Hevea brasiliensis.*

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OP-06 *Biology and Agronomy of rubber production*

The Recovery of Fine Roots in Rubber Plantation After The Installation of Minirhizotron

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ABSTRACT

Fine roots play a major role in water and nutrient uptake. Their production and turnover are important processes in the carbon flow and nutrient cycling of ecosystems. Nevertheless, fine roots dynamics is less studied than the dynamics of leaves or other aboveground part of plants because of methodological difficulties. Minirhizotrons (root observation tubes) are commonly used but their cost is high. A simpler device (PSU-Minirhizotron-1) has been developed and used in the field to monitor the growth and development of individual roots through transparent acrylic tubes. An issue with the use of minirhizotrons is that their insertion into the soil disturbs the roots. A specific objective of the study was to assess the time to recover steady-state growth after installation of our device. The initiation and development of fine roots of rubber (*Hevea brasiliensis*) plantation was compared between 100 and 150 cm long tubes with 45 and 60 degreehorizontal angle, respectively. The images were collected every 2 weeks by home-made webcam system. They were analyzed by Root Fly software (GNU General Public License). The analysis with logistic growth curve showed that the maximum rate of recovery was obtained around 32 and 57 days after installation for the 100 (0.0033±0.0016 mm $mm^{-2}day^{-1}$) and 150 (0.0007±0.0002 mm $mm^{-2}day^{-1}$) cm long tubes, respectively. It took around 67 and 122 days to approach steady state after installation for 100 and 150 cm long tubes, respectively. Such dynamics should be taken into account when studying fine roots with minirhizotron in rubber plantations. With 150 cm long tubes, we had to open the pit down to 0.8 m and continue with hand auger. This disturbed more the soil, resulting in longer recovery time. Consequently, the drilling method should be adapted to the length of the tubes.

Keywords: Minirhizotron, Root dynamics, Logistic growth curve, *Hevea brasiliensis*

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OP-07 *Biology and Agronomy of rubber production*

Does Afforestation of Arable Land With Rubber Tree Improve Soil Functioning? A Case Study in a Chronosequence of Rubber Plantation in Thailand

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ABSTRACT

Land use changes (LUC) in Southeast Asia are characterized by the conversion of natural forests and arable lands to tree plantations, particularly rubber plantations. However, despite the importance of these changes, scientific studies investigating the impact of rubber plantations on the soil functions remain scarce. To address this question, we investigated the impact of rubber tree plantations on soil organic carbon (SOC) content and quality, and soil biological diversity (soil fauna) related to main soil functions such as OM mineralization and nutrient cycling. All these parameters were measured along a chronosequence of rubber plantations (1 to 25 year-old) compared to cassava fields, the previous crop in the study area. Near Infra-Red Spectroscopy (NIRS) was used to predict the organic carbon content of the soil samples. Soil respiration was measured fortnightly during two months. Floor litter and fine root biomass were measured in the 0-10 cm layer. Quality of the soil organic matter was assessed using the Rock-Eval method. Macrofauna was sampled using the standard TSBF methodology. Compared to cassava field, most of the measured variables showed significantly higher level in the old rubber plantations. However, the shift from cassava to young rubber plantations (< 7 years old) resulted first in a decrease of all these parameters. The soil ecosystem started to recover from this shift after the closing of the canopy of the plantation. Interestingly, soil fauna structure seemed to be more sensitive to plantation age than to land use change (cassava vs. rubber). Compared to cassava fields, a 25% increase of the soil carbon stock together with an increase of recalcitrant form of SOM was measured in old rubber plantations. These results suggest that planting rubber trees could be a better alternative than cassava crops in terms of soil sustainability. Anyway this result should be confirmed in others soil type and climatic conditions before to be generalized.

Keywords: *Hevea brasiliensis,* Land use change, Soil fauna, C sequestration, OM mineralization, Soil engineer

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OP-08 *Biology and Agronomy of rubber production*

Impact of Rubber Plantations on the Soil Microbial Community: Case Study of a Rubber Trees Chronosequence in Chachoengsao Province, Thailand

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ABSTRACT

Due mainly to land use changes, soils of tropical countries like Thailand are subject to degradation processes, such as carbon and diversity loss and nutrient depletion reducing deeply soil fertility. In South East Asia, rubber expansion in different soil contexts represents a good model of this rapid agrarian transition. However, despite the importance of this cash crop, scientific studies investigating the impact of these plantations on the soil functions remain scarce. To address this question, we investigated the impact of rubber plantation age on the soil microbial community, because of their importance in overall soil functioning (80 to 90% of nutrient cycling). Soil microbial density (Substrate Induce Respiration, SIR), functional diversity (Microresp™) and genetic structure (molecular fingerprinting techniques) were measured along a rubber chronosequence at different stages in comparison to cassava crop in Chachoengsao province (Thailand). The shift from cassava to young rubber plantations resulted in a reduction of overall microbial density, soil DNA quantity and soil respiration rates. However, after canopy closure, all these microbial parameters increased. Multivariate analysis of the community level physiological profiles did not exhibit clear discrimination among the treatments, except for the older rubber plantation (14—25 years). Indeed, in this older stage, the microbial density and activities were higher than in the former cassava plantation. Cluster analysis made on 16S rRNA DGGE profiles, revealed that land occupation (cassava vs. rubber) was a key determinant of total bacterial community structure, with secondary variation assumed to be due to plantations' age (young vs old). This first study showed that (i) the land use changes, from cassava to rubber affected, with different level of intensity, all the different microbial descriptors (density, activity and genetic structure) (ii) older rubber plantations constituted a richer and more active soil microorganisms, compared to younger rubber plantations.

Keywords: Rubber, Soil microbial community, Microbial fingerprint, Soil physiological profiles

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OP-09 *Biology and Agronomy of rubber production*

Impact of Agricultural Practices on Soil Biological Functioning in Rubber Plantations

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ABSTRACT

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 this tree plantations is questionable. In this study, we hypothesize that soil organisms constitute a reliable indicator of sustainability of these perennial plantations. 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 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 practices intensity, high and low, and (ii) two levels of plantation's age, based on rather or not latex tapping is possible (immature <6 years old, mature > 6 years old). Macrofauna taxa's richness or evenness indices showed no differences in terms of plantations' management or age. However, soil macrofauna structure varied significantly as a function of the age of the plantation, while high intensity of practices tends to homogenize macrofauna community. Main soil engineers' density (termites, earthworms) are a good indicator of low practices' intensity in mature plantations, in opposition with immature plantations. *Diplopoda* and *Blattidae*, on the contrary, aligned with high intensity of agricultural practices. Low intensity managed plantations revealed also significantly more macrofauna activity (earthworm casts, skeletonized litter). These first results suggest that functional roles and activity assumed by soil macrofauna are better indicator of soil perturbation, rather than taxa affiliation. Moreover, identifying functional groups able to respond differently to a range of stress, is needed for further investigations on soil macrofauna's relevance as bio-indicator of rubber's soil management.

Keywords: Rubber, Ecosystem sustainability, Land management, Soil biodiversity, Soil fauna, Nematodes, Microorganisms

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OP-10 *Biology and Agronomy of rubber production*

The use of Nematodes as Bio-Indicator of the Impact of Different Agricultural Practices on Soil Environmental Condition in the Rubber Plantation

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ABSTRACT

Nematodes are one of the most abundant multicellular organisms living in soil and can be found in all types of soil. They are diverse and inhabit in water films surrounding soil particles, therefore, they tend to sensitive to soil perturbations. Moreover, they can also be classified into functional guilds whose respond similarly to soil environmental perturbations such as agricultural practices. Thus, nematodes can be used as a relevant bio-indicator for identifying the variation of soil environmental conditions. However, the investigation to confirm this relevance in the soil of rubber plantation is scarce and has never been carried out. Therefore, this study aims to determine the relevance by using nematode as bio-indicator to assess the impact of different agricultural practices on soil environmental conditions in rubber plantation. Soil samples from two different plantation stages, mature and immature with two different intensity of agricultural practices, high and low, were collected in KhonKaen. The result showed that the trophic group of nematodes did not respond to the same type of perturbations. The abundance of bacterial feeders was more sensitive to the plantation stage (lower density in the soil of mature plantation stage), on the other hand, the abundance of fungi feeders was more sensitive to agricultural practice (increased in plantations with lower practices intensity). The overall impact of agricultural practices on nematode's ecological indices was higher in the immature plantation than the mature. Bacterial index reveals the high level of perturbation of the immature plantation under intensive agricultural practices. Whatever the agricultural practices, mature rubber plantation showed a higher level of stability and seemed to buffer the perturbations, which was induced by agricultural practices. These preliminary results demonstrated that the trophic group of the nematodes community could be used as a good index of agricultural practices effects on soil in rubber plantations.

Keywords: Agricultural practices, *Hevea brasiliensis*, Nematode, Trophic index

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OP-11 ***Biology and Agronomy of rubber production***

Evaluation of *Trichoderma*s pp. for Biocontrol of *Rigidoporus microporus* White Root Disease in Rubber

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Abstract

The spread and severity of disease in the White roots. Affect the income of smallholders. Rubber plantation is red root, white root and brown root disease. Of these, a white root disease of 24.24 hectares or 3.4 percent of the area surveyed. Therefore, the estimate that the level violence. And the distribution of white root disease began to spread rapidly.

White root disease caused by *Rigidoporus microporus* is abundant in rubber plantations of Thailand. Control of the disease by applying systemic fungicides is expensive, pollutes the environment and causes health hazards. The objectives of the present work were to isolate antagonistic *Trichoderma*s pp. soil dilution plate method and to test them for their activity against *Rigidoporus microporus. Trichoderma* 548 isolates obtained from rubber plantations were screened and found antagonistic against *R. microporus*. However, *T. harzianum*s train SK 31 was the most antagonistic activities in dual culture technique (92.96 %) this was followed *T. koningii*s train TR 7(92.59 %). Two of the selected isolates showed penetration and coiling around *R. microporus* hyphae. Different media was also evaluated to mass produce the *Trichoderm* isolate. The media evaluated in this study included the solid substrates sorghum seeds, rice extract, paddy and rice band, respectively. Although mycelia growth was fastest and the highest yield of spores of *T. harzianum* strain SK 31 was observed 10 days after inoculation in sorghum seeds (7 x10^{24} cfu/g) . The shelf life of *T. harzianum* strain SK 31 consisting of sorghum seed mixture in polyethylene bag was satisfactory even after 4 months under room temperature.

Keywords: *Hevea brasiliensis,* White root disease, *Rigidoporus microporus,* Biocontrol, Antagonistic microorganisms

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OP-12 *Biology and Agronomy of rubber production*

Impact of Long Term Rubber Plantation on the Nutrient Status of Soils and Leaves: the Case of Immature Rubber in the East Coast of Upper Part of Southern Thailand

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Abstract

Major rubber plantation in Thailand is in the southern part of the country, in which soils are highly weathered and acid. Most of the plantations are replanted both from rubber and other crops repeatedly for more than 40 years, which could explain soil fertility loss. Forty three samples of soils and leaves were collected from 4 year-old rubber plantations during June to July 2009 in the east coast of upper part of southern Thailand. The samples then were analyzed following standard procedures. The nutrient status was done by comparing nutrients with the diagnostic criteria. From the criterion of rubber soils, the results showed that CEC and exchangeable K were low in every sample. Most of the soils had medium organic matter and exchangeable Ca, but low in available P and exchangeable Mg. The results of leaf analysis showed that most of the samples had low N and K. P and S were in a wide range of low to high. Mg was high to very high. Fe and Cu were medium to high in almost samples. And most of them had high Ca, Zn and B. Mn was very high to toxic in almost samples. From the results, the farmers should apply more N, P and K fertilizer than those of normally recommendation in this region. Mg, Ca, Cu, Zn and B are not the problem for nutrient management in most of the samples. These nutrients may be added to maintain them in the soils. Mn is found very high in both soils and leaves. Thus, farmers should be aware of Mn toxicity.

Keywords: Nutrient status, Rubber growing-soil, Rubber leaves, Rubber

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PP-01 *Biology and Agronomy of rubber production*

Position of Probe Setting on Sap Flow Value and Transpiration of Young New Clone Rubber Tree

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ABSTRACT

The rubber tree transpiration nowadays is interested for water consumption by tree. However, many techniques of sap flow measurement still have been in the process of development of accurate estimation. Therefore, this work was to study the effect of position of probe setting on response of xylem sap flow value and also evaluate the tree transpiration of young new clone rubber tree. The three positions of sap flow probe setting at 10 cm, 50 cm and 100 cm above ground along the vertical trunk of 2 years old rubber tree planted in fruit tree division, Khon Kaen University were evaluated. The transient thermal dissipation method according to Do and Rocheteau (2002) and Isarangkool Na Ayutthaya et al. (2010) were used for sap flow measurement in this work. The result showed that the probe setting at 10 cm above ground were not responded to the tree transpiration, they were extremely over estimated. The probes at 50 cm and 100 cm above the ground exposed the possible value of xylem sap flow, the maximum value of sap flux density in these positions were less than 4 L $dm^{-2}h^{-1}$. Additionally, the evaluation tree transpiration of 2 years old of young 8 new rubber tree clones which planted in Nongkhai Rubber Research center, Thailand was conducted during June-August 2014. The probe of sap flow measurement was inserted on the trunk at 50 cm above ground. The result showed that the tree transpiration of young rubber trees were range from 500-2500 ml $tree^{-1}$ day^{-1}. However, the number of leaves on the tree was a main factor that regulated the tree transpiration.

Keywords: *Hevea brasiliensis*, Transpiration, Sap flow probe, Probe position

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PP-02 *Biology and Agronomy of rubber production*

Potential of Phosphate Solubilizing Bacteria Isolated from the Rubber Tree Plantations in Northeast Thailand to Solubilize Insoluble Phosphates and IAA production under *invitro* Conditions

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ABSTRACT

Besides the current climate change problems and the degradation of natural resources, which are the main factors affecting agricultural productivity, the adoption of rubber tree cultivation coupled with the clear-cutting of forests, and the use of high levels of chemical fertilizers and pesticides destroy ecosystems and soil fertility. Generally, the activities of soil microbes are involved in decomposition processes of organic matter and the release of minerals in the soil. Phosphate-solubilizing bacteria (PSB) are an alternative to enhance the solubilization of insoluble P compounds while enabling the conservation of ecosystems with sustainable practices. Phosphate solubilizing bacteria (PSB) isolated from rubber tree plantations were able to solubilize phosphate into available inorganic phosphorus for plant growth and enable auxin (IAA) production by using different P sources [Tri-calcium Phosphate ($Ca_3(PO_4)_2$), Ferric Phosphate ($FePO_4$) and Aluminum Phosphate ($AlPO_4$)]. The present study examined PSB isolated from different root rhizospheres of rubber trees in RoiEt, Mahasarakham and KhonKaen provinces on specific culture media (National Botanical Research Institute Phosphate Growth Medium, NBRIP). Our results showed that only five pure isolates encoded PSB RK01-05 at KhonKaen province efficiently solubilised $AlPO_4$ and $FePO_4$, which is the main form of insoluble phosphates in acidic sandy soils, by releasing 419.75 and 1,492.46 mg of inorganic P per liter respectively after five days of incubation. Finally, the IAA production of the 5 pure isolates of PSB were analysed. The results showed that only 4 pure isolates were able to produce IAA hormone. PSB isolates encoded PSB RK-01 produced a significantly ($P \leq 0.01$) higher amount of IAA hormone (1,897.50 mg/L) over the other PSB isolates after five days of incubation. These results highlight the variability of specific PSB isolates sampled in rubber tree plantations in different areas.

Keywords: Auxin, Bacteria, Phosphate Solubilization, Rubber

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PP-03 *Biology and Agronomy of rubber production*

Effect of Moisture Content on Pollen Storage of Hevea clone RRIM 600 and RRIT 251

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ABSTRACT

Non-synchronous flowering and low natural pollination make breeding between clones of *Hevea brasiliensis* difficult. Pollen storage in liquid nitrogen (-196°c) was an ideal strategy for long-term preservation for hybridization. This study investigates pollen viability of clone RRIM 600 and RRIT 251 after long storage in liquid nitrogen. Anther of both rubber cloneswere dried to 7% and 11% of moisture content levels before storage in liquid nitrogen for 180 days. Pollen viability was assessed by in vitro germination and 2,3,5- triphenyl-tetrazolium-chliride stained in every 5 days storage. The results showed the moisture content at 11% in the final day storage (180 days) were found pollen stained and pollen germination higher than at 7% of moisture content. This were the pollen stained and pollen germination in clone RRIM 600 at 2.00%, 1.31 % and clone RRIT 251 at 2.06 % and 1.38% respectively. This study finding the pollen storage for 90 days was suitable for breeding by hand pollination within the same season, at both moisture contents. With this storage time pollen viability were more than 10 % which correlated with the duration of Hevea flowering period (3 months).

Keywords: *Hevea brasiliensi*s, Rubber tree, Liquid nitrogen, Pollen viability, Pollen germination

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PP-04 *Biology and Agronomy of rubber production*

Somatic Embryogenesis and Plant Regeneration from Inner Integument of *Hevea brasiliensis*

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ABSTRACT

To evaluate the ability of somatic embryogenesis and plantlet regeneration from culturing inner integument of rubber tree (*Hevea brasiliensis*) four different clones of the trees, RRIM600, BPM24, RRIT251 and RRII105 were studied. The results showed that clones of rubber tree play significant role in somatic embryogenesis and plantlet regeneration. The highest frequency of callus induction, embryogenic callus induction, somatic embryogenesis and plant regeneration was obtained in RRIM600. In this studies, somatic embryo induction at frequency of 39 and 18 % was obtained in RRIM600 and BPM24, respectively. Only clone RRIM600 could regenerate into plantlets at frequency of 2 %.

***Keywords*:** *Hevea brasiliensis*, Inner integument, Callus, Somatic embryogenesis, Regeneration

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PP-05 *Biology and Agronomy of rubber production*

The Efficiency of Microsatellite Marker from Cassava in Genetic Analysis of Rubber Tree

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ABSTRACT

The purpose of this research is to study the efficiency of microsatellite marker from cassava in genetic analysis of rubber tree. A total of 40 SSR primer were used to analyse. Twenty - five SSR primers were able to amplify DNA fragments from rubber tree. A sixty-three DNA fragment were generated in range of 18 to 372 bp, of which average 1 to 6 alleles per marker. While a total of 40 primer pair were able to amplify DNA fragments from cassava. A hundred and six DNA fragment were generated in range of 94 to 377 bp, of which average 1 to 5 alleles per marker. The result indicated that microsatellite marker from cassava could be used as molecular markers for rubber tree genetic study.

Keywords: Alleles, DNA fragments, Microsatellite marker, Primers

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PP-06 *Biology and Agronomy of rubber production*

Microcutting as a Tool for Propagation and Genetic Transformation in Rubber Tree

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ABSTRACT

Rubber tree, belonging to the genus *Hevea,* is an economically important crop of Thailand. Propagation of the tree is generally carried out by budding. In this case, rootstock is necessary, and may affect latex yield due to interferences between rootstock and scion. To avoid this situation microcutting would be preferable and further used as initial explants for gene transformation. Murashige and Skoog (MS) medium supplemented with 5 mg/l 6-Benzyladenine (BA), 0.5% activated charcoal, 3% sucrose and 0.75% agar induced multiple shoot formation in both nodal segment and shoot tip explants. Addition of silver nitrate to the culture medium at concentration of 1 mg/L increased the number of shoots to maximum 5 shoots/culture explants with a better quality. For *Agrobacterium*-mediated gene transformation shoots segments inoculated with *A. tumefaciens* carrying plasmid pCAMBIA 1304 for 30 min in darkness on rotary shaker at 100 rpm and 28°C showed the higher survival rate than nodal segments after being cultured on glyphosate containing MS medium for one month. Assessment of transformed shoots revealed positive results in GUS histochemical assay. The integration of genes in plant genome was positively detected by PCR technique and dot blot hybridization. From this success improvement of some important traits e.g. herbicide and disease resistance, especially white root disease, is possible and will be propagated for future plantation.

Keywords: Rubber tree, Microcutting, Silver nitrate, Gene transformation, Shoot tip

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Rubber Technology

OT-01 *Rubber Technology*

Homogeneous of Natural Rubber Coagulum under Outdoor Maturation

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ABSTRACT

The objective of this study was to understand the homogenous of maturated natural rubber coagula. The natural rubber coagulum is obtained by naturally coagulated latex in the cup after tapping. The maturated coagula were spread under outdoor condition for 45 days. Outside and inside parts of coagulum were representative to evaluate the homogenous of rubber during maturation time. The variation of pH during naturally coagulation was investigated. The physical properties of rubber , Total Solid Content (TSC), Initial Plasticity(Po) and Plasticity Retention Index (PRI) were analyzed at 4, 15, 30 and 45 days of maturation. The results shown that, the initial pH of fresh latex was 6.7-6.9 after 24 hours of standing, it decreased to 4.9-5.2 and slightly increased up to 5.4-5.6 after 60 hours. The properties of outside part were lower than inside parts, such as Po and PRI while TSC and pH of Inside part were higher.

Keywords: Fresh latex, Natural rubber coagulum, Maturation**,** Homogeneous of rubber**,** Physical properties of rubber

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OT-02 *Rubber Technology*

Properties of Polymer-Modified Cement and Coated Para Rubber Shell Concrete

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ABSTRACT

This research was aimed in producing of green building materials on context of para rubber latex (PRL at 60% DRC) using as filler and para rubber shell (PRS) as coarse aggregate. Under synthetic processing involved 50%PRL and sulfur 50 phr with heating at 70°C for 13 h was produced epoxidized natural rubber (ENR-35). PRS aggregate was coated by ENR-35 dipping method, and vulcanized for two stages. Primary stage, ENR-35 PRS aggregate dipped in PRL+H_2SO_4+emulwin+distilled water+formic acid 96% conc+H_2O_2 mixture with heating at 70°C for 24 h then increasednearly120°C for 30 min was adopted on the first layer of PRS. After a day it was coated over the coated PRS (CPRS) again by same vulcanization for the second layer. The second stage, CPRS was performed pre-wetting before casting the concrete specimens for five days. The specimens were cast bynon-compacted concrete (NCC) method and accompanied water to binder ratio constant at 0.45 throughout this study. The ENR-35 was also mixed about 5 wt.% of water using in preparing specimen in 8 batches and polyvinyl sheet to prevent moisture loss during curing in ambient temperature (29°C, 84%RH) for 28 days was wrapped. The series testing was composed of volumetric drying shrinkage, bulk density and compressive strength. The most ingredient suitable mixture of NCC regarded Portland cement: sand: CPRS of 1:0.94:0.046. The CPRS concrete provided slump in 120 mm, bulk density of 1,916 kg/m^3, compressive strength of 37 MPa and volumetric drying shrinkage in 6 months was decreased steady less than 2%. However, dominant specimen was met specification of structural lightweight concrete. This beneficiation of CPRS concrete is also product as the green innovation building in terms of construction materials and resources, leaving minimal environmental impact, and *eco-friendly materials.*

Keywords: Rubber technology**,** poxidized natural rubber, Para rubber shell aggregate, Light weight concrete, Green building materials.

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OT-03 *Rubber Technology*

Selection of Antioxidants from Natural Rubber and Development of Clean Extraction Method

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ABSTRACT

Hevea latex, obtained from rubber trees by tapping, is known to contain around 3-5 % of non-isoprene substances besides 30-45% of rubber hydrocarbon (poly (cis-1,4-isoprene)). These "non-isoprene" consist of various compounds such as proteins, carbohydrates, lipids, amino acids, nucleic acids and inorganic constituents. The lipid extraction method for both latex and dry rubber were purposely developed by our group in order to study the impact of lipids on NR quality. The work showed that chloroform/methanol (2:1 v/v) was suitable for lipid extraction from natural rubber latex and that some lipids may have antioxidant activity. However, to utilize those lipids for other applications for instance in pharmaceutical area, lipid extraction using less solvent toxicity must be developed. The purpose of the present work was to improve lipid extraction by proposing the use of more environment friendly solvents such as ethyl acetate, limonene and ethyl: ethanol (2:1; v/v) and to test the anti-oxidant activity of extracted lipids. Among the tested solvents, ethyl acetate and ethyl acetate/ethanol (2:1 v/v) gave statistically the same lipid extraction yield (2.0% and 2.4%) while limonene was not found appropriate for the extraction. However, by using ethyl acetate alone, the step of water soluble component removal using 0.9%NaCl solution could be skipped. Besides the extraction yield, antioxidant activity of lipids extracted from different solvents was measured using DPPH methods. The results showed that the antioxidant activity of total lipids extracted from all solvents indicated by %DPPH remaining were similar at our tested concentration. Moreover, the unsaponifiable fraction which mainly contained plant sterols and tocotrienol gave higher level of antioxidant activity than those of total lipids. Therefore, ethyl acetate appeared to be the suitable choice for this purpose.

Keywords: Natural rubber latex, Lipid, Antioxidant, DPPH method

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OT-04 *Rubber Technology*

Optimization of Protein Extraction from Different Latex Samples of *Hevea brasiliensis*

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ABSTRACT

The objective of this work is to provide the protein composition of latex of different clones of *Hevea brasiliensis* (i.e. PB235, RRIM600, BPM24, GT1 and RRIT251). Additionally to the extraction method itself, different treatments of whole latex (WL) were tested to prevent latex from any deterioration/destabilization, which might damage proteins. These treatments include: stabilization of whole latex with an adequate buffer to generate stabilized latex (SL), freezing WL and SL in liquid nitrogen to generate frozen whole latex (FWL) and frozen stabilized latex (FSL) respectively, freeze-drying WL and SL to generate dehydrated whole latex (DWL) and dehydrated stabilized latex (DSL) respectively.

Latex in the form of WL, SL, FWL and FSL were treated using four different aqueous extraction buffers. After freeze-drying process, DWL and DSL were ground and proteins were extracted using an organic solvent. The protein composition of the extracts obtained from different samples and extraction methods was studied by one-dimensional (SDS-PAGE) and two-dimensional (electro focusing) gel electrophoresis. This systematic study provides a complete protocol to compare the protein composition of latex from different clones of *Hevea brasiliensis*.

Keywords: Clone, Latex, Protein extraction, SDS-PAGE, 2D electrophoresis.

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OT-05 *Rubber Technology*

Study of The Rubber Particle of Latex from *Hevea brasiliensis* by a Biomimetic Approach in Langmuir Films

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ABSTRACT

Rubber particles are made of a core of polymer surrounded by a mixed lipid/protein monolayer. One major protein, REF, is located on the surface of particles. The yield and the quality of NR depend on certain proteins present on the surface of particles and it is thus of prime importance to understand the mechanisms governing the lipid/protein/polymer interactions determining the structure of NR particles.

To mimic the lipid/protein monolayer surrounding the rubber particle, we have studied recombinant REF protein interacting with Langmuir films, i.e. native phospholipid monolayers formed at the air/water interface. The REF/phospholipid interactions were investigated using different methods of biophysics: vibrational spectroscopy, microscopy and ellipsometry. The results show that REF displays very specific properties in the presence of model membranes made of native lipids from latex.

Keywords: Latex, Langmuir model, Phospholipids, Rubber Elongation Factor (REF), Rubber particles.

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PT-01 *Rubber Technology*

Effect of Blowing Agent Content on Microcellular Structure, Physical Properties and Thermal Conductivity of Natural Rubber Foams

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ABSTRACT

Natural rubber (NR) foams were prepared by compression molding technique. The chemical blowing agent used in this study was oxybis (benzene sulfonyl) hydrazide (OBSH). The effect of OBSH content on the cell structures, physical properties and thermal conductivity of the NR foams was investigated. It was found that relative foam density, hardness, 300% modulus and tensile strength decreased with increasing OBSH content, while the compression set increased. The morphology showed that the foam porosity increased with increasing OBSH content. Moreover, the thermal conductivity of the NR foam decreased as increasing loading levels of OBSH, which is associated with the formation of smaller foam cells and greater number of cell structures. Higher foam porosity of the foams directly corresponded to lower relative foam density and thermal conductivity. Among them, 9 phr OBSH produced the cellular rubber with the finest morphology, lowest thermal conductivity, significant density reduction and acceptable loss of mechanical properties.

Keywords: Blowing agent, Density, NR foam, Oxybis (benzene sulfonyl) hydrazide, Thermal conductivity

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Socio-Economics

OS-01 *Socio-Economics*

Development of Natural Rubber Products for the Natural Disasters Relief in Thailand

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ABSTRACT

The most devastating natural disasters in Thailand during last decade are flooding and earthquake, leading to loss of life and economic damages. In the case of severe flooding occurred during the 2011, the World Bank has estimated 1,425 billion baht in economic damages and losses due to flooding. Most of this was to the manufacturing industry, as seven major industrial estates were inundated by as much 3 meters (10 feet) during the floods. Flooding persisted in some areas until mid-January 2012, and resulted in a total of 815 deaths (with 3 missing) and 13.6 million people affected. The disaster has been described as "the worst flooding yet in terms of the amount of water and people affected. Furthermore the damage from earthquake in Thailand, often occurs in northern, western, and southern part of Thailand, becomes major problem. The latest and largest inland earthquake in Thailand occurred on May 5, 2014 in Chiang Rai province, Northern Part of Thailand and the magnitude was 6.3. The damage from this quake was estimated to be larger than 1 billion baht. In the first year project for the water barrier produced from natural rubber, the influence of hydrogel content on the morphology and water absorbability of cellular rubber produced by dry natural rubber and latex. The morphological studies indicated that the porosity of dry rubber decreased with the adding amount of hydrogel from 20 to 50 phr, while the increase of hydrogel concentration tended to increase the porosity and water absorbability. The water absorbability of cellular rubber tended to decrease with the increasing amount of hydrogel from 100 to 150 phr. The results obtained from latex showed that the porosity decreased with the increase of hydrogel content. However, in the case of hydrogel was coated by polyethylene glycol (PEG) prior to mixing with latex, it can be observed that the hydrogel was well dispersed and can be used to increase the loading of hydrogel content and thus enhanced the water absorbability. Furthermore, the analytical results obtained from the Finite Element Method (FEM) for the construction of flood barrier and base isolator showed the suitable pattern for designing both products. The water barrier and base isolator obtained in this work will be manufactured and verified by testing equipment and field test.

Keywords: Flood barrier, Base isolator, Natural rubber, Hydrogel, Finite element analysis.

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OS-02 *Socio-Economics*

The Study of Rubber Smoked Sheet Price Forecasting Model

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ABSTRACT

The objective of this paper is to identify time series forecasting model of Rubber Smoked Sheet Prices (RSS3) for short periods (7 days) forward. Daily price from January 2008 to July 2012 were uses as main factor. Three forecasting techniques, namely Box and Jenkins, Hybrid Forecasting methods and Multiple Regression were applied to identify the suitable forecasting model. Daily Rubber Smoked Sheet Prices (RSS3) data from Nakhon Si Thammarat central rubber market were used as main data in Box and Jenkins (ARIMA model). While Hybrid Forecasting methods are forecasting method using ARIMA Model together with Artificial Neural Network. Whereas Multiple Regression, Singapore Commodity Exchange (SICOM), Tokyo Commodity Exchange (TOCOM), Shanghai Futures Exchange (SHFE) and exchanged rate USS to Thai Baht have been used as main factors for forecasting RSS3. Then three statistic value, (1) Mean Absolute Error: MAE (2) Root Mean Square Error: RMSE and (3) Mean Absolute Percentage Error: MAPE were investigate the accuracy of these three forecasting models. The result of comparative study showed that the results of the comparative study show that Hybrid Forecasting method gave the lowest value of MAE, RMSE and MAPE as 0.214, 0.988 and 0.668 respectively. The result from Multiple Regression showed the value of MAE, RMSE and MAPE as 0.786, 1.339 and 0.842 respectively. While the result from Box and Jenkins showed the highest value of MAE, RMSE and MAPE as 0.970, 1.353 and 1.061 respectively. From the result can be concluded that Hybrid forecasting method is the most suitable for predicting Rubber Smoked Sheet Prices (RSS3). Disadvantage of Hybrid Forecasting Method, cannot be displayed the factor which influence to the variation of RSS3 price. While according to consisted of important factors as Singapore Commodity Exchange (SICOM), Tokyo Commodity Exchange (TOCOM), Shanghai Futures Exchange (SHFE) and exchanged rate USS to Thai Baht, even though Multiple Regression showed higher value of MAE, RMSE and MAPE than Hybrid Forecasting Method, but this model gave more information about the factors which impact to Rubber Smoked Sheet Prices (RSS3).

Keywords: Forecasting model, Box and Jenkins, Hybrid forecasting, Multiple regression, Rubber smoked sheet prices (RSS3)

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OS-03 *Socio-Economics*

Social Security of Smallholders which Practice Associate Crops in Rubber Plots in Southern Thailand

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ABSTRACT

Over ninety percent of rubber plantations in Thailand are monocrop and depend on price uncertainty. The rest have some associate crops in their rubber plots (ACRP) to protect economic and environmental conditions. Meanwhile, social aspects of ACRP seem to be overlooked by most farmers and academics. This study aims to assess social security, a hidden value of ACRP that can be of great use to future agricultural development. It was conducted in Songkhla and Phatthalung where there was a diversity of ACRP systems as well as farmers' groups and networks promoting ACRPs. A purposive sampling was introduced to select the sampled groups. Data was collected in 2013 by a number of field surveys and interviews with 12 ACRP farmers, their neighbors and village leaders (an interview ratio was 1 ACRP farmer: 3 neighbors: 1 village leaders) and analyzed data with a content analysis.

With all seven indicators of ACRP social security, developed by this study, the results showed that all ACRP farmers gained: (1) more ACRP knowledge ranging from professional to semi-skill levels, (2) respect from individuals and related organizations, and (3) better health because they usually worked in farm with shady and refreshing circumstances and ate chemical-free products of the associate crops. Most ACRP farmers donated 8-80 % of the productions of associate crops for charity, and participated in ACRP promoting networks. Half of the ACRP farmers joined their community ACRP promoting groups. A few ACRP farmers gave their productions of associate crops to traditional activities. Therefore, the social security of ACRP farmers helped strengthen their communities regarding self-esteem, capacity building, quality of life, traditional descent, and harmony. Also, ACRP farmers indirectly supplemented the routine social welfare programs of local and central governments into community by ACRP practices.

Keywords: Associate crop in rubber Plot, Social security, Southern Thailand

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OS-04 *Socio-Economics*

Farm Trajectories and Recent Changes in the Rubber Farms in Southern Thailand

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ABSTRACT

Rubber has been grown in Southern Thailand for many decades. Now, in 2014, the rubber sector faces several challenges: land use changes, labor constraints, and price fluctuation. Therefore, the aim of this paper is to show how the rubber farms evolved in this changing environment. A purposive sampling household survey of 393 rubber landholders and interviews of key informants from four representative villages in Songkhla and Phatthalung provinces provided data for analysis. We established and characterized a typology of rubber farm trajectories since 1990. An innovative method using two sequence steps: multivariate analysis and systematic clustering technique was conducted. The results show that six farm trajectories can be identified depending on farm structure evolution. Stability of family farms (38.2% of farms) showing no evolution of the farm size and labor use, is the trajectory gathering the largest proportion of farms for the past 20 years. High structural change of the farms (10.5% of farms) and declining very small farms (25.0% of farms) are constituted by farms that experienced a decrease in the size and limits to expansion. In opposite, three trajectories, namely "growth of large family farm enterprise" (4.1 %), "growth of medium family farm enterprises" (14.5%), and toward "patronal farms" (7.7%) are composed of farms with a continuing expansion in landholding and hired labor use. The six farm trajectories highlight ongoing structural transformation of rubber economy in Southern Thailand during the 1990-2010 periods.

Keywords: Farm trajectories, Typology of farm, Farm change, Rubber economy

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OS-05 *Socio-Economics*

Agriculture Practices of Rubber Plantation in Northeast Thailand and Its Relation to Crop Growth

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ABSTRACT

With various numbers of small and inexperienced rubber holders in Northeast Thailand agricultural practices may vary resulting in the variation of crop growth. Therefore, this study targeted to classify farmers' practices in rubber production as well as its impact on rubber growth. Stratified sampling technique with finally 161 farmers were done in Kranuan, Nampong, Ubonrat and Muang districts in Khon Kaen province, Northeast of Thailand and data were collected by using structured questionnaires. Classification of agricultural practices according to management intensity in rubber was performed. The results showed that on average, farmers had 1.6 plots per each with maximum of 4 plots. Average rubber area is 1.65 ha/household varied from 0.16-9.6 ha. Average rubber age was 7.23 years old with lowest of 0.1 year and oldest of 27 years old. RRIM 600 clone is most widely grown by farmers (93% of total plots) while RRIT 251 is about 6%. More than 50% of plots have sugarcane as a previous crop, followed by cassava (less than 40%). Cassava was the intercrop widely grown during immature period (>50%), followed by mono-rubber (25%). Based on tillage, intercropping, fertilization, herbiciding and irrigation intensities, 4 types of classes has been identified for both immature and mature rubber; high intensity, medium, medium/low and low practices. No significant difference was found among different practices in tree girth in both immature and mature rubber. This work indicates that plant growth in terms of tree girth was not affected by different management intensity. However, further study on yield variation, particularly long term production of various practices under different land suitabilities may provide information for production improvement of rubber in Northeast Thailand.

Keywords: Cultural practice, Management intensity, Tree girth

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OS-06 *Socio-Economics*

Impact of Rubber Plantation on Daily Time Spent of Small Holders in Northeast Thailand

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ABSTRACT

Expansion of rubber into new planting areas is expected to affect the daily time spent of growers; however knowledge on this aspect is still very less study on rubber activity impact to traditional activities on farm. This study aimed to investigate the impact of rubber production on the daily time spent on income-earning and non-income earning activities of small holders in Northeast Thailand. The sampled households included non-rubber growers and rubber growers at non-tapping and tapping stages, each with different sizes of land or rubber plantation holding. Data were collected by interviewing totally 114 households in three villages, representing areas with high and moderate densities of rubber plantations in different promotion periods. The results showed that, when the rubber plants could be tapped, growers spent a lot of time on rubber production activities, but they also maintained much of other income-earning activities. Consequently, tapping rubber growers spent more time in the overall income-earning activities (38.3%) than non-rubber growers (20.5%) and non-tapping rubber growers (16.3%), meaning that they worked harder than farmers in the other two groups. Significant effects were also found on the time spent on non-income earning activities. At the tapping stage, growers spent less time in sleeping, in activities with family members, and in relaxation and household tasks when compared to non-tapping and growers groups, but no clear effect was observed on the time spent on public and community activities. The times in doing these activities were also changed to fit the working time for rubber tapping and processing, which in the most part were done during the night time. It appeared that rubber growers in the Northeast have already adjusted their time spent on these activities to the best of their earned income. The effects of rubber production on growers' daily life were not seen as a barrier for new growers in the region to take up rubber plantation.

Keywords: Rubber production, Labor use, Labor allocation, Small rubber plantation holder

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PS-01 *Socio-Economics*

Adaptations of Small Rubber Farmers to Drought and Fluctuated Rubber Price Conditions in Northeast Thailand: A Case of Kra Nuan District, Khon Kean Province

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ABSTRACT

Rubber plantation was introduced and has been promoted throughout the Northeastern Thailand characterized by typical dry condition. In addition, rubber farmers faced fluctuated rubber price in recent years. How do these conditions affect rubber smallholders and the way these farmers adapt themselves to these conditions were the focal interest of the current study. A structured interview was conducted with 18 non-tapping and 19tapping farmers in Kra Nuan District of Khon Kaen province in June 2014. Qualitative data analysis was done. The study found that both non-tapping and tapping rubber farmers perceived the fluctuated rubber price to have more impact on their farming activities than the drought conditions. As a result, the rubber farmers have adapted themselves to the rubber price conditions by adjusting production and labor cost that compromises with household income and expenses. The study also found that the drought condition affects both non-tapping and tapping rubber farmers on their rubber farming schedule activity. Thus, the farmers have adjusted themselves to the drought conditions by being flexible on their farming scheduling that suits the environmental conditions. Supplement irrigation, delayed fertilization, and increased manure fertilizer application were found as the main responses during drought of immature rubber farmers. Delayed fertilization and tapping were the coping strategies of tapping farmers to drought while farmers respond to fluctuated price of rubber by delay tapping, changes to sell coagulum instead of rubber sheet and group selling of the products. Diversified sources of income by relying on off-farm activities were found to be farmers' main adaptation under both conditions. This study suggests that farmers only have a short- term coping strategies in response to both problems. Long-term and well-planned strategies by all stakeholders should be implemented for the future.

Keywords: Adaptation, Dry condition, Impact, Smallholder, Low price of rubber

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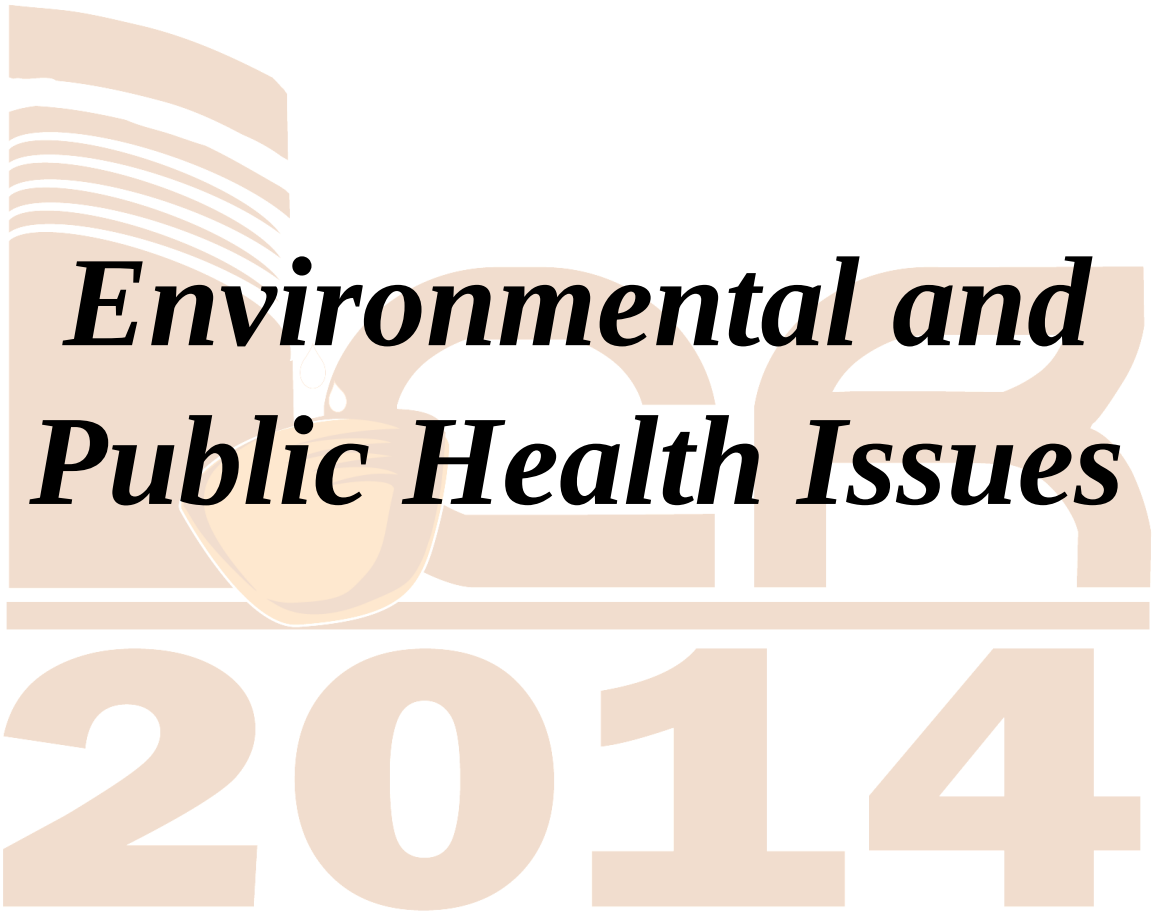
Environmental and Public Health Issues



OE-01 *Environmental and Public Health Issues*

Scaling-up Upflow Bio-Filter Circuit (UBFC) for Sulfate-Sulfide Rich Treatment from Rubber Sheet Process Wastewater

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ABSTRACT

Sulfate and sulfide contamination in wastewater caused a major crisis of water pollution that need to be treated by a bio-electrochemical technique of microbial fuel cell. In this study the UBFC, a bio-catalyst microbial fuel cell was applied to remove sulfate-sulfide from rubber latex sheet process waste water. Two sizes of UBFC reactors (40L and 250L) were scaled up from the original (4L) and tested their capability and feasibility. The results presented a high sulfide removal efficiency over 70% of initial concentration of sulfate-sulfide 350-450 mg/L without chemical and nutritional addition in all reactor sizes. The minimum cost of the 250L plant scale prototype was US$ 1,280 / m^3 and the operating power consumption was less than 0.32 kWh/m^3. It indicated that the economic strategy of the plant scale UBFC prototype has potential to promote as sulfate-sulfide rich wastewater treatment technology for rubber latex sheet process industries.

***Keywords*:** Bio-catalyst, Microbial fuel cell, Rubber latex, Sulfide, Wastewater treatment

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OE-02 *Environmental and Public Health Issues*

Risk of Vector-Borne Diseases in Relation to Rubber Plantations in Lao PDR

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ABSTRACT

The land cultivated for rubber is expanding rapidly in Laos. We anticipate that the change, from secondary rainforest and agricultural land to rubber cultivation and the maturation of these rubber trees, will change the risk from vector-borne diseases. Specifically the tapping of latex at night and collecting of latex during the day will increase the exposure of rubber workers and their families to vector mosquitoes. Our objective was to recognize possible vectors in the rubber plantations and identify at which times rubber workers are exposed to these mosquitoes. We investigated the exposure risk in northern Laos by comparing the mosquito diversity and density in the mature rubber plantations (i.e. tapped for latex) with that of immature rubber plantation, secondary forests and villages. We used a new sampling tool, the 'double bed net method', to collect anthropophilic mosquitoes. In 2013 we sampled mosquitoes every hour for two days and two nights in three study areas every month from July to November. In 2014 this was carried out every two months from January to July. More than 19,000 mosquitoes have been collected from the rubber plantations, secondary forests and villages. Results of the comparison between habitats are expected soon. A total of 68 different mosquito species were identified in the mature rubber plantation, including *Aedes albopictus, Anopheles dirus s.l., An. minimus s.l., An. maculatus s.l.* and *Culex visnui*. The highest mosquito exposure in mature rubber plantations was from 15:00 to 22:00, which overlapped with when rubber labours were working. Thus vectors of globally important diseases like dengue, chikungunya, malaria and Japanese encephalitis were found inmature rubber plantations with rubber workers active in the plantation during the highest mosquito exposure. This study emphasizes the need to further explore the relations between rubber plantations and vector-borne diseases in order to protect rubber workers and their families.

Keywords: Laos, Mosquito ecology, Rubber plantation, Vector-borne diseases

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OE-03 *Environmental and Public Health Issues*

Ergonomic Design of Rubber Tapping Knife

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ABSTRACT

The objective of this study was to design an ergonomic Rubber Tapping Knife which could reduce work related risk of musculoskeletal disorder (MSDs) and meet the users'satisfaction. The design was specific on size and shape of Rubber Tapping Knife. Enquiries were made on body discomfort and satisfaction of 30 rubber tappers selected from Nayong and Yantakaw district, in Trang province. The research methodology included 9 steps as follows: 1) data collection of existing problems concerning conventional rubber tapping, 2) assessment of the users' body discomfort and their level of satisfaction on that conventional knife ,3) test of REBA technique, 4) Data management and hypothesis for ergonomic design, 5) development of a prototype tested in fields, 6) assessment and analysis of comments , 7) redesign for minimizing limitation, 8) data analysis, and 9) conclusion for final ergonomic model. This study revealed that the ergonomic Rubber Tapping Knife, outcome of this study, resulted in improve dusers' working postures so that it could reduce work-related of MSDs. In addition, the satisfaction of users is acceptable.

Keyword: Musculoskeletal disorder, Rubber tapping knife, Ergonomic

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OE-04 *Environmental and Public Health Issues*

Musculoskeletal Disorders among Rubber Tappers: Case Study Paphayom District, Phatthalung Province

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ABSTRACT

This cross-sectional descriptive to determine the prevalence of musculoskeletal disorders (MSDs) among rubber tappers. There were 250 rubber tappers in Paphayom District, Phatthalung Province enrolled into this study. Data were collected by a questionnaire-based interview. Descriptive statistics was used to describe the general data and prevalence. The factors affecting to MSDs and odds ratio (OR) were analyzing by inferential statistics at 95% confidence interval (95%CI). The results showed that most participants were female (56.8%), the mean age was 42.1 years (S.D. = 12.6 years), the mean working experience was 12.6 years (S.D. = 8.3 years) and the mean Body Mass Index (BMI) was 22.3 (S.D. = 3.5). The Prevalence of MSDs in last 6 months was 87.2 (95%CI = 83.03-91.36) with low back pain, hand & wrist pain, upper back pain, knee pain, and foot pain in percentage of 72.8, 40.0, 34.0, 31.6 and 28.4 respectively. Risk factors were statistical significantly resulted in MSDs, namely, age ≤42years (OR=2.89, 95% CI=1.24-6.78), work experience ≤7 years (OR=2.46, 95% CI=1.16-5.22), drinking (OR=2.61, 95% CI=0.96-7.06) and firm tool grip (OR=0.30, 95% CI= 0.14-0.65). From the multivariate analysis, gendle male (adjOR = 4.28, 95% CI = 1.65 – 11.08), age ≤42 years (adjOR = 3.16, 95% CI = 0.03 – 1.11), drinking (adjOR=8.26, 95% CI=2.44-27.91), firm tool grip (adjOR=0.24, 95% CI= 0.99-0.58) and number of rubber trees (adjOR = 2.57, 95% CI =1.05 – 11.08), were significantly associated with MSDs. From the analysis, it was found the high prevalence of MSDs in this study were lower back and hand & wrist pain. Personal factors and working conditions that affect of MSDs are helpful for health promotion of rubber tapper. Furthermore, the rubber tappers have to learn the principles of ergonomics to reduce MSDs.

***Keywords*:** Ergonomics, Low back pain, Musculoskeletal disorders, Prevalence, Rubber tappers

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OE-05 *Environmental and Public Health Issues*

Evidence – Based Interventions to Promote Functional Ability and Working Performance for Aged Para Rubber Farmers with Knee Osteoarthritis in Thailand

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ABSTRACT

The majority of para rubber farmers in Thailand are aged workers who commonly having knee pain from osteoarthritis. Few perform interventions to control their health problem despite well-documented about joint protection nondaily activities and muscle strengthening for potential functional ability and quality of life of elderly with knee osteoarthritis. Especially, the aged para rubber farmers in Thailand that rarely perform those preventive measures on their daily activities including working process. This systematic review aimed to analyze the interventions that promote functional ability and working performance for elderly with knee osteoarthritis and synthesize the findings for developing self-care promoting program in order to enhance health and well-being of the elderly who working in para rubber farms of Thailand.

Methodology: Ten studies including meta-analysis, randomized controlled trials, and quasi-experimental studies published during 2000 - 2013 from electronic databases were recruited.

Findings: Participatory ergonomic interventions and muscle strengthening delivered by educational and self-management program are two effective strategies that promote functional ability and working performance for elderly with knee osteoarthritis. The evidences were used to develop a self-care promoting program that enhances health and well-being of the elderly who working in para rubber farms of Thailand.

Recommendation: interventions should focus exclusively on participatory ergonomic and muscle strengthening by educating and training skills that modify the clients'pattern of living and working process.

Keywords: Knee osteoarthritis, Self- management, Elderly, Ergonomic, Muscle strengthening

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OE-06 *Environmental and Public Health Issues*

Safety Behavior for Rubber Workers in KhoTao Sub-District, Paprayom District, Phatthalung Province

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ABSTRACT

Hazard from workplace conditions that may cause rubber workers' injury or illness are not known. Therefore it is interesting to explore the demographics, safety behavior and prevalence rate of occupational disease and work-related diseases of rubber workers. Three hundred and sixty eight rubber workers in Kho - Tao sub-district were randomly selected data on health and exposure collected using a questionnaire.

The prevalence of occupational and work-related diseases were occupational dermatoses, musculoskeletal disorders and poisoning (97.0%, 94.8% and 92.1%, respectively). The participants reported regular skin exposure to chemicals (97.0%) and exposure to heavy load (59.5%). The rubber workers did not use mask, ear plug or safety glasses (81.5%, 79.3% and 53.8 %, respectively).

To prevent occupational disease and work-related diseases among rubber workers, workplace conditions should be evaluated, and controlled. Following that appropriate work instructions should be established.

Keywords: Safety behavior, Rubber worker

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PE-01 *Environmental and Public Health Issues*

Practice Improvement for Emission Control of Dust from a Wood Polishing and Drilling Processes in the Rubber Wood Factory

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ABSTRACT

This research aims to decrease the emission of dust in a wood polishing and drilling processes of the rubber wood factory participated in the project. The analysis showed that the high degree of dust emission is a result of inappropriate hood and practices. Before improvement for dust emission in workplace is 2.71 mg/m^3 and personal exposure is 0.83 mg/m^3. The result after design and improvement the hood and practices for dust emission in workplace is 0.21 mg/m^3(decrease 92.25%) and personal exposure is 0.42 mg/m^3 (decrease 49.40%). Improvement capture distance in work station, Opening duct air blow and changing the hood reduces wood dust emission significantly.

Keywords: Emission, Dust, Slot hood, Capture velocity

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