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Proceedings

**PROCEEDINGS OF
THE 10TH INTERNATIONAL CONFERENCE OF
THE EAST AND SOUTHEAST ASIA FEDERATION OF
SOIL SCIENCE SOCIETIES**

**Soil, A Precious Natural Resource:
Agricultural Ecosystems, Environmental Health &
Climate Change**

October 10 – 13
Cinnamon Lakeside Hotel
Colombo, Sri Lanka



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University of Peradeniya

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**Soil, A Precious Natural Resource:
Agricultural Ecosystems, Environmental Health & Climate Change**

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Soil Science Society of Sri Lanka

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Foreword

With the rapid increase in population growth humans have intensified their activities on the soil resource in order to meet food, fodder and fiber requirements. In addition, the pollutant load added to land has threatened the sustainability of soil and water resources. These activities have led to rapid changes in the global climate which has a direct and profound impact on the environment. Soil Scientists in the East and Southeast Asian countries, the most populous region in the world, have an enormous task ahead to understand the impact of human activities on the functions of soil resources in the region and then their contribution to minimize regional and global climate change issues. Such an understanding will then lead to formulate strategies to sustainably manage the soils in this region. With this objective in mind, the Soil Scientists in the region discuss their research findings, biannually, at the International Conference of the East and Southeast Asia Federation of Soil Science Societies (ESAFS) since it was established in 1990.

This year the Soil Science Society of Sri Lanka is hosting the 10th International Conference of the ESAFS (ESAFS10) at the Cinnamon Lake Side Hotel, Colombo, Sri Lanka from October 10-13, 2011. The theme of the ESAFS10 is **"Soil, a Precious Natural Resource: Agricultural Ecosystems, Environmental Health & Climate Change"**. Under this theme, ten currently important topics were discussed at the ESAFS10. These were: Land Degradation and Management, Management of Paddy soils for Sustainable Production, Material Cycling in Soils and Regional Environment, Soil Ecosystems and Human Health, Hydrology and Water management, Plant Nutrition and Environment, Climate Change and Land Use, Cropping Systems for Sustainable Management, Soil Biology and Crop Production, and Soil Databases & Digital Soil Mapping. These topics have a direct relevance to how we manage soil resources in ESAFS countries in order to overcome future challenges while meeting current requirements.

We received over 150 volunteer papers from 15 countries to be presented through oral and poster presentations, under above mentioned topics. All papers were carefully reviewed by a panel of reviewers and suggestions for improvements were returned to the authors to be incorporated wherever appropriate. Extended abstracts of the revised papers are published in the Proceedings of the ESAFS10. In addition, three invited speeches, and several reports on the activities of the member societies and soil information of the member countries were also included into these Proceedings. Hence important advances made in soil science research in the region since the ESAFS9, with special reference to **Agricultural Ecosystems, Environmental Health & Climate Change**, are published in the Proceedings of the ESAFS10.

This publication is a tribute to the dedication of the all authors, panel of reviewers, editorial board, publisher and the printer.

R.S. Dharmakeerthi
Editor-in-Chief
ESAFS10

Message from the ESAFS President

It is with great pleasure and pride that I send this message as the convener of the 10th International conference of the East and Southeast Asia Federation of Soil Science Societies (ESAFS) held on 10-13th October, 2011, at the Cinnamon Lakeside Hotel, Colombo, Sri Lanka. The office of the Federation moves from one member society to another every two years and the Soil Science Society of Sri Lanka is in-office hosting the conference this year.

The main objective of the Federation is to promote research in soil and related sciences and disseminate the acquired knowledge and technology for the benefit of the member societies in the region. The membership of the Federation consists of scientific societies on Soil Science, Plant Nutrition and Fertilizer Management and Technology in different countries in East and Southeast Asia where rice-based cropping system is an important component of agricultural production system. Twelve national level societies are currently serving as members of the Federation.

Member societies in the region are rich and poor in different aspects of soil knowledge and technology. Some countries have made steady progress in Soil Science research with rich soil data base while others are moving at a slower pace. Regional soil partnerships would be a good opportunity to minimize the knowledge gap through south-south cooperation for steady developments in Soil Science in the region.

Development of a nation is based on wise management of natural resources, especially soil and water. Further it is evident that nations surviving on fertile lands are rich with fewer difficulties simply because of the fact that the nutrition level and health conditions of the nations are closely associated with soil health. Unfortunately, soils in many places, especially, in the tropics are at fatigue stage due to many misuses where intensification of land uses is one of the main reasons. Increasing pressure on soil resources beyond its resilience threatens food security. Therefore, understanding these main issues related to soil sustainability, the ESAFS is conducting its 10th international conference under the theme of "Soil, a precious natural resource: Agricultural ecosystems, Environmental health and Climate Change.

Let us have our goal as healthy and productive soil for a food secure world. Let us together strengthen our capacity to protect the soil for future generations.

I wish the 10th International Conference of the East and Southeast Asia Federation of Soil science Societies a great success.

Srimathie P. Indrarane (Ph.D.)
Professor of Soil Science
President
Soil Science Society of Sri Lanka (2010-2012)
East and Southeast Asia Federation of Soil Science Societies (2010-2011)

Message from the Chief Guest

It is indeed a great pleasure for me to send this message for the 10th ESAF conference which is being held in, Sri Lanka for the first time. After a successful turnover from a period of unrest and calamity, Sri Lanka has entered in to an era of vibrant and dynamic growth and development. Sri Lanka has laid its foundation for development on agriculture which depends on the natural resource base, soil, water and climate. I have no doubt that all the countries in the South and South East Asia region also give high priority to agriculture and hence recognize the importance of managing their natural resource base which is not second to all other resources. In this scenario, treatment of this crucial resource base is of prime importance.

The shift in global developmental aspirations from a solely economic growth to sustainable development demands growth in agricultural productivity accompanied with conserving the environment and the resources. The limited extents available for cultivation of crops and other developmental needs exert a heavy pressure on soil and water resources demanding more productive management of these natural resources. Soil, being the primary nutrient reserve for the sustenance of fauna and flora on earth, has to be an efficient nutrient supplier. Increase in soil degradation due to improper management has to be arrested scientifically while ensuring the improvement of soil quality and resilience against climate change. Efforts should also be taken towards the reduction of green house gas emission and increase in carbon sequestration while making the soil more productive and fertile. Varying management options for different soils and circumstances including the redistribution and recharge of water with conserved soil structure are similarly important considerations for productive soils.

This forum would be an opportunity for the scientific community in South and South East Asian countries engaged in research activities on the management of this vital resource base to share and exchange information on the development of efficient, productive and sustainable executions of soil and water resources. Research and technological innovations in soil and water related aspects are needed every day to meet the ever growing concerns of the sustainable management of this vital resource base.. I have no doubt that this forum would be an excellent focal point for developing such technologies not only for the people in the region but for all mankind.

I wish the deliberations every success.

K. E. Karunathilake
Secretary
Ministry of Agriculture
Sri Lanka

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NUTRIENT CYCLE IN *ACACIA CRASSICARPA* PLANTATION ON DEEP TROPICAL PEATLAND AT BUKITBATU, BENGKALIS, INDONESIA

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Introduction

Development of annual crops on tropical peatland in Indonesia in most cases eventually ended up in failures and has resulted in serious environmental deterioration, including the latest huge one million-hectare rice project in Central Kalimantan. The causes of failures were widely discussed and primarily failures were attributed to land and soil characteristics for crops cultivation. Among others, flooding, peat subsidence, and problems associated with low decomposed peat material in deep peat (ombrogenous peat) and nutrient deficiencies were mentioned.

Mindful of the problems and environmental impact that could happen, utilization of tropical peatland for perennial crop production poses both economic and environmental challenges (Darmawan et al., 2011). It is too early to say however that any utilization of peatland in Indonesia will drastically lead to environmental deterioration and that it is not beneficial for the country's development. There are strong indications that some utilization for forest and oil palm plantations appear to be wise choices.

Bukitbatu is one of Indonesian peat areas in Sumatra Island dominated by deep peat having more than 10 m depth. The peatland now are used for forest plantation by cultivation of *Acacia crassicarpa* as raw material of pulp industry. Although the *A. crassicarpa* is only fertilized in the first year and with a very low rate, the growth of plant is very fast. The objective of this research is to study the nutrients cycle of the *A. crassicarpa* planted in peatland.

Materials and Methods

The research was conducted at peat swamp area in the working area of Sinar Mas Plantation at Bukitbatu, Bengkalis Regency, Riau Province, Indonesia. The area is now planted with *A. crassicarpa*. The acacia plants usually are harvested after 5 years and planted again for the next cycle. Soil samples were collected for chemical and physical analysis. For soil chemical analysis, the samples were taken compositely from the upper 10 cm layer for pH, macro and micro nutrients. The samples for bulk density were taken by using box sampler with a size of 30 cm x 30 cm x 30 cm.

Biomass measurement of standing *A. crassicarpa* plants of different ages were conducted by cutting down sample trees and weighting part of the trees. The trees were sampled within a plot of 20 m x 20 m. Some 6-7 plants of each age were sampled. The amount of litter fall down to the ground was measured by collecting the litter using a net of 1 m x 1 m size placed on about 75 cm from the ground under 3 years old of acacia trees. Each month the litter fall trapped in the net was weighted for calculating the total litter fall added to the soil. The macro and micro nutrients in the litter fall were analyzed for calculating nutrient cycle. In a separate research, rate of litter decomposition was measured by using litter bag containing litter fall laid in plantation floor. Some 48 bags containing 20 g of litter fall were laid on the surface and sub surface of the top soil with two replications. Each month, 4 bags containing litter fall were taken from the surface and subsurface soil for weighing the rest of litter fall in the litter bag.

Results and Discussion

Soil chemical analyses showed that peat soil has very low pH ranged from 3.2 to 3.5 and contained very poor in macronutrients and micronutrients. The bulk density ranged from 0.15-0.17 g/cm³ in oxidized surface layer and 0.08-0.10 g/cm³ under submerged condition. Those soil properties showed that the fertility of peat was very low. Therefore, the utilization of peatland for perennial crops which need high fertility will run into some problems. Furthermore, intensive land cultivation that must be done for the annual crops will accelerate land to change especially with peat decomposition. On the contrary, perennial crops such as *A. crassicarpa* can grow well and gave good production. To date, *A. crassicarpa* at Bukitbatu has entered to the second cycle. This fact showed that *A. crassicarpa* has proven as perennial crop that gave minimal land changes and demonstrated as very adaptive tree to grow on deep peat areas.

A. crassicarpa grows very fast (Table 1). The plant is a legume, requiring N, P, K fertilization and cultivation only in the first year. This statement is supported by the fact that in one year after planting, the height

of plant reached 6 m with diameter of 5.5 cm. The plant usually was harvested 5 years after planting with the height reaching 30 m and the diameter of 25 cm. With this growth characteristic, *A. crassicarpa* is classified as a fast growing plant and adaptive to deep peat.

Table 1. Average growth parameter of *A. crassicarpa* during 5 years (weights on oven dry weight basis).

Age (Year)	Diameter (cm)	Height (m)	Root (kg)	Stump (kg)	Stem (kg)	Branch (kg)	Leaf (kg)	Total (kg)
1.0	5.5	6.0	0.8	1.0	2.5	2.6	3.8	10.8
2.0	11.0	12.0	2.9	3.3	16.0	6.7	4.8	33.6
3.0	15.0	16.5	7.0	8.0	40.4	12.6	4.9	72.9
4.0	19.0	22.5	15.2	17.3	78.3	26.8	6.9	144.5
5.0	25.0	30.0	35.3	40.1	144.4	65.4	26.5	311.8

Based on litter fall measurements, during 8 months of observations, there has been 611.12 g/m² of dry weight litter fall or equal to about 9.2 ton/ha/year oven dry weight. Decomposition of litter fall of *A. crassicarpa* was very fast, 60% litter fall from *A. crassicarpa* was decomposed in 3 months whereas litter fall from natural forest in the same period only decomposed 40%. From macronutrient analysis of litter fall the amount of potential macro nutrients released from litter fall to soil could be estimated (Table 2). The highest nutrient released from litter fall was nitrogen. In one ha, the nitrogen content in litter fall was 271 kg/ha/year or equivalent to 602 kg urea/ha/year. The very high number of nitrogen content in litter fall was attributable to the fact that acacia is a leguminous plant having dense lateral roots rich in nodules. The other nutrients (P, K, Ca, Mg and S) will cycle from litter fall, released to soil and taken again by plants without a significant increase. These nutrients become available for growing plants after the litter fall is decomposed by microorganisms. Based on litter fall decomposition in the litter bag, acacia leaf decomposed very fast indicating that acacia leaf is good composting material.

Table 2. Content of macronutrients in litter fall and equivalent macronutrients for one ha per year.

Litter Fall from Acacia	N	P	K	Ca	Mg	S
Content of macro nutrients (%)	2.95	0.15	1.76	0.91	0.36	0.28
Equivalent of macro nutrients based on the amount of 9.2 ton litter fall/ha/year (kg/ha/year)	271.1	13.8	161.9	83.7	33.1	25.8

The nutrients releases from litter fall decomposition are used for enriching soils and growing of acacia plant. From the above results, *A. crassicarpa* shows success as a plantation crop that can sustain growth on peatland due to the nutrient cycle produced by the plant itself with low fertilizer input.

Conclusions

Peatland has low pH and are poor in macro and micro nutrients. However, *A. crassicarpa* can adapt and grow in peat soils due to the plant having lateral roots rich in nodules. Measurement of litter fall using nets showed that one hectare of Acacia plantation aged 3 years produced about 9.2 tons/ha/year oven dry weight of litter fall or equivalent to 271 kg N ha/year. After 3 months some 60% of litter fall have been decomposed.

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