



**UNIVERSITI PUTRA MALAYSIA**

**CHANGES IN ORGANIC MATTER CONTENT AND CHEMICAL  
PROPERTIES OF DURIAN SERIES SOIL AFTER CONVERSION OF A  
JUNGLE TO AN OIL PALM PLANTATION**

**MOHD SABRI HASSAN**

**FP 2007 15**



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**MOHD SABRI HASSAN**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra  
Malaysia, in Fulfilment of the Requirement for the Master Science.**

**DECEMBER 2007**



## DEDICATION

**This thesis is dedicated to my all family members especially my mother and father, supervisory committee and staffs of Department of Land Management, Faculty of Agriculture, Universiti Putra Malaysia (UPM).**

Abstract of the Thesis Submitted to the Senate of Unversiti Putra Malaysia in Fulfilment of the Requirements for the Degree of Master of Science.

**CHANGES IN ORGANIC MATTER CONTENT AND CHEMICAL  
PROPERTIES OF DURIAN SERIES SOIL AFTER CONVERSION OF A  
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By

**MOHD SABRI HASSAN**

**December 2007**

**Chairman : Associate Prof. Datin Rosenani Abu Bakar, PhD**

**Faculty : Agriculture**

Oil palm activities have increased rapidly since the 1980's. The establishment of the oil palm plantations involves opening up of new areas of forested land, conversion of rubber to oil palm and replanting. It is well established that clearing of jungle for agriculture purpose results in environmental problem, including land degradation, especially in hilly terrains, when terracing is carried for crop cultivation. However, under oil palm cultivation, unlike other crop, the crop management practices involved the additional of empty fruit bunches (EFB) as a mulch and establishment of legume cover crop in the immature stages and placement of pruned fronds in mature phase, which add a lot of organic mater back to the soil to rebuild soil organic matter (SOM) or carbon (C) storage in the soil. Although work has been done to show the benefits of EFB and frond placements



and leguminous cover on lowland soils cultivated with oil palm, there are no documented information on the effects of these palm residues on the terraced to show the extent of the addition crop residues (EFB as a mulch, fronds pruned and placement interrows and leguminous establishment) rebuild SOM and rehabilitate the soil. Hypothetically, similar beneficial effects of residues on terraced soil in hilly terrain areas should also be observed.

In 1993, a study was initiated at an oil palm plantation at Bukit Rokan, Gemas, Negeri Sembilan, which established after clearing a logged-over jungle in a hilly terrain. The aim was to investigate the long-term in SOM and other related soil chemical characteristics in a hilly terrain. The terraced on hill slope of about 30 degrees. This project was initiated by the Department of Land Management, Faculty of Agriculture, Universiti Putra Malaysia (UPM), in 1993. This study is a continuously of the above with the following: i. to assess the short-term changes (1 year period) of soil organic carbon (SOC) and other related chemical characteristics on a terrace of an 8 ½ year old oil palm area converted from jungle, ii. to determine the long-term (8½ years) changes of SOC and other soil chemical characteristic in the above area, over a period 1993 (under jungle) to 2003 and iii. to compare the SOC content and other soil chemical characteristics of the soil under oil palm in objective ii and soil under jungle in an adjacent jungle area.

Since the soil surface cover under the palms is not the same, the establishment of the long term study in 1993, bulk soil sampling was done at three different sites with eight replicated along the terrace around the palm at along the terrace in

stratified random sampling. The area were on upper terrace of hilly area around the base where EFB was earlier applied during the 1<sup>st</sup> three years, bare soil area – 1 m radius around outside the palm base and with legumes cover and/or fronds placement between two palms. For the first objective, a short-term study, (1 year) was carried whereby soil samples were taken at three time interval, i.e. 3<sup>rd</sup> March 2002, 5<sup>th</sup> September 2002 and 3<sup>rd</sup> March 2003 at 0 – 15 cm (topsoil) and 15 -30 cm (subsoil) soil depths. Altogether there were 64 soil samples collected (3 times interval x 3 sites x 2 depth x 8 replication). Soil sample were analysed for total mineral N i.e. ( $\text{NH}_4^+\text{-N}$  +  $\text{NO}_3^-\text{-N}$  and  $\text{NO}_2^-\text{-N}$ ), pH ( $\text{H}_2\text{O}$ ), total N, organic C, light fraction organic matter, available P, exchangeable cations and cation exchange capacity (CEC).

There for the second objective, for a long term study, was carried out based on data obtained from the first study from samples collected at 98 and 104 month after planting (MAP) and data from similar soil sampling by previous workers from the time area under jungle, then jungle clearing and planting of palms in a period of about 8½. The third objective was achieved by selecting an adjacent jungle area to the cultivated terraced area in study (ii) as the similar slope. Four terraces were selected in the two cultivated slope and four levels at similar heights of the 4 terraces on two slopes under jungle. Bulk topsoil (0 – 15 cm) samples were collected at 8 replicated points above each terrace (under area of oil palm) and level (under area of jungle). Altogether, there was 128 soil sampling [2 main areas (oil palm and jungle) x 4 terrace/level x 2 slopes x 8 replicated point sampling].

Results of this study showed dynamic short-term changes in SOC and other chemical characteristics. Small changes or fluctuation in the soil chemical characteristics including SOM occurred that could be attributed to crop management practices and environmental factors. Soil organic carbon, light fraction organic matter, soil pH and CEC of topsoil showed dynamic significant difference between times of sampling under all area of soil cover types (area of EFB apply, bare soil area and area of cover crop). Soil organic carbon for the topsoil, at all soil cover types, showed significant increased until second time sampling but remain similar at third time sampling while at the area of cover crop (Subsoil) showed highly significantly different from first time sampling (0.083%) to third time sampling (1.577%). Soil pH, generally showed significant decreased especially at bare soil and cover crop.

Generally, long term-changes study under different area of soil cover types showed fluctuating trend. At the end of this study, at 104 MAP, all soil cover types showed lower values of soil organic carbon (SOC) and other chemical characteristics compared with soil under jungle except for exchangeable potassium. Started from at palm planting until 104 MAP, the build up of SOC and other soil chemical characteristics in this area are about 55 to 65 per cent comparing with soil properties when this sites is under jungle. Study there, showed CEC under jungle area ( $14.9\text{cmol}_c\text{kg}^{-1}$ ) significant high than oil palm ( $6.5\text{cmol}_c\text{kg}^{-1}$ ) while available P showed significant lower than oil palm area. Only exch. Ca and Mg at J2 showed small differences between levels. Generally, it was concluded that short-term study showed dynamic changes of soil properties and fluctuation trend in long-term

study. After 8 ½ years SOC and other soil chemical characteristics under oil palm cultivation on terrace still lower than under jungle area but study there showed that not differences soil properties under oil palm and nearby jungle.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi Syarat untuk ijazah Master Sains.

**PERUBAHAN KANDUNGAN BAHAN ORGANIK DAN SIFAT – SIFAT  
KIMIA BAGI TANAH SERIE DURIAN SELEPAS PEMBUKAAN HUTAN  
KEPADA LADANG KELAPA SAWIT.**

Oleh

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**Disember 2007**

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**Fakulti : Pertanian**

Semenjak 1980, aktiviti penanaman kelapa sawit telah meningkat secara mendadak hasil daripada penukaran kawasan ladang getah kepada ladang kelapa sawit dan pembukaan kawasan hutan yang baru untuk tujuan penanaman kelapa sawit. Telah direkodkan, pembukaan hutan kepada aktiviti pertanian akan memberikan kesan negatif kepada alam sekitar termasuklah kemerosotan tanah terutamanya yang melibatkan kawasan tanah tinggi dimana teres dibuat untuk penanaman. Walaubagaimanapun, kelapa sawit tidak seperti tanaman lain, aktiviti penanaman kelapa sawit melibatkan sistem pengurusan yang melibatkan penggunaan tadang kelapa sawit kosong (EFB) sebagai penutup bumi, penanaman tanaman tutup bumi semasa peringkat kelapa sawit belum matang dan pada peringkat matang aktiviti pemangkasan dan meletakan pelepah pokok kelapa sawit, menambahkan bahan

organik kepada tanah seterusnya meningkatkan kandungan bahan organik tanah (SOM) atau kandungan simpanan karbon dalam tanah. Terdapat banyak kajian yang telah dicatatkan mengenai kesan penggunaan EFB, peletakan pelepah dan penanaman tanaman tutup bumi dikawasan tanah rendah yang ditanam dengan kelapa sawit, walaubagaimanapun tidak terdapat maklumat yang jelas dicatatkan mengenai kesan peningkatan bahan organik tanah hasil daripada penggunaan kaedah sama keatas kawasan tanah tinggi atau cerun yang berteres. Secara teorinya ia akan mendatangkan kesan yang sama seperti yang terdapat pada kawasan tanah rendah.

Pada tahun 1993, satu kajian dikawasan tanaman kelapa sawit di Bukit Rokan, Gemas Negeri Sembilan telah dijalankan. Penanaman kelapa sawit ini dibuat dikawasan tanah tinggi yang asalnya merupakan hutan yang telah dikeluarkan hasilnya. Tujuan utama kajian ini dibuat adalah untuk penyelidikan jangka panjang mengenai bahan organik tanah dan sifat-sifat kimia tanah yang berkaitan dikawasan tanah tinggi yang berteres dengan kecerunan 30 darjah. Penyelidikan ini dimulakan oleh Jabatan Pengurusan Tanah, Fakulti Pertanian, Universiti Putra Malaysia (UPM) pada tahun 1993 dimana kawasan ini masih hutan. Kajian ini diteruskan untuk mencapai tiga matlamat iaitu: i. untuk mengenalpasti perubahan jangka pendek (satu tahun) kandungan bahan organik karbon dan sifat-sifat kimia tanah yang berkaitan dikawasan penanaman kelapa sawit yang berusia 8½ tahun, dimana kawasan ini pada asalnya adalah kawasan hutan dan kelapa sawit ditanam pada cerun yang berteres, ii. untuk mengenalpasti perubahan jangka panjang terhadap kandungan bahan organik karbon tanah dan sifat-sifat kimia tanah yang

berkaitan di kawasan yang sama bermula daripada tahun 1993 (kawasan hutan) sehingga tahun 2003 iaitu selepas 8 ½ tahun kelapa sawit ditanam dan iii. untuk mengetahui perbandingan kandungan bahan organik karbon tanah dan sifat-sifat kimia tanah tertentu di kawasan hutan yang bersamaan ciri kecerunan dengan kawasan kelapa sawit yang ditanam disepanjang teres.

Oleh kawasan permukaan tanah yang telah berubah-ubah, penghasilan kajian jangka panjang dibuat dengan mengambil sampel tanah pada tiga kawasan, sebanyak lapan tempat disepanjang teres sekeliling pokok kelapa sawit secara "stratified random sampling". Kawasan tersebut adalah sekeliling pokok kelapa sawit dimana EFB telah diletakan pada tahun pertama sehingga ketiga penanaman, kawasan tanah rang – 1 meter sekeliling pokok kelapa sawit dan kawasan tanaman penutup bumi dan tempat dimana pelepah pokok kelapa sawit diletakan selepas proses pemangkasan. Untuk kajian jangka pendek, sampel tanah diambil sebanyak tiga kali iaitu pada 3hb Mac 2002, 5hb September 2002 dan 3hb Mac 2003, untuk kedalaman 0-15 cm (tanah atas) dan 15-30 cm (tanah bawah). Secara keseluruhannya sebanyak 64 sampel tanah telah diambil dan dianalisis (3 masa x 3 kawasan x 2 kedalaman x 8 replikasi). Tanah yang diambil ini di tentukur kandungan mineral N ( $\text{NH}_4^+\text{-N}$  +  $\text{NO}_3^-\text{-N}$  and  $\text{NO}_2^-\text{-N}$ ), pH ( $\text{H}_2\text{O}$ ), jumlah N, karbon organik, fraksi ringan bahan organik, ketersediaan P, kation tukar ganti (CEC) dan kadar pertukaran kation (Ca, Mg dan K).

Untuk mencapai objektif kedua iaitu kajian jangka panjang, ia adalah berdasarkan data daripada kajian pertama iaitu sampel yang diambil pada 98 dan 104 bulan

selepas penanaman (MAP) dan daripada data yang terhasil daripada kaedah persampelan yang sama oleh pekerja yang terdahulu bermula daripada kawasan ini adalah hutan, proses pembersihan hutan dan sehingga 8½ tahun selepas penanaman. Kajian ketiga pula melibatkan perbandingan kawasan penanaman kelapa sawit di cerun yang berteras seperti diobjektif (ii) dan kawasan hutan. Di kawasan kelapa sawit melibatkan dua kecerunan dengan setiap satu kecerunan melibatkan empat teras dan untuk kawasan hutan melibatkan juga dua kecerunan dan empat aras yang sama dengan kawasan kelapa sawit. Sampel tanah diambil pada kedalaman 0 – 15 cm dengan 8 replikasi. Jumlah keseluruhan sample yang diambil adalah 128 [2 kawasan utama (kelapa sawit dan hutan) x 4 teras/aras x 2 kecerunan x 8 replikasi].

Hasil daripada kajian menunjukkan perubahan secara dinamik keatas sifat organik carbon tanah dan sifa-sifat kimia tanah tertentu. Perubahan jangka panjang adalah secara kecil-kecilan atau secara turun naik pada sifat kimia tanah termasuklah kandungan bahan organik tanah, ini mungkin disebabkan oleh pengaruh amalah pengurusan penanaman dan alam semulajadi. Kandungan karbon organik tanah, fraksi ringan bahan organik, pH tanah dan CEC untuk kedalaman 0-15 cm (tanah atas) menunjukkan perbezaan dengan masa bagi kesemua jenis kawasan tanah. Kandungan karbon organik tanah untuk tanah atas bagi semua kawasan menunjukkan peningkatan daripada masa pertama sehingga kedua dan kekal sama pada masa ketiga manakala pada kawasan tanaman tutup bumi (tanah bawah) menunjukkan peningkatan yang ketara daripada sampel pertama (0.083%) hingga

sampel ketiga (1.577%). pH tanah secara amnya menunjukkan penurunan terutamanya pada kawasan tanah rang dan tanaman tutup bumi.

Secara keseluruhannya, kajian jangka panjang terhadap bahan organik carbon dan sifat-sifat kimia tanah tertentu bagi kawasan ini menunjukkan keadaan turun naik. Pada 104 MAP, semua kawasan menunjukkan nilai bahan organik tanah dan sifat-sifat kimia tanah tertentu yang rendah tetapi mencapai tahap 55 – 56 peratus berbanding tanah hutan sebelum penanaman kelapa sawit dikawasan ini dibuat kecuali untuk kation K. Kajian ketiga pula menunjukkan CEC untuk kawasan hutan ( $14.9\text{cmol}_c\text{kg}^{-1}$ ) lebih tinggi daripada kawasan kelapa sawit ( $6.5\text{cmol}_c\text{kg}^{-1}$ ) manakala ketersediaan P. pula sebaliknya. Hanya kation Ca dan Mg pada kawasan hutan 2 (J2) menunjukkan perbezaan antara aras. Dapat disimpulkan, kajian jangka pendek menunjukkan perubahan yang dinamik pada kadungan bahan organik tanah dan sifat-sifat kimia tanah tertentu dan berlaku turun naik untuk tempoh sehingga 8 ½ tahun selepas penanaman, walaubagaimanapun nilai masih rendah jika dibandingkan dengan keadaan tanah semasa kawasan hutan tetapi hampir sama jika dibuat dibandingkan dengan keadaan hutan yang berhampiran (kajian3).

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I certify that an Examination Committee has met on **Disember 18<sup>th</sup> 2007** to conduct the final examination of **Mohd Sabri Hassan** on his **Master of Science** thesis entitled "Changes in organic matter and soil chemical characteristics after conversion of a jungle to an oil palm plantations in a hilly terrain" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the Master Science. The members of the Supervisory Committee were as follows:

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Date: 8 May 2008





## DECLARATION

I declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Putra Malaysia or at any other institution.

---

**MOHD SABRI HASSAN**

Date:

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