



UNIVERSITI PUTRA MALAYSIA

**ESTIMATION OF CARBON IN *Jatropha curcas* L. BIOMASS
AND CARBON FOOTPRINT IN ITS SEED PRODUCTION**

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FOOTPRINT IN ITS SEED PRODUCTION**

By

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**This Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
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July 2011

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the Requirement for the degree of Master of Agricultural Science

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July 2011

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Biofuel from plants is claimed to be carbon neutral where unlike fossil fuel, carbon dioxide (CO₂) produced from the combustion of biofuel is the same CO₂ assimilated by the plant during photosynthesis. Among the plants that are attracting attention nowadays is *Jatropha curcas*. However, before biofuel from *Jatropha curcas* could be labeled as carbon neutral, CO₂ emission and/or sequestration from all sources of the production chain must first be quantified. The present study was therefore carried out from July 2009 until July 2010 at the Tanah Merah Estate, Port Dickson, Negeri Sembilan to (i) quantify carbon fixation through dry matter production of *Jatropha curcas* biomass, (ii) compare the carbon balance between land cultivated with *Jatropha curcas* and the land in its native state and (iii) establish a carbon footprint of *Jatropha curcas* seed production.

Measurements were made at two different plots, one plot planted with *Jatropha curcas* while the other plot was the native state of the area. Soil CO₂ flux and soil

total and labile carbon were measured monthly while monthly plant biomass of *Jatropha curcas* was estimated from monthly stem diameter measurements 20 trees and an established allometric equation. The estimated biomass was then converted to amount of carbon stored based on analysis of biomass carbon content. In comparing the carbon balance between the two types of land use, carbon balance was calculated as the amount of carbon stored in biomass minus the amount of carbon emitted as soil flux and emissions associated with the use of agricultural inputs. The carbon footprint of *Jatropha curcas* was calculated by dividing the total emitted carbon by the amount of yield (i.e. seed).

Results from this study showed that 2.46 Mg carbon ha⁻¹ was sequestered in biomass of *Jatropha curcas* while emission from *Jatropha curcas* cultivation was 9.12 Mg carbon ha⁻¹. Soil carbon at both plots did not show any significant changes ($P < 0.05$) throughout this study. Comparison between the two plots showed that emission from the plot planted with *Jatropha curcas* was marginally higher than at the natural state plot by only 1.20 Mg carbon ha⁻¹. The minimum carbon footprint value of *Jatropha curcas* cultivation during the first year of its cultivation was 2.96 Mg carbon Mg seed⁻¹.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
Sebagai memenuhi keperluan untuk ijazah Master Sains Pertanian

**PENGANGGARAN KARBON DALAM BIOJISIM *Jatropha curcas* L. DAN
JEJAK KARBON DALAM PENGELUARAN BIJINYA**

Oleh

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Biofuel dari tumbuhan dikatakan bersifat karbon neutral di mana tidak seperti pembakaran bahan api fosil, gas CO₂ yang terhasil akibat pembakaran biofuel adalah gas CO₂ yang sama yang diserap semasa fotosintesis. Antara tumbuhan biofuel yang sedang mendapat perhatian ketika ini ialah *Jatropha curcas*. Walaubagaimanapun, bagi membolehkan biofuel dari *Jatropha curcas* dilabel sebagai karbon neutral, pembebasan gas CO₂ dari semua punca sepanjang rantai pemprosesan haruslah ditentukan terlebih dahulu. Oleh itu, satu kajian telah dijalankan bermula dari Julai 2009 sehingga Julai 2010 di Estet Tanah Merah, Port Dickson, Negeri Sembilan dengan tujuan berikut: (i) menentukan pengikatan karbon dalam pembentukan jisim kering *Jatropha curcas*, (ii) membandingkan keseimbangan karbon antara kawasan yang ditanam dan kawasan yang tidak ditanam *Jatropha curcas* dan (iii) menerbitkan jejak karbon bagi penghasilan biji *Jatropha curcas*.

Pengukuran dijalankan di dua plot berbeza dimana satu plot telah ditanam *Jatropha*

curcas dan satu lagi plot merupakan keadaan asal kawasan tersebut. Fluks CO₂ tanah dan kandungan karbon dan karbon mudah terurai dalam tanah diukur setiap bulan manakala penentuan biojisim *Jatropha curcas* setiap bulan ditentukan melalui pengukuran diameter batang 20 pokok *Jatropha curcas* dan persamaan allometrik yang telah diterbitkan. Penganggaran kandungan karbon dalam jumlah biojisim dibuat berdasarkan analisis kandungan karbon dalam biojisim. Bagi perbandingan keseimbangan karbon pada kedua-dua kawasan kajian, keseimbangan karbon dihitung sebagai jumlah karbon tersimpan dalam biojisim ditolak dengan jumlah karbon yang dibebaskan sebagai fluks CO₂ tanah dan dari penggunaan input pertanian. Jejak karbon dihitung sebagai jumlah karbon terbebas dibahagi dengan hasil biji *Jatropha curcas*.

Hasil kajian ini menunjukkan sebanyak 2.46 Mg karbon ha⁻¹ telah tersimpan di dalam biojisim *Jatropha curcas*. Jumlah karbon terbebas pula adalah sebanyak 9.12 Mg karbon ha⁻¹. Kandungan karbon dalam tanah didapati tidak mempunyai sebarang perubahan bermakna ($P < 0.05$) sepanjang kajian ini. Perbandingan antara dua kawasan kajian ini mendapati pembebasan karbon pada plot yang ditanam dengan *Jatropha curcas* hanya melebihi plot keadaan asal sebanyak 1.20 Mg karbon ha⁻¹ sahaja. Jejak karbon bagi penghasilan biji *Jatropha curcas* adalah 2.96 Mg karbon Mg biji⁻¹.

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I certify that an Examination Committee has met on **26 July 2011** to conduct the final examination of **Muhammad Firdaus Bin Sulaiman** on his **Master of Agricultural Science** thesis entitled “**Estimation of Carbon in *Jatropha curcas* Biomass and Carbon Footprint in its Seed Production**” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the student be awarded the Master of Agricultural Science.

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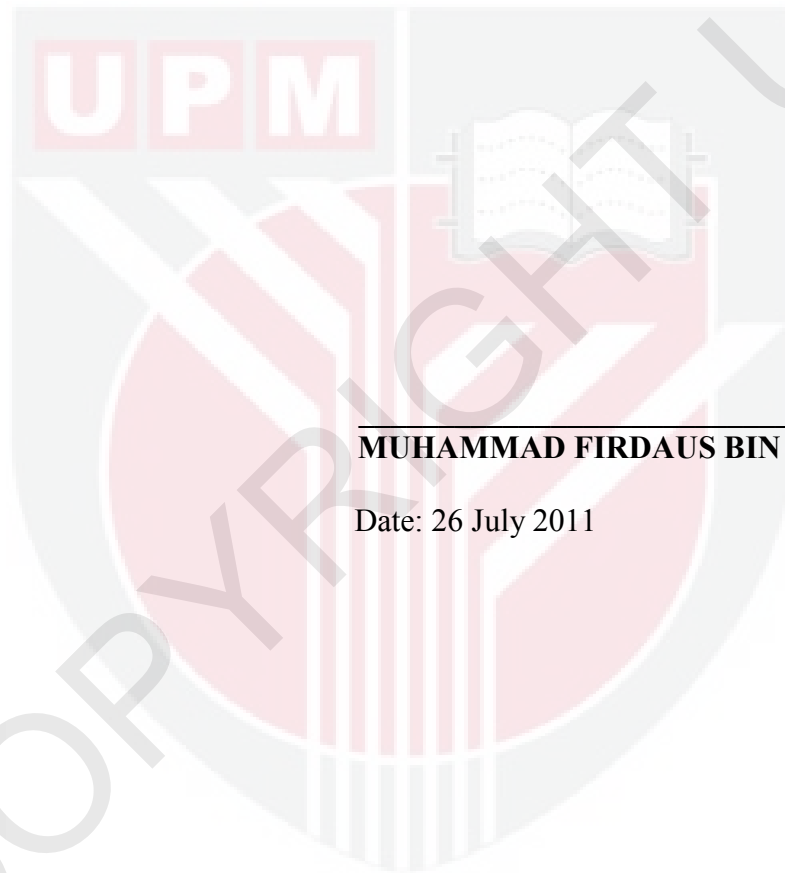
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DECLARATION

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



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TABLE OF CONTENTS

	Page
ABSTRACT	ii
ABSTRAK	iv
ACKNOWLEDGEMENTS	vi
APPROVAL	viii
DECLARATION	x
LIST OF TABLES	xiii
LIST OF FIGURES	xv
LIST OF ABBREVIATIONS	xvii
CHAPTER	
1 INTRODUCTION	1
2 LITERATURE REVIEW	
2.1 Greenhouse Gases and Climate Change	4
2.2 The Global Carbon Cycle	8
2.3 Carbon Assimilation in Biomass	10
2.4 Carbon in Soil	13
2.4.1 Soil Organic Carbon	13
2.4.2 Soil Labile Carbon	15
2.5 Soil Carbon Exchange to the Atmosphere	16
2.5.1 Soil Respiration	16
2.5.2 Factors Influencing Soil Respiration	17
2.5.3 Soil CO ₂ Flux	19
2.6 Biofuel	20
2.6.1 History of Biofuel Production	20
2.6.2 Biofuel Production from Various Feedstock	21
2.6.3 Status of Biofuel in Malaysia	24
2.7 <i>Jatropha curcas</i>	26
2.7.1 History of <i>Jatropha curcas</i>	26
2.7.2 Distribution of <i>Jatropha curcas</i>	26
2.7.3 Botanical Description of <i>Jatropha curcas</i>	28
2.7.4 Agronomic Practices in <i>Jatropha curcas</i> Cultivation	29
2.7.5 Oil Extraction from <i>Jatropha curcas</i> Seed	30
2.8 Carbon Balance	32
2.9 Carbon Footprint	37
2.10 Carbon balance and carbon footprint of <i>Jatropha curcas</i> biodiesel production	39
3 MATERIALS AND METHODS	
3.1 Study Site and Experimental Setup	42
3.1.1 Site Description	42
3.1.2 Experimental Setup	45
3.2 Biomass Dry Matter Production	47
3.2.1 Establishment of Allometric Equation	47
3.2.2 Planted Plot	49

3.2.3	Shrub Plot	49
3.2.4	Determination of Litterfall Production	50
3.3	Determination of Carbon in Biomass	51
3.4	Soil Sampling and Analysis	53
3.4.1	Bulk Density	53
3.4.2	Water and Air Filled Pore Space	54
3.4.3	Total and Labile Carbon	55
3.5	Soil CO ₂ Flux	56
3.6	Carbon Balance	58
3.7	Carbon Footprint	60
3.8	Statistical Analysis	61
4	RESULTS AND DISCUSSION	
4.1	Dry Matter Production and Sequestered Carbon in Biomass	63
4.1.1	Establishment of the Allometric Equation	63
4.1.2	Biomass Dry Matter Production	65
4.1.2.1	Biomass at Planted Plot	65
4.1.2.2	Biomass at Shrub Plot	69
4.1.2.3	Litterfall Production	70
4.1.3	Carbon Accumulation in Biomass	71
4.1.3.1	Carbon Accumulation at Planted Plot	71
4.1.3.2	Carbon Accumulation at Shrub Plot	74
4.1.3.3	Carbon in Litterfall	74
4.2	Soil Carbon	76
4.2.1	Total Carbon	76
4.2.2	Labile Carbon	77
4.3	Soil CO ₂ Flux	79
4.3.1	Measured Flux	79
4.3.2	Extrapolated Flux	80
4.4	Relationship Between Soil Labile Carbon, Water and Air Filled Pore Space and CO ₂ Flux	82
4.4.1	Water and Air Filled Pore Space with Soil Flux	82
4.4.2	Labile Carbon with Soil Flux	83
4.5	Carbon Balance	84
4.5.1	Carbon Balance at Planted Plot	84
4.5.2	Carbon Balance at Shrub Plot	86
4.5.3	Comparison between Plots	86
4.6	Carbon Footprint	87
5	CONCLUSION	90
6	FUTURE RESEARCH RECOMMENDATIONS	92
	REFERENCES	94
	APPENDICES	102
	BIODATA OF STUDENT	110
	LIST OF PUBLICATIONS	111