UNIVERSITI PUTRA MALAYSIA

ECONOMIC VALUATION OF PINEAPPLE CULTIVATION ON PEAT SOIL AT THE INTEGRATED AGRICULTURAL DEVELOPMENT AREA, SAMARAHAN, SARAWAK

ADRIAN DAUD
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ECONOMIC VALUATION OF PINEAPPLE CULTIVATION ON PEAT SOIL AT THE INTEGRATED AGRICULTURAL DEVELOPMENT AREA, SAMARAHAN, SARAWAK

By

ADRIAN DAUD

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

Specially dedicated to my parents (Dad & Mom); for their undying support and sacrifices throughout the years. Your love, support and encouragement will always be treasured and your prayers are the guidance that carries me through. To my sister (Ya) and brother (Bin)…all family members and also Ryn.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman : Khalid Abdul Rahim, PhD

Faculty : Economics and Management

Agricultural activities on peat soil are quite common in Malaysia. There are about 2.4 million hectare of peat in the country with 60% of this is located in Sarawak. Pineapple has been traditionally cultivated on peat soil in Malaysia as is the case in Samarahan, Sarawak. The economic value of pineapple cultivation on peat soil should measure beyond private benefits (profit) and include global/social benefits (carbon sequestration value and willingness-to-pay value for better environment). Farmers surrounding the Integrated Agricultural Development Area (IADA) prefer to plant pineapple by using traditional method which means they are not maximizing their returns by planting at a much lower density than recommended by IADA. The high cost in fertilizer associated with pineapple cultivation caused some farmers to resort to plant at a lower density. The returns of the farmers are compared to the potential return with the matrix system (high-density planting). These farmers are also using the traditional method of residue burning which is harmful to the environment. There is a need to emphasize on the proper management of our resources like the sustainable utilization of natural resources such as peat soil. The practice of zero burning technique (ZBT) in pineapple cultivation has the advantage of greater carbon

sequestration in soil compared to the traditional practice of residue burning and this the indirect benefit of using ZBT. The value of using ZBT is compared to residue burning technique in terms of net present value (NPV) by using cost-benefit analysis (CBA). The total economic value (TEV) is the sum of the private benefits and global/social benefits. There is the incentive to adopt ZBT as it gives higher value than residue burning technique. Farmers who switch to ZBT may experience lower profitability (private benefits) but it results in higher global/social benefits especially through the value of soil carbon sequestration. In the long run it is environmentally sound as it results in the sustainable use of natural resources. The benefit of soil carbon sequestration can compensate the extra cost associated with ZBT. The market price of carbon should be at least RM6.72/tC for ZBT to yield similar total benefits with residue burning technique. The total economic value (TEV) shows that ZBT offers greater net benefit than residue burning. Adopting sustainable practices such as ZBT in our agricultural system is a good step in the utilization of natural resource and should be practiced extensively.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENILAIAN EKONOMI PENANAMAN NENAS DI ATAS TANAH GAMBUT DI KAWASAN KEMAJUAN PERTANIAN INTEGRASI, SAMARAHAN, SARAWAK

Oleh

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Aktiviti pertanian di atas tanah gambut adalah agak biasa di Malaysia. Terdapat seluas 2.4 juta hektar tanah gambut di negara ini di mana 60% daripadanya terletak di Sarawak. Nenas secara tradisional ditanam di atas tanah gambut di Malaysia seperti juga yang ditanam di Samarahan, Sarawak. Nilai ekonomi penanaman nenas di atas tanah gambut seharusnya mengira bukan sahaja faedah persendirian (keuntungan) tetapi merangkumi faedah global/sosial (nilai-nilai penyimpanan karbon dan kesanggupan membayar untuk mendapat alam sekitar yang lebih baik). Petani di sekitar “Kawasan Kemajuan Pertanian Integrasi” (IADA) lebih gemar menanam nenas dengan kaedah tradisional di mana mereka tidak mendapat pulangan yang maksima kerana menanam pada kadar yang lebih rendah daripada yang disyorkan oleh IADA. Kos baja yang tinggi untuk penanaman nenas menyebabkan sesetengah petani memilih untuk menanam pada kepadatan yang rendah. Pulangan kepada petani dibandingkan dengan potensi pulangan jika menggunakan system matriks (kepadatan yang tinggi) Petani juga mengamalkan kaedah penanaman tradisional iaitu pembakaran yang mana ianya mencemarkan alam sekitar. Adalah perlu untuk menitikberatkan tentang pengurusan sumber yang bersesuaian umpamanya

penggunaan sumber semulajadi seperti tanah gambut yang mapan. Penggunaan kaedah pembakaran sifar (ZBT) dalam penanaman nenas mempunyai kelebihan untuk menyimpan karbon yang lebih jika dibandingkan dengan kaedah pembakaran dan ini merupakan faedah tidak langsung penggunaan kaedah pembakaran sifar. Nilai penggunaan kaedah pembakaran sifar dibandingkan dengan kaedah pembakaran dalam bentuk nilai kini bersih (NPV) dengan menggunakan analisis kos-faedah (CBA). Jumlah nilai ekonomi (TEV) merupakan jumlah dari faedah persendirian (keuntungan) dan faedah global/sosial. Terdapat insentif untuk mengamalkan kaedah pembakaran sifar kerana ianya memberi nilai yang lebih tinggi berbanding dengan kaedah pembakaran. Petani yang mengamalkan kaedah pembakaran sifar ini mungkin mendapat keuntungan yang lebih rendah tetapi ianya menghasilkan nilai global/sosial yang lebih tinggi khususnya dari nilai penyimpanan karbon. Untuk jangka masa yang panjang ianya baik bagi alam sekitar kerana menyebabkan penggunaan sumber semulajadi yang mapan. Faedah penyimpanan karbon di dalam tanah boleh memberi pampasan terhadap kos yang lebih dalam penggunaan pembakaran sifar. Harga pasaran karbon harus berada pada kadar sekurang-kurangnya RM6.72/tan karbon bagi kaedah pembakaran sifar untuk memberi faedah yang lebih kurang sama dengan kaedah pembakaran. Jumlah nilai ekonomi (TEV) menunjukkan bahawa kaedah pembakaran sifar memberi lebih faedah atau manfaat berbanding dengan kaedah pembakaran. Mengamalkan kaedah yang mapan seperti pembakaran sifar di dalam sistem pertanian adalah langah yang baik dalam penggunaan sumber asli dan harus diamalkan secara menyeluruh.

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I certify that an Examination Committee has met on **6th August 2009** to conduct the final examination of **Adrian Daud** on his **Doctor of Philosophy** thesis entitled "**Economic Valuation of Pineapple Cultivation and Soil Carbon Sequestration on Peat Soil at the Integrated Agriculture Development Area (IADA) Samarahan, Sarawak**" 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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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 at any other institution.

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ADRIAN DAUD

Date:

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AFTA	ASEAN Free Trade Agreement
API	Air pollution index
CBA	Cost benefit analysis
B-C	Benefit-cost (ratio)
CDF	Cumulative density function
CDM	Clean development mechanism
CE	Choice experiment
CEC	Cation exchange capacity
CER	Certified emission reduction
CH_4	Methane
cm	centimeter
CM	Choice modelling
CO_2	Carbon dioxide
CR	Contingent ranking
CS	Compensating surplus
CV	Compensating variation
CVM	Contingent valuation method
DID	Department of Irrigation
DOA	Department of Agriculture
DOE	Department of Environment
DUV	Direct use value
EKC	Environmental Kuznet curve
ES	Equivalent surplus
EV	Existence value
EV	Equivalent variation
FAO	Food Agriculture Organization
FELCRA	Federal Land Consolidation and Rehabilitation Authority
FELDA	Federal Land Development Authority
FFB	Fresh fruit bunch
GKUR	Greater Kuching Urban and Regional
GAPs	Good agricultural practices
GDP	Gross domestic product
GHGs	Green house gases
ha	hectare
HP	Hedonic pricing
IADA	Integrated Agriculture Development Area
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
IUCN	International Union for Conservation of Nature
IUV	Indirect use value
MARDI	Malaysian Agricultural Research and Development Institute
mm	millimeter
MPIB	Malaysian Pineapple Industry Board
MOA	Ministry of Agriculture
MPOB	Malaysian Palm Oil Board
MRTP	Marginal rate of time preference
NAP	National Agriculture Policy

NGO	Non-governmental organization
NOAA	National Oceanic and Atmospheric Association
NPV	Net present value
N_2O	Nitrous oxide
NREB	Natural Resource and Environmental Board
NUCV	Non-use value
PFEs	Permanent forest estates
OP	Option value
PORIM	Palm Oil Research Institute of Malaysia
PORLA	Palm Oil Research and Licensing Authority
PV	Present value
PSF	Peat swamp forest
RSPO	Roundtable on Sustainable Palm Oil
SALCRA	Sarawak Land Consolidation and Rehabilitation Authority
SPU	State Planning Unit
SS	Strong sustainability
TCM	Travel Cost Method
TEV	Total Economic Value
UiTM	Universiti Teknologi MARA
UNDP	United Nations Development Programme
UNFCC	United Nations Framework Convention on Climate Change
UNIMAS	Universiti Malaysia Sarawak
UPM	Universiti Putra Malaysia
UV	Use value
WCED	World Commission on Environment and Development
WS	Weak sustainability
WTA	Willingness to accept
WTO	World Trade Organization
WTP	Willingness to pay
WWF	World Wildlife Fund
ZBT	Zero burning technique

CHAPTER 1

INTRODUCTION

1.1 Introduction

Assigning value to the environment has never been an easy task. Today there are many efforts to place value on the environment so as to educate the global society of the importance of preserving our nature. Despite that, it is also interesting to note that there are some people who contempt the idea of placing value on the environment as they feel that it should belong to everyone and it is not proper to place any kind of value to it. In other words, as described by Pearce and Seccombe-Hett (2000) they feel that it is not ethical to place value on the environment and that it is priceless. Nevertheless, it is a well-accepted idea that the environment has value but the more important question that needs to be addressed is how to interpret "value". According to Pearce and Turner (1990), there can be many ways of interpreting the term "value" but for the economist this is taken as a monetary value, which is measured using individual consumer preferences. This is the part that makes the measurement of environmental value complicated as it does not take account of the intrinsic quality or value of the environment. So there is always the possibility of arriving at a few different values since human perception is not always the same. Strictly speaking from an economics point of view, values are expressed in terms of willingness to pay (WTP) and willingness to accept (WTA). WTP and WTA show the preferences of an individual over something where WTP is associated with gains and WTA with losses. So we can measure the gains and losses of an

individual and will be able to determine his/her wellbeing. How much would an individual willing to pay for a good/service reveals his/her WTP for that good/service.

Land has been converted into many different purposes because of the process of development. Among the major reasons for land clearing is because of agriculture and this has given us the incentive to weigh the costs or benefits of such decision. As pointed out by Pearce and Moran (1994) there are relatively more and more land used for agricultural purposes in Asia and this has caused a concern especially in South East Asia. Although not being a large area compared to mainland Asia, the rate of land conversion to agriculture use in South East Asia is quite high in the last century. In Malaysia most of the permanent forest estates (PFEs) in between 1978 to 1997 have been degazetted for agriculture (Letchumanan, 2002). Among the types of forest being used for agricultural purpose in Malaysia is the peat swamp forest (PSF) which can be found along the coastal areas of Peninsula Malaysia and Sarawak, with only a limited area found in Sabah (Joseph et al., 1974).

The function of peatland as a major carbon sequestration must not be taken for granted. Today, the effect of greenhouse gases (GHGs) emission continues to be a hot issue in the wake of concern for the global warming phenomenon. Cultivation of different crops will have a different impact on the environment (Azqueta and Sotelsek, 2007). In fact since the 1997 fire and haze problems, Malaysian Government through the Environmental

Quality Regulations 1974 (amended in 1998) banned the open burning of crop residues. We should press for better agricultural practices and improved land management that will ensure our natural resources are used in a sustainable manner (FAO, 2001; Freeman et al., 2005). There is also a need for us to be aware of good agricultural practices (GAPs) that conserve soil and one of this is to enhance carbon sequestration in soil (Lal, 1997). Goss et al. (2001) and Rastogi et al. (2002) state that an important method to reduce carbon dioxide (CO_2) emission level is by sequestering carbon in the soil.

Environmental concern on the use of peatland or peat soil[1] for agriculture is becoming an issue nowadays as it destroys the ecological function especially as a major global carbon sequestration. Agricultural activities come second in contributing to GHGs into the atmosphere after the burning of fossil fuel (Lal, 2001a). This has become a major concern to the global society especially after the 1990s because GHGs raise the atmospheric temperature. This has brought to the inception of the Kyoto Protocol in 1997, which is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). This agreement states that countries that ratify it are committed to reduce the emission of CO_2 and other GHG. As stated under Article 2 of UNFCCC, the objective of the Kyoto protocol is to stabilize GHGs concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Thus, it is worth knowing that there are agricultural practices that can reduce the

[1] The terms *peatland* and *peat soil* are used interchangeably throughout this study. The former is a general term referring to the area of land covered with peat whereas the latter is usually used specifically in relation to the planting of crop on the soil – pineapple.

emission of carbon which require a good management of any land cleared for agriculture (Lal and Bruce, 1999).

This is also important as it can educate the society to learn to appreciate the needs for sustainable agricultural practices. The clearing of land for agriculture will change the environment and for peat swamp forest the area needs to be drained as peatlands are waterlogged by nature. This involves the construction of drains to drain the water from the area and this will turn influence the water table. Different crops require different amount of water and therefore the height of the water table has to be conducive to the crop. The amount of water drained from the area can result in the area being overdrained and thus will significantly pose a hazardous condition to the peatland..

1.1.1 Land Conversion and Management

A poor management of the cleared peatland for agricultural purposes could also result in the depletion of peat due to irrigation for instance (FAO, 2001). Malaysia has joined in the campaign to conserve and promote sustainable use of its peat swamp forests. For example, the conservation project funded by the United Nation Development Programme (UNDP) which involves three different areas in Malaysia shows that a proper management of peatland is important to preserve the ecosystem surrounding it. The converted peatland on the other hand need to be properly managed so as to avoid any harmful effects such as peat fire which have been a frequent occurrence in places like

Indonesia and Malaysia. The long period of drought in 1997/8 for example resulted in peat fires in Borneo (Sarawak and Kalimantan in Indonesia). Crop plantation on peat soil is not uncommon in Malaysia as the distribution of peat soil in Malaysia is quite wide and it happens to be located near populated area where it is easily accessible (Hashim, 1984). The kind of plantation ranges from the huge oil palm plantations owned by the big plantation companies to the self-sustenance planting of paddy practiced by the local farmers.

Today, this is still being practised and we can see that commercial crops such as pineapple, oil palm, sago, pepper, tapioca, and sweet potato are planted on peat soil and the suitability of peat for agriculture has been looked into back in the 1970s (see Joseph et al., 1974). The planting of crops on peat is currently done in several areas in Malaysia especially in Johor, Selangor and Sarawak. There is an estimated 2.4 million hectare of peat in Malaysia and more than half of this is located in Sarawak. What is interesting about peat when it comes to agriculture is that it is used to be known as a problematic soil and associated with a high maintenance cost because of the lack of certain minerals that are required for a healthy growth to some crops (Joseph et al., 1974).

Today however, peat is not necessarily something of marginal value to agriculture as cultivation on peat has become a common practice. Some researchers notably from Malaysian Agricultural Research and Development Institute (MARDI) have been working on finding out the suitability of peat

soil for agricultural purposes (Tay et al., 1969; Joseph et al., 1974; Chew 1977; Tay and Lowings, 1985). The use of peat for agriculture has raised some important environmental issues and one of them is because peat swamp has to be drained and therefore this will affect the ecological aspect of the soil and the environment. All of the agriculture land in peat area need to be drained before any cultivation takes place because of its water-logged condition (Tay, 1981). Pineapple cultivation for example requires proper drainage and this is carried out after the land is cleared. The nature of crops planted could have different effects on the soil itself.

The relatively large area of peat in Sarawak compared to the other states in Malaysia results in some agriculture activities taking place on peat. Agricultural activities along the coastal region especially between Miri and Sibu for example, are on peat soil. One of the reasons why the cultivation took place on peat is because these areas are accessible by roads which link the major towns in Sarawak expanding form Kuching in the southern region to Miri in the northern region. The road system plays an important role in Sarawak and proper roads are found only in the coastal areas of the state. Some of the interior areas of the State are now accessible by timber roads which previously used to be only accessible through rivers. Transportation is a major obstacle for any activities in the interior part of Sarawak and therefore it is not surprising to see that most of agricultural projects such as the oil palm plantations are located in the plains which are not too far from the river delta. The distribution of peat in the State can be found in these

areas where the major rivers in Sarawak are located (see Chapter 2 for more detail).

Another important reason for the use of peat is that there is a limited land that is suitable for agriculture in Sarawak. This is based on the Department of Agriculture (DOA) of Sarawak classification of soil whereby soils are classified into five major types based on their fertility (1 being the most suitable and 5 is not suitable). Despite having a large land area Sarawak only have 1.77 million ha (14%) of land that are classified under categories 1-3. This is lower than the situation in Sabah and Peninsular Malaysia where the latter has about 46% of its land classified under categories 1-3. Clearly Sarawak is at a disadvantage position when we look at the availability of suitable land for agriculture. Thus, peatland is an important resource for the State (Uyo, 2007) as it is possible to plant crops on peat despite of its limitations on certain aspects. It was also reported that only 26% of the land in Sarawak are suitable for conventional agriculture which means that the demand for suitable agricultural land is high (Uyo, 2007). This is also the reason why we see that oil palms are being cultivated on peat as it requires a large area of land for the crops to be cultivated profitably.