Palm oil - strategic source of renewable energy in Indonesia and Malaysia

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Abstract

This paper seeks to answer the question of how the global industry of palm oil is affecting the economies and natural environments of its two main producers – Indonesia and Malaysia. The first section examines the contemporary uses of palm oil in a variety of products and industries. It also sets out to describe the global palm oil market. The second section takes a historical perspective, analysing the origins of palm oil cultivation and trade and its rapid rise to global prominence. The third section looks into the increasingly important role of palm oil as biofuel component and the implications this has for its use. The fourth section investigates both main producers of palm oil. The fifth section presents the controversies which arise from palm oil cultivation, trade and use in many consumer products. The paper concludes by describing the prospects of market growth and the economic and ecological implications for Indonesia and Malaysia.

Streszczenie

Niniejsza praca jest poświęcona badaniu wpływu globalnego przemysłu oleju palmowego na gospodarki i środowisko naturalne dwóch głównych producentów tego surowca – Indonezji i Malezji. Część pierwsza analizuje współczesne wykorzystanie oleju palmowego w różnych produktach i gałęziach gospodarki. Celem tej części jest również opis globalnego rynku oleju palmowego. Część druga przedstawia kontekst historyczny, analizując początki kultywacji i handlu olejem palmowym i szybki wzrost znaczenia tego surowca. Część trzecia jest poświęcona rosnącej roli oleju palmowego jako składnika biopaliw i znaczenia tego faktu w ewolucji stosowania tego oleju. Część czwarta analizuje sytuację obu głównych producentów surowca. Piąta część przedstawia kontrowersje, wynikające z kultywacji, handlu i użycia oleju palmowego w wielu produktach konsumpcyjnych. Niniejsza praca podsumowuje te rozważania przedstawiając perspektywy wzrostu tego rynku, oraz gospodarcze i ekologiczne implikacje tych zjawisk dla Malezji i Indonezji.

Keywords

palm oil, biofuels, economic development, environmental impacts, Indonesia, Malaysia

Słowa kluczowe

olej palmowy, biopaliwa, rozwój gospodarczy, wpływ na środowisko naturalne, Indonezja, Malezja

Palm oil is a vegetable oil derived from the fruit of the palm tree. It is an important and efficient type of oil which is used as a raw material for both food and non-food industries. Crude palm oil (CPO) is a highly-valued product that is traded on the international commodities and futures markets. Processed palm oil is used in a huge variety of products in cosmetics, foods, lubricants and also fuels (Clay, 2004). CPO is used for example in shortenings, pastry margarines and cakes, frying oils, coffee whiteners and emulsifiers and can also be used in a wide range of food products including gravy granules, suet mixes, frying oils, snack foods and toffee. That's half of all packaged foods in supermarkets (WWF Australia, 2013). Three main edible oils are palm, soybean and rapeseed, which together represent about 75% of total production in recent years (Rosillo-Calle, Pelkmans and Walter, 2009). Palm oil is a leading edible oil traded on global markets and comprises nearly 40% of all oils derived from vegetable sources (United States Department of Agriculture, 2008).

Total global production of palm oil is estimated at over 45 million tonnes (United States Department of Agriculture, 2008). Two countries in South East Asia, Malaysia and Indonesia, produce over 85% of the internationally traded CPO, while significant crop expansion is occurring in Thailand, Papua New Guinea, Costa Rica, Colombia, Ecuador, Cameroon and the Democratic Republic of Congo, yet the dominance of Indonesia and Malaysia is likely to endure for quite some time still. This is because palm oils require a temperature range of 24-32°C throughout the year, ample sunshine (~ 5-7 hours a day in all months), evenly distributed annual rainfall of 1780–2280 mm, soil pH <7.5, relative humidity ~ 85%. It's possible to plant palm oil at a +/- 10 degrees range off the equator, however prime areas of cultivation are within the +/- 5 degrees equator range. Major importers include India, China and the European Union, while the USA is a small market for palm oil compared to the above (Glastra, Wakker and Richert, 2002).

In 2009 the world consumed approximately 6.5 kilograms of palm oil *per capita* annually (Food and Agricultural Policy Research Institute , 2010a). By 2020, global consumption of palm oil is expected to achieve almost 60 million tonnes. Overall, the consumption of processed palm oil has more than doubled between 2000 and 2010 and the main new demand sources were Eastern Europe, India and China. Palm oil is a major global commodity with traded value of nearly $50bn in 2011 (around $24bn in 2000). In general terms, palm oil prices have risen steadily during the past 20 years, with a price spike in early 2008 (due to interest in biofuels) followed by a crash, after which its price returned to pre-boom levels and then continued a more gradual upward trend.

One of the biggest pros of CPO is that oil harvested from oil palms is cheap and its cultivation is up to a dozen times more efficient (higher oil yield per ha) than in the case of other oil sources. For example oil palm plants yields are 10 times higher in pounds per acre than soybeans (Arumughan, Skhariya and Arora, 2004: 644). More information can be found in Table 1. Palm oil requires the lowest fertiliser inputs (~1MT of fertiliser per planted ha), and has a long productive cycle

of ~25 years. Palm oil is the most cost-competitive vegetable oil for producing bio-diesel (Thoenes, 2006). The fresh fruit bunches (FFB) are typically 52 per cent dry weight and have an extractable oil content of 15-25 per cent (Weng 1999; Henson 1999). Returns on land, capital and labour produce substantial revenues both for companies and for countries. (Yusoff and Hansen 2007)

In this study my main aim will not be to conduct a detailed analysis of nutritional qualities and health effects concerns with regard to eating palm oil products. Considerable research has already been conducted on these subjects (see Colon-Ramos et al. 2007; Karsulinova et al. 2007; Ladeia et al. 2008; van Rooyen et al. 2008).

Brief History of Palm Oil

Palm Oil originated in the tropical rainforest region of West Africa. The main cultivation belt runs through the southern latitudes of Cameroon, Côte d'Ivoire, Ghana, Liberia, Nigeria, Sierra Leone, Togo and into the equatorial region of Angola and the Congo. Processing oil palm fruits for edible oil has been practiced in Africa for thousands of years, and the oil produced, highly coloured and flavoured, is an essential ingredient in much of the traditional West African cuisine. The traditional process is simple yet tedious and inefficient (Food and Agriculture Organisation of the United Nations, 2010).

Captain James Welsh was the first European who took 32 barrels of palm oil (together with 150 elephant tusks, 589 sacks of pepper, and cotton wool made from palm trees) from Benin to England in 1591 (Kalunta-Crumpton and Agozino, 2004: 210). During the 14th to 17th centuries some palm fruits were taken to the Americas and from there to the Far East. The plant appears to have thrived in the Far East, thus providing the largest commercial production of an economic crop far removed from its region of origin. Wherever they may have originated, the four original trees planted in Java in 1848 became the seed source for all Southeast Asian plantations developed over the following century (Henderson and Osborne, 2000). By the early 19th century, palm oil was being used to make soap and candles, later also being utilised for heating and cooking and in many other products from dynamite through tinplating (as used in the food canning industry) to margarine (Henderson and Osborne, 2000; Poku 2002). By 1930, palm oil had become important enough to justify the merger of Margarine Unie, a Dutch producer of margarine, and Lever Brothers, a British soap maker, into Unilever (Sheil *et al.*, 2009).

The international trade in palm oil started at the beginning of the nineteenth century with the development of trades in palm kernel after 1832. Nigeria occupied a strong position in the global palm oil export market in the twentieth century. The country supplied 75% of the 157,000 tonnes of palm kernel exports that originated from the British-colonised West Africa in 1911, and was the world's largest exporter. Nigeria was the largest exporter until 1934 when the country was surpassed by Malaysia. By 1966 Indonesia had also exceeded Africa's total palm oil production. According to *Oil Palm Review*, published by the Tropical Development and Research Institute in the United Kingdom,

over 3 million tonnes of palm oil were produced by Malaysia alone in 1983, compared with a total of about 1.3 million tonnes of African origin. Malaysia was subsequently outdone by Indonesia in 2006.

By 1998, palm oil constituted more than 5 per cent of Malaysia's GDP (Yusoff, 2006). Production in Indonesia meanwhile increased from 168,000 tonnes yielded from 105,808 hectares in 1967, to approximately 16.4 million tonnes cultivated on 6.2 million hectares as of 2006 (Indonesian Ministry of Agriculture) (annual yields rose from 1.58 t/ha to 2.6 t/ha) (BisInfocus, 2006; IPOC, 2006). Some subject matter experts say that the recent expansion in Asia has amounted to 0.4 million hectares a year (Corley, 2005). Most of this increase has taken place in Indonesia with an average of 350,000 hectares of new oil palm plantations planted each year in the period between 2000 and 2006 (IPOC, 2006).

Palm oil – the fuel of the future?

A potential crisis associated with high petrol and diesel prices has sparked global interest in producing alternative fuels and the use of electric propulsion rather than sticking with internal combustion. China, India, and other emerging economies have reacted to rising global demand by claiming an increasing number of energy sources in a variety of ways. Moreover, China has invested heavily in oil efficiency strategies for vehicles such as fuel economy standards which are more efficient even than those in the United States, ambitious electric vehicle plans and the deployment of plug-in hybrids, coupled with programmes for increased efficiency and technological progress. Japan and India have also sought better fuel efficiency standards. Yet while the idea of an engine propelled by electric energy is especially fashionable nowadays, cars based on this energy system are not very effective and both their purchase and usage price deters potential customers. Meanwhile biofuels are becoming an interesting alternative for a market where the price of oil is steadily increasing. Particularly palm oil is considered one of the best and cheapest biofuel ingredients for diesel engines.

Currently 77 per cent of palm oil is used for food and food products (United States Department of Agriculture, 2008). But palm oil is also a major driver of economic growth and a source of alternative fuel. Palm oil was basically the only driver of poverty reduction and eradication in Malaysia and has also enriched Indonesia. Nowadays the growth of new palm oil plantations in Malaysia and Indonesia is being criticised. The scale of palm oil demand is very large and continues to rise. Between 1962 and 1982 global exports of palm oil increased from around half a million to 2.4 million tonnes annually. In 2008 world production of palm oil and palm kernel oil amounted to 48 million tonnes. According to FAO forecasts by 2020 the global demand for palm oil will double, and triple by 2050, notwithstanding that given sharp volatility on the oil market this type of oil can become an interesting alternative. From 1970 the area of palm oil cultivation has risen in Indonesia by a factor of more than 30, and 12 in the case of Malaysia. This expansion was possible thanks to the availability of cheap labour and support from these governments, which have used loans from international

financial organisations, such as the World Bank, and also from private banks, to induce companies to start plantations in their respective territories.

If we only take into account the energy sector, the oil palm can become a key crop of our times. This is because it is quite possible that within a dozen or so years the world will largely run out of oil and its price will rise drastically. The key lies in research conducted in Malaysia and Indonesia which focuses on genetic modifications to oil crops and also research which should solve the problem of palm oil solidification when exposed to high temperatures. Currently this oil can be used as biodiesel in specially-heated equipment fitted in cars. Thus it may turn out that Malaysia and Indonesia, countries with a specific and unique strategy for developing their energy sectors, will become the source of cheap fuel, which will permanently bring prosperity to South-East Asia.

Indonesia

In May 2010 the Indonesian President Susilo Bambang Yudhoyono announced a policy of developing oil palm plantations on "degraded land" instead of the current practices of placing them on forest or peatland. As part of the national REDD+ strategy equipped with an unprecedented budget of $1 billion and a partnership with Norway, this policy is set to allow the palm oil industry continued expansion, which would generate profits, government revenues, and jobs, simultaneously reducing greenhouse gas emissions caused by deforestation and the degradation of forests (The REDD Desk, 2013). Despite the fact that there remain many questions about the Indonesian strategy of reducing emissions from deforestation and forest degradation (REDD+), the national government has recently stated that there are 6 million hectares of degraded land (an area exceeding the size of the Indonesian province of Aceh) which could be used for the expansion of oil palm plantations. This would suffice to achieve the country's national target of doubling palm oil production by the year 2020 without additional deforestation.

The production of palm oil is a reliable source of income for many of the Indonesian rural poor, with some experts suggesting that the employment generated from palm oil production in Indonesia has the potential to achieve 6 million and lift these workers out of poverty. Palm oil is the second largest agricultural product of Indonesia; in 2008, Indonesia produced over 18 million tonnes of palm oil. During the last decade palm oil has been the country's most important agricultural export. In 2008 Indonesia exported in excess of $14.5 billion of palm oil-related produce, according to the Indonesian Palm Oil Commission. The Indonesian palm oil industry has seen major growth in recent years and approximately 1.3 million ha of new areas dedicated to the cultivation of palm oil since 2005, reaching a level of nearly 5 million ha in 2007 (constituting 10.3 percent of the 48.1 million ha of agricultural land) (Food and Agricultural Policy Research Institute, 2010). This significant expansion has been caused by higher returns which in turn are the direct effect of increasing demand. The majority of Indonesia's palm crop is grown in Sumatra, with a total of over 75 per cent in mature palm area and 80 per cent of total palm oil production (United States Department of Agriculture,

2008). The main Indonesian provinces which produce palm oil are: Riau, Sumatera Utara, Sumatera Selatan, Jambi and Sumatera Barat. In 2008 approximately 49 percent of palm oil plantations were privately owned, 41 percent by small shareholders and the remaining 10 percent were government plantations. Private plantations are the largest producers of palm oil in Indonesia, contributing over 9.4 million tonnes of palm oil in 2008. In the same year smallholder plantations produced 6.7 million tonnes of palm oil and government-owned plantations produced 2.2 million tonnes of palm oil.

Malaysia

Malaysia is globally the second largest producer of palm oil after Indonesia and its production totalled 18.3 million tons in 2011. Palm oil is an important agricultural crop in the country, with approximately 3.5 million ha of area dedicated to its cultivation which makes up 11% of the national territory. 80 million tons of solid biomass are produced (empty fruit bunches, fibres) and 60 million tons of palm waste liquid is also obtained as a result of the production of palm oil, with 90% of this discarded without further use.

Enjoying strong support of foreign investment and development banks palm oil production started in 1971 with 300,000 hectares and reached a total of almost four million hectares in 2007. The industry grew quickly owing to rising foreign demand for vegetable oils that led to increased plantation area, recording 172 per cent growth between 1990 and 2001. Currently the main Malaysian production areas of palm oil are Johor, Sabah and Pahang (Teoh, 2002). In 2007 the palm oil industry produced approximately 15.8 million tonnes of oil from 4.3 million hectares, which ranked Malaysia second in the world with a 41 per cent share of the global market of palm oil worth 38.13 million tonnes. The main export partners are China at 3.94 million tonnes or 28.73 percent of total palm oil exports, the EU and Pakistan are next, with purchases of 2.06 million tonnes and 1.07 million tonnes, respectively. The whole industry employs around 900,000 people and makes up over four per cent of Malaysian GDP (Malaysian Palm Oil Council, 2007).

The Malaysian government has announced a plan to reduce the country's CO2 emissions by 40% relative to 2005 levels by the year 2020. Using biomass from palm oil is the key success element in achieving this goal. If the biogas (methane) generated from the palm waste liquid could be used to generate electricity, 400 MW of electricity would be generated in effect, which on its own would reduce CO2 emissions by 12%.

Controversies

Oil palms are cultivated on huge, industrial plantations, often (especially in the case of Indonesia) created on newly-cleared (i.e. first burnt out and then deforested) areas of rainforest, and also on ecologically valuable peatland. The plant's high yield means that palm oil is significantly cheaper than other vegetable oils to produce. However, the rapid rise in demand is having a serious

impact on the tropical countries which grow oil palms. There is a direct relationship between the growth of oil palm estates and deforestation in Malaysia and Indonesia (Clay, 2004: 218–219).

Replacing primary rainforests with plantations across South East Asia is limiting biodiversity, destroying local communities, and exacerbating climate change through the emissions of carbon dioxide which had previously been locked up in trees and peatlands. Increased production will destroy more rainforests, tilt animals such as the orang-utan, Sumatran tiger, elephants and rhinos towards extinction, and forcefully relocate indigenous people who live sustainable lives in forest ecosystems. Only a century ago, 85 to 90 percent of Indonesia's total land area was covered with tropical rainforest. Still as late as 1950 forest covered 77 percent of the land. Forest loss became a serious problem in the 1970s, when industrial-scale logging concessions were first allowed (Brown and Jacobson, 2005). According to FAO estimates, 98 per cent of original rainforest in Indonesia will disappear by 2022. Indonesia has been named in the 2008 Guinness Book of Records as the country with the fastest rate of deforestation (jamie, 2007). Another issue is the evolution of animals who call primary rainforest home (Figure 4).

Demand for biofuels could yet increase competition for land, become a threat for food production and raise inequality between the rich and the poor (Astyk, 2006). Many economies are currently in the process of adopting policies which encourage the use of biofuels. If these blending policies are carried out an additional 4 million hectares of oil palm would be needed to meet the requirements of the European Union alone. A significant role of stimulating the production of palm oil has been played by EU legislation, because due to biofuel subsidies European governments have caused a spike in palm oil demand. A further million hectares might be needed to satisfy China's demand, making biofuel production even more attractive (Sheil *et al.*, 2009). Even if current levels are maintained, palm oil is a destructive force. Global warming concerns and problems with global energy use have escalated controversies surrounding palm oil. Greenhouse gases and high prices of fossil fuels have led to increased interest in biofuels and other alternative energy sources. However, interest in biodiesel derived from palm oil (palm oil methyl ester) is currently a leading biofuel option and large investments are already being planned to convert further millions of hectares of tropical forests and other land types to oil palm plantations.

Research has shown that palm oil does not meet ecological balance standards (at economic equilibrium) set out by the European Commission. These standards establish that a litre of any biofuel should reduce CO2 emissions by 35 per cent in comparison with traditional fuel. Yet palm oil not only doesn't reduce these emissions but increases them by 32 per cent. Thus palm plantations not only don't compensate the oxygen production of „green" jungle, but they also contribute to the destruction of exotic equatorial ecosystems and in theory lead to increased emissions of the dreaded CO2. Captivatingly, biofuels made of palm oil are often seen as an attractive fix to reduce greenhouse gas emissions. By 2020, 10% of fuel sold in the EU will be biofuel. This is the effect of the EU Renewable Energy Directive (RED) which came into law in December 2010 and is in the process of transposition

into national law of all Member States. The RED is part of the EU's 2008 climate and energy package. This package establishes three legally binding and unilateral targets which should be reached by 2020: a 20% reduction of greenhouse gas emissions with regard to 1990 levels; a 20% reduction of energy use through improving energy efficiency as compared to 1990 levels; and a 20% share of renewable energy in total energy consumption. Within the 20% target for renewables it sets a target of 10% for renewable fuels in the transport sector, including biofuels (Agenzia per la promozione all'estero e l'internazionalizzazione delle imprese italiane, 2012). The irony of assumptions is quite clear: solving a problem on one side creates another on the other (Greenpeace UK, 2013).

Environmental protection organisations have criticised the production of palm oil due to its part in destroying rainforest, while the NGO "World Growth" has defended this resource, claiming it's a valuable ally in the fight against poverty. All this has led to forming a consensus opinion and creating the "Roundtable on Sustainable Palm Oil", together with the certification of this resource. These actions aim to promote sustainable production of palm oil and the protection of the environment. Can we be sure this happens if the price of oil increases? The Roundtable on Sustainable Palm Oil (RSPO) is based on the cooperation of oil palm growers, palm oil processors or traders, consumer goods manufacturers, retailers, banks and investors, environmental or nature conservation NGOs, and social or developmental NGOs, with the stated aim of 'promoting the growth and use of sustainable palm oil products through credible global standards and engagement of stakeholders'. Its members include high-street names such as Tesco, Nestle and Cadbury, as well as palm oil traders such as Cargill and ADM. Together, these companies represent 40 per cent of global palm oil trade. Palm oil companies wishing to certify their production as sustainable must pay independent RSPO-approved certification bodies to audit their production. Until today, about 10 % of the production of palm oil has been certified (Levin, 2012). The RSPO meets annually and is governed by an executive board (Teoh, 2010). Any stakeholder can become a member of the roundtable, but in order to be a certified grower or processor they must follow eight principles, each of these principles also containing more specific criteria:

1. Commitment to Transparency
2. Compliance with Applicable Laws and Regulations
3. Commitment to Long-Term Economic and Financial Viability
4. Use of appropriate Best Practices by Growers and Millers
5. Environmental Responsibility and Conservation of Natural Resources and Biodiversity
6. Responsible Consideration of Employees and of Individuals and Communities by Growers and Millers
7. Responsible Development of New Plantings
8. Commitment to Continuous Improvement in Key Areas

Conclusions

Malaysia and Indonesia, neighbouring countries in South East Asia, see their future in biofuels. The long-term energy strategy of these countries is based on the cultivation of palm oil. Profits and the possibility of effective plantation management are enabled by optimal climate conditions, low land prices and a short crop-growing period of 3 years. Thanks to cheap labour, with wages which amount to 750 RM-850 RM in Malaysia and approximately 800-900 thousand rupees in Indonesia, this is a golden opportunity for companies and the entire economies of these countries (author's calculations based on Agenzia per la promozione all'estero e l'internazionalizzazione delle imprese italiane, 2012). To picture the size and scale of cultivation we just have to imagine that in Indonesia alone palm oil plantations take up more than two times the area of Belgium. Thus it is no wonder that this land-rich country is counting on the cultivation of palm oil, which is slated to lift Indonesians out of poverty. Ultimately as many as 3.7 million Indonesians are currently employed at the plantations (Skinner, 2013). This is also the reason for ongoing discussions about even more increases of cultivation areas.

Fossil fuels have enabled the creation of a wealth of devices and tools which make our everyday work and life so much easier. Without them, without industry, the energy sector, and transport our world doesn't exist. Fuel is a stimulus which makes us try to solve our ecological problems by shifting responsibility to the emerging economies, often with destructive consequences for their natural environments. This is because palm oil is not only present in biofuels, but nearly in all products we can buy at our local supermarket, starting with beauty products all the way through to processed foods. In other words Malaysia and Indonesia are producing palm oil because Western and Chinese citizens need it, thus "eating away" a bit o jungle every single day and further transforming our world. This natural process (fighting it is futile) will probably lead to a situation where there won't be enough energy for everyone. On the other hand, if oil prices will return to their levels from the first half of 2008 (almost 150 USD/barrel) or even rise beyond that, it might just be that prosperity will finally come to South East Asia.

References

Agenzia per la promozione all'estero e l'internazionalizzazione delle imprese italiane (2012), *Malaysia – The Malaysian Palm Oil Sector – Overview (June 2012)*, online: http://www.ice.gov.it/paesi/asia/malaysia/upload/173/Palm%20Oil_overview_2012.pdf [accessed 26 August 2013]

Arumughan C., Skhariya R. and Arora R. (2004), 'Edible oil outlook for India', *Inform*, Vol. 15(10), p. 644

Brown, E. and Jacobson, M.F. (2005), *Cruel Oil: How Palm Oil Harms Health, Rainforest and Wildlife*, Center for Science in the Public Interest, online: http://www.cspinet.org/palm/PalmOilReport.pdf [accessed 26 August 2013]

FAOSTAT (2010), *FAOSTAT database*, online: http://faostat.fao.org/site/291/default.aspx [accessed 26 August 2013]

Food and Agricultural Policy Research (2010c), *Global Forest Resources Assessment 2010: Country Report Indonesia*, The Forest Resources Assessment Programme.

Food and Agricultural Policy Research Institute (2010a), *U.S. and World Agricultural Outlook*, online: http://www.fapri.iastate.edu/outlook/2010/ [accessed 26 August 2013]

Food and Agriculture Organisation of the United Nations (FAO) (2010b), *Global Forest Resources Assessment 2010*, online: http://www.fao.org/forestry/fra/fra2010/en/ [accessed 26 August 2013]

Food and Agriculture Organisation of the United Nations (FAO) (2013), *Oil palm*, online: http://www.fao.org/docrep/005/y4355e/y4355e03.htm [accessed 26 August 2013]

Glastra, R,. Wakker, E., Richert, W. (2002), *Oil Palm Plantations and Deforestation in Indonesia. What Role Do Europe and Germany Play?*, World Wide Fund for Nature Germany

Greenpeace UK (2013), *Palm oil*, online: http://www.greenpeace.org.uk/forests/palm-oil [accessed 26 August 2013]

jamie (2007), *Indonesia gets new world record: fastest logger*, Greenpeace UK, online: http://www.greenpeace.org.uk/blog/forests/indonesia-gets-new-world-record-fastest-forest-logger [accessed 26 August 2013]

Journey to Forever (2013), *Oil yields and characteristics*, online: http://journeytoforever.org/biodiesel_yield.html [accessed 26 August 2013]

Kalunta-Crumpton A. and Agozino B.(eds.) (2004), *Pan-African Issues in Crime and Justice*, AshGate Publishing

Levin, J. (2012), *Profitability and Sustainability in Palm Oil Production: Analysis of Incremental Financial Costs and Benefits of RSPO Compliance*, WWF, FMO and CDC, online: http://awsassets.panda.org/downloads/profitability_and_sustainability_in_palm_oil_production__update_.pdf [accessed 26 August 2013]

Malaysian Palm Oil Council (2007), *MPOC Annual Report 2007*, Malaysian Palm Oil Council, online: http://www.americanpalmoil.com/publications/MPOC_AnnualReport_2007.pdf [accessed 26 August 2013]

Mielke, S. (1991), *Economic prospects for oilseeds, oils and fats toward the 21st century*, In: Basiron, Y. and Ibrahim, A. (eds.), *The proceedings of the 1991 PORIM International Palm Oil Conference. Kuala Lumpur*, 9–14 September 1991. *Module iv: Promotion and marketing*, 1–16. Palm Oil Research Institute of Malaysia

Rose, M. (2010), *The palm oil problem - what can be done?*, Daily Info, Oxford, online: http://www.dailyinfo.co.uk/reviews/feature/5024/Orangutans_and_how_to_help_them [accessed 26 August 2013]

Rosillo-Calle, F., Pelkmans, L. and Walter, A. (2009), *Global Overview of vegetable oils, with reference to biodiesel*, IEA Bioenergy, online: http://www.bioenergytrade.org/downloads/vegetableoilstudyfinaljune18.pdf [accessed 26 August 2013]

Sheil, D., Casson, A., Meijaard, E., van Noordwijk, M., Gaskell, J., Sunderland-Groves, J., Wertz, K., Kanninen, M. (2009), *The impacts and opportunities of oil palm in Southeast Asia***,** CIFOR, online: http://www.worldagroforestry.org/downloads/publications/PDFs/OP16401.PDF [accessed 26 August 2013]

Skinner, B. (2013), 'Indonesia's Palm Oil Industry Rife with Human-Rights Abuse', *Bloomberg Businessweek*, 18 July 2013, online: http://www.businessweek.com/articles/2013-07-18/indonesias-palm-oil-industry-rife-with-human-rights-abuses [accessed 26 August 2013]

Sumatran Orangutan Society (2007), *The Orangutan Crisis*, online: www.orangutans-sos.org/orangcrisis.htm [accessed 15 December 2012]

Teoh, C.H. (2002), *The Palm Oil Industry in Malaysia: From Seed to Frying Pan*, WWF Switzerland.

The REDD Desk (2013), *REDD+ National Strategy (Indonesia)*, online: http://www.theredddesk.org/countries/indonesia/info/plan/redd_national_strategy_indonesia [accessed 26 August 2013]

Thoenes, P. (2006), *Bio-fuels and Commodity Markets—Palm Oil Focus*, FAO Commodities and Trade Division.

United States Department of Agriculture (USDA) (2008), *Oilseeds: world markets and trade. Circular Series FOP 10-08*, October 2008, online: http://www.fas.usda.gov/psdonline/psdDataPublications.aspx [accessed 26 August 2013]

United States Department of Agriculture (USDA), *Foreign Agricultural Service's Production, Supply and Distribution (PSD) online database*, online: www.fas.usda.gov/psdonline [accessed 26 August 2013]

WWF Australia (2013), *What is palm oil?*, online: http://www.wwf.org.au/our_work/saving_the_natural_world/forests/palm_oil/ [accessed 26 August 2013]

Table 1. Oil production of palm and other major oil crops

Oil type	Oil yield (kg/ha)
Palm	4000–5000
Rapeseed	1000
Groundnut	890
Sunflower	800
Soya bean	375
Coconut	395
Cotton seed	173
Sesame seed	159

Source: Journey to Forever, 2013; Mielke, 1991

Figure 1. Global Vegetable Oil Production in 2011 (100% = 154 million tonnes)

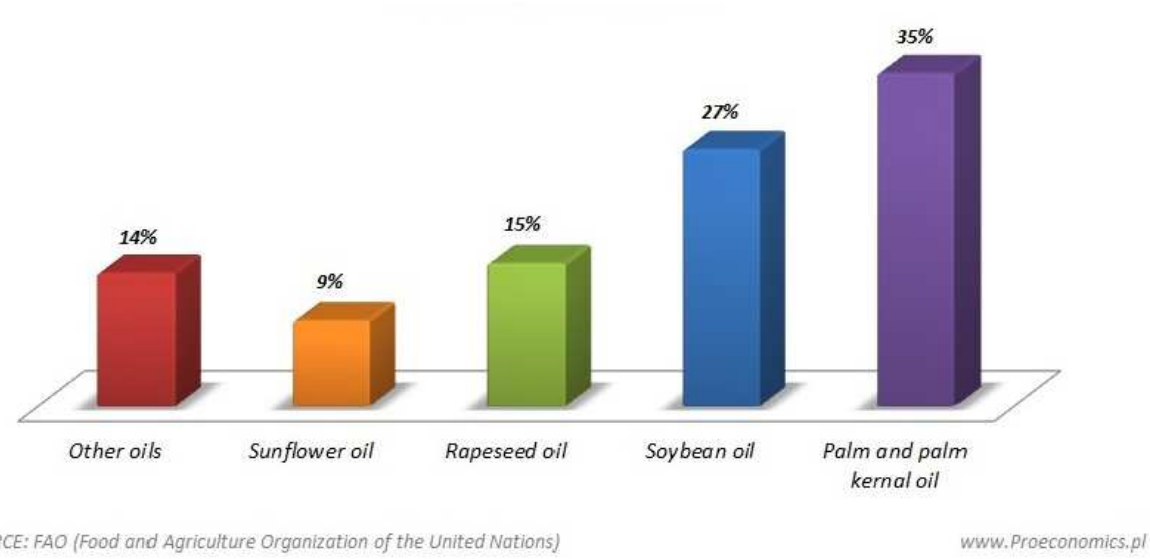
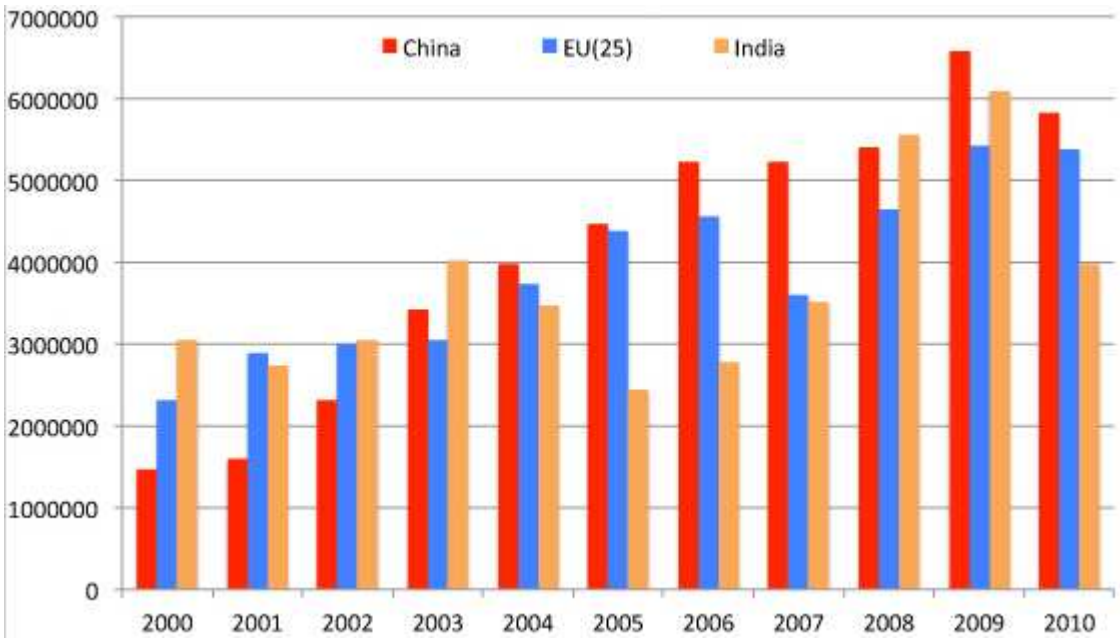


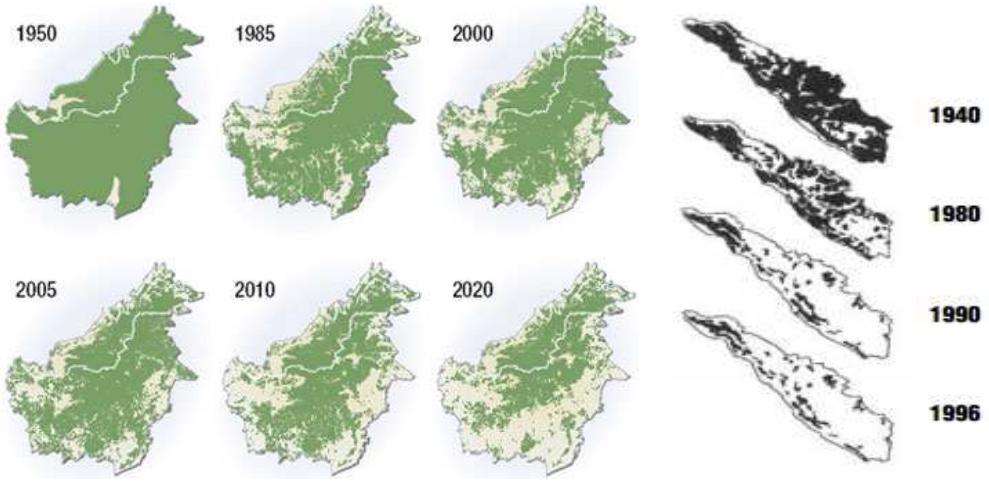
Figure 2. Palm oil production 1985-2011 (metric tons)

Figure 3. Palm oil imports, 2000-2010 (metric tonnes)



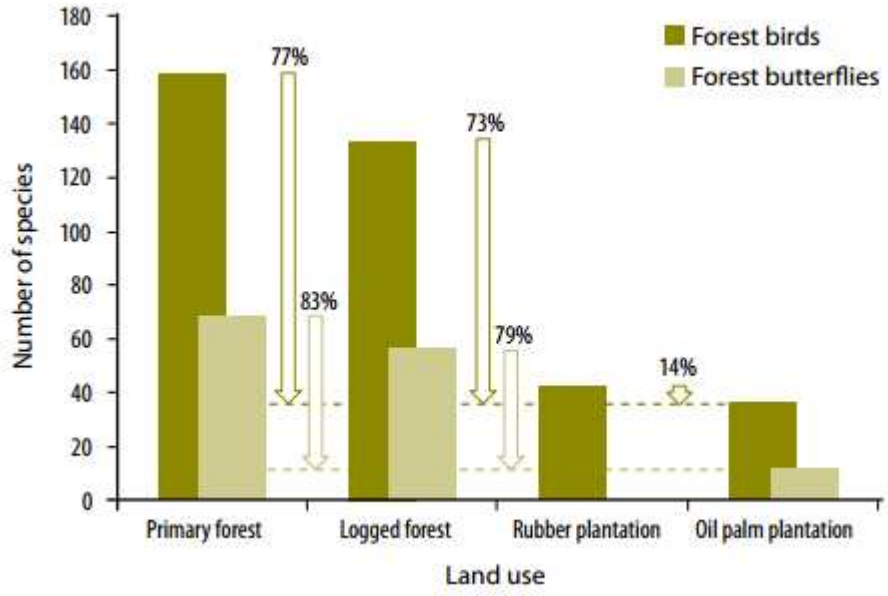
Source: FAOSTAT (2012)

Figure 4. Extent of deforestation of Borneo Island (in Indonesia Kalimantan) projection towards 2020 (left), and deforestation of Sumatra island (right)



Source: Sumatran Orangutan Society, 2007; Rose, 2010

Figure 5. Total number of species of forest birds and forest butterflies recorded from different land use types in southern Peninsular Malaysia and Borneo, respectively



Source: Koh and Wilcove 2008a; Sheil *et al.*, 2009