SUSTAINABLE OIL PALM CULTIVATION IN MALAYSIA – ARE PEATLANDS A SUITABLE CHOICE?
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Abstract
Malaysia has fully nurtured oil palm cultivation since its first commercial planting in 1917 till it became the most important economic crop. Located in the most suitable climate zone for oil palm, significant expansion of its cultivation was recorded, including replacing other less competitive existing crops such as rubber, cocoa and coconut. However, its expansion was limited due to availability of arable land as well as its commitment to the pledge at the Earth Summit in 1992, to keep at least 50 per cent of its land as forest cover. Being one of the mega biodiversity countries, the protection of Malaysia’s forestland cannot be compromised. Increasing the productivity within the existing available land, through planting of DNA-tested high yielding breeds and clonal materials, as well as accelerating replanting of unproductive palms, could be an alternative to overcome this limitation. Another option is to convert managed peatlands, which have already been converted for use by other cash crops. However, oil palm cultivation on managed peatlands needs to adhere to strict drainage management in order to mitigate negative environmental and climate impacts, given that peatlands contain vulnerable soils that can function as net carbon sinks. By ensuring that water tables are maintained within MPOB best-practice guidelines, growers can ensure that oil palm plants are able to reach their maximum potential yield while minimising peat carbon loss and soil subsidence. Furthermore, drainage can also stimulate GHG emissions, particularly enhanced emissions of soil carbon dioxide (CO2); careful water table management within MPOB guidelines can reduce this efflux. Even though soil CO2 emissions during earlier stages of plantation establishment may be high, net emissions decline as plantations reach maturity. A collaborative study between MPOB and UK partners on peatlands issue related to drainage and conversion in this complex ecosystem have been carried out. Preliminary results show that CO2 emission over a newly drained and planted oil palm estate was indeed releasing CO2 emission. These CO2 emissions progressively reduced over the year following planting. Responsible use of existing managed peatlands for oil palm requires growers to follow more stringent water table management, in order to minimise environmental and climate impacts, as stipulated in industry best practice guidelines and the National Action Plan for Peatlands.

Keywords
Peatlands, oil palm, sustainability, GHG emissions, management, Malaysia

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1. Introduction

Oil palm has been an important crop in the agriculture sector and the oil palm industry remains an important economic asset in Malaysia since 1960s \(^1\). With approximately 5.81 million hectares of oil palm planted, Malaysia produced about 19.92 million tonnes of palm oil or about 29.6% of total world palm oil production in 2017 \(^2\). The production of palm oil increased by 15.0% in 2017 to approximately 19.92 million tonnes relative to 17.32 million tonnes in 2016.

The growing world population and increasing purchase power has pushed the global demands for oils and fats to greater heights. The oil palm industry can remain competitive and sustainable in the global market with consistent maximum productivity \(^3\). Higher productivity is essential to enhance the performance of oil palm industry with current extent of oil palm planted area. This is mainly due to scarce availability of land which can then allow continued sustainable production of higher (FFB) yield.

Oil palm sustainability is an essential effort and commitment to effectively manage the plantation, with a focus to reduce environmental degradation while maintaining a competitive and sustainable global market. Sustainability is the driving force in the oil palm industry to achieve positive future environmental stewardship and prosperous global economy \(^4\). The knowledge that contemporary human activity on the management of plantations has important implications for sustainable production of oil palm that eventually influence global concerns on economic governance, international trade, technological advancements, politics, and society.

Sustainable peatland management of oil palm plantations has been a crucial issue in an attempt to reduce greenhouse gas emissions and maintain the storage of peat carbon. Current rates of peatland development already exceed the threshold of ecosystem stability and resource expansion. With these trends likely to continue for the next several decades at least, contemporary peatland management strategies informed by scientific research, and with a focus on economic efficiency and socio-ecological systems will likely become increasingly important in the future.

Addressing these key elements of sustainability in oil palm plantations requires extensive integration of knowledge from ecosystem and plantation sciences with that from social sciences and technological advancements. Ecosystem and plantation sciences can be described, studied and understood in terms of bio geophysical interactions controlled by environmental factors. Based on this knowledge, effective policies, management and governance needs to be integrated with advances in scientific research to formulate effective and environmentally responsible sustainable management of oil palm plantations.

2. Sustainable oil palm management

A sustainable oil palm industry refers to truly efficient production of nutritionally high-quality food where all stakeholders involved in the production chain are committed to ensuring that the wider environment and the well-being of the community are not compromised \(^5\). The awareness for oil palm sustainability is growing rapidly, particularly the implications of different management practices for the environment and climate change through different parts of the supply chain.

There are considerable records of environmental and sustainable practices of oil palm plantation industry. Best practices are continually being developed and updated to encourage sustainable practices. Some common Best Management Practices (BMP) are as follows:

- Land selection for new plantings (Soil Survey)
- Guidelines on Zero Burning Technique
- Guidelines on Integrated Pest Management (IPM)
- Guidelines on Waste Minimisation and Recycling
- Guidelines on Conservation of Riparian Reserves and Marginal Lands
- Guidelines on Occupational Safety and Health Management; and
- Guidelines on Oil Palm Cultivation on Peat Soils

The Malaysian Standard (MS) on Malaysian Sustainable Palm Oil (MSPO) initiative was implemented in oil palm industry through voluntary basis starting from 1 January 2015.
and will be made mandatory by 31 December 2019. The MS comprises of four parts, including general principles, requirements for independent smallholders, plantations and organised smallholders, and mills. Each of these principles are supported by criteria and indicators. The four parts of the MSPO are as follow:

- **Part 1: General Principles**
- **Part 2: General Principles for Independent Smallholders;**
- **Part 3: General Principals for Oil Palm Plantations and Organised Smallholders;**
- **Part 4: General Principles for Oil Palm Mills**

There is a genuine, long-term sustainability issue for plantation agriculture on peat. This is not just an issue relating to greenhouse gas emissions, it is also an issue to do with wasting (loss) of the peat substrate leading to land surface lowering (subsidence), reduced drainage and an increased risk of flooding. Reducing plantation peat carbon loss is therefore in the industry’s best interests, since conserving the peat substrate will also prolong the productive life of the plantation and mitigate other environmental impacts (e.g. flooding), which could have negative impacts not only for wider society but also for plant growth and yield. The protection of the peat substrate in order to optimise plantation sustainability is best achieved by optimised management (including hydrological management, but perhaps also optimised use of fertilisers and other management operations). To achieve this science-based management approach (which could also be termed “best use”), all stakeholders need high quality, published science to provide a robust understanding of current rates of carbon loss.

3. **Oil palm cultivation on peatlands**

Tropical peatland is a significant terrestrial carbon sink and covers a total area of 440,000 km². Peatland conversion significantly contributes to global anthropogenic greenhouse gas (GHG) emissions, with managed land cover types contributing 78% of Southeast Asia’s total peat oxidation emissions (146.2 Mt C yr⁻¹). Central to this has been the expansion of oil palm plantations (OPP) across Peninsular Malaysia, Borneo and Sumatra. This form of conversion is responsible for 32% of total emissions from peat oxidation in Malaysia.

Oil palm expansion on peat has been quantified using various methods resulting in a range of estimates. In Malaysia, projections of OPP on peat soils by 2020, range from 14%, following a business as usual (BAU) approach, to 42%21. These projected increases in area are comparable to historical growth averages with Malaysian oil palm cultivated on peat increasing from 8% to 13% between 2003 and 2008. However, large uncertainties exist relating to these trends with changing policies amongst countries and provinces and opposition to palm oil regulation likely to impact the rate of future expansion.

The expansion of oil palm plantations has often resulted in the clearing of peat swamp forest and drainage. In order to grow oil palm on peat soil, the water table is normally artificially drawn-down to enable oxic conditions for the crop roots to grow. Peatland drainage does not necessarily lead to over-draining, excessive drying of peat or fire, but merely draining to optimum water and maintaining the level for planting in accordance to best management practices.

In tropical conditions, it is expected that peat undergoes microbial decomposition, producing CO₂. The average CO₂ emission of tropical peat oxidation reported in Southeast Asian region is approximately 15 Mg C ha⁻¹ yr⁻¹. Undrained peatland may also contribute to CH₄ emissions with higher water level that leads to anaerobic conditions and methanogenesis in peat. CH₄ emissions has a Global Warming Potential 25 times that of CO₂ over 100-year timeframe.

Soil CO₂ emission associated with oil palm plantations over various ages of development is estimated between 6 and 40 Mg C ha⁻¹ yr⁻¹. CO₂ emission from peat in oil palm plantations may be high; however, averaged across all oil palm plantations of different ages it is estimated to be approximately 18 Mg C ha⁻¹ yr⁻¹, suggesting that CO₂ emissions decline as oil palm plantations reach maturity.

Our collaborative study between MPOB and UK partners is an intensive study in Sarawak investigating the effects of peatland drainage and conversion on the greenhouse gas fluxes,
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carbon and nutrient cycling at different stages of oil palm development. Following 1 year of intensive measurement, we found that CO\textsubscript{2} emissions from a newly drained and a mature oil palm estate was indeed releasing large amounts of CO\textsubscript{2}. As such, effective water table management in oil palm plantations provide an important mechanism for minimizing the greenhouse gas emissions from oil palm plantations. Regulation of high-water table within peatland oil palm plantations should take paramount importance, with potential implications for carbon cycling and the loss of historically stored carbon – i.e., water table should be kept as close to the peat surface as possible with minimal seasonal variation.

4. Management strategies for sustainable oil palm cultivation on peat

Taken together, our recent results provide several management suggestions to effectively reduce and mitigate peatland emissions on oil palm plantations on peat. Any form of development and agricultural or crop plantation on tropical peatland will require strict and guided drainage management. This is imperative to ensure an optimum level of water that facilitates both plant growth while mitigating negative environmental and climate impacts. Hence, even if peatland drainage is inevitable for utilisation by agriculture, the process of drainage should follow strict guidelines and standard operating procedures\textsuperscript{34}. One of the main practices is to regulate water table management at optimum level\textsuperscript{35}, at or above 60 cm from peat surface. This will significantly reduce CO\textsubscript{2} emissions and the amounts of peat carbon being lost. In addition, consistent water levels will ensure that the peat is not vulnerable to extreme wetting and drying spells that may influence bio-geophysical feedbacks to the peat ecosystems. Regular clearance of debris (i.e., vegetation) within the collection and field drains may ensure that the water flows efficiently, and thus help with water table regulation. However, the uncertainties associated with maintaining higher water table may be related to yield and productivity, root expansion, nutrient uptake and growth of oil palm on peat. Considerable knowledge and scientific data are still needed to simulate such condition for productivity and planting enhancement.

The adoption of best management practices\textsuperscript{36,37} in oil palm cultivation on peat is imperative to ensure sustainable plantation towards less environmental degradation and greenhouse gas emissions. Common practice to clear paths and compacts the peat has been the adopted in most peat plantation. However, if peat compaction can be reduced then the hydrological functionality will be maintained. For example, water will flow more quickly through the peat, giving dissolved organic carbon less time to be transferred into the moving body of water and lost from the system. In addition, with less compaction, there will be a lower concentration of carbon above the water table, which is vulnerable to biological breakdown and mineralization (MPOB, unpublished data).

5. Conclusion

There is significant evidence from the practices of oil palm cultivation on peat and sustainability initiatives being implemented to improve the environmentally sustainability of oil palm plantations. An important aspect of plantation industry is the quality and quantity of oil yield with less environmental degradation. Striking the balance between the two challenging facets of pathways has been an uphill task. The industry must make continuous improvements and ensure consistency in the adoption of BMPs, and the sustainability of the palm oil industry will also depend on how well it convinces consumers of its sustainable practices and overall sustainability.

A stable trajectory in environment and production of oil palm industry requires deliberate science-based management with social responsibility to avoid crossing the irreversible and degraded threshold. A deep transformation of sustainable management based on fundamental science advancement, technologies, economies reorientation, and social values is required. The pathway toward oil palm sustainability involves considerable changes to the structure and management strategies, which are to be given priority than at current decision-making.

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