The Sustainability of Palm Oil Production In LAC Region

Executive Summary

Assuming CPO yields can be improved to say 4.0MT/Ha (from circa 3.5MT/Ha on average today), over the next 10 years (with replanting and improved operational methods), the global planted area of circa 22M Ha (2022) could produce 88M MT of CPO annually before the middle of the next decade. This would imply a requirement of some 8M MT of CPO to be produced from new planted area – which at 4MT CPO/Ha would suggest 2M new hectares. However, with new higher yielding materials it may be possible for yields closer to 6MT CPO/Ha – especially in LAC region, which would reduce the globally required new area to 1.3M Ha.

Palm oil is an emotive commodity. In Europe and North America, the commodity is associated with deforestation and the wholesale loss of biodiversity. The development of the palm oil production sector in Indonesia and Malaysia resulted in the deforestation of 36% of forest areas in Sumatra between 1985 and 2016, and 43% in Borneo between 1973 and 2015. The value chain has responded with the launch of the Round Table For Sustainable Palm Oil (RSPO). The RSPO has introduced a range of measures and protocols to improve the sustainability of production, and by extension, the image of the commodity. Central to the measures introduced by the RSPO is the requirement that new plantations must only be developed on land that has been previously intervened. In turn, this has raised concerns about the capacity of the global production sector to meet future demand from a world population which is expected to reach some 9.7BN by 2050. Projections that a further 6M Ha in the humid tropics may be needed for oil palm plantations are considered unrealistic for environmental and sustainability reasons.

However, with a combination of improved genetic materials capable of producing perhaps as many as 10MT of palm oil products per hectare, and improved practices to realise more of the crop's genetic potential from existing plantations, the requirement for new land could perhaps be limited to another 1-2M Ha only. For diverse reasons, the expansion of new planted area favours regions outside Southeast Asia. LAC region looks to have abundant land with suitability for oil palm in tropical regions where land deforested many decades ago, has been intervened for grazing (cattle), and or to produce other crops, of which some are illegal. Moreover, studies show that much of LAC region palm oil plantation development has followed a different trajectory from Indonesia and Malaysia, by cultivating the crop on previously grazed land and cropland, rather than on recently felled prime forests. The palm oil production sector in LAC region has also been characterised by a push to adopt RSPO principles. This has been supported by the midstream and downstream segments of the value chain and by state actors. RSPO certified plantations reached 355,300 Ha in 2019 and produced 1.06M MT of RSPO certified sustainable palm oil, representing 22% of the regional total (4.79M MT).

Cultivation of palm oil across LAC region has a wide geographic range, extending from latitudes 8 degrees south to as much as 18 degrees north (Central Peru to Southeast Mexico). In the more northerly regions, irrigation is required to optimize yields due to the variable distribution of annual rainfall. The sustainability of water is both a current issue and a long-term concern, as CLIMEX modelling suggests climate change could significantly change the map of LAC region in terms of areas suitable for palm oil production by 2100. Breeding for drought resistance will be just one of the mitigations required from the sector to ensure sustainability of the crop's cultivation in the region for the long-term.

Introduction

For many observers, the palm oil sector, and in particular the industry in the two leading producer countries of Indonesia and Malaysia, has been responsible for widescale deforestation and the destruction of biodiversity. As the author of this paper has observed in Sarawak (2011) and East Kalimantan (2012), on the day the final logs were hauled from an area of former primary forest, the oil palm plantation engineers moved onto site.

In Indonesia the area planted to oil palm expanded from 2.5M Ha to more than 8M Ha between 2000 and 2014, for a loss of more than 423,000 Ha of rainforest every year on average during the period. Several studies have examined the impact of land use on biodiversity on the island of Borneo (now Sarawak and Kalimantan), noting the reductions to biodiversity as complex rainforest ecosystems have been replaced by monocultures, producing comparatively species-poor plantation systems.

The RSPO now insists that to gain RSPO Certification, new plantations must not replace primary forest, or any area required to maintain or enhance one or more High Conservation Values (HCV). Moreover, developments should actively seek to utilize land that has been previously cleared or is degraded. The rule for applying for carbon credits from reforestation projects is that the land must not have been felled in the preceding 10 years. Several published studies suggest that a limited degree of oil palm expansion might be possible (sustainably) on land already designated as degraded, thus obviating the argument that further expansion is necessary on primary tropical forest lands (Jackson 2019; Wicke et al 2011). However, under pressure from civil society organisations, NGOs and leading brands, governments across the tropical belt have been introducing tighter controls, and even bans, on the conversion of tropical environments to oil palm plantations. Some commentators argue that Indonesia in particular, could still do far more to protect its remaining tracts of forest and peatland.

Considering that to maintain the 2022 status quo of global per capita consumption of palm oil (circa 9.8kg) through to 2050 and a world population projected at 9.7BN, would require 96.8M MT of CPO, for growth of some 17-19M MT. If yields were to remain around 3.5 MT /Ha, this would require 27.7M Ha of oil palm, for an increase of some 5.0-5.5M Ha. Industry estimates range up to 6M Ha of required expansion by 2050, but this is described as “a formidable challenge” (Murphy et al 2021), in view of the scarcity of land which would be deemed acceptable for cultivation for oil palm. Alternatively, yields could rise and or the portion of the crop which is absorbed for the manufacture of biodiesel (19%) could be released to the dietary market, so reducing the requirement for new plantation area.

In terms of yield growth, two pathways are open: improved genetics and improved practices. Breeding efforts have focused on commercially important goals including oil yield and composition, resistance to pest & disease, and the growth pattern and stature of the palm. Genomics-based strategies (including marker-assisted selection) have led to the development of valuable new traits for oil yield, fatty acid composition and crop morphology (Xia et al 2019). In 2020 it was announced that new lines had been developed with the potential to more than double current oil yields. Sime Darby’s ‘Genome Select’ programme has announced results of a five-year field trial in which average yields were achieved of 9.9MT CPO/Ha.

Sustainability of Palm Oil Production Expansion In LAC Region

Expansion On Land Previously Intervened For Cattle Grazing

In LAC region it is posited that expansion area for new palm plantations could be found on land currently used for cattle ranching, other crops, and illegal farming of coca. A 2021 study of tropical native grasslands / savannas, covering some 210 million hectares across Bolivia, Brazil, Colombia, Guyana, and Venezuela, concluded that this vast area was being used for cattle-based production systems rather than cropland, on a ratio of approximately 4:1. (R.R. Vera, Pontificia Universidad Católica de Chile). Pirker et al. 2016, estimated that there may be more than 83M Ha available for palm oil production in LAC region outside protected regions. The scale of this area implies that it should be possible to find 1-2 million hectares for new oil palm cultivation within LAC region, without intruding on to sensitive areas such as the 17M Ha Pantanal (substantially under threat from cattle ranching).

In 2017, a team from the University of Puerto Rico, led by Paul Furumo, mapped oil palm plantations in LAC, to determine prior land use and prior land cover. To do this Furumo's team used high-resolution imaging from Google Earth. Based on a sample of 342,032 Ha of oil palm plantations across the region, the team found that:

- 79% replaced previously intervened land – often previously used for cultivation of bananas, crops and for grazing cattle – this latter category making up 56% of the total.
- The remaining 21% had been planted on areas classified previously as 'woody vegetation' (forests), and the report specifically noted this pattern in the Amazon region, and the Peten region of northern Guatemala. (Furumo et al; 2017).

The research paper published by Furumo et al explored the possibility that "*oil palm expansion in Latin America may be following a distinct land-use trajectory from Asia*". In the period 2001-2008, the Furumo research noted that oil palm cultivation in Colombia had expanded by 155,100 Ha with 51% occurring on former cattle grazing lands, 30% replacing other crops, and only 16% replacing natural vegetation. These findings followed a global survey conducted in 2016 (The Impacts of Oil Palm on Recent Deforestation and Biodiversity Loss; Vijay V et al 2016), which estimated that only 2% of new plantations established in Central America/Caribbean between 1989 and 2013 were planted on previously forested lands. The pattern in the Peruvian Amazon has been more impactful on natural forests however: Vijay et al reported that some 72% of oil palm expansion in the Peruvian Amazon (between 2000 and 2010) occurred on forested lands.

Bid-rent Theory

Vijay et al concluded that except for Mexico, each LAC nation (analysed in the report) was 'forested' or had half of its land mass covered with forest, but that this notwithstanding, lands used for cattle grazing remained the "*most significant of new oil palm plantings across LAC*". The report suggested that 'bid-rent theory' predicts the pasture-palm oil transition as property values increase with proximity and connectivity to centres of commerce, thus favouring expansion into areas previously cleared of forest as compared to more remote, less accessible lands.

It is also the case that palm oil cultivation – especially when practised by small farmers, needs to be located within reasonable proximity to a palm oil mill. Most holdings producing fresh fruit bunches (FFB) across LAC are in the hands of small and medium sized producers (defined as farming fewer than 500 Ha). These producers typically do not have the capital to invest in a palm oil crushing mill. The requirement for plantations to be located near to a market (a crushing mill) also means that they need access to serviceable roads. Ideally, fresh palm fruit should be processed within 6 hours of harvest, but in more remote regions, the time indicator stretches to 24 hours.

Palm oil is also a labour-intensive crop. Highly efficient, semi-mechanised agro-industrial plantations can manage 15 Ha with one full time staff equivalent (FTE), but the industry norm is 10 Ha: 1 FTE, and on less efficient plantations the ratio can fall to as low as 7.0 Ha: 1 FTE. This requirement for agricultural labour also encourages clustering of palm oil plantations in proximity to pools of labour.

Institutional Guidance

The implication of the research undertaken by Furumo et al is that the expansion of palm oil production in LAC can follow a different, and more sustainable development path than in Southeast Asia, simply because considerable tracts of forest land were intervened for cattle ranching and other uses, many decades ago. Indeed, reforesting even with an oil palm monocrop can improve carbon sequestration across a region, and particularly if combined with interplanting of native species to encourage proliferation of regional biodiversity. Vijay et al posed the question "*how can this sector (palm oil production) continue down a more sustainable pathway?*" The research concluded that because previously degraded/intervened lands are abundant throughout LAC, the expansion of the sector could be sustainably accommodated. However, the report recommended that such expansion would require "*institutional guidance through regulation and incentives*", particularly when combined with internationally recognised sustainability certification.

Climate Change – An Emerging Threat

Because new commercial oil palm plantations can expect to have an economically useful life of up to 35 years due to the developments in compact high yielding varieties and clones, investors in such plantations need to consider the potential threats from changes to the climate across the tropical belt. Climate change has the potential to threaten the sustainability of palm oil production via factors including temperature change, rainfall quantity and distribution patterns, and pest & disease patterns changing as a consequence of such climatic patterns.

Climate Change Impact On Oil Palm

The first expected result of climate change will be to the range of suitable locations for the crop. Suitable oil palm climatic impact data have been used to create schemes for its mortality, by postulating that large degrees of unsuitable and marginal climates were likely to cause high amounts of mortality (Paterson 2021a). LAC region, and Brazil in particular, have been assessed to have high future mortalities. A study (Paterson 2021a) of predicted oil palm mortalities in South America found that by 2050:

- low mortalities are predicted in
  - the East Coast from Brazil to Suriname
  - more centrally in Paraguay
  - Colombia, Peru, and Ecuador in the west.

By 2100, Paterson et al determined high mortalities could be expected for:

- Guyana, Bolivia, Western Brazil, and Venezuela.

Indeed, much higher mortalities were determined for all the palm oil producing countries in LAC region by 2100, except Paraguay, which appeared virtually immune to the effects of future climate, according to the study. Paraguay appears to gain suitability in climate for growing oil palm in South America, whereas
Venezuela is expected to have a particularly low level of suitable climate by 2100. French Guiana, Surname and Guyana appear to maintain suitable climates, but large losses were considered likely in west Brazil by 2100.

The western countries of Colombia, Peru and Ecuador are expected to suffer severe losses of suitable climate. Furthermore, a three-phase trend in suitable climate rather than a single direct longitudinal change was predicted. (Paterson 2021b).

The scientific modelling and associated literature suggest that changes in climate will have broad-

scale impacts on the distribution of oil palm. Alterations in cold, heat and dry stresses were largely responsible for the changes in climatic suitability for oil palm cultivation, hence extending the range of parameters from temperature alone (Paterson et al. 2017). Apart from temperature (Feeley et al. 2017) and diseases, a wide range of other factors has yet to be evaluated. One of the most important future threats is the emergence
of new pests and diseases and/or the movement of existing diseases from one part of the world to another. The transfer of existing biotic threats could occur due to climatic factors, but another mechanism is movement via trade, travel, or other human agency where potential pathogens might elude current biosecurity measures.

Irrigation and Sustainability

In many regions where oil palm is cultivated, including countries in West Africa and Central America, the uneven distribution of rainfall throughout the year, necessitates the use of irrigation systems to optimize yields of FFB. Guatemala has been particularly successful in this respect with very high national average yields of 25.6MT FFB/Ha and 5.86MT CPO/Ha. The Guild of Palm Oil Producers in Guatemala, GREPALMA notes on its website that Guatemalan palm oil producers have implemented reservoir systems to capture rainwater for use in operations that require irrigation; 20% of all the plantations in the country (located mainly on the southern coast) need irrigation, while the remainder rely on precipitation. Moreover, plantations have invested in the acquisition of water meters, rain gauges, tension meters and micro-sprinkler systems to ensure the efficient use of water in irrigation systems. GREPALMA also notes that to ensure minimal but optimal use of water, palm oil mills keep water usage logs and implement procedures for the efficient operation of the milling processes. Training programs have been instituted across the value chain for water management to achieve increased efficiency of usage.

In the last few decades, the growing demand for agricultural commodities has translated into increasing pressure on global freshwater resources, often leading to their unsustainable use. While from the perspective of commodities producers, irrigation is deemed a sustainable practice when it provides uninterrupted access to water resources at a price not exceeding the marginal revenue they generate (clearly without accounting for environmental externalities), from the standpoint of water resources, irrigation can only be described as sustainable if it does not deplete freshwater stocks or environmental flows.

Agriculture is a major actor in the human appropriation of water resources (Green et al., 2015). About 70% of global freshwater withdrawals are used for irrigation to sustain global crop production (Rockström et al., 2017). In fact, irrigated areas account for 18% of global croplands but contribute to about 40% of global food production (Chartzoulakis and Bertaki, 2015; Food Agriculture Organization, 2019). At the same time 40% of global irrigation practices are considered unsustainable because they deplete environmental flows and/or groundwater stocks (Wada and Bierkens, 2014; Rosa et al., 2018).
Sustainable irrigation needs to ensure that (1) water stocks (e.g., aquifers, rivers, or lakes) are not depleted by keeping withdrawal rates lower than those of natural replenishment; (2) withdrawals from water bodies do not lead to losses of aquatic habitat and irreversible ecosystem degradation; and (3) irrigation does not cause other forms of environmental damage (e.g., soil salinization) with associated losses of ecosystem services and functions (e.g., de Perthuis and Jouvet, 2015).

Sustainability is often characterized through indicators that express the performance of an irrigation system not only in terms of its ability to deliver the water needed by agriculture with no loss of natural capital, but also from the standpoint of economic viability. Strong sustainability is achieved when irrigation does not entail the depletion of either natural or human capital (Aeschbach-Hertig and Gleeson, 2012). This means that both conditions of environmental and economic sustainability are met. The former entails that irrigation water requirement can be met while preserving environmental flows and freshwater stocks (Jägermeyr et al., 2017). Economic sustainability requires that the cost of irrigation does not exceed the value of the marginal productivity of irrigation with respect to the baseline of rainfed production.

The section above owes a considerable debt to: Weak and Strong Sustainability of Irrigation: A Framework for Irrigation Practices Under Limited Water Availability (Eros Borsato et al., 2021; Department of Land, Environment, Agriculture and Forestry, University of Padua, Padua, Italy; Department of Environmental Science Policy and Management, University of Berkeley, Berkeley, CA, United States).

Palm Oil Production In A Net-Zero Economy

According to diverse studies, palm oil plantations can absorb a net average of 64 tons of CO2 per hectare each year. While CO2 sequestration would need to be audited by technical experts on a plantation-by-plantation basis, the eligibility for such sequestrations for carbon credits would be cancelled, if the development of those plantations had resulted in prior deforestation. However, in situations where oil palm has been planted on land previously intervened for the grazing of cattle, there may be a valid argument for climate finance, if it can be demonstrated, that climate finance was necessary for the development.

In September 2021, Maria Vincenza Chiriacò of CMCC (Euro-Mediterranean Centre on Climate Change) Division on Climate Change Impacts on Agriculture, Forests and Ecosystem Services (IAFES) presented a paper “The environmental impacts of palm oil and main alternative oils”, in which it was claimed that palm oil has an average emission of 0.45t CO2eq/t oil compared to 2.89 for soya, 2.47 for rapeseed and 1.18 for sunflower.

Ir. Qua Kiat Seng, Senior Lecturer & Fellow, Monash-Industry Palm Oil Education and Research (MIPO) Platform, and Dr. Jaybalan Tamahrajah, Senior Technologist, KL-Kepong Oleomas Sdn. Bhd, performed a series of calculations based on two distinct production models:

1. a plantation and mill as one unit – for which their calculations indicated emissions of 2.94 Mt CO2eq/MT CPO for a plantation without GAP (Good Agricultural Practices) and a mill powered by diesel and electricity supplied by an external source.
2. a plantation and mill as one unit – indicated emissions of 0.634 Mt CO2eq/MT CPO for a plantation with GAP and the mill using all its biomass and biogas for energy generation.
3. For every tonne of crude palm oil, 4 tonnes of biomass (empty fruit bunches, mesocarp fibre, palm kernel shells) is available. Seng and Tamahrajah calculated that 0.072 Mt CO2eq/MT CPO should be discounted for the GHG from biomass, because the biomass is renewable and a by-product of the milling process.

Seng and Tamahrajah noted that these calculations do not provide a demonstration model for palm oil production that is net-zero, but they stress that an efficient production process, including biogas driven mills, gets palm oil production very close to net-zero carbon, and that further mitigations can take the process further, especially in connection with downstream refining etc. Seng and Tamahrajah also emphasised the importance of increasing the yield and the OER (oil extraction rate) upstream to further reduce the emissions per tonne. https://www.icheme.org/membership/communities/special-interest-groups/palm-oil-processing-sig/news/the-palm-oil-industry-can-be-net-zero-carbon-by-2040/

Palm-oil mills using biogas to generate electricity through gas turbines, might use this electricity for provision of heat and light across operations and, or to export to national grids, providing electricity to nearby households. This model represented a paradigm shift when first adopted in Malaysia and

Indonesia as it avoided methane emissions into the atmosphere and generated green energy. In 2020, annual biogas production in Indonesia was approximately 56 million cubic metres; while 125 out of 452 oil mills in Malaysia operated a biogas plant. The green energy produced from this initiative has saved approximately 712 kt CO2 per annum.

Palm Oil Mill Effluent (POME) is the source of biogas and biofuels for palm oil mills and even refineries. Palm sludge oil, a common term used to describe residual oil from POME, is an alternative feedstock to produce biodiesel and hydrogenated vegetable oil (HVO), which is a completely renewable diesel alternative. Furthermore, POME oil is considered a cheap low-quality oil, and is also classified as a material that is eligible for double accounting of greenhouse gas savings under the EU Renewable Energy Directive (RED) II.

At present, POME oil is a waste feedstock that Neste – a Finnish producer of renewable diesel and sustainable aviation fuel - uses to produce biofuels. In 2020, Indonesia and Malaysia produced approximately 1.4 million tonnes of POME oil. If all POME oil produced was used for biofuel production, it would have translated to an energy content of 7.4% of the EU's total biodiesel consumption in 2019. https://www.weforum.org/agenda/2021/08/how-palm-oil-industry-is-transitioning-to-net-zero/.

Conclusions

Planted on appropriate land, oil palm plantations can contribute towards climate change mitigation through the sequestration of carbon (over a modern plantation life of 35+ years), and potentially also, through the co-generation of 'green' electricity. However, for commercial viability, palm oil plantations may require irrigation, especially in the context of less predictable weather patterns due to climate change. In such cases, the utilisation of water should not deplete sources important for environmental and social purposes and should be available at a cost below the marginal returns from its provision. Longer term, climate modelling indicates that suitable environments for oil palm may shift to wider latitudes and higher altitudes. It will also be important for breeders and developers of genetic material to produce varieties able to produce commercial volumes of palm oil during periods of more prolonged and severe drought.

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