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Achieving High Soil Fertility, Efficient Fruit Harvesting and Low Carbon Footprint Palm Oil Production in Malaysia

Michael James Platts[1], Yuen Yoong Leong[2]

[1]Institute for Manufacturing, University of Cambridge, Cambridge, UK
[2]WAYY Consulting, Kuala Lumpur, Malaysia
Email: mjp@eng.cam.ac.uk, YYL@thewayy.com

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Abstract

The current palm oil harvesting process removes the whole fruit bunch from the palm with most of the fruit unripe, and takes the whole fruit bunch from the plantation to a processing mill. There are two consequences. This robs the symbiotic palm/soil eco-system of important nutrients and steadily reduces soil fertility. Poor soil fertility is now the limit to palm oil production in peninsular Malaysia despite much use of expensive fertiliser, and weak palms in unhealthy soil are prone to the fungus *Ganoderma*. Secondly, it takes much energy to remove the fruit from the bunch and the quantity and quality of the oil is less than that of ripe fruit. All this is because ripe fruit—which naturally becomes loose—has been defined as "a problem" in harvesting. This paper proposes covering the fruit bunch in a mesh sack whilst ripening, which prevents ripe fruit naturally becoming loose from being a problem and transforms the whole harvesting process. This allows efficient fruit separation and fruit pressing to be done at the foot of the palm tree with only the oil being removed from the plantation, both simplifying and improving the harvesting process and maintaining the organic fertility cycle, adding value in every respect.

Keywords

Soil Fertility, Oil Palm Productivity, Harvesting Efficiency, Carbon Footprint

1. Introduction

The Roundtable for Sustainable Palm Oil (RSPO) has been effective in improving the economic sustainability of the oil palm industry in terms of share price and fresh fruit bunch (FFB) yield, but less so in improving environmental and

social sustainability [1]. In the study, the environmental metrics used were orangutan and fire; the social metrics used were poverty and health services. This paper proposes a new thinking paradigm for redesigning the FFB harvesting process, reducing the carbon footprint of palm oil production, improving soil fertility and improving oil yield. This transformation will impact all three economic, environmental and social sustainability metrics.

The oil palm industry currently uses a decades-old, energy-intensive and organically inefficient harvesting process belonging to a bygone era. Palm fruits are harvested when they are not fully ripe. Ripe oil palm fruits increase the yield by over 10% and give very easy processing. Unfortunately, instead of seeing ripening as a core growth process that delivers value and protecting it, ripening is currently defined as "a problem".

The proposed change involves harvesting palm fruits when they are ripe. Correcting this wrong choice made concerning one step in the harvesting process can lead to efficient fruit harvesting. After that, extracting the oil in the palm estate—instead of trucking the FFB to a mill—and leaving the empty fruit bunches (EFB) in the estate, can increase soil fertility and lower the carbon footprint of palm oil production.

A clear distinction is made here between "new" oil palm plantations on what was peat-based virgin forest—which gets all the attention—and the "old" plantations in peninsular Malaysia, where the land has been cultivated for many decades. For the latter, the Malaysian government has admitted that the limit to palm oil production is the fertility of the soil. Whilst chemical fertiliser can feed some major elements of nutrition into the organic cycle (e.g. nitrogen), this is a simplistic understanding of what actually constitutes that fertility. It is the lack of the trace elements—when they are removed from the organic cycle as the current oil palm processing does—that limits the formation of the microorganisms in the soil that "are" the fertility. This impoverishes the soil's "productive capital".

The palm industry contributes 5% - 7% of Malaysia's GDP [2]. From the Malaysian government's perspective, depletion of the fertility which is the productive "capital" in the soil, in an economy where agriculture is one of the important backbones, will undermine long term development. It is thus important to understand what constitutes "fertility" and formulate agriculture policy that nurtures this productive capital and facilitates sustainable agriculture development at the national level.

2. Current Oil Palm Harvesting and Processing Practices

FFB are currently defined as "ripe for harvesting" when the first fruit ripens and falls off—*i.e.* when most of the fruits are still essentially unripe. The fruits are extremely hard to remove at this stage for two reasons [4]:

1) The individual fruits are strongly attached to the spikelets and cannot be removed by hand;

2) The spikelets are densely packed around the spine such that the spine roots are inaccessible.

When the FFB hits the ground, many fruits break loose and the cutter and carrier spend up to a third of their time collecting these loose fruits [5]. This is not the best use of man-hours when labour shortage for FFB harvesting and collection is a long standing problem [6]. The whole bunch is then transported to the mill—sometimes a journey of tens of kilometres—and then subjected to a long hot steaming process, to loosen the fruit from the bunch (**Figure 1**). The EFB, which constitutes ~22% of FFB weight (**Figure 2**), is then defined as "waste" and is usually burnt.

Removing the fruit bunch and the non-oil part of the palm fruit from the plantation leads to soil fertility issues.

3. Soil Fertility Issue

Oil palm is one of the most productive crops in converting solar energy into dry matter and palm oil. This process requires a large quantity of nutrients, which must be supplied by the soil or fertilisers, to achieve and sustain good palm nutrition content and large yields. Unfortunately, most soils planted with oil palms now have low fertility. Planters resort to mineral fertilisers to try to substitute for the fertility that has been removed from the plantation soil by removing fruit bunches and the non-oil part of the fruit. However, this is only partly successful and is expensive. Fertilisers alone constitute 24% - 60% of the total production cost of oil palm [8] [9].

Furthermore, evidence emerging from the Parit Seraya RISDA Benut Plantation, Johor, suggests that oil palms planted in, and maintained in, richly fertile

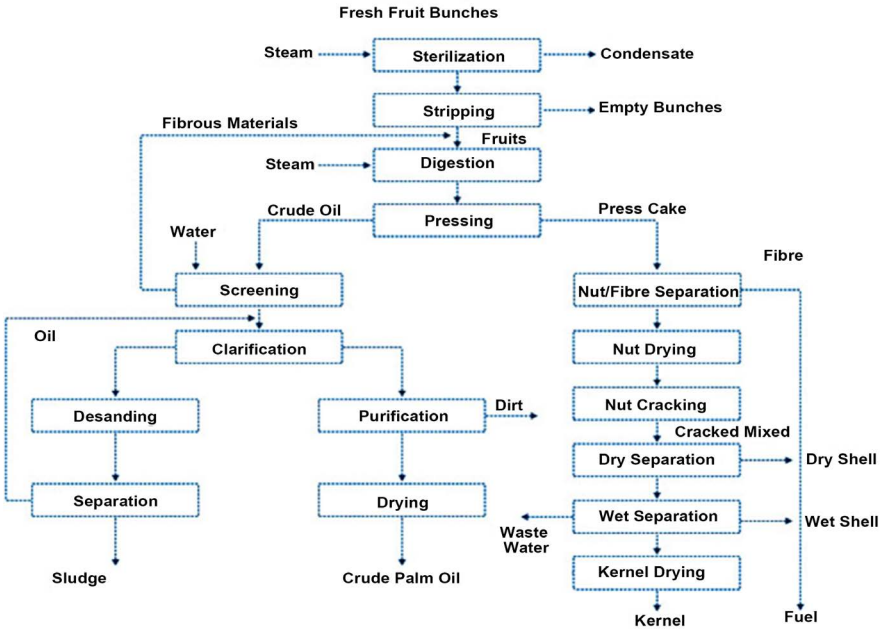

Figure 1. Palm oil extraction process [3].

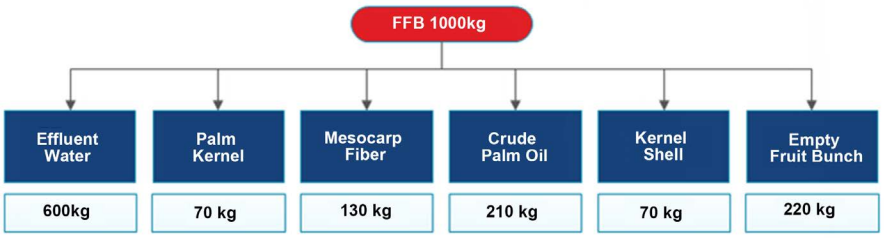

Figure 2. Extraction per tonne of fresh fruit bunch [7].

soil "seeded" with carefully developed Organigro fertiliser (Organigro SDN BHD) to trigger its fertility, are vibrantly healthy and completely resistant to *Ganoderma*, a fungus that infects weak palms in poor soil and is a major problem—and another significant cost—in many oil palm plantations.

4. Carbon Footprint and Soil Carbon Sequestration

The transportation, the steaming and the fertiliser all represent a very large carbon footprint "price" for not doing the following:

- Understanding the organic cycle in the first place;
- Cherishing, protecting and enhancing the core value creating process (the "ripening");
- Cherishing, protecting and enhancing the foundational capital value of the fertility in the soil (the organisms that in fact "are" the fertility), which is the "productive capital" on which the whole oil palm industry is built.

Besides enhancing soil fertility, keeping the EFB in the plantation also contributes to soil carbon sequestration, which can reduce greenhouse gas (GHG) emissions. This can help mitigate climate change impacts of oil palm, for example rise in temperature, water stress and flooding.

"Silent Spring" 40 years ago was a detailed criticism of mankind's destruction of the soil [10]. According to Intergovernmental Panel on Climate Change (IPCC) scientific advisors, about 90% of GHG mitigation potential resides in improving soil carbon levels [11].

5. New Thinking Paradigms

5.1. Harvest when Palm Fruit Is Ripe

As palm fruit comes to ripeness (**Figure 3**), two valuable things happen. Both the percentage of oil (which increases from around 45% to over 50% of mesocarp weight), and the quality of the oil (in a fresh, ripe, un-bruised fruit the free fatty acid (FFA) content of the oil is <0.3%) increase significantly and the fruit becomes loose on the bunch [12].

If a harvester ties a large open-mesh draw-string sack over the fruit bunch, the harvester will be able to let the fruit bunch ripen and then cut it intact, shake off all the fruit and press it there and then, storing the oil in a collection van which can also contain all the harvesting and pressing equipment. The only thing which needs to leave the palm plantation is the oil.

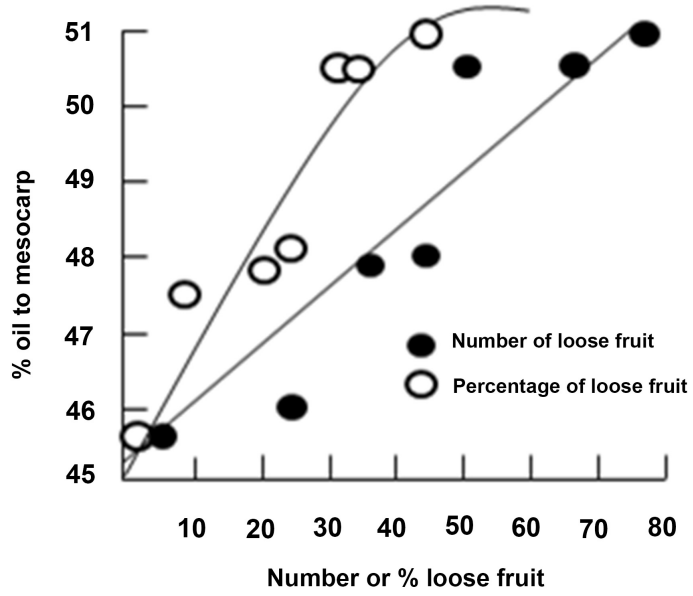

Figure 3. Oil yield increase with fruit ripeness [4].

5.2. Not Removing the Fruit Bunch from the Plantation

The fruit bunch, which weighs as much as the fruit on it, can be shredded, along with the leaf fronds that have been cut. These materials are in fact important in sustaining the symbiotic organic food cycle that links the palms and the organisms in the soil and it is fatal to remove it from that cycle. More than this, the trace elements contained in the fibre and kernel of the fruit—which are 50% of the weight of the fruit—are key elements in the health of that cycle. Thus, they too must not be removed from the cycle.

The Malaysian Palm Oil Board (MPOB) and government linked palm plantation companies have experimented with rearing dairy and meat goats in palm estates many years ago because the estates can serve as grazing land [13] [14]. If crude palm oil extraction is done in the estates, the palm fruit fibre and kernel can be crushed and, together with the shredded bunches and leaf fronds, fed to goats, whose meat and milk will create a second source of income for the plantation.

The goats' urine and faeces will do the preliminary breaking down of the fibre materials into a form of nutrients ready for nourishing the microorganisms that are in fact the "fertility" in the soil. The microorganisms in the soil then do the digesting that processes the bulk organic material into the nutrients that palm roots can absorb. The cycle of fertility continues, vibrant with life.

These new plantation management approaches will enable the highest revenue to be attained at the lowest possible cost, and enhance the attractiveness of the oil palm industry. The ability of the oil palm industry to compete with other industries is important for attracting reliable and skilled workers and reducing the high turn-over of work force. This is vital towards the long-term sustainability of oil palm plantations.

6. A New Harvesting Process

An open mesh sack container is placed over a fruit bunch before it ripens and sealed over the spine. This is then left to ripen. When the fruit bunch ripens, a cutter would use a sickle to cut the spine of the FFB contained inside the container. On impact with the ground, the loosely attached fruits will fall off. The container can now be opened and the FFB inspected. Any remaining attached fruits can be removed with a fruit separator (Figure 4).

Figure 5 shows an idea of a palm fruit comb to get the final fruits off the bunch. Such a device does not have to be complicated or expensive. The sketch aims to prompt people to begin to explore, to try things etc. and develop what works for them. As the ripe fruit is now loose and much of it has already fallen off, it is now possible to vibrate the remaining fruit off or remove it with a simple claw-shaped rake or comb.

7. Vision for the Future

7.1. Malaysian Soil—A Scientific Treasure House

Far beyond simply preserving Malaysian soil, we need to understand it because it is a scientific treasure house. Almost all the research into soil organisms has been done in temperate climate soils, which were glaciated and are thus only about 15,000 years old. Malaysian soils, which are millions of years old, are orders of magnitude richer in organisms that will be valuable to mankind but are as yet un-researched. Malaysia has a treasure house that should be fueling the world's most exciting research and drawing people to work there.

7.2. Restore the Soil, Prosper the Nation

Soil fertility is measurable and should be defined as productive capital, to be measured and thereby focused on as a national strategic asset. Soil security underpins the world's six existential challenges: food, water and energy security, climate change abatement, biodiversity protection and human health [15].

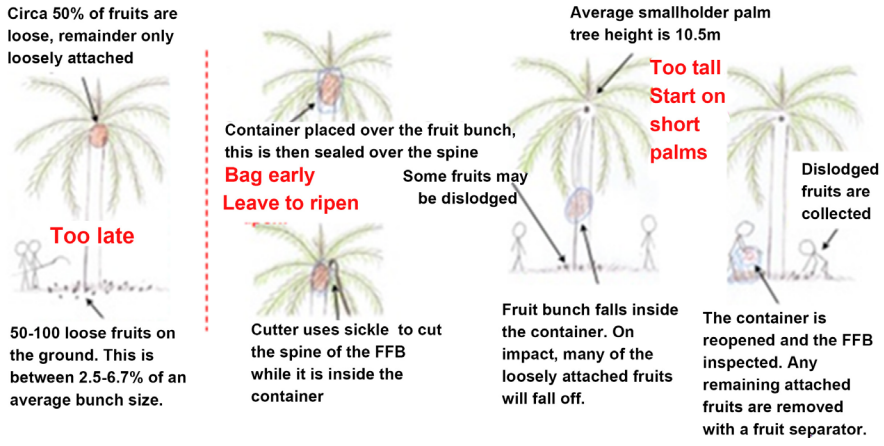

Figure 4. New oil palm harvesting process.

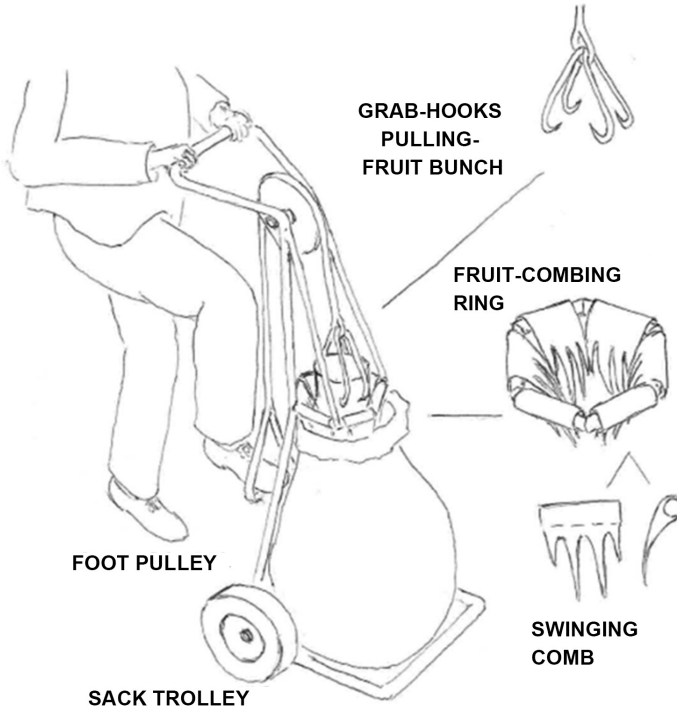

Figure 5. Palm fruit comb.

Improving soil health could help draw down carbon to neutralise Malaysia's emissions. It has the potential to neutralise Malaysia's annual emissions of 260 m tonnes of CO_2 [16].

Recommendations to the Malaysian government include a national soils-policy with a permanent soil advocate, better education for oil palm planters and agricultural scientists and funding for case studies in revamping the oil palm harvesting process. Support could come in the form of tax deductions for oil palm planters who revamp their harvesting process or the government part-funding the oil palm harvesting revamping work. The objective is to convince the average conventional oil palm planter to change without being frightened about being not economically viable. They need the support of the government.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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