Zero Discharge Milling
to Ensure Soils Restoration, Carbon Storage and Business Sustainability

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Palm Oil Mills only export oil (CPO = carbon + oxygen + hydrogen) while plantations consume chemical fertilizers (NPK). Where is the mistake?

Our agribusiness is based on biomass production (photosynthesis). Biomass production is high, but soil fertility (= organic matter = carbon) is decreasing year after year. Where is the carbon going? What are we doing wrong?

Organic matter: A missing link?

Tropical climate is favorable for high-yield biomass production. Organic matter (OM) in the soils improves physical, biological and chemical soil properties and is a requirement for biomass productivity and resistance to droughts and parasitism. Due to high temperatures and humidity, organic matter has a high rate of mineralization in tropical soils; a permanent OM addition is therefore required. A failure in OM management drives to a reduction of agricultural production and sustainability and/or to an increase in the cost of chemicals and other inputs. The stagnation of palm oil yields (average of 3,8 T oil/ha-year for the last 40 years) is an example of it.

Mills' discharges treatment vs. recycling

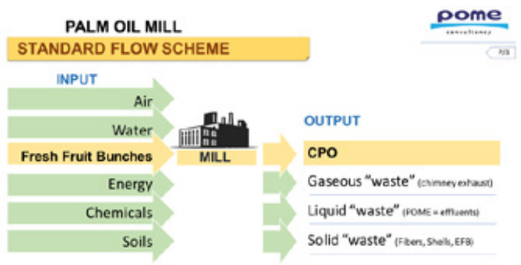
Organic matter and nutrients discharge to the environment (pollution) is not a sustainable long-term option for human activities. The society could at any moment consider that industries have the right to use freshwater meanwhile they do not discharge to the environment, at least as a "business model".

Organic load (COD, BOD) removal, with ETP (Effluents Treatment Plants), under local regulations, is an acceptable short-term environmental answer, but not a sufficient goal for the industry to assure the profitability and sustainability of the business.

Organic matter comes from the photosynthesis (biomass production) and must somehow go back to the soils. Nutrients have also to go back to soils to reduce chemical fertilizers requirements. By the way, the industry must close the cycle of carbon and nutrients and not discharge them into the air or watershed.

The agro-industry standard flow scheme

All agro-industries transform biomass into some marketable product. They need some inputs, and they generate by-products and effluents. Most of the nutrients are found in these by-products. In the palm oil sector, the marketable product (CPO) is only 22% of the weight of the Fresh Fruit Bunch (FFB), and the FFB is only part of the biomass production (trunks, roots, leaves).

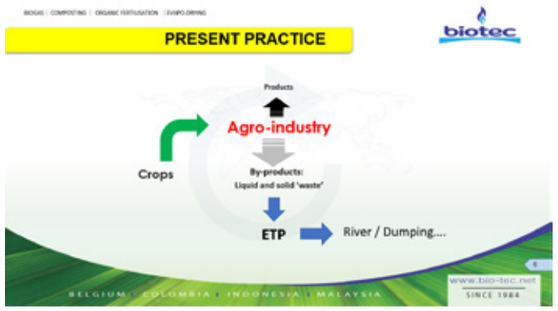


Business indicators

In addition to the main short-term indicator, which is the CPO market price, business sustainability is guided by other key indicators:

- Market perception
- Consumption of external "inputs"
- Plantation diseases
- Biodiversity
- Greenhouse Gases (GHG) emissions
- Pollution

Let's point here that soil fertility improves most (all) of these indicators, while, strangely, it is rarely considered as a business indicator.



Environmental constraints

Effluents discharge standards in Malaysia are stringent (BOD 100 ppm or BOD 20 ppm in function of the region). Compliance implies the construction of facultative and aerobic open ponds (around 1 M US$) + a sophisticated aeration and polishing plant (around 1 M US$).

Due to a national commitment for palm oil sustainability, MPOB and the government also drove millers to capture their greenhouse gases emissions and, at least, to flare them. For a typical 60 T/h mill, this is an investment between 1,5 and 2,5 M US$ in function of the quality and reliability of the biogas plant (market prices in Malaysia).

Environmental constraints can only increase, year after year, when Malaysia will meet international environmental practices, like:

- Lining: Open lagoons (as well as lagoon-based biodigesters) must be 100% lined to avoid water table contamination (additional investment of 1 M US$ + sometimes the necessity to rebuild the ponds)
- Sludge management to avoid soils, watershed or water table contamination (additional investment of 250.000 US$ for a dehydration unit)
- Nitrogen (N) and Phosphorus (P) removal before river discharge (generating other additional investment of 1 M US$ + additional O&M costs)
- Color removal (cost?)

Carbon and nutrients cycle - POME and EFB value

The fertilization is driven by the Liebig's law of the Minimum. To provide all the macro and micronutrients to the plantation in due proportion requires huge costs of analysis, fertilizers, and application. The smartest and more secure fertilization strategy is to apply to the crops what has been exported by the crops and sent to the mill. POME and EFB contain most of the macro y micronutrients exported by the fruits (FFB). Alone, they can replace around 25% of the chemical fertilizers of the plantation.

Oil palm also require good soils, for high yield, resistance to drought and to parasitism and high oil extraction rate. This is the carbon (organic matter) input. Organic matter improves physical, chemical and biological quality of the soils. What is the value we give presently to the carbon recycled to the soil? Why isn't it considered in our annual balances?

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We can observe an impressive reduction in the OM content of the soils after a few decades of plantations. Carbon has been mainly released into the atmosphere as CO_2, what means as GHG. A typical plantation has released around 400 T of CO_2-equivalent per hectare in fifty years. At the present cost of the CO_2-equivalent on the market, it represents around 12.000 US$, what means 240 US$/ha-year, additional to the actual agricultural value of the carbon for the soils and for the business sustainability, which is still higher.

POME value as fertilizer: 4 to 5 US$/T FFB

EFB value as fertilizer: around 3 US$/T FFB

POME value as energy: 0 to 5 US$/T FFB (*)

(*) If POME is methanized ("biomethanated"), the biogas production (around 15 m3 CH4/T FFB) value is between 0 and 5 US$/T FFB, in function of the biogas use.

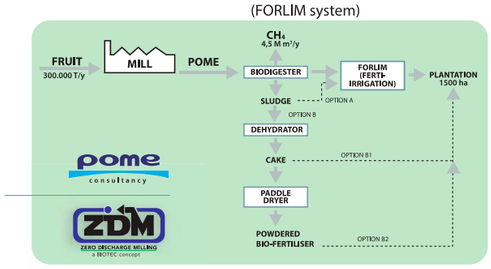
The challenge is to achieve this valorization. Many technologies have been developed in the last 20 years to catch this potential, but the objective has to be clearer: zero discharge to the environment and carbon + nutrients recycling to the soils. This is the keystone of the business sustainability.

Four options for ZDM (Zero Discharge Milling)

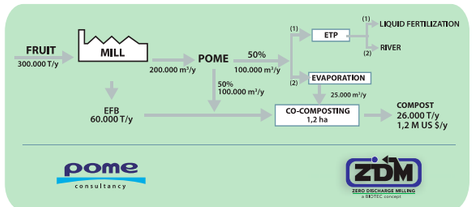
1. FORLIM (Dosed and monitored liquid fertilization with biomethanated POME)
   - Can fertilize intensively 1.500 hectares (for a 60 T/h mill)
   - Save 100% of chemical fertilizer on that superficies
   - Allow yield increase compared with traditional intensive chemical fertilization
2. Co-Co (EFB + POME co-composting)
   - Can process 2 m^3 POME/T FFB
   - Allow intensive fertilization of more than 2.000 hectares (for a 60 T/h mill)
   - Compact (around 12.000 m2 for a 60 T/h mill)
   - Does not require roof (BIOTEC technology)
3. B-E-D (POME Bio-Evapo-Drying, up to powdered biofertilizer)
   - Well developed technology in other agro-industries
   - Self-sufficient in energy thanks to the biogas generated
   - High value final powder
   - Possibility to market a humic-rich soluble biofertilizer
4. E-D (Raw POME Evapo-Drying, up to powdered animal feed)
   - Transforms raw POME into ingredient for animal feed
   - Requires steam and electricity from the mill

POME to liquid biofertilizer

(FORLIM system)

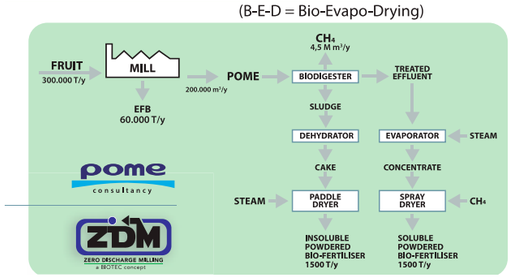


EFB + POME CO-COMPOSTING

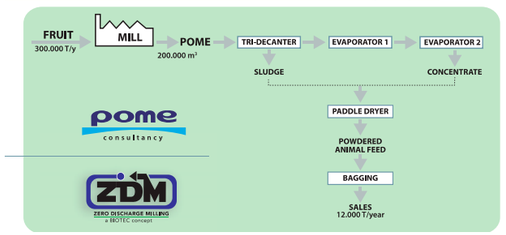


POME to powdered biofertilizer

(B-E-D = Bio-Evapo-Drying)



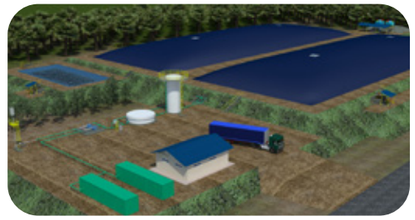
POME to animal feed (evapo-drying)



Pictures

RAC-T (bolted) tank-based biogas plant

RAC-L lagoon-based biogas plant



FORLIM liquid fertilization

Co-Composting plant

POME bio-evapo-drying plant

POME evapo-drying plant (for a 30 T/h mill)

Conclusions

To reach business sustainability, we have to change our mindset. Continuing with POME and EFB "treatment" to mitigate the impact on the environment is a dead end, a blind alley. It is a secure method to perpetuate:

- Investment without return
- Environmental impacts
- Operational headaches
- Reduction of the carbon content of the soils and consequent increase of the GHG emissions

All the agro-industry, including palm oil mills, will definitively have to switch to the concept of ZERO DISCHARGE MILLING which allows:

- no impact on the environment
- inputs reduction
- carbon storage in the soils and consequent increase of the soil fertility
- a positive impact on yields
- R.O.I. (Return on Investment)

Acknowledgment

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