Composting for a More Sustainable Palm Oil Production

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ABSTRACT

Today Indonesia is contributing to more than half of the global palm oil production, with approximately 34.5 million tons produced in 2016. This production has been projected to increase to 50 Million tons by 2025. To reach this level of production and still maintain its committed sustainability standards, Indonesia will have to address a triple challenge: protecting high conservation areas, such as primary forest and peatland; closing the yield gap between smallholders and agro-industries; and reducing the environmental impact of existing oil palm plantations. In this context, we chose to focus on the third challenge and investigated the opportunity of composting palm oil mill by-products to mitigate the environmental impact of palm oil production. We studied the composting process in palm oil plantations and analyzed the results from waste management, agronomic and environmental perspectives.

We conducted experimental co-composting of empty fruit bunches (EFB) and pre-digested palm oil mill effluents (POME). We studied the effect of the ratio of POME to EFB and the turning frequency of the compost using a split-plot experimental design comprising 24 compost heaps, in a covered composting platform on a concrete floor. The composting process lasted 60 days, during which the compost piles were regularly turned and sprayed with POME. We found that the biological degradation composting process reduced the dry weight of EFB by 45%. It also led to the evaporation of 60% of the water contained in POME and the EFB, thereby considerably reducing the amount of waste that comes out of the palm oil mill. In terms of recycling efficiency, a recovery rate close to 100% was achieved for K, P and Mg. We also observed loss of Nitrogen of about 25-30% during the composting process.

We found that a high POME to EFB ratio ($3m^3$/ton EFB) increased moisture above optimal water content and reduced free air space within the compost piles. Adding too much POME to the EFB also increased the quantity of leachate from the compost pile and washed away Potassium, the most important nutrient found in the palm oil mill compost. The dose of POME added to compost piles should be adjusted according to the fermentation phase and recycling all leachate is of paramount importance to preserve compost quality. We estimated that the composting process can effectively recycle about 0.8 to 1.4 m^3 of POME per ton of EFB in 60 days. This process is facilitated by turning the compost pile, to regulate the oxygen content for optimal aerobic digestion of the compost material.

From an agronomical perspective, the compost was very valuable for fertilizing the oil palm (N: 1.6%; P:0.25%; K: 4.5%; Mg: 0.45%). Our results confirm that a dose of compost of 60-90 kg per palm per year could replace mineral fertilizers in mature plantations. Compost from

the mill by-products could cover about 30% of the oil palm plantations' fertilizer needs, and up to 40% if the composting process is optimized to limit nitrogen loss. In these conditions, the palm oil mill compost would be highly profitable given the current prices of fertilizers. We tested the palm oil mill compost as a fertilizer in a nursery, which proved to be a good substitute for mineral fertilizers at a rate of 9 kg/palm. In this nursery trial, compost was found to have improved the soil quality (pH, CEC, exchangeable nutrients) compared to mineral fertilizers and raw EFB. The capacity of compost to improve soil quality was consistent over two contrasted soil types (Podzol and Alluvial Clay). We also conducted field application trials in areas prone to *Oryctes sp*. attacks. Results after five months of observation showed that composted EFB are less attractive for Oryctes than fresh EFB.

From an environmental perspective, composting has several benefits. The reduction of the amount of waste through biological activity means that less transportation is necessary for field application (60% reduction) as against fresh EFB. The POME treated through the aerobic process of composting prevents the negative impacts of the pond treatment, such as GHG emissions to the atmosphere. An efficient nutrient recycling through composting would significantly reduce the amount of imported inorganic fertilizers and all the negative impacts resulting from their use. Compost application improves soil quality and can store additional carbon in soils. For young palms replanted in Oryctes-infested areas, compost can reduce the need to use insecticide as compared to EFB.