# FEATURE ARTICLE

# GUIDELINES ON LAND APPLICATION OF PALM OIL MILL EFFLUENT (POME)

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## INTRODUCTION

Under the Environmental Quality Act (1974), palm oil mills are required to treat their effluent to a prescribed level before final discharge into the water course. The practice of treating and discharging treated palm oil mill effluent (POME) into the waterways is not only costly but is a waste of valuable resources. This is because POME is essentially organic in nature and with a high plant nutrient content. It could be recycled as an inorganic fertilizer replacement for most crops including oil palm.

Studies have shown that judicious applications of POME on oil palm plantations to be economically viable and environmentally safe. However, the potential of this organic waste has yet to be fully exploited by the oil palm industry. The Malaysian Palm Oil Board (MPOB) in collaboration with the industry and the Department of Environment (DOE) have formulated guidelines on the land application of POME. The use of this guidelines will ensure that the scheme conforms closely with the environmental quality standards stipulated by the DOE. It is also beneficial in assisting the industry to realize the full potential of POME as a valuable resource whilst reducing the discharge of treated POME into public waterways thus ensuring a safer and cleaner environment.

## CHEMICAL CHARACTERISTICS AND FERTILIZER VALUE OF POME

POME is essentially not highly toxic but polluting. In its raw state, POME has extremely high concentration of biochemical and chemical oxygen demands (BOD and COD). Its nutrient content is high especially nitrogen and potassium. The chemical composition of POME after various treatment processes is given in *Table 1*.

In the anaerobic digestion processes of POME, the BOD concentration is drastically reduced but at the same time much of the nutrients, especially nitrogen and potassium, may be lost through leaching and settling of sludge solids at the bottom fraction of the pond. In the tank digestion treatment system, the effluent is kept agitated and stirred and the process does not greatly change the nutrient contents. The breaking down of organic solids into less complex molecules would make it more readily available for plant uptake. From plant nutrition point of view, the tank digested effluent would make a good source of plant nutrients especially for recycling in the field.

The fertilizer value per 100 t of POME has been calculated as shown in *Table 2*. At current price, the total fertilizer value is equivalent to RM 5792. The value of micronutrients in the POME is not included in this estimate.

## BENEFICAL EFFECTS OF POME UTILIZATION

The concept of POME utilization is to recycle plant nutrients onto cropped land by means of controlled application techniques with a view of deriving agronomic benefits and with minimal environmental impact. The rationale behind this concept is that whatever is removed from the soil-crop system is safe enough to be returned or recycled back. POME has been proven to be a good source of organic fertilizer and is currently available in large volume from palm oil mills at little cost (Teoh and Chew, 1983). Applied at rates corresponding to the nutrient requirement of the crop, it will not have any detrimental impact on the environment. Studies have shown that soil-plant system is an effective natural filter capable of screening undesirable contaminants in the effluent during the process of land application.

Results from various studies have shown the beneficial effects of POME application on crop performance and yield, when applied at rates corresponding to crop requirement. Most recent studies showed that application of POME at the optimum rates (without fertilizer supplement) gave higher yields compared with plots receiving normal estate fertilizer rates. The yield increase was attributed to the beneficial effect of nutrients and moisture improvement (Mohd Tayeb *et al.*, 1987).

TABLE 1. TYPES OF POME AND THEIR CHEMICAL COMPOSITION

| Type of POME | Chemical composition (mg litre$^{-1}$) total | | | | |
|---|---|---|---|---|---|
| | BOD | N | P | K | Mg |
| Raw | 25 000 | 948 | 154 | 1 958 | 345 |
| Digester (anaerobic) | | | | | |
| Stirred tank | 1 300 | 900 | 120 | 1 800 | 300 |
| Supernatant | 450 | 450 | 70 | 1 200 | 280 |
| Supernatant + 10% slurry | 191 | 320 | 42 | 1 495 | 258 |
| Bottom slurry | 1 000-3 000 | 3 552 | 1 180 | 2 387 | 1 509 |
| Digested (aerobic) | | | | | |
| Supernatant | 100 | 52 | 12 | 2 300 | 539 |
| Bottom slurry | 150-300 | 1 459 | 461 | 2 378 | 1 004 |

TABLE 2. ESTIMATED FERTILIZER EQUIVALENT VALUE PER 1000 t OF POME

| Fertilizer | Equivalent (t) | Price t$^{-1}$ (RM) | Fertilizer value (RM) |
|---|---|---|---|
| Ammonium sulphate | 5.03 | 424 | 2 134 |
| Phosphate rock | 1.30 | 225 | 293 |
| Muriate of potash | 4.58 | 474 | 2 171 |
| Kieserite | 3.98 | 300 | 1 194 |
| Total | | | 5 792 |

The beneficial effects of POME application onto soils can generally be summarized as follows:

- Improved soil fertility and physical structure;
- Increased infiltration and aeration;
- Increased soil moisture and retention;
- Increased root development and proliferation;
- Increased soil organic matter;
- Increased soil cation exchange capacity;
- Increased soil pH, and
- Increased soil microflora and microfauna population and activity.

## GUIDELINES ON LAND APPLICATION OF POME

### Approval from the DOE

Application should first be made to the Director-General of DOE before any land application of effluent can be made. The DOE also requires that the POME intended for land application must have a BOD concentration of less than 5000 mg litre$^{-1}$.

In order to expedite the processing of the application, the following information and documentation should be furnished:

i) Indicate the type, quantity and BOD concentration of effluent intended for application;
ii) Indicate the method and rate of POME application to be adopted for land application;
iii) Provide a site plan with details of the land topography of the application site, water catchment area and nearest flow of waterways (water-course);
iv) Some briefs on the possibility of wash down or surface-runoffs at the application site;
v) Provide details of soil texture and permeability rate at the application site;
vi) Other relevant information such as the dominant soil types, distance to nearest population (dwelling) *etc.*;
vii) Briefs on monitoring activities on water quality to be undertaken at the application site.

## METHOD OF LAND APPLICATION

Several methods of land application systems are available (Kanagaratnam *et al.*, 1981). The choice of a suitable system will depend largely on the specific condition of the site with reference to the following factors:

i) Type and quantity of POME available;
ii) Nature of terrain in the area to be applied;
iii) Age of palm;
iv) Land area available in the estate for application and its distance from the mill;

v) Distance to water source;
vi) Capital and operational cost; and
vii) Distance of population in the surrounding area.

Some of common systems of land application of POME currently being adopted by the industry on a commercial scale are as follow:

- Sprinkler/pipe irrigation system;
- Flatbed/longbed system;
- Furrow/gravity flow system; and
- Tractor/tanker/pump system.

As a general guideline, the sprinkler system is well adapted to flat and gently undulating land, with good infiltration type of soils. The system is more suitable for mature palm areas. Some of the problems associated with this system include blockages of pipes and clogging of sprinklers, and occasional burst pipe, if the system is not maintained and operated properly.

Flatbed system is suitable for digested effluent when applied on undulating and hilly areas. The system would ensure uniform distribution of POME to the palms. The control of application to alternate row and less blockage problems are some of its advantages. The installation cost is directly related to the application area covered.

The use of longbed or furrow system is more adapted to the clayey and poorly permeable type of soils. In terms of cost, furrows are much cheaper to construct than longbeds. On near-flat terrain straight furrows are more suitable whilst zig-zag furrows are normally adapted on steeper slopes. Some of the problems associated with this system are the prevention of erosion and silting, and overflowing.

The tractor/tanker/pump system offers the lowest capital and operating costs among the systems mentioned above. This system is also suitable for commercial application in oil palm area with a flat to gently undulating terrain.

## COST OF LAND APPLICATION SYSTEMS

The cost of the various methods of land application of POME varies as shown in *Table 3*. Generally the cost items involved are mainly the capital and operating costs (Yeow and Zin, 1981). Capital cost is incurred mainly in the initial phase with the construction of furrows, longbeds, flatbeds and the purchase of pumps and fittings. In the case of the sprinkler system, the capital cost is incurred for the purchase and installation of pipes, fittings, sprinkler heads and pumps. Tractor, tanker and pump are the main capital cost items of the tractor/tanker system.

Operating costs are mainly incurred by maintenance and supervision of the various systems. In most systems, depending on the size of the land application scheme, two to three workers are employed full time to ensure the smooth running of the system.

## RATE AND FREQUENCY OF APPLICATION

The optimum rate and frequency of POME application to land has been established by field experiments (Zin *et al.*, 1990). The maximum rate of application should be based on twice the rate of nitrogen requirement of the oil palm or a maximum equivalent of 650 kg N $ha^{-1}$ $yr^{-1}$. In terms of frequency, application should be evenly spread out at no less than three rounds a year and each application should not exceed 2.5 cm rain equivalent.

It should be noted that excessive POME application could be detrimental to the performance of the crop and the environment. The crop yield may decline and this could be attributed to the occurrence of effluent/water logging resulting in anaerobic conditions which affect the palm growth. Studies have also shown that excessive POME application could cause nutrient ratio imbalance, especially for K/Mg and Ca/Mg ratio in the soils, which could affect plant performance (Lim, 1987).

## MONITORING WATER QUALITY

There is a need to monitor the subsurface water quality in any land application scheme. When POME is applied on to soils, the organic and inorganic constituents may be retained by the soil, taken up by the palm, leached through the soil or washed

**TABLE 3. AVERAGE COSTS OF LAND APPLICATION OF POME SYSTEMS**

| System | Capital cost $ha^{-1}$ (RM) | Annual operating cost $ha^{-1}$ (RM) |
|---|---|---|
| Longbed | 1 680 | 180 |
| Flatbed | 1 800 | 235 |
| Furrow | 1 500 | 240 |
| Sprinkler | 1 800-3 120 | 290-312 |
| Tractor/tanker | 384 | 108 |

by surface run-off.

Groundwater quality should be monitored immediately below the water-table surface near the site of application. This is to ensure that any polluting effects entering the groundwater system, which have a tendency to remain in the upper layer, are detected. Subsurface water can be monitored through the use of PVC tubes driven below the permanent water table.

## METHOD AND PARAMETERS OF MONITORING

Groundwater should be monitored regularly to detect presence of POME by having a number of test sites located on areas, where groundwater is present. As a guideline, monitoring should cover the following sites:

i) Native groundwater flowing in the vicinity of application scheme;
ii) Water within the mixing zone of natural groundwater and renovated water; and
iii) Water further down from the mixing zone that could provide background quality of the groundwater that might enter nearby streams or rivers.

Prior to the application of POME onto land, sampling of groundwater should be done at a minimum of three monthly samplings from each monitoring site. Water samples should be collected monthly during the first two years of sampling. A measured volume of water should be taken form the tube well for analysis. Before each monitoring, the water level in the tube well needs to be recorded and the tube be covered with a cap at all times.

The water samples collected from the monitoring sites should then be analysed for the following parameters:

i) pH;
ii) BOD;
iii) Nitrate nitrogen; and
iv) Potassium.

Studies have shown that the above parameters need to be analysed since their concentrations are normally found to be high in POME. Furthermore, their mobility are comparatively greater than other elements.

## CONCLUSION

There is a vast potential in the utilization of POME as organic fertilizers. With clear guidelines on the proper approach to land application, the utilization of POME should be fully exploited to benefit the plantation industry. Based from research and practical experience, judicious application of POME on to land has shown to be an economically viable agricultural practice. This will help to reduce significantly the volume of treated POME discharged into the waterways thus ensuring a safer and cleaner environment. POME as a fertilizer substitute could also help in reducing the importation of fertilizers thus contributing substantially to the savings in foreign exchange.

To ensure that land application of POME scheme meets the DOE's regulatory requirement, it is essential that the scheme be properly supervised or managed by competent technical personnel. In addition to the monitoring of water quality in the POME applied area, it is also beneficial to conduct a regular soil and foliar sampling. The data obtained from these analyses could serve as an indicator for long term monitoring.

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