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Palm Pulverisation in Sustainable Oil Palm Replanting

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Abstract : Malaysia has banned open burning of old oil palm biomass at replanting. The most widely adopted zero burn techniques of replanting oil palms in Malaysia currently are the "chipped and windrow" and "under-planting" methods. These methods resulted in very high breeding of *Oryctes rhinoceros* beetle, which has become the most serious pest in immature and young mature palms in Malaysia currently. Three new no-burn methods of clearing old oil palms for replanting whereby almost the entire palms are pulverized into fine pieces of less than 0.1g dry weight each and spread widely over the entire field and the root mass dug up at felling are reported. More than 50% of the pulverized palm biomass decomposed by 24 weeks after pulverization, which increased to 80% by the 56th week. All the three methods have good potential in reducing the breeding of *Oryctes rhinoceros*. They also have good potential in reducing the rat and *Ganoderma boninense* disease problems. In addition, the new clearing methods reduced the fallow period, facilitated replanting and the subsequent field upkeep work, and improved the utilisation of nutrients released by the decomposing palm biomass by the newly replanted palms. The methods of clearing old oil palms for replanting are environmentally less polluting and also improve the sustainability of oil palm plantations.

Key words : Beaver^{TM}, EnviroMulcher^{TM}, Ganoderma, MountainGoat^{TM}, Pulverizing and decomposition of oil palm biomass, Rhinoceros beetle.

Before the ban on open burning was introduced, the most common method of clearing old oil palms for replanting in Malaysia was the "chip and burn method" With the ban on open burning, the chipped palm biomass were not burnt but windrowed, usually two palm rows to one windrow, and left to decompose in the palm inter-rows or pulverized when the palm chips were partially dried and decomposed. The other zero burning technique of replanting oil palm is the "under-planting method" whereby the young palms are planted under the old palms, which are gradually poisoned. The windrowed palm biomass and the poisoned palms take more than two years to decompose completely and this results in very high breeding of *Oryctes rhinoceros* beetles, which have become the most serious pest in immature and young mature palms in Malaysia. Liau and Ahmad (1991) and Chung *et al.* (1999) reported that beetle damage could cause crop losses of 40% and 92%, respectively, in the first year of harvesting. Apart from *O. rhinoceros*, the palm biomass can also become the source of rats and *Ganoderma boninense* disease problems. In addition, the presence of large amounts of palm biomass (about 85 t/ha dry matter) in large sections, impedes field access and hinders replanting and the subsequent field upkeep work. The other drawback is that the nutrients released by the decomposing palm biomass are beyond the root zone of the young replanted palms. This paper reports three methods of pulverizing old oil palms at replanting which have good potential in reducing the foregoing problems.

Materials and Methods

1. Methods of clearing oil palms

The three new methods of clearing old oil palms for replanting have the same basic objective, i.e. to pulverise the entire palm into fine pieces and to dig up the root mass, and spread them thinly throughout the field at felling. The three methods are:

(1) The EnviroMulcher^{TM} method

The EnviroMulcher^{TM}, a Malaysian invention, is basically an attachment consisting of a cylindrical steel drum bolted with 111 tungsten carbide tip knives and mounted at the end of a track-type 120-horsepower excavator's boom (Plate 1). The method is an improved version of the clearing method reported by Ooi et al. (2001) and comprises the following operations:

- To pulverize a palm, the excavator first places the EnviroMulcher^{TM} on the highest part of a palm trunk that can be reached by the excavator boom and then proceeds to cut it into two. The upper portion of the trunk and canopy is allowed to fall to the ground. The EnviroMulcher^{TM} then pulverizes the standing portion of the trunk until the root bole. The excavator then moves towards the fallen trunk and continues to pulverize the remaining portion of the palm including the crown but excluding the fronds, which are left in situ. The pulverized palm

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Plate 1: The EnviroMulcher™

Plate 2: The MountainGoat™

Plate 3: The Beaver™

Fig. 1

biomass is spread thinly over the ground in the process.

- Another track-type 120-horsepower excavator fitted with a chipping bucket follows behind to stack the fronds into alternate inter-rows and also to dig up the root mass and spread them out beside the frond stacks. The excavator then covers up the resultant holes with soil.

(2) The MountainGoat™ method

The Morbark 50/36 E-Z MountainGoat™ was imported from USA where it is used to cut soft wood and shrubs into fine chips. It is built on a Caterpillar 325L undercarriage and powered by a 750 horsepower Caterpillar 3412 engine (Plate 2). The method comprises the following operations:

- Two track-type 120-horsepower excavators fitted with a chipping bucket fell the palms and line them in neat rows for the MountainGoat™. The trunk is split into two halves longitudinally if it is more than 90cm in diameter. The same excavators also dig up the root boles and the surrounding root mass and chip them into small pieces before spreading them in the field. They then cover up the resultant holes with soil.
- The MountainGoat™ follows the excavators to pulverise the entire palm including the fronds and spread the pulverized biomass thinly throughout the field.

(3) The Beaver™ method

The Beaver™ is another Malaysian invention built on a D3 Caterpillar undercarriage and powered by a 300 horsepower Caterpillar 3306 engine (Plate 3). The method comprises the following operations:

- To fell a palm, the Beaver™ pushes a cutting blade into the ground immediately below the root bole to severe as much of the root mass as possible on one side of the palm.
- The palm is then pushed down with the same cutting blade.The felled palm is then pushed forward and away from the root bole and its surrounding root mass dug up with the cutting blade.
- The Beaver™ then proceeds to pulverize the felled palm in situ by driving over the felled palm in a forward and backward direction. Usually two forward and one backward passes are required to pulverize a full palm. Pulverisation is achieved by a rotating drum fitted with 20 pieces self-sharpening flails and mounted at the front of the Beaver™. The pulverized biomass is discharged behind the Beaver™ in rows over the fallen palms. About 30% of the fronds are not pulverized but left in situ.

2. Rate of decomposition of palm chips

To study the rate of decomposition of palm chips produced by the EnviroMulcher™, representative samples of the freshly pulverised palm biomass were collected from four palms (representing four replicates) during pulverisation. The pulverized biomass from each palm was thoroughly mixed and quartered and divided into 12 samples of about 2 kg each and placed inside a muslin bag and labeled accordingly. The muslin bags were placed in the palm inter-rows in a newly replanted field in four replicates and left to decompose under field condition. The muslin bags were retrieved to determine the rate of loss of the dry matter at 0, 1, 4, 8, 12, 16, 24, 32, 40, 48 and 56 weeks after pulverization.

Results

1. Productivity of the machines

The productivity of the machinery used in the three methods of clearing are summarized in Table 1

The productivity of the EnviroMulcher™ and Beaver™ was similar but the former required the assistance of an excavator to stack fronds, dig up root mass and cover up the resultant holes. The Beaver™ would also require the assistance of an excavator if stacking of the remnants of fronds and wider spreading of the pulverized palm biomass were required. The MountainGoat™ was 6.7 times more productive than the EnviroMulcher™ and Beaver™ but required the support of two excavators. The productivity figures quoted assumed no breakdown of machinery, which did happen sometimes.

2. Size of pulverized palm chips

Table 1. Productivity of the machinery used in the three methods of clearing (L.H. Ooi, unpubl.)

Method of clearing	Operation	Productivity per day	
		Palm	Ha
EnviroMulcher™	EnviroMulcher™ pulverizing palms	60	0.43
	Excavator stacking fronds/digging up root mass/covering up holes	200	1.45
MountainGoat™	Excavator felling palms, digging up root mass and filling up holes	200	1.45
	MountainGoat™ pulverising palms felled by excavator	400	2.90
Beaver™	Beaver™ felling and pulverizing palms and digging up root mass	60	0.43

Table 2. Size of the palm chips produced by the three methods of clearing (L.H. Ooi, unpubl.)

Method of clearing	Length (mm)	Thickness (mm)	Dry weight per chip (g)
EnviroMulcher™	29	2	< 0.1
MountainGoat™	24	3	< 0.1
Beaver™	94	< 1	< 0.1

Table 3. Rate of decomposition of EnviroMulcher™ chips

Week after pulverisation	1	4	8	12	16	24	32	40	48	56
% loss of dry matter	12	17	21	42	48	56	62	70	71	80

The size of the palm chips produced by the three methods of clearing is tabulated in Table 2.

Although the size of the pulverized palm chips varied considerably, its dry weight was less than 0.1g for all the three new methods. This is very small compared to the 4400g per chip produced by the conventional chipping method by an excavator fitted with a chipping bucket reported by Ooi *et al.* (2001).

3. Rate of decomposition by EnviroMulcher™

At 24 weeks after pulverization, 56% of the dry matter was decomposed and this increased to 80% by the 56th week (Table 3). The leftover portion was mainly inert material unsuitable for the beetles to breed. Breeding of beetles continues for more than two years in the conventional no burn method without pulverization (B.N. Ang, pers.comm.).

Discussion

As it takes 3.8 to 8.6 months from egg laying to emergence of adult beetle (Bedford, 1980), the new land clearing methods have great potential in reducing the beetle breeding problem in oil palm replanting. Estate managers who have switched from the conventional "chip and windrow"or "chip and windrow and later pulverised"methods of replanting to the new methods all reported reduced beetle activities and damage to the replanted palms. These commercial scale observations have yet to be quantified. The more even spreading and faster decomposition of the pulverized palm biomass also denied the rats of a suitable breeding ground.

Although control of Ganoderma disease is still not well understood, clean clearing of palm biomass, particularly digging up of the root mass at replanting is considered essential and recommended. This is because the palm biomass particularly the intact root mass of Ganoderma infected palms is an important source of disease inoculums.

The new techniques of land clearing were able to reduce the fallow period between felling and replanting of palms. Theoretically, harvesting of old palms could continue until the last day before they were felled. At the same time, replanting of palms could proceed immediately after the old palms have been pulverized.

The small chips, which were spread throughout the field, could be easily gathered to mulch the newly planted palms to suppress weed regeneration, and supply nutrients and organic matter. Ooi *et al.* (2001) reported that an equivalent of 50kg dry weight of the pulverized palm biomass is able to supply the entire N, P, K and Mg requirement of a palm in its first year of growth. Khalid *et al.* (1996) estimated that about 85t/ha of above ground palm biomass dry matter containing some 577kg N, 50kg P, 1255kg K and 141kg Mg were available at replanting. These nutrients would be released at a much faster rate in the new clearing methods and hence at higher risk of being lost through run-off and leaching. Planting a mixture of quick growing leguminous cover crops such as *Pueraria phaseoloides, Calopogonium mucunoides, Calopogonium caeruleum, Centrosema pubescens,* and *Mucuna bracteata* would reduce this risk.

Conclusions

All the three new zero burn methods of clearing old oil palms for replanting have good potential in reducing rhinoceros beetle, rat and Ganoderma disease problems in an oil palm to oil palm replant

besides conferring other benefits such as reduction of fallow period, facilitating replanting and the subsequent field upkeep work, improving the utilisation of nutrients released by the decomposing palm biomass by the newly replanted palms. The new zero burn techniques of replanting are environmentally less polluting and also improve the sustainability of oil palm plantations.

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