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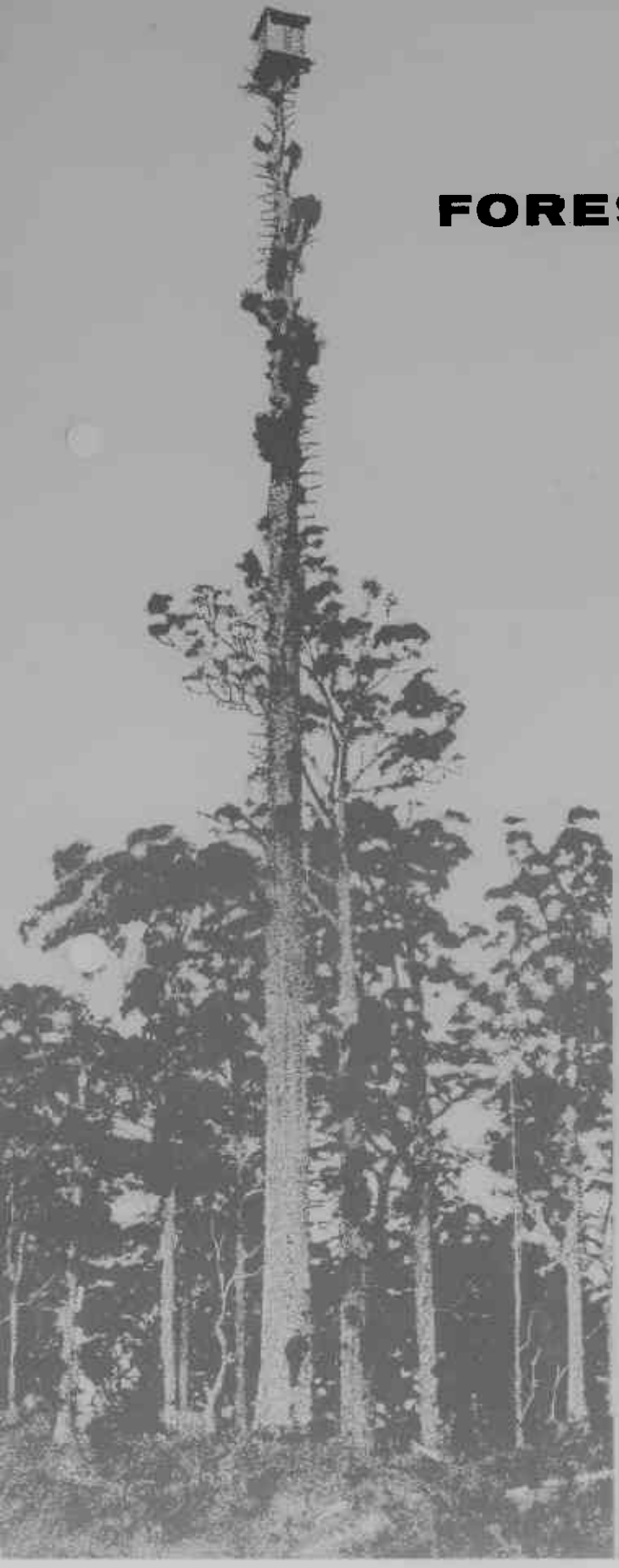

SOME ASPECTS OF LOGGING HYGIENE

by

F. BATINI and J. N. CAMERON

SUMMARY

The potential of a number of vehicles to spread diseased soil was tested. All units were capable of transporting diseased soil for considerable distances, but the potential for initiating new infections varied greatly between units. The large soil weights which can be transported indicate that segregated logging operations and the elimination of cross travel from diseased into healthy sites are essential if the artificial spread of *P. cinnamomi* is to be reduced to a minimum. Care in the planning of all logging operations is an important aspect of hygiene. Where transfer of equipment from diseased into healthy sites becomes necessary, washing with a high pressure spray can remove over 90 per cent of the soil on even the most difficult units.

INTRODUCTION

Jarrah (*Eucalyptus marginata Sm.*) is the most important timber species in Western Australia. Parts of this forest are affected by a disease caused by the root rotting pathogen *Phytophthora cinnamoni* Rands. Aerial photo mapping indicates that less than five per cent of the total area of forest is currently affected and that most of the diseased areas occur on the poorer jarrah sites.

The pathogen has never been isolated from areas of healthy forest and artificial inoculation with small plugs of diseased soil have initiated new centres of infection in previously healthy sites. Although it is appreciated that failure to isolate *P. cinnamomi* from healthy areas is not conclusive evidence of its absence from these sites, the current evidence in Western Australia indicates that this pathogen has been introduced into the jarrah forest area.

Spread of the fungus by natural means within the soil is very slow in comparison to its distribution by the transport of soil containing infected root material. Man, with his ability to transport large quantities of soil over great distances in a very short time, is the most efficient carrier of this disease into healthy areas. No data is available on the relative quantities of soil carried by different types of equipment or on the patterns of spread.

Where transfer of logging units from diseased to healthy forest becomes necessary, washing down with a high pressure hose has been recommended. As the effectiveness of this technique has not been tested under operational conditions, it was decided to investigate the quantities of soil carried and spread by both washed and unwashed equipment.

METHOD

The tests were carried out in the Mundaring Division, in a plantation area not affected by *P. cinnamomi*, and located approximately five miles north-east of the Mundaring Weir Headquarters. The following units were used:

a. Caterpillar D7 tractor,
b. Caterpillar D4 tractor,
c. Michigan tractor shovel (fitted with fork lift arms),
d. Bedford 7-ton tip truck (one set of duals),
e. Chevrolet 15-cwt. ex-military truck,
f. Land Rover (short wheelbase).

Each of the units was bogged in a wet creek crossing and then walked or driven in second gear for ten chains along a gravelled road. A 50 per cent (one track) sample of the soil falling on the road between the start point and the 7.5 chain mark was collected, air dried and weighed. At the 10 chain mark, any readily removable soil was collected into bins, the unit was washed thoroughly and the soil collected on a tarpaulin. This soil was subsequently air dried and weighed.

In the second run, the units were bogged in the same creek and then moved onto a nearby road. They were then washed thoroughly by their drivers using a standard heavy duty pumper unit. Where necessary, large clods of earth were chipped away, using a crowbar, and the units were moved forward so as to wash the remainder of the tracks or tyres. The units were then walked or driven in second gear for 7 chains along a gravelled road. The sampling and rewashing at 7 chains was then repeated as described previously. These trials were carried out during the summer months.

The tests on the different soil types were carried out in early winter after appreciable falls of rain. A Bedford 3-ton standard gang truck fitted with a single set of duals was used. The soils were a loamy sand, a lateritic gravel and a loam. The unit bogged in the loam soil and had to be towed on to the road. The gravel test was conducted in a pit where deep piles of gravel occurred. Though the wheels sank and spun in this soil, the truck did not bog. Initially, the truck drove over the sandy soil with great ease. In a subsequent run, the truck was made to drive through a fairly deep hole, where it bogged, and had to be removed by towing. The subsequent sampling and washing processes were carried out as already described.

RESULTS

The weight of soil carried and dropped by the various types of equipment is shown in Table 1, and the data indicates marked differences between these units. At the 10 chain mark, relatively little soil remained on the rubber-tyred units with the exception of the Michigan. In contrast, considerable weights of soil were retained on the tracked equipment. The D4, Bedford and D7 lost the greatest quantities of soil whilst travelling whereas the losses from the other units were relatively small by comparison.

The patterns of spread by the various units are shown graphically in Figure 1. Most of the soil which fell on to the road was lost quite rapidly (Table 2).

Table 3 indicates the very substantial reduction in soil weight as the result of thorough washing with a high pressure spray. In the case of the D4 and D2, respectively, the weights of soil retained after washing were approximately 15 per cent and 10 per cent of the original soil weights on the unwashed units. With rubber tyred units, less than half a per cent of the original soil weight was retained after washing. Washing of the D7 was completed in 75 minutes, the D4 in 30 minutes, and all the rubber tyred units were washed in less than 15 minutes.

In the fortnight preceding the trial on the effects of soil type, the metereological station at Mundaring Weir had recorded a total fall of 592 points of rain, 126 of which fell in the 48-hour period preceding the trial. Details of these soils is shown in Table 4 and the data indicates considerable differences between the three soils tested.

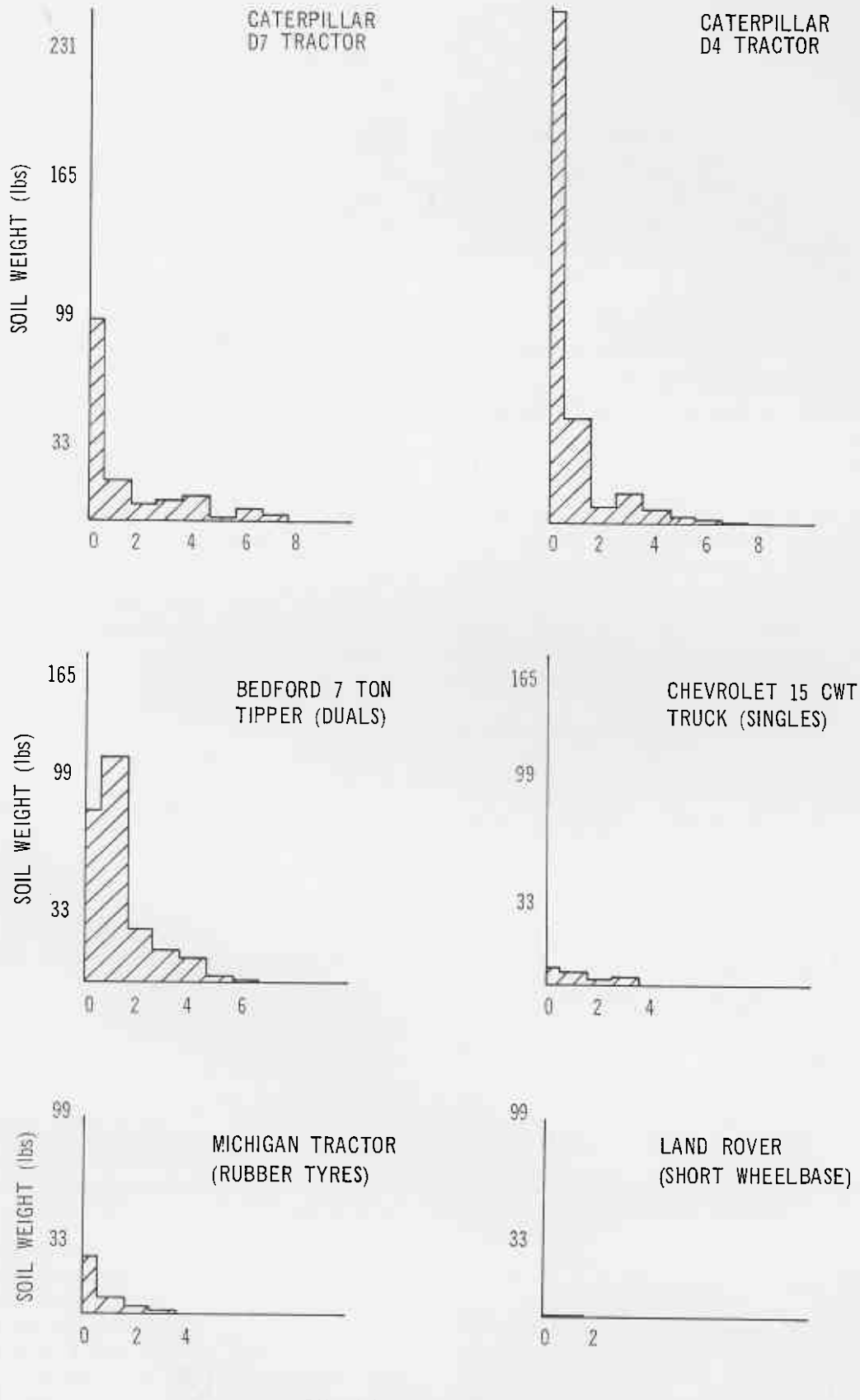

FIGURE 1: ***Weight of soil dropped over a distance of seven and a half chains by different types of equipment.***

Table 5 demonstrates that the quantity of soil carried by the Bedford varied considerably between soil types. It appears that the amount carried is dependent on the moisture content, the gravel per cent, and the percentage of fines (silt and clay) in the soil. Of the three soils tested, the very wet and heavy textured loam was particularly hazardous from a hygiene point of view.

The pattern of spread for these three soils is shown graphically in Figure 2. In the loam soil, a rapid fall-off of soil loss with distance travelled occurred. In all soil types, peak losses were observed between 1.5 and 3.5 chains, i.e. as the truck began to gather speed.

DISCUSSION

The data presented should be used to obtain trends rather than quoted as absolute values. Though care was taken in the sampling and washing processes, some soil was inevitably lost. It is considered that these losses were not great and that they would not materially alter the trends obtained. The soil falling on to the road could be easily distinguished due to its colour and wetness, and was readily handled excepting for the smallest particles. The units were washed at 10 chains so as not to interfere with the samples on the road. As the soil losses between 7.5 and 10 chains were small, the calculated soil weights on the units at the beginning should be reasonably accurate.

Since *P. cinnamomi* may be readily isolated from diseased soil samples weighing three to four ounces, the extremely large soil weights transported by these units constitute a real threat to any hygiene programme. The weights tabled are air-dry equivalents and under normal operating conditions could be increased by one-sixth to one-third, depending on the soil moisture content. This dead weight could adversely affect machine performance.

Most of the soil which fell on to the road was lost within the first 1.5 chains and, in most instances, large clods were uncommon beyond 3 chains. The probability of initiating a new centre of infection is likely to depend on both soil weight and on clod size. This indicates that the two or three-chain-wide strip adjacent to the diseased area is most likely to become infected during cross travel, although new infections at ten chains or beyond are still possible.

The proportion of soil lost to soil retained differed greatly between the units. This is a function of a number of factors: rubber tyred or tracked, travelling speed, road quality and vehicle construction. The observed differences between the D4 and the D7 are probably due to the D7's longer track base and heavier weight, which reduce jolting. The general construction of the D7 also provides a number of flat surfaces which are suitable for the retention of soil. Of the rubber tyred units, the Michigan tractor and the Land Rover were atypical in the amounts of soil retained. In the former, a large mound of soil adhered to the large, flat towbar frame. In the latter most of the soil was retained on the sump protection plate. Both of these attachments had been fitted at Departmental workshops. In contrast, the two trucks were relatively efficient at self-cleaning.

The soil retained on these vehicles constitutes a further source of infective material. The efficiency of this source is highly dependent on its subsequent treatment. If the soil dries thoroughly *in situ*, the survival of *P. cinnamomi* will be greatly reduced. If, however, the unwashed unit is rapidly transferred to a new area on a low loader, long range spread of the pathogen to a healthy site is possible.

The data indicates considerable differences between the three soil types tested. All three soils were above field capacity at the time of the trial. This factor,

TABLE 1
WEIGHT OF SOIL (AIR DRY) CARRIED BY DIFFERENT TYPES OF EQUIPMENT (UNWASHED)

UNIT	Approximate Soil Weight on Unit at Beginning (lbs.)	Soil Weight Lost Between 0 and 7.5 Chains (lbs.)	Soil Weight on Unit at 10 Chains (lbs.)
Caterpillar D7	1629	172	1457
Caterpillar D4	697	357	340
Michigan Tractor	181	45	136
Bedford 7-ton Truck	270	260	10
Chevrolet 15-cwt. Truck	26	19	7
Land Rover	12	3	9

TABLE 2

WEIGHT OF SOIL (AIR DRY) FALLING ONTO ROAD WITHIN SPECIFIED DISTANCES, AS A PERCENTAGE OF THE TOTAL WEIGHT OF SOIL FALLING ONTO THE ROAD

UNIT	DISTANCE		
	0 - ½ Chain	½ - 1½ Chains	0 - 1½ Chains
Caterpillar D7	60%	12%	72%
Caterpillar D4	72%	15%	87%
Michigan Tractor	64%	17%	81%
Bedford 7-ton Truck	33%	45%	78%
Chevrolet 15-cwt. Truck	43%	24%	67%
Land Rover	52%	24%	76%

TABLE 3

WEIGHT OF SOIL (AIR DRY) CARRIED BY DIFFERENT TYPES OF EQUIPMENT, AFTER WASHING WITH A HIGH PRESSURE HOSE

UNIT	Soil Weight on Unit After Washing (lbs.)	Soil Weight Lost Between 0 and 7 Chains (lbs.)	Soil Weight on Units at 7 Chains (lbs.)
Caterpillar D7	160	6	154
Caterpillar D4	105	9	96
Michigan Tractor	0.5	0.1	0.4
Bedford 7-ton Truck	0.2	0.1	0.1
Chevrolet 15-cwt. Truck	Nil	Nil	Nil
Land Rover	Nil	Nil	Nil

TABLE 4

SOIL MECHANICAL ANALYSIS AND MOISTURE CONTENT PERCENT

Soil Type	Moisture Content (Per cent)	Gravel (Per cent)	Mechanical Analysis of Particles < 2mm Diameter	
			Sand (Per cent)	Silt & Clay (Per cent)
Loam	61.5	3.0	74.5	25.5
Lateritic Gravel	19.8	49.9	65.0	35.0
Loamy Sand	17.7	Nil	86.0	14.0

TABLE 5

WEIGHT OF SOIL (AIR DRY) CARRIED BY THE BEDFORD 3-TON TRUCK

Soil Type	Approximate Soil Weight on Unit at Beginning (lbs)	Soil Weight Lost Between 0 and 7.5 Chains (lbs)	Soil Weight on Unit at 10 Chains (lbs)
Loam	100	53	47
Gravel	19	5	14
Sand (Second Run)	8	4	4
Sand (First Run)	Nil	Nil	Nil

and the deliberate bogging of the truck in the sandy soil indicate that the conditions tested were relatively severe. The greatest difference between soil types was due to the duals packing with soil in the loam site whereas this did not occur in either of the other two sites. Only in the case of the loam soil were large clods deposited on the road. These were sprayed out from between the duals— particularly as the truck began to gather speed. Soil type also affects the ease of washing and it was readily apparent that the heavier textured soils were more difficult to wash off the unit. It is interesting to observe that, as a result of soil type, a potentially more hazardous unit (a truck with duals) in a potentially more hazardous season (winter), may in fact be less dangerous, from a hygiene point of view, than a Land Rover or a truck without duals. It is probable that the difference between the soil types tested would be even greater in summer, when the likelihood of picking up any sand or gravel would be extremely low.

Washing down greatly reduced the weight of soil retained on these units and, as a consequence, would reduce their ability to initiate new centres of infection in areas of healthy forest. Rubber tyred units were relatively easy to clean, due to their construction and their height off the ground. In contrast, the D7 and D4 retained a considerable weight of soil after washing. Tracked equipment is difficult to clean completely due to the collection of soil in locations such as under the track adjustment spring covers, the top of the engine and transmission underside protection plate, the track shoes and the area around the track pins.

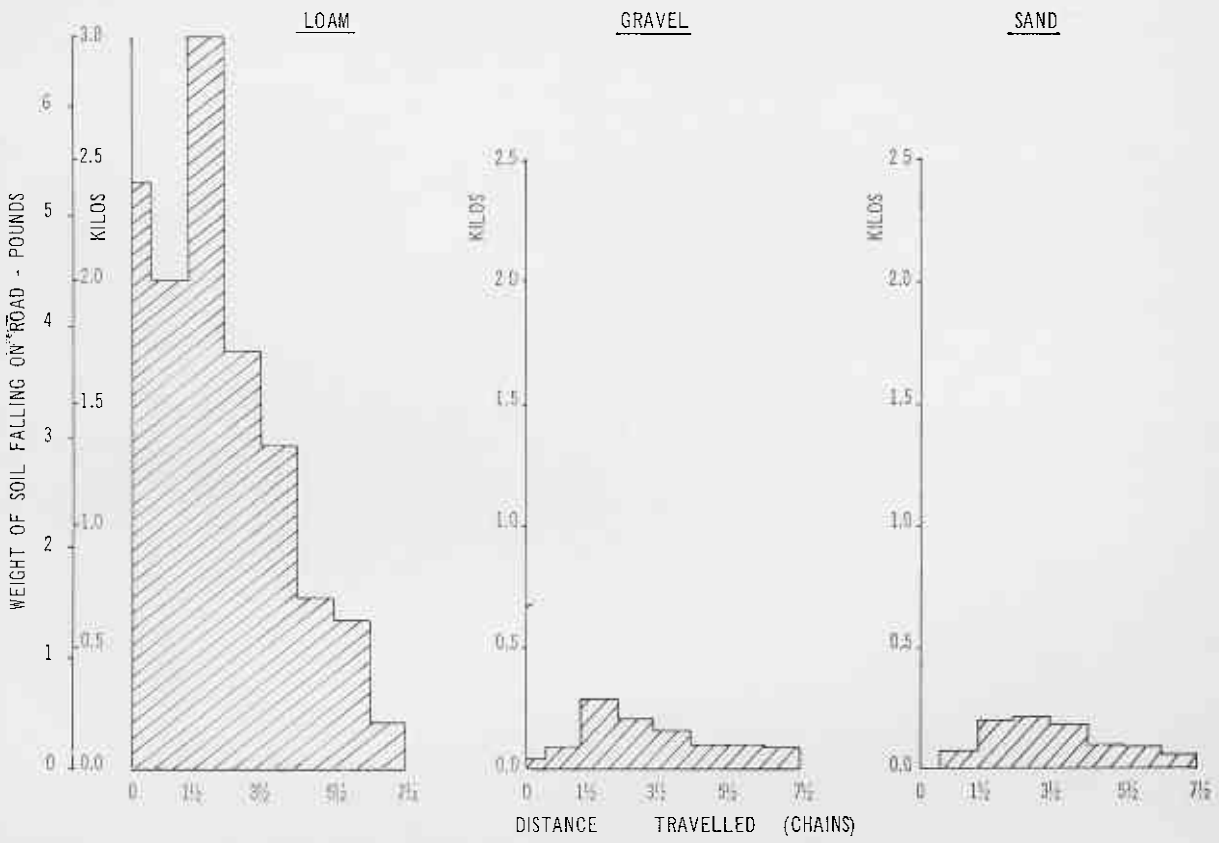

FIGURE 2: *Soil spread by equipment from three different types of soil.*

Nevertheless, washing has reduced the weight retained by these units by between 85 and 90 per cent and the actual weight of soil falling on to the road was reduced by over 95 per cent. The greater percentage retention observed with the D4 is probably due to its smaller size, which creates difficulty in access whilst washing.

The high pressure wash was carried out by the unit's driver. In a number of cases, some readily removable soil on the treads, the rear of the dozer blade and the track pins was missed in the original washing process. It is considered that these results would be quite typical of a reasonably thorough wash carried out under operational conditions. Minor structural modification to some of these units should be considered, so as to reduce the weight of soil collected and assist the washing process.

All of the units tested are capable of transporting diseased soil for considerable distances. Potential for initiating new infections varies greatly between units. The D4, Bedford with duals, and D7 are the most efficient units for spreading diseased soil over short distances, whilst the D7 and the D4 have the greater potential for spread over longer distances. The large soil weights involved indicate that segregated logging operations and the elimination of cross-travel from diseased into healthy areas are essential if the artificial spread of *P. cinnamomi* is to be reduced to a minimum. A careful selection of the site, the soil type, the time of year, and the type of logging unit can markedly reduce the likelihood of spreading the pathogen during logging operations. Care in the planning of a logging operation is just as important an aspect of logging hygiene as is the washing down of dirty equipment prior to its transfer into healthy areas.

To be efficient, washing down must be carried out conscientiously and large clods should be chipped away with a bar. It would be preferable to wash tracked units on boards, moving the unit forward during the washing process so as to clean the portion of the tracks previously in contact with the ground. The unit should then be moved one or two chains in order to dislodge any soil missed in the washing process and this soil should then be removed by a short rewash. Using this technique it should be possible to remove over 90 per cent of the original soil on even the most difficult units.

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