

# MACHINERY USE FOR LAND PREPARATION: AN ANALYSIS ON SOIL AND EARTH ASPECTS

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## **Introduction**

Use of earth moving machineries for land preparation is increasingly becoming popular among tea growers in all tea-growing areas mainly due to the scarcity of skilled workers. In addition, factors such as high cost of labor, time delay and poor quality of manual work *etc*, are also attributed for moving into machineries. For instance, about 520 man days is required to prepare a land before planting grass manually (Jayakody and Shyamalie, 2002), whereas it needs only 45-100 working hours with an appropriate machine. Other advantage is that unlike labor, machines can continuously be used in the field covering a large area, without idling.

Tea growers use different earth moving machineries like excavators, backhoe loaders and bulldozers for land preparation. Major operations with these are uprooting of tea bushes and shade trees, removal of boulders/ stones and forking. Leveling of land is also undertaken to some extent. The growers' intention is to finish the work very quickly and to follow the next step in replanting process.

The cost of land preparation varies with tea growing elevation (Jayakody and Shyamalie, 2002). However, there will be differences in cost according to the nature of land even within a given elevation. For a steep land with many rocks, a higher rate per working hour is charged. Further, rate may be varied according to the extent of the field and the location. The larger the extent, the lower the unit rate for work and vice versa. Particularly for remote areas, a higher rate is charged

due to high transport cost and idling time of the machine. Since different machines with different engine capacities (ranging from 6-100 kW/ 5-75 hp) are used in the field, and different types of earth moving machineries are available, like back hoe loaders, bulldozers and excavators, the cost of a working hour would vary with type of the machine and size of the machine.

#### **Disadvantages of machinery use**

Even though, machinery use seems to be a better alternative for man power, there are some adverse effects such as possible physical changes of soil, which need more attention particularly when operating in hilly terrains. However, such adverse effects could be minimized by adopting some precautionary measures.

#### **Soil erosion**

Soil erosion is an existing problem in tea fields, mainly during replanting period. About 250 tones of soil is lost from a hectare over a period of four years of replanting from land preparation (Hasselo and Sikurajapathy, 1965). Erosion becomes heavier during period of uprooting, as the bare soil is exposed to physical effects like wind and rainfall. With cleaning of lands using machines and when tea land is ploughed with tillers, there could be some gully erosion (Plate 1). Severe erosion could take place after removing top soil during rains.

#### **Soil compaction/ hardpan formation**

Use of heavy machinery for land preparation can lead to soil compaction. Highly compacted soil with bulk densities in excess of 1.7, corresponding to porosities of less than 36%, root growth normally become slower or ceases (Ahn, 1993). This suggests that higher compaction of soil could lead to bush debilitation with a poor root system. Low grown tea fields with a shallow soil can be severely affected if the soil gets compacted during land preparation.



**Plate 1. Large tillers make trenches in the land, accelerating erosion**

The wheel/ traffic system of the machine is one of the main causes for soil compaction in the field (Plate 2). Different types of wheel/ traffic systems are used in heavy agricultural machinery to reduce soil compaction. They include the use of wider tires, operating under low inflation pressure and use of rubber crawler instead of wheels. The higher compaction is caused by tyres than track system. The tyre/ soil contact stress of a standard tire that is used in farm machinery ranges from 89-175 kpa (Douglas *et al.*, 1998).



**Plate 2. Soil is compacted due to heavy machine movement over the soil**

### **Potential occurrence of earth slip**

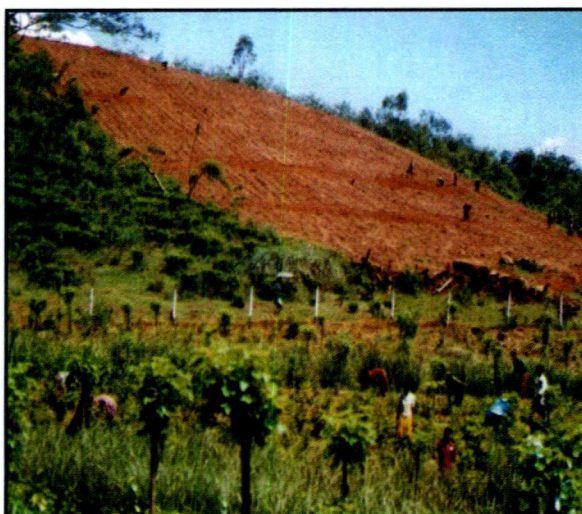
Usage of earth moving machinery for land preparation in sloppy tea lands could result in earth slips mainly due to two reasons (Plate 3). Machine operation in tea field could block drains and pathways of the runoff water (Plate 4). The runoff water is then get accumulated on the soil surface. Ploughing of the land could then increase water movement into the soil. Sudden penetration of water through soil and continued water logging due to poor drainage then cause earth slips (Liyanage, 2002).

Abrupt uprooting of large trees exposing soil gives rise to earth slip. During land preparation machines are mostly used to remove old high shade trees. Removal of large trees followed by incomplete closing up of pits also causes earth slips. These pits serve as collecting points of runoff water, which ultimately increase water seepage into the soil.

Besides, the machine movement over the soil at a critical angle itself may cause land slip (Bandara, 2002). Identification of soil physical parameters is very important before operating machines to decide the suitable type and size of the machine that should be used in a particular field to minimize such damages.

### **Weed growth**

In addition to soil erosion and other effects, profuse growth of annual weeds such as Kura Thampala (*Amaranthus viridis*), Mottu (*Physalis angulata*), Wal Aba (*Cleome viscosa*), Diyanilla (*Peperomia pellucida*) and *Boraria spp.* could be seen in barren lands after land preparation. Some biennials and semi woody weeds such as Getakola and Wal Kottamalli (*Scoparia dulcis*) are also found due to exposure of weed seeds buried underneath.



**Plate 3. Use of earth moving machine in steep lands increases soil erosion**



**Plate 4. Blocking of waterways due to machine movement**

### **Optimizing the machinery use in field operations**

Even though, there are ill effects of machinery usage for land preparation, there are many added advantages such as better land preparation, saving of time and reduction of labour requirement as

machinery use for land preparation is becoming more essential, the proper use of earth moving machines needs to be emphasized. Proper evaluation and specific field guidelines are required for sound and effective use of machinery in tea lands. Followings are some factors that are important, for the use of earth moving machinery.

### **Selection of suitable machinery**

Use of single machine for different jobs may not yield good results. Unsuitable machines result in poor land preparation and heavy loss of soil. Removal of deep stones/ boulders requires an excavator and a backhoe loader is not sufficient for a such activity. Tractor mounted winch can be used to uproot tea bushes in a flat land with less operating cost than a big excavator. To level a land properly, bulldozer is better than an excavator. Use of lightweight and small machines always do lesser damage or disturbance to soil and such machines can even be used by grower himself at a low cost.

### **Better conveyer system**

Different conveyors are used in earth moving machines. Those are standard tyres, wider tyres, steel belts and rubber belts. The best traffic system should be selected so as to minimize the soil compaction. In a pasture land of clay loamy soil, tyre -soil contact stress can range from 89-175 kPa in standard tyre, whereas with wider tire of low inflation rate it can be 30-127 kPa (Douglas *et al.*, 1998). In tea land preparation, construction vehicles are often used. They are normally fitted with standard tyres. By lowering the inflation pressure during field operations, soil compaction can be reduced.

### **Avoid critical areas and time periods**

For a given vegetation type the probability of land sliding depends on storm rainfall, slope angle and rock type (Dymmand *et al.*, 1999) Hence, safe locations need to be identified to minimize soil erosion and risk of earth slip. Machine use for land development above worker housing

schemes and rural community needs much attention and should be avoided as much as possible. Soil type and its related physical properties are important in accessing the suitability of a particular field for machine use.

High soil erosion is the result of exposure of land to heavy rains during or after land development process. Therefore, suitable period for the operation can be identified with past rainfall records, by contacting local meteorology authority or through internet search. Usually, land preparation should be completed well before the onset of monsoon rains.

### **Grass planting and covering up of soil pits**

Uprooting of tea bushes and land development should immediately be followed by planting either Mana (*Cymbopogon confertiflorus*) or Guatemala (*Tripsacum laxum*) grass. It is very important to establish a good ground cover early preventing weed occurrence and reducing the soil erosion, since it intercepts rainfall and reduces runoff. Grass roots which produce in higher amounts also act as barriers for moving water on the slope. Grass or tea planting should not be delayed until the entire area is uprooted, forked and leveled (Somaratne, 1986).

Uprooting of rubber plants is reported to be a cause for earth slip. But uprooting of high shade trees is not considered as a cause for earth slip, as uprooting is followed by land leveling and grass planting in tea estates (Bandara, 2002). Therefore it is important to cover soil pits created by uprooting of shade trees, plant grasses without an undue delay (Plate 5).

### **Erosion control measures**

It is extremely important to reduce the exposure time of bare soil to rains with the use of machine before grass planting. Construction of stone walls and cutting of lateral and leader drains are very important in order to protect the loosened soil within the land. As shown in the Plate 4, lot of

damages would occur to drains with machine work. For the construction of erosion, control barriers and grass planting necessary with land preparation.



**Plate 5. Pit created by the removal of high shade tree**

#### **Selection of suitable sites for machinery use**

Since most of the tea lands, are located in hilly terrains, imposing of restrictions for use of earth moving machinery only for suitable site practical. Hence, the best result of mechanization cannot be achieved from every site/location. However there are some lands where terrains are flat to gentle slope. Machineries could successfully be used in such lands. New technologies such as GIS applications can be used to identify potential areas and to build up models. Tea districts such as Galle, Ratnapura, Kalutara and Morawakkorale are regarded as the areas with higher potential for mechanical land preparation.

#### **Conclusion**

Though, initial investment is high for mechanized land preparation, it will be the solution for future labour problems in the tea industry. With careful supervision and planning, disadvantages of using machines for land development can be minimized thereby achieving better results.

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