

5. CONCEPTUAL DESIGN OF MACHINES

5.1 Basic Information

Rubber leaf density in area basis can be derived from the survey data as 0.142 kg/m^2 which is equivalent to 725 leaves/m^2 . Taking the average leaf dimension of $8.192 \times 4.172 \text{ cm}^2$ it implies about 2.48 layers of leaves on the ground floor.

Rubber trees are generally planted in rows of 6-7 meters apart and the distance between each tree is 3.5-4 meters. Irregularity of the plantation surface is common.

The possibility of introducing mechanization to the waste collection process was studied. An existing cyclone separator was used to collect the leaves placed on concrete floor. It is believed that the concept of using a cyclone separator is possible but some difficulties have to be overcome. Higher suction power is needed to cope with the irregularity of the plantation surface. Observation in the field found that weed could be another obstacle. The conceptual designs of the mechanization are given below.

5.2 How to Obtain the Wastes from the Ground Surface

Three possible methods that are able to get the wastes from the ground are suction, pinned roller and rack. The suction method employs vacuum cleaner principle. The pinned roller is a drum with arrays of sharp pins. The pins pierce through the leaves as

the drum rolls over. The rack method gathers the wastes as it is pulled across the plantation. The pinned roller and the rack methods cannot cope with the irregularity of the plantation profile, unless flexible roller (or rack) is used. They also need additional mechanisms capable to collect the leaves, i.e., pull out the leaves from the pins or collect the leaves at the end of excursion in the rack method. After a careful consideration, the suction principle was chosen

5.3 How to Collect the Leaves

As the suction method has been chosen, there are two collecting alternatives to be considered, namely filter bag and cyclone separator. The cyclone method, which was demonstrably possible (see section 5.1), will face with wear of the blower blades since the wastes have to flow through them. The amount of wastes collected has no effect on the suction pressure, though. The filter bag method, on the other hand, will encounter with the fluctuation of the suction force. The more the wastes are collected, the less the suction force. However, this method results in a longer-service-life blower since, unlike the cyclone method, only air passes through the blower. It is anticipated that the leaves are large enough so that the pressure drop across the bag is minimal. Furthermore, the filter bag method will collect the wastes at higher density which is desirable. The filter bag method is selected.

5.4 How to Move the Machine in the Plantation

The machine can be manoeuvred in the plantation either by a motorcycle or a pushing cart. A motorcycle with a sidecart carrying collecting equipment can move around the plantation. However, the manoeuvrability is limited as it cannot move backward or is not able to collect the wastes near the tree trunks. A 2-wheel push cart in the same fashion as a lawnmower is considered superior to the motorcycle because it is easy, simple and less capital cost. It has a better manoeuvrability and suits to the surface irregularity.

5.5 How to Densify the Wastes

Biomass densification machines can be classified as piston press, screw press, pellet press and manual press (Eriksson and Prior 1990). Past experience in many places showed that the screw press was successfully used to densify many kinds of biomass. Thus, a screw press was chosen as a study model.