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Design concept for developing a back pack power mounted harvesting equipment for oil palm

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Oil palm *(Elaies guineensis)* constitutes 33 per cent of the world's oil and fat export trade. Palm oil is the second major oil produced in the world after soybean oil (Goble, 2011). In India, oil palm is grown largely in Andhra Pradesh followed by Tamil Nadu and Karnataka. Oil palm starts yielding 24-30 months after planting. Each palm can produce 8 to 15 fresh fruit bunches (FFB) every year weighing about 15 to 25 kg each, depending on the planting material and age of the palm (Hazir *et al.*, 2012).

Harvesting of oil palm consumes major portion of the production cost of the plantation (Penna, 2011). It involves front integrated activities *viz.*, cutting of fronds and fruit bunches, stacking the fronds, collecting the loose fruits and carrying the harvested fruit to the collection point (Jelani *et al.*, 1998). In the pioneering days of harvesting oil palms, adult male workers performed the cutting and carrying of bunches, while women and children gathered loose fruit in baskets (Badmus, 1990). In the traditional method of harvesting of bunches, the operator reaches the top of the palm with the use of a plastic, rubber ropes or ladder. Another conventional method is harvesting with a specially designed knife attached to light weight bamboo or aluminum pole (Yak *et al.*, 1981). All the conventional methods of harvesting oil palm fruit bunches are strenuous and time consuming (Jelani *et al.*, 1999).

Harvesting fruits from short palm is relatively easier. A chisel attached to a short mild steel pole is normally used to hit the bunch to be harvested at a particular angle with great speed (Leng, 1999). Harvesting fruits from tall palms on the other hand requires different technique which is carried out by sickle attached to bamboo or light weight aluminum pole. The harvester basically is involved in two main operations *viz.*, first to lift the pole upright and second to cut the fronds and fruit bunches which require high skill and energy (Jelani *et al.*, 1999). One person can harvest 0.4 to one tonne of FFB per day depending on the age of palms, season of harvesting, skill of the harvester and topography of the field.

The oil palm industries are facing a major problem due to non-availability of skilled labour for handling the heavy and strenuous task such as the harvesting of FFB and cutting fronds in oil palm plantations (Ahmad and Zamri, 2000). At present, most of field operations, *viz*, land clearing, manuring, spraying and fresh fruit bunch (FFB) transporting are already being mechanized and hence there is a need to mechanize the harvesting operation also. The weight and size of the frond and the bunches, strong adherence of their base to the stem and the height of the palm, make the orientation and positioning of the cutting tool very difficult. A motorized mechanical harvesting tool has to be developed to overcome these hurdles and to make the harvesting of FFB bunches in an easier way with less cumbersome operations.

Design considerations for development of the equipment

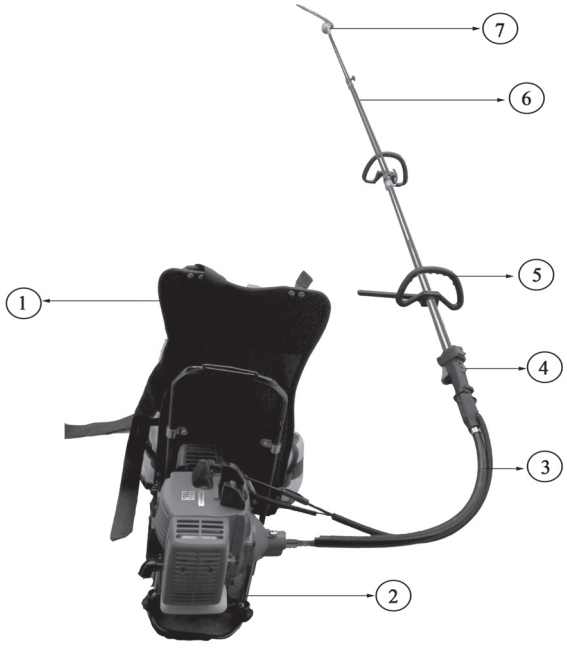
The following points have been considered while designing the proposed mechanical harvesting device for the oil palm.

1. Equipment should be light weight.

2. FFB cutting action need to be motorized to reduce the energy requirement.
3. The power source should be back mounted so as to reduce weight and vibration of hands of the operator while harvesting FFB.
4. Power transmission to the harvesting pole from the light weight engine to be transmitted by means of flexible shaft enabling easy operation of the equipment.
5. Reduce the direct contact of the operator's hand with the telescopic pole, so that the vibration is not directly transferred from the pole to the operator.

Development of the equipment

In an effort to develop a motorized bunch harvesting tool for medium tall oil palms, the design concept for a back pack mounted oil palm harvesting equipment (Fig. 1) was developed by Central Institute of Agricultural Engineering, Industrial Extension Project, Coimbatore, Tamil Nadu in collaboration with Directorate of Oil Palm Research, Pedavegi, Andhra Pradesh. The equipment consists of four major parts namely, light weight engine, flexible shaft, light weight telescopic pole and cutter head mechanism.



1 - Back pack arrangement, 2 - Light weight engine, 3 - Flexible shaft, 4 - Accelerator, 5 - Handle, 6 - Telescopic pole, 7 - Cutter head

Fig. 1. Back pack model oil palm harvesting equipment

A two stroke petrol engine of 50 cc and 1.75 HP power with a total weight of 2 kg was used as source of power and tested for its suitability for back pack mounting. A flexible shaft of 8 mm diameter was attached from the engine to the cutter head through telescopic pole to transmit the power. A light weight telescopic pole of aluminium alloy with 30 mm diameter, through which the drive shaft to the cutter head is provided, could be varied from 90 cm to 300 cm by telescopic arrangement. Handles are provided in the telescopic aluminium pole, so that harvester can hold the equipment easily.

The cutter head consists of two parts namely, driving mechanism and cutting knife. The reciprocating cutter knife is mounted on the light weight telescopic aluminum pole which could be operated till 6-7 m. To transmit the power form the power source to the reciprocating cutter knife at an rpm of 5000 to 6000, two types of transmission mechanism was designed. In the first mechanism, the linear movement is obtained with an eccentric cranking arrangement converted into rotary movement by bevel gear arrangement (Fig. 2a). In the second mechanism, the power transmission to the knife is obtained by cranking of the knife base directly from the drive shaft to obviate vibration due to the eccentricity (Fig. 2b).

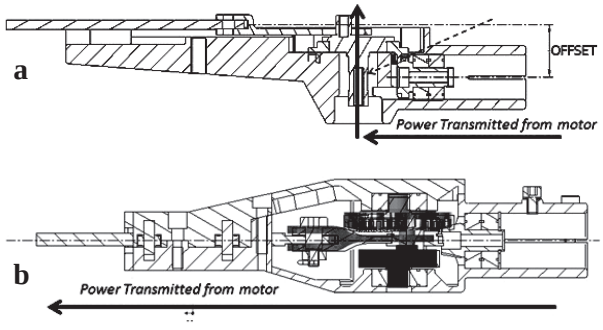


Fig. 2 a & b. Details of the power transmission mechanism from power source to reciprocating cutter head

Various models of existing knives *viz.*, Kerala model, Andhra Model, Malaysian model, Cantass model *etc.* were evaluated to suit the requirement of the back pack model of oil palm harvesting equipment.

In an effort to reduce the vibration directly coming on the harvesting pole, the following provisions were given

i) Nitral rubber (Core hardness 60-70 HRC) of 2.2 cm diameter and 3 cm height each was provided as padding all along between the drive shaft and telescopic pole.

ii) A pair of adjustable handles was mounted on the telescopic shaft, so that the operator could hold them during harvesting, to reduce the vibration transmitted directly from the vibrating knife to the operator.

A back pack model of power operated oil palm harvesting equipment based on the concept was developed and preliminary evaluation was carried out at various oil palm plantations at different height (Fig. 3). It was observed that that the device can be operated up to a height of 4-5 m comfortably. The total weight of the back pack model of harvesting equipment is about 12-13 kgs. The number of palms harvested would depend on various factors like efficiency of the operator, number of mature bunches per plant, orientation of bunches, height of palm, land profile, *etc*. The equipment is being further evaluated for recommending it as a harvesting device in oil palm plantations.

Fig. 1. Performance evaluation of back pack model of oil palm harvesting equipment

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