MECHANICAL LOOSE FRUIT COLLECTOR (MK II)

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Loose fruit collection is part of fresh fruit bunches (FFB) harvesting and evacuation process. The conventional methods used for loose fruit collection are by hand picking or by manually raking and scooping into a bag. The techniques are not only time-consuming but also tedious and laborious. The debris content in raking can be as high as 60% by weight (Ahmad *et al.*, 1995). Thus the introduction of mechanical loose fruit collector to the plantations is one way to reduce time of harvesting and the manpower dependence.

OBJECTIVE

The main objective of developing a mechanical loose fruit collector is to replace the manual collection of loose fruits. The main benefits to be derived are as follows:

- Reduction in labour requirements
- Reduction in cost of production
- Increase in productivity per worker
- Maximum fruit recovery.

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DESIGN CONCEPT AND CONSIDERATION

Several design concepts have been considered in developing the machine. The focus was on methods of collection that would be suitable to be operated under a wide range of field conditions. In addition the following features have also been considered:

- The machine can collect loose fruits from the palm base and transport them to the road side
- Simple to operate (require no skill)
- Built-in separator unit to separate loose fruits from debris
- Minimum damage to the fruits during collection
- Suitable to operate in uneven surface and narrow terraces
- Relatively fast in movement – for bigger coverage
- One-man operation type – driving and collecting loose fruits
- Permits the operator to perform the job without squatting down or bending his body.

PROTOTYPE DEVELOPMENTS

Our first commercial type, which was a push-cart, was designed and tested in 1995. This machine has undergone exhaustive field trial on commercial estates. Based on the trial results and feedback from the estates, it was found that the push-cart type machine working coverage was considerably low because the operator has to walk and push the collector. Our effort was then to develop a machine for bigger capacity and coverage. A self-propelled type collector seems to be a very suitable machine to be developed. A three-wheeler FFB carrier (Badang) which is locally manufactured and distributed by Agricultural & Industrial Machinery Sdn. Bhd. was chosen because this machine is small and able to maneuver around the palm effectively. There is no difference between the push-cart and the self-propelled type collector in terms of the principle used. The only difference is that the self-propelled type is upgraded to achieve bigger coverage and capacity. Modifications were made to the main frame of the machine so that it is suitable to attach to the collector and this can be divided into two:

Suction parts: Installation of suitable driving pulley, belt, driven pulley, tensional pulley, shaft, bearings and the mounting bracket. The fan and casing is fixed at the end of the shaft.

Related components: Installation of separator unit, containers (fruit and debris) and suction nozzle.

The main functional components of the machine consist of a pickup mechanism (suction nozzle), separator unit and containers (loose fruits and debris). *Table 1* presents the detail technical specifications of the collector.

TABLE 1. TECHNICAL SPECIFICATIONS OF THE THIRD PROTOTYPE MECHANICAL LOOSE FRUIT COLLECTOR

Overall Dimensions		
Length (L)	:	2050mm
Width (W)	:	1200mm
Height (H)	:	1600mm
Air speed	:	20-35m/s
Engine		
Model	:	Air-cooled Yanmar L60 Diesel
Rated power	:	4.5kW
No. of cylinder	:	1
Transmission	:	3 stages – forward 1 stage – reverse
Gear Box	:	c/w Differential lock

FIELD TRIAL

Field trials were carried out in estates with the aim to:

- Assess the efficiency of the machine
- Establish a system for the machine
- Evaluate the productivity of the machine
- Monitor the robustness of the machine and its components
- Carry out basic economic analysis.

The machine was tested in fairly flat areas with old palms accessible by the three wheelers (Badang) during the peak season. We implemented three systems *i.e.*: (i) single operator (one-man operation) (ii) team of two (one operator and one helper) and (iii) team of three (one operator and two helpers). Based from the test results we found that the team effort of three was the most efficient system in terms of productivity compared to the single operator and team of two (*Table 2*).

Subsequently we carried out field trials and found that the productivity ranged from 1.4 to 1.7 tonnes per

TABLE 2. PRODUCTIVITY OF MECHANICAL LOOSE FRUIT COLLECTOR PER HOUR FOR THREE DIFFERENT SYSTEMS OF COLLECTION

Systems	No. of worker(s)	Productivity (kg/hr)
Single operator	1	40 - 60
Team of two	2	60 -100
Team of three	3	100-250

day. A sample productivity of the machine during the field trial is as in *Table 3*. It should however, be stated that the productivity depends on the skill of the operator and the factors below:

- Field condition - higher productivity in cleaner field
- Harvesting round and harvesting standard – the shorter the harvesting round and the lower the harvesting standard, the lower is the productivity as the machine has to travel further to collect loose fruits
- Palm height – the taller the palm, the lower the productivity as the machine has to cover bigger area due to scattering of loose fruits in bigger area.

Apart from that, we also found that the belt and the spring tensioner for the fan were the parts that experienced higher wear and tear. Another part that experiences the same problem was the suction hose. A small tear on the hose may cause loss of suction power and will reduce the productivity of the machine.

CONCLUSIONS AND RECOMMENDATIONS

The mechanical loose fruit collector, a machine designed for infield loose fruit collection has undergone exhaustive field trial. Based on a number of trials, we found that productivity per worker has increased meaning that we can anticipate a reduction in labour requirement and cost. The operation of the collector can be performed while standing thereby reducing fatigue. Other advantages include easy handling of the machine and the ability of collecting scattered loose fruits around the palm base even at a narrow angle and uneven surface. Minimal damage to the fruits during collection and little soil disturbance to minimize compaction are added advantages of this collector. In general, the collector works well in areas accessible to the machine and reduces the problem of loose fruits left uncollected. With the collector, it is envisaged that the recovery of loose fruits will be greatly improved.

To increase acceptance and wider use of the machine, PORIM and the manufacturer of the machine are continuously promoting the machine to the estates.

TABLE 3. PERFORMANCE OF MECHANICAL LOOSE FRUIT COLLECTOR.

Trial No.	No.of Bags	Time Taken (hrs)	bags/hr	kg/hr	tonnes/day
1	73	7.0	10.4	208	1.5
2	85	6.0	14.2	284	1.7
3	70	5.3	13.2	264	1.4
4	68	5.5	12.3	246	1.4
5	85	6.2	13.7	274	1.7
Average	76.2	6.0	12.8	255.2	1.5

Note:
Average bag weight = 20kg
Number of workers (1 operator + 2 sweepers) = 3

Apart from that, PORIM is putting more effort in improving the machine productivity by: -

- Redesigning the fan to improve the suction power.
- Introducing mechanical way of pre-collection operations.

From the commercial field trial, it was found that a higher suction power is required for higher production rate. This can be done by increasing the engine power. It is suggested that a closer look on other systems of collection should be considered so as to improve the systems of loose fruit collection.

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