BATTERY POWERED OIL PALM HARVESTING TOOL

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MPOB introduced the oil palm motorised cutter (*Cantas*) to the industry in 2007. *Cantas* is suitable for harvesting fresh fruit bunches (FFB) from palms up to 7 m harvesting height. *Cantas* increases harvesting productivity which improves harvesters' earning besides reducing workers on the payroll, currently dominated by foreign workers (Razak *et al.*, 2013).

Cantas (*Figure 1*) is a motorised cutter specifically designed for harvesting FFB and cutting fronds. It is powered by a small petrol engine and utilises either a specially designed C-sickle or chisel as the cutting knife. MPOB is the owner of the technology with patents filed in Malaysia, Indonesia, Thailand, Brazil, Costa Rica and Colombia. *Cantas* helps workers to speed up the harvesting operation thus increasing harvesting productivity.

Figure 1. Cantas *motorised cutter.*

PROBLEM STATEMENTS

The current *Cantas* utilises gasoline engine (petrol engine) which triggers some general concerns such as exhaust emission (smoke), vibration and heavy engine. The problems that are associated with the engine have prompted the initiative to look for other alternatives to address the issues.

Issues on the rising price of fuel and spare-parts also warrant other effective alternatives.

The work is also in line with the initiative in adapting a green tehcnology which is more environmental-friendly, good for the people and planet.

THE TECHNOLOGY

The technology is a motorised cutter powered by a battery.

The main objective is to develop a battery powered cutter which is cost-effective, ergonomic and environmental-friendly. Amongst other advantages of this technology are:

- No engine - thus no fuel, no lubrication oil (2T) and no spark plug
- Emision free (as it has no engine)
- Less noise
- Low vibration
- Lighter
- Low maintenance as less mechanical parts
- Requires less preparation work (does not need refueling, mixing petrol and 2T, checking spark plug *etc.*)

The novelty of the technology are described as follows:

- The use of electrical power in place of petrol engine. In this technology, the cutting device is activated by an electrical motor powered by a battery.

- The gear-box is placed at the bottom of the pole instead of at the top (as in the engine powered Cantas). This can bring down the point of centre of gravity of the pole which makes the handling of the tool is much easier and convenient for the operator. The gear box is used to convert rotational motion from the motor into a linear motion for the purpose of cutting.

The Prototype (*Figure 2*)
Specifications:

- Total length : 4.0 m.
- Total weight : 8.0 kg.
- Specific weight : 2.0 kg m^{-1}.
- Motor type : Brushless motor.
- Battery : 20 V high energy Lithium ion (direct current).
- Cutting Knife : C-sickle.

Figure 2. Battery powered Cantas.

Table 1 shows the technical specifications differences between the new technology (battery powered *Cantas*) and the prior art (engine powered *Cantas*).

FIELD TESTS

Battery durability test

Battery durability test is a test to examine how long the power (voltage) in the battery can last. It was conducted in the quality testing laboratory at MPOB. At the same time the motor and pole temperatures were also measured. *Figure 3* shows the battery voltage against time. From the original voltage of 20 V, it had depleted to 15.2 V after 235 minutes (4 hr) of running at a depletion rate at about 1.22 V per hour. As for motor temperature, it was almost consistent at an average of 55°C *i.e.* the normal operating temperature of the motor.

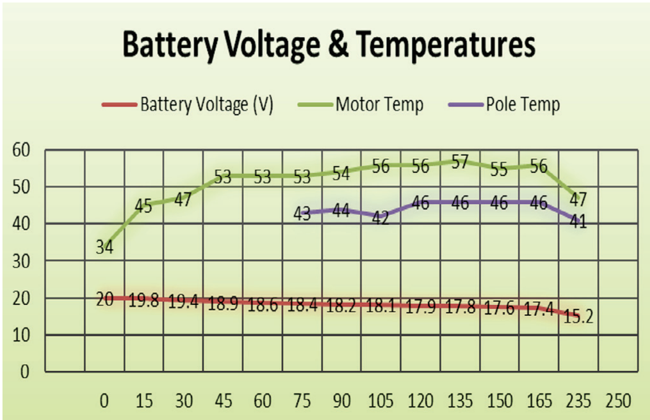

Figure 3. Battery voltage and motor temperature against time.

Vibration test

Vibration test was carried out to measure the magnitude of vibration transferred to the hand of the harvester. Vibrations were measured at two points *i.e.* at the throttle and at the pole, the point where the harvester holds the pole during harvesting (*Figure 4*).

TABLE 1. THE DIFFERENCES BETWEEN THE NEW TECHNOLOGY AND PRIOR ART

Descrption	New Technology (Battery powered *Cantas*)	Prior art (Engine powered *Cantas*)
Activator	DC Electrical motor	Petrol engine
Power source	DC Battery	Fuel (petrol)
Gear box placement	At the bottom of pole	At the top of pole
Transmission	Electrical	Mechanical – shaft and bearings
Cutting knife	Chisel & sickle	Chisel and sickle
Length (m)	4 m	4 m
Weight (kg)	8.0 kg	7.4 kg

Figure 4. Vibration measurement at throttle point (left) and pole point (right).

In the experiment, the magnitude of vibration was measured during cutting of frond. Dewesoft vibration equipment was used in this exercise.

Results showed that magnitude of vibration at the pole and throttle points were 1.3 and 0.8 m s^{-2}, respectively, proving that the vibrations were far below the threshold level *i.e.* 2.5 m s^{-2} (Hand Vibration At Work. User guide), indicating that the tool is safe to use within 8-hrs working a day.

Performance Test

The field test of the prototype was carried out by a smallholder at Banting, Selangor. The palms were about 2 to 5 m height and the topography was flat. Trial conducted showed that the average harvesting productivity was about 6 t FFB day^{-1} (5-hrs working a day), with the voltage depletion at about 1.06 V hr^{-1}.

ECONOMIC ANALYSIS

Manufacturer perspective

From the manufacturer perspective, the following economic analysis can be used as a reference if one were to start the business.

Internal rate of return (IRR)	: 28%.
Net present value (NPV)	: RM 970 350.
Payback period (PB)	: 4 yr.
BC ratio	: 1.36.

Assumption

Material cost	: RM 1 500 $machine^{-1}$.
Average production	: 50 units $month^{-1}$.
Working day	: 26 days $month^{-1}$.
Utilities and office	: RM 10 000 $month^{-1}$.
Equipment and machine	: RM 1 000 000.
Labour cost	: RM 105 day^{-1} (3 workers).
Operating cost per month (OPEX)	: RM 93 000.
Capital expenditure (CAPEX)	: RM 1 100 000.

User Perspective

From the user perspective, the fixed costs include the battery, motor, gear-box and pole while variable costs are labour, electricity (charging) and repair and maintenance. The operational cost per tonne FFB was calculated using a straight-line depreciation method. The details of the calculation are shown in *Table 4*.

Assumption

Machine selling price	: RM 4000 $unit^{-1}$.
Life span	: 2 yr.
Performance	: 6 t day^{-1}.
Labour cost	: RM 50 day^{-1}.

Therefore the operational cost per tonne FFB comes to about RM 9.81 (harvest only).

Nevertheless, the bottom line is that the industry is looking at the cost-effectiveness (CE) of the technology. The lower the CE, the more the technology will likely to be adopted by the industry. The cost-effectiveness is calculated by the following formulae (Stanners, 2002):

$$\text{Cost effectiveness (CE)} = \frac{\text{Tool or machine price (RM)}}{\text{Total bunches harvested (tonne FFB)}} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

= RM 4000/(6 t FFB day^{-1} x 300 day/yr x 2 yrs)

= RM 1.11 t^{-1} FFB or RM 0.016 $bunch^{-1}$ (average bunch weight: 15 kg).

Therefore, the cost effectiveness of battery powered harvesting tool is RM 1.11 t^{-1} FFB or RM 0.016 $bunch^{-1}$.

IMPACT

The introduction of such technology is expected to offer a significant impact to the industry and the country in-terms of increasing harvesting

TABLE 4. COST ANALYSIS OF BATTERY POWERED CANTAS USING STRAIGHT LINE DEPRECIATION

Description	Calculation	Cost (RM day^{-1})
Depreciation (price/(life span x 300 days)	4000/(2 yr x 300d)	6.67
Electricity (Charging)	2 hr x RM 0.22/ kWh x 2 sets	0.88
R&M cost @ 10% per year of purchase price	10% x 4000 / (300d)	1.33
Labour cost		50
Total		**58.88**
Cost per tonne = total cost/productivity	(RM 58.88 day^{-1}) / (6 t day^{-1})	RM 9.81 t^{-1} FFB

productivity and workers' income, reducing operational cost as well as workers requirement, besides adopting a green technology which is good for the environment.

IP STATUS

A patent application has been filed.

CONCLUSION

The introduction of this technology has brought the industry to move forward towards a green technology which is sustainable for the oil palm industry. This technology has numerous advantages such as more users and environmentally friendly, emission free, no petrol, less noise and vibration and more cost-effective.

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