Cantas™ – A TOOL FOR THE EFFICIENT HARVESTING OF OIL PALM FRESH FRUIT BUNCHES

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ABSTRACT

The Malaysian Palm Oil Board (MPOB) has developed a motorized cutter popularly known as Cantas™ *for harvesting fresh fruit bunches (FFB) at less than 4.5 m height.* Cantas™ *is a hand-held cutter powered by a 1.3 hp petrol engine.*

Trials carried out on Cantas™ *revealed that the productivity of the machine was 560 to 750 bunches per day (equivalent to 9.50 to 12.6 t day^{-1} at a bunch weight of 17 kg). The productivity very much depends on the cropping level, the topography of the estate and the operator's skills. By comparison, the productivity of manual harvesting (using a conventional sickle) is only 250 to 350 bunches per day (4.20 to 6.00 t day^{-1}). Therefore, the productivity of* Cantas™ *is equivalent to two to three human harvesters. Using* Cantas™*, the estate would be able to reduce 50% of its labour requirement in the harvesting operation. Another advantage of this cutter is that the terrain or topography of estates does not restrict its usage. Saving on fringe benefits amounts to RM 238 120 per year or RM 29 765 per person due to savings in housing, housing maintenance, levy, electricity and water bills, and medical leave.*

As for the economics of the machine, based on the machine cost of RM 4500 per unit plus its operational, repair and maintenance costs, the harvesting cost comes to about RM 22.10 t^{-1}. The cost-effectiveness was calculated at RM 0.70 t^{-1}.

Keywords: mechanical harvesting, mechanical cutter, motorized cutter, harvesting, oil palm.

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INTRODUCTION

A report by the Statistical Department of Malaysia reveals that up to December 2006, there were about 400 000 labourers working in oil palm plantations on various field operations. About 90% of these were foreign labour which accounted for about 360 000 workers. This is a very serious issue and should be addressed in order to reduce foreign labour in this country and at the same time to find ways and means on how to encourage local people to work in plantations. Harvesting uses about 60% of the work force and accounts for about 50% of production cost (Malek, 1993). To overcome these problems, mechanization of the harvesting activities need immediate attention, and this could be achieved through the introduction of efficient and economical mechanical harvesting technology (Wan Ishak and Zohadie, 1999).

Increases in labour productivity can be affected by many factors such as adoption of new technology, improvements in cultural practices, mechanized field operations and improving the quality of the workforce. Increased productivity can be measured in terms of labour requirement per hectare, or output obtained per worker. As the country is facing labour

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shortage, the introduction of field machinery would be one way of increasing the labour productivity (Tan, 1990).

Efficient harvesting of fresh fruit bunches (FFB) plays a vital role towards improving the quality of the harvested fruits. Harvesting of FFB from short palms (<3 m high) is a relatively a simple operation. A chisel attached to a short steel pole is normally used. The tool will be aimed at the target point (frond base or bunch stalk) at a very high speed to affect the cutting. The weight of tool coupled with the very high speed of chopping creates high momentum, which provides enough energy to cut through the frond or the bunch stalk (Abdul Razak, 1997). However, harvesting FFB from palms of more than 3 m height requires a different method and technique. In this situation, a long pole with a sickle at the end is used. Two activities have to be carried out: lifting the pole upright, and cutting the frond or/and fruit bunch. This operation demands that the operator be highly skilled in handling the tool and having enough energy to carry out the cutting operation (Abdul Razak *et al.*, 2003).

In the early days, bamboo was the most popular pole used for harvesting FFB from tall palms (Abdul Razak *et al.*, 1998). However, due to low productivity and scarcity of bamboo, other options had to be identified.

Realizing the problem, PORIM (now MPOB) developed an improved harvesting pole made of an aluminum alloy that gives it better strength and durability, and is lightweight, thus making it easy to handle (Rahim *et al.*, 1988; Abdul Razak *et al.*, 1998). This type of pole is now being widely used by estates.

One of the main focuses of MPOB is to develop an effective motorized cutter for palms of middle height (palms below 6 m height) in areas where the *Mechanical Harvester* (a harvesting machine developed by MPOB for palms of 6 to 12 m height) is not technically suitable.

This article highlights the development of the motorized cutter popularly known as *Cantas*™. It includes its design and field trials on the machine in commercial estates with the objective of evaluating its performance and providing recommendations to the industry.

PROTOTYPE DEVELOPMENT

The main objective of the project was to develop a motorized cutter with the following aims:

- developing an efficient cutter for cutting the frond and the fruit bunch;
- reducing the labour requirement in the harvesting operation;
- reducing the cost of production;
- increasing productivity per worker; and
- reducing the operator's efforts in executing the harvesting operation.

A good motorized cutter should have the following characteristics:

- ease of handling (by the operator);
- efficiency and speed in cutting;
- increases productivity (as compared to manual harvesting); and
- comfort in handling/ergonomic design.

Design Limitation Factors

There are two major factors that greatly influence the design of cutting devices and must be taken into consideration (Abdul Razak, 1997). These are:

- the fronds and bunch stalks are made up of fibre bundles that contain cellulose, which are difficult to cut; and
- the tight arrangement and limited space of fronds and fruit bunches on the palms leaves very little room for the tool to be placed.

Design Concept

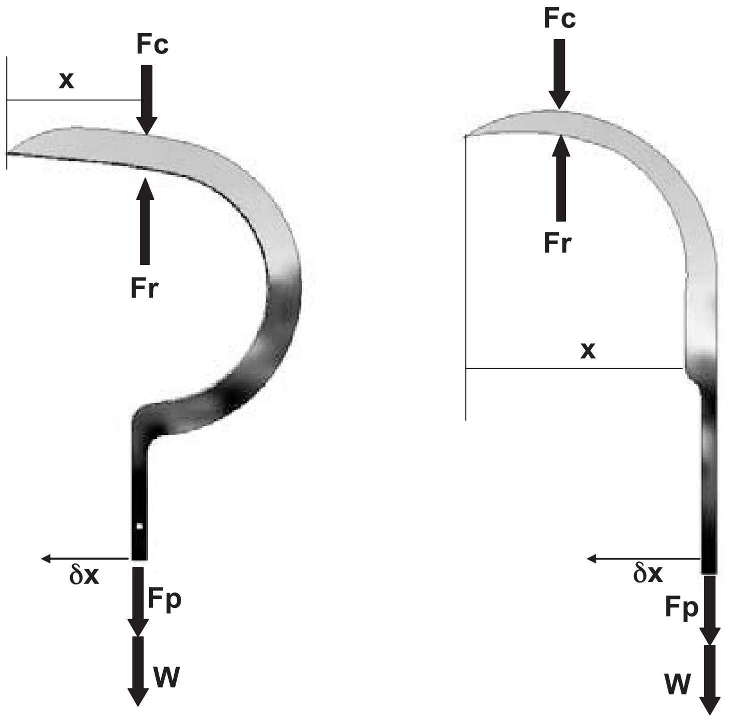
At present, a sickle attached to a pole is the normal tool used in harvesting FFB from mature palms. Although a number of cutting methods has been developed, none of them has been as efficient as cutting using a sickle. This is due to the fact that the sickle, with its unique design, could effectively get access to the fronds as well as the bunch stalks during the harvesting process (Abdul Razak *et al.*, 2003).

Thus, in this new design, the sickle concept is maintained, while the cutting action is executed mechanically.

Sickle Design

For efficient cutting, the sickle (*Figure 1*) has been designed with a 'C-shaped' profile. This profile has been found to be effective in providing efficient cutting as well as reducing the vibrations transferred to the operator during the cutting operation. It is called a 'C-sickle' which enables the cutting force (F_c) to act in-line with the reaction force (F_r), thus giving maximum cutting force (efficient cutting), and at the same time minimizing significantly the vibrations transferred to the operator. Cutting is performed when the sum of F_c, F_p and W is greater than F_r (*Figure 2*), as given in the following formula:

Figure 1. Profile of the C-sickle.



(a) C-sickle

(b) Conventional sickle

Figure 2. Forces acting on the C-sickle and the conventional sickle.

$$F_c + F_p + W > F_r \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where:

F_c = cutting force required to accomplish the cutting, N.

F_p = pulling force applied by operator, N.

F_r = reaction force, *i.e.* the force from the operator to counter the cutting force developed.

W = weight of tool, N.

x = the maximum distance where the point of F_c can be applied.

δx = the distance of point F_c from the sickle holder.

The vibrations which develop are due to the effect of the moment developed by the cutting force (F_c) and the distance of F_c from the sickle holder (δx), which means the greater the δx, the more vibrations will be developed. A greater vibration will result in a lower cutting efficiency and at the same time will transfer the vibrating effect to the operator. The magnitude of moment can be calculated by the following formula:

$$\text{Moment} = \sum_{0}^{x} F_c \,.\, \delta x \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Using Equation (2), it can be seen that cutting using a conventional sickle will generate a larger moment which generates a greater vibration, resulting in a lower cutting efficiency.

The shape and dimensions of the sickle were designed by considering the size of the frond and of the bunch stalk, and also the ease of cutting the frond or stalk with minimum cutting force.

The main components of the cutter (*Figure 3*) are the cutting head, telescopic pole and engine. The cutting head comprises a C-sickle, gear set, connecting-rod, head casing and cover. The telescopic pole comprises a basic pole and extension pole, telescopic shaft and bearings, while a two-stroke petrol engine of 1.3 hp is used as the power source. Most of the components are made of an aluminium alloy for its light weight.

The specifications of the machine are as follows:

- 2-stroke petrol engine
- Power : 1.3 hp
- Fuel capacity : 440 cm^3
- Maximum length : 3.6 m (telescopic)
- Total weight : 7.5 kg

and one hospital assistant. Thus, the ratio of staff to land is 1:31.5 ha. The total number of field workers is 222, consisting of 34 Malays (15.3%), 187 Indonesians (84.2%) and one Indian (0.5%). Thus, the worker to land ratio is 1: 11 ha.

Trial Plots

The trials were carried out in Block P97 which has 292 ha of oil palm planted in the year 1997. Block P97 was selected because the palms were at a height

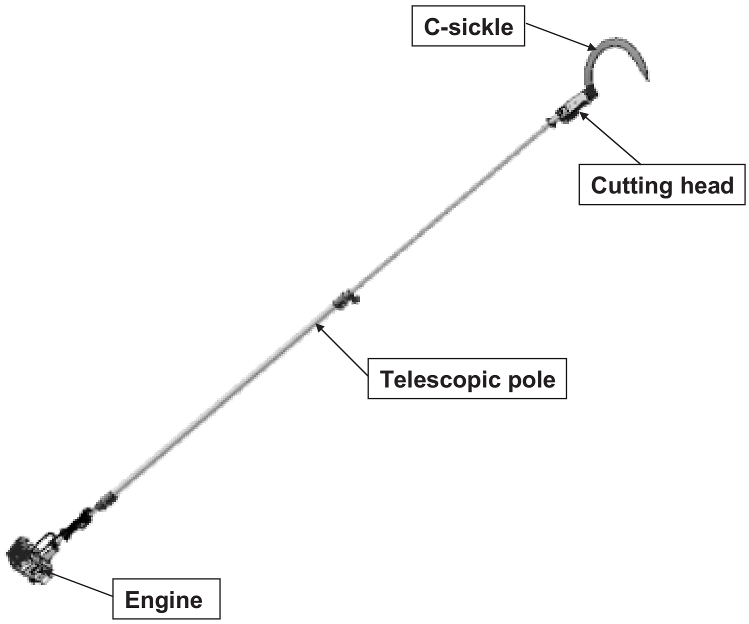


Figure 3. Motorized cutter, Cantas™.

MATERIALS AND METHODS

Tools Used

The manual sickle and motorized cutter (*Cantas*™) were compared in a few trials. The dimensions of the tools are shown in *Table 1*.

TABLE 1. DIMENSIONS OF TOOLS USED

	Manual sickle	*Cantas*™
Length (m)	4.0	3.6
Weight (kg)	6.0	7.5

Estate Background

The trials were carried out in Tereh Selatan Estate, an estate belonging to the Kulim Plantations Group. It is located in Mukim Paloh, Kluang, Johor, about 40 km from Kluang town. The estate was established in 1974 and now covers 2726.89 ha. Data on land use of the estate are shown in *Table 2*.

The estate is managed by a manager, four assistant managers, six field staff, three office staff

TABLE 2. LAND USE IN TEREH SELATAN ESTATE

Description	Area (ha)	Percentage of total (%)
Mature oil palm	1 967	72.13
Immature oil palm	622	22.81
Vacant land within fields	44.22	1.62
Nursery	5.19	0.19
Building sites and roads	21.59	0.79
Effluent ponds/reservoirs	8.78	0.32
Vacant land, unplantable	15	0.56
Total	2 726.89	100

suited for *Cantas*™ to be used, namely between 2.5 and 3.0 m. The yield profile for this particular block for the year 2006 is shown in *Figure 4*.

Harvesting System

Two systems were tested, *viz*. the *Cantas*™ system and the conventional manual system.

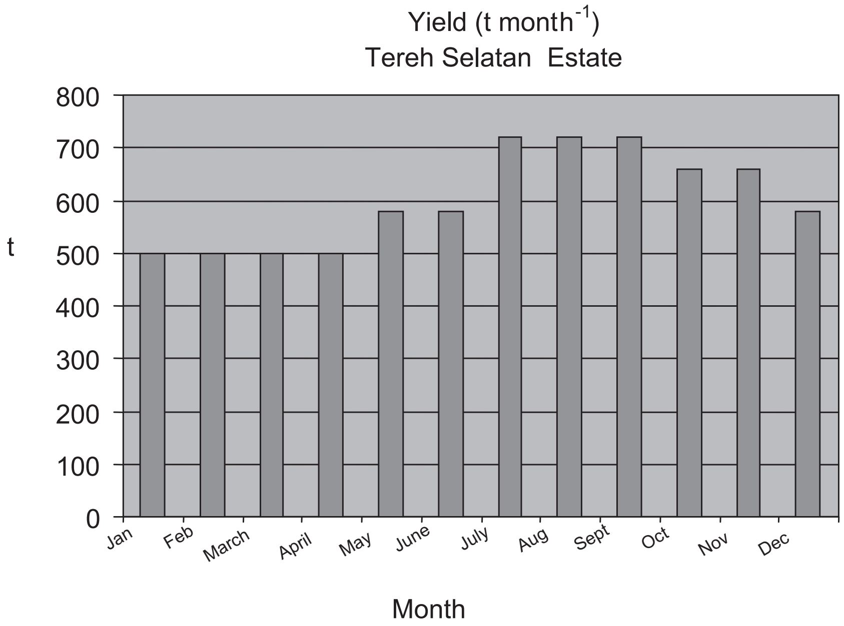


Figure 4. Yields (t month^{-1}) from Block P97 of Tereh Selatan Estate for the year 2006.

Cantas™ System

A team of four workers was formed to use the machine. One worker who operated the *Cantas™* only did the cutting job, while the other three workers did the stacking of fronds, collected loose fruits, cut long stalks and loaded FFB onto the buffalo cart. The FFB were transported using a buffalo hitched to a half-tonne cart. The team was paid at RM 20 t^{-1} of FFB harvested, and the income was divided equally among the four workers.

Manual System

A team of two workers was formed, with one worker (equipped with the conventional sickle on a long pole) cutting FFB, stacking fronds and cutting long stalks, while his helper collected loose fruits and loaded FFB onto the buffalo cart. Similar to *Cantas™* system, payment was at RM 20 t^{-1} of FFB harvested, and the income was divided equally between the two workers.

FIELD EVALUATION

Time and Motion Studies

Time and motion studies (TMS) on the two systems were carried out to compare the time taken for the cutting operation by the two methods, *i.e.* manual *vs. Cantas™*. Specifically, it was the time taken by the worker to cut fronds and bunches from one point to another. In the studies, the time was recorded when the worker started cutting from the first palm on the first row until the last palm on the second row (*Figure 5*). Referring to *Figure 5*, the operator would start the cutting from point A and finish at point B, and then continue from point C and ending at point D. At the same time, the number of FFB harvested and total number of palms visited was also recorded.

Field Trial

Tereh Selatan Estate has started using *Cantas™* since January 2006, and uses this mechanized cutter on 292 ha of the area under maturity. In 2006, two units of *Cantas™* were in use with a total labour force of eight workers. The manual sickle was previously used in this particular area. Data on productivity, labour requirement and cost were compared between the *Cantas™* and manual sickle systems for the period from January to December, but in different years. As the trials were made in the same block (P97), data for *Cantas™* were collected from January to December 2006 and compared to data from the use of the manual sickle which had been recorded from January to December 2005. The previous system (manual sickle) required 16 workers.

Trial Procedures

In the trial, two team of four workers each were formed. One worker in each team did only the cutting, while his team members did the frond stacking, collection of loose fruits, cutting of long stalks and loading the FFB onto the buffalo cart. Data on the number of FFB cut, total working hours and fuel consumption per day were recorded. At the same time, costs of repair and maintenance were also recorded.

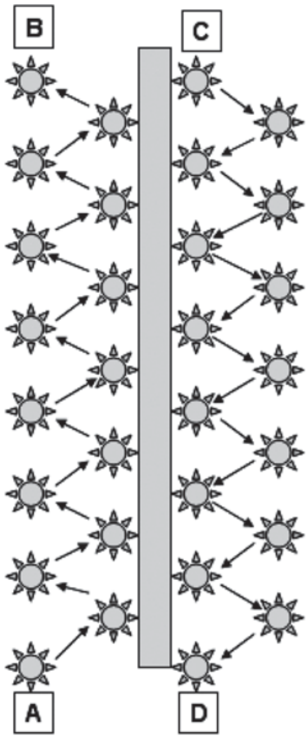


Figure 5. Working procedure of the operator.

RESULTS AND DISCUSSION

Time and Motion Studies

Tables 3 and *4* show the results of the TMS using the manual and *Cantas*™ systems, respectively.

With the daily working hours totalling about 7 hr using the manual system, the effective working time was only 255 min (4.25 hr day^{-1}). The average productivity per hour was about 50 bunches, while the total FFB harvested per day was 214 bunches (3.60 t) or 107 bunches per man-day (1.80 t per man-day) (*Table 3*). By contrast, in the *Cantas*™ system (*Table 4*), the daily working hours totalled 10 hr with an effective working time of 449 min (7.5 hr day^{-1}). The average productivity per hour was 75 bunches, while the total FFB harvested per day was 561 bunches (9.50 t) or 140 bunches per man-day (2.40 t per man-day).

The studies revealed that the daily productivity using *Cantas*™ was 163% higher than that when the manual sickle was used, while individual productivity of *Cantas*™ team was 31% higher than the manual team. This shows that workers in *Cantas*™ team would also get 31% higher income compared to workers in the manual team (*Table 5*).

TABLE 3. TIME AND MOTION STUDY ON THE USE OF THE MANUAL SICKLE FOR HARVESTING

Time in	Time out	Total time (min)	FFB	Palms	Time/FFB (min)
8.00 am	8.40 am	40	30	40	1.33
8.50 am	9.20 am	30	17	40	1.76
9.30 am	10.00 am	30	25	40	1.20
10.00 am	10.30 am	break	-	-	-
10.30 am	1.00 am	30	23	40	1.30
11.05 am	11.35 am	30	30	40	1.00
11.40 am	12.15 pm	35	29	40	1.20
12.15 pm	3.00 pm	break	-	-	-
3.00 pm	3.30 pm	30	25	40	1.20
3.30 pm	4.00 pm	30	35	40	0.86
Total		255	214	320	-
Average		FFB hr^{-1} = 50			1.23

TABLE 4. TIME AND MOTION STUDY ON THE USE OF THE *Cantas™* FOR HARVESTING

Time in	Time out	Total time (min)	FFB	Palms	Time/FFB (min)
8.05 am	8.52 am	50	47	40	1.06
8.52 am	9.32 am	40	53	40	0.75
9.32 am	10.12 am	40	51	40	0.78
10.12 am	10.54 am	42	49	40	0.86
10.54 am	11.15 am	break	-	-	-
11.15 am	11.51 am	36	48	40	0.75
11.51 am	12.28 pm	37	48	40	0.77
12.39 pm	2.30 pm	break	-	-	-
2.37 pm	3.18 pm	41	56	40	0.73
3.18 pm	3.57 pm	39	53	40	0.74
3.57 pm	4.41 pm	44	54	40	0.81
4.41 pm	4.55 pm	break	-	-	-
4.55 pm	5.36 pm	41	51	40	0.80
5.36 pm	6.15 pm	39	51	40	0.76
Total		449	561	440	-
Average		FFB hr^{-1} = 75			0.80

TABLE 5. COMPARISON OF MANUAL *vs.* *Cantas™* SYSTEMS

Description	Manual	*Cantas™*	Difference	% difference
Daily working hours (hr)	7	10	+ 3	+ 42
Effective working time (hr)	4.25	7.50	+ 3.25	+ 76
Average FFB hr^{-1}	50	75	25	+ 50
FFB day^{-1} $team^{-1}$	214	562	348	+ 163
FFB $man\text{-}day^{-1}$	107	140	33	+ 31

The studies also revealed that using *Cantas™*, the operator could conserve his energy, thus prolonging the working time to 10 hr a day, whereas when using the manual sickle the harvester could only work 7 hr a day. In terms of the effective working time, the operator using *Cantas™* was able to work an extra 3.25 hr compared to when using a manual sickle although the two teams started at the same time, *i.e.* at 8.00 am. *Cantas™* workers stopped at 6.15 pm, while the manual team stopped at 4.00 pm.

Comparison of Times Taken to Cut a Bunch

Figure 6 shows the comparison of times taken to cut a fruit bunch by the *Cantas™* system and by the manual system. The graph shows that the average times taken to cut a bunch were 1.23 min FFB^{-1} and 0.78 min FFB^{-1} for the manual and *Cantas™* systems, respectively, which means cutting with *Cantas™* was 37% faster than with the manual sickle.

Field Trial

With two teams of four workers each (total of eight workers) covering an area of 292 ha, the ratio of worker to land was 1:37 ha, while the ratio of *Cantas™* to land was 1:146 ha. In other words, one unit of *Cantas™* can serve 146 ha of plantation area.

Table 6 shows the comparison of the *Cantas™ vs.* the manual systems in terms of labour reduction, worker to land ratio and cost of harvesting. Labour requirement was reduced from 16 to only eight (50% reduction) workers, worker to land ratio was increased from 1:18 to 1:37 ha (105%) while the productivity increased from 4.19 to 11.6 t FFB day^{-1} (176%).

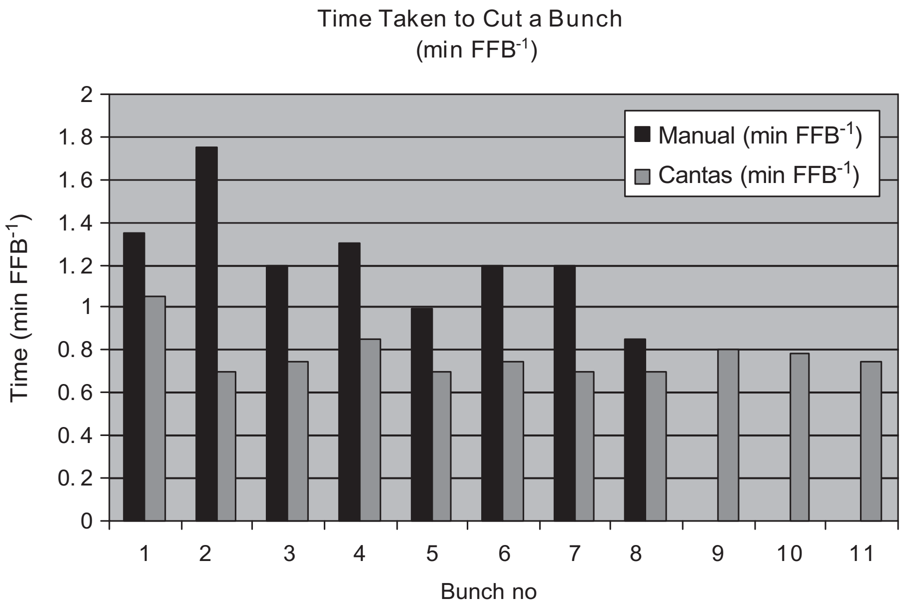


Figure 6. Comparison of times taken to cut a bunch by Cantas™ vs. *manual sickle.*

TABLE 6. COMPARISON BETWEEN THE *CANTAS™* AND MANUAL SYSTEMS

Field	Description	Manual	*Cantas™*	Difference	% difference
P97	Hectare	292	292	0	0
	Total workers	16	8	-8	-100
	Worker ratio	1:18	1:37	+1:19	+105
	Productivity (t day^{-1})	4.19	11.60	+7.41	+176

ECONOMIC ANALYSIS

Cost-effectiveness

Cost-effectiveness is measured in terms of the total FFB harvested for the period of its economic life against the price of the tool (Stanner, 1992), as in the following equation:

$$\text{Cost effectiveness, Ec} = \frac{\text{Machine price}}{\text{Total FFB harvested}} \quad \text{.... [4]}$$

The following assumptions were made:

	Sickle/pole	*Cantas™*
Machine price, M	RM 200	RM 4 500
Economic life, E	6 months	2 years (24 months)
Productivity, P	300 FFB	560-750 FFB day^{-1} (9.5-12.8 t day^{-1})
Labour cost, Lc	-	RM 20 t^{-1}
Working days per month	23	23

Cost-effectiveness of the conventional sickle/pole and *Cantas™* were calculated to compare the cost per bunch harvested. With the same manpower, the cost of the tool can be determined over the period of usage.

For sickle/pole (manual):
Total number of bunches harvested
= 6 months x 23 days x 300 bunches
= 41 400 bunches
Cost-effectiveness = RM 200/41 400
= RM 0.005/bunch x 58 bunches t^{-1}
= **RM 0.29 t^{-1}**

For *Cantas™*:
Total number of bunches harvested
= 12 months x 2 years x 23 days x 650 bunches
= 58 800 bunches
Cost-effectiveness = RM 4500/358 800
= RM 0.012/bunch x 58 bunch t^{-1}
= **RM 0.70 t^{-1}**

To determine the cost of harvesting (based on actual data collected from January to December 2006):

$$\text{Depreciation: } \frac{\text{RM 4500}}{\text{2 years}} = \text{RM 2250 yr}^{-1}$$

Total FFB harvested (Jan-Dec 2006)	= 81 763 bunches
Total tonnage	= 1390 t
Total working days	= 170 days
Total working hours	= 1301 hr
Total repair and maintenance costs	= RM 418
Total fuel	= RM 263
Total labour cost	= RM 27 800
Depreciation	= RM 2250
Total cost	= RM 30 731
Therefore **cost per tonne**	= RM 30 731 / 1390 t
	= **RM 22.10**

Fringe Benefits

The use of *Cantas™* in Block P97 has reduced the work force by eight workers. *Table 7* shows the savings in fringe benefits in a year as a result of a reduction of eight workers.

TABLE 7. SAVINGS IN FRINGE BENEFITS PER YEAR

Description	Cost/unit (RM)	Number of units	Total cost (RM)
Housing (unit)	30 000	2	60 000
House maintenance (unit)	500	2	1 000
Levy (person)	540	8	4 320
Bills – electricity, water (person)	50	8	4 800
Medical leave* (person)	812	8	168 000**
Total			238 120

Note: *Medical leave granted by the MAPA/NUPW agreement is a maximum of 14 days per year.
** This is equivalent to: 14 days per year x 3 t FFB per person x 8 persons x RM500 t^{-1} FFB = RM 168 000.

Thus, the estate will be able to reduce its operational cost by as much as RM 238 120 per year which comes to about RM 29 765 per person per year.

Commercialization

An initial budget of RM 195 000 was approved by MPOB to start up the business of manufacturing the *Cantas™* cutter. To encourage and promote the wide use of this technology in the plantations, MPOB decided to sell the cutter at the material cost price (*i.e.* RM 3000 per unit). Later, two companies have been appointed to manufacture and market *Cantas™*, namely Jariz Technologies Sdn Bhd for Peninsular Malaysia and Saplantco Sdn Bhd for Sabah and Sarawak. Jariz Technologies has delivered 78 units to FELDA Plantations Sdn Bhd, while Saplantco Sdn Bhd has supplied more than 500 units to Borneo Samudera Sdn Bhd (BSSB) and other estates in Sabah and Sarawak.

The technology has won five awards, *viz*. *The Very Best Award* and gold award in the Malaysian Technology Expo (MTE 2006) held at PWTC in February 2006, and a silver medal at I-TEX 2005 at the same place in May 2005. It has also won a bronze medal in the International Exhibition of Inventions of Geneva 2007. The most recent award received was the *MPOB Gold Award 2007*.

The technology has also been patented in seven countries, *i.e.* Malaysia, Colombia, Costa Rica, Philippines, Brazil, Indonesia and Thailand.

Potential Market and Income Generated

Table 8 shows the expected labour reduction with the use of *Cantas™* and sales volume for this tool in Malaysia. It is estimated that a reduction by 60 000 workers could be attained (60% saving) with a total saving of approximately RM 0.5 billion a year.

The sales volume would be about 20 000 units per year with the total gross income of RM 90 million (based on the sale price of RM 4500 per unit). Taking 5% in royalty earnings, MPOB will earn approximately RM 4.50 million per year from the sale of this product. *Table 8* also shows labour cost savings as a result of using *Cantas™*.

GENERAL DISCUSSION

Based on the trials conducted, *Cantas™* is very effective and practical for use on palms below 4.5 m in height. Less manual energy is required in harvesting, hence allowing the operator to prolong his working hours, and therefore increasing his productivity and daily income. Trials have also proven that the machine is technically sound with only some minor modifications are required to overcome some weaknesses such as durability of parts to improve the overall efficiency.

Using *Cantas™*, the labour requirement was reduced from 16 to only eight workers (50% reduction), worker to land ratio was increased from 1: 18 to 1: 37 (105% increase), and worker productivity increased from 4.19 to 11.6 t day^{-1} (176% increase).

Cost-effectiveness of the *Cantas™* system was found to be higher (RM 0.70 t^{-1}) as compared to the conventional manual system (RM 0.29 t^{-1}). However, with *Cantas™*, at least 50% of the field workforce could be reduced. This reduction in number of workers would reflect in the current dependence on foreign workers; thus, much savings in terms of hidden costs could be made, such as levy, housing,

TABLE 8. ESTIMATED LABOUR REDUCTION AND COST SAVINGS USING *Cantas™*

Total planted area of oil palm in Malaysia	4.0 million hectares
Cantas™	-
Assuming 50% area suitable for *Cantas™*	2.0 million hectares
Total number of harvesters required *Cutting performance: 50 ha per harvester using Cantas™*	2 000 000/50 ha = 40 000 men
No. of units *Cantas™* required per year *Cantas™ life span: 2 years*	40 000/2 years = 20 000 units per year
Total income from sales (RM) *Sales price : RM 4500/unit*	20 000 units x RM 4500 = RM 90 million per year
Royalty @ 5% to MPOB	5% x RM 90 million = RM 4.5 million per year
Manual Sickle and pole	
Assuming 50% palms below 5 m height	2.0 million hectares
Total number of harvesters required *Cutting performance: 20 ha per harvester using sickle and pole*	2 000 000/20 ha = 100 000 men
Savings	
Labour reduction Manual – *Cantas™*	100 000 – 40 000 = 60 000 men **60% reduction in workforce**
Total money saved from reduced workforce	60 000 workers x 23 days per month x 12 months per year x RM 30 per day= RM 496 800 000 (approx. RM 0.5 billion) **RM 0.5 billion in savings !!!**

utility bills and so on. Other issues such as social problems with foreign labour could also be minimized.

Cantas™ is well accepted by the industry where its productivity and performance has been very satisfactory. Future development can be made based on the current model. It is envisaged that this machine will lead to new technology aimed at developing a cost-effective, mechanically-assisted harvesting system that is more acceptable to the oil palm industry.

It is important to mention that the worker's attitude is a prime factor in making the trials a success, followed by the estate management itself. In some estates where the acceptance of the machine by the operator has been very encouraging, the productivity is higher as compared to estates where the operators are not receptive to the technology. Operators who are committed do take care of the machines and therefore less breakdowns were observed.

The combination of hardware and software is very crucial to the success of any new invention. In this case, the hardware is the machine itself and the software is the attitude of the operator and the system used, as well as the commitment from the estate management. A good combination of these two will be the main factor in successful mechanization.

CONCLUSION

The use of *Cantas™* has been proven to increase productivity in harvesting FFB, and also to reduce worker's fatigue. The introduction of *Cantas™* to the industry recently has, to some extent, opened up a new perspective in mechanization of the harvesting operation. This machine conserves the energy of workers during the cutting operation, thus prolonging their working hours. FFB from palms less than 4.5 m high can be efficiently harvested. Besides cutting FFB, the machine was found to be very effective in the frond pruning as well. The productivity of the worker can be maximized over time as his skill in handling the machine improved. Using *Cantas™*, an operator could harvest 560 to 750 FFB day^{-1}, which is equivalent to two to three manual workers using the conventional sickle and pole. *Cantas™* was well accepted by the operators due to its high efficiency, ergonomic design (which offers comfortable handling), ease of operation and its being safe to use.

The limited height of reach, however, is a limitation in this current technology. Therefore, MPOB has developed motorized cutters with longer reach known as *Cantas5*, *Cantas6* and *Cantas7* which have the total reach of 5, 6 and 7 m, respectively. As an extra benefit, it is recommended that the machine is used not only for harvesting FFB, but also as a pruning tool. With good maintenance and care, it is envisaged that the machine would be more cost-effective in the long run.

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REFERENCES

ABDUL RAZAK JELANI (1997). *Design and Development of an Oil Palm Fresh Fruit Bunch Cutting Device*. M.Sc thesis. Universiti Putra Malaysia. Unpublished.

ABDUL RAZAK JELANI; AHMAD HITAM; ABDUL RAHIM SHUIB; JOHARI JAMAK and MALIK MOHD NOR (1998). The effect of physical characteristics of the harvesting pole on the harvesting productivity. *PORIM Bulletin No. 36*: 13-20.

ABDUL RAZAK JELANI; RAHIM, A S; AHMAD, H; JOHARI, J and MALIK, N (2003). Hand-held mechanical cutter. *MPOB Information Series No. 180*.

MALEK MANSOR (1993). Economic of mechanization in oil palm cultivation in Malaysia. Paper presented to the Technical Advisory Committee. 6-7 December, 1993, PORIM. Kuala Lumpur.

RAHIM, A S; HALIM, H and AHMAD, H (1988). Development of harvesting machine. *Proc. of the National Oil Palm/Palm Oil Conference*. Kuala Lumpur. 11-15 October 1988. p. 1-7.

STANNER, G H (1992a). Investigating the true cost of conventional harvesting tools. Paper presented at the Eastern Plantation Agency Bhd Seminar. *The Planters Vol. 68*: 485 - 497.

TAN, B T (1990). Trends in labor wages and productivity in oil palm cultivation. Paper presented at the MOPGC/PORIM/ISP workshop on 'An Agenda for Research into Further Mechanization of Oil Palm Estates in Malaysia'.

WAN ISHAK WAN ISMAIL and ZOHADIE, M B (1999). Automation and robotic in agriculture: with special reference to the oil palm industry. *Proc. of the PORIM International Palm Oil Congress*. Kuala Lumpur.