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DEVELOPMENT OF AN IMPROVED MOTORISED CUTTER FOR HARVESTING OIL PALM FRESH FRUIT BUNCH

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ABSTRACT

Currently, Oil palm is one of the important crops that has being cultivated to develop the economy of Malaysia. The maximum economic potential from this crop can be achieved by increasing the usage of mechanization. Harvesting fresh fruit bunch (FFB) is one of the activities conducted in oil palm plantation. However, there are some barriers like effortless and skilled labour shortage as well as weight of the old cutter called Cantas facing the whole process. A newly developed motorized cutter has been adopted to overcome the barriers faced by Cantas. The new design consisted of Flexible shaft drive which was installed between a gasoline engine and the pole. The productivity for the new motorized cutter was 39.4% better than the manual cutting method for harvesting FFB. Moreover, the new design reduced the weight of the harvesting pole from 7.5kg to 6.5kg which subsequently decreases the fatigue on the manual labour.

KEYWORDS

Harvesting FFB, Motorized Cutter, Agricultural Mechanization. Flexible Transmission System.

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INTRODUCTION

Agriculture industry is one of the important economic sectors which can increase income for governments and countries (Nur et al.,2014). Development of countries in Asia and Africa largely depend on technology applied and the agricultural mechanization which take place in the agricultural sector (Onwude et al., 2016). Malaysia is now becoming one of the industrialized countries, though agriculture is still an important area in its economy.

Agricultural mechanization is a mechanical system that implements the principles of agricultural engineering to reduce dependence on human effort. In addition, agricultural mechanization works to reduce the health and material risks that may be experienced by workers in agricultural field (Norzan et al.,2014).

Vegetable oil plays a role in food consumption and economic growth. The increase in human consumption of vegetable oil due to population growth and expansion of economic growth of developing countries is one of the main reasons why the global demand for vegetable oils is increasing (Mahat, 2012). Oil palm tree (*Elaeis guineensis Jacq*) does not have branches, but it has many wide and long leaves with stalks called fronds. The rapid expansion in oil palm cultivation has resulted in a corresponding 17,200 metric tons of crude palm oil in 2014 (Otieno et al., 2016). Now Malaysia is the second largest producer of palm oil in the world. In order to maintain and increase production capacity, palm fruit harvesting must be made sustainable. (Yusoff et al., 2014).

Agricultural activities in palm oil plantations can be summarized by four main activities: Cutting and stacking the fronds, cutting the fresh fruit bunch (FFB), collecting the loose fruits, and evacuating FFB and loose fruits (Jelani et al., 1998).

Since the last three decades many harvesting machines have been developed and innovated by Malaysian universities or research institutes such as Malaysian Palm Oil Board (MPOB), Federal Land Development Authority (FELDA) and agriculture machine manufacturer in this sector (Norzan, 2014). All these machines were aimed to resolve the problems of harvesting and evacuation of the fruits of palm oil in Malaysian plantation areas. The objectives of these earlier attempts were to reduce the numbers of labor involved, reduce effort, and cost of production as well as increase productivity.

This paper focusses on the development of a harvesting machine using flexible shaft through motion time for pruning fronds, cutting FFB and its comparison with the manual cutting tool.

MATERIALS AND METHODS

The experiments were carried out by using the new concept of harvesting machine to prune fronds and harvest the FFB. The specifications for the motorized cutter with the new transmission system are summarized in Table 1. The concept is to reduce the weight of the machine by separating the gasoline engine from the pole and utilizing the flexible shaft drive (FSD) to transmit the movement and the power from the engine to the telescopic shaft inside the pole. This will reduce the weight for the machine because the engine itself weighs about 4.5kg, while the FSD with a protective outer casing weighs about 2.4kg. The FSD itself is an instrument for transmitting rotary motion between two objects which are not fixed relative to each other. It consists of a rotating wire rope or coils which are 3-7 layers flexible but has some torsional hardness. Usually it has a covering (casing), which also bends but does not rotate. The FSD may transmit considerable power, or only motion, with negligible power. The concept of using several layers is to make the cable shaft hard enough against torsion and flexible at the same time see Figure (1). Moreover FSD can transmit the torque with speed from 4000 to 20,000 rpm (Bell, 1971). The FSD was joined to a long shaft by aluminum bush, locked and fixed to the casing through screws.

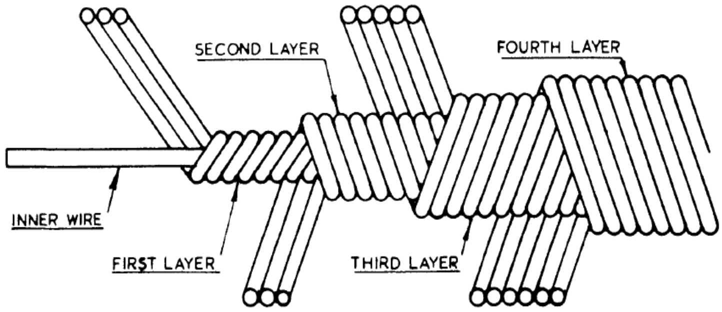

Figure 1: Flexible shaft drive structure source (Bell, 1971)

A six-bush connector was used to attach the casing of the FSD to each other (Figure 2). These parts were fixed to the ends of the flexible casing by screw. A special connecting piece was utilized to connect the FSDs together. The pole and the bevel gearbox at the end of the pole and the sickle are similar to the Cantas (motorized cutter produced by MPOB). A gasoline engine was used to operate the machine (Figure 3). The engine was put on a mini tractor Kubota L 2800 during the test.

Table 1 Specifications for development of motorized cutter

Work speed, RPM	Total height reachable, m	Type of engine & horse power, (hp)	Type of knife	Type of transmission system	Note
5000-9000	4-5 with human body	Backpack gasoline engine 2T and 1.5hp	Sickle MPOB design	Flexible shaft drive 5 layers; L 38”; Ø8 mm; head square shape 7χ7 mm	6 pieces joined together to make one long shaft 5.7 meter

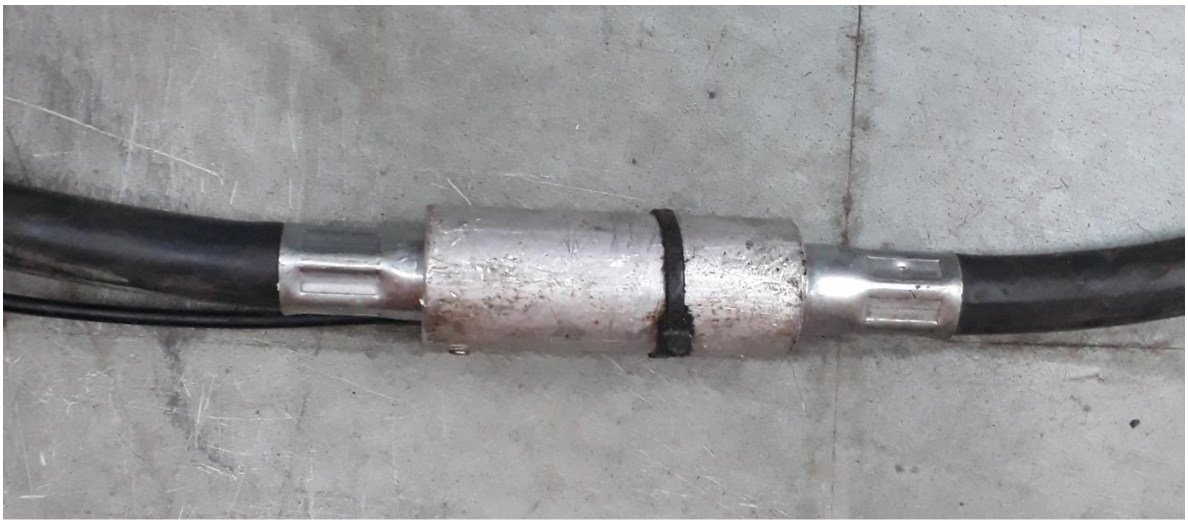

Figure 2: The connecting bush between the flexible shaft drive

The motorized cutter was tested in Banting oil palm plantations. The total weight for the motorized cutter with the new transmission system was 6.5kg, 1kg less from the existing motorized cutter (Cantas). The oil palm trees were 8-11 years old and the average heights of trees were 3-5 meters. The method of test was to prune the fronds and then cut the fresh fruit bunch FFB and calculated the time for both processes. The results for both mechanical and manual harvesting techniques were analyzed to determine the time taken for each harvesting method.

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Figure 3: Honda backpack 1.5hp engine

DISCUSSION

The motorized cutter using new transmission system showed good results in time of motion and it was significantly reduced by 11.1s than the manual cutting using aluminum pole with sickle. The actual time for harvesting using the developed motorized cutter was 17.1s, while time of cutting for manual tool was 28.2s (Figure 4). Table 2 shows the ANOVA table on time and motion studies for both harvesting methods.

Table 2: The ANOVA analyses for time and motion studies to harvest the FFB by Mechanical and Manual methods.

Source	Sum of Squares	DF	Mean Square	F	Sig.
Corrected Model	616.050	1	616.050	24.835	*
Intercept	10260.450	1	10260.450	413.635	*
Harvesting technique	616.050	1	616.050	24.835	*
Error	446.500	18	24.806		
Total	11323.000	20			
Corrected Total	1062.550	19			

Based on the results obtained, productivity increased by 39.4% using the newly developed motorized cutter with the transmission system FSD as compared to the manual harvesting tool (Table 3). The newly developed motorized cutter was good in maneuvering and fast in cutting action.

Table 3 Results for both mechanical and manual methods.

Harvesting technique	Mean	Std. Deviation	N
Mechanical	17.10	3.510	10
Manual	28.20	6.106	10
Total	22.65	7.478	20

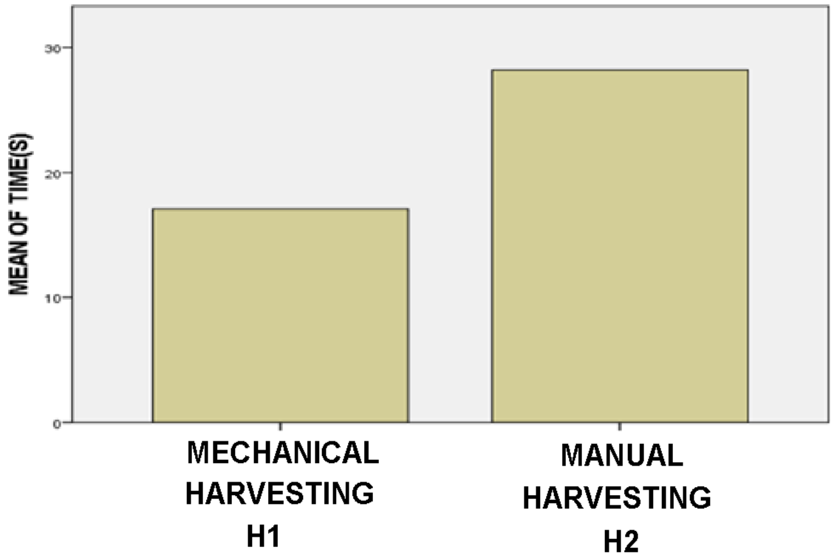

Figure. 4: The difference in time motion studies for both Mechanical and Manual harvesting methods.

CONCLUSIONS

The newly developed and improved motorized cutter decrease the time consumed for pruning fronds and cut FFB by 11.1s. Hence the productivity is expected to be increased by 39.4%. Moreover, the strain worker need to bear to complete the harvesting process will be less than the manual harvesting method required because the weight of the improved motorized cutter is less than the existing one by 1 kg and easy to handle.

RECOMMENDATIONS

The newly improved motorized cutter can be developed further to be more reliable by:

1. Utilizing a long piece of flexible shaft drive as one part instead of 6 pieces of FSDs. Thereby it will be much lighter and easy to maintain.
2. Using a different power source from the vehicle that the farmers normally use such as power wheelbarrow or mini tractor, from flywheel of the engine or PTO shaft as mechanical power source or through hydraulic system with hydraulic motor as power source or even pneumatic system thus reducing the fuel consumption and pollution instead of using two engines (one for the vehicle, and another for the motorized cutter).
3. Using the motorcycle engine as power source as it will be so economic, reliable, useful and fast. The FSD with the pole can be connected to the motorcycle engine during field operation and it can be disconnected when travelling in the plantation area.

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