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Conceptual Design of Toughfar Oil Palm Loose Fruits Separator Machine

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***Abstract* – Toughfar Loose Fruit Sieve (TFLS), is an attempt to transform Loose Fruit (LF) collecting concept. TFLS main objective is to 'collect' the whole LF after cutting the Fresh Fruit Bunch, FFB. All loose fruits shall be collected and 'cleaned' simultaneously thus, eliminatory the LF dirty and low quality before sending to mill. A major factor considered during TFLS development is the adaption of sieving technology in the market into a potential and workable solution of collecting LF. In this concept, a three-wheeler, Toughfar as the prime mover and sieving working principle is integrated into Toughfar, the TFLS. This machine functioning as collect and clean LF, but also ensures the stability in various ground topography. TFLS will ensure the quality of LF in 100% good condition in oil extraction rate (OER) and also promised an LF processing without trash such as stone, soil, debris and anything which effect a hygiene quality in the milling process. From fact, a high quality of crude palm oil will produce a premium oil. At the side of milling FFB, a lot of energy and labour will be saved because no trash/dirt process with FFB and FFB processed in optimum energy consumption.**

***Keywords* – Loose Fruits Palm Oil, Toughfar Machine, Harvesting FFB, Dirt, OER and Cost.**

I. INTRODUCTION

Oil palm harvesting work will increase if the harvesting cycle is not achieved as planned. This is because many fruits are loose due to delay in fresh fruit harvesting (FFB). Abdul Razak informed that loose fruit found at the base of palm oil makes up about 3% -5% of the group weight [1]. Large quantities of loose fruit will delay the harvest, manually loosening the fruit collection by selecting or clapping. Kamarudzaman, A stated that the high percentage of debris collected in loose fruit using the scraping method was reduced to an acceptable level due to the poor quality of the collected fruit [2]. Several machinery prototypes have been built to facilitate the collection of loose fruits scatted around palm base because an impact and FFB ripeness. Ganreported that the average time spent to collect the fruits by hand was three minutes and this was five times the time taken to cut a fresh fruit bunch [3]. Thus, most workers did not collect the loose fruits. Loose fruits are found not only in the fields but also at the unloading ramp. Human labour is employed to pick these fruits by hand. In 2012, Abd Rahim et al, developed loose fruit collecting machine using vacuum suction concept, loose fruit are sucked into conical shape towards its bottom [3]. The cylindrical shape creates a cyclone atmosphere one the fruits are sucked, with minimal bruising to the fruit. As the fruit circulate with the barrel/chamber, the heavier fruits fall to the bottom of barrel (as it loses energy) with the lighter material such as dried leaves will be sucked out of the system. Azali. A, explained how the loose fruit scatter at palm base [5]. Figure 1 show when harvesting FFB, Loose fruit will be scatted around 1.5m to 2.5m. Loose fruit will collected using racking, scrapper and net. Below show conventional equipment use to collect loose fruit.

Fig. 1. Loose fruits scatted around palm base.

Nowadays, the loose fruits will be collected manually. All the loose fruits of the relay will be ‘cleaned by 'rack'. Loose fruits are currently collected by hand picking or raking. This technique is not only labour demanding, and time-consuming but also is tedious and laborious. The workers need to squat and stand up thorough out the day during the collection process. This action contributes to their tiredness. Furthermore, by raking the debris collected can be as high as 60% by weight. It was estimated that time taken to collect loose fruits is about 30% of the total fruit handling time. The average productivity of each operator is 200 kg to 250 kg of fruits day-1 depending on various factors. The figure 2 below shows how the loose fruits are collected.

Fig. 2. Loose fruits in collecting process.

Azali.A, also showed a trash contain in every collection of loose fruit [6]. Below in figure 3 a trash contain with loose fruit. Trash contain stone, debris, soil and another ‘matter’ which will lowed a quality of crude palm oil.

Fig. 3. Trash in loose fruits collection.

In mechanised collection, a cost-effective loose fruit collection system is still one of the main targets of oil palm industry. Various inventions have been introduced but the objective has not been met due to the various technical limitations and constraints [7]. Among the objectives for mechanising loose fruits collection are:

1. Reduction in labour requirements.
2. Reduction in cost of production.
3. Increase in productivity per worker.
4. Maximum fruits recovery.

II. MATERIAL AND METHOD

Toughfar Loose Fruit Separator, TFLS is specifically designed to clean the loose fruit during the collection process. To recover some of the lost, the secondary processes are carried out to collect and clean the loose fruits from the ground. The loose fruits may be contaminated with ground soil and debris. This complicates the cleaning process at the mill. There are several key objectives that TFLS shall produce:

1. To evacuate Loose Fruits (LF) effectively, fresh and free from contamination.
2. To minimize yield lost due to LF. LF loss is expected to be reduced to a minimum as 2 % during the harvesting process.
3. To clean loose fruit as effectiveness as can.
4. To reduce foreign worker and utilize worker to do a task at maximum in plantation.

The machine is maintaining the sieving concept, the loose fruit are throw/put into sieve. As the fruits are sieving at rack, the dirt/trash will fall to bottom of rack. The whole loose fruit will travel to sack using chute. At rack/sieve, this technology is capable of sieving of loose fruits and collecting loose fruit hence producing clean loose fruit to collection point. Figure 3 show the principal of TFLS main concept.

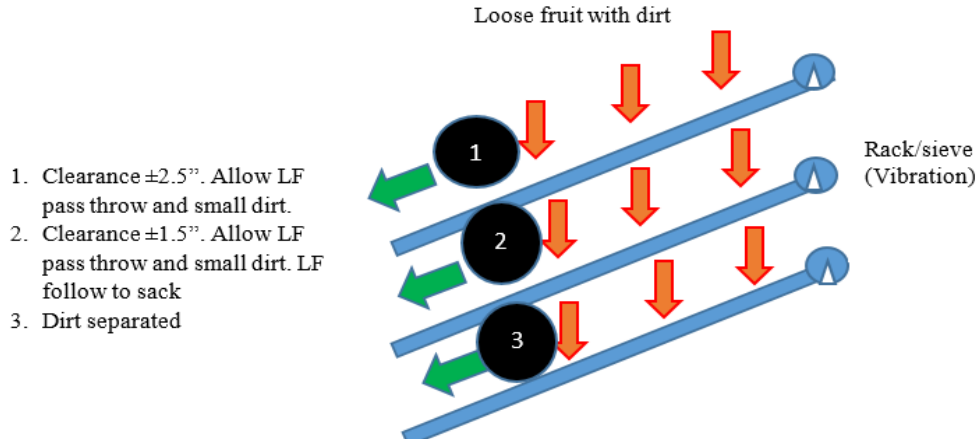

Fig. 3. TFLS main concept.

Concept of Machine

Below figure 4 show a conceptual of TFLS. A detail design include main mechanism and flow of loose fruits. The concept of TFLS is using Toughfar three wheeler where it a proven work in plantation. Vibrator system is a prime working tool to perform separating of loose fruit task. TFLS is powered by diesel engine separated from

main engine and its works in different functional from main engine. The compact sieve/ rack install in three layer to separate dirt and loose fruits. Vibrator drive using belt and pulley from engine shaft. A un-balance shaft fitted at end of vibrator shaft to provide more vibration.

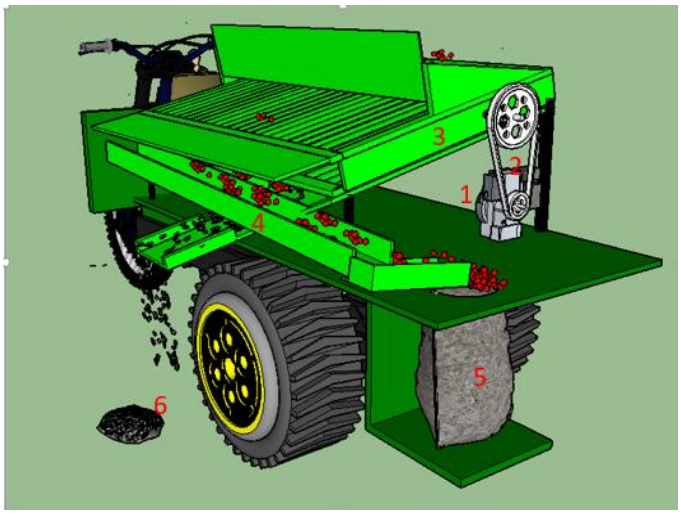

Fig. 4. Toughfar Loose Fruit Separator consists of 5 major components with following functions.

Table 1. TFLS main components and functions.

Components	Function
Engine	Give power to belt and pulley vibration
Pulley and belt	Transfer rotation power to un-balance shaft
Rack/sieve	Vibration and separator
Chute	Clean loose fruit follow to sack
Collection compartment	Loose fruit fill automatic in sack
Trash	Dirt from separator

III. TFLS FEATURES

i. TFLS consists of prime mover and sieve in one machine.

ii. The TFLS can access through terrace area.

iii. The TFLS load capacity is 500kg.

iv. TFLS is capable to operate effectively in flat and mild undulating topography.

v. Driver can view and accessibility a rack/sieve during operation.

vi. TFLS top rack/sieve is capable of handling maximum load of 50kg.

vii. TFLS works within acceptable noise level.

IV. RESULT AND DISCUSSION

From a result, a process flow design diagram for TFLS prototype shown. Diagram shows as below describe a motion study of TFLS prototype. This is an important study to design TFLS prototype because harvesting needs a step of motion parallel with software design. Abdul Razak Jelani [8] was studied the design of harvesting tools

from using a manual harvesting tool to motorized cutter based on the movement of a harvester, specification of cutting edge and production of fresh fruit bunch. From study also shows a new development of CANTAS was developed and improved the production of fresh fruit bunch. It means to design and conceptual very important to do before the project started. The process flow diagram in figure 5 shows a motion of TFLS begin from start until loose fruits unload to platform or BIN. This sequence important to guide the design of the prototype can achieve the target of this project.

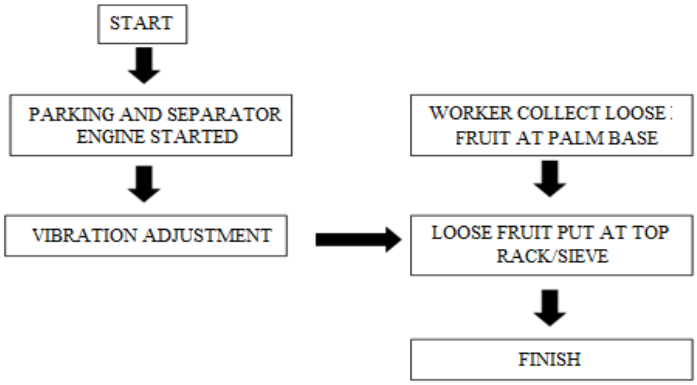

Fig. 5. Motion of machine.

Design Illustrations

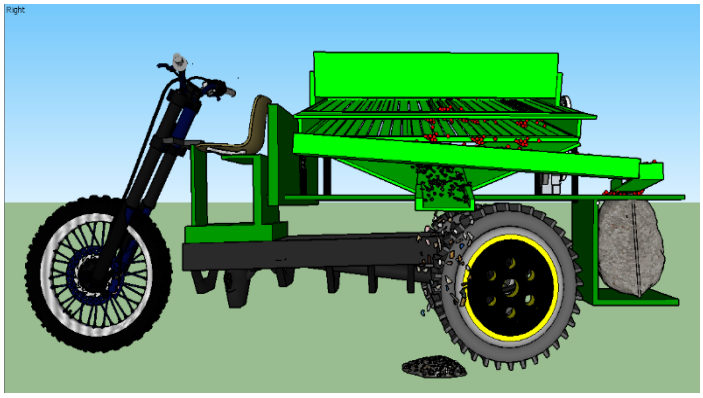

Fig. 6. Side view (right).

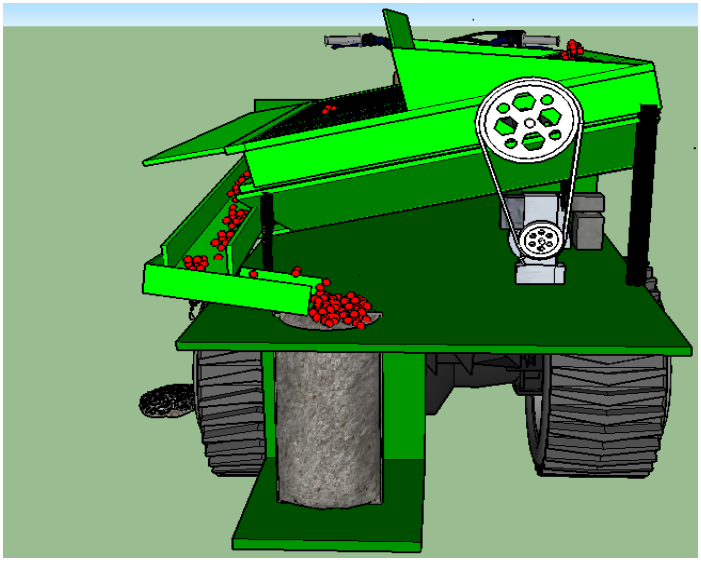

Fig. 7. Back view.

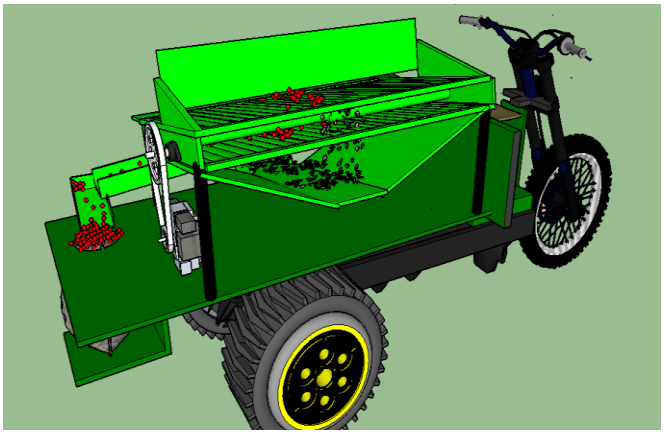

Fig. 8. Isometric view.

The figures above shows the prototype TFLS illustration. Figure 6 shows the prototype in operation of separation and cleaning loose fruit. Dirt and trash will fall a side of machine. After separation and cleaning of loose fruit follow in chute direct to sack, a rack/sieve with different clearance will be adjusted to appropriate vibration. Vibration will vibrate loose fruit with dirt and trash and separate it. Figure 7 and Figure 8 shows the others view of TFLS design.

V. CONCLUSION

There is a lot of handful of challenges and risks that may be posed towards TFLS completion, implementa--tion, and plant-wide practice. Mohd Ramdhan stated that an equipment used in plantation not as problem but assisted operation in plantation [9]. TFLS does not present new or advanced technology. TFLS adapting vibration technology that is proven and readily available in the market. It may not pose a difficult task to maintain TFLS and make TFLS as a productive plantation machine. The current design limits machine working with using 2 worker to complete task of collecting loose fruit. With some understanding of how TFLS performs on various harvesting constraints, knowledge gains from TFLS implementation and some engineering work, TFLS has the potential to be further developed to install vacuum suction and other equipment. The plantation management may have limitations over TFLS unless the TFLS can handle the current harvesting method called daily FFB harvested daily. TFLS needs to perform to show the effectiveness of usage.

While that may prove an effectiveness, TFLS offers other benefits where the current harvesting method may not able to achieve though, such as:

i. Economy value gain due to the effective recovery of a quantity of LF collection.

ii. Economy value gain due to OER improvement from effective loose fruit collection.

iii. Reduction in harvesting cost due to reduction or elimination of LF collection, separation and cleaning.

iv. Improvement cleanliness quality of LF.

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