Design assembling and testing of the oil palm bunches cutting machines

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Abstract. One of Indonesia plantation products, which is considered very potential and strategic to be developed, is palm oil, which is a national mainstay product, and palm oil has a bright prospect for the growth of plantation commodity exports when compared to other vegetable oil products. Harvesting oil palm is cutting fresh fruit bunches from trees to transportation to the mill. This tool is designed from a lawnmower by changing the motion of lawn blades into a back and forth translational motion. Trimming or cutting blades will be converted into a back and forth movement of movements to cut oil palm bunches. From the results of this development found the results of research in the form of the speed required by the machine that is 1400 mm/min then the power needed to cut fresh fruit bunches with age 3-8 years which weighs 3.5-13 kg/bunch is 0.81 kilowatts or 810 watts which have a 6000 rpm combustion motor rotation using a cutting blade whose material is steel with an angle of 135° with a pole length of 2.9 m which can be extended to 4.5 m.

1. Introduction

The agricultural sector, as an overall agribusiness system, still has a significant role in national development. One of Indonesia's plantation products, which is considered very potential and strategic to be developed, is the palm oil commodity. As a national mainstay product, palm oil has a bright prospect for the growth of plantation commodity exports compared to other vegetable oil products. Palm oil. Besides one of the palm trees, which contributes the most abundant vegetable oil in the world in the amount of 2.000±3.000 kg/ha [1, 2]. The rate of development of the palm oil industry is increasing in line with the increasing knowledge, especially in technology. The role of smallholder oil palm plantations as the backbone of the country foreign exchange earnings and employment is increasingly evident. Ownership of oil palm plantations is a solution for overcome the problem of unemployment and poverty in rural areas.

North Sumatra is the second largest CPO production center in Indonesia, with a contribution of 16.24% [3]. The production of oil palm fresh fruit bunches (FFB) in North Sumatra in 2016 reached 18.5 million tons, with an area of 1.2 million hectares [4, 5]. Of the total FFB production, crude palm oil (CPO) produced as much as 4.2 million tons. That shows that the potential of plantations in North Sumatra is very promising. Palm oil harvesting is the process of cutting oil palm fruit bunches from trees up to transportation to the factory, including cutting ripe fruit bunches, citing, cutting midribs, and transporting produce to palm oil mill. Palm oil harvesting activities require special techniques to get quality results. Harvesting oil palm bunches in Indonesia is currently still done with simple tools, namely, tools called “dodos” and “egrek.” Dodos are
knives that are used to trim both the midrib and the midrib. Bunches using piercing. Egrek is a sickle-shaped knife used to cut midribs and bunches by pulling.

Figure 1. The process of harvesting palm oil using trimming blade

Harvesting using conventional tools manually can reduce work productivity and the risk of work accidents. The harvesting oil palms such as dodos or egrek in the harvest must adjust to the height of the oil palm. The egrek requires additional poles that can be set using rubber tires that spend much time when tying poles and releasing rubber tires repeatedly. The use of conventional harvesting equipment consumes much energy because it is quite difficult, and the tool is quite substantial.

So farmers often experience health problems such as skeletal muscle disorders. Disturbances that are often felt by farmers during the process of harvesting oil palm are on the right shoulder, left wrist, and right so that farmers think the work becomes disrupted. This disturbance is due to the high pressure on the shoulders and wrists during the harvesting process of oil palm fruit bunches. Given the palm oil harvesting process, which is less effective in terms of time and not good for farmers' health, on that basis, the team tried to trace the literature and review the results research previous that related to the process of harvesting oil palm. Machine tripe grass carries on generally move rotation to cut grass. This tripe grass machine will later be engineered into a palm harvest tool. The blade motion will be converted into a translational motion to cut the palm bunches. This palm harvesting tool will provide convenience in terms of working time and reduce the risk of farmers. So farmers no longer need much energy to cut oil palm bunches.

Figure 2. The process of using a carrying grass tripe machine

Based on the description, the team offered a solution in the form of a palm harvest machine design through the engineering of a lawnmower. This tool can cut oil palm bunches, and the height can be adjusted according to the height of oil palm. This tool will be used as an alternative solution to help farmers (as a first step) in harvesting oil palm. The palm harvest machine is designed so that
it can later be used to cut grass. This palm harvest engine engineering's objectives are:

- The development of a tripe grass machine into a palm harvesting tool.
- Design and produce tools that can be manufactured and used in oil palm plantations and smallholder oil palm farmers by using a transmission system that moves back and forth on dodos or egrek.

The tool is very appropriate to be used by small farmers in managing oil palm. Where in managing oil palm requires many maintenance costs as well as the cost of harvesting oil palm. So if using palm oil harvesting tools can be more efficient in terms of time and reduced risk of work accidents.

The main components in the palm harvesting tools are [6, 7]:

- Motor Fuel
  The motor fuel is adjusted to the specifications of the tripe engine itself. Tripe grass machine uses a two-stroke motor. Two-stroke motor motors are usually used for jobs that require more power in longer operating times. This condition is caused by a two-step motor that has special lubrication. It causes the combustion motor to be more resistant to heat.

- Gear Rotating Axle
  The gear rotating shaft functions as a component that works to continue the rotation provided by flexible slings to the gears contained in the gears box. This shaft is located on the handle or handles that are connected to the gears box.

- Flexible Sling
  Flexible slings are knot-shaped devices in the arrangement of smooth slings. This tool serves as a successor to the rotation of the combustion motor to the gear shaft with a flexible work area.

- Gear Box
  Gearbox functions as a channel of power or the power of a wheeled machine, so that the unit can move and move from place to place.

- Bevel Gear and Miter Gears
  The bevel gear and miter gears or commonly known as the elbow gear and the miter gear is a pair of gears that work in the position of the shaft that moves and is moved to form a right angle (90 degrees).

- Connecting Rod
  Connecting rod functions as a spin modifier on the bevel gear into back and forth translational motion, working with the tip that moves following the bevel gear rotation. And the other end moves on a rail or a straight line. In other words, the connecting rod functions as a link between moving objects and moving objects back and forth in one direction. At both ends of the connecting rod in the form of a flexible shaft, it is intended that the connecting rod can move when rotating or moving back and forth.

- Sliding
Sliding is a device that functions as the entry and exit of workpieces. How to use it by sliding the workpiece.

- **Trimming and Cutting Blade**
  Trimming and Cutting are blades that function to cut oil palm bunches. Trimming blade is used for trees that are still low or young (maximum height of 2 meters). The cutting blade is used on trees with a minimum height of 3 meters.

![Image of Trimmed and Cutting Blades]

**Figure 4.** (a) Trimming and (b) Cutting [9]

This palm harvesting tool's working principle is designed using a slash grass tripe machine using a 2-stroke motor. The engine rotation is forwarded by the gear shaft, which is forwarded by a flexible sling to the gearbox.

### 2. Methodology

The method used to make this tool realized and as expected is as follows:

- Literature search relating to the working system tools.
- The design of the slash grass tripe machine is converted into a palm harvesting machine.
- The process of making and assembling a palm harvest machine.
- Undertake the process of testing the palm harvest equipment on the plantation.
- Evaluate the performance of the palm harvesting machine.

The length of cutting distance is 14 m. The speed of electrical motor 6000 rpm, time needed 1 minute. The value of the velocity \( (v) \) is 14000 mm/minutes. Meanwhile, the pitch of connecting rod is 14000. So, the power for cutting the bunches obtained 810 watts. In making oil palm harvesting tools, the first step is to search for literature relating to the work of oil palm harvesting tools. Then proceed with the design of the machine using the 2014 solid work application. The planned design and parameters are adjusted to the availability of materials in the market. The next activity is the collection of materials and equipment needed to carry out the process of making the palm harvest machine. In the manufacturing stage of the machine includes planning machine elements, manufacturing machine elements, and assembly of palm harvesting equipment, testing the tools to maximize the work of the palm harvesting tools, and the last stage is evaluating the performance of the palm harvesting machine.

If there are deficiencies in the oil palm harvesting machine, it is necessary to do a re-planning in the form of both the design and planning of the machine elements.

### 3. Results and Discussions

This palm harvesting tool is engineered from a tripe grass machine. The engine used is a two-step combustion motor as a source of power to rotate the shaft and convert it into translational motion back and forth. So that when the machine is turned on, the dodos or egrek blades will move back and forth by the speed set by the operator (farmers). In the process of harvesting oil palm, the position of
farmers with oil palm will be harvested. Farmers must adjust the blade and pole length to harvest the oil palm. If oil palm trees are still low (maximum 2 meters), farmers can use a dodos blade in harvesting and without the need to extend the pole to the palm harvest machine. But if the palm tree has a minimum height of up to 3 meters, farmers can use an egrek blade and must adjust the pole according to the height of the palm. With this palm harvest machine, farmers do not need a lot of energy in every harvest of oil palm. Farmers only need to direct the blade (dodos or egrek) on the palm bunches and then adjust the blade’s speed, and the palm bunches will be cut off from the tree. According to [9], every change in farming through mechanization is based on certain objectives that make these changes biased, logical, and acceptable. In general, the purpose of agricultural mechanization is a) Reducing job clarity and increasing the efficiency of human labor. b) Reducing damage to agricultural production c) Reducing the cost of production. d) Ensuring an increase in the quality and quantity of production e) Improve the standard of living of farmers. f) Allows the sub-system's economic growth (a type of agricultural needs of the family) to be the type of commercial farming (commercial farming) g) Accelerating the transition of Indonesia’s economic form from the nature of agriculture to the industry nature and can encourage the stage of takeoff. In the process of harvesting palm oil using a combustion engine from tripe with 810 watts of power with an engine speed of 6000 rpm, it found the required speed of 14000 mm/min with a height of 7 meters has an average cutting of 358 midribs/hour.

4. Conclusions
The engineered tripping of sled grass into a palm harvesting tool was made to assist and facilitate palm oil farmers carrying out oil palm harvests. The tripe tool is converted into a palm harvesting machine by changing the rotation of the tripe machine’s blade into a back and forth translational motion on the transmission. With the back and forth movements of these can move the cutting blade, either dodos or egrek. The testing tool that can now be adjusted by adjusting the pole according to palm height to be harvested found. The results of research in the form of the required speed of the machine, which is 1400 mm/minute, and then the power needed to cut fresh fruit bunches (FFB) with age 3-8 years, weight 3.5-13 kg/bunch. It is 0.81 kilowatts or 810 watts with a 6000 rpm combustion motor rotation using an egrek blade whose material is steel with an angle of 135° with length of 2.9 m which can be extended to 4.5 m.

5. References
[1] A Hamsi et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 801 012086
[2] Wantani Chaiwong, Nabil Samoh, Theera Eksomtramage and Kaewta Kaewtatip 2019 Surface-treated oil palm empty fruit bunch fiber improved tensile strength and water resistance of wheat gluten-based bioplastic, Composites Part B: Engineering 176, 107331, ISSN 1359-8368
[3] A Pintoro et al 2019 IOP Conf. Ser.: Mater. Sci. Eng. 505 012059
[4] Lilik Tri Mulyantara, Harsono Harsono, Roni Maryana, Guangfan Jin, Atanu Kumar Das and Hiroshi Ohi 2017 Properties of thermomechanical pulps derived from sugarcane bagasse and oil palm empty fruit bunches, Industrial Crops and Products 98 139-145, ISSN 0926-6690
[5] M Hazwi et al 2019 IOP Conf. Ser.: Mater. Sci. Eng. 505 012051
[6] Z Lubis et al 2019 IOP Conf. Ser.: Mater. Sci. Eng. 505 012091
[7] Samar et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 725 012051
[8] Fatin Syakirah Ali, Rosnah Shamsudin and Robiah Yunus 2014 The Effect of Storage Time of Chopped Oil Palm Fruit Bunches on the Palm Oil Quality, Agriculture and Agricultural Science Procedia 2 165-172
[9] A. Hamsi et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 725 012019