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Mechanization in Oil Palm Harvesting

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Abstract
Harvesting is an important process in oil palm plantation main objective of harvesting is to get fresh fruit bunches with excellent oil content and quality and can get the maximum profit. During harvesting the worker need mechanization to assist in collection of oil palm bunches. Currently there is many types of technological or mechanized tools for aiding the harvesting of palm oil. This paper is to grasp detail understanding on the history of mechanization used in oil palm plantation specifically for harvesting in Malaysia. For the traditional and manual method, wheelbarrow is only the best mechanization in assisted collection of oil palm bunches. It is because wheelbarrow can pass through all types of road surface, the gradient of slope, and type of soil. Wheelbarrow is a machine that is easy to work with and does not give pollution to environment. However wheelbarrow use more energy of worker to pull the wheelbarrow with full capacity. To reduce the use of worker energy, buffalo cart are used to replace the wheelbarrow. Buffalo cart can help to do human work by pulling the cart that full fill with oil palm bunch. Beside can reduce the use of energy, it can reduce the cost of worker and can make the time more short in harvesting system. After that, mechanization assisted in harvesting system is improve by using engine that is mechanical buffalo (Badang and Rhyno). Mechanical buffalo can help human work in plantation sector to more faster. Mechanical buffalo also can reduce the labour cost and can increase the productivity of worker.

Introduction
Harvesting in oil palms begins when they reach maturity which is approximately three years after being planted in the fields. As oil palms continue to mature, their yield increases and they generally reach peak production between their 7th to 18th years of growth. The yields of our oil palms are expected to gradually decrease after their 18th year. Each oil palm in our oil palm plantation is harvested for fresh fruit bunch once every 10 days and depend on the standard of practice of the company. The goal of harvesting is to be able to cut and collect all ripe fruit bunches in the field, also able to harvest fresh fruit bunches without damaging the fruit and the palm. Ultimately to be able obtaining fresh fruit bunches with excellent oil content and quality and can get maximum profit from the good practice. It is a common understanding for oil palm bunches to be harvested at every harvesting round also known as harvesting interval at least once every 10 or 12 days (Turner, 1974). Bunches are harvested at the right time and ripeness,

without causing damage to the bunch and the palm and the minimum ripeness standard of 7 – 10 loose fruits per bunch must be kept and the stalks are cut must less than 5cm to avoid the stalk absorb the oil.

The fresh fruit bunch of oil palms are only harvested when an appropriate quantity of fruit becomes detached from the bunch, indicating peak ripeness. The ripeness of bunch harvested is critical in maximizing the quality and quantity of palm oil extraction. Loose fruits are collected together with the harvested bunch to minimize wastage. The fresh fruit bunch harvested from oil palms and oil palms must be transport by to palm oil mill as fast as possible. Typically, 100% of fresh fruit bunches are processed within 24 hours after harvesting to minimize the free fatty acid release, which reduce the quality of CPO extracted. Malaysian Palm Oil Board (MPOB) has standardized that 5% of free fatty acid production because lack of transportation from field to mill.

The issue of harvesting mechanization has been a trend of discussion ever since palm oil has been classified as a major contributing commodity for our economy. In the era of heading towards 4th Industrial Revolution, and also exponentially growing globalization, Malaysia has made tremendous efforts to increase its productivity through technological advancements. These efforts would facilitate to develop and utilize technological tools hence improving and increase the agriculture industry's performance. To date, harvesting process particularly for oil palm, many technological tools have been incorporated to Malaysian plantation settings. With the existence of these tools, the issue of shortage of workers could be lessened and projected better economic returns. Currently various types of tools have been developed to assist oil palm plantation workers such as Cantas ®, Mechanical Harvester, Badang, etc.

Nonetheless, despite the existence of this technological tools, many farmers are inclined to make use or exploit the benefits of this technology (Shahbaz, et al, 2012). These rejections are caused by various factors hence the call to highlight the benefits and critics on this technology in this research paper.

History of Harvesting Assisted Collection Technique

Assist harvesting for collection is very important for all plantation sector. There are many attempts that have been made to assist harvesting by various schemes for collecting the fruit from beneath each palm and bring to the platform collection. Usually collection of bunch of inter row can be used using methods including mechanized or animal drawn vehicle. The animal used for inter row collection, mules, are usually owned by harvester. This type of assist harvesting are used at Colombia and the Philippine are found to be more convenient and inexpensive (Turner and Gillbanks, 2003). Then, horses and oxen also can be used as harvesting assisted collection. Inter row collection by bullock or oxen pulling tipping carts has long practiced at the suitable terrain and the area where there is limited availability of skilled labour. A buffalo drawn sledge type carrier has been used in East Malaysia and somewhere else with soil type that is peat soil. But using animal have the problem like the animal can effective work at suitable area. The other problem is the animal can be attack by various type pest and disease and also can be attack by wild animal or their prey.

Actually, there are many design mechanical harvesters that can assist have been created. However no design of mechanical has yet proved successful. Since mid-1960's various mechanical assist in field collection have been tried and do the experiment with more success (Turner and Gillbanks, 2003). This findings have found commercial acceptance in Malaysia in recent years, particularly in association with acute labour shortage. At Malaysia the simplest mechanisation form is by using wheelbarrows. Wheelbarrow system is a mechanism that has been used and accepted widely among plantation labors. It helps to increase productivity, lower harvesting cost, allow flexibility and it is readily available. However, wheelbarrow needs to be repaired and problem persists, repair and maintenance facilities must available. It is worth highlighted that smallholder only want the simplest mechanism that can assist in harvesting collection of oil palm.

Improvement in Harvesting Assisted Collection Technique

Research by research has been conducted in improving the vehicle for assist the harvesting of oil palm. Many various types of equipment have been used in field like dump trucks, that also known as mechanical buffalo that is small power ranging 20 to 25 hp tractors. While loading the bunch into the tractor can be manual or by using hydraulic grab, mechanical buffalo cannot handle loose fruit that must be loaded by hand or manually. Unloading has variously been into transfer ramps which must require additional re-handling, into roadside nets or through the use of high tripping dump trucks directly into transport unit. By using mechanical buffalo the level of labour saving claimed is 40% which is rather more than the theoretical figure. A major factor in this technique is reduction in worker fatigue (Turner & Gillbanks, 2003). The possible variant of this would be the use of large steriliser cages as the infield bins, to avoid any further handling of bunch. Ground compaction or soil surface is a serious problem at field. It can be minimized by using low pressure tyre or can use rubber-tracked vehicles in lower land area that is peat soil area that can affect the transportation of bunch.

Claimed 33% to 40% for labour productivity that assisted collection of bunch is separated from the cutting activity. Work studies in controlled harvesting system indicated that the lower figure is more. It is nothing do to reduce the time taken to collect loose fruit that which is important part of harvesting operation for maximum the production. Consequently, the potential to increase the economic efficiency by reduce of walking time, carrying time and also loading time, and also reduce that overall element of fatigue like labour energy. From this theoretical point of view, this approach by using mechanical buffalo have shown the greatest potential in increasing the labour productivity – by equipping each harvester with the vehicle or mechanical buffalo. Then, it also be able to reduce the time spent for moving over the ground to an irreducible minimum of once every harvesting round.

In trials, increased in productivity per man hour in the order of 60% to 80% have been recorded, which will in part be due to a decrease in the fatigue factor (P.D Turner, R.A. Gillbanks, 2003). However, each unit output was limited in about five times per day that was used by a harvester that assist with human to pick up the loose fruit. It is limited to five times per day because it requires capital and vehicle operation costs that is very high. Example cost incurred includes petrol or diesel consumption. However, the reduction in the amount of labour employed also reduce, also cost requirement for housing and infrastructure also reduce.

Buffalo Assisted Collection

The Malaysian buffalo is a swamp type buffalo found in western Malaysia. Used primarily as a draft animal, they are usually dark grey and occasionally white and usually with crescent horns. They originated from and are similar to *Bubalus arnee*. Buffalo also used in plantation sector as an animal that assist collection of oil palm. Buffalo is strong animal that can pull heavy objects. There are several benefits in using buffalo as assisted collection in oil palm sector. Firstly, we can reduce the 30% labour requirement in field. This is because, only several workers are needed to work with buffalo to handle it and bring to the platform. By using wheelbarrow, it can fill only a few bunch of oil palm fresh fruit bunches and need worker to pull the wheelbarrow. However with buffalo, worker does not need to pull it because of buffalo can pull the heavy things like oil palm bunches that is consigned inside the cart. After that, buffalo also can reduce the labour turn over with higher productivity and better income for workers. It help the productivity in labour because labour use less energy consumption and that will make the worker do the other task or do more work.

Furthermore, using buffalo also can minimize the extended harvesting interval during peak cropping. Normally, the cutter's productivity is limited by carrier's ability to evacuate crop in field mechanical collection and the value of buffalo appreciates. The major benefit is it can minimize the pollution to the environment. Buffalo is living organism that does not produce carbon monoxide that can harm the environment. We also can reduce the usage of nonrenewable fuel that is required by most of the vehicles. It also follows the Malaysian Sustainable Palm Oil (MSPO) and Roundtable Sustainable Palm Oil (RSPO) certifications' regulation that prevent the environment from being polluted. Lastly, waste manure can be processed and act as a fertilizer to oil palm.

Preparation is needed before usage of buffalo as assisted vehicle. Firstly, we need to see the accessibility aspect, means that the harvesting path must be free from the tree stumps, termite hills and have sufficient bridges. Other that, we must see the re-tasking aspect. Harvesting tasks allocated should be bigger than the wheelbarrow method. A buffalo with two workers should be able to cover 4 hectares a day. For worker, we must select a good worker with the interest in keeping and caring for the buffalo. To handle the buffalo, workers need to be close personally with the buffalo to ease the instruction delivery to facilitate the work. Buffalo cart is important because it is a place that to put the oil palm bunches and to be pull by the buffalo. So as a preparation before the arrival of buffalo, the cart must be ready to apply at the buffalo.

Regarding selection of buffaloes, buffaloes that can be used as buffalo cart is the buffalo should be between 11/2 – 2 years old (estimate weight for buffaloes is around 300 kg). Usually male buffalo will be used because male buffalo are stronger and also more weight that can pull high weight of cart. The buffalo should be well built with a thick neck, broad deep chest and look muscular.

On the arrival at the estate, the buffaloes are kept under the oil palm trees where there is a grass and water for two days. During the first two days, the owner will hand feed the buffaloes with salt, grass and water to make an initial human contact. It does a miracle as it allows the buffaloes

to be comfortable and can adapt with the environment of the field. The training can be conducted in an open area or in the oil palm fields to be conducted by the owner. Training takes about a week before the buffaloes can be used for harvesting operation. It takes about 1-2 months before the buffaloes become familiar with owner command.

In the context of maintenance, buffalo is also like other vehicle that need to be taken care. However it is different from machinery vehicles. Firstly, each buffalo must have their insurance. The function of insurance is to protect the buffalo when it is missing or be stolen, and if the buffalo is sick. Besides that, each buffalo must do their medical checkup for every year that to know the health level of the buffalo. If the buffalo is sick the veterinary will inject the medicine like Albenthic Plus that is used as a treatment of roundworm in the buffalo. After that to maintain the health of buffalo, the worker needs to give some supplements to the buffalo such as honey, egg and brown sugar.

Nevertheless, there are several disadvantages by using buffalo as assisted collection. It includes the risks to get diseases. Animal or living thing cannot run from disease such as worm and *Haemorrhagic Septicaemia* disease. Other that, the risk to be stolen is also high. The demand for buffalo beef is high among the dietary of people in Malaysia. Besides, it can also become an asset or as a ruminant for people. It has been reported that buffaloes in oil palm plantation are stolen every year in Peninsular Malaysia.

Mechanical Buffalo (Badang Or Rhyno) Assisted Collection

Badang or Rhyno is also known as mechanical buffalo. It is a small tractor that has been innovated and modified in such a way that it has cart that can load oil palm bunches. It is a new technology that has been widely used in oil palm sector that can help workers to facilitate the work. Rhyno have a several model. A single chassis Rhyno W700 has been specifically developed by Bawoo Company from South Korea with the collaboration of Malaysian Palm Oil Board (MPOB) and Mizou Holdings to meet the unique requirement of the palm oil industry (Mizou Holdings Sdn Bhd, 2016). Rhyno W700 was constructed to be compact and robust with the most efficient weight distribution ratio to ensure it can have a superior floatation and excellent manoeuvre capability in hilly terrain and swampy areas. Rhyno W700 has compact turning radius and it can be easily handle by a hydraulically powered steering. The central oscillation pivot on its frame and excellent suspension system has propelled Rhyno to be robust in the field. Rhyno W700 (Table 1) is capable of carrying up to 700 kg of FFB payload. A Power-Take-Off (PTO) is incorporated in Rhyno W700 so that Fertilizer Spreader and Pesticide Sprayer can be mounted on it, making Rhyno W700 is a truly multifunctional agricultural tractor. It utilising a minimal diesel fuel consumption of about 8 litres a day (Mizou Holdings Sdn Bhd, 2016).

Table 1 : Technical characteristics of Mizou Rhyno

Model	Mizou Rhyno W700
Rated Operating Capacity	700 KG
Operating Weight	910 Kg
Engine	19HP Water Cooled
Starting	Electric starter motor
Transmission	6 Speed synchromesh with 5FW & 1RV
Drive	(2WD / 4WD)/ Low & High
Steering	Power Steering
Steering Type	2-Wheel Steering System
Frame	Central oscilliation pivot
Operation Platform	Adjustable Seat, Instrument Panel & Cabin
Tyre	Floatation tyre 29*12.5*15-6PR
Dumper	Standard, dumping by hydraulic cylinder, high pivot
Implement attachment	Fertilizer Spreader and Pesticide Sprayer

The main objective of developing a multipurpose wheel – tyre transporter is to transport FFB in difficult areas such as peat, narrow terrace, undulating terrain and soggy ground. Advantages of rhino or badang include the specification of rhino tyre is fitted with four wheel drive that is low pressure tyres to reduce the soil compaction on the terrain. Rhyno also is incorporated with power take off for other activities such as fertilizer application and weed control (Deraman, 2013). The design with central oscillation pivot for balance and stability on even terrain. After that, rhyno can easy to operate and is manoeuvred by a hydraulically powered truck – type steering. Lastly, it can elevate high pivot tipping to reduce repetitive work (double handling)

Cantas Motorized Cutter

The Malaysian Palm Oil Board (MPOB) has also developed a motorized cutter popularly known as Cantas TM for harvesting fresh fruit bunches (FFB) at less than 4.5 m height. Cantas TM is a hand-held cutter powered by a1.3 hp petrol engine. Trials carried out on CantasTM 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 (Jelani, 2008). 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 TM is equivalent to two to three human harvesters. Using Cantas TM, 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 (Jelani, 2008). 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 . There are several objectives of this motorized cutter. First it is to develop more efficient work in cutting process of frond and oil palm bunches. It is also designed to reduce the requirement of labour

during harvesting. When labour is less so the cost of production can be reduced. Then it can increase productivity per worker and reducing the operator's efforts or energy use during harvesting operation. A good motorized cutter should have the following characteristics, ease of handling (by the operator), efficiency and speed in cutting, then, increases productivity (as compared to manual harvesting) and lastly it comforts in handling and the design must be ergonomic.

Comparison of Manual Vs. Cantas Systems

Referring to Table 3, study have shown that daily productivity using Cantas TM during harvesting can increase 163% more higher productivity that using manual sickle, while for the individual productivity of CantasTM team was 31% higher than team that used manual sickle. Hence the income of worker will increase in 31% compared to the usage of manual sickle. After that, the study also shown that using the Canyas TM can reduce the energy use, where it is observed that usage of Cantas TM working time is in 10 hours per day while for manual sickle is able to work for 7 hours per day. Working time is more effective and efficient by using Cantas TM because it can do extra works as much as 3.25 hours per day (Jelani, 2008). If the manual sickle stop work at 4.00pm, the Cantas TM plus 3.25 hours that means the worker can stop at 6.15pm.

Table 3 : Comparison of Manual and Cantas

Description	Manual	Cantas TM	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-day-1	107	140	33	+31

Issues and Challenges

There are several issue and challenges by using buffalo cart and mechanical buffalo (Ryhno and Badang). Everything in the world have their own advantage and disadvantage depending on the perspectives of the user. It can does harm if abusing the technology but it also accommodate the work hence giving benefits or profits if used it rightly. First issue and challenges by using of buffalo cart is it is highly notably that buffalo can help the human or worker in assisting collection of oil palm bunch in field, where it can reduce labour cost and less maintenance compared to other vehicle that have engine. On the other hand, usage of buffalo to assist in collect oil palm bunches is a bit too much if they are exploited excessively. A sense of humanity should take a role in utilizing the mean of this technology.

Using mechanical buffalo also have their issue and challenges. Mechanical buffalo is vehicle to assist harvesting collection that can reduce labour cost. The issue is when many field operations use mechanical buffalo and do not use human and wheelbarrow, job opportunities will decrease because machine can replace the human work. After that, when job opportunities are decreased the rate of unemployment also increase.

Recommendation

During harvesting process, we need tools that can help to do our work more easily and can shorten the period of processing. Nowadays many technologies has been created to assist the worker work. For example, mechanical buffalo (Badang or Rhyno) was created to assist harvesting collection of oil palm bunches. It is very useful to assist the worker beside can increase the productivity of worker and also can reduce the labour cost. From certain result of my reading had said that the engine of mechanical buffalo can do heavy duty work and can go through the bad soil surface such as peat soil but it easy to overheat. We need to find more powerful engine and can do more extreme work and also can carry high capacity of bunches. After that, all workers should wear personal protection equipment and follow the safety instructions that have been established in the workplace during work. When control things that have engine and use fuel like mechanical buffalo or tractor, workers should wear face masks to avoid inhaling carbon monoxide smoke that are released from the engine machinery. This is because carbon monoxide is a poisonous gas and can be harmful to the health of workers. Hence the need to emphasize on the safety at the field.

Conclusion

In a nutshell, mechanized tools are modern alternatives to the current agriculture industry. The outcome of this research could be utilized by various relevant parties. A good technology tool should possess quality ergonomic design characteristics. Based on the analysis coming from this research, workers are open for technology but subjected to few constraints; largely contributed by the factor of comfortability using the tools and able to do things faster compared to other tools. This should give motivation for innovators to not give up in introducing new technology to facilitate harvesting. Government and private agencies should involve in research and innovation to improve the farming sector. In addition, university worldwide are assisting in the search for new methods in farming to obtain a high yield, low cost and the use of left an impact on environmental pollution. It must be highlighted that in every effort conducted, every part of the stakeholder in the production line must be protected. All agencies should follow the standards that have been established in the Roundtable Sustainable Oil Palm (RSPO) and the Malaysia Sustainable Oil Palm (MSPO) to achieve a sustainable production supply chain of oil palm.

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