A comparative research of the fresh fruit bunch productivity between three-wheeler machine and buffalo assisted in-field collection in Muadzam, Pahang, Malaysia

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ABSTRACT

Background: Malaysia's palm oil exports may experience a steady increase due to the ongoing Russia-Ukraine conflict. Although the demand for palm oil is increasing, there is still a significant labor shortage in the plantation industry. As a result, the use of machinery has become a key component in Malaysia's oil palm plantation industries, particularly for in-field collection.
Purpose: The purpose of this study is to evaluate the performance of a three-wheeler machine and BAIC as a harvesting mechanization in the oil palm estate.
Design/Methodology/Approach: This study involved a time and motion study to make a comparison between the performance of a three-wheeler machine and BAIC.
Findings: The trials proved that the total average productivity for three-wheeler machines and BAIC is 12.81 mt/day and 4.55 mt/day, respectively. Additionally, the average productivity for each harvester that uses a three-wheeler machine is 3.2 MT/day/harvester, while for BAIC it is 2.27 MT/day/harvester. The cost-effectiveness of a three-wheeler machine is MYR 7.28/mt/harvester, while for BAIC it is MYR 1.41/mt/harvester (MYR = Malaysian Ringgit).
Conclusion: The use of a three-wheeler machine has been proven to increase the productivity of FFBs. Although using a three-wheeler machine requires more caution, it really makes the in-field collection process for labour much easier for the laborers, ultimately improving productivity rates and increasing laborers' pay.
Research Limitations: It is quite difficult to find an estate that still uses buffalo for in-field collection because most of the estates have switched to machinery.
Practical Implications: This research can be used as a reference and guidelines to improve estate management and ensures the sustainability of the oil palm industry around the world.
Contribution to Literature: The literature on BAIC will be expanded by this study, particularly in the area of oil palm plantations.

Keywords: *Buffalo assisted in-field collection, Fresh fruit bunch, In-field collection, Oil palm plantation, Productivity, Three-wheeler machine.*

1. INTRODUCTION

Malaysia is the second largest producer of palm oil, accounting for more than 44% of the global palm oil exports after Indonesia. Malaysia's palm oil exports may experience a steady increase due to the ongoing Russia-Ukraine conflict. This is due to India and the European Union seeking substitutes for sunflower and mustard oils, which Ukraine can no longer supply (Amy, 2022). Furthermore, there has been a reduction in the export of vegetable oil from Ukraine. According to S&P Global Platts, Ukraine exported 16% of the world's corn in 2021–2022, which is lower than the 46.9% of the world's sunflower oil that they exported in the same period.
Although the demand for palm oil is increasing, there is another major issue: the lack of workers in the oil palm plantation sector. Malaysia's oil palm industry has lost an estimated RM10.46 billion in the first five months of this year due to labor shortage. The breakdown of a Memorandum of Understanding (MoU) between Malaysia and

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Indonesia on the entry of domestic workers led to a ban on Indonesian citizens entering Malaysia. Furthermore, the peak season of the crop coincided with Indonesia's temporary ban on laborers entering Malaysia, which has been a significant setback for Malaysia's agricultural sector.

Foreign labour is crucial in the agricultural industry, as they perform important tasks such as gathering fresh fruit bunches, weeding, and other basic duties. However, Malaysia has difficulty finding local laborers since most of them are not interested in working in the agriculture sector, especially in oil palm plantations. According to the head of Southeast Asia at LMC International, a consulting firm, locals find it humiliating and uncool, so they avoid working in oil palm plantations.

Mechanization has been a key component in Malaysia's oil palm plantation industries, particularly for in-field collection. The industry has turned to mechanization to address the severe manpower shortage, which continues to worsen. The mechanization for in-field collection for FFBs that are used in oil palm plantations includes wheelbarrows, both traditional and manual, buffalo carts, three-wheeler machines, Mini Tractor Grabber (MTG) systems, and Mini Tractor Without Grabber (MTWG) systems. Therefore, the main objective of this research is to evaluate the performance of a three-wheeler machine and BAIC as a harvesting mechanization in the oil palm estate.

2. LITERATURE REVIEW

2.1. Harvesting in-field collection mechanization

2.1.1. Three-wheeler machine

The three-wheeler machine was first introduced in 1987, and its cost may be recovered by a 30% increase in harvesters' productivity as compared to the wheelbarrow system (Teo, 2000). A Three-wheeler machine is versatile and can be used on all terrains. It is also simple to use and to maintain, and more affordable than a mini tractor.

Additionally, the multipurpose wheel-tire transporter for three-wheeler machines can move Fresh Fruit Bunches (FFB) through challenging terrain, such as peat, narrow terraces, undulating terrain, and muddy ground. The transporter's rhino tire is fitted with four-wheel drive and low-pressure tires to reduce soil compaction, making it one of the advantages of the three-wheeler machine (Zahid-Muhamad & Ab Aziz, 2018).

Figure 1. Three-wheeler machine.

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Figure 2. Engine inside the three-wheeler machine.

Figures 1 and 2 show the three-wheeler machine that was used at an estate in Muadzam, Pahang. This three-wheeler machine can transport approximately 15 – 20 bunches of Fresh Fruit Bunches (FFB) at a time, with an estimated weight of FFB 20.11 kg/bunch. Yanmar brand engines were used for this three-wheeler machine, and this brand is more expensive than other brands that are usually used in three-wheeler machines, such as Lone Star and Agro Star brands. The price for a three-wheeler machine that uses a Yanmar engine is RM 21,800, while another brand costs RM 18,500.

Additionally, the actual team that uses a three-wheeler machine at this estate consists of four (4) laborers: two (2) laborers as a cutter and stacker of fronds and two (2) carriers (one (1) person riding the mechanical buffalo, and one (1) person collecting FFBs). They do not require loose fruit collectors because there are very few loose fruits in the field, which the laborers collect them by hand.

2.1.2. Buffalo Assisted In-field Collection (BAIC)

The use of buffaloes in-field collection is becoming increasingly uncommon nowadays, even though it can reduce costs, particularly maintenance costs. Today, using buffaloes has been considered outdated since more plantation estates are already using machinery for their in-field collection, which makes daily labour work in the estate easier, and faster and more productive.

Furthermore, buffaloes are very strong animals that can pull up to 1.5 metric tonnes of FFB's weight. Moreover, the usage of buffalo does not have any issues regarding animal abuse and is comparable to the Roundtable on Sustainable Palm Oil (RSPO) and Malaysian Sustainable Palm Oil (MSPO) standards. Additionally, using buffaloes also promotes environmental sustainability since it lessens air pollution caused by vehicles that release large amounts of carbon monoxide gas. While it may not entirely solve the issue of excessive carbon monoxide levels, using buffaloes is a step towards reducing air pollution in the agricultural sector.

Despite the COVID-19 issue, the use of buffalo has been reduced in most companies due to the shortage of laborers. The government of Indonesia has restricted the movement of Indonesian laborers into Malaysia due to the breakdown of a Memorandum of Understanding (MoU). Furthermore, most of the estates tend to use machines because they are more productive, fast, and efficient, which reduces dependency on the labour requirement and, at the same time, may lessen the load on employees.

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The usage of BAIC in this estate required two (2) laborers, consisting of one cutter, and one carrier for each buffalo used. The cutter first enters the area to begin cutting fruit and fronds, while another labor (the carrier) enters the path once the FFB has been cut halfway to load it onto the buffalo cart. The carrier also stacks fronds and gathers loose fruit simultaneously.

Figure 3. Buffalo assisted in-field collection (BAIC).

Figure 4. The structure of buffalo cart.

The cart needs to be attached to the back of the buffalo, as shown in Figure 3, before the labourers start to train them. This is necessary to ensure the buffalo are used to the cart on their backs when they start working in the field to avoid any accidents from happening. The function of the gap in the buffalo cart, as shown in Figure 4, is to separate the debris when laborers put loose fruits from the ground into the cart.

The buffalo are trained when they reach a year and a half of age and weigh approximately 150 kg. Before training, the buffalo's noses are pierced to make sure that they listen to their trainer (laborers). To ensure that the buffaloes receive enough nutrition and minerals in their diets, they are given a salt lick, which helps to keep them calm during training.

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2.1.3. Wheel barrow

A wheelbarrow is one of the tools used to collect fresh fruit bunches in an oil palm estate. The use of a wheelbarrow is considered manual and traditional (Zahid-Muhamad & Ab Aziz, 2018). This is because the laborers still need to pull and push it with their full force. Furthermore, many laborers are reported to be at risk of getting work-related musculoskeletal problems, according to the palm oil business (WMSDs) (Ng, Bahri, Syah, Mori, & Hashim, 2013). Collectors and loaders in palm oil fields are particularly susceptible to MSD pain. This is because workers in the palm oil industry have to kneel to pick up fresh fruit bunches (FFBs) from the ground and place them in a wheelbarrow. Lifting bulky FFBs and pushing a fully loaded wheelbarrow from one tree to another require a lot of energy from laborers.

It is undeniable that using a wheelbarrow have a lot of benefits, such being low cost and requiring minimal maintenance, but it has limitations also, especially for large plantation estates. The wheelbarrow is too small to carry large quantities of FFBs, making it inefficient to operate. It can only transport 5 to 6 bunches of FFBs, each bunch weighing 17 to 20 kg. Labor repetition is required, resulting in fewer daily FFB collections (Nawi et al., 2015).

3. METHODOLOGY

3.1. In-Field Collection Mechanization

Three-wheeler machine and BAIC were used in this research to compare their performance in a five (5) days.

Table 1. Land use at estate in Muadzam, Pahang, Malaysia.

Description	Area (Ha)	Percentage of total (%)
Mature oil palm	1512	100%
Immature oil palm	0	0
Total planted area	1,512	100%
Others:		
Housing and building site	10.33	-
Roads	35.55	-
Pond	0.80	-
Football field	0.65	-
Stream	1.74	-
Vacant	2.76	-
Rounding adj	-0.46	-
Sub total	51.37	-
Total gross area	1,563.37	-
Less:		
Planted outside boundary	0.00	-
Area conversion adj	-0.39	-
Sub total	-0.39	-
Total title area	1,562.98	-

3.2. Study Area

This research has been conducted at an estate in Muadzam, Pahang, Malaysia. The location of this study was chosen because this estate still uses a buffalo and met the criteria, which aims to make a comparison between the uses of three-wheeler machines and BAIC. The total planting area for this estate is 1,512 ha, while the topography features of the research estate are flat (0 – 2 degree slope) and undulating (2 – 6 degree slope). Data regarding this estate are shown in Table 1.

3.3. Field Evaluation (Time and Motion Studies)

Time and motion studies (TMS) were conducted to make a comparison between two mechanizations, a three-wheeler machine and a BAIC, in terms of time needed, difficulty of handling and moving buffalo, productivity (total of bunches), and total coverage area.

Referring to Figure 5, this process starts at point A, where the three-wheeler machine and buffalo move up to point B, then turn around at points C and D, and continue until the end. During the movement of mechanizations (three-

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wheeler machines and buffalo) from one point to another, FFBs are collected, and at the end of each point during the unloading process, daily productivity (bunches) and time taken for each mechanization are calculated. The process begins with a three-wheeler machine followed by BAIC.

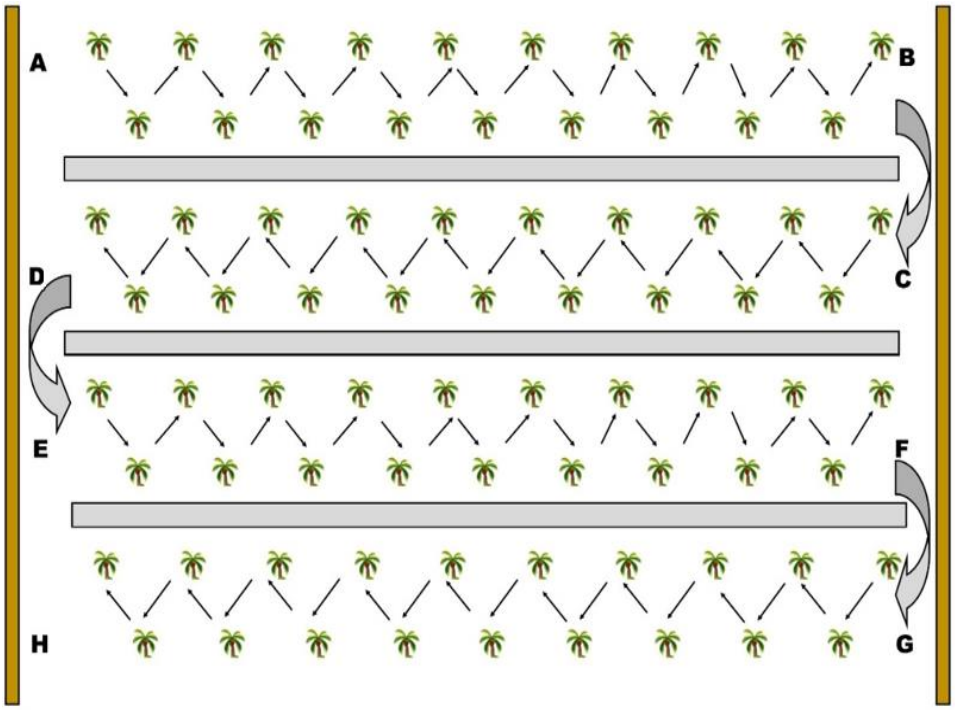

Figure 5. The movement of mechanizations in time and motion study.

3.4. Field Trial

This estate has been using BAIC since the beginning of its establishment. However, it switched to using three-wheeler machines starting in October 2022. The buffalo will serve as a backup and will only be utilized if there are too many FFBs or if the three-wheeler machine breaks down. Data on harvested bunches, time taken, required labour force, actual productivity, and costs will be compared between the use of three-wheeler machines and BAIC. These data will be collected in the same block for 5 consecutive days. The total run hours and the number of workers who operate the three-wheeler machine and buffalo will be the same throughout the five days to ensure the data is more accurate and to avoid any bias.

3.5. Trial Procedures

This procedure begins by forming a group for each mechanization that are used, and for this research, it was started with the usage of the three-wheeler machine first. Each three-wheeler machine required four (4) laborers, while the buffalo required two (2) laborers.

At first, the cutter would enter the oil palm area to cut fresh fruit bunches and fronds. Once the FFB from a row of palms (from point A to point B) had been fully harvested, a second worker called a carrier would enter with a buffalo to gather the fresh bunches. During this process, all data, including the time in and out for carriers and buffaloes transporting FFBs and the total productivity of FFBs from 8 a.m. to 6 p.m., was collected. The capital, maintenance and repair costs, and fuel consumption for mechanical buffalo were also recorded.

4. RESULTS

4.1. The Comparison of Productivity of FFB Per Hour Using Three-Wheeler Machine and BAIC

In order to carry out this study, the productivity of FFB was compared for each hour between these two mechanizations in order to determine the overall productivity of the three-wheeler machine and BAIC. As indicated in Tables 2 and 3, all the information that was gathered was recorded.

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Table 2. Productivity of FFB per hour using three-wheeler machine.

Start	End	Day					Total bunches	ABW (kg)	Average harvested bunches (kg)	Average harvested bunches (mt)
		1	2	3	4	5				
8.00AM	9.00AM	88	81	81	80	77	407	20.11	8,184.77	8.184
9.00AM	10.00AM	73	82	82	89	57	383	20.11	7,702.13	7.702
10.00AM	10.30AM	Break								
10.30AM	11.00AM	31	31	32	38	33	165	20.11	3,318.15	3.318
11.00AM	12.00PM	86	79	73	93	68	399	20.11	8,023.89	8.024
12.00PM	1.00PM	Break								
1.00PM	2.00PM	67	71	70	73	61	342	20.11	6,877.62	6.878
2.00PM	3.00PM	83	65	73	96	62	379	20.11	7,621.69	7.622
3.00PM	4.00PM	67	79	68	71	76	361	20.11	7,259.71	7.260
4.00PM	5.00PM	72	86	88	78	62	386	20.11	7,762.46	7.762
5.00PM	6.00PM	72	71	70	90	60	363	20.11	7,299.93	7.300
Total		639	645	637	708	556	3,185		64,050.35	64.050

Table 3. Productivity per hour of FFB using BAIC.

Start	End	Day					Total bunches	ABW	Average harvested bunches (kg)	Average harvested bunches (mt)
		1	2	3	4	5				
8.00AM	9.00AM	30	31	29	30	28	148	20.11	2,976.30	2.976
9.00AM	10.00AM	31	29	31	29	28	148	20.11	2,976.30	2.976
10.00AM	10.30AM	Break								
10.30AM	11.00AM	10	9	7	7	9	42	20.11	844.60	0.844
11.00AM	12.00PM	29	24	26	27	27	133	20.11	2,674.60	2.675
12.00PM	1.00PM	Break								
1.00PM	2.00PM	29	28	26	26	25	134	20.11	2,694.70	2.695
2.00PM	3.00PM	28	24	25	28	31	136	20.11	2,735.0	2.735
3.00PM	4.00PM	29	25	27	24	25	130	20.11	2,614.30	2.614
4.00PM	5.00PM	24	25	23	22	23	117	20.11	2,352.90	2.353
5.00PM	6.00PM	28	29	26	31	30	144	20.11	2,895.80	2.896
Total		238	224	220	224	226	1,132		22,764.50	22.764

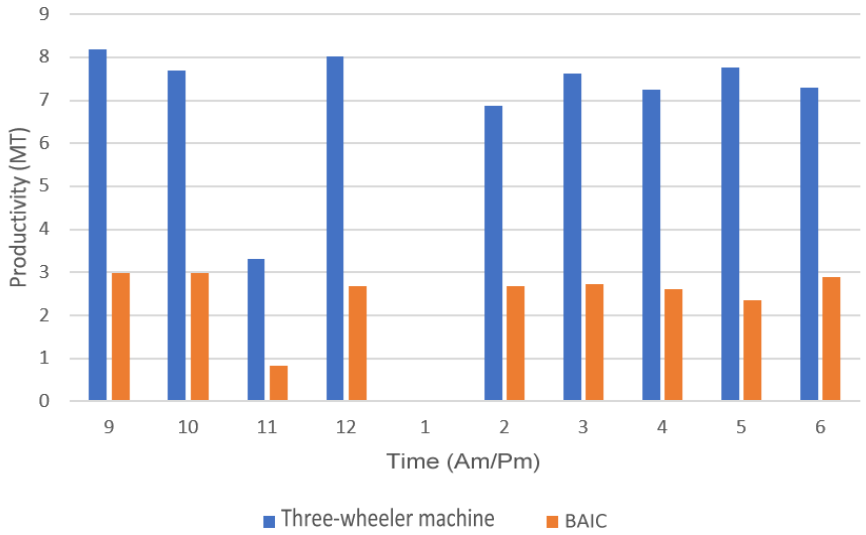

Figure 6. The comparison productivity of FFB per hour between three-wheeler machine and BAIC.

Tables 2 and 3 show a comparison that highlights the differences between using three-wheeler vehicles and BAIC for each hour over the period of five consecutive days. The research findings show that using three-wheeler

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machines differs significantly from using BAIC. The productivity chart in Figure 6 illustrates relatively low productivity between 10.00 am to 10.30 am because the laborers are taking their break, and it is also relatively slow between 12.00 pm to 1.00 pm as laborers are taking their break. The highest FFB harvest average was recorded by three-wheeler machines between the hours of 8.00 am to 9.00 am, while BAIC also recorded high averages between 8.00 am to 9.00 am and from 9.00 am to 10.00 am.

4.2. The Daily Comparison of Time and Motion Study between Three-Wheeler Machine and BAIC

Since the data reveals the productivity and daily time required for both mechanizations to move in order to collect the FFBs, each component of the research was assessed in terms of the average time and overall productivity for five (5) days. Therefore, the daily comparison of time and motion study between three-wheeler machine and BAIC is presented in Table 4 and 5.

Table 4. Time and motion study for 5 days using three-wheeler machine as a harvesting in-field collection mechanization.

Day (1)	Start	End	Time taken (Min)	Hectare covered (2)	Harvested bunches (3)	Actual mt (4) = (3*ABW/1000)
1	8.00AM	6.00PM	451	3.40	639	12.85
2	8.00AM	6.00PM	457	2.80	645	12.97
3	8.00AM	6.00PM	453	3.20	637	12.81
4	8.00AM	6.00PM	454	3.20	708	14.24
5	8.00AM	6.00PM	451	2.60	556	11.18
Total			2,266	15.2	3185	64.06
Average			453.2	3.04	637	12.81

Note: *Average bunch weight (ABW) = 20.11 kg / bunch.

Table 5. Time and motion study for 5 days using BAIC as a harvesting in-field collection mechanization.

Day (1)	Start	End	Time taken (Min)	Hectare covered (2)	Harvested bunches (3)	Actual mt (4) = (3*ABW/1000)
1	8.00AM	6.00PM	465	2.3	238	4.79
2	8.00AM	6.00PM	456	2.2	224	4.50
3	8.00AM	6.00PM	471	2.1	220	4.42
4	8.00AM	6.00PM	461	2.2	224	4.50
5	8.00AM	6.00PM	475	2.2	226	4.54
Total			4,328	11	1132	22.75
Average			465.6	2.2	226	4.55

Note: *Average Bunch Weight (ABW) = 20.11 kg / bunch.

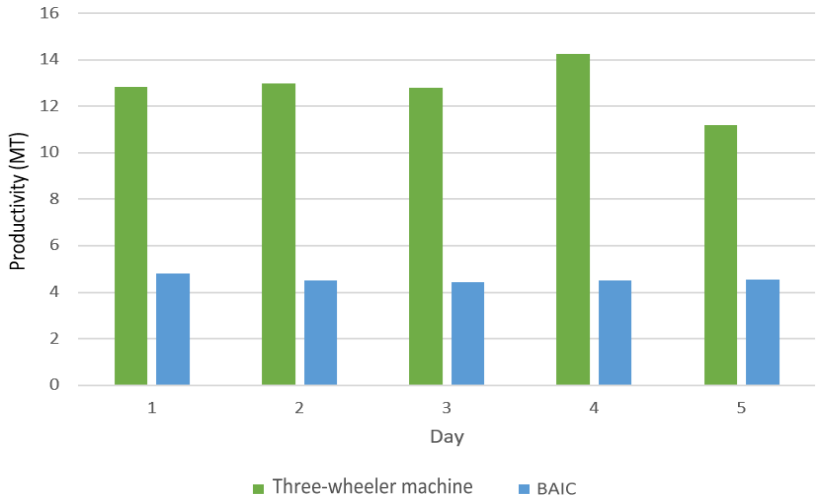

Figure 7. The comparison daily productivity of FFB between three-wheeler machine and BAIC.

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Tables 4 and 5 show the results time and motion study for the three-wheeler machine and BAIC. The daily working hours for both mechanizations are the same from 8.00 am to 6.00 pm per day. Figure 7 displays a total average productivity for three-wheeler machines and BAIC, which are 12.81 mt/day and 4.55 mt/day, respectively. The harvested bunch are 637 bunches/day and 226 bunches/day. Furthermore, the hectare coverage for using a three-wheeler machine is 3.04 ha, while for BAIC, it is 2.2 ha.

4.3. Comparison of Three-Wheeler Machine Vs BAIC

The percent difference in terms of daily working hours, total workers needed by each mechanization, effective working time, hectare coverage, worker ratio, harvested bunches, and average productivity (Mt/day and Mt/harvester) between three-wheeler machines and BAIC can be seen in the Table 6.

Table 6. Percentage of difference using three-wheeler machine and BAIC.

Description	Three-wheeler machine	BAIC	Difference	% Difference
Daily working hours (Hr)	9	9	0	0
Total workers	4	2	+2	+100
Effective working time (Hr/Day)	7.51	7.76	-0.25	-3.3
Hectare cover (Ha/Day)	3.02	2.20	+0.82	+37.3
Worker ratio	1:30	1:20	+1:10	+50
Harvested bunches (Bunches/Day)	637	226	+411	+181.9
Average productivity (Mt/Day)	12.81	4.54	+8.26	+181.5
Average productivity (Mt/Harvester)	3.20	2.27	+0.93	+40.97

To calculate the percentage difference is as follows:

$$Percentage\ difference = \frac{Difference}{Lowest\ original\ values\ (either\ BAIC\ of\ Three-wheeler\ machine)}$$

(Jelani et al., 2008).

The total difference shows that the usage of a three-wheeler has a higher percentage of difference compared to BAIC. The time for the motion study in this research was set from 8.00 am to 6.00 pm. Throughout this study, four (4) labors were used for the three-wheeler machines, while two (2) laborers were used for BAIC. The average productivity using a three-wheeler from 8.00 am to 6.00 am is higher than BAIC, resulting in 12.81 mt/day and 4.54 mt/day. Moreover, the average productivity per harvester was 3.20 mt/harvester for three-wheeler machines and 2.27 mt/harvester for BAIC.

Table 7. Machinery cost for three-wheeler machine and BAIC.

Description	Three-wheeler machine cost (RM/Mt)	BAIC (RM/Mt)
Depreciation	1.50	0.0193
Interest	0.40	0.0040
Tax and insurance	0.18	0.0016
Repair and maintenance cost	1.13	0.0013
Fuel consumption	0.78	-
Lubricant oil cost	0.24	-
Feeding / Caretaker	-	0.0820
Veterinary	-	0.0004
Security / Night watchman	-	0.0090
Overhead cost	0.99	0.0235
Others	0.70	-
Total cost per mt	5.92	0.3508

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4.4. Costing Analysis

The process of calculating potential earnings from a condition or plan after deducting the whole cost of implementi ng it is known as costing analysis.

The following Table7 compares the machinery costs for both the three-wheeler machine and the BAIC, while Table 8 shows the comparison for three-wheeler machine and BAIC in term of price, economic life, ABW, productivity, productivity per harvester, and working days per month.

Table 8. The comparison for three-wheeler machine and BAIC.

Description	Three-wheeler machine	BAIC
Price	RM 21,800 (Yanmar engine) = RM 21,800	Buffalo: RM 5.500 Cart: RM 1.500 = RM 7.000
Economic life (Year)	3	7
ABW	20.11 kg	20.11 kg
Productivity	637 Bunches/Day × 20.11 kg = 12.81 Mt/Day	226 Bunches/Day × 20.11 kg = 4.54 Mt/Day
Productivity per harvester	3.2 Mt/Day/Harvester	2.27 Mt/Day/Harvester
Working days per month	26	26

4.5. Cost Effectiveness

To examine the cost per bunch harvested, the cost-effectiveness of the three-wheeler machine and BAIC were computed.

$$Cost\ effectiveness, Ec = \frac{Machine\ price}{Total\ FFB\ harvested}$$

4.5.1. Three-Wheeler Machine

Total number of harvested bunches.
[Economic life, E × 12 months × Working days per month × Productivity (mt/harvester)].
= (3 x 12 months) × 26 days × 3.20 mt
= 2,995.2 mt
Cost-effectiveness = RM 21,800 / 2,995.2 mt
= RM 7.28/mt/harvester.

4.5.2. Buffalo Assisted in-Field Collection (BAIC)

Total number of harvested bunches.
[Economic life, E × 12 months × Working days per month × Productivity (mt/harvester)].
= (7 x 12 months) × 26 days × 2.27 mt
= 4,957.68 mt
Cost-effectiveness = RM 7,000 / 4,957.68 mt
= RM 1.41/mt/harvester.

5. DISCUSSIONS

Based on the conducted trials, the three-wheeler machines have proven to be quite effective, with a significant difference in productivity compared to BAIC, at 12.81 mt/day and 4.54 mt/day (181.5% difference), and hectare coverage at 3.02 ha and 2.20 ha, respectively (a 37.3% difference). Moreover, the labor-to-land ratio also increased from 1:20 ha to 1:30 ha (a 50% difference), which means one (1) labor can cover 20 ha by using a BAIC, while one (1) labor can cover 30 ha using the three-wheeler machine. However, the usage of BAIC has lower maintenance and repair costs compared to the three-wheeler machine because problems with BAIC are typically minor, such as bearing and buffalo cart breakage due to rust, which can be fixed at a minimum cost by welding. The bearing rarely needs to be changed, depending on the buffalo cart's movement rather than on the muddy path. It typically needs to be changed every 2-3 months.

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The cost of maintenance when using a three-wheeler machine depends on how the workers use it. Good care does not require a high cost for repair and maintenance. The only maintenance that is required on a three-wheeler is the replacement of the belt if it is broken or every six months, while the engine oil must be replaced every four weeks. Furthermore, the usage of three-wheeler machines requires diesel consumption of around 2L/day, and currently, in October 2022, the diesel price is RM 2.15, so the diesel price for one three-wheeler machine will be RM 4.30/day.
Regarding the number of laborers needed, a three-wheeler machine required four (4) laborers, while BAIC only required two (2) laborers. This is considered worthwhile because the coverage hectare and the productivity of using a three-wheeler machine are substantially different and greater than those of a BAIC.
Furthermore, the cost-effectiveness of a three-wheeler machine is RM7.28 per metric tonne per day per harvester, whereas the BAIC is RM1.41 per metric tonne per day per harvester, which is significantly different. This shows that using of BAIC requires less cost compared to using a three-wheeler machine. However, if laborers use a three-wheeler machine in the estate, their energy can be reduced, and they can save time collecting the FFBs.
However, the use of buffalo is being forgotten nowadays as most companies consider it is outdated with the availability of in-field harvesting machines. Despite this, some estates still use buffaloes as the cost is minimal. For example, the estate does not need to pay for buffalo food since the animals only eat grass and just need a salt lick. Additionally, buffalo can also be used for grazing on the estate for them to eat grass and at the same time can reduce usage of chemical on the estate. Moreover, the use of buffalo promotes a greener environment as it does not pollute the environment compared to machine users. However, due to severe labour shortages, most estates are currently unable to continue using buffaloes. The continued use of buffaloes would result in an increased workload for laborers and decrease worker income due to low productivity.

6. CONCLUSION

The use of three-wheeler machine has been proven to increase the productivity of FFBs. Although using a three-wheeler machine requires more caution because it cannot be forced to go through in mud compare to a buffalo, it really makes in-field collection process for labor much easier. Furthermore, it is important for management to think of ways to increase the laborers' salaries in order to ensure that they are satisfied and won't have a problem at the end of the month due to the low payment. Therefore, the usage of machines for in-field collection can increase the laborers' income since they are usually paid based on their daily productivity. Hence, the use of this machine is like killing two birds with a stone because it can improve productivity rates and increase the laborers' pay at the same time. Although using a three-wheeler machine requires a lot of repair and maintenance, proper care by laborers will extend its lifespan.

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CONFLICT OF INTEREST
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