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Short Communication

Paddy Harvesting Based on Acreage or Paddy Harvesting Based on Weight: A Comparative Study on Combine Harvesting Loss

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Abstract: Losses during paddy harvesting have been a common issue in Malaysia. Currently, there are two methods of harvesting charges, either based on acreage or based on weight. There is a need to observe the harvesting loss effects based on these harvesting charge methods. The experiment was conducted in MADA Regional Farmers' Organization (PPK) E-IV, Kota Sarang Semut, Kedah, using only reconditioned tangential-flow type combines provided by MADA. The combines used recommended, optimized settings to ensure reduced harvesting losses. Harvesting losses were measured using both acreage-based and weight-based harvesting charges. Harvesting losses were also measured using three different types of harvesting speed: 3.6 km/h (low), 4.5 km/h (medium) and 6.1 km/h (high). Results showed that the average harvesting loss using the weight-based method was 1.3%, while the average harvesting loss using the acreage-based method was 4.6%. Regarding harvesting speed, a low speed resulted in an average harvesting loss of 1%, while a moderate speed resulted in an average harvesting loss of 2%. The top harvesting speed produced an average harvesting loss of 2.6%. Results showed that any harvesting charge method can be applied as long as combine harvesters are properly adjusted according to the recommended settings provided by MARDI SOP. Combine harvester operators should ensure their combine harvesters follow the recommended machine settings and harvesting speed to achieve lower harvesting losses.

Keywords: combine harvester; combine harvesting loss; reconditioned tangential-flow combines

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1. Introduction

Combining harvesters for paddy harvesting has been used since the 1970s (Abu Hassan *et al.*, 2010; Ahmad *et al.*, 2018). Combine harvesters were introduced to overcome labour shortage and increase productivity and efficiency of paddy harvesting. A small portion estimated at 5% of these combine harvesters are owned by government agencies , while private companies own the remaining 95%. Ahmad *et al.* (2018) reported more than 1500 units of combine harvesters in Malaysia.

There are various types of combine harvesters that are operating in Malaysia. Most combine harvester operators use reconditioned combine harvesters rebuilt from imported, scrapped units. These combine harvesters use a tangential-flow-type threshing system that farmers in Malaysia widely accept. These combines, generally known as conventional type combines, have a single or sometimes double threshing drum or rotor, rotating perpendicular to the direction the combine travels. The threshing drum has several rasp bars fixed to the drum and a concave underneath it, which is made of parallel bars held together by parallel curved bars. When the crop is fed through the threshing drum, the crop is forced through the minimal gap between the concave and rasp bars, together with impact and rubbing action, that would produce the threshing effect. The separation process is achieved using oscillating straw walkers (Mokhtor *et al.*, 2020; Ahmad *et al.*, 2018).

The rice granary authorized by Muda Agricultural Development Authority (MADA) has paddy fields of 100,685 hectares. MADA has a few Regional Farmers' Organizations (PPK) that own 2% (11 units) of combine harvesters, while private and individual service providers own the remaining 98% (687 units).

Currently, there are two popular methods of harvesting charges: acreage-based harvesting charge and weight-based harvesting charge. Acreage-based harvesting charge is harvesting based on the amount of daily acreage that can be harvested by one combine harvester. At the same time, the weight-based harvesting charge is harvesting based on the harvested yield per plot. Weight-based harvesting charge is widely used in Perak, Selangor, and the East Peninsular. Usually, the acreage-based harvesting charge is popular in MADA because combine operators try to achieve as much daily acreage as possible. In return, the operators will be paid more. However, looking at the other harvesting charge, which is weight-based, some farmers prefer this method. This method would force the combine operators to harvest at a minimum speed of around 3.6 km/h. Combine operators must also ensure that their machine settings are optimized and in good condition. As a result, farmers claimed to obtain more yield and that combine operators would also be paid more due to the increase in yield.

The harvesting speed factor might be the only reason behind these two harvesting charge methods. Shahar *et al.* (2017), Ahmad *et al.* (2018), and Mokhtor *et al.* (2020) reported that by using different harvesting speeds, the harvesting loss could be reduced.

This paper aims to observe the harvesting loss based on two methods of harvesting charges, either based on acreage or weight.

2. Materials and Methods

The experiment was conducted in MADA Regional Farmers' Organization (PPK) E-IV, Kota Sarang Semut, Kedah. Two plots of similar size were selected to represent each harvesting charge method based on acreage or weight. Plots with no disease, no weed and a standing crop overall were selected to reduce factors associated with the plants. Both plots were thoroughly dried to reduce any issues with soft soil. Both plots used the same variety, which is MR263. Three randomly selected sampling areas of 15 m long and 5 m wide were identified in each plot. The sampling size was selected based on the overall dimensions of the combine harvester.

Another experiment was done to observe the harvesting losses based on different harvesting speeds. The same combine harvester model was used in this experiment. Three different levels of harvesting speeds were tested: low speed (3.6 km/h), medium speed (4.5 km/h) and high speed (6.1 km/h), following the recommended harvesting speed range (Ahmad *et al.*, 2018; ASABE, 2015, 2016; Mokhtor *et al.*, 2020). For this experiment, three plots of similar size and conditioned plots were chosen to represent each speed range. Three randomly selected sampling areas with the same sampling size were marked in each plot.

The combine harvester was a reconditioned, double-threshing tangential flow combine harvester (Clayson New Holland model 1545, Canada). Two units of similar models and conditions provided by MADA were used for each plot. The combines used recommended, optimized settings to ensure reduced harvesting losses. One jumbo bag with a maximum capacity of 1000 kg was placed at the straw exit area to collect unthreshed samples. Another jumbo bag was placed inside the grain tank to collect the yield of the sampling area. Another netted bag was placed in the blower exit area to collect unthreshed samples from the fan blower cleaning section (Abu Hassan *et al.*, 2010; Ahmad *et al.*, 2018).

2.1. Combine Harvester Losses

The sampling area within the chosen plot was determined based on the combine header width of 5 m. The sampling area length was three times the length of a combine, which was 15 m. This was to ensure that the combine harvester had enough space to maintain the targeted harvesting speed and that the harvested had enough time to be processed inside the combine. After harvesting the sampling area in a forward direction, the combine was required to proceed in reverse mode for 5m to collect the combine header loss. Combine header losses were gathered beneath the combine header using three 50 cm quadrats, and processing losses were collected at the combine rear using a jumbo bag mounted at the combine rear straw exit. Yield collected along the sampling area was collected using a jumbo bag fixed inside the combine grain tank. This procedure was replicated three times.

2.2. Combine Harvester Losses Calculation

Based on previous work by Abu Hassan *et al.* (2010; 2012), the following formula was used to calculate combine harvesting losses:

$$\text{Processing Loss, PL (\%)} = \text{a}/\text{c} \times 100 \tag{1}$$

$$\text{Combine Header Loss, HL (\%)} = \text{b}/\text{c} \times 100 \tag{2}$$

$$\text{Combine Harvester Total Loss, (\%)} = \frac{\text{PL} + \text{CL}}{\text{c}} \times 100 \tag{3}$$

Where
a = Total clean grain collected at the combine rear jumbo bag, g
b = Total clean grain collected beneath the combine header, g
c = Total yield collected in the grain tank, g

Parameters such as travel speeds were measured during harvesting inside the sampling areas. A similar speed was used to compare different harvesting charge methods, which was 3.6 km/h. After harvesting the sample area, all jumbo and netted bags were collected, weighed, and recorded.

3. Results and Discussions

3.1. Comparison of Harvesting Losses Between Harvesting Charge Method

The experiment conducted in MADA showed that the harvesting loss using a weight-based harvesting charge produced was only 1.3%, compared to the harvesting loss of 4.6% using an acreage-based harvesting charge. The weight-based harvesting charge method used a significantly reduced harvesting speed of 3.6 km/h compared to the acreage-based harvesting charge method of 7.6 km/h, the usual harvesting speed used by operators. Usually, operators would like to target harvesting up to 8 ha/day. Results also showed that threshing loss contributes the most to harvesting losses compared to header loss. Combining harvesters with recommended settings (MARDI, 2018) also contributed to reducing the harvesting loss.

Table 1. Harvesting loss between harvesting charge method

	Harvesting Charge Method	
	Weight	**Acreage**
Header Loss (%)	0.6	0.6
Threshing Loss (%)	0.7	4.0
Harvesting Loss (%)	**1.3**	**4.6**

3.2. Harvesting Losses Based on Harvesting Speed

A comparison of harvesting loss between three levels of harvesting speed was observed. Results showed that the lowest level harvesting speed of 3.6 km/h produced a harvesting loss of 1%. The medium-level harvesting speed of 4.5 km/h produced a harvesting loss of 2%. The highest-level harvesting speed of 6.1 km/h, the fastest the operator could drive during the experiment, produced a harvesting loss of only 2.6%. These speeds are similar to those done by Mokhtor *et al.* (2020), where the harvesting losses were similar.

Table 2. Harvesting loss between harvesting speeds

Harvesting Speed Level	Speed (km/h)	Harvesting Loss (%)
Low	3.6	1.0
Medium	4.5	2.0
High	6.1	2.6

The recommended harvesting speed range recommended by MARDI (2018) is between 3 km/h and 6.1 km/h. Results showed that harvesting by the acreage charge method adopts a higher speed than the recommended method. Hence, the harvesting loss was higher than the other harvesting charge method. The acceptable harvesting loss is below 3% (ASABE, 2016). However, if the combine harvester still complies with other machine adjustments as MARDI (2018) recommended, such as the combine header reel speed, threshing drum speed and blower speed, the losses could be reduced. This applies to both harvesting charge methods.

4. Conclusions

Combine harvesting losses were evaluated based on two harvesting charge methods: reconditioned, double threshing and tangential flow combine harvesters. Results showed that the average harvesting loss using the weight-based method was 1.3%, while the average harvesting loss using the acreage-based method was 4.6%. Regarding harvesting speed, a low speed resulted in an average harvesting loss of 1%, while a moderate speed resulted in an average harvesting loss of 2%. The top harvesting speed produced an average harvesting loss of 2.6%. Results showed that any harvesting charge method can be applied as long as combine harvesters are properly adjusted according to the recommended settings provided by MARDI SOP. Combine harvester operators must ensure their combine harvesters follow the recommended machine settings and harvesting speed to achieve lower harvesting losses.

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Conflicts of Interest: The authors declare no conflict of interest.

References

Abu Hassan, D., Ibni Hajar, R., Mohammud, C. (2010). *Combine harvesting losses in Malaysian paddy fields (in Malay)* (MARDI Report No 212). MARDI.

Abu Hassan, D., Mohd Shahril Shah, M., Zainuddin, Z., *et al*. (2012). *Combine harvester and combine harvesting loss evaluation technology manual (in Malay)*. MARDI.

Ahmad, M. T., Khadzir, M. K., Wan Ahamad, W. M. A., *et al*. (2018). *Comparison of combine harvesting losses between reconditioned tangential flow combines and axial flow combines in malaysia*. *2018* (NCAFM), 3–5.

Ahmad, M. T., Sharu, E. H., Nordin, M. N., *et al.* (2018). *Paddy harvesting losses due to combine harvesting verfication study (in Malay)*. MARDI Report No 224. MARDI

ASABE. (2015). Terminology for Combines and Grain Harvesting. In *ASABE Standards*. ASABE.

ASABE. (2016). Combine capacity and performance test procedure. In *ASABE Standards*.

MARDI (2018). *Standard operating procedure to reduce paddy post-harvest losses during combine harvesting.*In MARDI SOP. (in Malay)

Mokhtor, S. A., El-Pebrian, D., & Johari, N. A. A. (2020). Actual field speed of rice combine harvester and its influence on grain loss in Malaysian paddy field. *Journal of the Saudi Society of Agricultural Sciences*, *19*(6), 422–425. https://doi.org/10.1016/j.jssas.2020.07.002

Shahar, A., Harun, A., Ahmad, M. T., *et al.* (2017). *Postharvest management of rice for sustainable food security in Malaysia.* FFTC Agricultural Policy Platform (FFTC-AP).