VIBRATION ISOLATOR FOR THE OIL PALM MOTORISED CUTTER

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Efficient harvesting of fresh fruit bunches (FFB) is vital to ensure the FFB are harvested within the recommended harvesting round of 10 to 12 days interval. Manual harvesting (using a sickle or chisel) can only produce about an average of 1 t FFB man^{-1} day^{-1} (Azman *et al.*, 2015). Estates are now looking for more efficient harvesting tools that could increase productivity and ultimately reduce the number of workers. The harvesting productivity needs to be increased to about 4 t FFB man^{-1} day^{-1} if the country wishes to reduce labour requirement significantly (Abdul Razak *et al.*, 2013). One of the technologies that has been well accepted by the oil palm industry is the oil palm motorised cutter (called Cantas) that was introduced in 2007 (Abdul Razak *et al.*, 2013). Cantas is powered by a small petrol engine and utilises either a specially designed C-sickle or chisel as the cutting knife. Cantas has been categorised as a type of machine that generates vibration which could cause hand arm vibration syndrome (HAVS) when over exposure of daily usage. Therefore, it is necessary that the risks from vibration generated by Cantas should be managed and controlled.

Problem Statements

The current Cantas utilises petrol engine which triggers some general concerns such as vibration. The problems that are associated with the vibration have prompted the initiative to design the vibration isolator that can reduce the level of vibration of the machine.

Objective

The objective of the study is to design, develop and test the vibration isolator on the magnitude of vibration on Cantas.

THE TECHNOLOGY

Vibration Isolator Design

Sources of vibration of the oil palm motorised cutter fundamentally come from both rotational and linear motions of the moving components such as engine, transmission shaft, shaft guiders and gear-box (*Figure 1*). Rotational motions basically come from the engine, transmission shaft and bearings, while linear motions come mainly from the gear box. The vibration therefore is developed throughout the length of the machine during operation with the magnitude which may differ from point to point. Vibrations arise when a body oscillates due to external and internal forces. Vibration may be transmitted to the human body through the part in contact with the vibrating surface such as the handle and the pole of the machine.

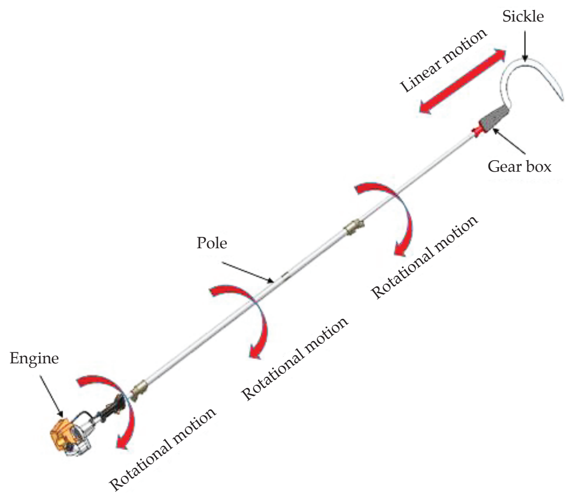

Figure 1. Sources of vibration of the motorised cutter.

The vibration isolator comprises of two basic components *i.e.* a compression spring and a pair of bearings. The spring with its nature of being elastic is functioning to isolate the vibration, while the bearings which are placed at both ends of the spring

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is functioning to stabilise the vibration collected by the spring (*Figure 2*). The arrangements of bearings were fixed in line with the spring axis and the dimension of vibration isolator is shown in *Figure 3*. The vibration isolator is to be placed on pole of the motorised cutter which its best position would be determined from this study. Theoretically the vibration generated by the machine would be collected and stabilised by the vibration isolator (*Figure 4*).

Measurement of Vibration

The study was conducted at MPOB Keratong Research Station in Pahang. The palms where the experiment was conducted were about 10 years old with the height range from 2.5 m to 3.5 m. The field topography was flat.

A tri-axial accelerometer was used to measure the magnitude of vibration generated by the machine. The measurement complied with the standard ISO5349, the same standard used by other reports (Salihatun *et al*., 2013; 2014; Amitkumar *et al*., 2015). In the experiment, the vibration sensor was placed at the holding points (P1 and P2) with the machine's pole angle was set at 60^{o} as shown in *Figure 5*. The data was recorded when the worker started cutting the frond until finish.

RESULT AND DISCUSSION

Effect of Vibration Isolator on HAV of Cantas

Table 1 and *Figure 6* show the average data of HAV generated by Cantas from the experiment conducted. The highest HAV was obtained at P2L1 (1.8 m s^{-2}) and the lowest HAV was obtained at P1L1 (1 m s^{-2}). As for comparison, the HAV of Cantas without vibration isolator were 2.7 m s^{-2} and 3.2 m s^{-2} for P1 and P2, respectively.

Figure 2. The design of vibration isolator.

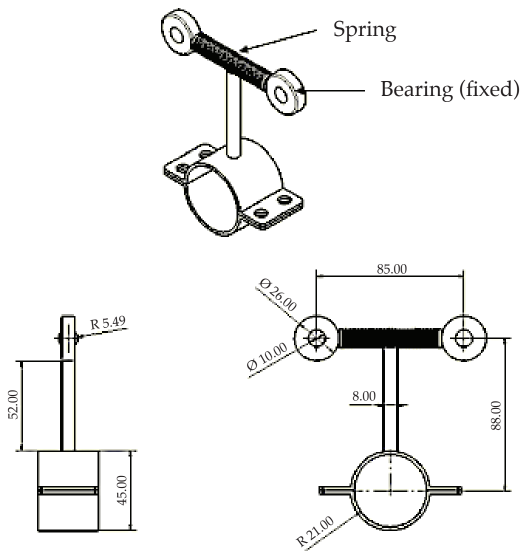

Figure 3. Schematic drawing of vibration isolator.

TABLE 1. HAV OF CANTAS (with and without vibration isolator)

Holding point	Control (without vibration isolator)	With vibration isolator			
		Distance from engine		Average of HAV	Percent of reduction (%)
		70 cm	120 cm		
P1 (m s^{-2})	2.7 n=6 σ = 1.29	1 n=6 σ = 0.50	1.5 n=6 σ = 0.68	1.25	(- 54)
P2 (m s^{-2})	3.2 n=6 σ = 0.61	1.8 n=6 σ = 0.92	1.7 n=6 σ = 0.69	1.75	(- 45)
				Overall	**(- 49.5)**

Referring to *Table 1*, generally fixing a vibration isolator on Cantas have given significant effects on the reduction of HAV. The isolator was found to reduce HAV significantly. The isolator had given a better effect where the HAV were reduced by 54% and 45%, respectively at P1 and P2, compared to HAV without vibration isolator. The experiment disclosed that the isolator is with overall HAV reduction of 49.5%.

Field Trial

The field trial of the prototype of the vibration isolator was carried out by a harvesting contractor (smallholder) at Banting, Selangor since July 2017. The isolator was fixed at the motorised Cutter at a distance of 70 cm from the engine.

Feedback received from the harvester that the use of vibration isolator on the Cantas reduces its vibration thus giving more comfortable during harvesting.

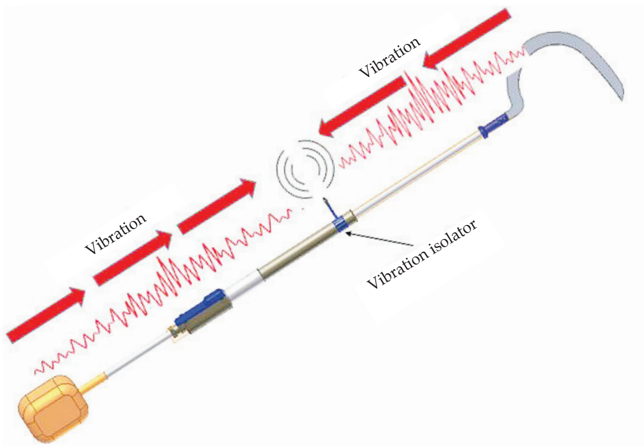

Figure 4. Vibration reduction of the motorised cutter by the vibration isolator.

Figure 5. Vibration measurement during cutting of frond.

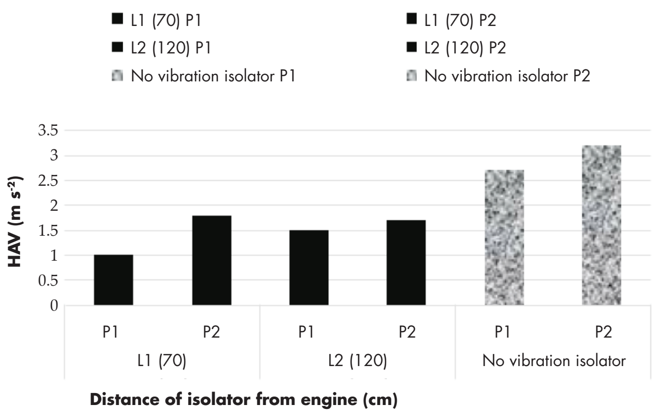

Figure 6. Results of hand arm vibration (HAV) of Cantas.

ECONOMIC ANALYSIS

Manufacturer Perspective

From the manufacturer perspective, the following economic analysis can be used as a reference if one were to start the business.

Internal rate of return (IRR)	:	42%
Net present value (NPV)	:	RM 133 992
Payback period (PB)	:	6 yr
BC ratio	:	1.19

Assumption

Material cost	:	RM 30 unit^{-1}
Average production	:	200 units month^{-1}
Working day	:	26 days month^{-1}
Utilities and office	:	RM 1000 month^{-1}
Labour cost	:	RM 1500 month^{-1} (one worker)
Operating cost per month (OPEX)	:	RM 4525
Selling Price	:	RM 120 unit^{-1}
Profit margin	:	28%

IMPACT

The introduction of such technology is expected to offer a significant impact to the industry and the country in-terms of increasing harvesting productivity and workers' income, reducing vibration issues and HAVS as well.

IP STATUS

Highly recommended to be filed as utility innovation.

CONCLUSION

The demand of this technology is expected to increase the requirement of Cantas in the future as it offers low vibration Cantas which is the users' preference for comfortable handling. The vibration isolator was proven to reduce the magnitude of vibration transmitted from Cantas. Feedback from harvesters using the vibration isolator that it reduces vibration of Cantas which makes the handling of Cantas is more comfortable. The use of vibration isolator will give less vibration during harvesting that ultimately will increase harvesting productivity of workers and reduces HAVS issues.

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