

# Design and Development of Rice Leaf Cutter

Suwipong Hemathulin<sup>1</sup>, Nattadon Pannucharoenwong<sup>2</sup>,  
Chatchai Benjapiyaporn<sup>3\*</sup>, Snunkhaem Echaroj<sup>2</sup>

<sup>1</sup> Department of Mechanical and Industrial Department, Faculty of Industrial Technology,  
Rajabhat Sakon Nakhon University 47000 Thailand.

<sup>2</sup> Department of Mechanical Engineering, Faculty of Engineering, Thammasat University 12120 Thailand.

<sup>3</sup> Department of Mechanical Engineering, Faculty of Engineering, Khon Kaen University 40002 Thailand.

## Abstract

This paper aimed to design and develop of rice leaf cutters to increase efficiency of the group of rice farmers, at Ban Nang Noi, Tao Ngoi, Sakon Nakhon Province. By cutting the old rice leaf using lawn mower. The cutting of rice leaf has an average time of 54.80 minutes per Rai. In comparison with rice leaf cutters, the average cutting time was 23.90 minutes per Rai. Farmers can reduce their working time by up to 43.61% . Design and development based on the theory of building combine harvester. The horizontal vibration value is in the same direction as the combine harvester. The cost of rice production can be reduced by 640 Baht per Rai.

**Keywords** Rice leaf cutter, Combine harvester, Vibration

## INTRODUCTION

Thailand is an agricultural country where people engage in agricultural occupations. With 34% of the households working in agriculture and 93% of them located in rural areas [1]. The highest number of crops is rice. For consumption and export rice area is about 11.3% of the country. Rice is one profession that generates revenue for the country. With this reason farmers are trying to produce more in order to suffice the demand. With economic problems the cost of farming is higher. Most farmers have turned to paddy-sown field. Due to the process of making uncomplicated less cost. Farmers are experiencing weed problems. Rice is not fully grown and yield less.

Rice Farmers Group, Ban Nang Noi, Tao Ngoi, Sakon Nakhon Province. Nowadays, it is mainly made paddy-sown field and used lawn mower cut rice leaf and weed. During the weeds begin to grow and flower or 1-2 months after sowing to break the cycle not to spread grass the rice grows evenly and high yield [2-3]. But uses of lawn mowers to cut the leaf it is heavy and vibration. The center of gravity is not balanced. When cutting rice leaf the machine must be to swing. Pose a danger during operation and fatigue while working. The researcher has the idea to develop a small rice cutter to be effective. Applying the concept of design from a combine harvester. With less vibration and lightweight for easy mobility reduce vibration and balance. Increase Performance reduced working time reduces cutting time and increase rice yield [4].

## LITERATURE REVIEW

Design and development of the rice leaf cutter can be performed by using the theory to design combine harvester. The direction of rice cutter combined with harvester likely reduces the size and weight to be given access to agricultural areas [4]. The design of the cutter and cut transmission by reducing vibration during operation thus increasing the efficiency of harvesters [5]. The design of the transmission system must be related to the rotation speed so that the rice can be cutting regularly [10]. And a good crankshaft design with regard to speed can reduce vibration as well as increase efficiency for the combine harvester [7]. Based on the theory and research to apply the design and development of the rice leaf cutter to reduce the time to cut.

## METHODOLOGY

Study on the design and development of rice leaf cutters. The vibration design of the cutter blade is minimized as the vibration is the cause of the damage especially in the combine harvester [9]. Which can cut rice leaf regularly. And to fit the physique of the farmers the main components are as follows.

1. The structural characteristics of rice leaf cutter shape with dimensions as shown in Fig 1. And the section cutting blade designed to tilt angle of 45 degrees down below and limited in length because the vibrations will be correlated with the length of the blade cut [6]. Use the materials stainless steel because does not rust light weight and have straps to fit user behavior as shown in Figure. 1.

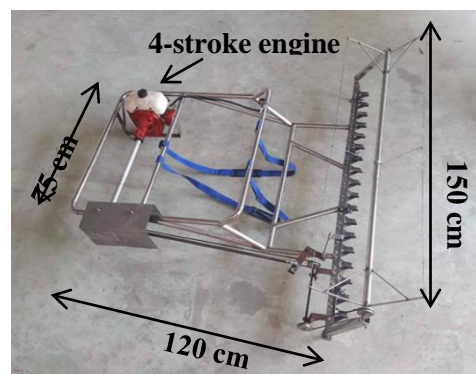


Figure 1. Dimension of structure

2. The power pack uses a lawn mower 4-stroke engine consumes less oil as shown in Fig. 1 fit to the structure of the machine to balance the front-back.

3. The cutting blade is made of aluminum for weight reduction and designed to reduce the vibration of cutting blade unit by decreasing the variation of cutting blade weight [13] and to be cut perpendicular to the rice crop and driven by gear and chain to prevent slipping loss [5]. Crankcase design to reduce the vibration as much as possible which is related to the speed round [10-11] as shown in Figure 2. And the selected speed 300 rpm because if the revs in the cutting at 250 rpm will cut rice leaf infected rice leaf all missing blades and if the speed at 400 rpm is too much vibration occurs [8] as shown in Figure 3 and also reduce the vibration of the cutting blade [6-7]. The working of the cutting blade is associated with a system of sliding mechanisms by virtue of bows crank as shown in Figure 3 so that the maximum cutting efficiency. Calculation of rotation speed and value ratios by using the equation (1) and (2).

$$d_1 n_1 = d_2 n_2 \quad (1)$$

$$i = \frac{n_1}{n_2} = \frac{d_2}{d_1} \quad (2)$$



Figure 2.. Gear and transmission system design

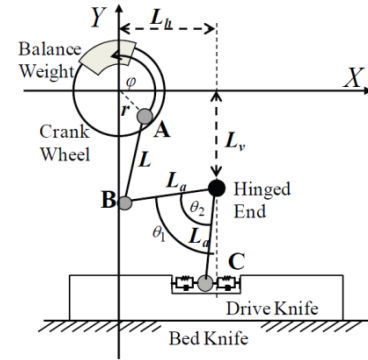


Figure 3. Simulation model of knife driving system

1. Researchers have designed a trial by summary in table 1.

Table 1: Experimental design of rice leaf cutter

Test area	Tester	Test time	Direction of cutting leaf	Number of tests
Prepare the rice planting area size 1 Rai of 10 plots of rice was planted. The rice cutting condition was determined for 2 months from the date of sowing.	Rice farmer, Baan Nang Noy Tao Ngai, Sakon Nakhon Province, 1 person, 35 years old.	Cut rice leaf from 8.00 am to 10.00 am, start cutting rice leaf at 8.00 am, stop at 1 Rai.	Cut along the y axis, cutting through the entire area and looping back.	The test is 10 times, 1 Rai total area of 10 Rai.



Figure 4. Farmers Tester cut rice leaves compare with Lawn mower cut rice leaf

Experiment with real users the rice seedlings were tested by one rice farmers rice leaf cutting trial was presented in Figure 4. The rice cutter was used in the morning session between 8 a.m. and 10 a.m. The time of cutting for 1 comparative the cutting using conventional lawn mowers.

2. Vibration tests the speed of cutting was increased by 50 cycles at 250 rpm, 300 rpm, 350 rpm and 400 rpm. To measure the vibration range of the cutter set in the horizontal axis by the VM-120 has an accuracy acceleration of 1.5% RMS. As shown in Figure 5. Measurement is in the Root Mean Square (RPM), which is mounted to the measurement location shown in Figure 6. Compares the results with the previous research [5].



Figure 5. Vibration meter kit VM-120

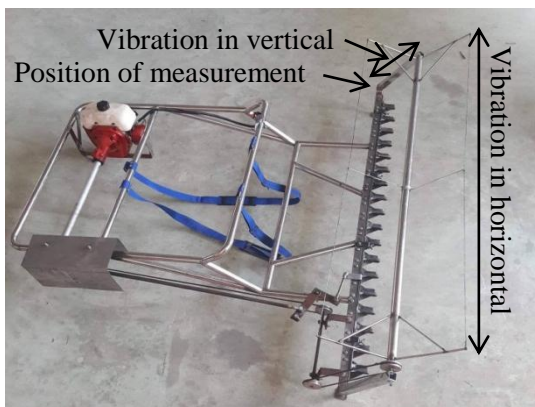


Figure 6. Vibration measurement

## RESULTS

Comparative of cutting time by 1-Rai with 10 times was compared with rice leaf cutting by using a lawn mower. The difference in cutting time was found to be more efficient and time-saving than the traditional cut by using a lawn mower method.

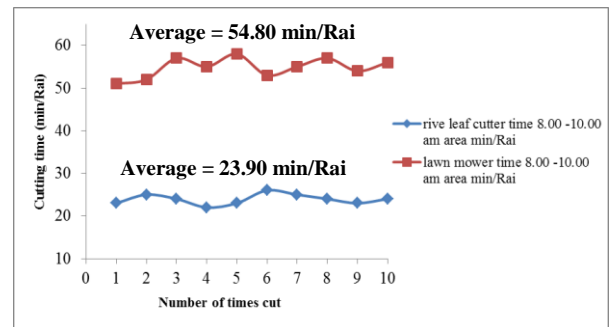


Figure 7. Comparative the time when using rice leaf cutter and lawn mower

Figure 8. shows comparison of the vibration of rice leaf cutter in horizontal. The vibration value is less than the traditional tractor. But it is more valuable than the harvest [5] by similar the results of the reference machine construction with the theory of combine harvester.

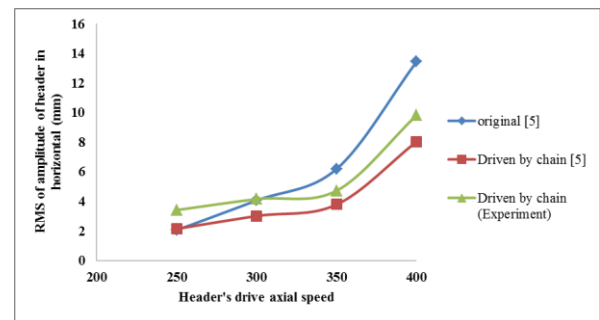


Figure 8. Comparative of correlation RMS of horizontal vibration and header's drive axial speed

Table 2 : Cost of rice production

Soil preparation	Cost of traditional farming (Baht/Rai)	Cost of rice leaf cutter (Baht/Rai)
1. Spray herbicide	300	300
2. Insecticide / herbicide 8-12 days - medication and labor cost	260	-
3. Insecticide / herbicide 35-40 days - medication and labor cost	310	-
4. Fuel Diesel - Gasoline	300	230
<b>Sum</b>	<b>1170</b>	<b>530</b>

Table 2 shows the cost of rice production based on the cost of rice production from the Department of Foreign Trade Ministry of Commerce at 21 January 2559 [12]. The cost of land preparation was 1170 baht / Rai while the cost of rice

leaf cutting cost was 530 Baht / Rai. Reduce the cost of farming to 640 Baht / Rai.

## CONCLUSION

The design of rice leaf cutter is based on the principles of reference and design of the theories and research related to the combine harvester. To test the efficiency of the rice leaf cutter was compared with the cutting rice leaves using a lawn mower. Figure 7. show rice leaf cutter can reduce the time to work it down. Farmers are easy to work and reduce fatigue. Figure 8 shown the measured vibration values compared to the vibration values of the combine harvester are likely to be in the same direction. Table 2 shows compared the cost of traditional rice cultivation without cutting leaf. The cost of rice leaf cutting can reduce the cost of rice production by 640 Baht per Rai and increase rice yields.

## ACKNOWLEDGEMENTS

This research has been successful. The research team would like to thank the farmers Ban Nang Noi, Tao Ngoi District, Sakon Nakhon Province. To study and collect information and suggestions for development and data collection in research. Thank you National Research Council of Thailand, Faculty of Industrial Technology, Research and Development Institute Sakon Nakhon Rajabhat University. Grants to support and facilitate research in this and this researched were supported by Faculty of Engineering Research Fund, Thammasat University.

## REFERENCES

- [1] Nattadon, P., Atichit, W., Chatchai, B., Jarinee, J. and Ponthepp, V., 2017, "Comparison of Bio-Methane Gas Wobbe Index In Different Animal Manure Substrate," *Energy Procedia*, 138, pp. 273-277.
- [2] Ali abdalla basyouni Abou-khalifa, A. N., Misra. and Abd El- Azeem. K. M. Salem., 2008, "Effect of leaf cutting on physiological traits and yield of two rice cultivars," *African Journal of Plant Science*, 2(12), pp. 147-150.
- [3] Konboon, Y., Sripodok, S., and Rattannasriwong , S., 2007, "Rice leaf cutting in Dry-seed broadcasting Rice," *Proceeding of Rice and temperate cereal crops annual conference*, Bangkok Thailand, p.112-118.
- [4] Josse, D.B. and Wouter, S. 2557., "Advanced Control of Combine Harvesters," KU Leuven, Department of Biosystems. Division MeBioS Kasteelpark Arenberg 30. B3001 Heverlee, Belgium.
- [5] Somchai, C., 2553. "Development of a Cutter Bar Driver for Reduction of Vibration for a Rice Combine Harvester," *KKU Research Journal*, 15 (7).
- [6] Fukushima, T., Inoue, E., Y., Mitsuoka Okayasu, T., and Sato, K., 2012, "Collision Vibration

Characteristics with Interspace in Knife Driving System of Combine Harvester," *EAEF* 5(3), pp.115-120.

- [7] Fukushima, T., Inoue, E., Mitsuoka, M., Okayasu, T., and Sato, K., 2006, "Vibration Characteristics and Modeling of Knife Driving System of Combine Harvester (Part 1)," *Journal of JSAM* 68 (5), pp. 52-58.
- [8] Chinsuwan, W. , Pongjan, N. , Chuan-Udom, S. , and Phayom, W., 200, " Effects of Reel Index on Gathering Loss of Rice Combine Harvester," *Thai Society of Agricultural Engineering Journal*, 11(1), pp.7-9.
- [9] Inoue, E. , Fukushima, T. , Hirai, Y. , Mitsuoka, M. , Marutani, I. ,Mori, K., and Jinyama, H., 2003, "Wavelet analysis of the vibration acceleration for field machines," *Sci. Bull. Fac. Agr. Kyushu Univ*, 57(2), pp.169-176.
- [10] Inoue, E. , Marutani, I. , Mitsuoka, M. , Hirai, Y. , Matsui, M. , Mori, K. ,Takase, A. , and Fukushima, T., 2004, "Mechanical model on the driving mechanism of combine's cutting section and verification," *Journal of JSAM*, 66 (2), pp.61-67.
- [11] Inoue, E., 2001, "Time series analysis of acceleration of cutting section of japanese combines in Japanese," *Journal of Kyushu Branch of JSAM*, 50, pp.31-36.
- [12] "thairiceinfo," 21 January 2016. [online]. Available: <http://www.thairiceinfo.go.th>.
- [13] Supakumnerd, K., Phimpisan, P., Chungchoo, C., and Asadamongkon, P., 2017, "Reducing Fan Blade Vibration in Rice Harvesters and Combine Harvesters by Applying Product Grouping," *International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 12*. pp. 3105-3110.