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# Performance Improvement Of Paddy Threshing Unit Using Brushless Direct Current Motor

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***Abstract: Paddy is the most important crop in the word. Much researchs have done to get the better quality and productivity of Paddy. In this study, we discuss an effort to improve the performance of a Paddy threshing, a machine for the separation of rice paddies from their stalks. This improvement using Brushless Direct Current (BLDC) motor, because the BLDC motor has higher efficiency and better torque at low speed. In addition to energy efficiency, the study also investigated the influence of the drum speed and the crop moisture content to the damage and loss of rice paddies. The results showed that BLDC motor can increase energy efficiency more than 20%. The speeds drum in lower and higher than 600 rpm, result the higher percentage of rice losses, while higher damage occurred at speed more than 600 rpm. Power cunsumtion in the higher moisture of rice also in higher rate. The optimum operating of the machine were 14% moisture and 600 rpm threshing drum speed.***

**Keywords: threshing, rice, BLDC motor, performance, efficiency, drum speed, moisture**

## I. Introduction

Rice (Oryza sativa L) is an important cultivation in the world. China, Indonesia, India, Thailand and other contries use rice as staple food. Figure 1 show rice consumption worldwide in 2014/2015 (in 1,000 metric tons) (The Statistics Portal, 2015). This great need, requires the high productivity cultivation of rice. One decisive factor in achieving high productivity is reducing losses and damage of the rice grain during the harvesting process (Alizadeh & Allameh, 2013). This harvesting process also have efficient of energy.

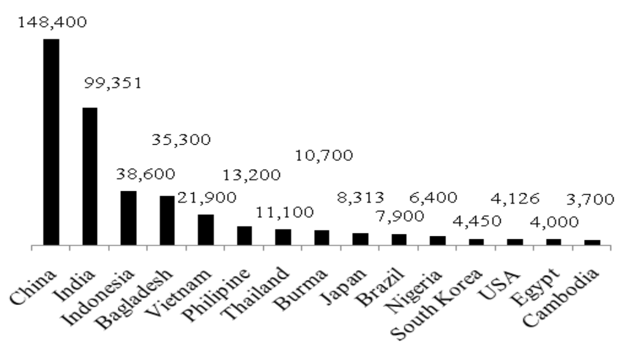



Fig.1 Rice consumption worldwide in 2014/2015

Usualy, after harvesting by sickle or mechanical reapers , the reaped plant left on the field to reduce crop moisture content (Alizadeh & Khodabakhshipour, 2010), and then transported and collected for threshing operation (Dibaba & Tesfaye, 2015). Many types of paddy threshing are used (Azouma, Porosi, & Yamaguchi, 2009 ). The traditional threshing of rice is done by hand: bunches of panicles are beaten against a wooden bar log or bamboo table (O.A., 2004). The modern threshing was built in about 1970. It consists of a threshing device with pegs, teeth or loops, and a cleaning-windowing mechanism based upon shakers, sieves and centrifugal fan (Oduma, Nwakuba, & Igboke, 2014). In Indonesia, single plant threshing is the most used today. This machine use 8 HP diesel as prime mover. The use of diesel in the machine results low efficient, air pollution and noise. In addition, the use of oil will also have a wide impact, the high oil consumption, and the emergence of global warming.

To improve performance of the threshing and to prevent environmental pollution because oil used, in this rstudy the prime mover will be replaced by Brushless Direct Current motor. The use of conventional electric motors for threshing has been done (Ajav & B.A, 2005), but not BLDC electric motors (Abbass, Elshami, & Mohamed, 2005). This motor type has many advantages than conventional electric motor (Sujanarko, Srikaloko, & Hasan, 2013)

The most obvious advantage of a brushless motor is there is no brushes and physical commutators. BLDC motors also tend to be more reliable, last longer, and be more efficient. The increased efficiency and reliability that a brushless motor offers, along with its low weight and small size, make this type of motor the perfect choice for a wide range of applications (Sujanarko, Srikaloko, & Hasan, 2013).

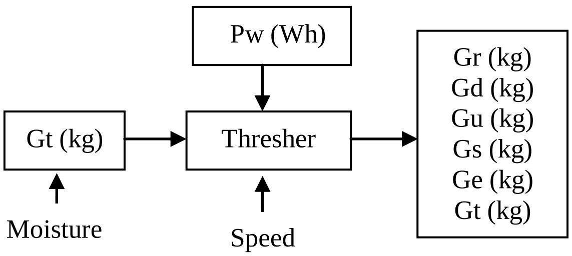
BLDC motors use in the threshing expected to increase energy efficiency, reduce air pollution and noise, get the ease of use of threshing and can reduce loss and damage during harvesting rice.

## II. Material and Methodology

Materials to accomplish this study are the single plant threshing unit, BLDC motor with controller, belts and pulleys for cleaning fan, accumulator and reaped plant of paddies. The main parts of the threshing are drum, concave, feeding tray, cleaning fan, chassis, collecting chute and grain speed reducer as shown in Figure 2. Digital wattmeter, digital moisture meter, digital tachometer, digital weigher and some instrumentations also used to measure and verify.

To evaluate the threshing performance, some criterias were used, Power Threshing Efficiency (PTE), Threshing Efficiency (TE) (Alizadeh & Bagheri, 2009), Losses Procentage (LP) and Damage Procentage (DP) (Asli-Ardeh, Abbaspour-Gilandeh, & Abbasi, 2009). Figure 3 show some parameter in threshering unit. These criterias observe in the various of speed and moisture. Speed variation are 400, 600, and 800 rpm, while the variation of moisture are 17, 14, and 12%.

Fig.2 Single plant threshing unit




Pw : power consumption (Wh)
Gt : total weight of grains fed into the threshing (kg)
Gr : total weight of perfect rice grains
Gd : total weight of damage grain
Gu : total weight of unthreshed grains
Gs : total weight of spilled grains
Ge : total weight of empety grains
Gt : total weight of stalk
Fig. 3 Parameter of threshering unit

The Power Threshing Efficiency (PTE) is the ratio of total power consuption in watt hour to the total weight of grains fed into the threshing. This criteria expressed in watt hour/kg. It can be evaluated by equation (1).

$$PTE = \frac{Pw}{Gt} \quad \text{.....................................................(1)}$$

The Threshing Efficiency (TE) is the ratio of total weight of grain threshed to the total weight of grains fed into the threshing, that expressed in percentage. It can be evaluated by equation (2).

$$TE = 100 - \frac{Gu}{Gt} X100 \quad \text{..........................................(2)}$$

The Losses Procentage (LP) is the ratio of total weight of loss grain because unthreshed and spilled to the total weight of grains fed into the threshing that expressed in percentage. It can be evaluated by equation (3).

$$LP = \frac{Gu+Gs}{Gr+Gd+Gu+Gs} X100 \quad \text{..................................(3)}$$

The Damage Procentage (DP) is the ratio of total weight of damage grain to the total weight of grains fed into the threshing that expressed in percentage. It can be evaluated by equation (3).

$$DP = \frac{Gd}{Gr+Gd+Gu+Gs} X100 \quad \text{...........................................(4)}$$

**III. Results and Discussion**

The results of the performance test were presented in Table-1. Variable performance test are moisture of paddies reaped and speed of drum. As shown in table, the moisture are in 12, 14 and 17 %, while the speed are varied on 400, 600 and 800 rpm.

Table-1 Performance test of threshering unit

| Moisture (%) | Speed (rpm) | PTE (Wh/kg) | TE (%) | LP (%) | DP (%) |
|---|---|---|---|---|---|
| 12 | 400 | 14.2 | 96.1 | 11.5 | 1.3 |
| | 600 | 13.6 | 97.2 | 8.7 | 1.4 |
| | 800 | 14.4 | 97.6 | 9.2 | 1.6 |
| 14 | 400 | 14.4 | 95.8 | 9.3 | 1.3 |
| | 600 | 12.8 | 96.2 | 5.8 | 1.1 |
| | 800 | 13.1 | 96.5 | 6.7 | 1.5 |
| 17 | 400 | 15.3 | 93.6 | 7.6 | 1.2 |
| | 600 | 14.2 | 94.7 | 4.1 | 1.4 |
| | 800 | 14.6 | 95.2 | 5.2 | 1.5 |

3.1 Power Threshing Efficiency

Electric power consumption for moisture 12% and in the 400 rpm of speed is 14.2 Wh/kg. For moisture 14%, the power consumption at the same speed is 14.4 Wh/kg, and in moisture 17%, the power consumption is 15.3 Wh/kg. It shows that in the higher moisture, the power consumption is decrease.

For speed 600 rpm, the power consumpion in the 12%, 14% and 17% are 13.6 Wh/kg, 12.8 Wh/kg and 14.2 Wh/kg. In this case, the power comsumptions are not linear, because it needed higher power to rotate the rice stalk with 17% of moisture. For 800 rpm of speed, the pattern of the power consumption for threshing rice is generally equal to the 600 rpm of speed, the power consumption are 14.4 Wh/kg, 13.1 Wh/kg and 14.6 Wh/kg.

These power consumption are smaller than the power consumtion of paddy threshering unit in the market. Usually power consumtion is 20-24 Wh/kg (International Rice Research Institute, 1986). So, there are improve of power efficiency more than 20%.

3.2 Threshing Efficiency

Threshering efficiency depend on speed and moisture. For speed 400, 600 and 800 rpm and 12% of moisture, TE increase gradually as shown in Fig. 4. In the Fig. 4 also shown TE in the 14% and 17% of moisture. This performance parameter is not different to the performance of the threshering rice unit in the market which is usually between 92-98% (International Rice Research Institute, 1986).

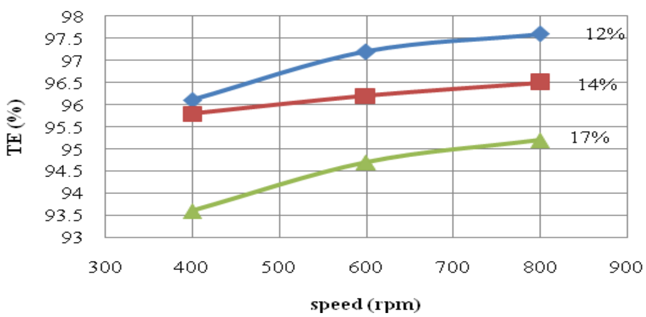



Fig. 4 Threshering efficiency

3.3 Losses Procentage

This performance parameter not in linear in speed and moisture. Table-1 shown, that losses procentage in the 12% of moisture are 11.5 %, 8.7% and 9.2%. In this case, the 600 rpm of drum speed has a lowest losses. In the 14% and 17% of moisture, the losses also in the same result. This result shown that in the 400 rpm speed, kinetic energy not enough to release the grains of their stalk. But in the 800 rpm of speed, the blowing of cleaning fan is too fast, so some grains spilled and flow in the empety grain pile. This performance parameter also not different to the performance of the threshering rice unit in the market which is usually between 3-12% (International Rice Research Institute, 1986).

3.4 Damage Procentage

Generally, the damage percentage is highly dependent on the speed. Shown in the table, that in the higher speed, the damage also in higher. But in 600 rpm of speed and in 14% of moisture, there is occur a lowest Damage Procentage, that is 1.1%. This phenomenon occurs, because in this speed and this moisture, the rice grain can easy to move, and kinetic energy does not cause the rice grains damage. This damage procentage has similar value with paddy threshering unit in the market, that has damage procentage value in the range 0.5–3%.

## IV. Conclusion

BLDC motor can increase energy efficiency more than 20%. The speeds drum 600 rpm is optimum speed, because can result the lower damage procentage about 1.1%, and has lower power consumption about 12.8 Wh/kg, although it did not produce the best threshering efficiency and losses procentage.

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## References

*i. Abbass, O. M., Elshami, O. M., & Mohamed, H. I. (2005). Modification And Performance Of Multi Crop Thresher. J. Sc. Tech , 6 (2), 4-19.*

*ii. Ajav, E., & B.A, A. (2005). Performance Evaluation Of An Okra Thresher. Cigr Ejournal , Vii, 1-8.*

*iii. Alizadeh, M. R., & Allameh, A. (2013). Evaluating Rice Losses In Various Harvesting. International Research Journal Of Applied And Basic Sciences , 4 (4), 894-901.*

*iv. Alizadeh, M. R., & Bagheri, I. (2009). Field Performance Evaluation Of Different Rice Threshing Methods . International Journal Of Natural And Engineering Sciences , 3 (3), 155-159.*

*v. Alizadeh, M., & Khodabakhshipour, M. (2010). Effect Of Threshing Drum Speed And Crop Moisture On Paddy Grain. Cercetări Agronomice În Moldova , Xliii (4 (144)), 5-11.*

*vi. Asli-Ardeh, E. A., Abbaspour-Gilandeh, Y., & Abbasi, S. (2009). Study Of Performance Parameters Of Threshing Unit In A Single Plant Thresher. American Journal Of Agricultural And Biological Sciences , 4 (2), 92-96,.*

*vii. Azouma, O. Y., Porosi, M., & Yamaguchi, K. ( 2009 ). Design Of Throw-In Type Rice Thresher For Small Scale Farmers. Indian Journal Of Science And Technology , 2 (9), 10-14.*

*viii. Dibaba, T., & Tesfaye, T. (2015). Evaluation And Selection Of Existing Machines For Rice Threshing. Journal Of Multidisciplinary Engineering Science And Technology (Jmest) , 2 (7), 1857-1859.*

*ix. O.A., O. (2004). Development Of A Rice Threshing Machine. Au Journal Of Technology , 8 (2), 75-80.*

*x. Oduma, O., Nwakuba, N., & Igboke, M. (2014). Performance Evaluation Of A Locally Developed Pigeon Pea Thresher. International Journal Of Applied Science, Technology And Engineering Research , 3 (2), 20-31.*

*xi. Sujanarko, B., Srikaloko, B., & Hasan, M. (2013). BLDC Motor Control Using Simulink Matlab And Pci. Iremos , 6 (6), 1899-1906.*

*xii. The Statistics Portal. (2015, December 2). The Statistics Portal. Take On December 2, 2015, From The Statistics Portal: Http://Www.Statista.Com/Statistics/255947/Top-Rice-Exporting-Countries-Worldwide-2011/*