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The Performance of Rice Mower Utilization in Kutai Kartanegara Regency East Kalimantan

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ABSTRACT

Rice mower can be applied in several region in Indonesia based on the specific location characteristic, due to its lower price and easier operation. The research was conducted to assess the performance of rice mower in Kutai Kartanegara Regency, East Kalimantan Province. The experimental design used the randomized complete block design with two treatments included the harvest methods namely: rice mower; plain sickle and serated sickle; and rice varieties namely Ciherang, Inpara 2, Inpari 15 Inpari 30 and Cibogo; in 5x5 m^2 area of sample. The parameters were: field efficiency; effective field capacity; yield loss and benefit and cost ratio. The results showed that the rice mower had the effective field capacity of 0.0294 ha/h, and the field efficiency was 52.97%. The mower utilization had the highest effective field capacity, which was different significantly (p<0.05) than the plain sickle by 0.0097 ha/h and serated sickle by 0.0099 ha/h as the lowest. Moreover, the mower utilization showed a higher effective field capacity on Inpari 15, Inpari 30 and Cibogo varieties; whereas had the lowest was on Ciherang and Inpara 2 varieties (p<0.05). The mower utilization resulted the lowest yield loss of 0.7196%; followed by serated sickle of 0.7651% and plain sickle of 0.9145% at the highest. While, the utilization of mower specified the Inpari 30 to had the lowest yield lost at 0.1517% (p<0.005). Furthermore, the utilization of mower had the highest benefit and cost ratio of 2.08 then followed by the plain sickle of 1.96 and the serated sickle was the lowest at 1.89. Therefore, it can be concluded that mower utilization of stem cutting in the harvesting activity, had advantages namely higher effective field capacity; lower yield lost and more economical.

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1. INTRODUCTION

The initial stage in rice harvest is cutting the matured rice panicles and straw from above the ground (IRRI, 2013). This can be done manually by using sickle or using rice stem cutter machine known as mower or either using combine harvester in together with all stages in rice harvesting. In most developed countries, or where there is a lack of agricultural labor with spacious land, modern tools are the best alternative for harvest. Nevertheless, there is still possibly occurred the utilization of conventional rice cutter due to several reasons namely: low capital; large amount of agricultural labor; and small land farming. This led to the need of study for the utilization of simple mechanical tools or machineries in the rice harvest stages.

Rice mower is one of a simple machine that considered applicable for small capital investment and handy. In some region in Indonesia, this machine could be one of the alternatives that can be used for farmer with small land holding and low capital. Basically, rice mower is operated such as lawn mower to cut plant stem in the field, which appropriate in substituting sickle and can be used for other plant (e.g. maize, soybean and wheat) (Sulistiaji, 2007; ICAERD, 2009). The simple and handy operation with higher coverage can give advantages to improve harvest quality and enhance production quantity. Moreover, one consideration in harvesting is to minimize yield loss, which mean that every alternatives are need to be assessed to perform the lowest yield loss to gain the highest rice production.

Yield loss is a loss of rice yield in the form of rice and husk or seed, which cannot be utilized by farmers. Inappropriate harvest method can cause yield lost with low quality. In the harvest stage, rice yield loss in Indonesia reached 9-10% (DGPMAP, 2009) if it is not well conducted. Yield loss and degradation of quality in manual harvest is necessary to be considered, especially when it is compared with the loss which may have economical value. Yield loss in rice harvest is effected by: plant variety; time to harvest; harvest method in all stages; and the harvest system (Setyono, 2015).

The rice yield loss in rice harvest is determined from the whole amount of losses which occurred in every harvest stages started from cutting, threshing, shifting, drying, milling and storing, as a sequence of rice post harvest handling. In cutting stage, the yield loss can be determined using the observation board method which basically employs a number of boards in given size dimensions to be spread randomly under the paddy plant before harvest in the sample area. These boards collect rice which is dropped caused by cutting operation. The amount of rice collected then calculated and converted into weight per area of observation (ICAPOSTTRD, 2013).

Utilization of improved tools is needed to perform good harvesting with low yield loss and high quality. This is subjected to produce high yield of rice in good quality. Nevertheless, to admit that a harvest operation is appropriate in obtaining a high gain, there have to be consider the economical characteristics of the method used in the harvest. Therefore, it is necessary to perform the farming analysis to determine parameters such as the revenue and cost ratio (R/C) or either the benefit and cost ratio (B/C).

According to Purwantiningdyah and Hidayanto (2015), integrated crop management has been used in East Kalimantan which gave advantages economically over the conventional method. The integrated crop management is an approach in cultivation which is focused on the integrated management of plant, field, water and plant-disturbing organisms with appropriate technology in given specific location (ICFORD, 2013). It was reported that in 2013, the total cost for wet rice production by integrated crop management application reached Rp.7,847,000,- (Table 1), which includes preparation, cultivation, harvest and means of production cost. Thus results into affordable B/C of 1.96.

Table 1. Partial analysis of wet rice farming in East Kalimantan in 2013.

PRODUCTION COST (Rp.)			**REVENUE (Rp.)**		
1.	Preparation, cultivation and harvest	5,500,000	1.	Revenue	23,240,000
2.	Means of production	2,347,000	2.	Benefit	15,393,000
	Total cost	7,847,000	3.	R/C	2.96
			4.	B/C	1.96

Source: (Purwantiningdyah and Hidayanto, 2015)

Mean while, the Kutai Kartanegara regency is a part of the East Kalimantan Province, Indonesia, which located in between 115^{o}26’ of East Longitude and 117^{o}36’ West Longitude and between 1^{o}28’ of North Latitude and 1^{o}08’ South Latitude. Kutai Kartanegara regency has the humid tropical forest climate, where the annual average rainfall is around 2000-3000 mm (Central Beureu of Statistics, 2010). The common situation of geographic and socio-economic in a specific region affects the biological ecosystem of the region (Ahmadi and Abadi, 2014) specifically in rice cultivation. In this case, the specific location of Kutai Kartanegara regency was the study area for the research that had been conducted.

In rice harvesting, the mower machine basically substituting other manual or simple mechanical cutting operation that is using sickle. There are mainly two types of sickle that can be used for cutting operation in harvest namely: plain sickle, that commonly being used by traditional farmer in Indonesia; and serated sickle, which considered better and efficient for cutting operation. Hence, the research was conducted to assess the performance of rice mower utilization in specific location of Kutai Kartanegara Regency, East Kalimantan province, in harvesting of some rice varieties.

2. RESEARCH METHOD

Research was conducted in Kutai Kartanegara Regency, East Kalimantan, Indonesia in Juli to December 2015. Rice was harvested in dry season in randomly chosen locations using five superior varieties namely: Ciherang; Inpara 2; Inpari 15; Inpari 30 dan Cibogo. The experimental design used the randomized complete block design with two treatments included the harvest methods namely: rice mower; plain sickle and serated sickle; and rice varieties namely Ciherang, Inpara 2, Inpari 15 Inpari 30 and Cibogo; in 5x5 m^2 area of sample. The parameters were: work efficiency; effective field capacity; yield loss and benefit and cost ratio. Materials which were used namely: rice mower; plain sickle; serated sickle; plastic rope; roll meter; and stopwatch. The rice mower which was used is the ICAERD type (2009), using gasoline fuel and 2 hp engine. The mower's knife cutter was serated type covered with casing in one side to direct the rice stem to be dropped in one side.

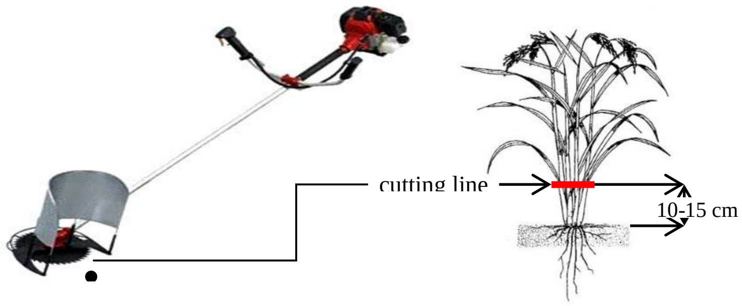


Figure 1. Type of mower which was used and cutting rice stem method.

Rice harvesting was started by sample blocks preparation where it used 5x5 m^2 size. The rice stem was cut at ± 10-15 cm above the ground (Figure 1). Data were recorded to calculate parameters, adopted from Hanna (2016), included the theoretical field capacity (*TFC*) in ha/h which was obtained by using a given equation:

$$TFC = wt \times vt \times 10^{-1} \quad (1)$$

Where *wt* is the theoretical working width in m, and *vt* is the theoretical working speed in km/h, where according to ICAERD (2009), was 0.54-0.57 km/h. While the actual field capacity or effective field capacity (*EFC*) in ha/h, was obtained from the field observation following the equation:

$$EFC = A \times t^{-1} \times 60 \quad (2)$$

Where *A* is the land area of testing (*ha*); and *t* is the time spent (minute). And the field efficiency (*FE*) in %, was calculated by:

$$FE = ka \times kt^{-1} \times 100\% \quad (3)$$

Furthermore, the yield loss was calculated using the observation board method from ICAPOSTRD (2013), and the fuel consumption was recorded at before and after harvest. Data then statistically analyzed using the analysis of variance followed by the Duncan's multiple range tests. Furthermore, the farming analysis was presented by B/C based on wet rice partial farming analysis by Purwantiningdyah and Hidayanto (2015).

3. RESULTS AND ANALYSIS

The performance test of rice mower was conducted together with other treatments (i.e. plain sickle and serated sickle) using one operator. The mower's front work space (width) was ± 100 cm which equal to ± 25 m (5 column x 5 m) corresponds to the "jajar legowo" rice planting system by 4:1 (strip distance=20 cm and space= 40 cm) perpendicular to the planting column. Determined from its technical specification (ICAERD, 2009), the average rice harvesting (cutting) speed for the mower machine was 0.5550 km/h. Hence, the theoretical field capacity (*TFC*) was 0.0555 ha/h, where the effective field capacity (*EFC*) was 0.0294 ha/h, so that the field efficiency (*FE*) was determined for about 52.97%. This means that the works that have been done was not as efficient as its potential due to some delays such as refueling, broken track, unskilled operator, etc. Moreover, the average fuel consumption was 0.74±0.0318 l/h.

The result showed that the effective field capacity of rice mower was ranges from 0.0075 ha/h to 0.0339 ha/h at the highest (Table 2). The average effective field capacity of plain sickle utilization was 0.0097 ha/h, serated sickle was 0.0099 ha/h and the rice mower utilization was 0.0294 ha/h (Table 2). Therefore, the utilization of rice mower has the highest effective field capacity and it was different significantly (p<0.005), compared to other cutting methods (i.e. plain and serated sickle), while the plain sickle and serated sickle have no different of effective field capacity. Hence, the utilization of rice mower in cutting operation of harvesting is recommended, especially when simple cutting method is considered suitable to be conducted by farmers in specific location.

Moreover, the average effective field capacity for all methods (i.e. plain, serated sickle and mower) was different significantly (p<0.05) among the rice varieties (Table 2) . The Inpari 30 has the highest, followed by Inpari 15 and Cibogo, while Ciherang and Inpara 2 were at the lowest. These statistics empirical evidence was possibly occurred because of different characteristic of those varieties. Furthermore, the mower utilization showed a higher effective field capacity on Inpari 15, Inpari 30 and Cibogo varieties; whereas had the lowest effective field capacity on Ciherang and Inpara 2 varieties; which was different significantly (p<0.05). These showed that different varieties were affected the performance of mower utilization. Therefore, it is suggested to study further, about the specific characteristics of rice varieties which specifically affecting the harvest operation.

Table 2. Rice mower performance by field capacity (ha/h).

No.	Variety	Effective Field capacity (ha/h)			
		Plain sickle	Serated sickle	Mower	Average
1.	Ciherang	0.0078	0.0076	0.0254^b	0.0136^c
2.	Inpara 2	0.0078	0.0075	0.0254^b	0.0136^c
3.	Inpari 15	0.0106	0.0106	0.0301^a	0.0171^b
4.	Inpari 30	0.0143	0.0122	0.0322^a	0.0196^a
5.	Cibogo	0.0091	0.0087	0.0339^a	0.0172^b
Average		0.0097^b	0.0099^b	0.0294^a	

Note: Different notation shows significant different for α=0.05.

The utilization of rice mower performs better in rice yield where the average yield loss is at the lowest of 0.7195%, even though it was not significantly different (p>0.05) among other methods subsequently: serated sickle was 0.7651% and plain sickle was 0.9145% at the highest (Table 3). Mean while, generally for all cutting methods, the yield loss was not significantly different among all varieties except for Inpari 30. The average yield loss for Inpari 30 was 0.4119% where it was the lowest yield lost in the cutting stages. It was also shown that the utilization of mower among rice varieties was specified the Inpari 30 to had the lowest yield loss (0.1517%) among other varieties, it was different significantly (p<0.05). This showed that the Inpari 30 varieties, by considering its physical or morphological characteristics, can be the best choice in term of performing the lowest yield loss among other varieties that will produce higher productivity.

Table 3. Rice mower performance by yield lost (%).

No.	Variety	Yield loss (%)			
		Plain sickle	Serated sickle	Mower	Average
1.	Ciherang	1.2213	0.8633	1.0177^a	1.0341^a
2.	Inpara 2	0.9506	0.7898	0.8244^a	0.8549^a
3.	Inpari 15	0.8678	0.9370	0.8234^a	0.8761^a
4.	Inpari 30	0.5299	0.5542	0.1517^b	0.4119^b
5.	Cibogo	1.0029	0.6815	0.7808^a	0.8217^a
Average		0.9145^a	0.7651^a	0.7196^a	

Note: Different notation shows significant different for α=0.05.

In performing the farming analysis for the rice mower utilization, the B/C ratio was determined based on rice farming which was conducted in 2015 and using the production cost summarized by Purwantiningdyah and Hidayanto, (2015) for integrated rice crop management in East Kalimantan. The production cost consists of labor, rent, fuel consumption, and other cost. The other cost was determined from the total production cost minus the labor cost in the utilization of manual plain sickle. In table 4, B/C ratio for overall method was determined, where the utilization of mower had the highest B/C of 2.08 then followed by the plain sickle where

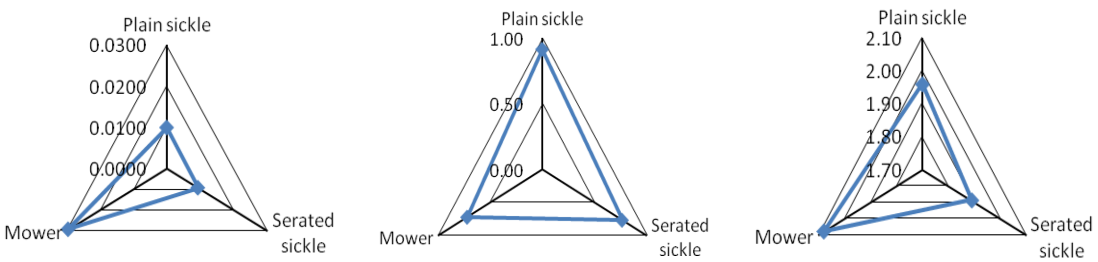
B/C is 1.96 and the serated sickle was the lowest at 1.89 of B/C. This showed that in term of economical consideration, the utilization of rice mower was also gave a better return among other methods in cutting operation of rice harvesting.

Table 4. Farming analysis of rice stem cutter (plain sickle, serated sickle and mower) utilization/ha in Kutai Kartanegara Regency, East Kalimantan.

PRODUCTION COST					RICE FARMING REVENUE				
COST		**UNIT COST (Rp.)**	**VOL.**	**AMOUNT (Rp.)**	**REVENUE**		**UNIT COST (RP.)**	**VOL.**	**AMOUNT (Rp.)**
Plain Sickle									
1.	Labor	100,000	14	1,400,000	1.	Revenue (R)	3,500	6640**	23,240,000
2.	Rent cost	5,000	1	5,000	2.	Benefit (B)			15,388,000
3.	Fuel cons.			0	3.	R/C			**2.96**
4.	Other cost*			6,447,000	4.	B/C			**1.96**
	Total			7,852,000					
Serated Sickle									
1.	Labor	100,000	16	1,600,000	1.	Revenue (R)	3,500	6640**	23,240,000
2.	Rent cost	6,000	1	6,000	2.	Benefit (B)			15,187,000
3.	Fuel cons.			0	3.	R/C			**2.86**
4.	Other cost*			6,447,000	4.	B/C			**1.89**
	Total			8,053,000					
Mower									
1.	Labor	100,000	4	400,000	1.	Revenue (R)	3,500	6640**	23,240,000
2.	Rent cost	500,000	1	500,000	2.	Benefit (B)			15,703,200
3.	Fuel cons. (0.74 l/h)	7,300	26	189,800	3.	R/C			**3.08**
4.	Other cost*			6,447,000	4.	B/C			**2.08**
	Total			7,536,800					

*= Total production cost (Purwantiningdyah and Hidayanto, 2015) - labor cost
** (Purwantiningdyah and Hidayanto, 2015)

Even if the machine is not owned by individual farmer, means it have to be rented, which will cost higher, it is still showed higher benefit in rice farming. Moreover, due to the lack of agricultural worker, which is caused by harvesting at the same time, it will give a consequence for the utilization of a machine, even if it is have to be as simple as possible to minimize cost and capital. In other fact, the utilization of mower machine in rice harvest had the highest field capacity and lowest yield loss. The mower machine may be a good alternative in this situation where it is still be affordable in the rice farming especially in the harvest stage. The mower performance in cutting operation of rice harvest is described in radar diagram below (Figure 2.):



a. Effective field capacity (ha/h) b. Yield loss (%) c. B/C

Figure 2. Radar diagram of the mower performance in rice harvest compare to plain and serated sickle.

In general, according to Figure 2, the effective field capacity of mower utilization is much higher than plain and serated sickle utilization. Plain and serated sickle were clearly almost equal and below mower. The yield loss of mower utilization was relatively lower which mean it has a better performance compare to plain and serated sickle utilization. Mean while, the utilization of mower in rice harvest, performs better economically which refer to higher B/C among other methods. Moreover, these actual performances were supported by the empirical statistic evidence especially for the field capacity. Regarding to the given circumstances of all of the methods for rice cutting operation in harvest (i.e. plain sickle, serated sickle and mower), the mower utilization is prefer among others.

4. CONCLUSION

From the result, it can be concluded that the mower machine had the harvesting speed of 0.5550 km/h and the average fuel consumption was 0.74$\pm$0.0318 l/h. The theoretical field capacity (*TFC*) was 0.0555 ha/h, where the effective field capacity (*EFC*) was 0.0294 ha/h, so that the field efficiency (*FE*) was 52.97%.

The mower utilization had the highest effective field capacity; which was significantly different (p<0.05) then the plain sickle by 0.0097 ha/h and serated sickle by 0.0099 ha/h as the lowest. Moreover, the mower utilization showed a higher effective field capacity on Inpari 15, Inpari 30 and Cibogo varieties; whereas had the lowest on Ciherang and Inpara 2 varieties; which was different significantly (p<0.05).

Even though it was not significantly different, the mower utilization resulted the lowest yield loss of 0.7196%; followed by serated sickle of 0.7651% and plain sickle of 0.9145% at the highest. Mean while, the utilization of mower on Inpari 30 variety showed the lowest yield lost at 0.1517% (p<0.005). Furthermore, the utilization of mower had the highest benefit and cost ratio (B/C) of 2.08 then followed by the plain sickle was 1.96 and the serated sickle was the lowest at 1.89. Therefore, it can be concluded that mower utilization of stem cutting in the harvesting activity had advantages namely higher field capacity; lower yield lost and more economical. Moreover, it is suggested for further study, about the effect of physical characteristics of rice plant varieties in rice harvest operation.

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