Measuring The Effectiveness of Agricultural Mechanization Performance on Irrigated Rice Area in Batubara Regency

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Abstract. One of issues facing by agricultural sector is the declining number and high-cost spend for agricultural labour, and followed by declining number of agricultural mechanizations. It affects to diverse planting time and the limitation of cultivated-area. Hence, this study conducted to measure the effectiveness of agricultural mechanization on rice cultivation in Aras Village (Air Putih District), started from January to December 2018. Some observed-variables are the field work capacity, number of labour, total cultivated-area and benefit cost ratio. The results show that jarwo transplanter has the capacity to replace twenty-one of agricultural labours and be economized IDR 405,000/ha. Meanwhile, the usage of combine harvester has ability to replace thirty-six of agricultural labours and be economized IDR 610,000/ha. Using agricultural mechanization share a higher B/C ratio compare with farmers style by 2.5 and 1.2, respectively. The usage of agricultural mechanization is mainly important to enhance rice production and farmers' income.

Keywords: combine harvester, effectiveness, jarwo tranplanter, rice, Batubara Regency.

1 Introduction

By a huge number of population, it is highly important for Indonesia to fulfil food need for their people. High potency of total land area and high fertility help government to fulfil food need from domestic production. Beside, rice as staple food for Indonesian people, provides jobs opportunity for 20 millions of farmers' households. Thus, it has critical and startegic concern when observed from food security perspective [1].

The ministry of agriculture has set the target for sustainable food self-sufficiency achievement, especially for rice within three years. There are some programs from Agricultural Ministry to reach the goal, such as food

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diversification, added-value of agricultural commodity, exports, and improve farmers' welfare which is supported by accurate data of land resources information.

Irrigated rice land share significant contributions to supply rice in Indonesia especially in North Sumatera. Unfortunately, it is difficult to increase rice productivity, except by implementing technological innovations, including usage new varieties with high productivity, using integrated crop management, and handling of harvest and post-harvest as well. It is estimated that in 2020 there is 35.97 million tons of rice need, by considering 137 kg/capita of rice consumption and land availability about 10.68 million ha. The huge of total rice need is influencing by rice is the only staple food in Indonesia [1].

The efforts to increase rice production facing many challenges to be solved, such as climatic condition which is unpredictable, declining total rice land area influencing by land use conversion issue [2], and decreasing total number of agricultural labor and high incentive to pay them [3]. The rice production at national level is tend to decrease which is affected by decreasing of rice production at local level. Hence, all supporting technologies should be implemented to increase the yield without ignoring environmental quality. Integrated Crop Management (ICM) is one of suitable strategic actions that can be implemented because it has participative, site specific location, integrated, synergy and dynamic characteristics [4]. The synergy effect among techological components in ICM contributes to give high yield [5].

The introduction of adaptive, effective and efficient technology (suitable for environmental condition and farmer capacity) to increase production such as in the model of ICM is much important. By implementing ICM on irrigated riceland, the production can reach 8.5 t of GKG/ha. In ICM model, solving problems through implementing innovative technology is the main priority. Thus, the techological package which is chosen in ICM is not constant, but site specific location. ICM is an approach to manage the nutrient, water and plant integrately and sustainably to increase plant productivity, farmers income and guarantee the sustainbale environment [6].

The synergy among technological components has to be determined to find out higher production. As an example, the planting system as *legowo* has some advantages, such as all plants which is on the border rows will give higher production (border effect), easily on pest and disease controlling, and more efficient on fertilizer [7].

Decreasing total number of agricultural labor is another main issue regularly find in the field. Mostly in the planting season, there were some difficulties to find labor in the predominant productive-region. Some impacts due to this issue are planting time in various date, low of total cultivated-area and influencing

number of cropping index. Delayed of planting time give impact on the risk of harvesting failure as well due to water scarcity, pest and disease. Furthermore, declining young generation interest on agricultural sector enlarging the problem on this site.

Thus, it needs agricultural mechanization to solve it which is the number of those is extremely scarce. These agricultural mechanization has an important role to achieve food self-sufficiency because all activities in the farming system will be easier, efficient and effective. Jarwo transplanter and combine harvester is one on solution to face the problem. These machines are created by *Balai Besar Pengembangan Mekanisasi Pertanian (BBP Mektan)* which is special generated to help farmers who plant jajar legowo system (2:1) for accelerating during planting time. Using jarwo transplanter, cost will be cheaper and planting time will be not take much time compared with labor because 1 unit of jarwo transplanter will replaced 20 labors [8]. Combine harvester is the machine which is operated during harvesting time. This machine is suitable for the riceland that implemented jarwo 2:1 [8].

The system of rice intensification is alternative cultivation technology that has big opportunity to increase rice production in Indonesia which has some changging in the plant, water, soil/land, and nutrient [9]. The basic concept from the system of rice intensification are high production, low input, no need much water, and acceptable by farmers (simple technology) and sustainable [10].

2 Methodology

This study was conducted in Aras Village, Air Putih District, Batubara Regency. This assessment aims to identify the effectiveness of jarwo transplanter and combine harvester on the irrigated farming system. The determining the research location was dicided by purposive methode where farmers used combine harvester technology, rice harvesting-tool, massively. The objects for this research are the farmers who used this agricultural mechanical tool and farmers didnot used. The scope of this research is focus on the effectivity and efficiency of the harvesting agricultural tool, and compared with manual system. In addition, this research used descriptive quantitative and qualitative analysis methode. The descriptive quantitative analysis is implemented to investigate the effectivity impact of combine harvester tool on production parameter specifically, while the qualitative analysis used to explaine the result which is gathered from quantitative analysis.

Some parameters collected during observation on jarwo transplanter are fuel consumption (l/ha), field work capacity (hours/ha), number of labors (days of

work-dow/ha), total of seed (kg/ha), velocity of work (rante/minute). Meanwhile, parameters on combine harvester are fuel consumption (l/ha), field work capacity (hours/ha), number of labors (dow/ha), total of seed (kg/ha), velocity of work (rante/minute).

The rice farming system is suitable as financial and economic views when B/C ratio is more than 1. The equation of Gross B/C [11] is: Gross B/C = PxQ/Bi , where P = Price of Production (Rp/kg), Q = Total Production (kg/ha), Bi= Production Cost of i (Rp/ha). B/C > 1 means the farming system of rice is suitable to be implemented and developed widely.

3 Results and Discussion

3.1 Effectiveness of Jarwo Transplanter

By comparing jarwo transplanter and manual system in the rice field on Batubara Regency, it can be observed that jarwo transplanter has more effectiveness. Table 1 shows that comparison between machine of jarwo transplanter and manual is very signicant. Jarwo transplanter needs 4 people only with 2 ha/day for the capacity, while planting system by manual needs 25 people with 1 ha/day for the capacity. The usage of agricultural machine has many advantages because it needs small number of labors then can minimize the cost during planting time, and make the schedule for planting season on time. It is consistent with the previous study which is mentioned that the usage of planting machine (transplanter) reduced the planting cost and accelerate planting time [12]. There were 86.79% of transplanter efficiency of work compared with manual [13]; and 80.43% of transplanter efficiency when implemented on tidal wetland [14].

Table 1. Comparison of Jarwo Transplanter and Manual

No	Parameter	Jarwo Transplanter	Manual
1	Fuel consumption (l/ha)	5	0
2	Number of labors (person)	4	25
3	Field work capacity (ha/day)	2	1
4	Total of seed (kg/ha)	30	30

It can be observed in table 2 that an cost analysis of planting system using a jarwo transplanter per hectare, Rp. 2,820,000, which is in line with less requirement for energy and the machine ability to work quickly so that the

required-costs are not as large as if using a manual planting system. Meanwhile, Table 3 presents the cost analysis of the planting system using the planting team (manual method), it requires a higher cost, Rp. 3,225,000,- so there is a difference in the cost of the jarwo transplanter planting system with the manual system, by Rp. 405,000,- per hectare. Similar with the previous study that mentioned the cost efficiency during planting by using a machine such as jarwo transplanter can save 73.73% [14]. Then, using transplanter machine can reduce planting costs by 49.7% compared to manual planting system.

Table 2. Cost Analysis using Jarwo Transplanter (per ha)

No	Item	Quantity	Unit	@	Sum
1	Seed	30	kg	50,000	1,500,000
2	Plastic	2.5	kg	20,000	50,000
3	Planting Cost	25	*rantai*	50,000	1,250,000
4	Meal Cost	4	person	5,000	20,000
	TOTAL				**2,820,000**

Table 3. Cost Analysis using Manual System (per ha)

No	Item	Quantity	Unit	@	Sum
1	Seed	30	kg	50,000	1,500,000
2	Sowing Cost	0.5	day	100,000	50,000
3	Seed-Removing Cost	25	*rantai*	16,000	400,000
4	Seed-Spreading Cost	25	*rantai*	40,000	1,000,000
5	Planting Cost	25	*rantai*	6,000	150,000
6	Meal Cost	25	person	5,000	125,000
	TOTAL				**3,225,000**

Based on the research result from economic analysis, it can be determined that implementation of jarwo transplanter is applicable, especially in terms of the unfixed cost and the prime operational cost. The calculation shows that the prime cost for planting by jarwo transplanter is Rp. 325,057,-, while by manual system is Rp. 653,343,-. Thus, it can concluded that wider the farmers riceland area will bigger the planting cost and number of labour, and will take longer time as well.

In the other side, the efficiency of jarwo transplanter tool is still be able to be improved because the power source of this tool came from human (operator). It means the velocity and total time consuming for this tool in the field is depend

on the operator skill. Besides, the efficiency is also influenced by climatic condition, the planting time and the working speed.

3.2 Effectiveness of Combine Harvester

The result of efectiveness analysis from combine harvester is presented on Table 4. It shows that by using combine harvester required less labor, 3 persons only, with 2 ha/day for field work capacity and 98.8% for grain rice cleanness. While, applying the manual system, it required 40 labors to harvest for 1 ha. The grain rice cleanliness is 91.2% which is lower than combine harvester. Implemented harvesting machine can speed up harvest time and reduce harvest costs as well. Furthermore, the price of rice which is harvested by machine is higher around Rp. 200 - Rp. 400 / kg compared to manual system due to the higher level of grain cleanliness. It is also consistent with the previous study which is mentioned that using combine harvester can increase farmers income because harvesting-cost is cheaper [15].

Table 4. Comparison of Combine Harvester and Manual System

No	Parameter	Combine Harvester	Manual System
1	Fuel Consumption (l/ha)	25	0
2	Number of Labor (person)	3	40
3	Field Work Capacity (ha/day)	2	2
4	Grain Rice Cleanness (%)	98.8	91.2

Furthermore, Table 5 presents the cost analysis specifically for combine harvester, need Rp. 2,515,000,- for the cost, while by using planting team / manual system requireed a higher cost, Rp. 3,125,000,-, so there was difference-cost around Rp. 610,000,- per hectare. It can be concluded that using jarwo transplanter planting combine harvester are more effective and efficient in terms of labor and cost analysis compared to the manual system. Similar with the previous study that mentioned a mini combine harvester in tidal land type B can save costs Rp. 1,000,000,- / ha compared to manual harvesting system [16].

Table 5. Cost Analysis for Harvesting Time using Combine Harvester (per ha)

No	Item	Quantity	Unit	@	Sum
1	Harvesting	25	*rantai*	100,000	2,500,000
2	Meal Cost	3	person	5,000	15,000
	TOTAL				**2,515,000**

Table 6. Cost Analysis for Harvesting Time using Manual System (per ha)

No	Item	Quantity	Unit	@	Sum
1	Harvesting	25	*rantai*	125,000	3,125,000
	TOTAL				**3,125,000**

According to the output of the harvesting machine effectiveness, it found that the usage of combine harvester on riceland in this regency is so effective in terms of the saving time, reducing number of labours, reducing cost, the increasing of productivity and reducing loss of production during harvesting time. The increase of income from reducing operational cost can be observed from the cost comparison between cost which spent by conventional system and spent by combine harvester. Furthermore, the contribution at post harvesting handling on the production is reflected from declining loss of production and the quality of grain/ rice.

3.3 Benefit Cost Analysis for Some Technological Packages using Planting and Harvesting Machines

This study also conduct a benefit cost analysis for some techological package using planting and harvesting machines on rice cultivation which is compared to the manual system (farmer's system). Table 7 presents the benefit cost analysis and shows that implementation of jarwo super system contributes to the highest B/C ratio, 2.50, and followed by Integrated Crop Management (ICM), Direct Seed Planting and Farmer's System by 2.14, 1.24 and 1.20, respectively.

Table 7. Benefit Cost Analysis for Some Technological Packages

Item	Technological Packages			
	Jarwo Super	ICM	Farmer	Direct Seed Planting
Input Cost	4,780,000	3,930,000	3,930,000	3,985,000
Labor	7,515,000	7,515,000	8,625,000	7,875,000
Total Cost	12,295,000	11,445,000	12,555,000	11,860,000
Income	43,200,000	36,000,000	27,520,000	26,531,000
Profit	30,905,000	24,555,000	14,965,000	14,671,000
B/C ratio	**2.50**	**2.14**	**1.20**	**1.24**

By observing total cost in Table 7, it shows that each technological package is dominated by labor-cost, such as Jarwo Super which is share Rp. 7,515,000,- or 61.12% of the total farming cost; ICM shares Rp. 7,515,000,- or 65.66%; Farmer method pays Rp. 8,625,000,- or 68.69%; and Direct Seed Planting System shares around Rp. 7,875,000,- or 66.39% of the total farming cost.

The big cost for labor is influenced by cost for land cultivation, planting, and harvesting. Furthermore, this issue is affecting by low number of labor in Batubara Regency. The farming system of rice must be supported by mechanization system. Procurement of planting tools such as jarwo transplanter and harvesting machine such as combine harvester will provide added value and give positive impact for reducing the intensity of pests and diseases, lowering lost yield during harvesting, and more efficient when using of labor. This output shows that using the adaptive technology and suitable on the environment condition and farmers ability is crucial needed to increase yield and profit. Finally, for enhancing the productivity and reducing the farming cost, there are four packages should be considered on the cultivation site, Jarwo Super System, Integrated Crop Management System, Farmers System and Direct Seed Planting System.

4 Conclusion

Agricultural machine takes main role in the rice farming system recently. It will make cultivation management on rice field more effective and efficient. The usage of jarwo transplanter during planting time can labor-saving 21 people compared with manual and saving Rp. 405.000,-/ha. While, combine harvester can labor-saving 36 people and saving Rp. 610.000,- during harvesting time. Furthermore, the usage of jarwo transplanter and combine harvester is significantly improve the farmers income by B/C ratio reach to 2.5. Thus, the local government contribution is also needed by adding number of agricultural machine tools and adding the farmers capacity building related to the cultivation technology and agricultural mechanization in Batubara Regency specifically.
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