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Efficiency Analysis of Using Combine Harvester In Rice Paddy (*Oryza sativa* L)Harvesting Activities

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Abstract:
Background*: Along with the thoughts that Indonesian farmers are increasingly being pushed to increase the production of rice paddy in order to meet their needs but are constrained by a lack of labor, farmers solve this problem by using technology, specifically a combine harvester, to overcome these problems, which aims to harvest optimal rice paddy production in a short time with the use of minimal labor.*
Methods*: The number of people sampled was 60, and the sampling method was simple random sampling. Interviews, observations, questionnaires, and documentation were used to collect data. The Wilcoxon test is the data analysis technique used.*
Results*: The results revealed a significant difference in the cost of harvesting rice paddy (oryza sativa l) manually versus the cost of harvesting using a combine harvester in Gunung Mulia Village, where the average cost per farmer harvesting manually is IDR 7,931,004 versus IDR 3,308,900 for harvesting using a combine harvester. The efficiency value of using the Combine Harvester in rice paddy Harvesting activities was calculated to be 58.28%..*
Conclusion*:There is a significant cost difference between harvesting rice paddy (Oryza sativa L) manually and harvesting using a combine harvester, with the cost of harvesting using a combine harvester being significantly lower than harvesting manually. Meanwhile, a cost-efficiency analysis of rice paddy harvesting activities revealed that using the Combine Harvester in rice paddy harvesting activities can save harvest costs by 58.28% when compared to manual harvesting.*
Key Word*: harvest, combineharvester,rice paddy*

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I. Introduction

The food crop agriculture sub-sector is a sub-sector that plays a strategic role in the agricultural sector's national economic development structure, particularly in rural areas. It is possible to create sustainable agricultural development by increasing technological progress and implementing operational assistance. The existence of community survival, particularly farmers who are prosperous and can produce in farming, which provides benefits for farmers to determine the best choice in doing farming, is one of the characteristics of sustainable agriculture.

Because labor factors affect production income, food crop farming typically necessitates a large amount of labor in order to complete production activities. Costs, on the other hand, have an impact on farming activities. Furthermore, food crop cultivation in Indonesia is still done manually or traditionally. As a result, the process of farming activities necessitates a lot of labor.

Along with the ideas that Indonesian farmers are increasingly being pushed to increase production yields to meet their needs but are constrained by a lack of labor, farmers solve this problem by applying technology to overcome these problems, which aims to With the, you can achieve optimal rice production results in a short period of time..

In the process of collecting results or harvesting paddy rice crops in general, there are two options: manually (traditionally) or with agricultural machinery (modern). The majority of harvest systems in several agricultural areas of Indonesia, particularly the islands of Java, Kalimantan, and Sulawesi, have begun to use a rice harvesting machine, also known as a combine harvester.

The majority of rice farmers in GunungMulia Village have switched to using modern harvesting machines, specifically the combine harvester, in the harvesting process. Whereas, with this machine tool, harvesting time can be reduced and labor requirements reduced. The benefits of the combine havester machine tool allow it to overcome the problem of labor shortages in GunungMulia Village and complete the rice harvesting process in a relatively short period of time, maximizing farmers' income.

The purpose of this study is to determine the significant difference and efficiency of using a Combine Harvester in rice paddy harvesting activities versus manual harvesting.

II. Methods

Lowland rice farmers in GunungMulia Village, Babulu District, North PenajamPaser Regency, were subjected to an efficiency analysis of the use of a combine harvester in rice harvesting activities.

Study design: The survey method with descriptive explanatory type was used in this study's research design.

Study location: GunungMulia Village is located in the Babulu District of the North PenajamPaser Regency.

Study duration: August 2021 to August 2022

Sample size: The number of samples in this study was 60 people.

Sample size calculation: The Sample size was calculated as 10% of the total population of 596 rice farmers, with respondents chosen using the Simple Random Sampling technique.

Data collection technique: The data collection techniques using observation techniques, interviews, questionnaires and documentation.

Statistical analysis: The data were analyzed using SPSS version 17. Paired Sample t-test was used to determine the significant difference between the cost of manual harvesting and the cost of harvesting using a harvest combine (if the data were normally distributed) and if the data were not normally distributed, the Wilcoxon test was used, while to confirm the normality of the data, the Wilcoxon test was used to confirm the normality of the data. Kolmogrov-Smirnov test. In addition, to calculate the value of efficiency, an analysis of cost savings is used from the use of harvest combine in rice harvesting activities, compared to manual harvesting.

III. Results

The results of the study indicate that the average cost per hectare for the implementation of manual rice harvesting activities is as follows:

Table 1. Total Cost of Harvesting Manually

Cost Description	Average Cost Per Ha (IDR)
Sickle and tarpaulin	150.021
Raffia Sack and Rope	303.900
Cutting	2.140.000
Threshing	3.855.250
Consumption	1.481.833
Total	7.931.004

(Source: data processed by researchers)

Based on the table above, the total cost of harvesting rice manually from 60 respondents based on the results of the study, it can be concluded that the average cost of harvesting rice manually is IDR 7,931,004 per hectare.

While the average cost per hectare for the implementation of rice harvesting activities using the Combine Harvester is as follows:

Table 2. Total Cost of Harvesting Using Combine Harvester

Cost Description	Average Cost Per Ha (IDR)
Sickle and tarpaulin	4.415
Raffia Sack and Rope	347.367
Combine Harvester rental	2.756.667
Consumption	200.000
Total	3.308.449

(Source: data processed by researchers)

From the table above, it is known that the total cost of harvesting lowland rice using a combine harvester from 60 respondents based on the results of the study obtained an average total cost of IDR 3,308,449.

The following are the results of the normality test from harvesting cost data from 60 respondents, both harvesting manually, and harvesting using a Combine Harvester

Table 3. Data Normality Test Results

	How to harvest	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Cost	Cost of Manual harvesting	.244	60	.000	.803	60	.000
	Cost of using combine harvester	.161	60	.001	.876	60	.000

a. Lilliefors Significance Correction

(Source: data processed by researchers)

Based on table 3 above, the significance value for manual harvesting costs is 0.000, while the significance value for combine harvester costs is 0.000, it can be concluded that the harvest cost data are not normally distributed. Because the data are not normally distributed, the test of the mean difference for the paired sample uses Non-Parametric statistical analysis using the Wilcoxon test.

The results of calculations using the Wilcoxon test were carried out using SPSS version .17.0 for Windows and the results can be seen in table 4 below:

Table. 4. Output Results of Ranks Values from the Wilcoxon Test

Ranks				
		N	Mean Rank	Sum of Ranks
Cost of using combine harvester- Manual harvesting costs	Negative Ranks	60[a]	30.50	1830.00
	Positive Ranks	0[b]	.00	.00
	Ties	0[c]		
	Total	60		

a. Cost of using combine harvester<Manual harvesting costs

b. Cost of using combine harvester>Manual harvesting costs

c. Cost of using combine harvester= Manual harvesting costs

(Source: data processed by researchers)

Based on the results of the output ranks above, it can be explained that:

a. Negative Ranks or the difference (negative) between the cost of harvesting manually and harvesting using a combine harvester. Here there are 60 negative data (N) which means that 60 farmers experienced a decrease in harvest costs after using a combine harvester. The mean rank or the average reduction in harvest costs is 30.50, while the number of negative rankings or Sum Ranks is 1830.00.
b. Positive Ranks or the difference (positive) between the cost of harvesting manually and harvesting using a combine harvester is 0, both in the N value, Mean Rank, and Sum of Rank. This value of 0 indicates that there are no farmers who experience an increase in harvest costs after using a combine harvester.
c. Ties is the similarity between manual harvesting and combine harvester costs is 0. So it can be concluded that there are no farmers with the same costs between harvesting manually and harvesting using a combine harvester.

Decision making in the Wilcoxon test is formulated with the following hypothesis::

H_0 : accepted if the significance value ≥ 0.05 means that there is no significant cost difference between harvesting manually and harvesting using a combine harvester

H_1 : accepted if the significance value < 0.05. it means that there is a significant cost difference between harvesting manually and harvesting using a combine harvester

Table 5. Test Statistics Values from Wilcoxon Test Results

Test Statistics[b]	
	Cost of using combine harvester - Manual harvesting costs
Z	-6.736[a]
Asymp. Sig. (2-tailed)	.000

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Based on the results of the "Test Statistics" output above, it is known that Asymp.Sig.(2-tailed) is 0.000. Because the value of Asymp.Sig.(2-tailed) < 0.05, it can be concluded that H_1 is accepted, meaning that there is a significant cost difference between harvesting manually and harvesting using a combine harvester.

For the value of the efficiency of using the Combine Harvester in rice paddy harvesting activities compared to manual harvesting, it is:

$$\frac{7.931.004 - 3.308.449}{7.931.004} \times 100\% = 58{,}28\%$$

From the results of the calculation of the efficiency value of using the Combine Harvester in Rice Rice Harvesting activities, it is 58.28%, this value can be interpreted that by using the Combine Harvester in Paddy Rice Harvesting activities, it can save harvest costs by 58.28%, when compared to harvesting. Manually.

IV.Discussion

The difference between the cost of harvesting manually and the cost of harvesting using a combine harvester

From the results of the analysis of the average difference test (Wilcoxon test) between the difference in the cost of harvesting manually and the cost of harvesting using a combine harvester in GunungMulia Village, Babulu District, North PenajamPaser Regency, there is a significant difference, where the cost of harvesting using a combine harvester is much cheaper than using a harvest manually.

The total cost of harvesting using a combine harvester is smaller or cheaper than harvesting manually. This is because harvesting using combine havester is more efficient, because with this harvesting system it does not require a lot of labor so that farmers do not incur a lot of costs or labor costs and consumption. In addition, harvesting using a combine harvester can be completed within 2 hours/ha. If harvesting is done manually it takes one to three days to complete the harvest with a workforce of 5-15 people to complete the rice harvest per hectare. Where at the time of harvesting manually, you have to do several steps for the harvest process such as cutting the grain first using a sickle/sickle, after that threshing the rice grains using a thresher machine, and then cleaning, and putting the grain into sacks. While harvesting using a combine harvester, the harvesting process, both cutting, threshing and cleaning is done by machines so that farmers only do rafting.

This is in accordance with the opinion of the KelompokTaniPati (2016) which states that harvesting with a combine harvester is an effort to streamline all harvest costs and speed up the harvest time process in order to get better production results. So that the need for tools and materials for harvesting is also not too much needed at the time of harvesting with a combine harvester. According to JohanesAmirrullah in the journal Efficiency of Using Rice Harvesting Machines Combine Harvester (2016) where the combine harvester machine is specifically designed to be operated on tidal land, both large rice fields and narrow rice fields. The manual harvesting stage requires a lot of labor with high wages, besides that at harvest some of the workers work outside the agricultural sector and do not want to work in the fields. However, there are some farmers who take advantage of this opportunity, especially for farmers whose cultivators have a small area of land to become laborers or hired workers, in the hope of increasing family income. At harvest time, farmers have to prepare a large enough cost, the amount of costs incurred is because farmers still use manual labor, in 1 ha during the harvest season per day it requires labor as much as 10-20 people per day/ha.

The presence of agricultural technology such as combine harvester does not shift the existing workforce to work as wage laborers or as laborers. Using this tool is only to avoid if during the harvest season, there is a shortage of labor, it is necessary to use a combine harvester at harvest time.

Combine harvester (harvest tractor) is a rice harvesting tool that can cut the plant panicles standing, threshing, cleaning and rafting grain while walking in the field. Thus, harvesting time is shorter than using human (manual) labor and does not require a large amount of human labor as in manual harvesting.

The components of manual harvesting costs incurred include tool costs, material costs, labor costs, and labor consumption costs. Where the tools needed, namely sickles/sickles, have varying types and prices, each rice farmer needs 2 or more sickles/sickles, the materials needed at harvest are tarpaulins as a place to accumulate harvested rice before it is threshed or rice containers that have been threshed, sacks as a place to store rice that has been threshed, and raffia rope as a material for binding sacks.

Combine harvester (harvest tractor) is a rice harvesting tool that can cut the standing plant panicles, threshing, cleaning and rafting grain while walking in the field. Thus, harvesting time is shorter than using human (manual) labor and does not require a large amount of human labor as in manual harvesting.

The components of manual harvesting costs incurred include tool costs, material costs, labor costs, and labor consumption costs. Where the tools needed, namely sickles/sickles, have different types and prices, each rice farmer needs 2 or more sickles/sickles, the materials needed at harvest are tarpaulins as a place to accumulate harvested rice before it is threshed or rice containers that have been threshed, sacks as a place to store rice that has been threshed, and raffia rope as a material for binding karuAnd the components of the cost of harvesting using a combine harvester that are incurred include equipment costs, material costs, combine harvester rental costs and labor consumption costs. At the time of harvest using a combine harvester, farmers do not use a sickle/sickle to cut rice anymore but to cut the rope during the rafting process. Material costs incurred

are costs for sacks and raffia. At the time of harvest using a combine harvester, the labor wage system is included in the rental of the combine harvester machine with a harvest distribution system of 7/1 sacks and for the labor consumption costs of the combine harvester, farmers spend IDR 40,000/person. When harvesting using a combine harvester, farmers no longer use tarpaulins as a place for piling rice. Because when harvesting, the grain automatically comes out of the machine and is put into sacks, so from this research it can be seen that there are some differences in treatment and also differences in the expenditure of harvest costs required from each harvesting system.

Efficiency of Using Combine Harvester in Rice Harvesting Activities

From the results of the analysis of cost efficiency in rice paddy harvesting activities, it can be concluded that by using the Combine Harvester in rice paddy harvesting activities, it can save harvest costs by 58.28%, when compared to manual harvesting.

The high value of cost efficiency in Rice Rice Harvesting activities using the Combine Harvester is in accordance with the function of this tool, where this tool is a combination of several different operations, namely cutting rice panicles, threshing and cleaning, as well as the convenience in the process of rafting grain, so that with this combination of operations which are carried out simultaneously while running, the use of this tool will speed up the harvesting process.

This is in accordance with the article fromBalaiPengkajianTeknologiPertanian Sulawesi Barat (2018) related to 3 Functions of the Combine Harvester, which explains that a combination harvester is a machine that harvests cereal crops. This machine, as the name suggests, is a combination of three different operations, namely harvesting, threshing, and winnowing, into a series of operations that can save labor costs and make farming more efficient, and usually the time required for harvesting is around 2 hours per ha..

Besides being efficient, using a combine harvester machine at harvest will reduce the loss of rice production. Because the harvest process must be precise, the timing of harvest is the initial stage of post-harvest handling activities, which can result in high yield losses and low grain/rice quality. This statement agrees with Prasetyo (2003) which states that rice harvesting must be carried out at the right harvest age, using harvesting tools and machines that meet technical, health, economic and ergonomic requirements and implement an appropriate harvesting system. Inaccuracy in harvesting rice can result in high yield losses and low yield quality. At this stage, the yield loss can reach 9.52% if the rice harvester is carried out incorrectly.

V. Conclusion

Based on the results of the study, it can be concluded as follows:

a. Based on the analysis results show that there is a significant difference between the cost of harvesting rice paddy (Oryza sativa L) manually and the cost of harvesting using a combine harvester where the cost of harvesting using a combine harvester is much cheaper than harvesting manually.
b. From the results of the analysis of cost efficiency in rice paddy harvesting activities, it can be concluded that by using a combine harvester in rice paddy harvesting activities, it can save harvest costs by 58.28%, when compared to manual harvesting.

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