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The Influence of Transplanter and Combine Harvester Use on Working Time, Labor Requirement, and Income in Organic Red Rice (*Oryza rufipogon*) Farming in Singojuruh District, Banyuwangi

Pengaruh Penggunaan Transplanter dan Combine Harvester Terhadap Waktu Kerja, Jumlah Tenaga Kerja, Serta Pendapatan Pada Usaha Tani Padi Merah (Oryza rufipogon) Organik Di Kecamatan Singojuruh, Banyuwangi

Dimas Triardianto[1*], Casilda Aulia Rakhmadina[2], Adhima Adhamatika[3], Aldi Badahuri Indraloka[4]

[1] Keteknikan Pertanian, Jurusan Teknologi Pertanian, Politeknik Negeri Jember
[2] Teknologi Rekayasa Pangan, Jurusan Teknologi Pertanian, Politeknik Negeri Jember
[3] Teknologi Industri Pangan, Jurusan Teknologi Pertanian, Politeknik Negeri Jember
Jl. Mastrip, Kecamatan Sumbersari, Kabupaten Jember, Jawa Timur, Indonesia
[4] Agribisnis, Politeknik Negeri Banyuwangi
Jl. Raya Jember KM 14, Kabupaten Banyuwangi, Jawa Timur, Indonesia

email: dimas.triardianto@polije.ac.id

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ABSTRACT
The Singojuruh District in Banyuwangi Regency plays a pivotal role in rice cultivation, characterized by a large agricultural area and the highest levels of rice production and productivity compared to other districts. Among the various rice farming practices, organic red rice cultivation has emerged as a promising alternative due to its growing market demand and favorable selling prices for farmers. However, its productivity and profitability remain suboptimal, primarily due to the limited use of agricultural machinery such as transplanters and combine harvesters. This study aims to examine the effects of mechanization—specifically the use of transplanters and combine harvesters—on working time, labor requirements, and farmers' income in organic red rice farming in the Singojuruh District. A survey method was employed, involving farmers as respondents to assess the relative conditions, distribution patterns, and inter-variable relationships. Furthermore, an independent sample t-test was conducted to compare the variables. The findings reveal that the application of transplanters and combine harvesters significantly reduces working time and labor requirements while simultaneously increasing farmers' income in organic red rice farming.

ABSTRAK
Kecamatan Singojuruh merupakan daerah yang memiliki peran penting dalam usahatani padi di Kabupaten Banyuwangi dengan tingginya luas lahan, produksi gabah, dan produktivitas gabah dibandingkan kecamatan yang lain. Salah satu usahatani dengan potensi yang besar adalah usahatani padi merah organic. Hal ini dikarenakan meningkatnya permintaan pasar dan harga jual yang menguntungkan petani. Namun, produktivitas padi merah organik serta

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keuntungan usahatani belum optimal karena minimnya penggunaan alat mesin pertanian seperti transplanter dan combine harvester. Penelitian ini bertujuan untuk menganalisis dampak penggunaan alat dan mesin tersebut terhadap waktu kerja, jumlah tenaga kerja, dan pendapatan pada usahatani padi merah organik di Kecamatan Singojuruh, Kabupaten Banyuwangi. Metode survei digunakan dengan sampel petani – petani yang tedapat pada daerah tersebut sebagai representasi populasi untuk menganalisis kondisi relatif, distribusi, dan hubungan antar variabel. Selain itu, uji beda independent sample t-test digunakan untuk membandingkan nilai variabel. Hasil penelitian menunjukkan bahwa penggunaan transplanter dan combine harvester secara signifikan mempersingkat waktu kerja, mengurangi jumlah tenaga kerja, dan meningkatkan pendapatan bagi petani pada usahatani padi merah organik di Kecamatan Singojuruh, Kabupaten Banyuwangi.

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1. Introduction

Banyuwangi is known as one of the national rice granaries because the majority of its population works in the agricultural sector and has a large area of land, high rice production, and productivity at the East Java Province and national levels. Based on 2022 data from the Badan Pusat Statistik (BPS), 315,607 residents [1], or 35.72% of the total population of Banyuwangi, work as farmers. In 2020, this region had 119,108 ha of rice fields, with a production of 788,971 tons of grain and a productivity of 66.24 quintals/ha [2].

One commodity that has experienced an increase in production is organic red rice, which produces organic red rice. Based on data from the Organic Institute (2019), the area of organic rice fields in Indonesia reached 53,974.19 hectares [3], and Banyuwangi contributed 81.49 hectares with a production of 515.5 tons/year [4]. This increase is driven by high market demand, as red rice contains anthocyanins—phenolic compounds that function as antioxidants and are beneficial to health [5]. From the farmers' perspective, organic red rice is also profitable because it has a higher selling price than white rice and non-organic red rice [6].

However, organic red rice production in Banyuwangi is still very small, accounting for only 0.06% of total rice production. One of the factors contributing to this low contribution is the suboptimal application of mechanization in organic red rice farming. Data from the Agricultural Research and Development Agency (2019) shows that the level of adequacy of agricultural tools and machinery in Banyuwangi is generally still low. This is particularly evident in the types of four-wheel tractors, dryers, transplanters, and combine harvesters, as shown in **Table 1**.

According to Firdaus and Adri (2021) [7], the use of agricultural tools and machinery can increase agricultural productivity, improve crop quality (increase rice yield, reduce broken rice, and reduce impurities in crops), and reduce crop losses during harvesting. Meanwhile, based on research by Suyatno et al. (2018) [8], the use of agricultural machinery can also substitute for labor, which is increasingly expensive and scarce in rural areas, reduce the cost of farming, and speed up the rice cultivation process.

Therefore, this study aims to analyze the effect of using agricultural tools and machinery with insufficient levels of availability, namely transplanters and combine harvesters, on working time, labor requirements, and income in organic red rice farming in Singojuruh District, Banyuwangi.

Table 1. Level of Sufficiency of Agricultural Tools and Machinery in Banyuwangi Regency

Type of Agricultural Tools and Machinery	Number (units)	Sufficiency of Agricultural Equipment and Machinery Needs (%)	Sufficiency Level Category of Equipment Needs
Two-wheel tractor	2,964	78	Moderate
Thresher	4,173	78	Medium
Four-wheel tractor	12	10	Less
Dryer	50	9	Less
Transplanter	64	17	Less
Combine harvester	130	32	Insufficient

Source: Agricultural Research and Development Agency Agricultural Tools and Machinery Data (2019)

2. Research Method

The research was conducted during the late planting season (August–December) 2024 on organic red rice farms belonging to the Lembu Asri Farmer Group located in Singojuruh District, Banyuwangi Regency.

The research was conducted using a survey and interview method on a sample (three farmers) who had the largest area of organic red rice fields in the Lembu Asri Farmer Group. Data collection was sourced from primary and secondary data. Primary data consisted of interviews with farmer respondents covering the characteristics of organic red rice farming, agricultural tools and machinery used, working hours, number of workers, production costs, production yields, and grain selling prices. Secondary data came from archives and reports from the Central Statistics Agency (BPS) and the Singojuruh Subdistrict Agricultural Extension Center, Banyuwangi Regency.

To examine the effect of agricultural machinery use on working hours, number of workers, and income from organic red rice farming in Singojuruh Subdistrict, Banyuwangi Regency, an assumption test was conducted, followed by an independent sample t-test using SPSS 25 software.

3. Results and Discussion

3.1 Characteristics of Farming in Singojuruh Subdistrict, Banyuwangi Regency

Singojuruh District is one of the districts with the largest rice field area, highest paddy production, and highest paddy productivity in Banyuwangi Regency (Banyuwangi Regency Agriculture Office, 2020) [2]. **Table 2** shows that Singojuruh Subdistrict ranks second in terms of harvest area, rice production, and rice productivity in Banyuwangi Regency. This indicates that Singojuruh Subdistrict plays an important role in the rice commodity in Banyuwangi Regency.

Organic red rice farming in Singojuruh Subdistrict, Banyuwangi Regency, is carried out starting from planting preparation, soil cultivation and planting, maintenance, and harvesting, which takes 95-105 days. Each of these activities incurs expenses. After harvesting, the grain from the farmers is sold to organic red rice mills.

Meanwhile, two-wheel tractors (used for soil cultivation), power sprayers (used for spraying), and threshers (used for harvesting) are agricultural tools and machinery that are already used by all respondent farmers. However, transplanter (used for planting) and combine harvester (used for harvesting) are still rarely used. This is in line with data from the Agricultural Research and Development Agency (2019), which states that two-wheel tractors and threshers are agricultural tools and machinery with a moderate level of adequacy, while transplanters and combine harvesters have a low level of adequacy. Therefore, the following discussion will compare the working time, number of workers, production costs, production yields, and selling prices of

farming businesses that use combine harvesters and transplanters with those that do not use these two tools and machines.

Table 2. Statistical Data on rice commodities in several districts of banyuwangi regency in 2020

District	Harvested Area (ha)	Production (tons)	Productivity (kg/ha)
Sempu	9,290	61,321	66.01
Singojuruh	9,083	60,500	66.61
Kabat	9,050	56,475	62.40
Songgon	8,376	54,241	64.76
Srono	7,367	49,529	67.23

Table 3. Analysis of costs, number of workers, working time, and organic red rice farming without transplanters and combine harvesters

No	Activity	Amount of Materials	Number of Workers (People)	Working Time (Hours)	Unit Cost	Cost	Total Cost
Planting Preparation							
1	Spread straw on the land	-	1	4	People/Activities	Rp90,000	Rp90,000
2	Construction of a nursery	-	1	4	Activities/Ha	Rp90,000	Rp90,000
3	Seedlings	35	-	-	Kg	Rp14,000	Rp490,000
Soil Preparation and Planting							
4	Tractor rental	-	1	24	Activity/Ha	Rp1,600,000	IDR 1,600,000
5	Repair of rice field embankments	-	1	6	Activities/Ha	Rp650,000	Rp650,000
6	Planting	-	6	13	Activities/Ha	Rp1,200,000	IDR 1,200,000
Maintenance							
7	Weed control	-	1	6	Activities/Ha	Rp550,000	Rp550,000
8	Fertilization 1	-	1	5	Activity/Ha	Rp100,000	Rp100,000
9	Fertilization 2	-	1	5	Activities/Ha	Rp100,000	Rp100,000
10	Organic Fertilizer	475	-	-	Kg	Rp3,000	IDR 1,425,000
11	Biological agent	1	-	-	Package	Rp1,000,000	IDR 1,000,000
12	Spraying	4	-	-	Activity/Ha	Rp80,000	Rp320,000
Harvest							
13	Thresher machine rental	50	2	12	Sack	Rp18,000	IDR 900,000
14	Rice harvesting	50	1	12	Sacks	Rp30,000	IDR 1,500,000
15	Transportation of rice sacks	50	4	-	Sacks	Rp25,000	IDR 1,250,000
Total			**20**	**91**			**Rp11,265,000**

Source: Primary Data Analysis (2024)

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Table 4. Analysis of costs, number of workers, working hours, and organic red rice farming with transplanter and combine harvester

No	Activity	Amount of Materials	Number of Workers (People)	Working Time (Hours)	Unit Cost	Cost	Total Cost
Planting Preparation							
1	Spread straw on the land	-	1	4	People/Activities	Rp90,000	Rp90,000
Land Preparation and Planting							
2	Tractor rental	-	1	24	Activity/Ha	Rp1,600,000	IDR 1,600,000
3	Repair of rice field embankments	-	1	6	Activities/Ha	Rp650,000	Rp650,000
4	Transplanter Machine Rental (including seedlings)	-	2	6	Activity/Ha	Rp2,500,000	Rp2,500,000
Maintenance							
5	Weeding		1	6	Activities/Ha	Rp550,000	Rp550,000
6	Fertilization 1		1	5	Activity/Ha	Rp100,000	Rp100,000
7	Fertilization 2		1	5	Activities/Ha	Rp100,000	Rp100,000
8	Organic Fertilizer	475	-		Kg	Rp3,000	IDR 1,425,000
9	Biological agent	1	-		Package	Rp1,000,000	IDR 1,000,000
10	Spraying	4	-		Activities	Rp80,000	Rp320,000
Harvesting							
11	Combine harvester rental	1	3	11	Activity/Ha	Rp1,800,000	Rp1,800,000
Total			**11**	**67**			**Rp10,135,000**

Source: Primary Data Analysis (2024)

Table 5. Analysis of income from organic red rice farming without transplanter and combine harvester compared to organic red rice farming with transplanter and combine harvester

Component	Organic Red Rice Farming Without Transplanter and Combine Harvester	Organic Red Rice Farming with Transplanter and Combine Harvester
	Value	**Value**
Paddy Production	5,560 kg/ha	5,715 kg/ha
Rice Price	Rp6,000/kg	Rp6,000/kg
Total	**IDR 33,360,000**	**IDR 34,290,000**

Source: Primary Data Analysis (2024)

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Table 6. Analysis of organic red rice farming income without transplanter and combine harvester compared to organic red rice farming with transplanter and combine harvester

Component	Organic Red Rice Farming Without Transplanter and Combine Harvester	Organic Red Rice Farming with Transplanter and Combine Harvester
	Value	Value
Income	Rp33,360,000	IDR 34,290,000
Expenses	IDR 11,265,000	IDR 10,135,000
Total	**Rp21,735,000**	**IDR 24,155,000**

Source: Primary Data Analysis (2024)

Table 7. Results of Independent Sample T-Test for Number of Workers, Working Hours, and Income

Variable	t	Sig.	Note.
Number of Employees	13.1	0.00	Significant
Working Hours	33.2	0.00	Significant
Income	-8.1	0.00	Significant

Source: Primary Data Analysis (2023)

3.2 The Effect of Transplanter and Combine Harvester Use on Working Time

Based on **Table 3** and **Table 4**, it can be seen that organic red rice farming using transplanters and combine harvesters has a faster total working time, namely 66 hours, compared to organic red rice farming that does not use transplanters and combine harvesters, which has a working time of 84 hours. The results of the independent sample t-test in **Table 7** show that there is a significant difference between the working time values.

This difference in working time is due to the fact that planting rice seedlings using a transplanter is faster, namely 5 hours/Ha, compared to planting using manual labor carried out by a group of six people, which takes 13 hours/Ha. In addition, during harvesting, the combine harvester can carry out the process of cutting rice stalks, threshing grain, cleaning grain, and transporting grain sacks all at once, so that 1 hectare only requires 11 hours. Meanwhile, harvesting using a thresher requires time for manual cutting of rice stalks (threshing) by human labor on the first day for 12 hours/ha, and the process of threshing and cleaning the grain with a thresher machine on the second day, which takes 12 hours/ha, so that the total harvesting time using a thresher machine requires 24 hours.

The results of this study are in line with the research by Umar and Pangaribuan (2017) [9] and Zulkarnain et al. (2022) [10], which show that the average rice planting capacity with a transplanter is 6.15 hours/hectare, which is faster than planting by hand, which requires an average of 13.5 hours/hectare. Additionally, harvesting rice paddies with a combine harvester is up to three times faster than harvesting with a thresher.

3.3 The Effect of Transplanter and Combine Harvester Use on Labor Requirements

Based on **Tables 3** and **4**, it can be seen that organic red rice farming using transplanters and combine harvesters requires fewer workers, namely 11 people, compared to organic red rice farming without transplanters and combine harvesters, which requires 20 workers. The results of the independent sample t-test in Table 9 show that there is a significant difference in the number of workers.

This difference in the number of workers is due to the fact that planting rice seedlings using a transplanter only requires two operators who take turns operating the machine, while planting seedlings using human labor requires a group of six people. Harvesting using a combine harvester requires three people to operate the combine harvester, one person to operate the machine, and two people to take turns holding and closing the grain bags at the output hole. Meanwhile, harvesting using a thresher requires a total of seven people, two to

operate the thresher, one to cut the rice, and four to transport the grain sacks from the thresher to the side of the road.

Based on research by Suyatno et al. (2018), it shows that agricultural tools and machines can substitute human labor in rice farming [8]. Purwantini and Sri (2018) added that the reduction of labor by agricultural tools and machines can speed up work time and reduce costs in rice farming [11]. More broadly, this condition is relevant to the national trend of declining labor in the agricultural sector. According to data from "Agricultural Sector Employment Statistics" (2023) [1], the number of agricultural workers (in the narrow sense) reached 36.46 million people, or about 26.07% of the total national workforce. This figure shows a downward trend in the proportion of agricultural workers from year to year, as the workforce—especially the younger generation—shifts to the non-agricultural sector. In this context, mechanization through the use of agricultural machinery is a strategic solution to overcome labor shortages, maintain productivity, and improve the efficiency of rice farming in a sustainable manner.

3.4 The Effect of Transplanter and Combine Harvester Use on Income

Based on Table 5 and Table 6, it can be seen that organic red rice farming that uses transplanters and combine harvesters has a higher income, namely IDR 24,155,000, compared to organic red rice farming that does not use transplanters and combine harvesters, which has an income of IDR 21,735,000. The results of the independent sample t-test in Table 9 show that there is a significant difference between the income values.

This difference in income is due to the use of transplanters and combine harvesters, which reduces costs and increases income from organic red rice farming. A significant reduction in costs can be seen in the harvesting process, where the rental price for a combine harvester is only IDR 1,800,000/ha. Meanwhile, when using a thresher, there are several additional cost components that arise, apart from the thresher rental cost, such as the cost of labor for cutting rice (ngarit) and transporting sacks from the thresher located in the middle of the field to the side of the road to facilitate the loading process into transport vehicles. These costs depend on the number of sacks of grain produced (one sack contains 100-120 kg of grain). In addition, the use of a combine harvester minimizes grain losses compared to using a thresher. This can be seen from the grain production per hectare in Table 5. Grain production per hectare in organic red rice farming that uses transplanters and combine harvesters is higher than that which does not use these machines.

The results of this study are in line with studies conducted by Prasetio et al. (2022) [12], Nurdin et al. (2021) [13], and Emalia et al. (2021) [14]. These studies show that the use of agricultural tools and machinery in paddy farming has a significant effect on reducing grain losses during harvesting and increasing grain production and farmer income.

4. Conclusion

The use of transplanters and combine harvesters in organic red rice farming in Singojuruh Subdistrict, Banyuwangi Regency, significantly reduces working time, lowers labor requirements, and increases farmers' income compared to production systems that do not utilize these machines. These results underscore the critical role of agricultural mechanization in improving operational efficiency, enhancing economic outcomes, and supporting the long-term sustainability of organic red rice farming.

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