Combine rice harvester performance test in Takalar Regency

Iqbal, Supratomo and A Azis
Engineering Agricultural Department, Universitas Hasanuddin, Makassar, 90245, Indonesia.

E-mail: iqbalqma@yahoo.com

Abstract. Post-harvest handling of rice is a very strategic effort to support increase in rice production. The main problem of the farmers in handling the harvest and post-harvest rice is high yield loss and bad quality grain and rice produced. Combine rice harvester is a rice harvester that can cut the stems of plants, shed and clean grain while walking in the field. The purpose of this study was to determine the work capacity and efficiency of a combined rice harvester in rice fields in Takalar regency. The results of the research are the use of rice harvesting machines in the rice field can accelerate the process of rice harvesting. The work capacity of the combine rice capacity is 5 hectares per day with 70 Horse Power.

1. Introduction
Rice is one of the most important plants in civilization [1]. Rice is an annual plant, rooted in fibers, short stems and in the form of structures formed from a series of leaf sheaths that support one another. Rice is a carbohydrate-producing food consumed by almost all Indonesians (96.87 % of the population) and contributes more than 90 % of caloric needs to both urban and rural communities [2–4]. Rice has a round and hollow stem shape leaves are elongated like a ribbon that stands on the stem segment and has a panicle found at the end of the stem. With a population of about 250 people and an annual population growth of 1.49 %, national rice needs reach 38 million tons [3].

Rice is one of the raw materials for food that contains adequate nutrition and reinforcement for the human body because rice contains ingredients that are easily converted into energy so that rice can be called a food source of energy. Broadly speaking, rice plants have two main parts, namely the vegetative part and the generative part [5].

Post-harvest handling of rice is a very strategic effort to support increased rice production by producing grain in good condition so that it can be consumed or for processing raw materials. The contribution of post-harvest handling to the increase in rice production can be seen from the decrease in yield losses and the achievement of grain or rice quality that is following the quality requirements. One of the factors that influence good post-harvest handling is technical factors.

Harvesting activities are the final part of the production process and become very critical because of the limited number of workers. Harvesting must be done at the right time so that it can reduce crop losses, especially for rice varieties that fall off easily. Rice harvesting is the end of pre-harvest activities and is the beginning of post-harvest activities. Harvesting must be done at the right harvest age so that it can produce results and benefit farming activities. Unclean at the age of improper harvest will produce grain and rice that is not good quality, while a good harvest method can qualitatively reduce yield losses [6].
Harvesting equipment that is often used in rice harvesting varies, such as using ani-ani, using an ordinary sickle, jagged sickle and so forth. With the introduction of new superior varieties of rice that have high yield potential and short posture, there is a change in the use of harvesting tools from ani-ani to the use of ordinary sickle and the use of jagged sickle. In rice harvesting, it can cause lower yield losses. How to harvest depends on the harvesting tools to be used. In general, ani-ani is used by farmers to harvest local rice that is resistant to loss and high-posture rice plants by cutting on the stems. How to harvest new superior varieties of rice with a sickle can be done by cutting the top, middle cut, or cut down depending on how to thresh. The method of harvesting cut down is generally done if the threshing method is by slamming/slashing or by using a pedal thrasher while the rice harvest by using the top cut and the middle cut is done if the threshing method using threshing machines [7].

The main problem faced by farmers in handling the harvest and post-harvest rice is high yield loss and low-quality grain and rice produced. The low quality of grain is caused by high levels of dirt, empty grains, and whitewashing grains so that the milled rice yield is low. This whitewashing grain is influenced by genetic factors, fertilization, and watering techniques, while technical factors, namely threshing only influence the level of impurities. Most of the traditional harvesters shed rice by slamming or using a pedal thrasher so that the grain produced contains high levels of dirt and empty grain [7].

The process of threshing rice can be done by using several techniques, ranging from pounding rice on a piece of wood by letting the rice grain fall into a certain place, trampling rice straw with human or animal power, and threshing rice using mechanical power. But mechanically, rice threshing can be done by using a combined rice harvester machine power. One of the rice thrasher machines that can be used is combined rice harvester. This type combines several activities carried out at once, namely harvesting, threshing and packaging of rice.

Rice threshing is the post-harvest stage of rice after cutting rice (harvesting). This stage of the activity is aimed at releasing the grain from its panicle. Rice threshing can be done manually and by using threshing tools and machines. The principle to release grain from the panicle is to put pressure or blow on the panicle. The process of threshing rice contributes significantly to the overall loss of rice yield. At the threshing stage of rice, yield losses due to inaccuracy in threshing can reach more than 5 % [7].

Rice threshing is one of the post-harvest stages that contribute quite significantly to overall yield loss. Threshing needs to be done immediately after the rice is harvested, not stacked first. Delay threshing will increase yellow/broken grains and broken rice and reduce the yield of the rollers [8]. This harvesting machine needs performance testing so that it can provide information to farmers about work capacity and farmers can make the most of the technology. The purpose of this study was to determine the work capacity and efficiency of a combined rice harvester in rice fields in Takalar regency.

2. Materials and methods

2.1. Tools and materials
This research was conducted in the Pattalassang and North Polombangkeng District, Takalar Regency, South Sulawesi. The tools used in this study combined rice harvester. The material used in this study is the rice crop.

2.2. Research methods

2.2.1. Harvest capacity calculation. Calculation and data on harvest potential and wages are obtained by first calculating the capacity and potential of each crop using an equation of harvest capacity (HC) [9]:

\[ HC = \frac{W \times Y \times P}{S} \]

where:
- \( W \) = weight of rice
- \( Y \) = yield of rice
- \( P \) = price of rice
- \( S \) = area of rice field
2.2.2. Calculating equipment field efficiency. Data analysis and formulas used include;

1. Theoretical Field Capacity. The theoretical field capacity (TLC) obtained by measuring the working width of the combine tool then measures the Combine forward speed in the distance determined by using the equation [9].

\[ KLT = 0.36 \left( v \times P \right) \]  

Information:
- TLC = theoretical field capacity (ha/hour)
- v = Average speed (m/s)
- P = Average work width (m)
- 0.36 = Conversion factor (1 m²/s = 0.36 ha/hour)

2. Effective Field Capacity. In the calculation of effective field capacity (EFC) is done by measuring the area of land harvested and the time required in the process of harvesting on land and calculate using the following equation [10]

\[ KLE = \frac{L}{WK} \]  

Information:
- KLE = Effective field capacity (ha/hour)
- L = Extent of cultivated land (ha)
- WK = working time (hours)

3. Field Efficiency. Field efficiency can be calculated from the value of theoretical field capacity and effective field capacity obtained. The formula used to determine field efficiency is by equations [9].

\[ efesiensi = \frac{KLE}{KLT} \times 100\% \]  

Information:
- KLE = effective field capacity
- KLT = theoretical field capacity

3. Results and discussion

Combine a rice harvester is a tool and practical agricultural machinery to use. It has three functions, namely cutting, threshing and packing rice. In general, the basic operational functions of combine rice harvester are cutting the standing plants, conducting the crop that into the cylinder, knocking out grain from the stalk or stem, separating grain from the straw, and cleaning the grain by removing empty grain and foreign matter.

The works principles of the combine rice harvester are:

- The rice that was cut, including the straw, was all put into the threshing section.
- Thresher grain is collected in a tank, and the straw is scattered randomly above the ground.
- All types of combines are operated by riding (riding type).
- Cutting widths range from 1.5 to 6 meters. But the popular one is 4 meters.
- The engine as a source of motion power is about 25 hp per 1-meter cutting width. The forward driving part is using a wheel, or half-track type or full-track type.
### Table 1. Test results of rice Harvesting Machines in Pattalassang District

| No | Length of track (m) | Duration (s) | Rice Weight (kg) | Large (m²) | Work Capacity (ton/hour) | Work Capacity (ha/hour) |
|----|---------------------|--------------|------------------|------------|--------------------------|------------------------|
| 1  | 28                  | 39           | 32               | 56         | 2.95                     | 0.52                   |
| 2  | 28                  | 29           | 37               | 56         | 4.59                     | 0.70                   |
| 3  | 28                  | 22           | 35               | 56         | 5.73                     | 0.92                   |
|    | Average             | 30           | 34.67            | 56         | 4.42                     | 0.71                   |

### Table 2. Test results of rice harvesting machines in North Polombangkeng District

| No | Length of track (m) | Duration (s) | Rice Weight (kg) | Large (m²) | Work Capacity (ton/hour) | Work Capacity (ha/hour) |
|----|---------------------|--------------|------------------|------------|--------------------------|------------------------|
| 1  | 42                  | 51           | 53               | 84         | 3.74                     | 0.59                   |
| 2  | 42                  | 55           | 52               | 84         | 3.40                     | 0.55                   |
| 3  | 42                  | 28           | 40               | 84         | 5.14                     | 1.08                   |
|    | Average             | 44.67        | 48.33            | 84         | 4.10                     | 0.74                   |

Tables 1 and 2 show the results of the measurement of work capacity on each land that is harvested using a rice harvesting machine having a mean value that is not much different. The working capacity of rice field harvesting machines in Pattalassang sub-district is 0.71 ha/hour and on the paddy field in the North Polombangkeng sub-district is 0.74 ha/hour. Both of these values indicate that a rice harvester with a power of 70 HP only takes about 1.4 hours per hectare. Thus one rice harvesting machine can complete 5 hectares of paddy land per day.

The test results show that land conditions greatly influence the performance of Combine rice harvester at the time of harvest [11]. At the time of harvest, the condition of the land which is inundated greatly influences the movement and speed of the equipment. That is because muddy soil conditions can make the speed and movement of the device relatively slow. As the results of Wardhana’s research which states that to improve field efficiency and effective field capacity in the use of this harvesting machine, paddy fields must be dry when harvesting [9]. This is to prevent the harvesting machine from sinking.

As a comparison, one example of a Combine Harvester Automatic Rice Harvesting Machine is the Indo Combine Harvester rice harvesting machine designed by the Agricultural Research Agency. This machine is to support the achievement of the national rice self-sufficiency program through efforts to reduce crop losses. The ability of Automatic Combine Harvester Type Automatic Rice Harvesting Machine can combine cutting-hauling-cleaning-sorting-bagging-bagging activities in one process controlled activity.

The combined and controlled harvesting process results in a yield shrinkage that only occurs at 1.87 % or below the average shrinkage yield of the "gropyokan" method (about 10 %). While the level of cleanliness of harvested grain produced by these machines reaches 99.5 %. Combine Harvester rice harvesting machine operated by one operator and two helpers can replace the harvest labor of about 50 HOK/ha. The working capacity of the machine reaches 1.5 hours per hectare. The actual combine harvester machine is not only applied to rice cultivation. For corn crops, corn combine harvester is used; for peanut plants, a peanut combine harvester is used; for potato plants, a potato plant harvester is used.

### 4. Conclusion

The conclusion of this research combines rice harvester that can accelerate the process of the rice harvest. The work capacity to combine rice harvester is 5 hectares per day.
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