Contribution of agricultural machinery to achieve food sovereignty in Yogyakarta special region

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Abstract. Optimization and dissemination of the use of agricultural machinery to achieve food sovereignty in Yogyakarta are carried out through a direct assistance program through demonstration plots to farmer groups at three districts from 2017 to 2019. Planting and harvesting with machine were assessed in both technical and economic aspects. Regarding technical aspect, jaro transplanter and combine harvester are suitable to be developed optimally in an irrigated rice fields that has a soil depth of less than 30 cm. Concerning economic aspect, jaro transplanter saves labor and speeds up planting time, while combined harvester saves harvesting labor, post-harvest handling and accelerates harvesting process. Rice planting using jaro transplanter requires 2 labors for planting rice in 7 hours covering a 1-hectare area. It is much more efficient than manual planting which requires 12 labors in 2 days for planting 1 hectares. Combine harvester reduced labor, as 2 people in 6 hours for harvesting 1 hectare of rice, compared to manual harvest which requires the 10 labors in 10 hours for 1 hectare. With labor and time efficiency, the agricultural machine was suggested to support synchronous cropping and harvesting of irrigated rice fields which in the end contributes to food sovereignty achievement.

1. Introduction
Agricultural development in Indonesia has directed shortly to sustainable agricultural development, as part of an effort to realize food sovereignty through increased rice production. The current and future national production increase strategy is pursued by increasing productivity and expanding the planting area, both through increasing the cropping index (IP) and expanding paddy fields [1]. This effort is optimistic that it can be realized because of the availability of various innovations and research technologies, especially those produced by the Agricultural Research and Development Agency (Balitbangtan), but only part of the technology has been applied by farmers.

Currently, the national rice productivity has reached 5.28 tons/ha. The Ministry of Agriculture in 2016 is targeting national rice production of 76.26 million tons. Aspects of concern in increasing rice production are increased efficiency and environmental preservation as they relate to production competitiveness [2].

One of the innovations that are being promoted is the Jajar Legowo Super method of planting [3], this is an integrated implementation of Balitbangtan’s innovative rice cultivation technology based on the Jajar Legowo planting method which includes 1). Superior varieties with high yield potential, 2). Jarwo planting system 2: 1, 3). Use of biodecomposer (M-Dec) after the first tillage, 4). Use of biological fertilizers (Agrimeth) as seed treatment before sowing in the nursery, 5). Use of balanced organic and inorganic fertilizers, 6). Control plant pests (OPT) with botanical pesticides (Bioprotectors) and 7). Use
of 2:1 jarwo transplanters and combine harvester agricultural machines. This technology aims to significantly increase the productivity and profitability of rice farming while maintaining the sustainability of the production system. Labor limitations can be overcome with mechanical technology in the form of adaptative agricultural tools and machines ranging from pre-harvest to post-harvest according to social conditions.

Legowo row method 2:1 able to produce a total plant population of 213,300/hectare or 33.31% more than the tile planting method (25×25) cm, with a plant population of only 160,000/ha. Through the legowo line technology innovation dissemination program in every work area of AIAT throughout Indonesia, until September 2013 the legowo row has been adopted covering an area of 1,613,550 hectares. The average increase in productivity achieved by applying the legowo row was 13.83% compared to the tile planting method [4].

This study aims to conduct a therapeutic study of rice transplants and combine harvesters to optimize and disseminate the use of agricultural machinery in achieving food sovereignty in the Special Region of Yogyakarta.

2. Materials and methods
The assessment was carried out in three districts (Bantul, Kulon Progo, and Gunungkidul) of the Special Region of Yogyakarta from 2017 to 2019. The main equipment used was an Indo Jarwo rice transplanter and a Quick H140R combine harvester.

Implementation of activities involving UPJA Sumber Makmur starting from the nursery and harvesting. The need for seeds per dapog is 125 g and ready to be planted at the age of 15 days, for 1,000 m² requires 25 dapok. The labor for rice transplanter is 2 people (1 operator and 1 helper to help embark on empty clumps. Harvesting with a combine harvester requires 2 workers (1 operator and 1 helper to help carry sacks of harvest).

The observations made included the performance and ability of the equipment to operate, fuel consumption, and work results, then the data were analyzed to estimate the value of technical and economic parameters. To find out the performance of the tools (planting and harvesting) it is compared with the manual method that farmers usually do. The economic feasibility of the tool is based on the costs incurred for operating the tool [5].

3. Results and discussion

3.1. Rice transplanter
The performance of the rice transplanter showed different results depending on the land conditions in the three different areas. Rice transplanter will work well in muddy and runny land if the depth of the wheel immersed in the land is less than 30 cm (radius of indojarwo transplanter wheel 30 cm). This land condition causes the work capacity to be different (Table 1). This happens because the speed of working on heavy land will be smaller as a result of which the spacing in rows produced from three locations is also different.

| Specification          | Bantul | Kulon Progo | Gunungkidul | Manual |
|-----------------------|--------|-------------|-------------|--------|
| Spacing (cm)          | 20     | 20          | 20          | 20     |
| Spacing in rows (cm)  | 13.22  | 13.60       | 12.48       | 10     |
| Empty clump (%)       | 5.65   | 6.24        | 3.81        | 0      |
| Working capacity (hour/ha) | 6.54  | 6.34        | 7.26        | 192 (24 HOK/ha) |

Indojarwo plant spacing 2:1 rice transplanter 20 cm with legowo spacing 40 cm. The spacing in rows is set at the smallest scale with a size of 10 cm, but in the field, different land conditions will affect work speed and fieldwork capacity, for Kulon Progo the fastest results are 6.34 hours/ha. Also, the condition of the plot of land being worked on is wider than that of Bantul and Gunungkidul.
On light land such as in Kulon Progo, rice transplanters can run quickly resulting in a higher fieldwork capacity, but the disadvantages are the high empty clumps of up to 6.24% compared to Bantul and Gunungkidul areas which amounted to 5.65% and 3.81%.

Planting rice with the 2:1 legowo model requires labor to make flow with a tick of 18.5 hours/person/ha or 2.3 HOK/ha if 1 working day is 8 hours. The labor wage is Rp. 75,000/day, the cost of making the planting / caplak flow is Rp. 172,500/ha. The cost of removing and transporting seeds requires 5 male workers with a wage of Rp. 50,000 per 0.5 days, it requires Rp. 250,000. Manually planting rice with legowo 2:1 spacing 20 cm, legowo 40 cm and spacing in rows 10 cm requires 24 HOK/ha so that the planting cost reaches Rp. 1,800,000. The total manual planting cost is Rp. 2,222,500.

The need for manual rice planting labor is 24 HOK/ha, equivalent to 192 hours/ha. While the use of rice transplanter labor is 2 people for 7 hours/ha, the total planting time is 14 hours/ha. Thus, there is a saving in working hours of 192 hours / ha-14 hours/ha 187 hours/ha or 92.7% compared to manual rice cultivation. Therefore, the use of mechanical planting tools such as rice transplants in the Tajarwo Super system is highly recommended because it is proven to be able to significantly save work time compared to manual planting.

The economic analysis of the operating costs of the Indojarwo rice transplanter (Table 2) gives the manager an advantage, namely the rental fee of Rp. 2,000,000/ha, for one year (50 working days, 8 hours a day), and the costs incurred for operating one hectare are Rp. 617,850, the profit obtained is Rp. 1,382,150. So that to return the capital equal to the purchase price of a rice transplanter, it is necessary to cultivate an area of Rp. 60,000,000 / Rp. 1,382,150 ie 43 ha.

### Table 2. Indojarwo rice transplanter planting costs

| Variabel                  | Unit | Price        |
|---------------------------|------|--------------|
| Initial price             | Rp   | 60,000,000   |
| Final price               | Rp   | 6,000,000    |
| Economic age              | Years| 5            |
| Working hours / day       | Hours| 8            |
| Working day / year        | Days | 50           |
| Working time / year       | Hours| 400          |
| Work capacity             | Ha/ Hours | 0.143    |
| Bank interest             | %/years| 10        |
| • Cost of depreciation    | Rp/ years | 10,800,000 |
| • Capital interest        | Rp/ years | 3,600,000  |
| Fuel price                | Rp/Lt | 10,000      |
| Fuel consumption          | Lt/hours | 0.82      |
| Fuel costs                | Rp/ hours | 8,200    |
| Spare parts               | Rp/ hours | 14,300   |
| Hydraulic and engine oil costs | Rp/ hours | 853        |
| Total manpower            | Persons | 2           |
| Labor wages               | Rp/ hours | 37,500    |
| Fixed cost                | Rp/ hours | 27,411    |
| Variable cost             | Rp/ hours | 60,853    |
| Total Cost                | Rp/ hours | 88,264    |
| Planting costs            | Rp/ha | 617,850     |

### 3.2. Combine harvester

Based on the observations made on the use of the combine harvester on rice fields in three districts at the location of the super jarwo activity, it is required to have a depth of 20 cm of rice fields, not muddy and muddy and water has been drained in the fields. The performance of the Combine Harvester is greatly influenced by the conditions of the land at the time of harvesting because the movement and speed of the tool will be relatively slow in watery and muddy land.
The combine harvester operates on the principle of combining harvesting equipment/machines as well as threshing, namely cutting, transporting, threshing, cleaning, and bagging. The use of machines to harvest rice by combing the rice stalks, releasing the unhulled grains from the panicles and channeling the combs to the reservoir at the back of the machine and leaving the straw in the field. Grain is temporarily collected in a container and poured into sacks while the straw stalks are cut into pieces and spread in the rice fields.

Table 3. Results of the combine harvester performance in three different regions

| Specification                  | Bantul  | Kulon Progo | Gunungkidul | Average |
|--------------------------------|---------|-------------|-------------|---------|
| Harvesting time (hours)        | 1.02    | 1.25        | 0.53        | 0.93    |
| Land area (m²)                 | 1,500   | 1,900       | 700         | 1,367   |
| Working capacity (ha/hour)     | 0.147   | 0.152       | 0.132       | 0.14    |
| Working capacity (hour/ha)     | 6.80    | 6.58        | 7.57        | 6.98    |

From field observations (Table 3) it shows that the working capacity of the combine harvester is also influenced by land conditions where a wider area will produce a higher working capacity. This is due to the efficiency of lost time in maneuvering each corner to turn less over large areas of land. Operators carrying out the harvest also find it easier to control the unit harvesting machine. To minimize turning time, it is done by making rice fields with a large ratio of length and width so that it will obtain better field efficiency. Of the three harvest locations in Bantul, Kulon Progo, and Gunungkidul districts using the same combine harvester machine, the results differ depending on the conditions of the land being harvested.

Manual harvesting of 1 ha is completed in 10 hours with 10 laborers starting from harvesting, threshing, cleaning, and bagging. Meanwhile, the use of the combine harvester only requires 2 workers with an average working capacity of 6.98 ha/hour.

4. Conclusion

The use of a mechanical rice transplanter cropping machine saves labor by 92.70% compared to manual planting. The combine harvester is also able to make harvesting energy efficient by only 2 people for 6 hours for an area of 1 hectare, compared to manual harvesting which requires 10 people for 10 hours for an area of 1 hectare of rice fields. With the efficiency of labor and time, agricultural machine tools can support simultaneous cropping patterns and simultaneous harvesting of irrigated rice fields, which in turn can contribute to the achievement of food sovereignty.

References

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