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Study Performance of Rice Transplanter in C Type of Tidal Field at South Kalimantan

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Abstract:
Background: *The process of planting of the seedling of paddy In Indonesian farming system almost by labor of people. Seedling transplanter was a machine wich is created to planting of paddy seedling in a adequate conditions to make it faster, easier and more economical. The aim of the exsperiment was to evaluate the performance of the seedling transplanter machine in tidal field at Batalas Village, Tapin Regency, South Kalimantan.*
Materials and Methods: *The method used was experimental in the field with six reciprocating. The parameters tested were the number of filled holes, number of perfectly planted seedling, empty hole, fallen seedling, floated seedling, sinking seedling, effective work capacity, theoretical work capacity and work efficiency.*
Results: *The results showed that the number of hole was filled up to 93.25% with 98.38% perfectly planted seedling, 6.75 % empty hole, 1.33% fallen seedling, 0.29% floated seedling and 0% sinking seedling, 4.0-7.5 cm planting depth and 15-19 cm spacing in rows. The effective work capacity and theoretical work capacity of the machine were 0.11 and 0.19 ha.hour^{-1} respectively so that it. Resulted the work efficiency of 59.01%. The field capacity of the machine to plant one hectare of paddy fields was 9.1 hours.*
Conclusion: *The performance of paddy seedling transplanting machine in tidal land at Batalas Village, Tapin Regency, South Kalimantan. was potential by increasing the work efficiency.*
Key Word: *field capacity, work efficiency, transplanting*

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I. Introduction

Tidal paddy fields are potential and strategic to be developed as agricultural land because of their flat topography, wide availability, excess water sources, and land suitability levels which are at a sufficiently suitable level to very suitable (Sulilawati et al., 2016) However, tidal lands have several limiting factors in terms of soil fertility, including high Fe and Al content, low nutrient content, acidic soil pH and waterlogging that is difficult to control (Purnomo et al., 2005).

The area of land owned by South Kalimantan makes this province has the potential to become one of the national rice barns by increasing the productivity of existing rice (Agricultural Research and Development Agency, 2015). This is reinforced by the making of South Kalimantan as the target province of the Save Farmers Welfare Swamp (SERASI) program in 2019 together with South Sumatra by the Ministry of Agriculture. The target of this program is to increase the cropping index (IP) and productivity of rice crops in 250,000 hectares of tidal swamps and lowland swamps (Kementerian Pertanian, 2019).

One of the ways to intensify tidal fields is by implementing agricultural mechanization. Agricultural mechanization is a technology that aims to increase productivity, streamline time, minimize costs and improve production yields (Handaka & Prabowo, 2014; Iqbal, et al., 2015).

One of the paddy farming processes that requires a large amount of energy and high costs is cropping. This is because the process of transplanting in Indonesia is mostly still manual and by paying workers outside the family. The seedling transplanting tools is a technology created to assist farmers in the process of transplanting by streamlining time, labor and production costs. The use of a seedling transplanting machine can reduce production costs by 38% (Lampung Agricultural Technology Research Institute, 2014) to 73.73% (Umar & Pangaribuan, 2017) compared to manual planting costs. Taufik (2010) also states that using a seedling transplanting tools can increase yields by 10-15%. In addition, the transplanting process can be carried out simultaneously (Saliem et al., 2015).

One of the challenges in the adoption of new technology by society is the socio-cultural factor. Farmers in South Kalimantan have their own local wisdom in the process of cultivating rice from generation to generation by adjusting the existing land types (Wahyu, & Nasrullah, 2012). People also generally prefer local varieties of rice to superior varieties (Ningsih & Nafisah, 2014).

The use of paddy transplants in tidal lands is currently not fully implemented due to existing limiting factors, both from factors of land conditions and socio-cultural factors of local farmers. Therefore, this study aims to evaluate the performance of the seedling transplanting machine in tidal rice fields in Batalas Village, Tapin Regency, South Kalimantan. How many holes are filled, empty holes, perfectly planted seedling, fallen seedling, floating seedling, sinking seedling, planting depth, effective working capacity, theoretical working capacity, work efficiency and field capacity in the field.

II. Material And Methods

This research was conducted in Batalas Village, Tapin Regency, South Kalimantan in June 2019. The land used was tidal land type C measuring 15 m x 28.8 m with 12 replications. The land typology is uneven with inundation height 0-5.5 cm and a foot depth of 6.5-13 cm. The rice seedling used were the Mekongga variety which was 20 days old with a seedling height of 6.5-13 cm. Seedlings are sown in a tray measuring 58 cm x 18.3 cm with the number of seedling per dapog 100-120 gr. The paddy seedling transplanting machine used is a walking type with a 2: 1 legowo model. The specifications of the seedling transplanting tools which used can be seen in Table 1.

Tabel 1. Specifications *rice transplanter*

	Descriptions	Unit
Type	seedling transplanting tools walking type	
Models	Legowo 2:1, 20 and 40 cm	
	Long	1480 mm
Machine dimensions	Wide	1700 mm
	High	860 mm
Total weight		178 kg
	Motor type	4 stroke combustion
	Power	3,5 (4,6) kW (HP)
Motor type	Rotation	3600 rpm
	Gasoline	Premium
	Fuel consumption (max)	0,8 liter. hour^{-1}
Transmission		2 forward, 1 reverse
	Type	wheels with rubber
Wheels	Total	2 pieces
	Diameter	625 mm
	between rows	200 mm
Spacing	*Legowo*	400 mm
	In rows	100/130/150 mm
The Number of row plants		4 clumps
	Nursery method	Dapog
	The thickness of the soil in the *dapog*	20-30 mm
Seedling requirements	Seedling age	15-20 days
	Seedling height	150-200 mm
	Dapog dimensions (lxw)	180 x 580 mm
	Needs of dapog (legowo)	300 unit.ha^{-1}
	Needs of seeds	40 kg.ha^{-1}
	land preparation	
Work method	Depth of hardpan / *foot zinkage* max	250 mm
	Stagnant water height when planting	30- 50 mm
	Speed	1,5- 2,5 km.hour^{-1}
Performance	Field capacity	6-7 hour.ha^{-1}
	Number of seedling per clump	2-5 seedling
	Depth of planting	30-60 mm

Source: Kementerian Pertanian (2013)

Study Design: The method used is descriptive with technical field trials and interviews with farmers and an operator machine.
Study Location: This research was conducted in tidal land at Batalas Village, Tapin Regency, South Kalimantan, Indonesia.
Study Duration: June 2019.
Sample size: The method used was experimental on land area 28.8 m x 15 m with six reciprocating lines of the machine are in operation
Sample size calculation: Data were taken from field experiments using paddy seedling transplanting tools. Each planting process is carried out 12 times back and forth, then the data obtained is averaged.
Subjects & selection method: The method used in this research is experimental in the field. Determination of the experimental land using a purposive technique, according to the criteria of the type of land desired.

Procedure methodology: The method used in this research is experimental in the field. The parameters tested were the number of filled holes, empty hole, number of perfectly planted seedling, fallen seedling, floated seedling, sinking seedling, effective work capacity, theoretical work capacity and work efficiency. The number of filled holes was counted after the paddy seedling transplanting tools finished working. Seedlings planted in filled holes are differentiated into fully planted and not fully planted seedling (falling, sinking, floating). The flow to get the work capacity and work efficiency of planting can be seen in Figure 1.

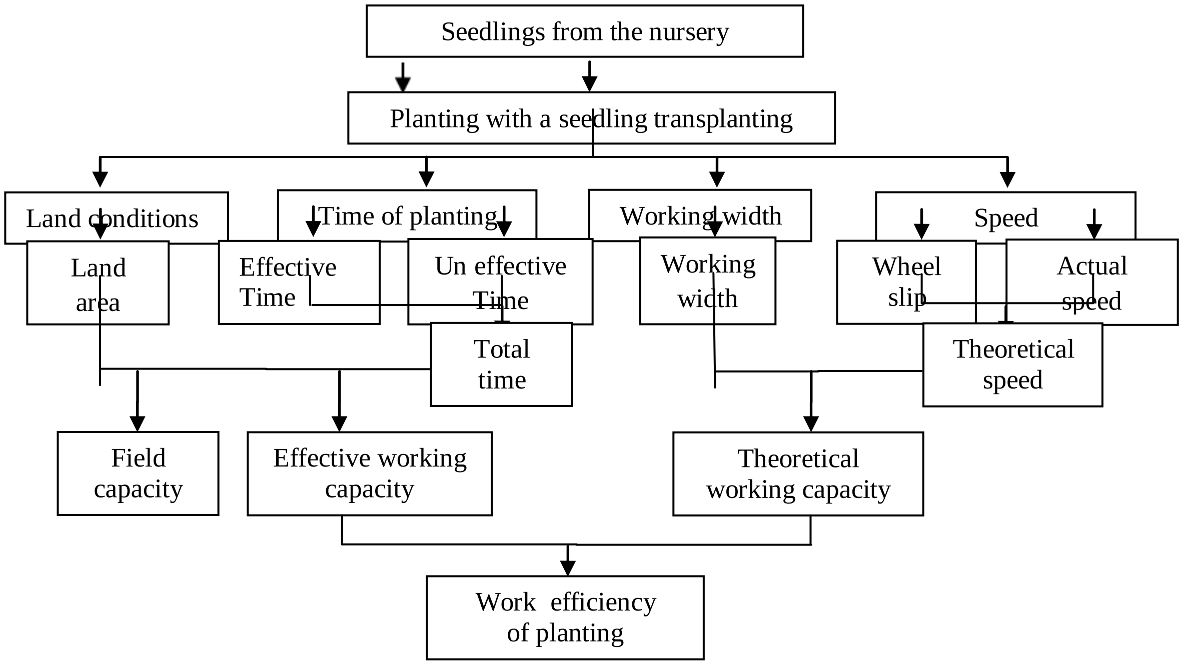

Figure 1. The flow of calculation of work capacity and efficiency of planting

Information :

1. Land area is 28.8 mx 15 m
2. The effective planting time is calculated at the time seedling transplanting works to drop rice seedling on an experimental field.
3. The ineffective time is calculated when the seedling transplanting tools does not drop the paddy seedling on to the land. The ineffective time consists of the time lost when turning and the time to replenish the seedling.
4. Working width is 2.4 m x 15 m
5. The total planting time is the sum of the effective planting time and the planting ineffective time.
6. The actual speed was calculated when the seedling planting machine seamlessly along the cropping trajectory.
7. Wheel slip is a condition where the wheel does not rotate but the engine is still moving or running.
8. The theoretical speed is the average planting speed without wheel slip.
9. The effective working capacity is the average of the work capacity of the tools in the field to complete the planting in a certain area.
10. The theoretical working capacity is the workability of a machine if it continues to run forward without lost time and works at maximum width.
11. Planting work efficiency is the ratio of the ratio of effective working capacity and theoretical working capacity.

Statistical analysis: This Experiments does not used a design and no hypotheses, so there was no statistical analysis

III. Result

The results of planting using a seedling transplanter are divided into filled holes and empty holes. Seedling in the filled hole are divided into fully planted seedling and seedlings that are not fully planted (such as damaged seedling, fallen, floating, drowning). The planting results are shown in Table 2.

Table 2. The results of planting a rice transplanter

Parameters	Unit	Result
Hole filled	%	93,25
Empty hole	%	6,75
Perfectly planted seedling	%	98,38
Crumbled seedling	%	1,33
Floating seedling	%	0,29
Sink seedling	%	0,00
Planting depth	Cm	4,0-7,5
Plant spacing in rows	Cm	15-19

Table 2 shows the number of holes filled with the results of planting using a paddy seedling machine was 93.25% and empty hole is 6.75%. The number of perfectly planted seedling is 98.38%, crumbled seedling 1.33%, floating seedling 0.29% and sink seedling 0.00%. Filled holes and fully planted seedling are affected by the density of the seed population in the dapog, height, groundwater level, and mud depth. The denser the seed population in the dapog, the less likely it is that there will be empty holes. This is supported by the opinion of Santosa (2017) which states that holes that are not planted are caused because when the seedling are not dense or uneven, so when planting tweezers the planter only enters the ground without taking and planting rice seedling.

The results of planting are also influenced by the condition of the land. The tidal land surface conditions were uneven at the time of planting so that the groundwater level and the depth of the mud were also uneven in the area of the experimental land. A higher groundwater level can cause the planter's tweezers to not reach the ground or to become a planter with a shallower planting depth, which can cause the seedlings to float or fall easily because the roots are not strong embedded in the ground. Too little amount of water can cause the seedlings to sink because they are planted too deep or the seedlings are below standard height. The depth of the mud that is not ideal can also cause the soil holding power against the seedlings so that the seedling float and the holes become empty.

The number of empty holes in manual planting is generally less than using a paddy seedling machine (Oktaviana, 2013). This is because in manual planting, farmers can manage one by one the planting of rice seedling regardless of the amount of time used. Meanwhile, in planting using a paddy seedling machine, operators will continue to move forward with planting in order to save time. To avoid this problem is to do embroidery manually in the empty holes after planting using a paddy seedling machine.

Paddy seedling transplants have the advantage of adjustable planting depth and spacing so that planting becomes more uniform (Suhendrata, 2015). Based on the evaluation results, the depth of planting based on the machine setting is 5 cm, however the test results show the depth of planting is around 4.0-7.5 cm. The different planting depths are caused by the typology of the wavy land surface, so that the planting depth may not match the machine setting standards. Likewise, the spacing in rows is set at 15 cm, but the test results show variations between 15-19 cm. Lestari (2017) also mentions that if the land structure is too soft and a lot of water causes the machine planting tweezers to shift backwards and causes the spacing in rows to increase. Sugandi et al. (2019) added that wheel slip can also have an effect on the spacing generated by the machine, because the grower's fingers will continue to keep moving to plant seedling when the machine experiences a variation in its mileage because the wheels do not get traction.

Seedling machine Performance Results

Planting efficiency is calculated based on the working capacity of the planting. The results of the calculation of work capacity and planting efficiency are shown in Table 3.

Table 3. Work capacity and planting efficiency

Parameter	Satuan	Hasil
Land area	ha	0,0432
Total time	hour	0,394
Lost time	hour	0,144
Wheel slip	wheel slip	7,303
Actual speed	$km.hour^{-1}$	1,435
Theoretical speed	$km.hour^{-1}$	1,548
Effective working capacity	$ha.hour^{-1}$	0,110
Theoretical working capacity	$ha.hour^{-1}$	0,186
Efficiency of planting work	%	59,014

Field capacity	$hour.ha^{-1}$	9,1

The effective working capacity is obtained from the ratio of the planted area to the total time which includes planting time, turning time and seed filling time. The result of effective working capacity is 0.110 $ha.hour^{-1}$. The factors that influence the total time on the effective working capacity are the size of the land, land conditions and the skill of the operator. The wider the land, the greater the total planting time. Uneven land surface conditions, land water level, depth and soil mud density will affect the speed performance of the paddy seedling planting machine, thereby affecting the total planting time.

The theoretical working capacity is the workability of a machine if it continues to run forward without lost time, maximum working width and without wheel slip. The resulting theoretical work capacity is 0.186 $ha.hour^{-1}$. The theoretical working capacity is directly proportional to the working speed and working width. The higher the working speed and the maximum working width, the higher the theoretical working capacity. The comparison between the effective working capacity and the theoretical working capacity results in the efficiency of the planting work. The resulting work efficiency is 59.014%. The greater the work efficiency indicates that in the same planting area, the less time is lost when planting. Time lost consists of turning time and seed filling time.

The main obstacle when operating a paddy seedling planting machine in tidal paddy fields is the water level which is difficult to control due to the tidal influence of river water. This is supported by Purnomo et al. (2005) which states that although tidal land is potential and strategically developed, this land has waterlogging problems that often cannot be controlled. In addition, the volume of tidal and low tide is also uncertain at any time. Rusdiansyah & Riduan's (2018) research on tidal fields in Terantang Marabahan Village, South Kalimantan, shows the results of tide measurements for 15 days with graphic images reflecting a non-harmonic motion. The tidal power is not constant but changes with distance and time.

The solution taken is to drain the rice field water using a water suction machine. This is done from before planting to the time of planting because the tide continues to flow. Herawati (2017) explains that in swamps there is minimal natural drainage system, so the first effort that can be done is to remove standing water, both from rainwater and river runoff. With the right water system network system, tidal swamp land has the potential for planting using a paddy seedling planting machine. Field capacity is the time it takes for a paddy seedling planting machine to plant one hectare of land. The results of the field capacity test were 9.1 $hours.ha^{-1}$. This figure is bigger than the standard test results of the paddy seedling planting machine manufacturer (Table 1), where the field capacity of the paddy seedling planting machine should be 6-7 $hours.ha^{-1}$. Field capacity is influenced by land conditions, engine speed and wheel slip. In ideal land conditions, with high engine speed and small wheel slip, the field capacity of a machine will be even greater.

IV. Conclusion

The performance of seedling planting machine in tidal land at Batalas Village, Tapin Regency, South Kalimantan. was potential by increasing the work efficiency.

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