Technical Performance Evaluation of Rice Transplanter Prototype for "Tapak Macan" on Planting Arm and Seedling Tray Mechanism

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ABSTRACT
Rice cultivation is an effort made by humans to meet basic food needs. However, the world's population growth continues to increase, so it is necessary to improve the cultivation quality to meet these needs. Researchers have developed many cultivation methods to meet these needs, one method discovered and widely adopted by farmers in Yogyakarta and surrounding areas are "tapak macan" cropping pattern. "Tapak macan" is a planting method that consists of three hills forming an equilateral triangle with a side length of 5-7 cm. This research was conducted to evaluate the prototype design on planting arm and seedling tray mechanism based on prototype performance. Furthermore, this research is used to evaluating the design of the prototype. The research begins with the preparation of rice transplanter and rice seedling on customized trays. After seedlings are ready to be used, the rice transplanter is operated on the work desk and observed the amount and success rate seedlings picked. From the research that has been done, obtained the results from the adding traction to the roller and seedlings holders made the transplanter that can't work, became works properly. The success rate for the improved rice transplanter was 89%, and the average amount of seedlings picked as much as 6.4 rice sticks for planting fork A1, 8 rice sticks for planting fork A2, and 6.2 rice sticks for the planting fork A3.

Keywords: *Technology, Agriculture, "tapak macan", Rice Planting System, Rice Transplanter.*

1. INTRODUCTION

Agriculture is a production activity based on the growth and development of plants and animals that aims to produce foodstuffs, industrial raw materials, energy sources, or manage the environment [3]. People who work in the agricultural sector are usually known as farmers. One example of an agriculture activity is rice cultivation. Rice (Oryza sativa L.) is a food crop that grows in subtropical and tropical climates. Rice grows in humid hot climate areas. Rainfall per year by the conditions of rice growth ranges from 1500 mm - 2000 mm. The recommended temperature ranges from 23°C or more. Rice grows well on fertile soil with a thickness of an upper soil layer of 30cm and loose soil with a blackish brown color [3]. The stages in rice crop cultivation start from seeds selection, land preparation, seedling, rice planting, rice maintenance, pest control, and the harvest process. At the stage of seeds selection, seeds are selected by soaking in water and selected drowned seeds. In selecting seeds, also pay attention to the suitability of seeds with the planted location. Furthermore, land preparation includes primary and secondary land processing. After that, the following process is growing the selected seeds. If the seeds have grown into seedlings and the land is ready to be planted, planting rice seeds can be done. After that, they continued the stages of rice care and maintenance and pest control until it was ready to harvest.

From 2011 to 2020, there was an increase in the world population of more than 700 million people and the amount of rice consumption also increased by 59225000 tons [4]. The increasing number of human populations and rice consumption show increased productivity to fulfill rice needs. Steps that can take to increase production capacity is to apply technology to each stage of rice cultivation.

The application of technology in the agricultural sector is a technology that is adaptive to local biophysical and socio-cultural conditions. It can also be interpreted in applying cultivation techniques that need to be adjusted to the location of cultivation because not all areas have the same environmental conditions and varieties. The exemplary efforts to apply technology to rice cultivation optimize land and intensify rice fields with appropriate technology. One of the agricultural technologies in rice cultivation that are considered successful in improving rice productivity is “tapak macan” cropping pattern that conducted in Ngaglik, Yogyakarta, in the 2014 growing season, the crop increased productivity by 15.7 tons/ha [5]. The “tapak macan” rice planting system is a modification of the SRI (System of Rice Intensification) [6]. SRI is a rice planting system that recommends the number of seedlings one stem per clump [7]. Modifications for SRI planting patterns include a cluster consisting of three plants planted with a triangular pattern and 5-7cm with a distance between clumps 30cm (Figure1).

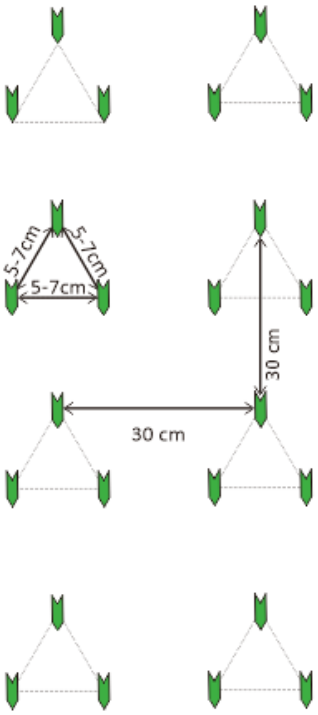


Figure 1 “Tapak macan” rice cropping pattern

The "tapak macan" method had the opportunity to be further developed to increase the productivity of the world's rice. But there are still obstacles in its application, especially in the planting process. We found that the farmers are done rice planting with a “tapak macan” cropping pattern done manually on observations made directly in the field. The problem arises by creating planting patterns that take a relatively long time and the needs of skillful planters.

Figure 2 Manual application of “tapak macan” rice cropping pattern

Farmers will first make a square pattern as a reference for planting with a distance between rows of 30cm. Then the farmer will start planting manually, assisted by a tick that is given 1 point as a reference for one of the planting points of the tiger tread pattern. For the other 2 points, the farmer only guessed that the seedlings planted were 5 - 7cm apart. It takes a machine that is easy to operate to overcome existing problems.

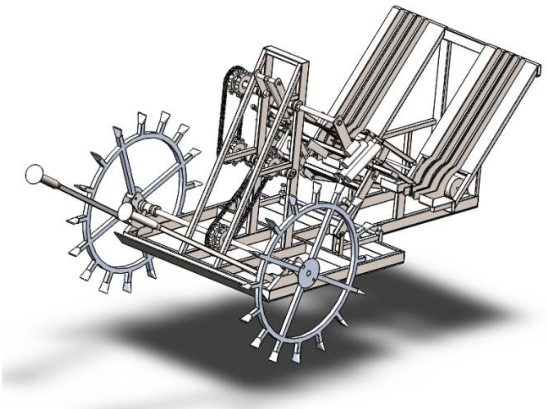


Figure 3 Design of rice transplanter prototype for “tapak macan” cropping pattern

The prototype of “tapak macan” rice transplanter is the answer to solves the obstacle when applying the method. It also intended to overcome labor shortages and make planting more efficient. This research was conducted to evaluate the prototype technical performance with variations in planting arm and seedling tray mechanism based on the amount and rate of success seedlings picked. Furthermore, this research is used to provide recommendations on the setup and evaluating the design of the prototype.

Figure 4 Rice transplanter prototype for "tapak macan" cropping pattern

2. MATERIALS AND METHODS

The research method used is direct observation. Furthermore, the research stage is divided into three stages (Figure 5).

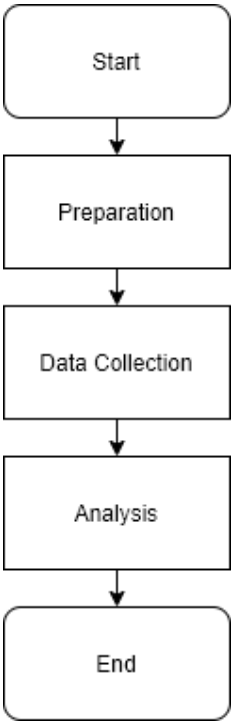


Figure 5 Steps of "Tapak Macan" Rice Transplanter Research

The first stage is the preparation, including prototype maintenance and seedling on the customized trays. When the seedlings are ready to be planted, the next step is testing to obtain the data of the amount and success rate seedlings picked. Seedlings that have been sown on a special tray are then taken and placed on all three pathways of the transplanter tray, then the transplanter is operated. The last stage is the evaluation of the amount and rate of success seedlings picked to decided the improvement needed to make the prototype works optimally. The planting arm and seedling tray mechanism can be seen in Figure 6.

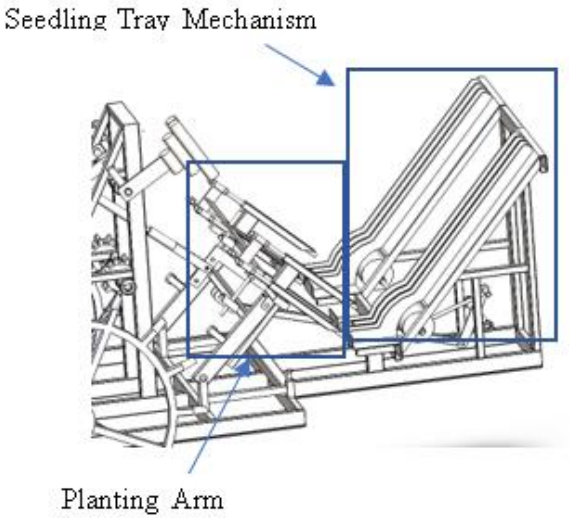


Figure 6 Design of rice transplanter prototype for "tapak macan" rice cropping pattern

3. RESULT AND DISCUSSION

In this research, two parameters are observed the amount and success rate seedling picked. The amount of seedling picked's target for each planting fork for the transplanter to work optimally is as near as one. The success rate of seedling picked compares the three planting forks successfully taking seedlings on each planting fork against the overall number of picking.The success rate of seedling picked target are exceeds 70%.

In the test of the performance of the seedling tray mechanism, the seedling is unwilling to move. The roller that has lacked traction made the seedling can't move so that the rice transplanter couldn't work. After observation on the mechanism of seedling trays, the next is the observation on the planting arm. This observation found that the phenomenon of seedlings dragged down following the movement of the planting arm. This incident makes the seedlings need correction to the correct position every time they finish planting movements. From the condition of the previous tool, then some improvements were made, obtained results that can be seen in Table 1 and Table 2 (Jaya, 2021).

Table 1. Success Rate of Seedlings Picked

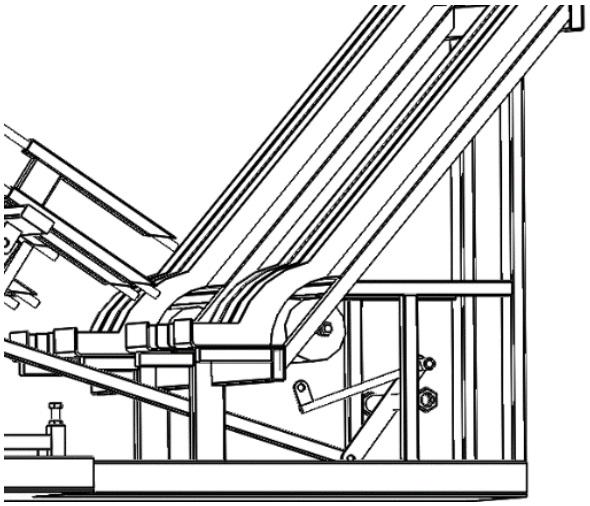
Repetition	The Number Of Picking	Success Picking	Success Rate
1	30	25	83%
2	27	26	96%
3	26	23	88%
Average	27,67	24,67	89%

The results obtained after the improvement of the tool design are extraordinary, from a tool that cannot work to a tool that can work well. The previous success rate was 0%, changed to 89%. The last result for the number of seedlings picked for each planting fork that is 0 for each

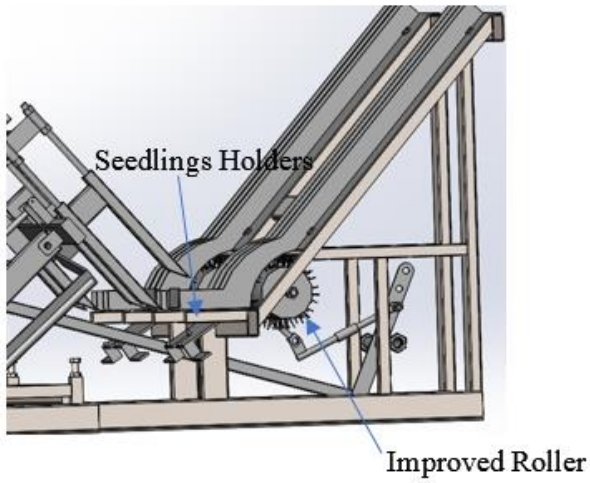
planting fork became 3.68 rice sticks for planting fork A1, 5.82 for planting fork A2, and 3.88 for planting fork A3. Furthermore, Azmi stated that improvements on seedling tray mechanism to add traction are adding teeth and that improvements made transplanter can works properly. Azmi (2021) stated that the improvements made for planting arm are adding seedlings holders, which makes the seedling not dragged down following the planting arms. The previous and improved design of the components can be seen in Figure 7.

Table 2. The Amount of Seedling Picked for Each Planting Forks

Repetition	The Amount of Seedling Picked for Each Planting Forks (rice sticks)		
	A1	A2	A3
1	3,62	6,05	3,90
2	3,73	5,95	3,86
3	3,71	5,46	3,88
Average	3,68	5,82	3,88



(a)



(b)

Figure 7 (a) Previous Design, (b) Improved Design

4. CONCLUSION

Based on this research so the conclusion is adding traction to the roller and seedling holders can be made the rice transplanter works optimally. The other conclusion form the improved design are 89% success rate seedlings picked and The amount of seedlings picked for each planting fork are 3.68 rice sticks for planting fork A1, 5.82 for planting fork A2, and 3.88 for planting fork A3

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REFERENCES

[1]Azmi, A N. (2021). Rancangbangun Prototipe Mesin Tanam Padi Manual Tipe Tapak Macan. *Skripsi*. Fakultas Teknologi Pertanian. Universitas Gadjah Mada, Yogyakarta.

[2]Jaya, G H. (2021). Evaluasi Kinerja Teknis Perototipe Alat Tanam Padi Sistem Tapak Macan Dengan Variasi Sudut Pengamblan Bibit dan Lokus Penanaman. *Skripsi*. Fakultas Teknologi Pertanian. Universitas Gadjah Mada, Yogyakarta.

[3]Purba, Deddy Wahyudin, et al. (2020). Pengantar Ilmu Pertanian. Yayasan Kita Menulis, Medan.

[4]Shahbandeh. (2021). Total Global Rice Consumption 2008-2021. https://www.statista.com/statistics/255977/total-global-rice-consumption

[5]Yuliska. (2018). Model Kewirausahaan Sosial di Lembaga. Agriculture Entrepreneur Clinics. Jurnal Pemberdayaan Masyarakat: Media Pemikiran dan Dakwah Pembangunan.2(1) 157-176

[6]Suharno, Nalinda, and Rika. (2016) Increase Rice Productivity Through Models of Cropping Systems and The Use of Hybrid Varieties. International Conference on Agribisnis Development for Human Welfare. Universitas Muhammadiyah Yogyakarta

[7]Kasim, M. (2004). Manajemen penggunaan air. Meminimalkan penggunaan air untuk meningkatkan produksi padi sawah melalui Sistem Intensifikasi padi (The System of Rice Intensification, SRI). Makalah Pengukuhan Guru Besar pada Universitas Andalas Padang