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MODIFIED SPRAYER DESIGN FOR RICE PLANT PEST CONTROL (*Oryza sativa* L.)

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ABSTRACT
The purpose of this study was to design and test the performance of a modified sprayer in controlling rice plant pests. Limitations of the manual sprayer include low capacity, uneven spray distribution, and high labor and time requirements, all of which lead to ineffective pest control. A research and development method was used, which included design, construction, and field testing. The test was conducted for four weeks on rice fields with the same plant spacing. The level of leaf damage due to pest attacks and spraying efficiency were two parameters observed. The results showed that the modified sprayer performed better than the manual sprayer, as indicated by a greater reduction in leaf damage levels during the observation period. In addition, the modified sprayer was able to improve work efficiency by expanding the spray range, speeding up spraying time, and reducing operator workload. In contrast, the manual sprayer showed a slower reduction in damage. These results indicate that the modified sprayer is more effective in supporting pest control and has the potential to be an appropriate technology to improve efficiency, productivity, and sustainability in rice cultivation.

***Keywords**: agricultural technology, pest control, rice plants, spraying efficiency, sprayer modification*

INTRODUCTION
Indonesia's agricultural sector plays a crucial role in driving the country's economy and food security. Farmers face several challenges with manual sprayers, particularly in terms of tool efficiency and pest control. Limitations of manual sprayers include low capacity, uneven spray distribution, and high energy and time requirements. These conditions lead to low work efficiency and ineffective pest control in rice cultivation.

Pest attacks can lead to reduced yields, and pest control is crucial for increasing rice production. The concept of integrated pest management (IPM) is heavily influenced by the sprayer used, even when used effectively. In practice, conventional sprayers often result in uneven spraying, operator fatigue, and ineffective pesticide application. Previous studies have shown that the use of electric pumps and modified nozzles can improve spraying efficiency and uniformity. However, simple, cost-effective, and user-friendly technology remains limited.

This study created a modified sprayer that utilizes ergonomic design, the use of electric pumps, and the addition of nozzles to improve spraying efficiency and reduce operator workload. This research supports and refines previous research to make it more relevant in the field. The aim of this research is to develop and implement a modified sprayer that is efficient and energy-efficient. They will also test its performance in more effective pest control in rice crops.

METHOD
This study used quantitative research and development methods to design, manufacture, and test the performance of a modified sprayer to control rice plant pests. The research stages included problem identification, tool design, construction, and field trials. Tests were conducted in a 15-square-meter area with a plant spacing of 25 cm × 20 cm. While the control variables consisted of the type of pesticide, spraying time, field area, and rice plant variety used, the independent variable was the sprayer modification. Pest control effects were measured by the level of leaf damage.

Rice plants in the test field, along with the operator using the tool, were the subjects of the study. The research method began with the construction of an instrument consisting of a tank, electric pump, pipe, and nozzle. Then, for four weeks, field trials were conducted with a spraying frequency of once per

week. Data were collected directly using observation sheets and recording spraying times. The number of damaged leaves and spraying time efficiency were two parameters observed. In quantitative descriptive data analysis, the results of the modified sprayer and the manual sprayer were compared, and a downward trend in plant damage was observed over the observation period.

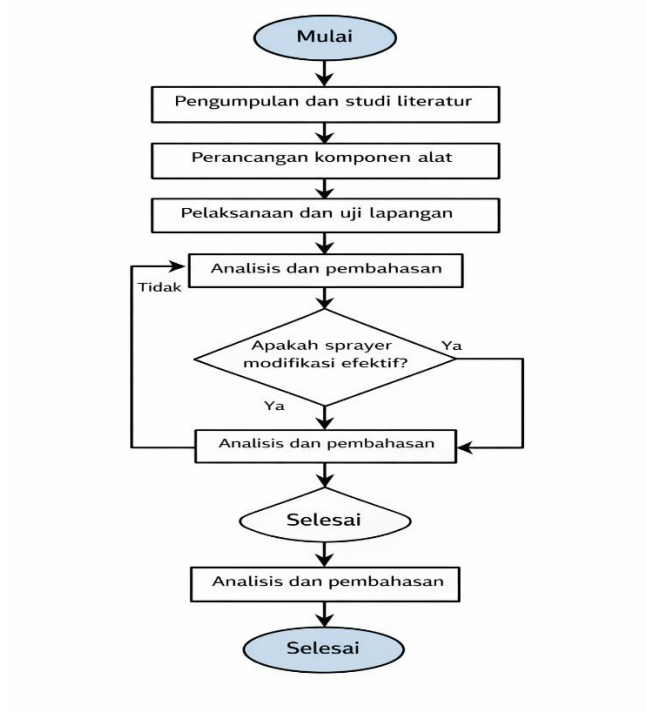

Figure 1. Research Flowchart

Based on the planning and design results, the tool uses several main components, as seen in Figure 2, which are adapted to technical needs in the field. The nozzle pipe is 52 cm long, and the right, left, and middle support pipes are each 54 cm long. During the spraying process, the pipe frame supports the fluid distribution system and maintains the nozzle's stable position. With a capacity of 15 liters, the storage tank used can hold a sufficient amount of pesticide solution for one spraying cycle. To ensure even spray distribution, the nozzles are installed at a distance of 20 cm from each other. The total length of the nozzle assembly is 125 cm. This dimensional configuration is made to ensure consistent fluid application to plants and increase spray coverage in a single work pass.

Figure 2. 2D Design of Modified Sprayer Frame

To improve the efficiency and effectiveness of pesticide spraying on rice plants, a modified sprayer was created, as shown in Figure 2. This tool consists of several main components: a storage tank, an electric pump, a spray nozzle, and a pipe frame that serves as the main support for the nozzle. The storage tank serves as a container for the pesticide solution or water to be sprayed, and its capacity is adjusted to meet operational needs in the field. Compared with manually operated systems, the electric pump installed in the system functions to generate a stable flow pressure, which ensures more even distribution of the liquid. The pump pressure is channeled to a series of distribution pipes via a hose. To atomize the liquid into small droplets, a nozzle is attached to the end of the spray bar. This allows for wider and more uniform spray coverage. Meanwhile, the pipe extends and serves as both a liquid distribution channel and the main support for the nozzle. This design allows for coverage of more than one row of plants in a single pass, creating a more stable, effective, and potentially wider spraying system than a manual sprayer.

RESULT AND DISCUSSION

During four weeks of testing, this study collected data comparing the performance of a modified sprayer and a manual sprayer in controlling rice plant pests. The level of leaf damage due to pest attacks and the efficiency of spraying time were two aspects of the data collected. Observations showed a trend toward decreasing plant damage and differing equipment performance between the two treatments. Data are presented in tables and graphs to visually demonstrate the differences in results and support the descriptive analysis provided.

Result

The results showed that the modified sprayer performed better than the manual sprayer. In the first week, the leaf damage rate on the modified sprayer was 15.0%, but gradually decreased to 5.0% in the fourth week. At the same time, the leaf damage rate on the manual sprayer only decreased from 16.7% to 11.7%. The modified sprayer was more efficient in terms of time efficiency because it could spray a wider area in a shorter time than the manual sprayer. The use of multiple nozzles on the modified sprayer allowed the spray to be distributed more evenly, allowing the pesticide to reach all parts of the plant better. The trend graph shows that the modified sprayer reduced plant damage more quickly and consistently than the manual sprayer.

Discussion

The results of this study indicate that a modified sprayer increases the effectiveness of rice pest control, with a greater reduction in leaf damage. This suggests that even pesticide distribution can improve the ability to control plant pests. The increased capacity of the sprayer also results in more efficient spraying times and reduced operator workload. Consequently, agricultural activities become more productive and effective.

These results align with previous research showing that the use of electric pumps and nozzle modifications can improve spraying efficiency. However, this study adds value to the design of a more user-friendly and user-friendly sprayer in the field. This demonstrates that the innovations not only improve the performance of the sprayer but also make it easier for farmers to use.

The modified sprayer can also reduce excessive pesticide use due to more targeted spraying, encouraging more efficient and environmentally friendly agricultural practices. Therefore, the modified sprayer offers advantages from a technical perspective, as well as from an economic perspective, and from agricultural sustainability. Overall, this study demonstrates that the modified sprayer is more efficient in pest control and operational efficiency than a manual sprayer. Therefore, the modified sprayer can be developed and used more widely in rice cultivation activities.

Table 1. Modified Sprayer Test Results

Week	Damaged Leaves	Total Leaves	Demaged (%)
1.	50	300	16,7
2.	45	300	15,0
3.	40	300	13,3
4.	35	300	11,7

Tablel 1. Manual Sprayer Test Results

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1.	50	300	16,7
2.	45	300	15,0
3.	40	300	13,3
4.	35	300	11,7

CONCLUSIONS

This study demonstrates that a modified sprayer can address the low efficiency and effectiveness of conventional sprayers in controlling rice pests. By adding a nozzle, a more ergonomic design, and using an electric pump, this device improves spray distribution, saves time, and reduces crop damage. Therefore, the modified sprayer is not only a technical innovation but also a practical solution for agriculture that can increase productivity, reduce farmer workload, and support more efficient and sustainable agricultural practices. However, limitations of this study lie in the short observation period and limited testing scale. Therefore, further research is recommended on land with more diverse environmental conditions and accompanied by an economic analysis that includes the costs of manufacturing and operating the device. Furthermore, further development can be directed at increasing the device's durability and refining the automation system, so that the modified sprayer can be used more widely to support advances in agricultural technology.

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