The design of dapog rice seeder model for laboratory scale

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Abstract. The dapog system is seeding rice seeds using a special nursery tray. Rice seedlings with dapog systems can produce seedlings in the form of higher quality and uniform seed rolls. This study aims to reduce the cost of making large-scale apparatus by designing models for small-scale and can be used for learning in the laboratory. Parameters observed were soil uniformity, seeds and fertilizers, soil looses, seeds and fertilizers, effective capacity of apparatus, and power requirements. The results showed a high uniformity in soil, seed and fertilizer respectively 92.8%, 1-3 seeds / cm² and 82%. The scattered materials for soil, seed and fertilizer were respectively 6.23%, 2.7% and 2.23%. The effective capacity of apparatus was 360 boxes / hour with 237.5 kWh of required power.

1. Introduction
Rice is consumed by nearly half of the world’s population, with rice cultivation using 24-30% of the world’s developed freshwater. A major challenge for food security in Asia in the coming decades is feeding the increasing population under water-scarce conditions. By 2025, an estimated 15-20 million ha of irrigated rice will suffer some degree of water scarcity include alternate wetting and drying, and the aerobic rice system. Another potential intervention is to reduce the growth duration of transplanted rice plants in the main field either by using short-duration varieties or by planting older but healthy seedlings [3]. Conventional way in rice breeding is usually done in rice fields so it requires a large area. The resulting seeds have poor roots and soil mixed. To support modern agriculture that uses rice transplanting as a mechanical planting apparatus makes this conventional method is considered less support. To avoid any confounding effect, sowing date in the nursery, seed rate and crop management in the main field were all the same [6]. Seeds with good root system and uniform plant height strongly support the performance of rice transplanting apparatus. The process of growing rice without the need for a long time to seeds back is one simple and advantageous method because it no longer will be limited supply of water [2]. Furthermore, for transplanted rice, seedlings can be produced on wet bed nurseries, dry bed nurseries, mat nurseries, or dapog nurseries for manual transplanting or in specialized seed trays for machine transplanting [1]. Therefore, appropriate seeding method can be used with dapog system. Dapog system can be operated with wet system in paddy field and dry system indoors can used with media tray. This research was conducted to make a model of dry dapog system with mechanical using media tray.

The modeling of these fixtures is carried out to ensure that the designs made are operable. This can save costs and simplify the manufacture of apparatus in large capacity because the constraints that occur can be overcome on the model. Model of small capacity seed breeding (laboratory scale) can be
used by students as learning materials in the laboratory [5]. Enable students to learn about the rotor rationing mechanism as well as the use of electric motor power and transmits power through pulleys. The design of the seed sowing machine is based on the design of the three rotor metering device mechanisms and a conveyor shaft powered by an electric motor.

2. Materials and Methods
The materials used in the research are soil, rice seed, fertilizer and tray. The tools used are stopwatch, camera, tachometer and wattmeter.

2.1 Stages of research
This research is based on design principles with several stages, (1) literature study, (2) problem analysis, (3) design of apparatus concept, (4) evaluation and design of apparatus, (5) manufacture of apparatus, (6) performance testing of apparatus

2.2 Functional design
Firstly hopper is the functional design consists of three hoppers placed on the main frame for the entry of soil, seeds and fertilizers as material for rice breeding before being dropped on to the tray. The size for each hopper is 143 mm long, 103 mm wide and 228.64 mm high made of iron plate with a thickness of 1 mm. Secondly is rotor, consists of three rotor that will control the process of dropping materials onto a tray that is 290 mm long, 140 mm wide and 40 mm high. The rotor of soil metering device is designed to drop the soil into the tray with a thickness of 12 mm. Based on this thickness, the rotor has a diameter of 75 mm and a length of 140 mm with a flow width of 28.10 mm and 7.50 mm groove height. The rotor of seed metering device is designed to drop 3 mm (3-4 seed / cm²) seed into the tray so that based on the rotor calculation it has a diameter of 75 mm and a length of 140 mm with a width of 43.56 mm and 5 mm groove. In the rotor of fertilizer metering device is designed to drop the fertilizer with a thickness of 5 mm to the top of the tray so that based on the calculation of the rotor has a diameter of 75 mm and length 140 mm with the width of the groove 28.10 mm and the height of the groove 2.50 mm.

2.3 Structural Design
This rice seeding apparatus has several structural components, namely: firstly is beam, its function is to place all components of rice seeding with length 560 mm, width 253 mm and height 534.79 mm using material of iron plate and iron strip with 3 mm thick. Secondly is bearing, its function is to reduce friction on the rotating system on the apparatus. This model of rice seeding apparatus using bearing type UCP 204. Thirdly is gear box, its function is to reduce the rotational speed of the shaft. This paddy seeding apparatus uses a size 40 gear box. Fourthly is belt conveyor, its function is to bring the tray in a horizontal direction with a roller lever system. The belt is driven by an electromotor through a pulley. In this model of rice seedling use a conveyor with a width of 66 mm. Fifthly is sprocket, its function is to transmit power and rotation from gearbox to sprocket through chain to rotate rotor of metering device. Sprocket used has 42 teeth. Sixth is pulley, its function is to forward the power and rotation of the electromotor through v-belt to rotate the gear box and to the three rotor of metering device. In the model of rice seeding apparatus uses 2 inch, 5 inch, 6 inch, and 8 inch pulleys. Seventh is electromotor are machines that convert electrical energy into mechanical energy. Using an electric motor of 1420 rpm.

2.4 Apparatus mechanism
This apparatus works by utilizing the rotary power of the electromotor that is transmitted through the pulley to rotate the rotor of metering device contained within the hopper and the conveyor roller. This apparatus has three hoppers each filled with soil, rice seed and fertilizer. When the electromotor is switched on, the conveyor roller will move the belt conveyor to bring the tray horizontally while the three rotors will rotate to drop the soil, seed and fertilizer according to the desired dosage.
The capacity of the soil hopper can be filled with soil as much as 750 gr, the capacity of the seed hopper can be filled with seeds as much as 500 gr. While the capacity of the fertilizer hopper can be filled as much as 750 gr of fertilizer. In the process of seeding required 363.3 gr of land, 40 gr of seed and 210 gr of fertilizer.

![Fig. 1. Model of seeding equipments](image)

2.5 Testing
Soil, seed and fertilizer are placed into each hopper while the tray position is placed as in Fig.1. Electromotor is switched then each shaft rotates, the tray is carried by the conveyor belt through the outlet of each hopper with rationing device starting from the soil, seeds and fertilizers respectively. The desired soil thickness for once seeding is 12 mm, seed density of 1-3 seeds / cm² and fertilizer with a thickness of 5 mm. This measure becomes the reference for determining the design accuracy made during the test.

2.6 Parameters
2.6.1. Percentage of uniformity of soil, seed and fertilizer distribution
Uniformity can be determined by calculating the standard deviation from the observed data on the targets to be achieved by equation 1.

\[
S = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2}
\]

where \( S \) mean standard deviation with \( n \) is the number of sample, \( x_i \) is value of \( x \) to-i and \( \bar{x} \) is sample data.

2.6.2. Percentage loosing of soil, seed and fertilizer
The amount of soil, seed and fertilizer that falls outside the tray at the time of seeding is considered a lost material. The percentage can be determined by equation 2.

\[
L = \frac{BBT}{BBA} \times 100\% \quad \text{(2)}
\]

where \( L \) mean percentage loosing of material (%), \( BBT \) is weight of material lost (gr) and \( BBA \) is total weight of material (gr).

2.6.3. Effective capacity of apparatus (KEA)
The effective capacity of the apparatus (tray/hour) can be determined by calculating the length of time required by the seeding tool to tray upon the capacity of the existing material with equation 3.

\[
KEA = \frac{\text{Number of trays}}{\text{time required}} \quad \text{(3)}
\]
2.6.4. Power Requirements

The actual power requirements used for the operation of this apparatus can be measured using a digital wattmeter. Digital wattmeter is a measuring instrument readings of electric power in watt which is a combination of voltmeters and ammeters. With these tool of digital wattmeter, can know the actual power and will be displayed on the LCD display screen on digital wattmeter.

3 Results and Discussion

3.1 Percentage of uniformity of soil, seed and fertilizer distribution

Figure 3 (a) explains that the measurements of the soil thickness have not fully reached the desired target. It can be seen that there are some measurement points whose values are not exactly on the target line (1.2 cm). Based on the calculation of percentage uniformity obtained an average deviation of 7.2%. However, this result can be expressed uniformly because of the great uniformity of 92.8%. Figure 3 (b) explains that the average seed density present in the tray is within the targeted range of 80%. The deviation occurs twice from 10 repetitions that is on the first repeat and the seventh repetition. If averaged, the seed density obtained is very good that is equal to 3.6 seeds/cm². Figure 3 (c) explains that the thickness of the fertilizer that falls into the tray is close to the desired target. From the experiment with 10 repetitions, the uniformity rate of fertilizer 82% was found or the average deviation of 18%. This can be caused by the rotation of the rotor of the metering device is too fast, so further research is needed to determine the rotor speed of the appropriate metering device of fertilizers.

![Fig. 2](a) the result of soil allotment, (b) the result of seed allotment, and (c) the result of fertilizer allotment

![Fig. 3](a) Graph of: (a) soil thickness uniformity, (b) seed uniformity, and (c) uniformity of fertilizer thickness

Based on recommendation from BPPP East Java [4] stating that the requirement of seeding for thickness of soil material on dapog system is 1.2 cm Fig 2 (a). The result of comparison of soil thickness measurement on tray conducted at 10 point randomly with 10 repetition treatment can be presented in Fig. 3 (a).

According to Tang [7], seed treatments have been developed in an efficient, safe, and economical which allows farmers to control insect pest on various crops of rice worldwide. Seed treatment technology is relatively simple and inexpensive in controlling diseases and insect pest in agricultural
crops. With seed treatment before seedling determines quality of the seed for the success a farm. On the measurement of the distribution of seed uniformity is done 10 repetitions Fig 2 (b). An analysis of the measurement results to determine how close to the expected target value. The results can be presented in Figure 3 (b).

BPPP East Java [4] states that the soil cover (soil mixed with organic fertilizer) should have a thickness of 0.5 cm then sprinkled with water. Measurements of soil height in the tray were performed at 10 random points with 10 repetitions Fig 2 (c). The final stage in the seeding is the closing of seeds with fertilizer. To measure the thickness of the fertilizer is done by determining the total targeted seeding thickness is 2 cm. The thickness measurement of the fertilizer is the total thickness of the material with the thickness of the seed and the thickness of the soil. Analysis of measurement results with expected target values is presented in Figure 3 (c).

3.2 Percentage loosing of soil, seed and fertilizer
Percentage loosing of soil, seed and fertilizer of the experimental results are presented in Figure 4. Figure 4 explains that the average percentage loosing of soil, seed and fertilizer is 6.23%, 2.17% and 2.23%, respectively. The percentage loosing of soil is greater than seed and fertilizer because the volume of soil dropped by rotor of soil metering device is greater than the amount of soil and fertilizer dropped. The way to fix this is to modify the rotor of metering device channel material according to the size of the tray used.

3.3 Effective capacity of apparatus (KEA)
The effective capacity of apparatus is the productivity apparatus during the rice seeding process. The capacity of the seeding tool is presented in Table 1. The effective capacity of apparatus is the productivity apparatus during the rice seeding process. Experiments conducted by three times repetitions obtained an average seeding of 2.5 trays for 24 seconds so that if converted per hour average can complete the seeding of 360 tray.

| Repetition | Number of tray | Time (second) | Effective capacity (tray/hr) |
|------------|----------------|---------------|-----------------------------|
| I          | 2.5            | 24            | 360                         |
| II         | 2.5            | 24            | 360                         |
| III        | 2.5            | 24            | 360                         |

3.4 Power Requirement
The results of measuring the use of electrical power during the seedling process using a digital wattmeter are presented in Table 2. The results of measuring the use of electrical power during the
seedling process using a digital wattmeter. Of the three repetitions performed, the highest electrical power requirement is at the first repeat of 240.0 watts, and the lowest electrical power requirement in the third repeat is 234.0 watts. The occurrence of the difference in power requirements can be caused by load conditions and unstable electrical current at the time of measurement.

| Repetition | Electric current (Watt) |
|------------|-------------------------|
| I          | 240                     |
| II         | 238.5                   |
| III        | 234                     |
| Average    | 237.5                   |

4. Conclusion

Design model of small-scale rice seeding tools can be used to produce seeding of dapog rice seed system using tray in laboratory. The average effective capacity of the apparatus in the laboratory-scale model of laboratory seedlings was 360 tray / hour for the seedbed of rice seed. The uniformity of soil, seed and average fertilizer in the model of rice plant seeding system laboratory dapog were 92.8%, 3-4 seeds / cm² and 82% for seeding of rice seeds. The average percentage loosing of soil, seeds and fertilizers on the laboratory scale model of laboratory seeding were 6.23%, 2.7% and 2.23% for seeding of rice seeds.

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