Development of System of Rice Intensification and Legowo planting systems on 'Rendengan' planting season using various rice varieties in different equatorial rainfall types in South Sulawesi

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Abstract. This study is expected to address the water shortage in irrigated land with the use of adaptive varieties. The purpose of the study is to obtain a model of water management with System of Rice Intensification (SRI) method of planting systems combined with Legowo and the use of appropriate rice varieties for the equatorial rain-type region. The experiment was conducted in Sidrap Regency on sand textured soil, in the form of experimental research using Split Plot Design. The treatment of the water management of the wet-dry method, water saturated condition and intermittent as the main plot and varieties consist of Mekongga, Inpari-4 and Inpari-30 as a subplot. The results show that water management with the wet-dry method gives a better effect on plant height at 30 days after planting (DAP) (44.74 cm), 60 DAP (84.74 cm), the time of harvest (101.62 cm), panicle length (27.87 cm) and plots (per hectare) which was 223.75 kg (6.78 t), while the number of tillers 30 DAP (20.80 tillers), productive tillers (21.20 tillers) obtained in the discontinuous method. Development of varieties in paddy fields textured sand should use Inpari-4 in combination with water management in wet-dry method.

1. Introduction

Excessive amounts of water in the soil alter various chemical and biological processes that limit the amount of oxygen and increase the formation of toxic compounds in plant roots. Heavy rainfall can damage crops directly or use flowering and pollination. The sensitivity to water deficiency differs from plant to plant and from one level of growth to another in one type of plant, besides that plant age also determines the sensitivity to water shortages [1].

Variations in water requirements also depend on rice varieties and paddy field management systems. This means that water management in paddy fields involves not only the irrigation system, but also the drainage system when it is needed, either to reduce water quality or to replace new water so as to provide opportunities for oxygen and nutrient circulation. Thus, water management techniques need to be significantly developed in accordance with lowland rice production and cropping patterns [2].

So far, the area of rice farming patterns is highly dependent on the availability of irrigation water, groundwater, rainfall, land and socio-economic conditions as well as local customs patterns. Farmers tend to use the rice-paddy cropping pattern if water is available mapped fields. Changes in water conditions and rain patterns require changes in cropping patterns according to available water conditions, so that changes in water availability will cause changes in cropping patterns, especially if
the available water is not sufficient to support plant growth, the pattern will change rice-secondary crops and the selection of secondary crops adjusted to the amount of water and the crop water requirement [3].

Lowland rice water needs are around 800-1,000 mm / season, or between 6-10 mm per day [4]. According to Budianto [5], technically lowland rice plants need 800-1,200 mm of water per season. Meanwhile, maize, soybeans and peanuts need 300, 350 and 450 mm per season, respectively. Thus, local rain and runoff from the rain catchment area are sufficient to meet the water needs of lowland rice crops, and even usually excessive water will be wasted in the rainy season. Some of the rainwater seeps into the ground and is stored as groundwater. Runoff water and groundwater are potential enough to be used in critical conditions.

System of Rice Intensification (SRI) is an intensive and efficient rice cultivation system based on integrated crop management, soil biology, water management and fertilization to increase root system growth, number of tillers, biodiversity (biodiversity) and soil biological strength [6] in support increase in productivity of rice plants in areas with equatorial rain patterns.

The provision of water intermittently (intermittently) in rice cultivation is one of the irrigation methods that can be measured practically. This irrigation is also known as Alternate Wetting and Drying (AWD), which is the arrangement of water on land in alternating stagnant and dry conditions. Intermittent irrigation is the recommended irrigation system in lowland rice cultivation.

2. Methodology
This research was conducted in Sidrap Regency, South Sulawesi Province. The research location is an area of rainfall with two peaks with an equatorial type occurring in December / January and April / May. Determination of rain distribution patterns was based on analysis of rainfall data for as much as 20 years, obtained from weather / climate observation stations. The research took two years, namely in the first year (I), which was carried out in October-March (known in local term as Gadu planting season) on clay texture types, while the second year research was carried out in April-September (local term: Rendengan planting season) on sand-textured soil types. The materials used were production facilities consisted of fertilizers: Urea 100-150 kg ha⁻¹, NPK and ZA as well as organic fertilizers. Pesticides used were Hypolast and Furadan, DMA, Cliver and rice seeds with three varieties, namely Mekongga, Impari 4, and Impari 30. While the tools used were hand tractors, planting tools (trans-planter), ropes, scales, BWD, plastic, bamboo, sprayers, pedals thresher, scales, hoes, machetes, plot boards, paints, brushes and writing tools.

The research was in the form of an experiment using a separate plot design that was planted with a 1:2 legowo planting system. As the first factor was the treatment of the water management system (W) which consisted of: Water supply system with dry wet / AWD (W1), water saturated condition by maintaining the water height of 0-2.5 cm (W2), and intermittent water management (W3), while the second factor is the use of varieties, namely Mekongga (V1), Inpari-4 (V2), and Inpari 30 (V3). low growing season April-September 2014.

The experiment began with soil tillage using a hand tractor. A complete soil tillage was conducted from plow to comb so the land was ready for planting. Then the paddy field was divided by 27 plots, so that the plot area was 20 m x 20 m. Previous to planting, the seeds were first germinated in a three-day process, then sown in other prepared rice fields. This nursery process is only intended for the transplanting system for 11-13 days. The planting system was mechanized by means of a trans-planter planting tool as a substitute for human labor.

Plant maintenance which includes replacement for dead seedlings was carried out according to plant conditions; fertilization was applied according to the measurement results of the PUTS tool combined with recommendations and experiences of farmers, while urea fertilizer was based on the leaf color chart (BWD) as an indicator of leaf color, pest and disease control adapted to the conditions of attack; weeding was done using herbicides and physical means; the provision of water was adjusted to the treatment; harvest age indicators were used, and the visual state of the plant after the grain is filled and yellow as much as 90%.
The components of the observations that were observed and measured in this experiment were: plant height, the maximum number of tillers, number of productive tillers, panicle length; number of grains per panicle, production per plot, and production per hectare.

3. Results and discussion

The results of the observation of plant height (table 1) show that the average plant height in intermittent water supply with the AWD system (W1V2) gave higher plant height and number of tillers in the Inpari-4 variety (table 2). Meanwhile, the average number of productive tillers tended to be intermittent treatment (W3V2) although it was not significantly different from showing the number of productive tillers were more.

Table 1. Average plant height (cm) of rice.

| Plant age | Water management system (W) | Varieties (V) | Average | Tukey’s 0.05 [W] |
|-----------|----------------------------|---------------|---------|-----------------|
| 30 DAP    | Dry-wet                    | Mekongga      | 43.56   | 44.19ab         |
|           | Saturated                  | Inpari 4      | 46.58   | 44.15b          |
|           |                            | Inpari 30     | 44.08   | 42.17a          |
| Intermittent |                          | Average       | 43.19   |                 |
| Tukey’s 0.05 [W] |                       |               | 1.63    |                 |
| 60 DAP    | Dry-wet                    | Mekongga      | 84.73   | 80.48           |
|           | Saturated                  | Inpari 4      | 89.16   | 83.17           |
|           |                            | Inpari 30     | 80.33   | 78.94           |
| Intermittent |                          | Average       | 80.48   |                 |
| Tukey’s 0.05 [W] |                       |               | 4.41    |                 |
| At Harvest| Dry-wet                    | Mekongga      | 95.94   | 90.19           |
|           | Saturated                  | Inpari 4      | 101.62  | 96.13           |
|           |                            | Inpari 30     | 94.45   | 92.74           |
| Intermittent |                          | Average       | 94.22   |                 |
| Tukey’s 0.05 [W] |                       |               | 4.45    |                 |

Numbers followed by the same letter in columns (x, y) and rows (a, b) are not significantly different based on Tukey’s at 5% confidence level. DAP=Days after planting.

Table 2. Average number of tillers and number of productive tillers of rice plants.

| Number of tillers | Water management system (W) | Varieties (V) | Average | Tukey’s 0.05 [W] |
|-------------------|----------------------------|---------------|---------|-----------------|
| 30 DAP            | Dry-wet                    | Mekongga      | 21.47   | 20.08           |
|                   | Saturated                  | Inpari 4      | 21.02   | 20.41           |
|                   |                            | Inpari 30     | 18.98   | 17.53           |
| Intermittent      |                            | Average       | 20.89   |                 |
| Tukey’s 0.05 [W] |                       |               | 3.94    |                 |
| 60 DAP            | Dry-wet                    | Mekongga      | 37.47   | 30.47b          |
|                   | Saturated                  | Inpari 4      | 32.87   | 29.58b          |
|                   |                            | Inpari 30     | 26.47   | 25.84a          |
| Intermittent      |                            | Average       | 30.73   |                 |
| Tukey’s 0.05 [W] |                       |               | 3.72    |                 |

Numbers followed by the same letter in columns (x, y) and rows (a, b) are not significantly different based on Tukey’s at 5% confidence level. DAP=Days after planting.
The application of water using the wet-dry method with the combination of Inpari-4 variety gave the highest panicle length of 27.87 cm and was significantly different from other combinations (table 3). While the average value of the number of grains per panicle obtained the highest value of Inpari-30 (V3) variety, namely 9.62 grains. The lowest average panicle length of the Mekongga variety in combination with wet-dry water (W1V1) was 22.79 cm. The number of grains per panicle obtained the lowest average value on the Mekongga Variety (V1) which was 8.84 pieces. Production per hectare (table 4), that the application of wet-dry method combination of Inpari-4 (W1V2) gave the highest production per hectare, namely 6.78 tonnes. The lowest average production was obtained by the Mekongga variety with a combination of saturated water (W2V1), namely 5.38 tons.

### Table 3. Average panicle length (cm), and number of grains (fruit) of rice plants.

| Parameter                  | Water management system (W) | Varieties (V) | Tukey’s 0.05 [W] |
|----------------------------|-----------------------------|---------------|------------------|
|                            | Tukey’s 0.05 [V]            |               |                  |
| Panicle length             | Dry-wet                     | Mekongga      | Inpari 4         | Inpari 30 |
|                            |                            | 22.79<sup>x</sup> | 27.87<sup>y</sup> | 24.22<sup>a</sup> |
|                            | Saturated                   | 23.09<sup>x</sup> | 24.03<sup>a</sup> | 22.94<sup>y</sup> |
|                            | Intermittent                | 22.87<sup>a</sup> | 25.52<sup>y</sup> | 23.87<sup>a</sup> |
| Tukey’s 0.05 [V]           |                            | 2.43          |                  |
| Number of grains           | Dry-wet                     | 8.48          | 8.95             | 9.57      | 9.00 |
|                            | Intermittent                | 9.10          | 8.80             | 9.55      | 9.15 |
| Average                    | 8.84<sup>a</sup>            | 9.02<sup>a</sup>| 9.62<sup>b</sup> |           |
| Tukey’s 0.05 [V]           |                            | 0.29          |                  |

Numbers followed by the same letter in columns (x, y) and rows (a, b) are not significantly different based on Tukey’s at 5% confidence level.

### Table 4. Average production per plot (kg) and per hectare (t) of rice crops.

| Production         | Water management system (W) | Varieties (V) | Tukey’s 0.05 [V] |
|--------------------|-----------------------------|---------------|------------------|
| Per plot           | Dry-wet                     | Mekongga      | Inpari 4         | Inpari 30 |
|                    | 199.71<sup>y</sup>          | 223.75<sup>z</sup>| 222.50<sup>b</sup>|
|                    | Saturated                   | 177.38<sup>b</sup> | 154.52<sup>a</sup> | 205.86<sup>c</sup>|
|                    | Intermittent                | 193.33<sup>b</sup> | 195.00<sup>y</sup> | 177.64<sup>b</sup>|
| Tukey’s 0.05 [V]   |                            | 10.31         |                  |
| Per hectare        | Dry-wet                     | 6.05<sup>a</sup> | 6.78<sup>b</sup> | 6.74<sup>y</sup> |
|                    | Saturated                   | 5.38<sup>x</sup> | 4.68<sup>a</sup> | 6.24<sup>y</sup> |
|                    | Intermittent                | 5.86<sup>y</sup> | 5.91<sup>y</sup> | 5.38<sup>a</sup> |
| Tukey’s 0.05 [V]   |                            | 0.31          |                  |

4. Conclusion
- PMI's technological innovation in paddy fields planted in sandy paddy fields and equatorial rain-type areas in the April-September growing season requires a combination of relatively little water management with the use of organic fertilizers and SP36 which are relatively higher than paddy fields with clay and loam textures.
- Wet-dry method of water management has a better effect on plant height at 30 days after planting (44.74 cm), 60 days after planting (84.74 cm), at harvest time (101.62 cm), panicle length (27, 87 cm) and production per plot (per hectare) of 223.75 kg (6.78 t)
• Development of varieties on sandy paddy fields should use the Inpari-4 variety combined with wet-dry method of water management.
• To obtain a recommendation for a water management system that is limited to clay, clay and dust textures, it should be implemented in the growing season of April-September and October-March in Monsoon rainy-type areas and local types with rice varieties that are in accordance with the regional and social conditions of the farmers.

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