Introduction of components of rice varieties technology in waterlogged land in Kendal Central Java

M N Setiapermas and S Minarsih

1Center for Agricultural Technology Studies of Central Java
Corresponding author: meinarttns@gmail.com

Abstract. Climate change can cause sea level rise and the expansion of rice fields affected by intrusion or seawater runoff. This problem is the adaptation of rice varieties that are tolerant of fresh or sea waterlogged in the farmers' land. The location of the activities was in Brangsong Sub-Regency, Kendal Regency, Central Java, in 2018. A split-plot factorial experiment was designed with 3 factors, variety of paddy, ameliorants, waterlogged height. This study's data analysis techniques are analysis of variance followed by standard real difference analysis and descriptive analysis. The observations of ubinan (rice harvesting tool) showed that Inpari 30 had the highest harvested dry grain productivity of 10 tons/ha in humic acid treatment in a 5 cm puddle. Meanwhile, the recommended varieties of Inpari 34 and Inpari 35 did not produce high productivity due to the easily collapsed cropping. Inpari 34 has a high percentage of filled grain, namely 90%.

1. Introduction
Climate change is predicted to cause the rise of sea levels, resulting in the expansion of waterlogged areas in the coastal rice fields of Pantura of Java. Saline rice fields spread throughout Indonesia, where rice fields are located near the coast [1]. This condition also occurs in the rice fields of Pantura of Central Java. Seawater runoff that enters irrigated rice fields causes a decrease in rice productivity in Pantura of Central Java. One way to determine whether the waterlogged land is still producing well is by introducing puddle tolerant rice varieties and using ameliorants. Brangsong Regency is one of the food buffer stock in Kendal Regency. Kendal Regency has an area of about 1,389 ha of agricultural land [2]. Exposure to freshwater puddles occurs from December to March, while those exposed to seawater puddles occur between May and September.

Farmers take advantage of the natural balance between seawater's entry and freshwater entry (rivers) in determining irrigation [1]. However, this natural condition usually occurs when the sluices are in normal condition. However, the real condition at the location is that the sluices are not functioning properly. Thus every time there is a maximum sea wave, seawater runoff in the rice fields and river water as irrigation cannot irrigate the rice fields. This problem occurs in the second and third planting seasons. In this activity, the selection of paddy varieties and ameliorants depends on the specific location (soil, puddle and farmer's ability, and even materials). The application of ameliorant or soil conditioner and fertilizer is an important factor for improving soil conditions and increasing land productivity [3].

Humic acid is an organic substance with a complex molecular structure with a high molecular weight/organic polymer containing an active group [3]. Furthermore, it creates a conducive soil situation to stimulate soil microorganisms that function in the decomposition process that produces humus (humification) [4].
Dolomite is an inorganic alkaline ameliorant material. Lime contains calcium and magnesium, which can reduce acidity and improve soil aeration. Thus, it can support biological activity in the soil. Other benefits of liming include optimal fertilizer absorption, strengthening roots and reducing toxins in the soil. Zeolite is a non-metallic mineral material that is very effective for nutrients ion exchange and storing water in soil particles. The use of zeolite is usually mixed with lime, humic acid, organic fertilizer, or urea. Zeolite compost is manure/organic given 10-30% zeolite when composting [5].

In general, paddy cultivation in Pantura region of Central Java is the same as in technically irrigated rice fields, including its varieties. This is because paddy is a crop that can grow in waterlogged land and help wash the salt on the soil surface into the lower layer. Thus, the land becomes suitable for the next cropping. The vegetative and the generative phase in sea-waterlogged land are influenced by salinity. The effect can vary depending on the stage of crop growth [6]. The selections of Inpari 30, Inpari 34, Inpari 35 and Inpara 8 are the results of a literature review based on the needs of fresh-waterlogged agroecosystems, sea-waterlogged land and saline land.

Inpara 8 varieties have a potential yield of 6 tons of Dry Matter (DM)/ha and has silken rice texture. Inpara 8 is a paddy variety recommended to be planted in tidal swamps, shallow lowlands and middle lowlands and tolerant from iron (Fe) poisoning. Inpari 30 is a variety with an average yield of 7.2 tons of DM/ha and has silken rice texture. Inpari 30 is suitable for planting in lowland irrigated rice fields up to 400 m above sea level (masl), in overflow area and in area which is prone to flooding. Inpari 34 has the potential yield of 8.1 tons of DM/ha and the rice texture is slightly dry. Inpari 34 is recommended to be planted on saline tolerant land in the nursery stress phase of 12 d Sm⁻¹ with an altitude of 0-500 masl. Inpari 35 has an average yield of 5.3 tons of DM/ha and the texture of the rice is slightly dry. Inpari 35 is a saline-tolerant paddy variety in the nursery phase at 12 dSm⁻¹ stress and suitable for rice planting [4]. One way to improve paddy productivity in lowland areas is to use new superior varieties, namely Situbagendit, Limboto, Batutegi, Inpago, Inpari-1, Inpari-4, Inpari-6, Inpara 3, Inpara 4 and Inpara-5 [5].

Paddy rice is the main crop in the system of tidal swamp farming. With cultivation techniques and Using suitable varieties, rice can grow well in all land typologies and overflow types. New superior rice varieties such as Inpari 1, Inpari 17, Inpari 30 and Ciherang in the lowland swamps in Alabio Regency polder area range from 5.57 7.56 tons MD/ha. The highest yield is Inpari 30 variety 7.56 tons MD/ha, and the lowest is Ciherang 5.57 tons MD/ha [6]. This study aimed to obtain rice varieties tolerant to puddles and ameliorants that produce high rice productivity in the dry season and to obtain recommended technology which can be adopted by farmers and the agricultural offices in the Kendal Central Java.

2. Materials and methods

2.1. Materials

The assessment activity was carried out in Purwokerto Village, Brangsong Sub-Regency, Kendal Regency, Central Java, Indonesia, from June to October 2018. This location is about 1.5 km from the beach.

2.2. Methods

The experimental design of a split-plot factorial with 3 factors, namely variety, ameliorant and waterlogged height (5 cm and 20 cm). The measurement result was obtained from a plot area about 4 m x 14 m (land area of 56 m²). The treatments applied to the main plots were varieties consisting of Inpara 8, Inpari 30, Inpari 34 and Inpari 35. Subplots were 5 cm inundation height and 20 cm. Subplots were humic acid ameliorant 25 kg/ha, gypsum 250 kg/ha and zeolite 25 kg/ha. The basic fertilizer consists of compost 2 tons/ha, urea 250 kg/ha, NPK fertilizer (phonska) 250 kg/ha, SP36 100 kg/ha, ZA 150 kg/ha and ZnSO₂.

Before the nursery, the seeds were treated with a pesticide application (reagent) for one night and the nursery was applied with compost, NPK (phonska), ZA and pesticides (furadan). The nursery was...
held on June 7th, 2018. Planting was carried out when the rice seeds were 33 days after seedling (DAS) on July 10th, 2018.

Figure 1. Location of nursery by farmers on June 7th, 2018

This study's data analysis techniques were analysis of variance followed by standard real difference analysis and descriptive analysis. The collected data included technical data, namely crop agronomic performance and productivity. Technical data were collected through direct field measurements.

3. Results and discussion

Management of irrigation and drainage in rice fields around the coast, which often occurs, can save crops sensitive to salt levels that inundate the plots or enter the rice field soil. Identifying the soil salinity level in a stretch of intensive rice field in Indramayu area showed a high proportion of rice fields that have undergone a salinity process [1]. The vegetative observations of cropping in Purwakerto Village, Brangsong Sub-Regency and Kendal Regency is shown in Table 1 and Table 2.

Inpara 8 and Inpari 30 varieties are rice varieties tolerant to inundation up to 14 days after planting. Meanwhile, Inpari 34 and Inpari 35 have saline tolerant conditions. However, the maximum number of tillers' agronomic component was not significantly different in those two saline tolerant varieties and was not significantly different between Inpara 8 and Inpari 30. The maximum number of tillers was also not significantly different among the ameliorants.

Table 1. The maximum number of tillers for rice cultivation in puddle/saline land in Purwakerto Village, Brangsong Sub-Regency, Kendal Regency

| Plant variety | Depth of puddle (cm) | Ameliorant | Humic Acid | Gypsum | Zeolite |
|---------------|----------------------|------------|------------|---------|---------|
| V1, Inpara 8  | D1 (5 cm)            | 28efgh     | 28efgh     | 33cdef  |
|               | D2 (20 cm)           | 41ab       | 45a        | 40abc   |
| V2, Inpari 30 | D1 (5 cm)            | 40abc      | 29defgh    | 31defg  |
|               | D2 (20 cm)           | 37bcd      | 35bcde     | 35bcde  |
| V3, Inpari 34 | D1 (5 cm)            | 22h        | 29efgh     | 32cdefg |
|               | D2 (20 cm)           | 26fgh      | 26fgh      | 25gh    |
| V4, Inpari 35 | D1 (5 cm)            | 32 cdefg   | 35 cdefg   | 37bcd   |
|               | D2 (20 cm)           | 37bcd      | 29 efgh    | 25fgh   |

The highest number of panicles filled with grain, which occurred in Inpari 34 with gypsum ameliorant in a 20 cm puddle, was 29 panicles. The first harvest estimation was carried out on Inpari 35 with 5 cm puddle from the physical appearance and the generative phase. Therefore, it is estimated that the harvest is gradual according to the harvest age for each variety. However, in reality, all varieties are harvested simultaneously. The productivity observations showed that Inpari 30 had the highest productivity of 10 tonnes/ha in humic acid and a 5 cm puddle treatment. While the Inpari 34 and Inpari 35 were not as big as Inpara 8 and Inpari 30. It can be said that ameliorant treatment resulted in a production that was not significantly different.
Meanwhile, the puddle treatment was significantly different. The recommended varieties of Inpari 34 and Inpari 35 did not produce high productivity due to the easily collapsed cropping. However, local farmers prefer Inpara 8 to be developed in the third cropping season in Purwokerto Village and Kendal Regency surroundings.

**Table 2.** The number of panicles for paddy cultivation in waterlogged/saline land in Purwokerto Village, Brangsong Sub-Regency, Kendal Regency

| Plant variety | Depth of puddle (cm) | Humic Acid | Gypsum | Zeolite |
|---------------|----------------------|------------|--------|--------|
| V1, Inpara 8  | D1 (5 cm)            | 24<sup>abcd</sup> | 20<sup>bcdef</sup> | 15<sup>efgh</sup> |
|               | D2 (20 cm)           | 16<sup>efgh</sup> | 19<sup>def</sup> | 6<sup>i</sup> |
| V2, Inpari 30 | D1 (5 cm)            | 22<sup>bcd</sup>e | 14<sup>ghi</sup> | 21<sup>bcd</sup> |
|               | D2 (20 cm)           | 23<sup>abcd</sup>f | 19<sup>def</sup> | 14<sup>ghi</sup> |
| V3, Inpari 34 | D1 (5 cm)            | 11<sup>ghij</sup> | 18<sup>def</sup> | 15<sup>efgh</sup> |
|               | D2 (20 cm)           | 16<sup>efgh</sup> | 29<sup>a</sup> | 27<sup>ab</sup> |
| V4, Inpari 35 | D1 (5 cm)            | 15<sup>efgh</sup> | 18<sup>def</sup> | 24<sup>abcd</sup> |
|               | D2 (20 cm)           | 26<sup>abc</sup> | 10<sup>ijk</sup> | 8<sup>i</sup> |

**Figure 2.** Paddy cropping on September 10<sup>th</sup>, 2018 (2 months DAS)

Based on the variety description, the potential yield is 6 tons/ha of milled dry grain, it is tolerant of Fe poisoning and resistant to falling and chills [4]. The observation results on the percentage of filled grain showed that 5 cm puddle had a higher percentage of filled grain than the 20 cm puddle. Meanwhile, the ameliorant treatment did not affect the percentage of filled grains. While for varieties, only Inpari 34 had a high percentage of filled grain, namely 90%.

The final result of this activity is that the application of Inpari 30 and Inpara 8 with humic acid treatment needs to be disseminated in the Pantura region of Central Java. To maintain food security, especially rice, the required policies are optimal utilization of existing land resources, such as irrigated rice fields, tidal swamps and dry land, by applying innovative rice cultivation technology. Paddy yields at the farmer level in North Sumatra are currently below the national average. The decreased level of soil fertility causes it. Also, farmers generally have not implemented the cultivation technology package correctly [7].

The anticipation of climate change and early-maturing paddy varieties is highly recommended since it produces lower emissions than deep-matured paddy. The increase in future agricultural production will be directed at strengthening the sustainability of food security and anticipating the impacts of climate change through the synergy of adaptation and mitigation actions for greenhouse gas emissions [8]. Sustainable agriculture is a continuous agricultural business system by utilizing land, water and crop materials economically and profitably. This agricultural activity must be sustainable by
considering the preservation of environmental quality, balance of agroecosystems and preservation of biodiversity. For farmers, sustainable agriculture as a production business that can produce products stably and optimally, with a relatively low input of production facilities and yields, provides a decent economic benefit for their family life [9].

Table 3. Productivity (tons/ha) of paddy in waterlogged/saline land in Purwokerto Village, Brangsong District, Kendal Regency

| Plant variety | Depth of puddle (cm) | Humic Acid | Gypsum | Zeolite |
|---------------|----------------------|------------|--------|--------|
| V1, Inpara 8  | D1 (5 cm)            | 6.7        | (7.0)  | 4.7    |
|               | D2 (20 cm)           | 4.3        | 4.2    | 2.0    |
| V2, Inpari 30 | D1 (5 cm)            | 10.4       | 8.1    | 8.1    |
|               | D2 (20 cm)           | 6.5        | 5.4    | 2.7    |
| V3, Inpari 34 | D1 (5 cm)            | 4.5        | 5.1    | 4.8    |
|               | D2 (20 cm)           | 4.8        | 2.2    | 1.7    |
| V4, Inpari 35 | D1 (5 cm)            | 4.7        | 6.5    | 5.7    |
|               | D2 (20 cm)           | 3.7        | 1.3    | 2.9    |

Table 4. Percentage of filled grains in rice fields in waterlogged/saline land in Purwokerto Village, Brangsong District, Kendal Regency

| Plant variety | Depth of puddle (cm) | Humic Acid | Gypsum | Zeolite |
|---------------|----------------------|------------|--------|--------|
| V1, Inpara 8  | D1 (5 cm)            | 52^hi      | 74^bdef | 77^bdef |
|               | D2 (20 cm)           | 69^defg    | 66^f   | 43^i   |
| V2, Inpari 30 | D1 (5 cm)            | 82^abed    | 83^abc | 69^defg |
|               | D2 (20 cm)           | 81^abcde   | 83^abc | 78^abcdef |
| V3, Inpari 34 | D1 (5 cm)            | 79^abcdef  | 90^a   | 87^ab   |
|               | D2 (20 cm)           | 71^cdedf   | 48^ha  | 78^abcdef |
| V4, Inpari 35 | D1 (5 cm)            | 67^efg     | 68^efg | 46^hi   |
|               | D2 (20 cm)           | 57^gb      | 68^efg | 52^hi   |

4. Conclusion

The final result of this activity is that the application of Inpari 30 and Inpara 8 with humic acid treatment needs to be disseminated in the Pantura region of Central Java. To maintain food security, especially rice, the required policies are optimal utilization of existing land resources, such as irrigated rice fields, tidal swamps and dry land, by applying innovative rice cultivation technology. Location-specific rice cultivation technology packages in paddy fields that have the potential to be flooded during the dry season include the use of puddle-tolerant rice varieties, use of ameliorants, puddle water drainage and intermittent irrigation. The observations of ubinan show that Inpari 30 had the highest yield of dry aloe yields of 10 tonnes/ha in humic acid treatment in a pool of 5 cm.

References

[1] Rachman A, Dariah and Sutono S 2018 Pengelolaan Sawah Salin Berkadar Tinggi (Bogor: IAARD Press).
[2] Dinas Pertanian, Peternakan, Perkebunan dan Kehutanan Kabupaten Kendal 2015 *Statistik Pertanian, Peternakan, Perkebunan dan Kehutanan Kabupaten Kendal 2014* Pemerintah Kabupaten Kendal.

[3] Suratman and Sukarman 2016 Peran Amelioran Tanah Mineral Terhadap Peningkatan Berbagai Unsur Kesuburan Tanah Gambut pada Perkebunan Kelapa Sawit *Jurnal Sumber Daya Lahan* 21-33.

[4] Sasmita P, Satoto, Rahmini, Agustiani N, Handoko D D, Suprihanto, Guswara A and Suharna 2019 *Deskripsi Varietas Unggul Baru Padi* (Bogor: Badan Litbang Kementan) p.107

[5] Suparwoto and Waluyo 2019 *Jurnal Litbang Pertanian* 38 13-22

[6] Suryana 2016 Potensi dan Peluang Pengembangan Usaha Tani Terpadu Berbasis Kawasan di Lahan Rawa *Jurnal Litbang Pertanian* 35 2 57-68

[7] Musfal 2019 *Jurnal Litbang Pertanian* 38

[8] Wihardjaka A, ArdiwinatanA N and Yulianingsih E 2018 *Status dan Mitigasi Emisi Gas Rumah Kaca Di Lahan Sawah (Status and Mitigation of Green House Gas Emissions on Rice Field Areas)*, dalam *Forum Komunikasi Profesor Riset: Mewujudkan pertanian berkelanjutan: Agenda Inovasi Teknologi Kebijakan* (Jakarta: IAARD Press).

[9] Sumarno 2018 *Pertanian Berkelanjutan: Persyaratan Pengembangan Pertanian Masa Depan (Sustainable Agriculture: Prerequisite for Agricultural Development in the Future)* dalam *Forum Komunikasi Profesor Riset: Mewujudkan pertanian berkelanjutan: Agenda Inovasi Teknologi Kebijakan* (Jakarta: IAARD Press).