Biofertilizer application of paddy field on tidal swampy areas in West Kalimantan

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Abstract. Biofertilizer is a fertilizer technology that is increasingly popular in rice cultivation, especially in tidal land. This study aims to determine of fertilization efficiency and rice productivity of biofertilizer provision in tidal swampy area. The method used was a field experiment method with a randomized block design and treatment of biofertilizers provision namely Bacillus spp, Mycorhiza, and Agrimeth. The results showed that the application of bio fertilizers in the form of Agrimeth generate the best rice and fertilizer efficiency, which could increase rice productivity in tidal swampland, i.e. from 3.5 to 5.7 t ha⁻¹ of milled dry grain or increased 2.2 t ha⁻¹ (63%), while the efficiency of fertilization was 17%.

1. Introduction
The demand for rice will continue to increase along with the increasing number of people and the decrease in fertile land. The Indonesian government seeks to realize food sovereignty, by targeting sustainable food self-sufficiency in strategic commodities such as rice, through special efforts within the next 3-4 years. In the last five years until now, the level of rice production in Indonesia has increased. Rice production in 2017 reached 81.382 million tons of dried milled grain (DMG, GKG = gabah kering giling) equivalent to 47.332 million t of rice, increased 2.027 million t (2.56%) From rice production in 2016 which amounted to 79.355 million t of DMG. Meanwhile, the number of Indonesian population in 2017 amounted to 262 million people and average rice consumption rate of 114.6 kg capita⁻¹ year⁻¹ [1]. In 2016 Indonesia rice surplus reached 11.4 million t. Meanwhile, rice production in West Kalimantan increased 10.04% by 137,028 t from 1,364,524 t in 2016 to 1,501,552 t in 2017 [1]. The results of experts predicted that Indonesia will experience a rice deficit of 9.668 million t in the year 2020. Meanwhile, to meet the increasing needs of the rice, according to experts required the addition of rice paddy area 20,250 ha year⁻¹ [2].

One of the alternative problem solvings and responding to the challenge is to utilize tidal swamp land as agricultural production area especially for rice crop, considering the area is very wide while the utilization has not Intensive and its utilization technology is quite available. The utilization of swamp land of 9.5 million ha of potential marshland, only about 500 thousand are utilized for food crops.
Indonesia’s tidal wetland area is about 20.12 million ha, consisting of 2.07 million ha of potential land, 6.72 million ha of acid sulphate, 10.89 million ha of peatland and 0.44 million ha of saline land. Tidal marshlands that have the potential to be used for agricultural land around 8,535,708 ha. From the area, which has been reclaimed around 2,833,814 ha and which has not been reclaimed around 5,701,894 ha. Area of Tidal swamp that has been used as new paddy field until 2011 around 407,594 ha [3]

West Kalimantan Province has a wetland agroecosystem covering an area of 3,659,736 ha [4]. While the area of tidal land in West Kalimantan 92,250 ha [1]. Based on these data opportunities for agricultural development, especially for rice paddy tidal land is still open wide. Therefore, the utilization and management of tidal marshes for rice farming, is a very important and strategic thing. However, in the use of tidal swamp land for rice farming requires specific handling.

The potential of tidal marshland in West Kalimantan can be increased productivity, among others, through improved land fertility. From the area of 92,250 ha of tidal swamp in West Kalimantan has the potential to produce rice 276,750 t year\(^{-1}\), when cultivated twice a year then the potential for rice yield can be 553,500 t year\(^{-1}\). Therefore, the increase of soil fertility and rice productivity in tidal marshes is important by utilizing biofertilizers. The purpose of this research is to know the growth and productivity of rice in tidal swampy by applying some biofertilizers.

## 2. Materials and Methods

The research was conducted on Type C of tidal land where the rice field was not affected by tides and water recede, but the water is shallow less than 50 cm from soil surface level [5]. This study was conducted in the dry season in Simpang Empat Village, Tangaran Sub-district, Sambas District, West Kalimantan Province from March to October 2018. The material used is a means of agricultural production such as rice seeds Inpago 8 varieties, biofertilizers, pesticide, tools and other auxiliary materials.

Rice cultivation techniques on this research using the rice seed varieties Inpago 8. Planting rice by Planting Legowo 2:1 (2 rows of plants and 1 empty line) planting distance 20 cm between rows of plants, 10 cm in a row of plants and 40 cm. Inorganic fertilizer application with a dose of Urea 150 kg ha\(^{-1}\), TSP 100 kg ha\(^{-1}\) and KCl 75 kg ha\(^{-1}\). The experiment used with a randomized block design with six replicates. Each tile measuring 10 m x 20 m with a distance between the plots as wide as 1 m. The treatment is as in Table 1.

| Code | Treatment | Description |
|------|-----------|-------------|
| T0   | Not in the Give Biofertilizer | Control |
| T1   | Given Biofertilizer "Bacillus spp" | Rice seed treatment before seedling with a dose of 1 L ha\(^{-1}\) |
| T2   | Given bio-fertilizer "Mikoriza" | Rice seed treatment before seedling with a dose of 1 kg ha\(^{-1}\) |
| T3   | Given Biofertilizer "Agrimeth" | Rice seed treatment before seedling with a measure of 400 g ha\(^{-1}\) |

Table 1: Treatment of biofertilizer in the field experiments

The treatment of Biofertilizer Bacillus spp. was performed by mixed water at the immersion of the rice seeds (seed treatment). The goal is to allow the bacteria to cling to the seed so that when the seeds are spread out in the nursery, the bacteria will be able to grow in roots and leaves. The dose was 1 liter of Bacillus spp. For rice seeds is 25 kg ha\(^{-1}\). Application of Mikoriza by soaking in the wet rice seed (seed treatment) with a doses 1 kg 25 kg\(^{-1}\) seed ha\(^{-1}\). Giving Agrimeth by soaking in the rice seed (seed treatment) with a measure of 400 g 25 kg\(^{-1}\) of seed ha\(^{-1}\).

The parameters observed were rice plant growth parameters such as plant height, panicle length, and number of panicles. The yield parameters observed were number of grains per panicle, number of filled grain per panicle, number of empty grains per panicle, grain weight of 1000 grains, and production of harvested unhusked rice and grinded dry grain ha\(^{-1}\) at 14% grain moisture content.
The effect of treatment on the observed parameters was carried out by analysis of variance (ANOVA) using the F-test at the confidence level of 5%. If the F-test shows significant or very significant effect, then to find out whether there are significant differences between treatments, the DMRT (Duncan’s Multiple Range Test) mid-range test was carried out at the 5% confidence level [6].

3. Results and Discussion

The research location is in Simpang Empat Village, Tangaran District, Sambas Regency. The area of Tangaran District is 186.67 km$^2$ or around 2.92 percent of the area of Sambas Regency. Simpang Empat village covers 83.50 km$^2$ or 44.73% of the area of Tangaran District. The highest amount of rainfall in 2017 in Tangaran District averaged 256.5 mm month$^{-1}$, while the highest number of rainy days averaged 13 rainy days month$^{-1}$ in May. Average temperatures range from 23.5 to 31.9 °C. The maximum air temperature occurs in July at 32.8 °C, while the minimum temperature occurs in February at 23 °C [1].

Based on the results of the field orientation and information collected from several farmers, it showed that the condition of the tidal swamp land in the study site was relatively flat with the drainage of the soil somewhat hampered. However, it was not experience long enough inundation, except in several locations where inundation and flooding occur when heavy rains occurred, and drought occurred in the dry season, but the depth of ground water was classified as shallow (<50 cm). Such conditions can be classified as tidal swamps with overflow Type C. Simpang Empat Village Farmers, Tangaran District in general were not familiar with bio-fertilizer, bio-rice cultivation was still using inorganic fertilizers (Urea, TSP and KCl), with rice yields still relatively low at around 3 t ha$^{-1}$, with income around 12 million rupiah per season.

Biofertilizers are non-pathogenic microbial-based fertilizers that can produce phytohormones, N-fixing and P solvents that work to increase soil fertility. Biofertilizers used in this study were Agrimeth, Bacillus spp., and Mikroriza. Agrimeth biofertilizers have enzymatic and phytohormone activity that have a positive effect on the absorption of macro and micro soil nutrients, stimulate plant growth, flowering, seed ripening, breaking dormancy, increasing vigor and viability of [7]. Some of the benefits of Agrimeth biofertilizers include saving production costs, increasing crop productivity by 20-50%, improving and increasing the growth of roots, stems, leaves, flowers and fruit [8]. Agrimeth fertilizer can also increase plant resistance to pathogenic microbial attack, ensuring the fertility of agricultural land is maintained, safe to use and friendly to the environment.

Bacteria Bacillus spp. is one of microorganisms that can be used as biological fertilizer. These bacteria are included in the types of aerobic bacteria that need oxygen for growth. Bacteria Bacillus spp. It acts as a plant growth promoting, which stimulates plant growth by helping plants absorb nutrients, both nutrients from the air and from the soil. Because of its role in spurring plant growth, these bacteria are used as liquid biofertilizers. Bacteria Bacillus spp. can help in root lengthening, leaf and stem growth, and flower and fruit growth [9]. Biofertilizer "mycorrhiza" is an arbuscular mycorrhizal fungus is an obligate symbiont that requires photosynthesis from the host plant for the growth of its hyphae. The hyphae which penetrate the host plant, help bring nutrients closer to the rice crop rhizosphere zone so that the growth and development of rice plants is faster [10].

3.1. Effect of Biofertilizer on Several Parameters of Rice Plant Growth

The results of analysis of variance showed that the treatments T0, T1, T2 and T3 did not show any significant difference in the height of rice plants. The average height of rice plants was 112.45 cm (Table 1).
Table 2: Effects of biofertilizer on plant height, panicle length, and number of panicles.

This shows that the application of biofertilizer does not affect the height of rice plants. Plant height parameters do not show any significant difference, it is suspected that biological fertilizers have not seen a significant role in increasing the height of rice plants. The description of Inpago 8 Paddy Plant height has a plant height of ± 122 cm. [11] states that differences in plant height are more determined by genetic factors, in addition to being influenced by environmental conditions of growing plants.

The results of analysis of variance and further tests showed that the panicle length of rice plants in the treatment of Agrimeth (T3) was the longest which was an average of 28.35 cm and significantly different from the control (T0) which had an average panicle length of only 15.38 cm, however, the T3 treatment was not significantly different from the treatment of Bassilus spp. (T1) and mycorrhizae (T2). This shows that the application of biofertilizer on panicle length parameters has a significant effect. [12] reported that the use of biofertilizers can increase panicle length in rice plants.

The results of analysis of variance and further tests of the number of panicles per clumps showed that the treatment of Agrimeth (T3) produced the highest number of panicles per clumps which was 12.86 strands, however it was not significantly different from other treatments except with T0 (control). The T0 treatment produced the lowest number of panicles, an average of 6.64 strands. This shows that the application of biofertilizer affects the number of panicles per clump in rice plants. Biofertilizers containing inoculants made from active microbes can break down or bind nutrients so that these nutrients can be available in the soil and utilized by rice plants for the growth of the panicle. N fastening microbes and P solvents contained in biological fertilizers play a role in increasing the number of panicles. Nitrogen is a constituent component of amino acids, nucleic acids, nucleotides and chlorophyll so that it can encourage rapid growth of panicle length and number of panicles in rice plants [13].

3.2. Effect of biofertilizer on rice yield parameters

The influence of biofertilizer on the number of grains per panicle, the number of filled grains per panicle, the number of empty grains per panicle, the weight of 1000 grains and the milled unhusked grain can be seen in Table 3.

Table 3. Effect of Treatment on Rice Results Parameters.

| Treatment  | Number of grains per panicle | Number of filled grains per panicle | The number of empty grains per panicle (grain) | Weight per 1000 grains (g) | Dry milled grain (t ha⁻¹) |
|------------|------------------------------|-------------------------------------|-----------------------------------------------|---------------------------|--------------------------|
| Control (T0) | 102.32 a                     | 82.2 a                              | 23.4 a                                         | 16.12 a                   | 2.82a                    |
| Bassilus (T1) | 163.25 b                    | 116.2 b                             | 70.4 b                                         | 24.22 b                   | 4.92b                    |
| Mikoriza (T2) | 184.09 b                    | 122.3 b                             | 68.8 b                                         | 25.24 b                   | 5.10b                    |
| Agrimeth (T3) | 186.84 b                    | 124.6 b                             | 65.6 b                                         | 26.82 b                   | 5.25b                    |
not significantly different. While the results of the comparison of biological fertilizers between Bacillus spp., Mycorrhiza, and Agrimeth did not show any significant difference. [14] research (2009) in greenhouses in rice plants showed that the application of biofertilizers significantly affected the number of panicles per clump, the number of filled and hollow grains per clump, and the weight of seed production per clump. Whereas [15] report that the application of 2 mL of liquid biofertilizer L\(^{-1}\) of water gives a high yield on panicle length and percentage of filled grain.

Grain yields in the treatment of biofertilizer in rice plants were significantly different from the control. Rice plants that were given Agrimeth biofertilizer (T3) can produce the highest dry unhusked rice (DUR) which is 5.25 t \text{ha}^{-1}, and the least in the control treatment is 2.82 t \text{ha}^{-1}. But between the treatments of Agrimeth T3, Bacillus spp. (T1), and mycorrhizae (T2) did not show any significant difference in rice yields (Table 2).

4. Conclusion
Application of biofertilizer in the form of Agrimeth in the treatment of rice seeds (seed treatment) can increase rice productivity in tidal land that is from 2.8 t \text{ha}^{-1} to 5.2 t \text{ha}^{-1} milled dry grain or increased by 2.4 t \text{ha}^{-1}.

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