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The Productivity and Income of Corn Farming Business through the Application of Biological Fertilizers

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Abstract

Keywords:

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The use of microbes' research as biological fertilizers in order to increase corn production had been performed, but the analysis of farming business related to this matter has not been conducted. This research aimed to determine the effect of one of the biological fertilizers, which was *Agrimeth*, on the seeds of various composite corns to the growth factors, the productivity of corn farming in dry land, and the amount of income that was obtained. This research was conducted in Betung Village, Betung Sub-District, Banyuasin Regency, South Sumatra. The corn varieties used were Bima 10, Bima 19, and Sukmaraga. The results showed that the seed treatment of corn seeds with *Agrimeth* showed an improvement trend of plant height, number of leaves, cob length and diameter, weight of 100 dry shelled grains, dry shelled production, and R / C in each variety. The application of *Agrimeth* biological fertilizers increased corn farming in dry land with R / C 2.79; 2.65; and 1.82 for each Bima 10, Sukmaraga and Bima 19 varieties.

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INTRODUCTION

Corn is an important commodity in the Indonesian food system that acted as the main food for some population in various regions. Also, being the main food for the poultry industry, and basic ingredient for processed food industry (Suryana and Agustian, 2014). With such a large role in the food system in Indonesia, so the efforts to increase corn production and productivity must continue to be developed. The central government had an important role in production policies related to the policy of fertilizer subsidies, land development and irrigation, and technological innovation (Dermoredjo, 2014).

The corn productivity depended on nutrition needs and management, especially nitrogen, phosphorus, and potassium. The high cost of inorganic fertilizers including the inability to condition the soil and its influence on the environment has directed concern to other soil fertilization sources to increase corn production (Kumar et al., 2019). The use of organic fertilizer (compost) was one of the efforts that made to increase plant nutrient absorbency, so that the use of inorganic fertilizers can be done more efficiently. Wilujeng and Handayanto (2019) reported an increase in corn production with compost application of 20 tons per hectare. The use of compost was often constrained by a lot of needs so that it increased production costs significantly.

The biological source research that can improve the efficiency of the use of inorganic fertilizers and production costs was needed. Microorganisms were involved in various processes that affected the transformation of soil phosphorus and atmospheric nitrogen into forms that can be used for plant growth. There was some evidence that growth and increase in crop yields can be stimulated by plant growth-booster bacteria because of its ability to fix nitrogen, phosphate solubility, and production of plant growth hormones (Zaeim, et al., 2017). The researches with microbial inoculants and nutrients have showed that some inoculants can increase plant nutrient absorbency and thus increased the efficiency of using chemical fertilizers and manure (Adesemoye and Kloepper, 2009). So, fertilizer efficiency by utilizing microorganisms was one of the methods that can be taken to achieve this. One of the biological fertilizer products of the Ministry of Agriculture's Research and Development Institution was Agrimeth, which consisted of several bacteria, which were *Azotobacter vinelandi* (moored non-symbiotic N₂ and soil solvent P), *Azospirillum sp.* (moored non-symbiotic N₂ and phytohormone producer), *Bacillus cereus* (soil solvent P, anti-pathogenic compounds producer), *Bradyrhizobium sp.* (moored symbiotic N₂), and *Methylobacterium sp.* which also produced *phytohormone* (Afandi, 2013).

Although several researches on microbes' application as biological fertilizers to increase corn production had been performed, but analysis of farming business related to that matter has not been performed. This research aimed to determine the effect of one of the biological fertilizers, which was Agrimeth, on the seeds of various composite corns to the growth factors, the productivity of corn farming business in dry land, and the amount of income obtained.

RESEARCH METHODS

This research was conducted in Betung Village, Betung Sub-District, Banyuasin Regency South Sumatra. The corn varieties used were Bima 10, Bima 19, and Sukmaraga. Before planting, corn was coated with biological fertilizer containing a microbial consortium of *Azotobacter vinelandii*, *Azospirillum sp.*, *Bacillus cereus*, *Bradyrhizobium sp.*, and *Methylobacterium sp.* (in the Agrimeth brand packaging, produced by the Indonesian Study Center of Agricultural Land Resources, Ministry of Agriculture). The treatments applied were seed treatment with Agrimeth and without seed treatment.

The research was performed on dry land owned by farmers. The area of each plot per treatment was 20 m x 20 m. Each treatment was repeated 4 times. Seeds were planted by making a hole with sharp stick where one hole was one seed, with a spacing of 70 cm x 20 cm. Fertilization of corn plants with a dose of 350 kg / ha Urea, 200 kg / ha SP-36 and 100 kg / ha KCl. Fertilization was done twice, which were at the age of 1 week after planting (MST) with a dose of 150 kg urea, 200 kg SP-36 and 100 kg KCl / ha and at the age of 4 weeks after planting (MST) with a dose of 200 kg urea / ha, given by lining between corns plants. Agrimeth was given at a dose of 400 grams for 25 kg of seeds. Variables that observed were plant height, number of leaves, cob length and diameter, weight of 5 wet cobs, weight of 100 dry shelled grains, and dry shelled production, analyzed by t-test.

Analysis of corn farming business was done by calculating the value of revenue-cost ratio (R / C), breakeven point price and breakeven point production (Hendayana, 2016 and Suratiyah, 2009). Analysis of breakeven point price and breakeven point production was used to determine the price limit of each product sale price and the amount of product that must be produced so that the farming business did not loss. The farming expectation was that the actual production result was higher than the breakeven point production and the breakeven point price must be lower than the actual selling price.

$$R/C = \frac{TR}{TC}$$

Where;

R = Income

C = Cost

TR = Total income

TC = Total cost

If $R/C > 1$, farming business economically profitable

$R/C = 1$, farming business economically in breakeven point

$R/C < 1$, farming business economically experience loss

$$TIH = \frac{TC}{Y}$$

Where;

TIH = Breakeven point price

Y = Production

$$\text{TIP} = \frac{TC}{P}$$

Where;

TIP = Breakeven point production

P = Price

RESULTS AND DISCUSSION

The Plant Height and Number of Leaves

The research result showed that corn seeds treatment with Agrimeth can improve the height of the plant. There was a significance different on the plant height of Bima 10 and Bima 19 varieties, between seeds that got seed treatment with Agrimeth and seed that planted without seed treatment. Meanwhile in Sukmaraga variety, seeds that got seed treatment, were higher in growth than seeds without seed treatment, but the difference was not significance. (Table 1)

Table 1. Plant height and number of leaves of some composite corn varieties with and without Agrimeth biological fertilizers application

Variety	Plant Height		Number of Leaves	
	A	B	A	B
Bima 10	182,47 a	205,83 b	9,13 a	10,67 b
Bima 19	185,93 a	206,33 b	9,47 a	9,33 b
Sukmaraga	187,40 a	195,00 a	9,03 a	9,33 a

Information

A = without Agrimeth, B = with Agrimeth

Source: Processed from primary data (2019)

One of the microbes contained in Agrimeth was *Methylobacterium spp.*, which was capable of producing quite high gibberelline phytohormone. Gibberellins were promoters of seed germination and can activate hydrolysis enzymes (α -amylase) found in endosperm (Danial et al. 2014). Gibberellins were compounds consisted of a gibbane skeleton which had biological activities that affected physiological characters such as elongation, division, cell enlargement, and stimulation of flowering. Darusandi (2012). The allocation of gibberellins can increase cambium activity and xylem development so that growth activity goes smoothly and quickly. Irvan and Adriana (2017) reported that gibberellins significantly affected the height of fragrant pandan rice plants.

The other microbes contained in Agrimeth were assumed also have a role in plant height growth. Ambarsari et al. (2016) reported that *Azotobacter sp.* inoculation had a significant effect on the growth of *Shorgum bicolor*. Sadrood et al (2013) also reported that the application of biological fertilizers that contain *Azotobacter* and *Azospirillum* increased plant growth and yield, and reduced the use of chemical fertilizer doses.

Agrimeth application showed different effects on the number of leaves in various varieties of corn. In the Bima 10 variety, plants that were applied with seed treatment with Agrimeth had significantly different leaves than plants that were not applied with seed treatment with Agrimeth. Whereas in Bima 19 and Sukmaraga varieties; there was no significant difference in the number of leaves between the

plants that were applied to Agrimeth seed treatments and those that were not applied. Astuti and Purba (2017) reported that Agrimeth 200 g ha⁻¹ + Gliocompost biological fertilizer 20 kg ha⁻¹ + recommended fertilizer has a significant effect on plant growth, which were plant height, number of leaves, number of nodules, number of flowers, number of filled pods and soybean yield. The better growth of nodules, which caused the ability of the roots to absorb water and bind the nutrients N, P, and K through increasing soils colloidal to support the plant growth and development.

An increase in plant height and number of leaves were identical to an increase in dry weight of crop waste. An increase in plant height and number of leaves indicated an increase in plant nutrient absorbency. Plants that can absorb nutrients better will be able to produce higher production. The data in Table 1 and Table 3 showed that there was a similar pattern between the tendency to increase plant height, number of leaves, and dry shelled production due to seed treatment with Agrimeth. Kasno and Rostaman (2013) reported an increase in dry weight of crop waste and dry shelled weight in corn plants which were given various fertilization treatments compared to controls.

Cob length and diameter, weight of 100 dry shelled seeds, and production

The seed treatment with Agrimeth did not show any significant difference in the length of the cobs in the Bima 10, Bima 19, or Sukmaraga varieties, although they generally showed a longer trend. While in measuring the diameter of the cob, the treatment with Agrimeth showed significant differences in the Sukmaraga variety (Table 2).

Table 2. Cob length and diameter of some composite corn varieties with and without Agrimeth biological fertilizer application

Variety	Cob length		Cob diameter	
	A	B	A	B
Bima 10	18,00 a	19,03 a	45,53 a	42,67 a
Bima 19	16,79 a	15,93 a	42,73 a	43,33 a
Sukmaraga	16,79 a	18,50 a	45,00 a	47,67 b

Information

A = without Agrimeth, B = with Agrimeth

Source: Processed from primary data (2019)

The weight of the cob was related to the length and diameter of the cob. An increasing in the length and diameter of the cob tended to increase the weight of the sweet corn cobs (Meity et al., 2012). Nugroho et al. (1999) stated that the increase in the weight of cob on sweet corn plants was in line with the increased efficiency of the photosynthetic process and the rate of photosynthate translocation to the cob. The results showed that seed treatment with Agrimeth in general had no significant effect on increasing the length and diameter of corn cobs. Except for the Sukmaraga variety, where seed treatment with Agrimeth significantly affected the increase in cob diameter.

The seed treatment application generally showed a trend of increasing seed weight, although not significantly. A significant difference in the weight of 100 dried

Sack	360 Sht	720.000	720.000	720.000	720.000	720.000	720.000
Agrimeth	2 sch	-	225.000	-	225.000	-	225.000
Total		7.256.250	7.481.250	7.256.250	7.481.250	7.256.250	7.481.250

Information

A = without Agrimeth, B = with Agrimeth

Source: Processed from primary data (2019)

The amount of costs for Bima 10 production facilities without and with Agrimeth application were 44.32% and 44.15%, Bima 19 without and with Agrimeth application were 47.01% and 47.85%, while Sukmaraga without and with the Agrimeth application were 44.32% and 44.15% of the total production costs. The most needed production facility costs were fertilizer purchasing, which was around 67.83% of the production facility costs or around 31.16% of the total production costs. Costs required to buy corn seeds were small, which was around 16.33% of the cost of production facilities. While the costs required to purchase Agrimeth biological fertilizers were very small which only 3.33% of production facilities costs.

Table 5. Farming business labor costs of some composite corn varieties with and without Agrimeth biological fertilizer application

Description	Bima 10		Bima 19		Sukmaraga	
	A	B	A	B	A	B
Land	1.687.500	1.687.500	1.687.500	1.687.500	1.687.500	1.687.500
Cultivation	1.350.000	1.350.000	1.350.000	1.350.000	1.350.000	1.350.000
Planting	337.500	337.500	337.500	337.500	337.500	337.500
Weeding	1.181.250	1.181.250	1.181.250	1.181.250	1.181.250	1.181.250
Embellishment	450.000	450.000	450.000	450.000	450.000	450.000
Fertilization	675.000	675.000	675.000	675.000	675.000	675.000
Spraying	562.500	562.500	450.000	450.000	562.500	562.500
Harvesting	1.181.250	1.181.250	742.500	742.500	1.181.250	1.181.250
Shelling	787.500	787.500	495.000	495.000	787.500	787.500
Drying						
Total	8.212.500	8.212.500	7.368.750	7.368.750	8.212.500	8.212.500

Information

A = without Agrimeth, B = with Agrimeth

Source: Processed from primary data (2019)

Fertilizer was one of the major expenses in corn cultivation. Dermoredjo (2014) stated that the sequence of the main policy alternatives for corn commodities, both in Java and outside Java was the same, which were the provision of fertilizer subsidies, the provision of production facilities, technological innovation, and intensification of farming business, and land development and irrigation. Suryana and Agustian (2014) stated that productivity improvement was performed through the dissemination of inbred and hybrid superior seeds and the application of location-specific corn cultivation techniques. Meanwhile, the output price policy in the form of a base price had not been implemented since 1990.

The labor costs in this corn farming business were greater than the costs of production facilities. The labor needs included in land management, planting, weeding, embellishment, fertilizing, spraying, harvesting, shelling and drying. The biggest labor cost was on land management, which was around 20.68% of the cost

of labor. The need for planting costs was close to the cost of land cultivation, which was about 16.55% of the labor cost requirements. The amount of costs for Bima 10 labors without and with the Agrimeth application were 55.68% and 54.85%, Bima 19 without and with the Agrimeth application were 52.99% and 52.15%, while Sukmaraga without and with the Agrimeth application were 55.68% and 54.85% of the total production costs. Then the total production costs incurred for corn farming in this research were for Bima 10 without and with the application of Agrimeth was Rp. 15,468,750, - and Rp. 15,693,750, -, for Bima 19 without and with the Agrimeth application was Rp. 14,625,000 and Rp. 14,850,000. While the total production cost for Sukmaraga without and with the Agrimeth application was the same with Bima 10.

Table 6. Farming Business Analysis of some composite corn varieties with and without Agrimeth biological fertilizer application

Description	Bima 10		Bima 19		Sukmaraga	
	A	B	A	B	A	B
Dry shelled (kg/ha)	7.808	8.775	4.883	5.400	7.493	8.325
Income (Rp/ha)	39.040.500	43.875.000	24.415.000	27.000.000	37.465.000	41.625.000
Production cost (Rp/ha)	15.468.750	15.693.750	14.625.000	14.850.000	15.468.750	15.693.750
Profit (Rp/ha)	23.571.750	28.181.250	9.790.000	12.150.000	21.996.250	25.931.250
TIH (Rp/kg)	1.981	1.788	2,995	2.750	2.064	1.885
TIP (kg/ha)	3.094	3.139	2.925	2.970	3.094	3.139
R/C	2,52	2,79	1,67	1,82	2,42	2,65

Information

A = with Agrimeth, B = without Agrimeth

Source: Processed from primary data (2019)

Table 6 showed the analysis of corn farming business conducted in this research profitable to all the varieties tested. This was indicated by the R / C value greater than 1 in all varieties. The highest R / C was found in the Bima 10 variety (2.52 and 2.79), then Sukmaraga variety (2.42 and 2.65), and the lowest R / C was in the Bima 19 variety (1.67 and 1.82). This showed that, using Agrimeth with relatively small input values can increase the R / C value of corn farming.

From farming business, it was expected that the actual production obtained was higher than the TIP and the selling price of the product was higher than the TIH. The difference between the actual product and the breakeven point of production (TIP) determined the amount of the income value. The higher the actual product' gap with the TIP, so that the higher the income. From the business analysis conducted, the highest gap between the actual product and the TIP was the Bima 10 which was given Agrimeth, with a product gap of 5,636 kg/ha, proven by the highest value of income, which was 28,181,250 Rp/ha. The lowest gap between the actual product and the TIP was Bima 19 without Agrimeth, giving a product gap of only 1,958 kg/ha, as proven by the lowest value of income, which was only Rp 9,790,000 kg/ha.

The selling price of dry shelled corn was Rp 5,000/kg. The greater the gap between the breakeven point of price (TIH) and the actual selling price of the product, so that the greater the income. The selling price gap with the highest break-even

point of Rp 3,212/kg was shown by Bima 10 with Agrimeth, while the lowest Rp 2,005/kg was shown by Bima 19 without Agrimeth.

Table 6 showed that the application of Agrimeth in corn cultivation can increase productivity, increase farmers' income, which was also accompanied by an increase in R/C. Through intensification, efforts were made primarily by increasing population per unit area of planting, or optimize fertilization so it can increase productivity. The challenge in intensification was in the form of technological innovation, especially on marginal lands, where nutrients were poor, or nutrients were bound, so that nutrient absorbency by plants was not optimal. The use of compost to improve land conditions and roots was one method that can be used to increase production. Widodo and Kusuma (2018) reported that composting caused changed in soil physical character (aggregate stability, content weight, and soil pores) that affected the growth of corn. The result of correlation from soil physical character (aggregate stability, content weight, and soil pores) to the growth of plants showed a positive correlation.

The use of compost was often constrained by many needs, thus increasing input significantly. Wilujeng and Handayanto (2019) reported an increase in corn production with an application of 20 tons per hectare of compost. Agrimeth application (biological fertilizer) can be used to complement the innovations needed in the intensification of corn farming business by considering the benefits that received by farmers.

CONCLUSION

The application of Agrimeth biological fertilizers to corn plants showed an improved trend in plant height, number of leaves, cob length and diameter, and production in composite corn varieties of Bima 10, Bima 19, and Sukmaraga. The application of Agrimeth biological fertilizers increased corn farming business in dry land with R/C 2.79; 2.65; and 1.82 for each Bima 10, Sukmaraga and Bima 19 varieties.

RECOMMENDATION

To find out the efficiency of using inorganic fertilizers with the application of biological fertilizers, so that reduce the production costs of corn farming business, it was necessary to do more in-depth research by reducing the use of inorganic fertilizer doses used with the economies scale.

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