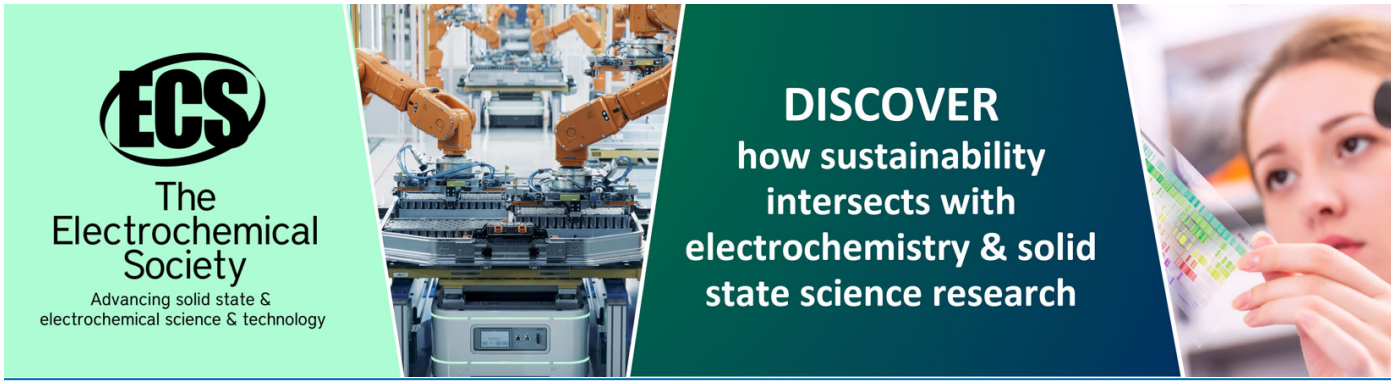
The agricultural sustainability in rainfed land through the application of largo super technology packages



The agricultural sustainability in rainfed land through the application of largo super technology packages

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Abstract. This research of largo super technology packages aimed to observe the effect of the complete and incomplete technology packages in rainfed land. This research was conducted in Desa Baru, Batang Kuis District, Deli Serdang Regency, North Sumatera from July to October 2019. The tested treatments were packages of A, B, C, D and farmer method (as comparison). The treatments were arranged according to a randomized block design with three replications on a 4x5 m^2 plot. From the results of this study, it can be concluded that the tested Largo Super technology packages have different effects. The more complete the components of the technology package provided, the higher the yields and the level of profit obtained. On the other hand, the less technology components provided, the lower the yields and the level of profit provided. On average, the application of direct seeding method with Jarwo planting system provided the higher yields and profit level than the farmer method that using the Tegel planting system. The increase in rice yields according to direct seeding method with the Jarwo planting system, because it is followed by an increase in the plant population.

1. Introduction

In order to maintain food security, the efforts that need to be conducted are : (1) control of agricultural land conversion, (2) creating new agricultural land (3) utilization of abandoned land and (4) intensification of agricultural system by implementing location-specific technology package that can improve productivity and at the same time maintain environmental quality [1].

National demand for rice every year continues to increase in line with the increase in population. To fulfill the demand for rice, the government is determined to continually increase National rice production by 5% per year and target to achieve 10 million tons of rice surplus in 2015 [2]. The efforts to achieve the rice surplus target must be carried out through intensification and extensification approaches. Currently, the efforts that have been made include accelerating planting, increasing planting area, building irrigation networks, providing production facilities such as agricultural machinery equipment and seeds of new superior varieties with high yield potential to farmers in various regions in Indonesia.

The efforts to fulfill National rice demand currently still expect from rice yields of rice fields, while the current problems of rice fields in various regions, especially in expansion or urban areas, have shifted their functions to other sectors. In North Sumatera, according to a report from the Department of Agriculture, it was estimated that the shrinkage of rice fields in 2015 could reach 1%. Based on the fixed figures of BPS – Statistics of North Sumatera Province (2015), the area of rice field (LBS) in 2014 reached 449,213 ha, compared to 2013 it decreased by 0.68% of the total land area of 452,295 ha. Land

conversion occurred in irrigated and non-irrigated rice fields, in Mandailing Natal Regency covering an area of 1,130 ha, Nias 1.726 ha, Langkat 927 ha, Karo 642 ha and Deli Serdang reaching an area of 200 ha. Increasing rice planting area currently needs to be developed on lands that have low productivity such as dry land or rainfed rice fields, which on average still carry out planting once a year. The use of dry land for rice farming has received less attention, most of them currently are still more interested in increasing rice production in irrigated rice fields. This is probably because there is an assumption that increasing rice production in irrigated rice fields is easier and more promising than rice in dry land which has a high risk of failure. The availability of rainfed rice fields in Indonesia is quite extensive and has the potential to be developed. The problem of rainfed rice fields is the availability of irrigation water that is not available, moreover it is constrained by the reaction of acid soil and certain nutrient deficiencies. According to [3], the improvement of land that has low productivity such as dry acid land or rainfed rice fields can be carried out through the application of amendments such as agricultural lime, organic fertilizers, balanced fertilizer application and planting appropriate varieties, and also harvesting groundwater or making dams. Through technologies that have been developed nowadays, rice productivity in rainfed rice fields has the potential to be increased to above 5 t/ha [4]. Largo Super technology is one of those that has the opportunity to be applied. This technology applies direct seeding method with jajar legowo (Jarwo) system that aims to increase the plant population and the variety used is the Inpago type which has drought-resistant properties. In addition, land fertility is improved by the application of amendments and the control of Plant Pest Organisms wisely and sustainably. The purpose of this activity was to observe the effect of the study of complete and incomplete technology packages on rainfed rice fields in North Sumatera.

2. Methods

The location of this activity was conducted in Desa Baru, Batang Kuis District, Deli Serdang Regency, North Sumatera on rainfed rice fields from July to October 2019. The tested treatment in the study of the largo super technology package was to compare the complete technology package with the incomplete package (Table 1). The treatments were arranged according to a Randomized Block Design (RBD) with three replications on a plot of 4x5 m^2. Observational data were analyzed statistically and continued with the significant difference analysis according to DMRT at 5% test level.

Table 1. The structure of the study of the Largo Super technology package in rainfed rice fields of Desa Baru, Batang Kuis District, Deli Serdang Regency, planting season in July 2019.

No	Technology Component Treatment	Package				
		A	B	C	D	Farmer
1	Jajar legowo 2:1 (25x50cm)	+	+	+	+	Tegel
2	Dolomite (kg/ha)	500	-	-	-	-
3	Guano fertilizer (kg/ha)	750	500	250	-	-
4	Bio-decomposer (3 kg/ha)	+	+	+	-	-
5	Bio-fertilizer (40 g/14 liters of water)	+	+	+	-	-
6	NPK(15:15:15)+Urea (300+200 kg/ha)	+	+	+	+	+
7	The control of Plant Pest Organisms according to the recommended dosage	+	+	+	+	+

Prior to treatment, the land was first cleaned from weeds by spraying with herbicides. Then treatment plot was made with a size of 4x5 m^2 with 3 replications. Furthermore, before processing, the land was sprayed with Bio-decomposer according to treatment at a dose of 3 kg/ha/400 liters of clean water, then the land was processed perfectly with a processing depth of 20-30 cm. Before planting, the land was spread with 500 kg/ha Dolomite lime according to the treatment and Guano organic fertilizer according to the dose and treatment. The land was planted with rice seeds of the IR.64 variety by using direct seeding method (without seedbed) according to planting system of jajar legowo (2:1) with plant row

spacing of 25 cm and the distance between lines of 50 cm. Bio-fertilizer (according to treatment) was applied at 7-10 DAP by spraying on plants with a dose of 1 sachet (40g)/spray tank (14 liters) of clean water. Plants were fertilized with 300 kg/ha of NPK fertilizer (15-15-15) and 200 kg/ha of Urea at 15 DAP in 1/2 dose and the rest at 30 DAP. For the control of pests and diseases when planting, 20 kg/ha Insecticide and fungicide were applied through planting seeds, then Fungicides and Insecticides were sprayed according to the recommended dose or according to the level of pest and disease attack in the field. The control of weeds was carried out at the age of 21 and 42 days after planting or adjusted to the level of weed growth in the field by spraying with selective herbicides and manually using a sickle or hoe. Harvest was adjusted to the age of the tested variety that was characterized by more than 90% yellowing of the grain, hardening and the moisture content of the grain in the range of 20-30%. Observations that were observed during the activity included: land characteristics, plant height at harvest, number of productive tillers/m2, panicle length, number of grain/panicle, percent of empty grain, 1000-grain weight, yields of harvest dry grain/ha and farming system analysis. Observational data were analyzed statistically and continued with significant difference analysis according to DMRT at the 5% test level.

3. Results and discussion

3.1 Land characteristics

Rice fields in Batang Kuis District in 2016 reached an area of 1.248 ha, all of them were rainfed rice fields (non-irrigated), Desa Baru had the widest rice field area in Batang Kuis District, 243 ha. In 2017 the area of rice fields in Batang Kuis District had changed to 1,032 ha [5]. There was a decrease in the standard area of rice fields due to the conversion of land functions to other sectors such as residential buildings.

Rainfed rice fields in Desa Baru are categorized as lowland area with an altitude between 4-30 m above sea level. The average rainfall is 211 mm/month and the number of rainy days with an average of 11-12 days. The cropping pattern is generally rice-blank-rice or planting rice twice a year. In the dry season, farmers use groundwater as a source of irrigation water through a pumping system. The nutrient status of rainfed rice fields in Desa Baru is on a scale of 1:10,000 according to [6] who reported that generally the soil C-organic, Nitrogen and Phosphorus levels are classified as low while Potassium is classified as moderate (Table 2).

Table 2. Map of nutrient status of rainfed rice fields in Desa Baru, Batang Kuis District, Deli Serdang Regency, planting season in 2018.

No	Chemical Properties	Land area (%)		
		Low	Medium	High
1	C-organic	68.13	2.07	29.80
2	N-total	49.97	16.73	33.30
3	P2O5-availability	100	-	-
4	K_2O-availability	6.27	93.73	-

According to the assessment of the nutrient status of the rice fields in Desa Baru, which are generally low except for potassium, to increase rice yields, it is necessary to carry out the balanced nutrient management according to soil nutrient conditions and plant needs. In addition, it is necessary to add organic fertilizer whether sourced from manure or the addition of natural phosphate fertilizers such as guano fertilizer.

3.2 Plant height

Plant height at harvest was affected by the tested package (Table 3). The tallest plant was seen in the treatment of package A namely 91.6 cm and this effect was not significantly different from the treatment

of packages B and C, while package D significantly produced the lowest plant height compared to other treatments.

The better plant growth by the application of package A compared to other packages is presumably due to the addition of dolomite lime. The addition of dolomite lime to the soil can improve the reaction of the soil from acidic to neutral (pH 7). According to [7], the better the soil reaction (close to neutral), plant growth will also be getting better because it is followed by an increase in the availability of nutrients in the soil and their absorption by plants. On the other hand, the application of package D significantly gave the lowest plant growth, it is presumed that the addition of NPK and Urea fertilizers alone did not provide an optimal plant growing environment. Whereas in packages A, B and C followed by the addition of guano fertilizer, biological fertilizer and bio-decomposer were seen to provide the plant growth that was significantly higher.

Table 3. Plant height at harvest on the application of the Largo Super technology packages on rainfed rice fields in Desa Baru, Batang Kuis District planting season in July 2019.

Technology Component Treatment	Package			
	A	B	C	D
Jajar legowo 2:1 (25x50cm)	+	+	+	+
Dolomite (kg/ha)	500	-	-	-
Guano fertilizer (kg/ha)	750	500	250	-
Bio-decomposer (3 kg/ha)	+	+	+	-
Bio-fertilizer (40 g/14 liters of water)	+	+	+	-
NPK(15.15.15)+Urea (300+200 kg/ha)	+	+	+	+
The control of Plant Pest Organisms according to the recommended dosage	+	+	+	+
Observation Parameter :				
Plant height (cm)	91.6 a	88.6 a	88.2 a	81.8 b

The numbers in the same line followed by the same letter are not significantly different according to DMRT at the 5% test level

The better effect of the application of packages A, B and C compared to package D on plant height, this is possibly due to the effect of the addition of bio-fertilizer containing nitrogen-fixing microbes and Phosphate solvents so that Nitrogen absorption by plants increases and plant growth becomes better. The results of the research by [8] reported that the application of bio-fertilizer containing *Azotobacter vinelandii*, *Bacillus cereus* dan *Bacillus megaterium* showed that it significantly increased Nitrogen absorption by plants by 142.42 % and plant dry weight up to 129.03% compared to no bio-fertilizer application.

3.3 Yield components and rice yields

The observed yield components were significantly influenced by the treatment of the tested technology package (Table 4). Package A provided the highest in the number of panicles, panicle length, number of grain/panicle, weight of 1,000 grains and the yields, on the other hand produced the lowest percentage of empty grain.

The better effect of package A compared to other packages on the yield components and the yields obtained is very possible, because the treatment of package A is given more complete production inputs (dolomitic lime, guano fertilizer, bio-fertilizer, bio-decomposer, NPK fertilizer and urea) with more optimal doses, while the other packages for the types of components of the Largo Super technology and their numbers are decreasing.

When viewed from each tested package, it appears that with the increase in the amount of guano fertilizer application, the obtained grain yields also increase. The highest grain yield of 7.80 t/ha was obtained by the application of guano fertilizer by 750 kg/ha (Package A), then 7.03 t/ha in the application of 500 kg/ha (Package B) and 6.50 t/ha in the application of 250 kg/ha (Package C) and the lowest yield

was 5.05 t/ha without the application of guano fertilizer (Package D). The response to the effect of Guano fertilizer application on the tested land is very possible because the tested land contains low P-availability [6].

An increase in yields is in line with the increase in the dose of Guano fertilizer, this is very possible because the guano fertilizer used contains P_2O_5 of approximately 22% and this nutrient is very instrumental in stimulating root growth, accelerating flowering, mature grain, and grain yields. While the experimental soil used contains P_2O_5 which is classified as low so that the application of guano fertilizer in this study provides a very good response to the increase of yield components and crop yields. According to [9], if the availability of certain nutrients is below the critical limit or low value, so these nutrients can be a limiting factor in plant growth, but if fertilizers containing these limiting nutrients are applied, they will show a very good response. On the other hand, if there has been an accumulation of certain nutrients in the soil, the plant will no longer show a response to fertilization. The results of the research by [10] reported that the application of guano fertilizer on ex-mining land could increase the NPK content in the soil. Furthermore, the results of research by [11] reported that with the increase in the NPK nutrient content in the soil, the application of fertilizers will be positively correlated with the nutrient absorption by plants and also with the yield components and the obtained grain yields.

Table 4. Yield components and rice yields on the application of Largo Super technology in rainfed rice fields of Desa Baru, Batang Kuis District planting season in July 2019.

Treatment of Technology Components	Package			
	A	B	C	D
Jajar legowo 2:1 (25x50cm)	+	+	+	+
Dolomite (kg/ha)	500	-	-	-
Guano fertilizer (kg/ha)	750	500	250	-
Bio-decomposer (3 kg/ha)	+	+	+	-
Bio-fertilizer (40 g/14 liters of water)	+	+	+	-
NPK(15:15:15)+Urea (300+200 kg/ha)	+	+	+	+
The control of Plant Pest Organisms according to the recommended dosage	+	+	+	+
Observation Parameter :				
Number of panicles/m^2 (stems)	293.3 a	262.0 ab	236.7 bc	209.7 c
Panicle length (cm)	24.7 a	23.9 b	23.6 b	23.0 b
Number of grain/panicle (grain)	132.2 a	128.6 ab	125.6 b	119.0 c
1000-grain weight (g)	26.19 a	25.27 b	24.8 bc	24.31 c
Empty grain (%)	7.11 c	7.15 c	8.92 b	10.59 a
Yield (t/ha) of harvested dry grain	7.80 a	7.03 ab	6.50 b	5.05 c

The numbers in the same line followed by the same letter are not significantly different according to DMRT at the 5% test level

Package D with the lowest yield of 5.05 t/ha was the only application of inorganic fertilizer without the addition of Largo Super technology components (dolomitic lime, guano fertilizer, bio-fertilizer and bio-decomposer) like the treatment in packages A, B and C which significantly increased yields (Package A is superior to B, C and D). From the result data of this study, it can be concluded that the only application of artificial fertilizers (inorganic) to the soil will not produce optimal rice yields, but if followed by the addition of organic fertilizers, bio-decomposers and bio-fertilizers, rice yields can become more optimal or increase significantly. Furthermore, the results of research by [12] proved in various locations of rice fields in North Sumatera that with the application of inorganic fertilizer (NPK + Urea) based on the PUTS recommendation test and followed by the addition of cow manure at 1 t/ha, bio-fertilizer and bio-decomposer at 2 kg/ha, the rice yields obtained were significantly increased by 25 - 42.67% compared to the farmer method that only used inorganic fertilizers. However, if the application of bio-decomposer was increased to 3 kg/ha, rice yields increased to 61.54%.

The increase in rice yields by increasing dosage of the use of bio-decomposer is presumed that the activity of bacteria which decompose organic material contained in bio-decomposer is more active in breaking down organic material from biomass, so that the availability of organic material is also increasing. [13] stated that with the increasing level of soil organic material, the absorption of nutrients by plants will be better and the use of inorganic fertilizer can be more efficient. The increase in nutrient absorption by plants will also increase the yields [14].

3.4 Farming system analysis

The tested packages gave different profit levels, the highest profit was obtained from package A followed by packages B, C, D and the smallest profit was according to the farmer method (Table 5). The high level of profit provided in this study is also followed by high production costs incurred. However, for the value of b/c ratio that compares the profit level with the production costs incurred, package B seems to provide the highest value of b/c ratio compared to other packages. The high value of the b/c ratio of package B compared to package A illustrates that the addition of production costs in package A for the purchase of 500 kg of dolomite lime, 250 kg of additional guano fertilizer and the application cost of dolomite lime of IDR 300,000,- in this study is irrational.

Table 5. Analysis of rice farming on the provision of several Largo Super technology packages and farmer method in rainfed rice fields in Desa Baru, Batang Kuis District, Deli Serdang Regency planting season in July 2019.

Production Components	Technology Packages				
	A	B	C	D	Farmer
Production Facilities (Saprodi) :					
Rice Seeds (IDR.10,000/kg)	750,000	750,000	750,000	750,000	300,000
Dolomite (IDR 500/kg)	250,000	-	-	-	-
Guano (IDR 1,500/kg)	1,125,000	750,000	375,000	-	-
Bio-decomposer (IDR75,000/kg)	225,000	225,000	225,000	-	-
Bio-fertilizer (IDR15,000/sachet)	300,000	300,000	300,000	-	-
NPK Phonska (IDR 2,700/kg)	810,000	810,000	810,000	810,000	810,000
Urea (IDR 2,000/kg)	400,000	400,000	400,000	400,000	400,000
Pesticide (IDR 250,000/liter)	750,000	750,000	750,000	750,000	750,000
Daily Wages :					
Land cultivation fee/ha	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000
Application of bio-decomposer (IDR 75,000/person)	150,000	150,000	150,000	-	-
Application of dolomite (IDR75,000/person)	300,000	-	-	-	-
Application of guano (IDR75,000/person)	300,000	300,000	300,000	-	-
Spraying pests (IDR75,000/person)	600,000	600,000	600,000	600,000	600,000
Fertilizer application (IDR75,000/person)	300,000	300,000	300,000	300,000	300,000

Production Components	Technology Packages				
	A	B	C	D	Farmer
Spraying pests (IDR75,000/person)	600,000	600,000	600,000	600,000	600,000
Afternoon wages (IDR75,000/person)	600,000	600,000	600,000	600,000	600,000
Harvest (yields/25*3)*IDR4,500)	4,212,000	3,796,200	3,510,000	2,770,200	2,160,000
Total cost (Rp)	13,072,000	11,731,200	11,070,000	8,830,200	8,070,000
Yields (kg/ha) of harvested dry grain	7,800	7,030	6,500	5,050	4,000
Income (Yields*IDR4,500)	35,100,000	31,635,000	29,250,000	22,725,000	18,000,000
Profit (IDR)	22,028,000	19,903,800	18,180,000	13,894,800	9,930,000
b/c ratio	1.69	1.70	1.64	1.57	1.23

The application of the Largo Super technology packages, complete or incomplete, in this study showed having great influence on the level of profit obtained. The more complete the package, the higher the profit level, on the contrary, the profit level decreases in line with the incomplete application of the technology package. The effect of the application of the tested package in this study reflects that the plant is very responsive to the treatment. According to [13], if the plant is very responsive to the application of fertilizers or other amendments, it shows that the soil used contains very low essential nutrients. This opinion is supported by the results of soil tests on nutrient mapping in rainfed rice fields in Desa Baru, Batang Kuis District in 2018 by [14], where the average nutrient content of C-organic, N-total and P-availability is classified as low except the interchangeable K is classified as medium.

Package D was given the same treatment as the Farmer method, but the only difference was the way of planting. Farmers applied the Tegel planting system through the seedbed first, while the treatment of package D applied direct seeding method or without the seedbed with Jarwo planting system. The results of this study showed that direct seeding method with Jarwo planting system (Package D) even though it required more rice seeds (75 kg) than the Farmer method (30 kg) but provided a higher profit level of IDR 3,964,800,- compared to the Farmer method. The increase in profit by direct seeding method with the Jarwo planting system was due to the increase in yields. The increase in yields was presumably due to the increase in plant population. According to [15] stated that with the increase in plant population, the provided yields will also increase quadratically, on the contrary, with a decrease in plant population, the yields will be less.

4. Conclusion

From the results of this study, it can be concluded that the Largo Super technology packages that were tested on rainfed rice fields in Desa Baru, Batang Kuis District, gave different effects. The more complete the components of the technology package provided, the higher the yields and the level of profit obtained. On the contrary, the less technology components provided, the lower the yields and the level of profit provided.

Package A produced the highest yields and profit level with the b/c ratio of 1.69 whereas package D provided the lowest yields and profit level with the b/c ratio of 1.57 However, when compared to the farmer method (the Tegel planting system), Package D (direct seeding method with the Jarwo planting system) was still better in obtaining yields and profit level. On average, the application of direct seeding method with Jarwo planting system provided the higher yields and profit level than the farmer method that using the Tegel planting system. The increase in rice yields according to direct seeding method with the Jarwo planting system, because it is followed by an increase in the plant population.

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