

# The Effectiveness of Organic Method for Increasing the Productivity of Oil Palm That Is Infected by Ganoderma

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Received: February 4, 2020

Accepted: March 5, 2020

Online Published: April 15, 2020

doi:10.5539/jas.v12n5p180

URL: <https://doi.org/10.5539/jas.v12n5p180>

## Abstract

The usage of organic fertilizer is expected to help developing organic plantation so that it can produce organic CPO and other organic derivate. Our study used organic fertilizer SUPER MOAF (Multi Organic Alkali Fertilizer), biopesticide and biofungiside CHIPS (Colony Highly Invasive Protection System) that is manufactured by PT. Propadu Konair Tarahubun. We conducted this study in 7 different plantation: Kecamatan Langgam, Riau block K and L with the plantation year of 2011; Kecamatan Bila Hilir, North Sumatra block DO and CO with the plantation year of 2011; Kecamatan Langgam, Riau block J and I with the plantation year of 2010; Kecamatan Long Ikliis, East Kalimantan block 26 and 27 with the plantation year in 2002; Kecamatan Sei Kijang, Riau block M12 and N12 with the plantation year of 2005; Kecamatan Langgam, Riau block F and H with the plantation year of 2009; Kecamatan Teluk Dalam, North Sumatra block R and M with the plantation year of 2006. All plantation is given the same treatment: nonorganic fertilizer in control block (L, CO, I, 27, N12, H, and M) and switching from using Non-organic fertilizer to MOAF organic fertilizer in experiment block (K, DO, J, 26, M12, F, and R), this study is conducted for 4-5 years (2014-2018). The switching from nonorganic fertilizer to organic fertilizer is done in 2015, except for the oil palm that the plantation year is in 2011 is done in 2016. After switching from Non-organic to organic fertilizer, in the experiment blocks, show increasing of production (26.47%-88.33%) per Ha meanwhile the control block show increasing of production (4.21%-38.76%) per Ha. Fertilizer is given to the tree that has infected by disease, damaged, and have to be replanted because of Ganoderma invasion. Using MOAF organic method can also increase the production approximately 64.34%-110.77% from PPKS production standard in palm oil that has been infected by Ganoderma. Using MOAF fertilizer, biopesticide, and biofungiside CHIPS are not only recovering the palm oil that is expected to collapse soon because of Ganoderma infection but also maximize the production that is similar to healthy palm oil. Organic method is an efficient and effective way to help increasing the production of palm oil and environmental sustainability even in Ganoderma infection condition.

**Keywords:** oil palm, organic method, organic fertilizer, Ganoderma

## 1. Introduction

Oil Palm (*Elaeis guineensis* Jacq.) is one of plant in Indonesia that has a good prospect. Orginally from North Sumatra and Nanggroe Aceh Darussalam, oil palm has spread widely through many regions in Indonesia including Riau, Jambi, South Sumatera, Bengkulu, Lampung, West Java, West Kalimantan, Central Kalimantan, Sulawesi, and Papua (Sunarko, 2012). With 75% of plantation company and CPO production is in Sumatera and Kalimantan (Anonymous, 2014). Oil palm plantation in Indonesia has grown rapidly and since 1939, Indonesia has been the largest producer and exporter in the world (Prayitno et al., 2008), serving half of the world commodities (FAOSTAT, 2015) and producing 80% of global production together with Malaysia (Pittman, 2013). Palm oil production is use in food industry, chemical industry, and a substitute for fuel. Indonesia is the largest producer of oil palm. (Dirjenbun, 2015), with plantation area of 12,307,677 ha in 2017 and palm oil production that reach 35,359,394 ton/year and carnel oil production of 7,071,877 ton/year (Dirjebun, 2018).

The main obstacle in oil palm plantation in Indonesia is the low productivity and the quality of oil palm (Dirjenbun, 2014). The expansion of the plantation area often do not compensate with the productivity, one of the reason is the soil condition that is not compatible of using nonorganic fertilizer. Recently, Ministry of Agriculture has started to direct an environment friendly plantation concept (Gingold, 2012). The other obstacles

in increasing oil palm production is the disease that infected the stem root (*Ganoderma boninense*) (Susanto, 2002). This infection can directly cause the loss of palm oil production and lower the weight of fresh fruit bunches (Susanto, 2005).

Maintenance is one of the most important factor to high productivity and fertilizer play important role in it. Fertilization given has to ensure the vegetative and generative growth to be normal so that production of fresh fruit bunches (FFB) is optimal and high quality and quantity of palm oil can be produced (Adiwiguna, 2007). Organic fertilizer has the benefit such as environment friendly, abundant nutrient content, and make good impact in growth and the productivity of oil palm (Mawardi et al., 2012). Fertilization effectiveness is directly link to the amount of nutrient that can be absorbed and fertilization is considered effective if it increases production (Tarigan, 2013). Thus, the aim of the research is to make known of the effectiveness of organic method in increasing production and the ability of organic method to help the survival of oil palm while infected by *Ganoderma*.

## 2. Material and Method

### 2.1 Materials

This study is conducted in 14 block of area of 7 different oil palm plantation that located in multiple regions in Indonesia with the area total of 33.93 Ha and block L (control) with the area of 31.95 ha located in Kecamatan Langgam, Riau, plantation year of 2011, using DxP Malaysia seeds. Block DO with 34.32 Ha and block CO (control) with 38.29 Ha located at Kecamatan Bila Hilir, North Sumatra, plantation year of 2011, using DxP Sucfindo seeds. Block J with 43.66 Ha and Block I (control) with 40.53 Ha located at Kec. Langgam, Riau, plantation year of 2010, using DxP Malaysia seeds. Block 26 with 43.76 Ha and Block 27 (control) with 44 Ha located at Kecamatan Long Iklis, East Kalimantan, plantation year of 2002, using DxP PPKS seeds. Block M12 with 22.65 Ha and block N12 (control) with plantation year 22.07 Ha located in Kec. Sei Kijang, Riau, plantation year 2005, using DxP Marihat seeds. Block F with 21.20 Ha and block H (control) with 27.11 Ha located in Kec. Langgam, Riau, plantation year 2009, using DxP Malaysia seeds. Block R with 35 Ha and block M (control) with 34.9 Ha located at Kec. Teluk Dalam, North Sumatra, plantation year 2006, using DxP Marihat Seeds.

### 2.2 Fertilization, Dosage, and Type of Nonorganic Fertilizer and Chemical Pesticide (Control Block)

Nonorganic fertilizer given in each control block is made of the combination of different type of nonorganic fertilizer and dosages. Fertilization in done twice per year, the first fertilization is done in early rainy season between September to November and the second fertilization is done in the end of rainy season between March to April.

Table 1. Type of nonorganic fertilizer used in each plantation

No	Location	Fertilizer Type	Dosage (Kg/Tree/year)
1	Kec. Langgam, Riau	Urea	3.80
		Rock Phosphate	1.58
		KCL/MOP	3.75
		Kieserit	0.33
		Boron	0.08
2	Kec. Bila Hilir, Sumatra Utara	Urea	2.75
		KCL/MOP	2.75
		Borate	0.20
		Rock Phosphate	2.00
		kieserit	1.75
3	Kec. Langgam, Riau	Ostindo	1.00
		Urea	2.50
		Rock Phosphate	1.50
		KCL/MOP	3.00
		Dolomit	1.50
4	Kec. Long Ikliis, Kalimantan Timur	CuSO <sub>4</sub>	0.02
		Fe	0.02
		NPK Hi-Grade	5.00
		Dolomit	4.00
		Urea	2.50
5	Kec. Sei kijang, Riau	Dolomit	3.00
		NPK Hi-Kay	6.50
		Juhar	2.00
		Urea	2.00
6	Kec. Langgam, Riau	Rock Phosphate	2.50
		KCL/MOP	2.50
		Kieserit	1.00
		Borax	0.075
7	Kec. Teluk Dalam, Sumatra Utara	Urea	3.50
		KCL/MOP	2.75
		Dolomit	3.25
		Rock Phosphate	1.50
		Borax	0.05

### 2.3 Dosage, and Type of Organic Fertilizer, Biopesticide, and Biofungicide CHIPS (Control Block)

MOAF organic fertilizer, biopesticide, and biofungicide CHIPS is using the same dosages, type of fertilizer, and biopesticide in each area. Fertilization is done once per year.

Table 2. Organic fertilizer and Biofungicide used in each plantation

No	Fertilizer Type	Dosage (Kg/Tree/Year)	Biopesticide and Biofungicide Type	Dosage (Kg/Tree/Year)
1	Super MOAF 1	2.00		
2	Super MOAF 2	2.00	CHIPS 2.1	3.00
3	Super MOAF 3+	2.00		

### 2.4 Switching From Nonorganic Fertilizer to Organic Fertilizer

Switching from nonorganic to organic fertilizer MOAF is to measure the increase in the production using organic method. The switching is done from 2015 to 2018 for oil palm plantation with the plantation year of 2011, as for oil palm with the plantation year of 2002, 2005, 2006, 2009, and 2010 is done from 2014 to 2018. Switching to organic fertilizer MOAF is not done simultaneously because of the difference of plantation year of the oil palm that is used in this study. Moreover, oil palm starts to produce from the third year, so switching to organic fertilizer MOAF is done in 2015 to clearly see the changes in production.

### 2.5 Data Analysis Method

Data of fresh fruit bunches production is being collected every year. Then, data is analyzed using T dependent test.

### 3. Result and Discussion

After application of MOAF organic fertilizer in the block that previously used nonorganic fertilizer, show increasing in productivity compared to the block that continue using nonorganic fertilizer. Study is done in oil palm, plantation year 2011, using organic fertilizer MOAF from 2015 to 2018, meanwhile oil palm with plantation years 2002, 2005, 2006, 2009, and 2010, using organic fertilizer MOAF from 2014 to 2018. Fertilization during production period is to fulfill nutrient need so that production of fresh fruit bunches is optimal and increase immunity to pest and disease. Four significant steps in fertilization are right amount or dosage, right time, and right way of applying fertilizer. Choosing type of fertilizer and dosages given have to consider several factors such as: leaf analysis, age of the plant, physical condition, soil, climate, cost, and production target (Sunarko, 2012).

Table 3. Fresh Fruit Bunches Production from 2014-2018

No	Location	Block	Luas (Ha)	Plantation year	Seeds Type	FFB (Kg/Ha/Year)				
						2014	2015	2016	2017	2018
1	Kec. Langgam, Riau	K	33.93	2011	DxP Malaysia	-	6.803	12.812	15.130	21.858
		L (K*)	31.95			-	8.145	9.397	12.873	16.921
2	Kec. Bila Hilir, Sumatra Utara	DO	34.31	2011	DxP Sucfindo	-	8.384	14.928	20.393	25.478
		CO (K*)	38.29			-	6.668	9.319	14.638	21.236
3	Kec. Langgam, Riau	J	43.66	2010	DxP Malaysia	6.400	10.304	13.941	19.798	24.450
		I (K*)	40.53			6.240	8.085	9.520	12.100	13.475
4	Kec. Long Iklis, Kalimantan Timur	26	43.76	2002	DxP PPKS	15.833	20.067	21.250	22.150	23.100
		27 (K*)	44.00			16.206	17.545	18.933	19.000	19.390
5	Kec. Sei Kijang, Riau	M12	22.65	2005	DxP Marihat	14.768	19.099	20.272	21.323	23.400
		N12 (K*)	22.07			16.870	17.580	17.741	18.700	20.820
6	Kec. Langgam, Riau	F	21.20	2009	DxP Malaysia	8.120	14.091	19.024	21.107	23.233
		H (K*)	27.11			9.894	13.658	16.101	17.305	18.742
7	Kec. Teluk Dalam, Sumatra Utara	R	35	2006	DxP Marihat	11.700	19.500	20.650	22.112	23.900
		M (K*)	34.90			12.600	15.500	17.230	18.417	20.298

*Note.* K\* = Control Block; Study that is done in oil palm that is infected by Ganoderma; Oil palm with plantation year 2011, study is done in 2015; Control block: 2015-2018, using nonorganic fertilizer; Experiment block: 2015, using nonorganic fertilizer and 2016-2018, using MOAF fertilizer; Oil palm with plantation year 2002, 2005, 2006, 2009, and 2010, study started from 2014; Control block: 2014-2018, using nonorganic fertilizer; Experiment block: 2014, using nonorganic fertilizer, and 2015-2018 using MOAF fertilizer.

After root analysis, size and shape of the fertilizer is adjusted so that it is easier to be absorbed. Dosage that is given is lower than the one in nonorganic fertilizer. Organic fertilizer MOAF is environment friendly because it does not cause chemical reaction that can damage soil, plant, and flora normal, moreover, it does not contain harmful chemical substances, prolong plantation age, and increase production of oil palm.

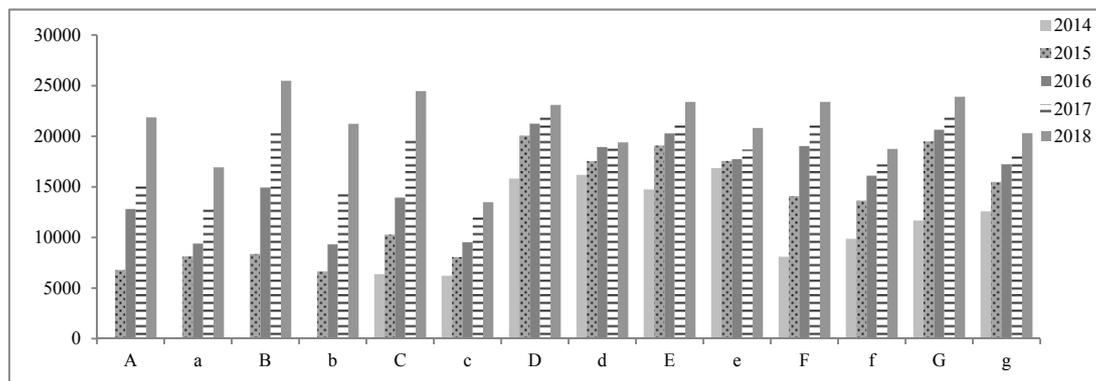


Figure 1. FFB production: Aa = block K and L in i Kec. Langgam, Riau; Bb = block DO and CO in Kec. Bila Hilir, North Sumatra; Cc = block J and I in Kec. Langgam, Riau; Dd = block 26 and 27 in Kec. Long Ikliis, East Kalimantan; Ee = block M12 and N12 in Kec. Sei Kijang, Riau; Ff = block F and H in Kec. Langgam, Riau; Gg = block R and M in Kec. Teluk Dalam, North Sumatra

Application of nonorganic fertilizer and organic Fertilizer MOAF has a different impact in oil palm productivity. With organic fertilizer MOAF, during the study, show differences in production to more than 5000 kg/ha/year compared to nonorganic fertilizer with the same area and plantation year. The significant differences in the production is because using organic fertilizer can increase nutrient originally from soil that directly link to C-organic contents in the organic fertilizer so adequate nutrient can be absorbed by the plant. Usage of organic material is one the way to increase the oil palm production. Moreover, organic material can neutralize organic acid that is toxic, increasing pH, maintaining growth, and increasing the production of oil palm (Mawardi et al., 1999). Moreover, high N elemental content show influences in increasing the amount of leaves so that photosynthesis is optimal (Elisabeth et al., 2014). Pahan (2008) stated that good fertilizer must have main nutrient content, additional nutrient, how the fertilizer react with soil, and fertilizer sensitivity to weather. MOAF fertilizer has a criteria to be a good organic fertilizer. According to FAO (1994) criteria of an organic fertilizer are:

- Minimum N content: 1-4%
- Minimum P content: 1.5-3%
- Minimum K content: 1.00-1.5%
- Total organic must at least 20% or more
- C/N ratio: 10:1 to 15:1
- pH: 6.5 to 7.5
- Odorless
- Do not contain non-biodegradable substances such as glass, metal
- Color: varies
- Texture: varies
- Pathogen-free

Main purpose of fertilization is to ensure optimal nutrient to support the growth of the plant so increasing in the production can be obtained. Efficient way of fertilization is that to give the exact size and dosage of fertilizer, the right way, and in the right time according to the need and the growth spurt of the plants (Tarigan, 2013). In this case, organic fertilizer MOAF have Smart Response technology, which it is prepared to cooperate with the roots and easily absorbed by the root, moreover, this technology can actively response to the need of the plants do that it can control the nutrient released. Auto Adapt Release technology, where nutrient released is based on weather-control, so at the drought season, nutrition can be released optimal and during rainy season, nutrition is not over released (Wigena, 2009).

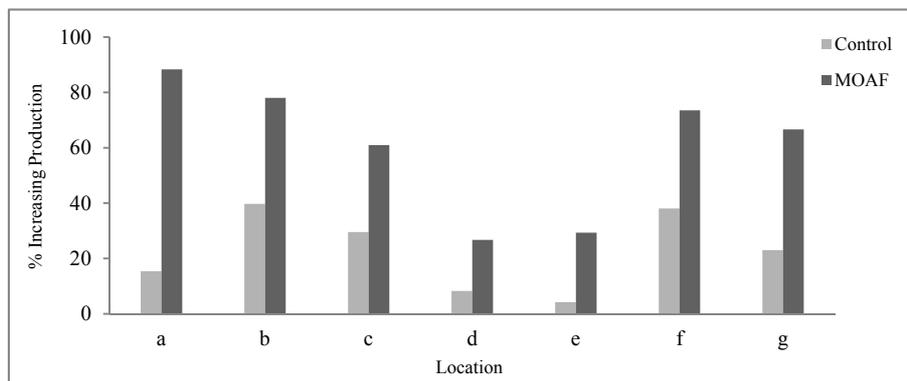


Figure 2. Comparison of productivity after switching to organic fertilizer MOAF with control block: a = Kec. Langgam, Riau block K and L, b = Kec. Bila Hilir, North Sumatra, block DO and CO, c = Kec. Langgam, Riau block J and I, d = Kec. Long Iklis, East Kalimantan block 26 and 27, e = Kec. Sei Kijang, Riau block M12 and N12, f = Kec. Langgam, Riau block F and H, g = Kec. Teluk Dalam, North Sumatra block R and M

After switching to organic fertilizer, show increasing in production to 88.3%. The breakdown of every area was: Kec. Langgam, Riau in 2016 block K was 88.33% while in block L was 15.37%; Kec. Bila Hilir, North Sumatra in 2016 blok Do was 78.05% while in block CO was only 39.76%; Kec. Langgam, Riau in 2015 block J was 61.00% while in block I was only 29.57%; Kec. Long Iklis, East Kalimantan in 2015 block 26 was 26.74% while in block 27 was only 8.26%; Kec. Sei Kijang, Riau in 2015 block M12 was 29.33% while in block N12 was only 4.21%; Kec. Langgam, Riau in 2015 block F was 73.53% while in block H was only 38.04%; Kec. Teluk Dalam, North Sumatra in 2015 block R was 66.67% while in block M was only 23.02%. Increasing in production in each area were significantly high, it showed that organic fertilizer MOAF can maximize the productivity of palm oil although the condition itself is not that good. According to Winarna (2009), one of the ways to increase effectiveness and efficiency is to continue fertilization and accurate choices of fertilizer type and dosage such as organic fertilizer is to be made (Wigena, 2009). Accurate fertilization can ensure the sufficient and the balance in oil palm nutrient so that it can produce optimal fresh fruit bunches and good quality of oil. Organic material can repair the physical, chemical, and biological of soil, moreover it can increase the capacity of water, cation exchange capacity, porosity, pH, and it can help to trigger the growth of microorganism in soil (Leszczynska & Malina, 2011).

The highest increasing productivity was found in palm oil with plantation year of 2011 in Kec. langgam, Riau: block K has increasing productivity that reaches 88.33% and in Kec. Bila Hilir, North Sumatra block DO has increasing productivity that reach 78.05%. Meanwhile, the lowest increasing productivity was found in palm oil with plantation year of 2002 in Kec. Long Iklis, East Kalimantan, block 26 (26.74%), palm oil with plantation year of 2005, and in Kec. Sei Kijang, Riau block M12 (29.33%). However, increasing in production is still higher than the area that uses nonorganic fertilizer, in Kec. Long Iklis, East Kalimantan, block 27 (8.28%) and in Kec. Sei Kijang, Riau, block N12 (4.21%). In order to reach such high productivity, nutrient such as N, P, K, Mg, and B are needed in most soil (Ng, 1997). Deficiency of this nutrient can lower the production (Woittiez et al., 2017), but nutrient criteria and end production depend on the type of soils (Goh, 2005) and plants necessity (Ollivier et al., 2017).

Low increasing productivity in Kec. Long Iklis, East Kalimantan and Kec. Sei Kijang, Riau was caused by soil saturation that is linked to nonorganic fertilizer that has been given for years. Novizan (2001) stated that if nonorganic fertilizer is given continuously, it will have impact in soil fertility because it can damage soil structure, lower the soil pH, disrupt natural organism, and the water quality on the surface. Specifically, soil play important role in the growth of the plants (Greenland & Szaboles, 1994). The main reason how nonorganic fertilizer can damage the soil is the nutrient that is wasted because overdosage of nonorganic fertilizer in given.

According to World Bank (2020), Indonesia plans to double the CPO production to 40 million ton per year and will expand 4 million hectare for plantation area. Expanding the plantation area will have impact in the forest area in Indonesia, it will takeover the primary forest to be palm oil plantation. Organic fertilizer can increase the productivity so it can reach productivity target, preserve soil, and palm oil so it can produce for long time, moreover, it can increase productivity without expanding plantation area so primary forest can still be preserved and ecosystem sustainability can be maintained.

Table 4. Nonorganic Fertilizer Price list

No	Location	Fertilizer	Dosage (Kg/Tree/Year)	Price (Rp/Kg)	Fertilizer Costs (Rp)	Total Price (Rp)
1	Kec. Langgam, Riau Block K & L	Urea	3.80	5.400	20.520	52.335
		Rock Phosphate	1.58	3.000	4.740	
		KCL/MOP	3.75	6.700	25.125	
		Kieserit	0.33	3.000	990	
		Boron	0.08	12.000	960	
2	Kec. Bila Hilir, North Sumatra Block DO & CO	Urea	2.75	5.400	14.850	55.650
		KCL/MOP	2.75	5.600	15.400	
		Borate	0.20	13.000	2.600	
		Rock Phosphate	2.00	3.500	7.000	
		Kieserit	1.75	2.600	4.550	
3	Kec. Langgam, Riau Block J & I	Ostindo	1.00	11.250	11.250	52.680
		Urea	2.50	5.400	13.500	
		Rock Phosphate	1.50	7.000	10.500	
		KCL/MOP	3.00	8.000	24.000	
		Dolomit	1.50	2.800	4.200	
4	Kec. Long Iklis, East Kalimantan Block 26 & 27	CuSO <sub>4</sub>	0.02	12.000	240	47.200
		Fe	0.02	12.000	240	
		NPK Hi-Grade	5.00	8.000	40.000	
5	Kec. Sei Kijang, Riau Block M12 & N12	Dolomit	4.00	1.800	7.200	69.900
		Urea	2.50	5.400	13.500	
		NPK Hi-Kay	7.50	5.200	39.000	
6	Kec. Langgam, Riau Block F & H	Juhar	2.00	4.500	9.000	46.750
		Urea	2.00	5.400	10.800	
		Rock Phosphate	2.50	3.500	8.750	
		KCL/MOP	2.50	8.700	21.750	
		Kieserit	1.00	4.100	4.100	
7	Kec. Teluk Dalam, North Sumatra Block R & M	Borax	0.075	18.000	1.350	52.575
		Urea	3.50	5.400	18.900	
		KCL/MOP	2.75	6.700	18.425	
		Dolomit	3.25	2.800	9.100	
		Rock Phosphate	1.50	3.500	5.250	

Table 5. Organic Fertilizer Price list

No	Location	Fertilizer (Kg/Tree/Year)	Dosage (Kg/Tree/Year)	Price (Rp/Kg)	Fertilizer Costs (Rp)	Total Price (Rp)
1	All Research Fields	Super MOAF <sup>®</sup> 1	2.00	7.200	14.400	44.200
		Super MOAF <sup>®</sup> 2	2.00	7.200	14.400	
		Super MOAF <sup>®</sup> 3+	2.00	7.700	15.400	

Inspite of damaging soil, nonorganic fertilizer need higher cost than organic fertilizer MOAF, the higher cost of the fertilizer, automatically increase the maintenance cost of the plantation, because 40-60% of the total cost is for fertilizer while 24% of total cost is for plant maintenance (Adiwiganda, 2007). Nonorganic fertilizer tend to has higher maintenance cost so it can lower the plantation profit, while using organic fertilizer MOAF, it has higher productivity with lower maintenance cost, so higher profit for the plantation can be obtained.

## 3.1 Comparison of Maintenance Cost Using Nonorganic and Organic Fertilizer

Table 6. Maintenance cost with Nonorganic

No	Activities	Tree/Ha	Norm	Rotation	Total	Price (Rp)	Total Costs (Rp)
1	<b>Fertilization</b>						
	Labor		8.50 WD/Ha	-	1.173	245	287.385
	Urea		1.90 Kg/Tree	2	524	5.400	2.831.760
	Rock Phosphate		1.58 Kg/Tree	1	218	3.000	654.120
	KCL/MOP		1.88 Kg/Tree	2	518	6.700	3.467.250
	Kieserit		0.17 Kg/Tree	2	46	3.000	136.620
	Boron		0.08 Kg/Tree	1	11	12.000	132.480
2	<b>Plant Disk Chemist</b>						
	Labor		0.27 WD/Ha	2	0.53	79.395	42.079
	Primax Herbicide	138	0.45 Liter/Ha	2	0.9	40.712	36.641
	Metafuron Herbicide		0.03 Liter/Ha	2	0.051	200.500	10.226
	Clean the Plant Disk		1.64 DW/Ha	2	3.28	79.395	260.416
3	<b>Pasar pikul + TPH</b>						
	Labor		0.21 WD/Ha	3	0.62	79.395	48.828
	Primax Herbicide		0.20 Liter/Ha	3	0.6	40.712	24.427
	Metafuron Herbicide		0.01 Liter/Ha	3	0.03	200.500	6.015
4	<b>Tripe Inter-Row</b>						
	Labor		0.44 WD/Ha	3	1.32	79.395	104.801
5	<b>Pruning</b>						
	Labor		75.00 Tree/WD	1	1.84	79.395	146.087
						<b>TOTAL</b>	<b>8.052.515</b>
<b>Production Result: 9.397 Kg/Ha</b>							

Table 7. Maintenance cost with organic

No	Activity	Tree/Ha	Norm	Rotation	Total	Price (Rp)	Total Costs (Rp)
1	<b>Fertilization</b>						
	Labor		6 WD/Ha	-	840	245	205.800
	MOAF <sup>®</sup> 1		2 Kg/Phn	1	280	7.200	2.016.000
	MOAF <sup>®</sup> 2		2 Kg/Phn	1	280	7.200	2.016.000
	MOAF <sup>®</sup> 3+		2 Kg/Phn	1	280	7.700	2.156.000
	CHIPS 2.1		3 Kg/Phn	1	420	12.500	5.250.000
2	<b>Plant Disk</b>						
	Clean the Plant Disk	140	1.637 WD/Ha	4	6.55	79.395	519.878
3	<b>Pasar pikul + TPH</b>						
	Labor		0.205 DW/Ha	3	0.62	79.395	48.828
	Primax Herbicide		0.2 Liter/Ha	3	0.6	40.712	24.427
	Metafuron Herbicide		0.01 Liter/Ha	3	0.03	200.500	6.015
4	<b>Tripe Inter-Row</b>						
	Labor		0.44 WD/Ha	3	1.32	79.395	104.801
5	<b>Pruning</b>						
	Labor		75.00 Tree/WD	1	1.87	79.395	148.204
						<b>TOTAL</b>	<b>12.495.954</b>
<b>Production Result: 12.812 Kg/Ha</b>							

Note. WD = Working Days.

High maintenance cost with MOAF method is because of biopesticide and biofungicide CHIPS. Palm oil that is infected by Ganoderma, with the biopesticide and biofungicide CHIPS, prove to be able to control the disease so that palm oil can recover and continue to produce, compared to using chemical pesticide that caused the death of palm oil. High maintenance cost using MOAF method can be compensated with the high production compared

to the production using nonorganic method that tends to lower productivity. Accurate dosage is based on the nutrient balance, so that the nutrient given is not too much and can be used by the plant optimally. Unaccurate dosage not only can cause the growth retardation in the plant but also a waste in labor and cost. Consideration in fertilization is not enough if only considering the soil condition but the principle of the plantation such as accurate dosage, type of fertilizer, and way in giving is important to consider (Ruhnayat, 2007).

The other factor that cause higher maintenance cost is the manual way to clean the plant disk, while non-organic tend to use herbicide. Organic method is done for environment-friendly purpose, as we know that using herbicide can pollute soil, water, air, and even cause disease in labor, moreover, it can also effect consumer from the end-product produced. MOAF fertilizer, biopesticide, and biofungicide do not contain any harmful chemical substances that can cause pollution. Plantation that use organic method in maintenance prove to have higher income that reach 10% compared to using nonorganic method in maintenance, in addition, organic method can ensure quality of the production and maintain the plant to continue grow and produce for longer time.

Table 8. Production percentage based on PPKS standard

No	Location	Block	(Ha)	Plantation Year	Types of Seeds	Production Percentage/PPKS Standard (%)				
						2014	2015	2016	2017	2018
1	Kec. Langgam, Riau	K	33.93	2011	DxP Malaysia	-	50.39	80.08	81.78	95.03
		L(K*)	31.95			-	60.33	58.73	69.58	73.57
2	Kec. Bila Hilir, Sumatra Utara	DO	34.31	2011	DxP Sucfindo	-	62.10	93.30	110.23	110.77
		CO (K*)	38.29			-	49.39	58.24	79.12	92.33
3	Kec. Langgam, Riau	J	43.66	2010	DxP Malaysia	47.41	64.40	75.36	86.08	95.88
		I (K*)	40.53			46.22	50.53	51.46	52.61	52.84
4	Kec. Long Ikliis, Kalimantan Timur	26	43.76	2002	DxP PPKS	56.55	71.67	78.70	85.19	90.59
		27 (K*)	44.00			57.88	62.66	70.12	73.08	76.04
5	Kec. Sei Kijang, Riau	M12	22.65	2005	DxP Marihat	52.74	68.21	72.40	76.15	83.57
		N12 (K*)	22.07			60.25	62.79	63.36	66.79	74.36
6	Kec. Langgam, Riau	F	21.20	2009	DxP Malaysia	50.75	76.17	82.71	82.77	82.98
		H (K*)	27.11			61.84	73.83	70.00	67.86	66.94
7	Kec. Teluk Dalam, Sumatra Utara	R	35.00	2006	DxP Marihat	45.88	69.64	73.75	78.97	85.36
		M (K*)	34.90			49.41	55.36	61.54	65.78	72.49

A comparison is made between productivity of oil palm in this study that used organic fertilizer to PPKS production (%), it showed that MOAF fertilizer production was 64.4%-110.77% while using nonorganic fertilizer was 45.88-92.33%. Production percentage was higher in using MOAF fertilizer than in nonorganic fertilizer even surpassed the standard production of PPKS. PPKS is research center that have so much contribution in developing palm oil in Indonesia and production based on plantation year is used as a standard in defining success in plantation. The remarkable of using MOAF fertilizer in this study is that the plant condition itself is infected by Ganoderma, did not able to produce, and is to be replanted but using MOAF organic fertilizer combined with biopesticide and biofungicide CHIPS, able to produce well and even equal to healthy palm oil.

Like other plants, palm oil is susceptible to some diseases such as stem rot. Ganoderma infection associated with plantation age has an important role in the productivity, based on the data, the older the plant, the faster the infection spread and affect vegetative and generative growth of palm oil. CHIPS has antagonist agent to Ganoderma that it can inhibit the growth of Ganoderma, moreover it can help the vegetative and generative growth of oil palm.

Stem rot disease cause low production of oil palm and lower fresh fruit bunch production. The damage can reached 80-100% even cause the death of the plant (Yulianti, 2001). Biopesticide and biofungicide CHIPS can minimize Ganoderma infection because it contain antagonist agent that can control the growth and the spread of Ganoderma.

#### 4. Conclusion

It showed that MOAF organic fertilizer, biopesticide, and biofungicide CHIPS are a solution for palm oil plantation intensification, with high productivity, it can be a solution in preventing functional shifting in primary forest to be oil palm plantation. Increase in production that is 30% higher than non-organic fertilizer is proven in this study.

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