Oil Palm Yield at Lowland Area through Groundtruthing of LiDar Strip

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Abstract. Many large oil palm plantation in Indonesia are located in lowland and flood prone areas, especially in South Sumatera. This causes the plant cannot produce optimally, do not grow well, and even death. The purpose of this research was to investigate the productivity of oil palm located in lowland and floodprone areas of Kelola Sendang Landscape, South Sumatera through groundtruthing (ground check) for validation of a GIS model. The research was conducted at lowland area of 6 (six) oil palm plantation companies located in the area of Musi Banyuasin District and Banyuasin District, South Sumatera Province. The result showed that the diversity of oil palm plant growth was quite high due to the number of inserted or abnormal plants and plant death. The low productivity of oil palm crops in lowland areas in the companies was caused by inadequate water management, lack of maintenance of plants, especially fertilization and weed control. The level of oil palm productivity in lowland areas were less than 50% of S3 standards land suitability class.

1. Introduction

The palm oil industry is one of the main industries that drives the economic and strategic sectors in Indonesia. According to data from the Indonesian Ministry of Agriculture, in the last ten years, there has been a significant increase in oil palm area and CPO production from 5.5 million ha (2005) to 11.3 million ha (2015), while CPO production from 11.9 million tons (2005) to 31.3 million tons (2015) [1]. This number is expected to increase to 13 million hectare and production will reach 35 million tons by 2020.

Many large oil palm plantations in Indonesia are located in lowland and flood prone areas, which spread in Kalimantan and Sumatera [1]. Especially in South Sumatera, this causes the plants do not grow well, cannot produce optimally, and even death. Therefore, to determine the effect of lowland and flood prone areas on the condition of the plant and the production of palm oil, field surveys were carried out. Faculty of Agriculture, Bogor Agricultural University, supported by an experienced team in the oil palm industry, conducted a survey of potential TBS particularly in marginal land/lowland.

About 70% of Indonesia's CPO production is from Sumatra, and South Sumatera as an important palm oil producing provinces. There are many oil palm concessions in Musi Banyuasin and Banyasin Districts, include oil palm plantations at the Sembilang-Dangku Landscape. In this area, many oil palm plantations are located in lowland and flood prone areas, where flooding and high water tables may result in low production or even the death of planted oil palm. In order to determine the impact of flooding and high water tables on oil palm production, the KELOLA Sendang Project was carried out an oil palm yield survey in the Musi Banyuasin and Banyasin Districts of South Sumatera. The purpose of this research was to investigate the productivity of palm oil in Kelola Sendang Landscape, South Sumatera through groundtruthing (ground check) for validation of GIS model.

2. Methodology

This research was conducted from February to April 2018. The survey locations were 7 palm oil companies area (PT-A, PT-B, PT-C, PT-D, PT-E, PT-F) which were covered by the LiDar Strip at Kelola Sendang Project Musi Banyuasin and Banyasin districts (Figure 1). Materials and tools required in this study included GPS, compass, maps, sticks, measuring tape, cameras, questionnaires, other stationery and survey equipments.
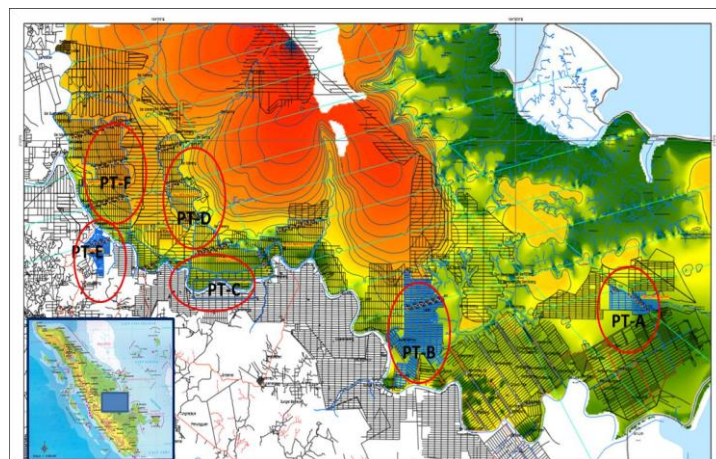

Figure 1. The location survey in this study, Musi Banyuasin and Banyasin Districts of South Sumatera.

Observation tools consisted of Garmin GPS, camera (with geotagging), the form of observations, and job boards and stationery supplies. There were 20 plants (each of ten plants on the left and right of the LiDar line) per plot sampling, in which for each plant (a) Number of trees, (b) Varieties, and (c) The planting year were recorded.

The nutritional status approach of oil palm plant observations was made based on (a) Visual leaf color, (b) Plant condition (normal-abnormal, dead), (c) Number of leaves, (d) Average bunch weight (ABW) and (e) The number of bunches per tree. As a reference in the determination of production estimation, the list of palm oil production potentials Land Class S-3 by the Indonesia Oil Palm Research Institute (PPKS) were used, are as follows (Table 1).

Table 1. Oil Palm Production Standard [2].

Age (year)	S-1	S-2	S-3
	ton ha^{-1} year^{-1}		
3 – 6	9.2 – 21.1	7.3 – 18.5	6.2 – 17.0
7 – 12	26.0 – 31.0	23.0 – 28.0	22.0 – 26.0
13 – 15	31.0 – 27.9	28.0 – 26.0	26.0 – 24.5
16 – 20	27.1 – 23.1	25.5 – 21.5	23.5 – 19.0
21 – 25	21.9 – 17.1	21.0 – 16.0	18.0 – 14.0
Average	24.1	21.9	20.1

3. Results and Discussions

General conditions of the 6 palm oil plantations are presented in Figure 2, 3, 4, 5, 6 and 7.
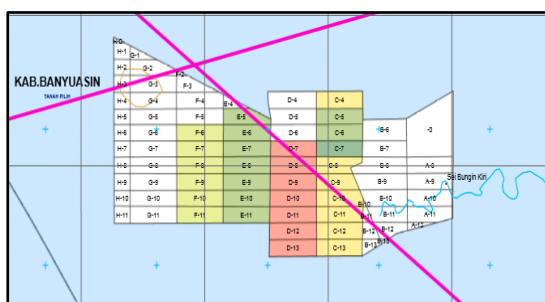

Figure 2. PT-A
Soil type : Typic Sulfaquents and Sulfic Endoaquepts
Number of LiDar strip : 2
No. Sample point : 15
Seed type : Socfin variety
Year planted block by LiDar strip : 2010, 2012, 2016 and 2017
Rainfall : 2,895.7 mm year^{-1}

Figure 3. PT-C
Soil type : Typic Endoaquepts
Number of LiDar strip : 3
No. Sample point : 15
Seed type : Lonsum variety
Year planted block by LiDar strip : 2007, 2008, 2009 and 2011
Rainfall : 2,416 mm year^{-1} and 136 days

Figure 4. PT-B
Soil type : Sulfic Endoaquepts, Typic Haplosaprists
and Typic Haplohemists
Number of LiDar strip : 2
No. Sample point : 14
Seed type : Socfin and Costa Rica varieties
Year planted block by LiDar strip : 2007, 2008,
2009 and 2011
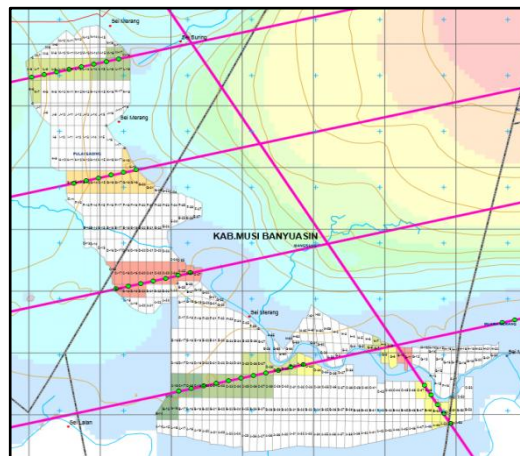Rainfall : 1,424 mm year^{-1} and 115 days

Figure 5. PT-D
Soil type : Typic Endoaquepts, and Typic
Haptosaprists
Number of LiDar strip : 5
No. Sample point : 37
Seed type : Socfin, LAM, Lonsum and SAIN
varieties
Year planted block by LiDar strip : 2007, 2008,
2010 and 2011
Rainfall : 2,415.6 mm year^{-1} and 134 days

Figure 6. PT-E
Soil type : Typic Sulfaquents
Number of LiDar strip : 1
No. Sample point : 8
Seed type : Lonsum and marihat varieties
Year planted block by LiDar strip : 2007, 2012
and 2014
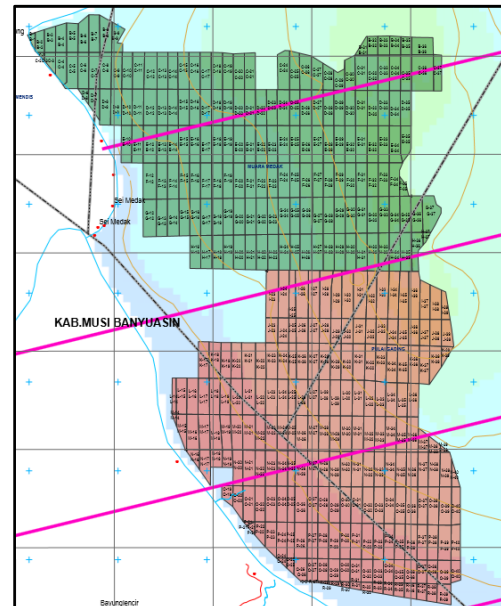Rainfall : 2,484 mm year^{-1} and 108 days

Figure 7. PT-F
Soil type : Typic Endoaquepts and Typic
Haplosaprists
Number of LiDar strip : 3
No. Sample point : 26
Seed type : marihat varieties
Year planted block by LiDar strip : 2007, 2012
and 2014
Rainfall : 2318 mm year^{-1} and 120 days

The sampling plot showed that PT-A consisted of 81.75% normal plants, 15% abnormal plants and 3.25% dead. Visual observation showed that mostly (> 50%) leaves color were yellowish green. This indicated that the leaf nutrient status was not sufficient enough. Field conditions of PT-A are showed in Figure 8.

Figure 8. Field conditions of PT-A.

PT-B consisted of 95.6% normal plants, <3.8% of abnormal plants and 0.6% dead. Visual observation showed that mostly (>90%) leaves color were green. This indicated that the leaf nutrient status was sufficient enough. Field conditions of PT-B are showed in Figure 9.

Figure 9. Field conditions of PT-B.

The condition of PT-C plantation area consisted of 92.1% normal plants (original), 5.5% abnormal plants and 2.4% dead. Plant height was around 6-8 meters. In general, visual observation showed that mostly (>85%) leaves color were green. This indicated that the leaf nutrient status was sufficient enough. Field conditions of PT-C are showed in Figure 10.

Figure 10. Field conditions of PT-C.

PT-D area occasionally has inundation with height less than 100 cm with a prolonged inundation of less than 1-2 hours once a day. The condition of PT-D plantation area consisted of 83.3% normal plants (original), 12.9% abnormal plants and 2.4% dead. Plant height was around 6-8 meters. In general, visual observation showed that mostly (>69%) leaves color were green. This indicated that the leaf nutrient status was sufficient enough. Field conditions of PT-D are showed in Figure 11.

Figure 11. Field conditions of PT-D.

The condition of PT-E plantation area consisted of 65.5% normal plants (original), 30.8% abnormal plants and 2.7% dead. Plant height was around 6-8 meters. Visual observation showed that mostly (>77%) leaves color were green. This indicated that the leaf nutrient status was sufficient enough. Field conditions of PT-E are showed in Figure 12.

Figure 12. Field conditions of PT-E.

PT-F plantation area consisted of 88.1% normal plants, <10.6% abnormal plants and 1.3% dead. Visual observation showed that mostly (>88%) leaves color were green. This indicated that the leaf nutrient status was sufficient enough. Field conditions of PT-F are showed in Figure 13.

Figure 13. Field conditions of PT-F.

The summary of field conditions is presented in Table 2. Conditions of the soil nutrient status and plant tissue of low oil palm plants need to be improved by a balanced fertilizer applications as well as improved culture techniques of oil palm plantation [3]. Nutrients from fertilizers become additional energy that is indispensable for the growth and productivity of oil palm [4].

The production record in last three years generally showed a decrease of production between -5.5% to -19.7% per year (average -11.1% year^{-1}). Therefore, the productivity in this area was still low (< 50% of the S-3 standard) (Table 3). Oil yield can be improved by increasing Fresh Fruit Bunch (FFB) yield. There was strong negative association between the two FFB yield components (annual bunches production and average bunches weight) [5].

Table 2. Oil palm plant conditions at sampling area.

Planted Year	Plant condition (%)			Leaf condition per plant (%)			Leaf number	Number of FFB	Bunch weight (kg bunch^{-1})
	Normal	Abnormal	Dead	Green	Yellowish green	Yellow			
PT-A									
2010	75.0	25.0	0	20.0	80.0	0	32.0	7.2	8.0
2012	62.0	35.0	3.0	40.0	58.0	2.0	25.2	2.14	4.0
2016	95.0	0	5.0	42.0	48.0	5.0	43.2	0	0
2017	95.0	0	5.0	5.0	82.5	12.5	9.8	0	0
Average-A	81.8	15.0	3.2	26.8	73.5	4.9	27.6	1.3	3.0
PT-B									
2007	96.0	3.0	1.0	99.0	0	1.0	53.6	4.5	15.1
2008	100.0	0	0	95.0	5.0	0	41.6	5.74	10.1
2009	98.75	0	1.25	98.8	0	1.2	45.3	5.47	9.0
2011	87.5	12.5	0	90.0	10.0	0	47.2	5.82	8.32
Average-B	95.6	3.8	0.6	95.7	4	0.3	47.0	5.4	10.6
PT-C									
2009	95.0	1.7	3.3.	88.3	6.7	5.0	53.3	7.3	9.2
2011	89.1	8.4	2.5	82.0	14.5	3.5	46.8	5.6	8.5
Average-C	92.1	5.0	2.9	85.2	10.6	4.3	50.2	6.5	8.9
PT-D									
2006	85.0	5.0	10.0	35.0	60.0	5.0	54.7	6.1	10.1
2007	82.5	14.2	3.4	78.3	20.9	0.8	49.2	6.6	8.0
2008	76.7	18.6	4.7	75.6	23.2	1.2	46.7	6.0	9.9
2009	83.2	15.7	1.1	62.1	34.8	3.1	44.5	5.9	6.1
2010	85.6	11.9	2.5	76.3	22.5	1.2	45.0	6.0	7.4
2011	86.9	12.3	0.8	87.1	12.5	0.4	46.1	8.1	6.2
Average-D	83.3	12.9	3.8	69.1	29.0	1.9	47.7	6.5	8.0
PT-E									
2007	67.5	27.5	5.0	92.5	0	7.5	45.3	6.9	8.5
2012	67.0	30.0	3.3	75.0	25.0	0	47.8	7.1	7.5
2014	65.0	35.0	0	47.5	47.5	5.0	46.0	4.0	4.0
Average-E	66.5	30.8	2.7	71.7	24.2	4.1	46.4	6.0	6.7
PT-F									
2009	90.0	10.0	0	67.9	32.1	0	54.0	7.3	9.0
2010	100.0	0	0	100.0	0	0	44.0	4.0	6.6
2012	75.0	20.0	5.0	85.0	15.0	0	44.8	3.0	10.0
2017	87.5	12.5	0	100.0	0	0	11.0	0	0
Average-F	88.1	10.6	1.3	88.2	11.8	0	38.4	3.6	6.4
Grand Average	84.6	13.0	2.4	72.8	25.5	2.0	42.9	5.1	7.3

Table 3. Fresh Fruit Bunch (FFB) productivity at sampling area.

Location	Component	2015	2016	2017	Trend (% Y^{-1})	Est.2018
PT-A	Area (Ha)	143.1	143.1	143.1		143.1
	Production (ton)	0	0	920.2	0	1.087.0
	Productivity (t $ha^{-1}y^{-1}$)	0	0	6.4	0	7.6
PT-B	Area (Ha)	336.0	336.0	336.0		336.0
	Production (ton)	7,739.9	6,571.0	6,765.6	-6.3	5,720.0
	Productivity (t $ha^{-1}y^{-1}$)	23.0	19.6	20.1	-6.3	17.0
PT-C	Area (Ha)	3,776.5	3,776.5	3,776.5		3,776.5
	Production (ton)	77,099.0	66,591.0	59,534.0	-11.3	49,668.0
	Productivity (t $ha^{-1}y^{-1}$)	20.4	17.6	15.8	-11.3	13.2
PT-D	Area (Ha)	1,139.0	1,139.0	1,139.0		1,139.0
	Production (ton)	13,413.0	9,525.0	11,947.0	-5,46	14,351.0
	Productivity (t $ha^{-1}y^{-1}$)	11.8	8.4	10.5	-5.46	12.6
PT-E	Area (Ha)	238.3	238.3	238.3		238.3
	Production (ton)	1,059.0	874.0	642.0	-19.7	1,834.0
	Productivity (t $ha^{-1}y^{-1}$)	4.4	3.7	2.7	-19.7	7.7
PT-F	Area (Ha)	6,163.0	6,163.0	6,163.0		6,163.0
	Production (ton)	17,621.3	7,651.1	11,068.7	-18.6	41,251.0
	Productivity (t $ha^{-1}y^{-1}$)	2.9	1.2	1.8	-18.6	6.7
TOTAL	Area (Ha)	11,795.9	11,795.9	11,795.9		11,795.9
	Production (ton)	116,932.2	91,212.1	90,876.5	-11.1	113,941.0
	Productivity (t $ha^{-1}y^{-1}$)	9.9	7.7	7.7	-11.1	9.7
	% to S3 Standard	49.6	38.7	38.5	-11.1	48.3

Conclusions

The low productivity of oil palm crops in lowland area was low at 7.7 to 9.7 ton ha^{-1} $year^{-1}$ (<50% of S3 standard). This was apparently caused by inadequate water management, lack of plant maintenances (especially fertilization and weed control), and the impact of dead plants due to land fires.

Acknowledgements

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