Fresh fruit bunch production of oil palm plantation in the lowland area of Sembilang Dangku Landscape

Rio Octarizza Segara¹, Hariyadi², Sukarman³ and Kresno Dwi Santoso⁴

¹Study Program of Natural Resource and Environmental Management Science, Postgraduate School, Bogor Agricultural University, Baranangsiang IPB Campus, Bogor 16143, Indonesia
²Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University, Dramaga IPB Campus, Bogor 16680, Indonesia
³Indonesian Agency for Agriculture Research and Development of Land Resources, Ministry of Agriculture Republic Indonesia, Cimanggu, Bogor 16680, Indonesia
⁴Zoological Society of London (ZSL) Indonesia Programme, Palembang 16128, Indonesia

*E-mail: riooctsegara@gmail.com

Abstract. The results of the study showed that Sembilang Dangku Landscape had known two types of soil namely peat soil and mineral soil. Detail information for peat soil in this area namely Typic Haplosaprists and Typic Haplohemists meanwhile, for mineral soil, there are two types of soil that have been identified at these locations namely Inceptisols (Typic Endoaquepts and Typic Humaquepts) and Entisols (Typic Sulfaquents). This study aimed to analyze the production of oil palm plantations in lowland areas on marginal land. This research was conducted at six locations of oil palm plantations in Musi Banyuasin Regency, South Sumatra province. The methods used were descriptive quantitative and qualitative calculation of FFB (fresh fruit bunches) production that compared the standard potential production of the Palm Oil Research Center (PPKS referred in Indonesia). The yield of FFB oil palm productivity (ton/ha) on marginal land showed that Typic Haplosaprists, Typic Haplohemists and Typic Endoaquepts, Typic Humaquepts did not have a significant effect because yield from plantation management produced FFB production oil palm was quite good. The effect that has quite a different production is Entisols (Typic Sulfaquents) or L6 locations. Based on this research, the type of soil is a factor that greatly affects the productivity of oil palm.

1. Introduction

Oil palm plant is one of the seed plants in the plantation industry in Indonesia. Oil palm is one of the main sources of income for foreign exchange from the non-oil and gas sector [1]. The business of oil palm plantations in Indonesia is quite open because of the increasing demand for domestic and foreign palm oil. At present, there are around 10 million hectares of oil palm plantations in the country [2]. However, the amount is still considered to be increased to meet demand. The problem faced today is the
lack of mineral land resources that have optimum productivity characteristics for the growth and development of oil palm plants. One alternative that is used to overcome this problem is the use of abandoned marginal land. The current area of Indonesian peatlands is 14.85 million ha [3] whereas, the area of unproductive degraded peatlands in Indonesia is reported to be around 4.2 million ha [4]. Currently, oil palm plantations in Indonesia are generally located in degraded peatland locations, because 90% of Indonesia's peatlands are degraded [5]. This research was conducted in the lowland area of the Sembilang Dangku Landscape which was dominated by tidal areas. The locations research of oil palm plantation are outside of the wildlife reserve area (Suaka Margasatwa Dangku). This area has four areas designated as Business Use Rights (HGU) for industrial activities, including areas of oil palm plantations, Industrial Plantation Forests (HTI), and oil and coal companies [6]. In this study, there were three marginal soil types known as Histosol (Typic Haplosaprist and Typic Haplohemists), Inceptisols (Typic Endoaquepts and Typic Humaquepts), and Entisols (Typic Sulfaquents). This study aimed to look at the effect of marginal soil types in lowland areas on FFB productivity with potential production standards from Palm Oil Research Center (Pusat Penelitian Kelapa Sawit (PPKS) referred in Indonesia) [7].

2. Materials and methods

2.1 Place and time of research
The research was carried out in the Sembilang Dangku Landscape area in Musi Banyuasin Regency, South Sumatra Province. Sampling research was taken at six different plantation locations. A sampling of the research just was carried out on oil palm plantation blocks which were in lowland areas with a height of 5 msl (meter sea level). The ground checking method was performed in some companies. The term used in the study is Location 1 = L1, Location 2 = L2, Location 3 = L3, Location 4 = L4, Location 5 = L5 and Location 6 = L6. This research was conducted from January to March 2018.

2.2 Tools and materials
The tools and materials used in the study were GPS (Global Positioning System), company plantation maps, meters, cameras, notebooks, and stationery.

2.3 Methods
Secondary data is obtained by results of the soil map from the Indonesian Agency for Agriculture Research and Development of Land Resources by matching the company plantation map and ground check at the sampling location. The other secondary data research is obtained by soil types and FFB production data for the last three years at the sampling location of the Sembilang Dangku Landscape. The primary data was done by ground check at sampling areas. The data is processed in descriptive qualitative and descriptive quantitative depending on the results obtained and then the result of the data will be compared with standard potential production of palm oil (PPKS referred in Indonesia).

| Age (Year) | FFB (ton/ha) | ABW (kg/unit) |
|------------|-------------|---------------|
| 3          | 6,2         | 3             |
| 4          | 12          | 5,3           |
| 5          | 14,5        | 6,7           |

Table 1. Estimation of Oil Palm Production in the S-3 Land (marginal suitable land) based on Pusat Penelitian Kelapa Sawit (PPKS 2006)
| Age (Year) | FFB (ton/ha) | ABW (kg/unit) |
|-----------|-------------|---------------|
| 6         | 17          | 8.5           |
| 7         | 22          | 10            |
| 8         | 24.5        | 12.7          |
| 9         | 26          | 15.5          |
| 10        | 26          | 16            |
| 11        | 26          | 17.4          |
| 12        | 26          | 18.5          |
| 13        | 26          | 19.5          |
| 14        | 25          | 20            |
| 15        | 24.5        | 20.6          |
| 16        | 23.5        | 21.8          |
| 17        | 22          | 23            |
| 18        | 21          | 24.2          |
| 19        | 20          | 25.5          |
| 20        | 19          | 26.6          |
| 21        | 18          | 27.4          |
| 22        | 17          | 28.4          |
| 23        | 16          | 29.4          |
| 24        | 15          | 30.4          |
| 25        | 14          | 31.2          |
| Total     | 461.2       | 441.6         |
| Average   | 20.1        | 19.2          |

Note: FFB = Fresh fruit Bunch (ton/ha), ABW = Average Bunch Weight (kg/unit)

3. Results and discussion

The location sampling of the Sembilang Dangku Landscape is on the flat topography area. The shape of the research location is generally flat with a slope of 0-3%. The dominance of vegetation in the research location is lower vegetation category, including the types of grass and ferns. Mineral soil types that had been identified at the site are Inceptisols (*Typic Endoaquepts* and *Typic Humaquepts*) and Entisols (*Typic Sulfaquents*) whereas for peat soil types are *Typic Haplosaprists* and *Typic Haplohemists*.

The results showed that in general peat soil (Histosols) was not significantly different compared to Inceptisols, but its production was still better than Entisols. The results of oil palm FFB productivity showed that the productivity of L1 (*Typic Haplosaprists* and *Typic Haplohemists*) sampling locations were around 26 tons/ha (85% of the PPKS standard), L2 (*Typic Endoaquepts*) productivity was around
26 tons/ha (95% of PPKS standard), L3 (Typic Endoaquepts and Typic Humaquepts) productivities were around 9 tons/ha (45% of PPKS standard), L4 (Typic Haplosaprist and Typic Humaquepts) productivities were around 10 tons/ha (50% of PPKS standard), L5 (Typic Haplosaprist, Typic Endoaquepts and Typic Humaquepts) productivity were around 12 tons/ha (55% of the PPKS standard), L6 (Typic Endoaquepts and Typic Sulfaquents) productivities were around 3 tons/ha (25% of the PPKS standard). The location of L1 and L2 productivity meets the standard PPKS on S-3 land (according to standard of marginal land). These data showed in the production of palm oil production in Sembilang Dangku Landscape which is presented in table 2.

Table 2. Production of oil palm in Sembilang Dangku Landscape compared to the potential production of FFB (PPKS 2006) [7]

| Location | Type of soils | Planting year | FFB Production (tons/ha) | Standard Potential production of FFB (PPKS) based on Planting Year (tons/ha) | Production trends (%) |
|----------|---------------|---------------|--------------------------|--------------------------------------------------------------------------|-----------------------|
|          |               |               | 2015 | 2016 | 2017 | 2015 | 2016 | 2017 |                       |                       |
| L1       | T-Hs          | 2007          | 28.4 | 21.2 | 20.9 | 24.5 | 26.0 | 26.0 | -13.0                  |                       |
| L1       | T-Hs          | 2008          | 27.7 | 22.3 | 21.2 | 22.0 | 24.5 | 26.0 | -11.7                  |                       |
| L1       | T-Hs          | 2011          | 17.3 | 15.9 | 16.6 | 12.0 | 14.5 | 17.0 | -2.0                   |                       |
| L1       | T-Hh          | 2007          | 26.9 | 21.8 | 22.9 | 24.5 | 26.0 | 26.0 | -7.4                   |                       |
| L1       | T-Hh          | 2008          | 22.8 | 19.8 | 20.8 | 22.0 | 24.5 | 26.0 | -4.5                   |                       |
| L1       | T-Hh          | 2009          | 18.1 | 17.3 | 18.4 | 17.0 | 22.0 | 24.5 | 1.2                    |                       |
| L2       | T-Ea          | 1997          | 31.3 | 23.9 | 19.9 | 21.0 | 20.0 | 19.0 | -18.2                  |                       |
| L2       | T-Ea          | 1998          | 29.9 | 25.7 | 21.5 | 22.0 | 21.0 | 20.0 | -14.0                  |                       |
| L2       | T-Ea          | 2006          | 25.1 | 22.4 | 20.2 | 26.0 | 26.0 | 26.0 | -9.8                   |                       |
| L2       | T-Ea          | 2008          | 19.4 | 16.7 | 12.6 | 22.0 | 24.5 | 26.0 | -17.5                  |                       |
| L2       | T-Ea          | 2009          | 25.0 | 20.2 | 18.2 | 18.3 | 22.6 | 24.9 | -13.8                  |                       |
| L3       | T-Ea          | 2007          | 17.4 | 8.3  | 13.0 | 24.5 | 26.0 | 26.0 | -12.8                  |                       |
| L3       | T-Ea          | 2008          | 12.9 | 9.5  | 10.7 | 22.0 | 24.5 | 26.0 | -6.9                   |                       |
| L3       | T-Ea          | 2009          | 7.1  | 5.9  | 10.1 | 17.0 | 22.0 | 24.5 | 21.1                   |                       |
| L3       | T-Ea          | 2010          | 7.2  | 5.7  | 6.8  | 14.5 | 17.0 | 22.0 | -3.1                   |                       |
| L3       | T-Hq          | 2009          | 8.1  | 6.4  | 8.0  | 17.0 | 22.0 | 24.5 | -0.3                   |                       |
| L4       | T-Hs          | 2008          | 10.9 | 7.8  | 10.1 | 22.0 | 24.5 | 26.0 | -1.4                   |                       |
| L4       | T-Hq          | 2007          | 15.5 | 10.0 | 12.4 | 24.5 | 26.0 | 26.0 | -10.3                  |                       |
| L4       | T-Hq          | 2008          | 15.5 | 10.0 | 12.2 | 22.0 | 24.5 | 26.0 | -10.6                  |                       |
| L4       | T-Hq          | 2009          | 8.9  | 5.2  | 5.6  | 17.7 | 22.4 | 24.7 | -18.6                  |                       |
| Location | Type of soils | Planting year | FFB Production (tons/ha) | Standard Potential production of FFB (P&K) based on Planting Year (tons/ha) | Production trends (%) |
|----------|---------------|---------------|--------------------------|--------------------------------------------------------------------------------|------------------------|
|          |               |               | 2015  | 2016  | 2017  | 2015  | 2016  | 2017  |                                  |                        |
| L5       | T-Hs          | 2008          | 17.7  | 14.3  | 18.5  | 22.0  | 24.5  | 26.0  | 3.6                               |                        |
| L5       | T-Hs          | 2011          | 3.0   | 2.1   | 4.1   | 12.0  | 14.5  | 17.0  | 19.4                              |                        |
| L5       | T-Ea          | 2007          | 18.1  | 12.9  | 14.9  | 24.5  | 26.0  | 26.0  | -8.7                              |                        |
| L5       | T-Ea          | 2008          | 11.8  | 11.4  | 16.0  | 22.0  | 24.5  | 26.0  | 22.2                              |                        |
| L5       | T-Hq          | 2010          | 10.0  | 7.2   | 8.4   | 14.5  | 17.0  | 22.0  | -8.0                              |                        |
| L6       | T-Sq          | 2007          | 15.2  | 11.1  | 8.6   | 24.5  | 26.0  | 26.0  | -21.3                             |                        |
| L6       | T-Sq          | 2012          | 2.5   | 3.3   | 2.0   | 6.2   | 12.0  | 14.5  | -10.3                             |                        |
| L6       | T-Ea          | 2012          | 0.6   | 1.2   | 0.8   | 6.2   | 12.0  | 14.5  | -8.6                              |                        |

Note: L = location, T-Hs = Typic Haplosaprists, T-Hh = Typic Haplohemists, T-Ea = Typic Endoaquepts, T-Hq = Typic Humaquepts

Based on the palm oil production table in L1 locations, Typic Haplosaprists and Typic Haplohemists had good FFB productivity. The highest productivity at the L1 location was Typic Haplosaprists which was able to achieve productivity of 28.4 tons FFB in the planting year (2007) and then continued to decline until planting year (2017) with a production of 20.9 tons. The lowest production of oil palm FFB at L1 location in 2017 which was type soil namely Typic Haplosaprists the planting year of 2011 (production is about 16 tons). The yield of FFB productivity in L1 locations was quite stable, as evidenced by the trend of decreasing productivity which was not too high at 2 to 13%.

The location of L2 in the form of Inceptisols (Typic Endoaquepts) had the highest FFB productivity. This is because the management applied by the company is very good. This can be caused by the use of suitable fertilizer doses and the right time in fertilizing. Because based on the type of land, generally this soil is not too good for plantation, but because of good management so that the product produced is also good. Based on its nature, the land has properties that are newly developed with obstructed drainage, the pH was quite acidic, base saturation was <50% [4].

Soil type at L3 location is Inceptisol (Typic Endoaquepts and Typic Humaquepts). The highest productivity of the L3 location was owned by the planting year 2007 (Typic Endoaquepts) in 2015 which reached 17.4 tons. This is considered to be too low, the production potential that should have been achieved according to [7] in the planting year was around 24.5 tons/year. L3 location (Inceptisol soil type) is should get higher productivity by Typic Humaquepts soil when compared to Typic Endoaquepts. It caused Typic Humaquepts to consist by the enrichment of organic material from peat that has been decayed and mixed with the mineral soil which is able to improve the physical and chemical properties of the soil resulting in better productivity of FFB. It described that better soil utilization for oil palm plantations has a wide potential productivity potential depending on the management of the plantation [8].

Locations of L4 and L5 that have type of peat soil (Typic Haplosaprists) and Inceptisols (Typic Endoaquepts and Typic Humaquepts) with many different of planting years. At L4 location, FFB productivity in Typic Humaquepts soil types was higher, namely ± 12.4 tons/ha compared to Typic Haplosaprists (±10.1 tons/ha) which has type of mature peat soil. This indicates that Typic Humaquepts
is better than *Typic Haplosaprists*, so that means mineral soils mixed with organic matter (peat-mineral) produce higher values than soils which only contain organic matter. Location L5 has the highest FFB productivity in Inceptisols (*Typic Endoaquepts* and *Typic Humaquepts*), around ±10-18 tons/ha in a year. This is due to the density of oil palm plants on peatlands which tend to be higher than marginal mineral soils (Inceptisols), so as to produce more plant populations in each hectare, which implements to the higher productivity of FFB. Compaction of plant paths (plant density) using mechanical tools and making a hole in hole planting methods with puncher is an effort that is often done by large plantations [9].

L6 locations generally consist of Entisols soil. Entisols are in the category of young soils or undeveloped soil that still similar to the main material. The results of the study on L6 locations namely *Typic Sulfaquents* and *Typic Endoaquepts* have low productivity in both. It showed that in L6 locations especially *Typic Sulfaquents* still decreasing productivity even at older planting year. The results of *Typic Endoaquepts* productivity at L6 location only ranged from 0.6 to 1.2 tons (ha-1 year) which should be at the age of the plant for the appropriate land category (S-3 field) can produce ±6-14 tons/ha.

4. Conclusion

Oil palm plantations in the Dangku Landscape are located in the flat topographic area in the Musi Banyuasin Regency of South Sumatra Province. The object of this research is only carried out on oil palm plantation blocks which have marginal land areas at an altitude of 5 MSL. The yield of FFB oil palm productivity (ton/ha) on marginal land showed that *Typic Haplosaprists*, *Typic Haplohemists*, *Typic Endoaquepts*, and *Typic Humaquepts* had the good enough productivity although not too many the evidence. The effects that are quite different are indicated by *Typic Sulfaquents*. Soil type of Entisols that is *Typic Sulfaquents* has the lowest FFB productivity in this study when seen generally with the same planting year conditions on other marginal soils (peat soil and Inceptisols). The results of oil palm FFB productivity showed that the productivity of L1 (*Typic Haplosaprists and Typic Haplohemists*) sampling locations was around 26 tons/ha (85% of the PPKS standard), L2 (*Typic Endoaquepts*) productivity was around 26 tons/ha (95% of PPKS standard), L3 (*Typic Endoaquepts and Typic Humaquepts*) productivity was around 9 tons/ha (45% of PPKS standard), L4 (*Typic Haplosaprists and Typic Humaquepts*) productivity was around 10 tons/ha (50% of PPKS standard), Its L5 (*Typic Haplosaprists, Typic Endoaquepts, and Typic Humaquepts*) productivity was around 12 tons/ha (55% of the PPKS standard), L6 (*Typic Endoaquepts and Typic Sulfaquents*) productivity around 3 tons/ha (25% of the PPKS standard). The location of L1 and L2 productivity meets the standard PPKS on S-3 land (according to marginal). Based on this research can be described that type of soil is a main factor that greatly affects the productivity of oil palm.

Acknowledgment

The authors would like to express their gratitude to the supervisor Dr Ir Hariyadi MS and Dr Ir Sukarman MS for their guidance in helping to provide ideas and input on this research. Also, thanks to the ZSL (Zoological Society of London) and KELOLA SENDANG with one of the representatives Mr Kresno Dwi Santoso who has given the mandate to work on this project.

References

[1] Suryana A, Hutabarat B, Susilowati SH. 1998. Penawaran dan permintaan serta peluang pasar komoditas tanaman industri dan perkebunan. Prosiding. Pertemuan Komisi Penelitian Pertanian Bidang Perkebunan. Peremajaan Rehabilitasi dan Perluasan Tanaman Perkebunan: Kelapa, Kelapa sawit, Karet, Kopi, Kakao, The, Lada, Pala dan Jambu Mente. Pusat Penelitian dan Pengembangan Tanaman Industri, Badan Penelitian dan Pengembangan Kehutanan dan
Perkebunan

[2] Ditjenbun. Direktorat Jenderal Perkebunan. 2013. *Statistik Perkebunan Indonesia 2012-2014 : Kelapa sawit*. Jakarta (ID) : Kementerian Pertanian

[3] Wahyunto W, Nugroho K, Ritung S, Sulaeman Y. (2014). Peta lahan gambut Indonesia: Metode pembuatan, tingkat keyakinan dan penggunaan. In A. Wihardjaka, E. Maftu’ah, Salwati, Husnain, & F. Agus (Eds.), Prosiding Seminar Nasional dan Network Meeting Pengelolaan Berkelanjutan Lahan Gambut Terdegradasi untuk Mitigasi Emisi Karbon dan Peningkatan Nilai Ekonomi. (pp. 81–96). Balai Besar Litbang Sumberdaya Lahan Pertanian. Kementerian Pertanian

[4] [BBSDLKP]. Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian. 2013. Peta dan Rekomendasi Pengelolaan Lahan Gambut Terdegradasi di Sumatera. Bogor (ID): Kementerian Pertanian

[5] Joosten H. 2009. *The Global Peatland CO₂ Picture: Peat Land Status and Emission in all Countries of The World*. Wet Land International

[6] Kelola Sendang. Kemitraan Pengelolaan Lanskap Sembilang Dangku. 2017. *Menjajal pengelolaan lanskap berkelanjutan di sub-lanskap Dangku*. Factsheet. Palembang (ID) : Hal 1-8

[7] [PPKS]. Pusat Penelitian Kelapa sawit. 2006. Petunjuk Kultur Teknis Tanaman Kelapa sawit. Medan (ID) : Pusat Penelitian Kelapa sawit

[8] Pahan I. 2006. Panduan Lengkap Kelapa Sawit: Manajemen Agribisnis dari Hulu Hingga Hilir. Penebar Swadaya. Jakarta

[9] Sutarta, Purba ESP, Darmosarkoro W. 2003. *Budidaya Kelapa Sawit*. Medan (ID) : Pusat Penelitian Kelapa Sawit Sumatera Utara