DOI :https://doi.org/10.36378/juatika.v5i1.1410
JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL. 5 NO. 1 January 2023
eissn 2656-1727
pissn 2684-785X
Hal : 239 – 249

Total Biomass of Oil Palm Plants (*Elaeis Guineensis Jacq*) in Oil Palm Agroforestry Systems and Gaharu Plants (*Aquilaria Malacensis Lamk*) in Oil Palm Monoculture Systems.

Khaerul Basyar*, Wawan dan Nurul Qomar
Program Magister Ilmu Pertanian, Universitas Riau
Jln. Pattimura No. 9 Gobah, Pekanbaru 28131, Riau
*email : khaerul@gmail.com

ABSTRACT

The purpose of this study was to compare the total biomass of oil palm in oil palm and gaharu agroforestry systems with oil palm monoculture systems. This research was conducted in February 2020 - April 2020 on an area of agroforestry land (1 ha) and monoculture land (1 ha) located in Bukit Kemuning, Kampar - Riau. The method used in this study is a survey method and systematic sampling and determination of sample plots using the zig-zag method. The results of this study indicate that the microclimate is the light intensity in the agroforestry system ranging from 2,672 lux - 10,928 lux and in the monoculture system 3,023 lux - 12,065 lux, the air temperature in the agroforestry system is 27.1oC - 29.8oC and in the monoculture system it ranges from 27, 0oC – 31.8oC and air humidity in agroforestry has a value of 73% - 88% and in monoculture systems the value ranges from 70% - 80%. The total weight of oil palm plant biomass in the oil palm and gaharu agroforestry system was 4,502.49 kg with an average total biomass of 52.11 tonnes/ha. In the monoculture system, the total weight of biomass in the monoculture system is 4,402.01 kg with an average total biomass of 50.95 tonnes/ha. The results of the 5% level t test showed that the total weight of oil palm plant biomass in the agroforestry system of oil palm and agarwood plants was not significantly different compared to the total biomass of oil palm plants in the monoculture system. The presence of gaharu plants in the oil palm agroforestry system does not affect the total oil palm biomass in the land.

Keyword: *TotalBiomass, oil palm biomass, agroforestry, monoculture, andagarwood*

1. INTRODUCTION

The cultivation of coconut plants, which is currently developing a lot, still applies a cropping pattern with a monoculture system. It is widely known that the oil palm cropping pattern with this monoculture system has a negative impact. Several researchers revealed the negative impact, among others; 1) There is an increase in CO2 gas emissions, resulting in a decrease in plant carbon stock (Herman and Las, 2009). 2) causing low biodiversity in plantation areas due to the absence of forest vegetation (Danielsen et al., 2009). 3) low C-organic content as a source of organic matter in monoculture systems compared to agroforestry systems in increasing plant growth (Agriani et al., 2021).

An alternative to reducing these negative impacts is to develop an agroforestry pattern system (Roslianti, 2020). An agroforestry system also provides a positive role for the environment and can supply organic matter and nutrient cycles in controlling climate factors through soil cover by canopy and litter. In addition, it has another important role are 1) Increasing plant carbon stocks and reducing increases in atmospheric CO2 and other greenhouse gases, 2) Increasing soil fertility through the biomass of tree root systems that are above the ground, and 3) Increasing biodiversity (Roslianti, 2020).

Plants that can be combined with oil palm agroforestry systems are gaharu plants. Gaharu plants are plants that are semi-tolerant or require shade and can increase high economic value in the international market. The oil palm and gaharu agroforestry system has a positive effect on the environment, namely it can produce carbon stocks and can reduce GHG emissions (Sianturi, 2017). However, empirical data to determine the total oil palm biomass in the oil palm and gaharu agroforestry system is not yet available. This research was conducted to determine and compare the total biomass of oil palm in oil palm and gaharu agroforestry systems with oil palm monoculture systems.

2. MATERIALS AND METHOD

2.1. Site Description

This research was conducted in the area of Bukit Kemuning Village, Tapung Hulu District, Kampar Regency, Riau with the coordinates of the research location 0o 38' 51.42" North Latitude and 101o 55' 44.53" East Longitude. With rainfall of ± 2500 mm/year, average temperature is 26o – 28o C and humidity is 78o – 85o C. The research area used was oil palm monoculture (1 ha) with a planting age of 20 years and oil palm and agarwood agroforestry land (1 ha) is at the age of 10 years. The research period lasted for 3 months starting from February 2020 to April 2020.

2.2. Determination of Sampling Plots

The research was conducted using a survey method. Determination of sample plots using the Purposive Sampling method, namely taking sample plots on monoculture oil palm land and oil palm and gaharu agroforestry systems. Determination of sample plots is by using the zig-zag method in each cropping system (agroforestry system and monoculture system). In each cropping system there were 6 sample plots with a plot size of 8x18m. Oil palm samples were taken on 5 samples in each observation plot with a total of 30 samples in each cropping system.

2.3. Observational Measurement

2.3.1 Microclimate measurement.

Microclimate parameters were measured in each observation plot in monoculture systems and agroforestry systems. This environmental parameter is measured because it influences photosynthesis and biomass production optimally. Measurements were taken one day (morning, afternoon and evening) a week for 3 months. The microclimate parameters measured in each observation plot are:

1. Sunlight intensity, light intensity observations were carried out on each sample plot in monoculture and agroforestry systems using a *Luxmeter*
2. Air temperature, temperature observations were made on each sample plot in the monoculture and agroforestry system of oil palm and agarwood using a hanging thermometer.
3. Air humidity. Observations of air humidity were carried out on each sample plot in the oil palm and gaharu monoculture and agroforestry system using a *hygrometer.*

2.3.2. Measurement of Oil Palm Biomass in Agroforestry Systems and Monoculture Systems.

Measurements on the observation of oil palm biomass were carried out on 6 plots in each system where there were 5 oil palm stands. Measurements were made by measuring the diameter of the oil palm tree using a diameter tape with a measurement height of 130 cm from the ground surface. Measurement of the height of the oil palm tree is measured by using a vertex.

Measurement of oil palm plant biomass was carried out based on a non-destructive method with the allometric equation of oil palm biomass using the method according to Lubis (2011) using the allometric equation as follows:

$$Y\ sawit = 0{,}002382\ .D^{2{,}3385}\ .\ H^{0{,}9411} \quad \text{.....(1)}$$

Information:

Y palm = Palm dry biomass (kg)
D = Palm trunk diameter (cm)
H = Free height of palm fronds (m)

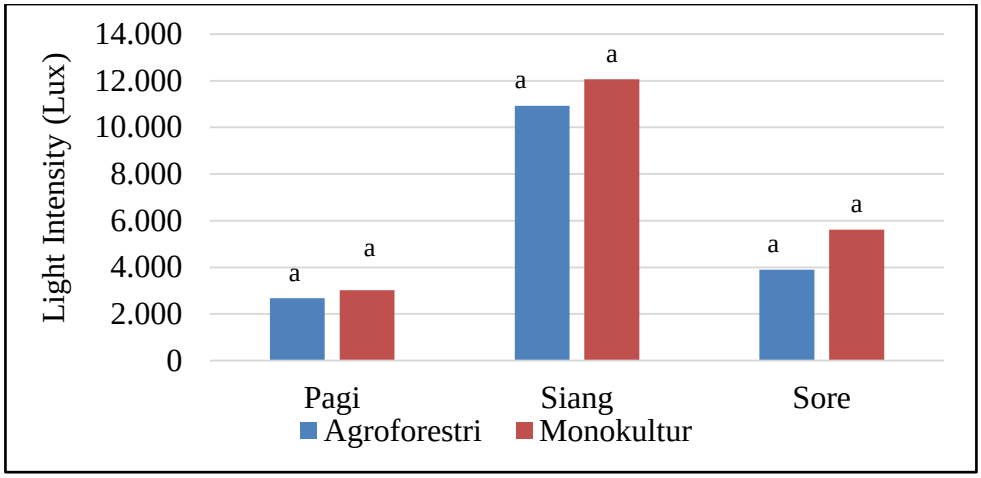
The results of the data analyzed the biomass of oil palm plants in agroforestry systems and oil palm monoculture systems were statistically analyzed using a 5% t-test.

3. RESULTAND DISCUSSION

3.1 Microclimate (Light Intensity, Air Temperature and Air Humidity)

a. Light intensity

The average value of light intensity observations in oil palm and gaharu agroforestry systems and oil palm monoculture systems is presented in Figure 1.



Information : Numbers followed by the same lowercase letter in the graph group are not significantly different according to the 5% level t test

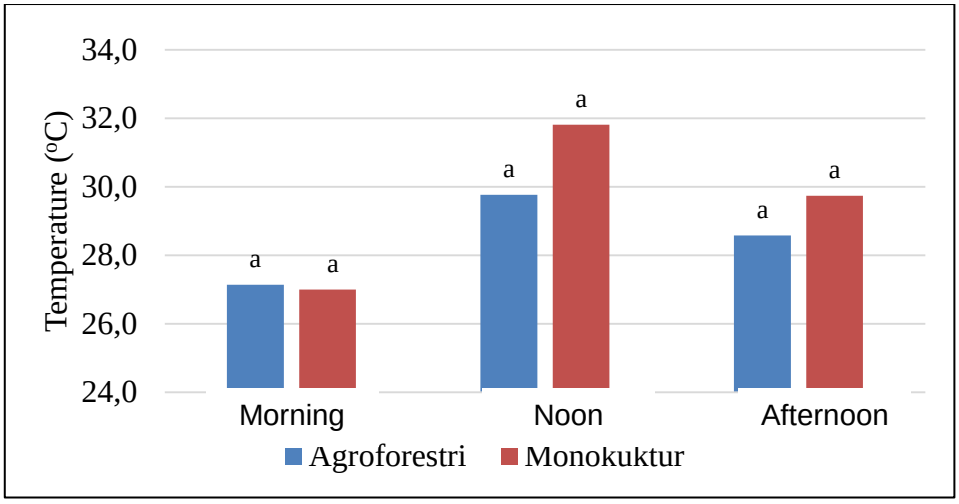
Picture 1. Average Sunlight Intensity Based on Time of Observation (Morning, Afternoon and Evening) in Agroforestry and Monoculture Systems.

Based on Figure 1, it can be stated that the average intensity of sunlight from morning to evening in agroforestry systems ranges from 2,672 lux - 10,928 lux and in monoculture systems 3,023 lux - 12,065 lux. Based on the results of the 5% t-test (showing that the light intensity in the oil palm and gaharu agroforestry system was not significantly different from the monoculture system. This was due to the oil palm canopy density in the oil palm and gaharu agroforestry system as well as in the monoculture system being almost the same. Oil palm in these two cropping systems has the same plant age, which is 20 years. The older the oil palm plant is, the crown density will increase (Zaitunah et al., 2018).

The density of the canopy of oil palm plants causes the light intensity to be low. Anuar and Karyati (2019) state that the presence of trees or vegetation, especially in the canopy, affects the reception of sunlight intensity so that the intensity of sunlight fluctuates based on the condition of the vegetation cover. According to Firdaus and Arifin (2019) the intensity of sunlight received by pure pine plots is greater than that of pine and coffee agroforestry plots, this is due to the smaller pure pine canopy area compared to the crowns of pine and coffee agroforestry systems.

b. Air Temperature

The average value of air temperature observations in the oil palm agroforestry system with gaharu and the oil palm monoculture system is presented in Fig. 2.



Information: Numbers followed by the same lowercase letter in the graph group are not significantly different according to the 5% level t test

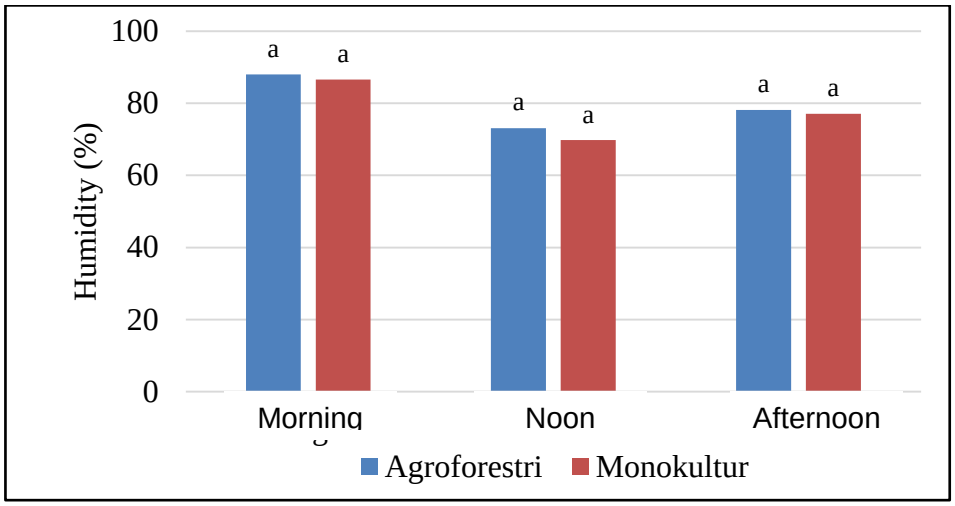
Picture 2. Average Air Temperature Based on Time of Observation (Morning, Afternoon and Evening) in Agroforestry and Monoculture Systems.

Based on the observation that the average air temperature based on different observation times in the agroforestry system is 27.1oC – 29.8oC with the lowest temperature in the morning, then the average air temperature in the monoculture system ranges from 27.0oC – 31.8oC, with the lowest temperature occurring in the morning. The maximum average air temperature in these two systems occurs during the day, then tends to decrease again in the afternoon. The results of the t test at 5% air temperature in the oil palm and gaharu agroforestry system were not significantly different compared to the oil palm monoculture system. In the oil palm and gaharu agroforestry systems, low light intensity will affect low air temperatures. Ecologically, air temperature is a factor supporting plant growth. The results of observations on air temperature showed that air temperature conditions were still within the temperature range needed by oil palm plants as a condition for growth, namely 27oC -31oC. Risza (2008) states that oil palm plants can grow at temperatures of 24oC - 38oC. Sumarna (2007) states that gaharu plants can grow at temperatures of 28oC – 34oC. The results of temperature observations in the agroforestry system showed an average daily temperature of 28.5oC so that the temperature at the study site was still supportive of gaharu growth in the agroforestry system. According to Sudaryono (2001), an increase in air temperature during the day is in line with the intensity of sunlight which increases and will decrease towards the afternoon. Karyati et al. (2016), that the tree canopy in the forest can also function to maintain minimum air temperature conditions.

c. Humidity

The average results of air humidity observations with different observation times in the oil palm and gaharu agroforestry system and the oil palm monoculture system are presented in Figure 3. The highest average humidity is in the morning, which is 88%. While the results of observations on the average air humidity in the monoculture system have a value in the range of 70% - 80% where the highest humidity is found in the

morning also with an average humidity of 80%.



Information: Numbers followed by the same lowercase letter in the graph group are not significantly different according to the 5% level t test

Picture 3. Average Air Humidity Based on Time of Observation (Morning, Afternoon and Evening) in Agroforestry and Monoculture Systems.

Based on the t-test at 5% air humidity in the oil palm and gaharu agroforestry system compared to the oil palm monoculture system, there was no significant difference. This shows that air humidity is affected by the level of light intensity and temperature which is not significantly different between the oil palm and gaharu agroforestry systems and the oil palm monoculture system.

Air humidity in the oil palm agroforestry system with gaharu and the oil palm monoculture system is inversely proportional to the level of light intensity. Low sunlight intensity will increase air humidity and vice versa. Risza (2008) stated that the moisture needed for oil palm plants for growth ranges from 74% - 81%. The results of observations of average air humidity in agroforestry and monoculture systems showed results of 80% and 78% where the humidity level was still within the range of moisture needed for oil palm plants to grow. Likewise with the humidity is needed by gaharu plants where gaharu requires humidity ranging from 60% -80% for its growth.

Anuar and Karyati (2019) stated that daily air humidity in sengon and long bean stands was higher than in open land, due to the presence of tree crowns which prevented sunlight from entering and resulted in a decrease in temperature and an increase in air humidity. According to Sanger (2016), trees tend to increase air humidity and lower temperature due to plant evapotranspiration activity, where trees are very effective in reducing air temperature.

3.2. Oil Palm Biomass in Agroforestry Systems and Monoculture Systems

a. Diameter and Height of Oil Palm

The average results of stem diameter and stem height based on the 5% t-test in the oil palm monoculture system and the oil palm and gaharu

agroforestry system can be seen in Table 1.

Table 1. Average Stem Diameter and Stem Height of Coconut Plants Palm Oil in Agroforestry Systems and Monoculture Systems

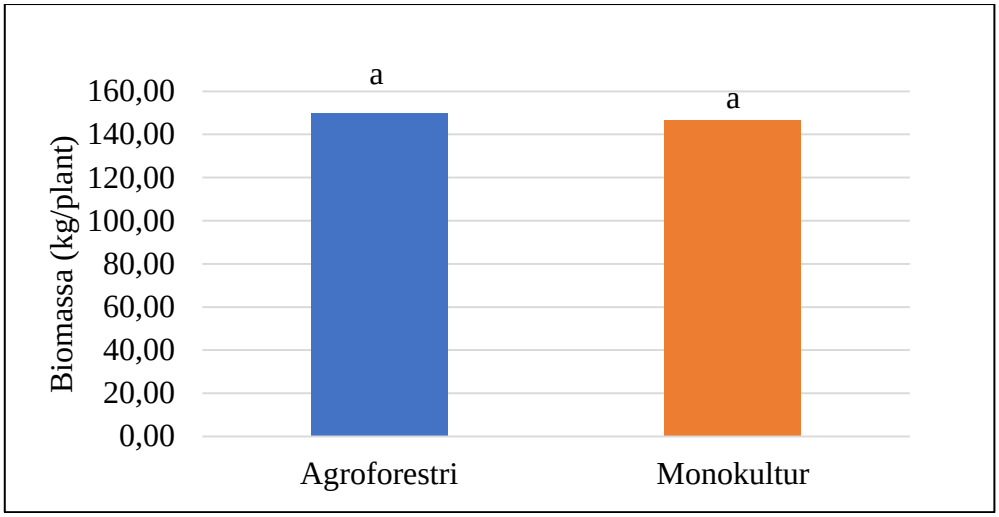
	Agroforestri	**Monocultur**
Stem Diameter (cm)	44,52 a	44,19 a
Stem Height (m)	10,01 a	9,87 a

Information: Numbers followed by the same lowercase letter on a line the same, not significantly different according to the t test at the 5% level

Table 1 shows the average diameter of each oil palm plant in the agroforestry system is 44.52 cm and 10.01 meters high. In the monoculture system, the average diameter of the oil palm plant is 44.19 cm and 9.87 meters high. Based on the t test at 5% level, it showed that the average stem diameter and height of oil palm plants in the agroforestry system and the oil palm monoculture system were not significantly different. This is caused by the oil palm planted in the agroforestry system and the monoculture system have the same age. Growth in stem diameter and height of oil palm plants can depend on plant varieties, soil fertility and climate. According to Leiwakabessy (1998) that the elements P and K play an important role in increasing the diameter of plant stems, especially in their role as a network that connects roots and leaves. Another opinion put forward by Setyamidjaja (2006) states that phosphorus (P) and potassium (K) can improve plant vegetative growth such as stem circumference. Based on the results of research at the same location by Agriani et al (2021) showed that the nutrients P (phosphorus) and K (potassium) in the agroforestry system were not significantly different from the monoculture system. These conditions are thought to support the growth of stem diameter and stem height of oil palm plants in the oil palm agroforestry system and gaharu are no different from the oil palm monoculture system.

b. Palm Oil Plant Biomass

The diameter and height of the oil palm plants are the variables needed in the allometric equation to calculate the biomass of the oil palm plants. The average value of the biomass of each oil palm plant in the monoculture system and the oil palm and agarwood agroforestry system is presented in Figure 4.



Information: Numbers followed by the same lowercase letter in the graph group are not significantly different according to the 5% level t test

Picture 4. Average Biomass of Oil Palm Plants (kg/tree) in Monoculture Systems and Agroforestry Systems

Figure 4 shows that the average biomass content of each oil palm plant in the oil palm and agarwood agroforestry system is 150.08 kg/tree and the average biomass content of oil palm in the monoculture system is the ranges from 146.73 kg/tree. Based on the results of the t-test at the 5% level, the average overall biomass of oil palm plants in the oil palm and gaharu agroforestry system was not significantly different compared to the oil palm monoculture system. This is influenced by the tree diameter and oil palm tree height, where the average diameter of oil palm trees in the oil palm and agarwood agroforestry system is 44.52 cm and the stem height is 10.01 m, not different from the monoculture system which has a diameter of 44.20 cm and a stem height of 9.77m. Yuliasmara et al. (2009) stated that geometrically stand biomass has a parallel relationship with stand diameter and stand height. This is also explained by according to Asari (2013), there is a strong relationship between plant age, height and stem diameter with above-ground biomass. Husch et al (2003) explained that the height of a stand is determined by the age of the stand, in other words, the biomass of the stand is directly proportional to the age of the stand.

The increase in oil palm biomass is influenced by the diameter and height of the tree. This was explained in the research by Rahayu et al. (2007) that the diversity of diameters, the presence of trees with a diameter of > 30 cm in a land use system makes a significant contribution of biomass to the total carbon stock as in primary forest. According to Lubis et al. (2013) standing carbon stocks increased along with an increase in stem diameter and an increase in stand biomass.

Table 2. Total Weight of Oil Palm Plant Biomass found in Agroforestry and Monoculture Systems.

Planting System	Biomass Weight (Kg)	Average Biomass (Ton/Ha)
Agroforestri	4.502,49 a	52,11
Monokultur	4.402,01 a	50,95

Information: Numbers followed by the same lowercase letter in the column the same, not significantly different according to the t test at the 5% level

Table 2 shows the total weight of oil palm plant biomass in the oil palm and gaharu agroforestry system is 4,502.49 kg with an average total biomass of 52.11 tonnes/ha. In the monoculture system, the total weight of biomass in the monoculture system is 4,402.01 kg with an average total biomass of 50.95 tonnes/ha. The results of the 5% level t test showed that the total weight of oil palm plant biomass in the agroforestry system of oil palm and agarwood plants was not significantly different compared to the total biomass of oil palm plants in the monoculture system. This is because the diameter and height of the oil palm trees in the agroforestry system are not different compared to the monoculture system. The total biomass of oil palm in the two plantations was not different, which means that the growth of oil palm was not different because the factors influencing growth were also not different. This was indicated by the light intensity, air temperature and air humidity in the oil palm and gaharu agroforestry systems, which were not different from the oil palm monoculture. Another thing is the good quality of the soil in the agroforestry system compared to the monoculture system because of the large amount of organic matter in the agroforestry system. The results of this study are in line with research at the same location by Agriani, et al. (2021), that the organic matter content in the oil palm and agarwood agroforestry system is higher than the oil palm monoculture system. Increased organic matter and soil nutrients play a role in improving soil quality which supports the process of plant growth, especially the growth of plant diameter and height.

Muhdi's research, et al. (2014), stated that the average biomass of oil palm plants in oil palm plantation plots in Binjai, North Sumatra, based on the level of soil fertility at the site, was respectively 64.31 tons/ha on fertile land, 59.32 tons/ha on medium fertility rate and 47.56 tonnes/ha in low fertility locations. Based on research by Yuliyanto et al. (2014), the content of stored biomass in oil palm plants (carbon biomass) in red yellow podzolic soil in the oil palm plantation of PT. DDP was grouped based on plant age and showed that the biomass content in the 16-20 year age group was 51.74 tons/ha. The results of research by Tjitrosemito and Mawardi (2001) stated that the biomass content of oil palm aged 19 years was around 40.28 tons/ha.

According to Haygreen and Bowyer (1997) that with age through the formation and enlargement of cells that divide repeatedly to form new cells that

are meristematic. Carbon derived from CO2 is taken up by plants and stored in the form of biomass, with increasing tree diameter, the ability of trees to store free carbon from the air is higher. Rahayu et al. (2007) stated that the factors that influence differences in biomass recovery are wood density, variations in diameter size and specific gravity. Trees that have a high wood density have a high biomass compared to trees with a low wood density.

4. Conclusion

The total biomass of oil palm plants in the oil palm and gaharu agroforestry system was not different from the total biomass of oil palm in the monoculture system. The factors affecting the growth of oil palm plants in the two systems were not significantly different, such as the microclimate, namely light intensity, air temperature and humidity. Another influencing factor is the soil quality in the agroforestry system is better than the monoculture system so that the presence of gaharu plants in the agroforestry system does not affect the growth of oil palm as a core crop.

REFERENCE

Agriani Feri, Rendika, Wawan dan Nurul Qomar. 2021. Physical Properties of Soil in Oil Palm Agroforestry Systems (*Elaeis guineensis* Jacq.) with Gaharu (*Aquilaria malaccensis* Lamk.) and in Oil Palm Monoculture Systems. *JUANTIKA*. 3(1): 18-28.

Asari N, Suratman MN, Jaafarm J, Khalid MM. 2013.Estimation of above ground biomass for palm oil plantation using allometric equations. IACSIT Press [internet]. [diunduh 2014 1 September]. Tersedia pada: www.ipcbee.com /vol58/022-ICBEC2013-H3013.pdf

Danielsen, F., H. Beukema, N. D. Burgess, F. Parish, C. A. Brühl, P. F. Donald, D. Murdiyarso, B. Phalan, L. Reijnders, M. Struebig, E. B. Fitzherbert., 2009. Biofuel plantations on forested lands: double jeopardy for biodiversity and climate. Conserv Biol. 23 (2) :348-358.

Firdaus, M. F. dan Arifin. 2019. Karakteristik Unsur Lingkungan Mikro pada Tegakan Hutan Pinus *(Pinus Merkusii Jungh)* dan Mahoni (*Sweietenia Macrophylla King*). *Produksi Tanaman*. 7 (3): 495-504.

Herman dan Irsal Las.2009. Analisis Finansial dan Keuntungan yang Hilang dari Pengurangan Emisi Karbon Dioksida pada Perkebunan Kelapa Sawit.*Jurnal Litbang Pertanian*. 28(4): 127-133.

Husch, B., TW Beers, JA Kershaw. 2003. Forest Mensuration. John Wiley and Sons Inc.: New Jersey.

Hairiah, K., Rahayu, S. 2007. Pengukuran ‘Karbon Tersimpan’ di Berbagai Macam Penggunaan Lahan.World Agroforestry Center.ICRAF Southeast Asia Regional Office. Bogor.

Karyati, Sidiq Ardianto, dan Muhammad Syafrudin.2016.Fluktuasi Iklim Mikro Di Hutan. *Jurnal AGRIFOR*.XV:1

Lubis AR. 2011. Pendugaan Cadangan Karbon Kelapa Sawit Berdasarkan Persamaan Allometrik Di Lahan Gambut Kebun Meranti Paham PT Perkebunan Nusantara IV Kabupaten Labuhan Batu Sumatera Utara. [skripsi]. Bogor (ID): Institut Pertanian Bogor.

Leiwakabessy, F. M. 1998. Kesuburan Tanah. IPB Press. Bogor

Muhdi, Hanafiah D.S dan Saragih E.S. 2014. Pendugaan Cadangan Karbon Pada Tanaman Karet (Hevea brasiliensis Muell. Arg.) Umur 10 Tahun di Perkebunan Rakyat Desa Tarean, Kecamatan

Silindak, Kabupaten Serdang Bedagai. Sumatera Utara

Rahayu, S., B. Lusiana dan M. Van Noordwijk.2007. Sistem Penggunaan Lahan di Kabupeten Nunukan, Kalimantan Timur.

Roslianti, M. 2020. Keanekaragaman Hayati Tanah pada Sistem Agroforestri Tanaman Kelapa Sawit (*Elaeis guineensis* Jacq.) dengan Gaharu (*Aquilaria malaceensis* Larmk.) dan Sistem Monokultur Kelapa Sawit. Tesis. Universitas Riau.

Setyamidjaja, D. 2006. Kelapa Sawit. Kanisius.Yogyakarta.127 hal.

Sianturi, F. 2017. Daya Saing Kelapa Sawit Indonesia dengan Sistem Budidaya Agroforestri. Tesis. Bogor. Institut Pertanian Bogor

Sudaryono.2001. Pengaruh Bahan Pengkondisi Tanah Terhadap Iklim Mikro pada Lahan Berpasir.*Jurnal Teknologi Lingkungan*. 2(2): 175-184.

Tjitrosemito, S dan I. Mawardi. 2001. Terrestrial Carbon Stock in Oil Palm Plantation. Biotrop. Bogor

Yulianti, N. 2009.Cadangan Karbon Lahan Gambut Dari Agroekosistem Kelapa Sawit PTPN IV Ajamu, Kabupaten Labuhan Batu, Sumatera Utara. Tesis Sekolah Pascasarjana Institut Pertanian Bogor. Bogor.

Yuliasmara F, Wibawa A, Prawoto AA. 2009. Karbon Tersimpan pada Berbagai Umur dan Sistem Pertanaman Kakao :Pendekatan Allometrik. Pelita Perkebunan. 25(2):86_100.

Yuliyanto , Dede Setiadi , Sulistijorini. 2014. Pendugaan Cadangan Karbon Tersimpan pada Kelapa Sawit (*Elaeis Guineensis* Jacq.) Dan Analisis Kesuburan Tanah di Perkebunan PT Daria Dharma Pratama Ipuh Bengkulu, Jurnal Citra Widya Eduksasi

Zaitunah A, Samsuri, Ahmad AG dan Safitri RA. 2018. Normalized difference vegetation index (NDVI) analysis for land cove types using landsat 8 OLI in Besitang Watershed, Indonesia. IOP Conference Series: Earth and Environmental Science. 126(1): 1-9