INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 8, No. 1, p. 81-86, 2016

RESEARCH PAPER OPEN ACCESS

Estimating stored carbon stock in oil palm (*Elaeis guineensis* Jacq.) plantation by age group in PT daria dharma pratama plantation Bengkulu Indonesia

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Article published on January 25, 2016

Key words: Carbon biomass, Oil palm plantation, PT DDP.

Abstract

The increasing concentration of carbon in the atmosphere is a serious environmental problem that can affect living system on earth. The increase in greenhouse gas emissions caused global warming that will affect the world climate change and rising sea levels. Climate change will disrupt farming system in both the micro and macro scale. Estimation of forest carbon emissions is one of the important efforts to reduce climate change. Land clearing for palm oil plantations will affect the stored carbon in the forest reserves. The aim of this study is to determine the biomass stored carbon stocks in oil palm plantations by age group in oil palm plantations in PT Daria Dharma Pratama (PT DDP), Bengkulu Province, Indonesia. Methods of measuring the stored carbon stock of palm oil biomass using allometric equations, is non-destructive method. Methods of measuring the stored carbon stock of undergrowth biomass and piled of oil palm fronds up was conducted by destructive methods. The largest biomass stored carbon stock was in the age group of 11-15 years crop of 69.32 tonnes ha^{-1}. Then, in the age group of 16-20 years were 54.13 tonnes ha^{-1}, age group of >20 years were 34.91 tonnes ha^{-1}, the age group of 6-10 years were 34.16 tonnes ha^{-1}, and the age group 0 - 5 year were 6.98 tonnes ha^{-1}, respectively. Stored carbon stock in oil palm was influenced by the age of the plant, soil fertility, as well as plant growth and development.

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Introduction

The increasing concentrations of carbon in the atmosphere is a serious environmental problem that can affect life on Earth. Greenhouse gas (GHG) avoids solar radiation energy reflected by the earth's surface to penetrate the atmosphere so that it will bounced back to the earth that can cause global warming. Between the years 1906-2005 the Earth's surface temperature increased by an average 0.74°C (IPCC, 2007). Temperature is an indicator of global warming affecting world climate change. Climate change will disrupt farming system in both the micro and macro scale. In 1997, The Kyoto Protocol has been agreed internationally to prevent global warming more severe and Indonesia has been ratified it on February 16, 2005. The Indonesian government will decrease the rate of global warming by reducing carbon emissions by 26%. The Indonesian Government (under President Susilo Bambang Yudhoyono leadership) pledged to the international community (The Climate Summit in Oslo, Norway, 2010) not to open new oil palm plantations on forest areas and on peatlands.

The expansion of oil palm cultivations, especially by converting forests, potentially causing the elevation of greenhouse gas emissions (GHG). Oil palm plantations in Indonesia rose sharply with an average rate of 12.30% within a year since 1980 (Herman *et al.* 2009). In 2013, oil palm plantations in Indonesia covering an area of 10.4 million ha and continued to increase in 2014, which includes 10.9 million ha and the estimated area in 2015 reached 11.4 million ha (Ditjenbun, 2014).

Campaigns by some developed countries about the global climate change which assuming that oil palm as one of the main causes of climate change much less fair. Rehabilitation shrub in the area of peatlands into oil palm plantations only increase the emissions of 8 tonnes of CO_2-equivalents ha^{-1} $year^{-1}$, than if thicket peat was abandoned (Fahmuddin *et al.*, 2009). Asmani (2014) stated that carbon emissions for shrub land were 5.5 tonnes of CO_2 ha^{-1} $year^{-1}$. Potentially, carbon stocks of oil palm grown on former scrub land was 24.64 tonnes of CO_2 ha^{-1} $year^{-1}$.

Oil palm is an annual plant that potentially absorb carbon emissions. The age of oil palm could reach more than 20 years. Carbon stored in palm oil plant will be amended along with the growth and development of plants. The growth rate of plants will be affected by the condition of soil fertility where the plant is located. The research objective was to determine the biomass stored carbon stocks in oil palm plantations (oil palm plant biomass carbon, undergrowth and piles of palm fronds) in each age group in the oil palm plantation at PT Daria Dharma Pratama, Bengkulu, Indonesia.

Materials and methods

Research time and location

This study was conducted in February 2014 and March 2015. The research process includes field activities, analysis field data and data processing. The study was conducted in PT Daria Dharma Pratama oil palm plantations, Bengkulu Indonesia.

Methods and research implementation phase

The research was conducted in three main stages which consists of research preparation, field measurements and data analysis.

Preparation

Research preparations include the determination of sample points for the data collection, which based on the map data acquisition block, the latest areal statement and staple census. Sample points were determined based on the year of oil palm planting in the block and slope conditions.

Field measurements

Carbon measurement of oil palm biomass

Determination of plant samples was done by considering the condition of the plantation land, which was approximately at the mid-way collection (collection road) on each block (Fig. 1). Data was collected in a single row crop plants with 10 samples, each was 5 plants at the right side and 5 plants at the

left side. At every age group of oil palm, the trunk diameter were recorded at chest height (DBH) (± 130 cm) and trunks height at branched freely trunk were 10 plants per ha as a sample.

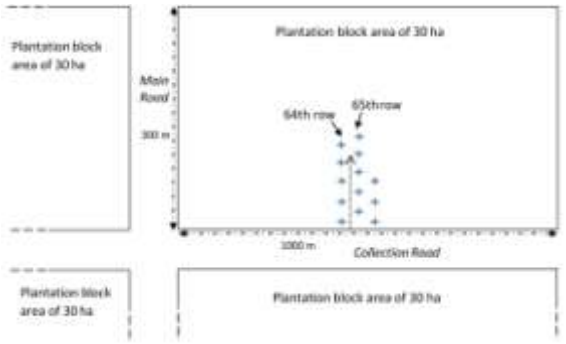

Fig. 1. Plan determination of plant samples.

Undergrowth carbon biomass and piles of midrib measurement

Sampling of undergrowth biomass and piles midrib were done by destructive methods (taking parts of the plant as an example). Sampling of undergrowth biomass and piles frond were done in the area in each age group of oil palm. Undergrowth plant samples were all plant life in the form of a tree with a diameter <5 cm, herbs and grasses. Sampling point of the undergrowth vegetation consists of three plots sized 1m × 1 m which was located on row life, row death and between plants. The sampling point of the piles of the midrib consists of two plots sized 1m × 1m which was located on row death (Fig. 2). All undergrowth plants and piles of midrib in each plot were taken using a knife/scissors then weighed for wet biomass. 100-300 g of undergrowth plant were dried using an oven to determine the weight of the dry biomass.

Data analysis

Estimation of the carbon biomass in oil palm

The carbon content in the oil palm biomass were estimated by non-destructive methods with allometric equation (Lubis, 2011). Model allometric equation used was $Y = 0.002382 \, . D^{2.3385} \, . H^{0.9411}$

Description:

Y = carbon dry biomass (kg/plant),

D = diameter of the trunk at chest height midrib measured perpendicular to the trunk (cm),

H = trunk height, branched freely plant (m).

Carbon biomass in the age group of plants per hectare (kg/ha) = Carbon biomass (kg/plant) x Σ plants/ha.

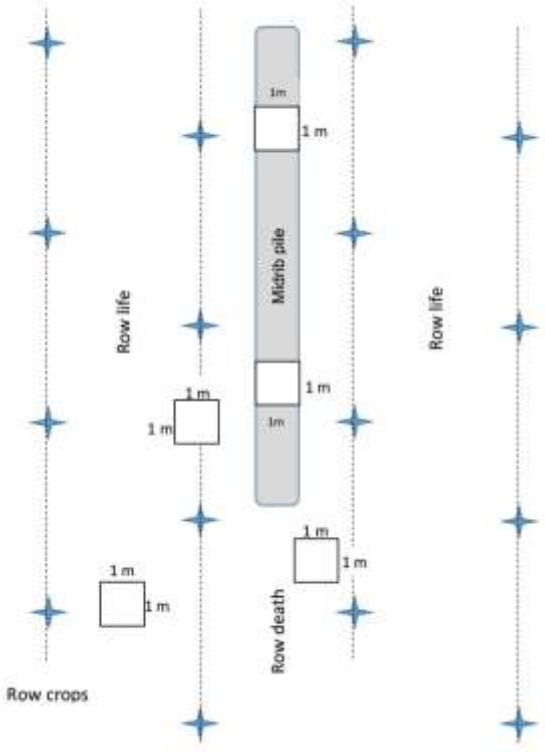

Fig. 2. Plot sampling of undergrowth and pile midrib sample in row death.

Estimation of undergrowth carbon biomass and piles midrib

Estimation of biomass carbon stock of the undergrowth plant and piles midrib were calculated by the following formula:

$$Biomass\ carbon\ stock = weight\ of\ dry\ biomass\ x\ \%organic\ C$$

The percentage of carbon in organic matter that is equal to 47% (Badan Standardisasi Nasional, 2011).

$$Weight\ of\ dry\ biomass/hectare = weight\ of\ dry\ biomass\ per\ m^2\ x\ the\ area/ha$$

Results and discussion

The stored carbon stock in palm oil plantation

Results of measurements of stored carbon stock in the oil palm plantations in PT Daria Darma Pratama is shown in Table 1. The largest stored carbon stock in oil palm crops are in the age group of 11-15 year, which the value is 65.89 tonnes ha^{-1}. The lowest stored carbon stock was in the age group of 0-5 years with the value 1.61 tonnes ha^{-1}. The stored carbon stock will increase along with increasing age of the plant. The taller the oil palm, the stored carbon stock will be affected. The older the plant will be followed by the increasing of plant height. According to Setyamidjaja (2010), the height growth rate of oil palm varies depending on the seed type or varieties. Generally, the height growth (height gain) of the oil palm approximately 25-40 cm per year. The growth and development of oil palm cannot be separated from the increasing rate of its photosynthesis. According to Gardner *et al.* (1991), photosynthesis will produce assimilate which will be accumulated into a dry weight of plants. Dry weight indicates the efficiency of absorption and utilization of solar radiation during the planting season. The increase of the dry weight indicates that there is an increase in the efficiency of absorption and utilization of solar radiation by the shoot, and the assimilate production will increase as well.

Table 1. Estimating stored carbon stock in oil palm crops by age group.

The age group of oil palm (year)	Average plant height (m)	Average plant diameter (cm)	C biomass plant (kg)	C biomass per hectare (ton ha^{-1})
0 – 5	0.20	71.80	11.86	1.61
6 – 10	3.28	83.87	234.26	31.86
11 – 15	8.05	79.07	484.46	65.89
16 – 20	8.04	71.53	380.47	51.74
>20	8.34	57.50	243.16	33.07

In the group of 16-20 years plant and group of > 20 years showed the decreasing of the stored carbon stock. This is because plant in the group of 16-20 years, the palm fronds start to fall separated from the trunk, causing a decrease in trunk diameter. According to Setyamidjaja (2010), the palm leaves base usually start off (fall) after the plant was 10 years or more. The midrib base that falls can start from anywhere, but more often from mid-tall trunks. A decline in the stored carbon of biomass is also suspected due to an increasing number and length of the palm leaf midrib along with the age of the plant. The planting pattern of the oil palm is equilateral triangular shape with the ideal number of plants 136 plants per hectare for mineral soil, with a spacing of 9.2 m × 9.2 m × 9.2 m (Pahan, 2006). Palm leaf midrib in length between 5 to 9 m (Hartley, 1988). Long fronds of palm oil crops will increase along with increasing age of the plant. The distance between plants is 9.2 m and the frond length is about 9 m, these can make the plant canopy overlapping, so that the plant will compete one and another for the sunlight. The intensity of sunlight receives by the midrib especially under the fronds will be less than the upper one. Declining the intensity of light received by the plant will impact on dry weight of the plant. The amount of light captured in the process of photosynthesis reflected as the biomass, while the amount of biomass in plant tissue reflects the dry weight of the plant (Widiastuti *et al.*, 2004). The older the age of the plant the higher level of sunlight is needed and otherwise the younger plants need lower light intensity till to its optimum limit (Nasaruddin *et al.*, 2006).

The highest stored carbon stock in undergrowth plant biomass in oil palm plantations in PT DDP was obtained by the age group 0-5 years with value 5.22 tonnes ha^{-1} (Table 2.). The lowest stored carbon stock of biomass was obtained by the age group> 20 years

with value 0.12 tonnes ha^{-1}. Increasing age of the oil palm hampered the growth and development of the undergrowth plants. Growth and development of undergrowth plants hampered because of the competition of sunlight for photosynthesis. Increasing age of the oil palms will then produce even greater vast canopy cover.

Table 2. Estimating stored carbon stock in the undergrowth and piles midrib by age group of plants.

The age group of oil palm (year)	Undergrowth		Piles midrib	
	C biomass per m^2 (gr)	C biomass per ha (ton)	C biomass per m^2 (gr)	C biomass per ha (ton)
0 – 5	702.14	5.22	235.80	0.15
6 – 10	97.41	0.72	2,473.66	1.58
11 – 15	71.33	0.53	4,538.01	2.90
16 – 20	22.71	0.17	3,470.24	2.22
>20	16.08	0.12	2,691.66	1.72

The largest stored carbon stock on a pile of palm fronds biomass located in death row are in the age group 11-15 years which amount to 2.90 tonnes ha^{-1}. The lowest stored carbon stock biomass found in the age group 0-5 years which amount to 0.15 tonnes ha^{-1}. Biomass carbon stored in the pile midrib depending on how many midribs are cut from the oil palm trunk and stacked in rows death. The productivity of oil palm plantations will affect the amount of heap midrib in row death.

Biomass carbon content stored on the palm plantations are affected by the carbon content of oil palm crop biomass, the carbon content of undergrowth plant biomass and the carbon content of the pile midrib biomass. This research showed that the stored carbon stock of biomass on oil palm plantation in PT DDP is in the range of 6.98-69.32 tonnes ha^{-1}. The stored carbon stock of crops biomass, in the age group 11-15 years, amount to 69.32 tonnes ha^{-1}. Then successively, in the age group 16-20 years amount to 54.13 tonnes ha^{-1}, age group> 20 years amount to 34.91 ton ha^{-1}, 6-10 years age group amount to 34.16 ton ha^{-1}, and the age group 0-5 years amount to 6.98 tonnes ha^{-1}. These results are higher than the results of Yulianti (2009), which states biomass carbon content of oil palm on peat soils in the range between 0.7-16.43 tonnes ha^{-1}.

Growth and development of palm oil plantations will affect biomass carbon in oil palm plantations and also influence plant biomass carbon under. Harvesting and and plants treatment will affect the amount of palm fronds are cut and stacked in rows death.

Conclusion

Stored carbon stock in oil palm is influenced by plant age, soil fertility, as well as plant growth and development. The highest stored carbon stock of biomass in oil palm Plantations, PT DDP, is in the age group of 11-15 years crop which amount to 69.32 tonnes ha^{-1}. Then respectively, the stored carbon stock of the age group of 16-20 years amounts to 54.13 tonnes ha^{-1}, age group of > 20 years amount to 34.91 ton ha^{-1}, age group of 6-10 years amount to 34.16 ton ha^{-1}, and age group of 0-5 years amount to 6.98 tonnes ha^{-1}.

References

[Ditjenbun] Direktorat Jenderal Perkebunan. 2014. Statistik Perkebunan Indonesia 2013-2015. Jakarta: Kementerian Pertanian.

[IPCC] Intergovernmental Panel on Climate Change. 2007. Climate Change 2007 - The Physical Science Basis, Contribution of Working Group I to The Fourth Assessment Report of the IPCC. New York: Cambridge University Press.

Asmani N. 2014. Kelapa Sawit Komoditas Unggulan Sumatera Selatan Yang Ramah Lingkungan. Makalah pada Seminar Pelantikan Pengurus Gabungan Pengusaha Kelapa Sawit Indonesia (GAPKI) Sumatera Selatan, Palembang 16 Januari 2014.

Badan Standardisasi Nasional. 2011. Pengukuran dan Penghitungan Cadangan Karbon-Pengukuran Lapangan Untuk Penaksiran Cadangan Karbon Hutan. Jakarta: SNI **7724,** 2011.

Fahmuddin A, Runtunuwu E, June T, Susanti E, Komara H, Syahbuddin H, Las I, Meine van Noordwijk. 2009. Carbon Dioxide Emission in Land Use Transitions to Plantation. Jurnal Penelitian dan Pengembangan Pertanian **28(4),** 119-126.

Gardner FP, Pearce RB, Mitchell RL. 1991. Physiology of Crop Plants. Jakarta: Universitas Indonesia Press.

Hartley, CW, S. 1988. The Oil Palm: (*Elaeis guineensis* Jacq.). London: Longman Group Limited.

Herman, Fahmuddin A, Irsal L. 2009. Analisis Finansial dan Keuntungan Yang Hilang dari Pengurangan Emisi Karbon Dioksida pada Perkebunan Kelapa Sawit. Jurnal Penelitian dan Pengembangan Pertanian **28(4),** 127-133.

Lubis AR. 2011. Pendugaan Cadangan Karbon Kelapa Sawit Berdasarkan Persamaan Alometrik di Lahan Gambut Kebun Meranti Paham, PT Perkebunan Nusantara IV, Kabupaten Labuhan Batu, Sumatera Utara [skripsi]. Bogor: Fak Pertanian IPB.

Nasaruddin, Musa Y, Kuruseng MA. 2006. Aktivitas Beberapa Proses Fisiologis Tanaman Kakao Muda di Lapang pada Berbagai Naungan Buatan. Jurnal Agrisistem **2 (1),** 26-33.

Pahan I. 2006. Panduan Lengkap Kelapa Sawit. Manajemen Agribisnis dari Hulu hingga Hilir. Jakarta: Penebar Swadaya.

Setyamidjaja D. 2010. Kelapa Sawit. Teknik Budidaya, Panen dan Pengolahan. Yogyakarta Kanisius.

Widiastuti L, Tohari and Sulistyaningsih E. 2004. Pengaruh Intensitas Cahaya dan Kadar Daminosida Terhadap Iklim Mikro dan Pertumbuhan Tanaman Krisan Dalam Pot. Jurnal Ilmu Pertanian **11(2),** 35-42.

Yulianti N. 2009. Cadangan Karbon Lahan Gambut dari Agroekositrunk Kelapa Sawit PTPN IV Ajamu, Kabupaten Labuhan Batu Sumatera Utara [tesis]. Bogor: Program Pascasarjana, Institut Pertanian Bogor.