ALLOMETRIC EQUATION OF OIL PALM: AN ESTIMATION APPROACH OF BIOMASS CARBON STOCK IN TROPICAL PEATLAND

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ABSTRACT

Allometric equation can be used to estimate both oil palm biomass and carbon, particularly in peatland. They are a supporting key of sustainable and environmental concept management. This study was carried out in oil palm agro ecosystem PTPN IV Ajamu, Labuhan Batu, North Sumatera, INDONESIA. Data were gathered by destructive method, and the method used was regression equation which biomass of oil palm was correlated to its dimensions. The result showed that to determine C biomass of oil palm, the best model found developed using allometric equations was $\hat{Y} = \beta 0 D \beta 1 H \beta 2$ *with R2 of 0.99. To obtain its model there were used several parameters : (i) stem diameter including rachis measured at natural angle (D1) combined by total height (H1), (ii) stem diameter including rachis measured at uphill side (D2) combined by the branch (H2), and (iii) stem diameter without rachis (D3) combined by the height of the stem without branch (H2).*

INTRODUCTION

The increase of carbon concentration in the atmosphere has become a crucial environment problem that affects the life system on earth. The increase of glass house gas causes the sun radiation energy absorbed by the earth unable to go through the atmosphere, and therefore, bounces to the earth and results in global warming. To provide worse global warming, an international agreement was made in 1997; namely Protocol Kyoto. In this agreement, there is an obligation of all developed countries to give contribution to the developing countries by providing compensation as much as the amount of carbon reduced known as carbon credit. If countries joint in the market so that they must have result of their carbon estimation.

Most of carbon stored in a tree stand derives from tree biomass; hence, the measurement of tree biomass in a region is the most essential stage in assuming the stored carbon. Such a measurement can be conducted either directly by cutting the tree and measuring weight each part of it, or indirectly by using allometric equation of tree biomass.

Allometric equation is solution for measure in large area. The formula of allometric equation used to assume oil palm biomass carbon was created by Thenkabail (2004), but it was not applied in the peat land. Therefore, this study was aimed to formulate them particularly in tropical peatland.

MATERIAL AND METHODS

The study was carried out in oil palm agroecosytem of PTPN IV Ajamu, Labuhan Batu, North Sumatera. Data were collected by field measurement and laboratory analysis. The equations arranged by destructive method namely, 34 trees were intentionally selected and then cut. Thus, they were calculated based on regression equation which biomass of oil palm was correlated to its dimensions such as models:

$\hat{Y} = \beta_0 D^{\beta 1}$ (Brown 1997)..... (1)
$\hat{Y} = \beta_0 + \beta_1 D^2 H$ (Ogawa *et al.* 1965)..... (2)
$\hat{Y} = \beta_0 D^{\beta 1} H^{\beta 2}$ (Chave*et al.* 2005) .....(3)

With:
$\hat{Y}$ is biomass (kg)
D is diameter/DBH (cm)
H is height (cm)
$\beta_0, \beta_1, \beta_2$ is regression Constanta
The best regression equation was selected from the above hypothetical model by using the coefficient of determination (R^2)

RESULTS

Oil Palm Dimensions

An interesting phenomenon on oil palm trees grown in peat land is that their age of planting is not always linear with their diameter and height of the trees.

Table 1. Average of Diameter and High Oil Palm Sample

Age (year)	Diameter (cm)			Height (cm)		
	With Rachis		Without Rachis			
	Natural Angle D1	Uphill Side D2	Uphill Side D3	Total H1	Without Branch H2	Slope Length H3
18	78.4	78.4	50.6	1502	518	528
17	80.5	74.4	51.2	1236	610	592
13	70.0	72.0	46.0	1106	314	295
11	81.5	81.5	55.2	1029	269	257
9	83.5	82.0	60.6	1136	244	236
2	44.6	44.6	26.8	336	53	53
1	35.3	35.3	22.8	308	46	46

Whereas, during growth of oil palm so its biomass will increase but stop at definite age.

Table 2. Biomass of Oil Palm Sample

Age (Year)	Dry Weight Biomass (kg/tree)
18	207.93
17	229.80
13	177.20
11	185.37
9	169.92
2	14.11
1	9.84

Allometric Equations

Each different plant has different pattern to form this kind of allometric equation. This study was first research in Indonesia to initiate the construction of an allometric equation for oil palm grown in peatland.

Table 3. Regression Constanta of Regression Model of Allometric to Calculate Oil Palm Biomass as Basic of Carbon Biomass Estimation

Regression Model	Variable	$ß_0$	$ß_1$	$ß_2$	R^2
Model I : $Y = ß_0 D^{ß1}$					
	D1	8.00 exp $^{-6}$	3.89		0.96
	D2	6.00 exp $^{-6}$	3.97		0.95
	D3	2.00 exp $^{-4}$	3.49		0.93
Model II : $Y = ß_0 + ß_1 D^2H$					
	D1;H1	8.30	2.00 exp $^{-5}$		0.92
	D2;H1	8.89	2.00 exp $^{-5}$		0.89
	D3;H1	17.59	5.00 exp $^{-5}$		0.84
	D1;H2	41.57	6.00 exp $^{-5}$		0.82
	D2;H2	32.97	6.00 exp $^{-5}$		0.87
	D3;H2	32.15	1.00 exp $^{-4}$		0.87
	D1;H3	43.74	6.00 exp $^{-5}$		0.80
	D2;H3	36.19	6.00 exp $^{-5}$		0.84
	D3;H3	34.49	1.00 exp $^{-4}$		0.86
Model III : $Y = ß_0 D^{ß1} H^{ß2}$					
	D1;H1	2.29 exp $^{-5}$	1.55	1.29	0.99
	D2;H1	2.14 exp $^{-5}$	1.51	1.33	0.93
	D3;H1	7.08 exp $^{-5}$	1.11	1.47	0.98
	D1;H2	2.69 exp $^{-4}$	2.31	0.57	0.98
	D2;H2	2.45 ex p^{-4}	2.30	0.60	0.99
	D3;H2	2.24 exp $^{-3}$	1.85	0.68	0.99
	D1;H3	1.38 exp $^{-4}$	2.41	0.55	0.98
	D2;H3	1.95 exp $^{-4}$	2.39	0.58	0.98
	D3;H3	1.95 exp $^{-3}$	1.93	0.66	0.98

CONCLUSIONS

The best allometric equation was Model III with a form $\hat{Y} = \beta_0 D^{\beta 1} H^{\beta 2}$. Variables used were combinations between (i) stem diameter including rachis measured at natural angle (D1) combined by total height (H1), (ii) stem diameter including rachis measured at uphill side (D2) combined by the height of the stem without branch (H2), and (iii) stem diameter without rachis (D3) combined by the height of the stem without branch (H2), in which each R^2 value of equation was 0.99.

It is suggested that in order to construct a more accurate allometric equation the plants used has a range of 1 to 2 year difference of planting age, including young plants up to those which were unproductive anymore. It is in this way that a more detail growth pattern will be able to obtain.

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