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BIOMASS TABLES FOR COMMON *LEUCAENA LEUCOCEPHALA*: TOOLS FOR STAND MANAGEMENT

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MACDICKEN, K.G., NULL, W.S. & ROBINSON, M.E. 1997. Biomass tables for common *Leucaena leucocephala* : tools for stand management. Stands of common varieties of the multi-purpose, nitrogen-fixing tree species *Leucaena leucocephala* (Lam.) de Wit (leucaena) are underutilized in Asia and the Pacific. These stands could be managed as sources of fiber and fodder if the quantities of useable wood and foliage could be easily estimated. Trees from mature, natural stands of common leucaena on the islands of Guam, Saipan and Oahu were measured and the data fit to equations for total tree weight, wood weight and foliage weight. Weight tables are provided as management tools for determining the amounts of wood and foliage present in common leucaena stands.

Key words: *Leucaena leucocephala* - biomass - weight tables - stand management - multipurpose tree species

MACDICKEN, K.G., NULL, W.S. & ROBINSON, M.E. 1997. Jadual biojisim untuk *Leucaena leucocephala:* alat untuk pengurusan dirian. Dirian varieti biasa spesies pokok pelbagai guna, pengikat nitrogen *Leucaena leucocephala* (Lam.) de Wit (leucaena) kurang digunakan di Asia dan Pasifik. Dirian ini dapat diuruskan sebagai sumber gentian dan ragutan sekiranya kuantiti kayu dan dedaun yang boleh digunakan dapat ditaksir dengan mudah. Pokok leucaena dari dirian yang matang dan semula jadi di pulau-pulau Guam, Saipan dan Oahu disukat dan datanya dimasukkan dalam persamaan-persamaan jumlah berat pokok, berat kayu dan berat dedaun. Jadual berat disediakan sebagai alat pengurusan untuk menentukan jumlah kayu dan dedaun yang hadir dalam dirian leucaena biasa.

Introduction

Increasing human populations and declining forest area suggest a need to explore the use of forest resources of all types. One resource of unknown size and value is scattered stands of common varieties of *Leucaena leucocephala* (Lam.) de Wit (leucaena). This multipurpose tree species has been used pan-tropically for a variety of wood and foliage uses. However, most of the leucaena varieties currently in use are "giant" varieties that have been planted in plantations or as components of agroforestry systems. Natural stands of common leucaena varieties are seldom used intensively for commercial purposes.

Natural stands of common varieties of leucaena are found in parts of Mexico, Central America, Southeast Asia and the Pacific. These common varieties are shrubby trees which rarely exceed 10 -12 meters in height, and are often found in very densely populated natural stands. Common leucaena (sometimes referred to as the Hawaiian variety) was introduced to the Philippines with Spanish galleons in 1565. It was introduced from there into other parts of the Pacific (Pound & Cairo 1983). By the 19th century it was used as a human food, cattle feed, shade and nurse tree (Oakes 1968). It is now found in dense natural stands on the islands of Guam, Saipan, Tinian, Corregidor and Oahu – all established by aerial seeding from military aircraft in the 1930s and '40s (National Research Council 1981).

In contrast, "giant" varieties of the species often grow to 20 m in height and produce much higher wood and forage yields than the common varieties (Brewbaker *et al.* 1972, Brewbaker & Hutton 1979). There is very little information available on qualitative differences between the Hawaiian and giant varieties, but it appears there are no significant differences in wood fiber qualities (Bawagan & Semana 1978) or foliage characteristics. It has been suggested that fast-growing trees may not always be the best fit for agroforestry systems that include shade or fodder trees where competition from the tree component with adjacent crops is a constraint (P. Cooper, ICRAF, personal communication).

An important limitation to the utilization of natural stands of common leucaena is that little is known about the quantities of wood and foliage available for harvest. Planned management and utilization of these stands is not possible without some quantitative estimates of the products. This study was carried out to develop biomass tables as management tools for assessing wood and foliage biomass in natural stands of common leucaena.

Methods and materials

A total of 337 sample trees were destructively sampled from natural leucaena stands in Guam, Saipan and Hawaii from June 1982 to January 1983 (Table 1). Sampling was done following the sampling rules described by Aldred and Alemdag (1988). Individual stems were selected at random from a total of nine stands with a minimum of 10 trees per 1 cm diameter class for all classes except those above 9 cm, which were represented by at least 4 trees per class. Sample trees were

collected in every class from every location. Approximately equal numbers were selected from each stand. Basal diameter at 10 cm above the ground and diameter at breast height (1.3 m) were measured to 0.1 cm prior to felling. Trees were cut at 10 cm above the ground and total length measured for every tree after felling and recorded to 0.1 m. Fresh weight of the total tree was determined using a spring scale, measured to 0.1 kg. Foliage and green twigs of <8 mm in diameter were removed by hand and the remaining stem and branch wood weighed. Foliage weight was determined by subtracting stem and branch wood weight from total tree weight.

Table 1. Sampling locations

Island	Location	Total number of trees weighed	Number of trees used to construct table
Guam	Approximately 15 km south of Agana	130	30
Saipan	Marpi Point	107	60
Oahu, Hawaii	Approximately 10 km NW of Kaneohe	100	62
Total		337	152

Of the 130 trees sampled in Guam, 100 were excluded from the total and foliage weight analyses because of near total defoliation of trees caused by strong winds of Typhoon Mac on 2 October 1982. The remaining 30 trees sampled in Guam were measured in January 1983 and were in full foliage at the time of sampling. It should be noted that all of the biomass values reported in this paper are for green weight in kg tree^{-1}. Trees with foliage values of zero were also excluded, as were values that appeared to be spurious or those that exceeded 20 trees per diameter class. A total of 152 trees were used for the regression models.

An analysis of variance using site as a source to compare all measured variables was done using the Systat for Windows Ver. 5.04. A wide range of regression models were estimated including equations commonly used in fresh weight total tree or above-ground biomass estimations for a large number of species (Saucier *et al.* 1972, Ribe 1973, Aldred & Alemdag 1988). The best fit in terms of the coefficient of determination and adjusted standard error was the equation:

$$a+b(dbh^2ht)$$

where a and b are constants.

Results and discussion

An analysis of variance showed no significant differences in tree height, diameter or biomass per tree between the samples drawn from the three locations. This suggests there were no systematic differences in tree size among the three sites.

Regression models for whole tree weight, wood weight and foliage weight were all highly significant ($p<0.001$) (Table 2). Total tree, wood, and foliage weights are given over the observed range of tree sizes (Tables 3 to 5). The predicted values given in Tables 3 to 5 are presented only for the cells represented by actual measurements. Care should be taken not to extrapolate these values beyond the limits of the tables. An analysis of stem diameter distributions on Marpi Point on Saipan demonstrates the importance of biomass in large diameter stems (Table 6). Over 80% of the stems had dbh of less than 2.5 cm, but contained only 2% of the wood volume (Robinson, unpublished). The biomass tables presented in this paper provide a tool for the inventory of both wood and foliage biomass and the informed management of common leucaena stands.

Table 2. Regression equations for common *Leucaena leucocephala* (fresh weight)

Variable	Equation	R^2	Adjusted standard error		p
			a	b	
Whole tree green weight (kg)	$5.509 + 0.055(dbh^2ht)$	.82	1.02	0.00	.0001
Wood green weight (kg)	$4.323 + 0.052(dbh^2ht)$	.80	1.03	0.00	.0001
Foliage green weight (kg)	$1.186 + 0.003(dbh^2ht)$	.26	0.21	0.00	.0001

Table 3. Common leucaena whole tree weight table (green weight in kg tree^{-1})

DBH (cm)	Height (m)										
	4	5	6	7	8	9	10	11	12	13	14
1	6	6	6	6	6	6	6	6			
2	6	7	7	7	7	8	8	8			
3	8	8	9	9	10	10	11	11	11		
4	9	10	11	12	13	13	14	15	16	17	
5	11	12	14	15	17	18	19	21	22	23	23
6	13	15	17	19	21	23	25	27	29	31	31
7	16	19	22	24	27	30	33	35	38	41	41
8	20	23	27	30	34	37	41	44	48	51	51
9	23	28	32	37	41	46	50	55	59	63	63
10			39	44	50	55	61	66	72	77	77
11				52	59	65	72	79	85	92	92
12					69	77	85	93	101	109	109
13						89	99	108	117	126	126
14							113	124	135	146	

Table 4. Common leucaena stem and branch wood weight table (green weight in kg tree^{-1})

DBH	Height (m)										
(cm)	4	5	6	7	8	9	10	11	12	13	14
1	5	5	5	5	5	5					
2	5	5	6	6	6	6	5	5			
3	6	7	7	8	8	9	6	7	5		
4	8	9	9	10	11	12	9	10	7	5	
5	10	11	12	13	15	16	13	14	10	7	5
6	12	14	16	17	19	21	17	19	14	10	7
7	15	17	20	22	25	27	23	25	20	15	11
8	18	21	24	28	31	34	30	32	27	21	16
9	21	25	30	34	38	42	38	41	35	29	23
10			36	41	46	51	46	51	44	37	31
11				48	55	61	56	62	55	48	40
12					64	72	67	74	67	59	51
13						83	79	87	80	72	63
14							92	101	94	86	

Table 5. Common leucaena foliage weight table (green weight in kg tree^{-1})

DBH	Height (m)										
(cm)	4	5	6	7	8	9	10	11	12	13	14
1	1	1	1	1	1	1					
2	1	1	1	1	1	1	1	1			
3	1	1	1	1	1	1	2	2	2		
4	1	1	2	2	2	2	2	2	2	2	
5	2	2	2	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	3	3	3
7	2	2	2	2	2	3	3	3	3	3	3
8	2	2	2	3	3	3	3	3	4	4	4
9	2	2	3	3	3	3	4	4	4	4	5
10			3	3	4	4	4	5	5	5	5
11				4	4	5	5	5	6	6	6
12					5	5	6	6	6	7	7
13						6	6	7	7	8	8
14							7	8	8	9	

Table 6. Distribution of wood volume by diameter class on Saipan (Robinson unpublished)

Diameter class (mm)	Number of trees	Stemwood volume (m^3 ha^{-1})
<3	546 (59%)	0.4
3 to 25	169 (18%)	1.8
>25	218 (23%)	116.0

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