Bamboos in Plantation

by

FELIX O. CHINTE
Chief Forester, A. Soriano y Cia.

INTRODUCTION

The Paper Industries Corporation of the Philippines* in search for a source of long fiber pulp established in its forest concession in Bislig, Surigao del Sur, an experimental bamboo plantation in sites other than along banks of rivers and creeks.

Studies show that while moisture is an important factor on the growth and development of bamboos, successful plantations could be established in drier sites. Mathur (6) in his survey of the bamboo resources in Kalagarh Forest Division, Western Circle, Uttar Pradesh, India found bamboo more abundant in drier forests than in moister areas but best growth is attained on moist slopes with well drained soil. Gupta (4) believed that bamboo does not seem to be very particular about the soil provided a certain amount of moisture is available for its growth. Prasad (7) noted that the time of planting bamboo has a marked effect upon its growth, i.e., those planted in the earlier part of the monsoon show much better growth and development. Brown and Fisher (1) found culms of kauayan-tinik (*Bambusa blumeana* Schultes f.) and kauayan-kiling (*Bambusa vulgaris* Schrad. ex. Wendl.) started to grow during the latter part of the dry season but made slow growth until the rainy season, that bolo (*Gigantochloa levis* (Blanco) Merr.) showed rapid growth in the later part of the rainy season, and that bamboos grow better when under shade than when in the open.

MATERIALS AND METHODS

Plantation sites — Three log landings used in a 1953 logging operation, expanded to adjacent areas containing residual trees, were selected for the experiment. The miscellaneous trees, shrubs and vines were chopped flat on the ground to serve as mulch for conserving soil moisture.

The soil is generally clayloam with thin humus on the surface. When moist it could be rolled between the fingers without breaking to about ¾ inch long. In some portion of the areas, clay is mixed with little gravel and sand. The sub-soil is heavy clay turning hard after drying.

Lot I, planted in May, 1961 is generally level and sloping to about 10 degrees with northeastern exposure. Lot II, also planted this year, has a western exposure of 10 to 15 degrees slope. Lot III, planted from January to April 1962 has northeastern and southern exposures with 10 to 22 degrees slopes and with a gully going down to a southwestern direction. A portion of Lot I was also planted in 1962.

The areas planted in 1961 were without residual trees while those areas planted in 1962 were with trees from 20 to 48 inches stump diameters and from 60 to 100 feet high, about 15 trees to the hectare.

The rainfall in the locality of Bislig is well distributed throughout the year (Table 1).

Species planted — The species thriving well in the locality were selected for the study: namely; (a) kauayan-kiling (*Bambusa vulgaris* Schrad. ex. Wendl.), (b) kauayan-dilau (*Bambusa vulgaris var. striata* (Lodd.) Gamble), (c) kauayan-tinik (*Bambusa blu-*

* Formerly Bislig Industries, Inc.

meana Schultes f.) (d) Giant-bamboo (*Gigantochloa aspera* Kurz.) and (e) bolo (*Gigantochloa levis* (Blanco) Merr.).

The bamboo cuttings were prepared from culms of about a year old. Each cutting consisted of two internodes with two nodes. The upper internode was cut open to about 45 degrees angle. The cuttings were planted inclined to either about 30 degrees on fairly level ground or about 15 degrees steeper than the slope of the ground. The upper opened internode was exposed to collect rain water, essential for retarding the drying of the cuttings. The two nodes were firmly covered with soil. The spacing were 4, 6, 8, 10 and 12 meters between rows and 2 meters along the row.

The number of cuttings and the date they were planted were as follows:

May, 1961 —	
Kauayan-kiling	866
Kauayan-dilau	80
Bolo	168
June and July, 1961 —	
Kauayan-kiling	2,759
January to April, 1962 —	
Giant-bamboo	642
Kauayan-kiling	1,703
Kauayan-dilau	111
Kauayan-tinik	82

Cleaning was performed on the newly established bamboo plantation three months after planting. In subsequent years cleaning was done one or two times a year. The cuttings planted in June and July of 1961, received no treatment.

Survivals of the cuttings were counted in September of 1963. Matured culms from three rows of each lot were counted from January 20 to 22, 1965. Five matured culms from each lot were cut as samples for study on shrinkage from green to air dry condition.

Each culm was measured for its middle diameter and total length up to 2 inches diameter, then cut into specified sizes, bundled and weighed before and after drying. Aluminum tags with embossed numbers identified each bundle, placed besides the boiler of the company from January 23 to March 4, 1965 or 40 days.

The statistical methods used in the analysis of the data are: for t-test, that of Husch (5); for determination of averages, standard deviations and standard error, that of Forsaith (2); and for the determination of the regression equations, covariance analysis, confidence limit, and correlation coefficients, that of Fresse (3).

RESULTS AND DISCUSSIONS

Successful cuttings — An inventory made in September, 1963 showed 27.67 to 59.60 per cent of the cuttings were forming clumps and were considered successful (Table 2). The Kauayan-tinik and bolo failed to grow. Brown and Fisher (1) reported 34 per cent survival of kauayan-tinik, 32 per cent survival of kauayan-kiling and 6 per cent survival of bolo, 1¼ years after planting.

Kauayan-kiling cuttings in an area cleaned one or two times a year after planting showed an average of 56.96 per cent success, while those cuttings left untended only 35.12 per cent. The difference was found significant. Cleaning the area after planting was found essential in the development of bamboo plantation. Successful cuttings of kauayan-dilau and giant-bamboo averaged 59.60 per cent and 27.67 per cent, respectively.

Shrinkage of bamboos — The weight per culm from 3 to 4 years old plantation ranged from 5.26 to 11.58 kilos when green and from 2.97 to 4.62 kilos when dry, (Table 3).

The regression equations showing the relationship between green and dry bamboos for each of the species studied were compared by analysis of covariance. No significant differences were found either on the slopes or level of the regression equations. One regression equation for diameter (Fig. 1) and another for weight (Fig. 2) were

therefore computed from the combined data of all species, with confidence limit of 95 per cent, namely;

$$Y(\text{dry diam.}) = 0.009 + 0.941\ X(\text{green diam.})$$

$$Y(\text{dry wt.}) = -0.014 + 0.519\ X(\text{green wt.})$$

The correlation coefficient is 0.993 for diameter and 0.976 for weight, indicating very intimate relationship. A bamboo culm shrunk from 4.34 to 6.13 per cent of green, in diameter and from 42.03 to 59.18 per cent of green, in weight (Table 4). These results are similar to the findings of Sekhar and Rawat (9) on *Bambusa nutans* which shrunk in diameter from 4.6 to 6.6 per cent.

Yield — A ton of bamboo from the 3-4 year old plantation contained from 86 to 190 green culms or from 216 to 337 air dry culms (Table 5). At 40 per cent pulp mill utilization some 540 to 843 culms of air dry bamboo will be necessary to produce a ton of pulp. Richmond as quoted by Tamolang et al. (10) obtained yield of 43 to 45 per cent unbleached pulp of buho (*Schisostachyum lumampao*) (Blanco) Merr.). In the work of Man Mohan Singh and V. N. Mukherjea (11) on eleven species of bamboos, the yield ranged from 39.0 to 47.2 per cent bleached pulp by sulphate method of pulping.

The total yield of kauayan-kiling plantation varied from 20,967 to 24,150 kilos of air dry bamboo per hectare at the age of 3-4 years, or 8.4 to 9.7 tons of pulp at 40 per cent pulp mill utilization. This means 2.4 to 2.8 tons of pulp annually per hectare. Giant bamboo plantation produced 1,989 to 3,203 kilos of air dry bamboo at the age of 3 years, or an annual yield of 663 to 1,068 kilos per hectare (0.3 to 0.4 ton of pulp). Kauayan-dilau produced from 1,261 to 1,735 kilos (air dry) per hectare, per year at the age of three years or 0.504 to 0.694 tons of pulp.

Considering that the average annual yield is 5.5 tons of air dry bamboo per hectare, the total yield at the end of seven years, will be 38.5 tons. If only 3/5 of the matured culms are harvested, leaving 2/5 with the young ones for the next cutting cycle of three years, the total harvest per hectare will be 23.1 tons of air dry bamboos or 9.24 tons of pulp.

The cost of land preparation, planting and care of one hectare of bamboo plantation compounded annually within seven years period is as follows:

₱100.00 @ 5% interest for 7 years	₱140.70
40.00 @ 5% interest for 6½ years	54.94
40.00 @ 5% interest for 6 years	53.60
40.00 @ 5% interest for 5½ years	52.32
40.00 @ 5% interest for 5 years	51.04
40.00 @ 5% interest for 4 years	48.64
Total Cost	₱401.24

With a total harvest of 23.1 tons of dry bamboo per hectare, or 9.24 tons of pulp per hectare, the cost to produce would amount to ₱17.37 per ton of dry bamboo, or ₱43.42 per ton of pulp.

The rotation set for the bamboo is seven years. Cleaning for the first three years is necessary to facilitate early development.

SUMMARY AND CONCLUSIONS

A preliminary study on the establishment of a bamboo plantation with five species found growing naturally at Bislig, Surigao del Sur are presented in this paper. The results found are:

1. Bamboo plantation can be established in logged-over areas with well distributed rainfall throughout the year.

2. Some 28 to 60 per cent of the cuttings developed into clumps 1½ years after planting.

3. Cleaning after planting is very essential for the survival and development of bamboo plantation.

4. The relationship of green and dry bamboo is expressed in the following regression equations:

$$Y(\text{dry diam.}) = 0.009 + 0.941 \times (\text{green diam.})$$

$$Y(\text{dry wt.}) = -0.014 + 0.519 \times (\text{green wt.})$$

5. The annual yield of air dry bamboo per hectare of 3 to 4 years old plantation was found to be 5,991 to 6,900 kilos for kauayan-kiling; 1,261 to 1,735 kilos for kauayan-dilau and 663 to 1,068 kilos for giant-bamboo. At 40 per cent pulp mill utilization the corresponding pulp production figures are: 2.396 to 2.760 tons for kauayan-kiling 0.504 to 0.694 tons for kauayan-dilau and 0.265 to 0.427 tons for giant-bamboo.

6. A ton of pulp could be produced from a man-made bamboo plantation at a cost of about ₱50.00.

ACKNOWLEDGMENT

Acknowledgment is made by the author to Mr. Wilfredo Abuton for his assistance in the computation of the data.

REFERENCES

(1) Brown W. H. and A. F. Fisher: Philippine Bamboos. Bureau of Forestry Bull. No. 22, Vol. 1 (1920) p. 249-310.

(2) Forsaith, Carl, C.: Statistics for Foresters, Tech. Pub. No. 62 (1943), The N. Y. State College of Forestry, Syracuse Unit.

(3) Fresse, Frank: Linear Regression Methods For Forest Research (Dec. 1964), U. S. Forest Service Research Paper. FPL. 17.

(4) Gupta, D. P.: Treatment of congested clumps and artificial regeneration of bamboo (Dendrocalamus strictus) in Vindhyan forests. The Indian Forester, Vol. 90; No. 12 (Dec. 1964).

(5) Husch, Bertram (1963): Forest Mensuration and Statistics. The Ronald Press Company, New York.

(6) Mathur, R. S.: Bamboo resources survey in Kalagarh Forest Division, Western Circle, Uttar Pradesh. The Indian Forester, Vol. 90; No. 11 (Nov. 1964).

(7) Prasad, B. N.: Bamboo Plantation in Dhalbhum tract of Singh-Bhum District of Bihar. Indian Forester, Vol. 9; No. 1 (Jan. 1965).

(8) Raghavan, S.: Comparison of New Culm Production in treated and untreated bamboo forests of Asifabad Forest Division, Andhra Pradesh. The Indian Forester, Vol. 90; No. 12 (Dec. 1964).

(9) Sekhar, A. C. and M. S. Rawat: Some studies on the shrinkage of Bambusa nutans. The Indian Forester, Vol. 90; No. 3 (March 1964).

(10) Tamolang, F. N., E. O. Mabesa, M. A. Eusebio, M. J. Sagrado and B. A. Lomibao: Fiber dimensions of certain Philippine broadleaved woods and bamboos. Tappi, Vol. 40; No. 8, (Aug. 1957).

(11) Man Mohan Singh and V. N. Mukherjea: Fibrous Raw Material For The Indian Pulp, Paper and Board Industry. The Indian Forester, Vol. 91; No. 7, (July 1965).

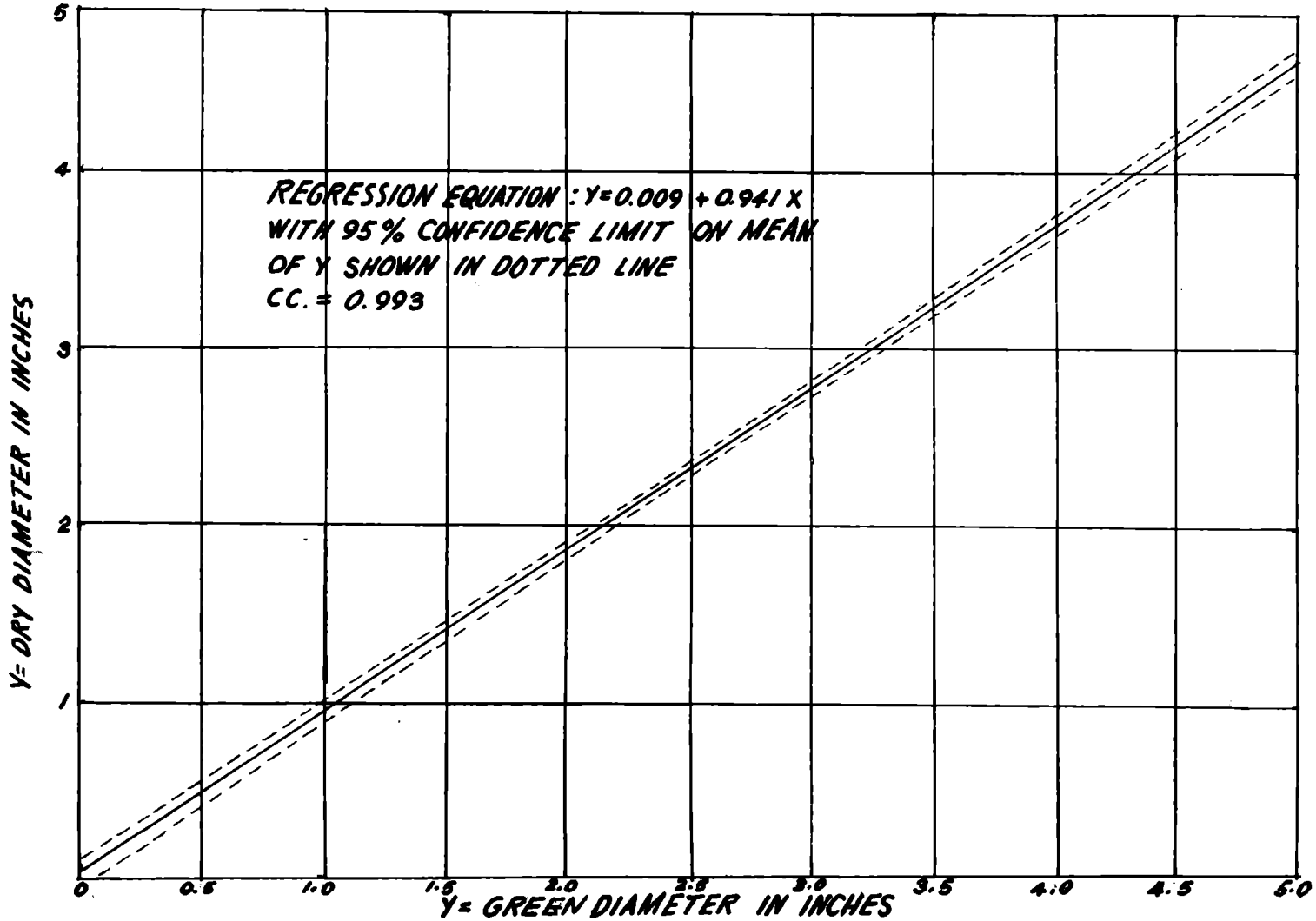

FIG. 1. RELATIONSHIP BETWEEN GREEN & DRY DIAMETER OF BAMBOOS

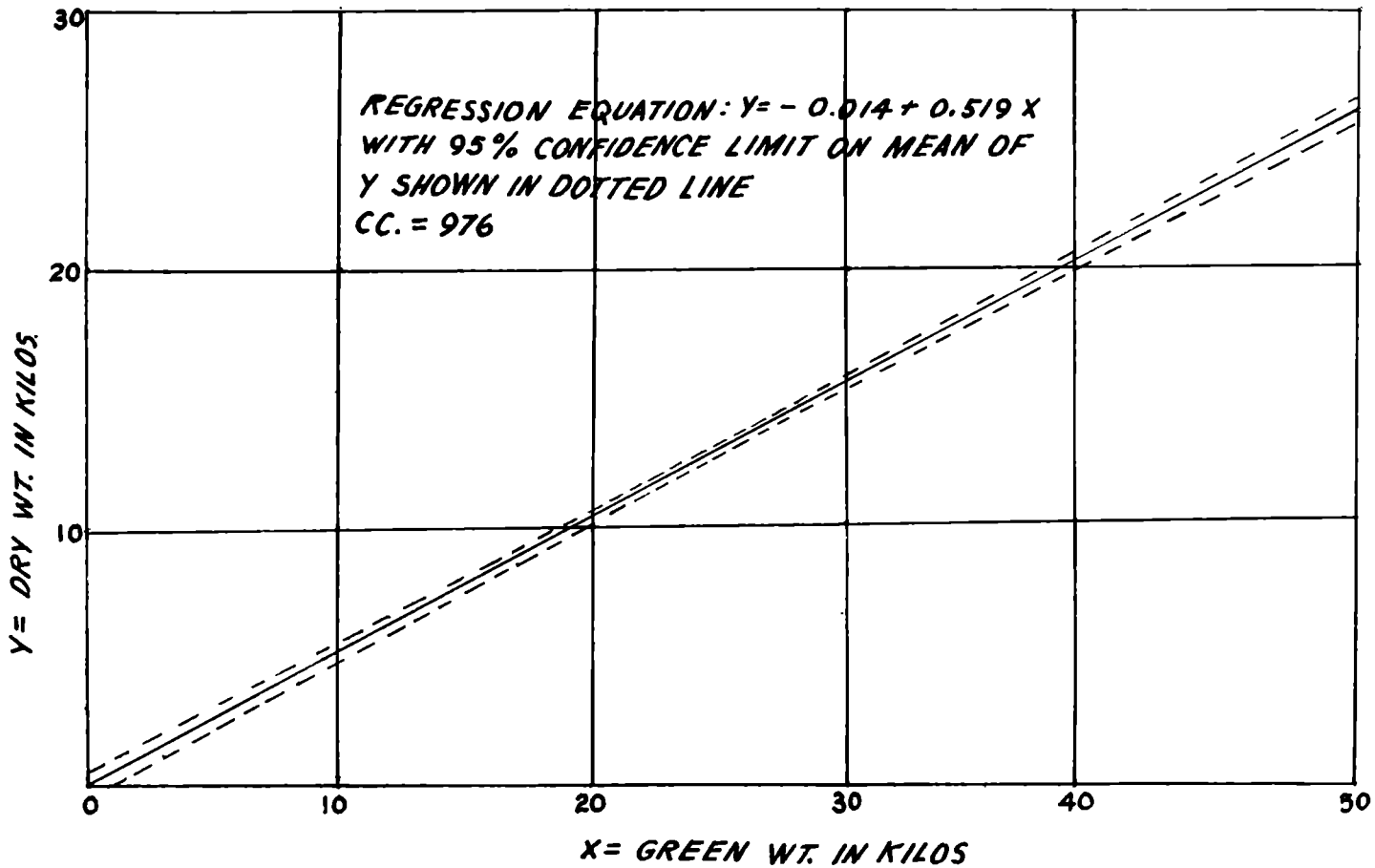

FIG. 2. RELATIONSHIP BETWEEN GREEN & DRY WEIGHT OF BAMBOOS

TABLE 1 showing rainfall at Bislig Bay Lumber Company, Inc. Camp Site
Mangagoy, Bislig, Surigao del Sur

MONTHS	YEARS											AVERAGE
	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	
	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
January	11.19	48.71	51.83	32.85	21.72	27.97	25.13	16.9	75.2	54.9	24.9	35.57
February	8.93	19.37	25.35	26.45	17.34	11.41	17.93	21.3	45.8	69.0	50.9	28.52
March	23.90	17.26	22.04	34.04	12.85	12.52	19.06	10.6	32.5	38.2	19.7	22.06
April	12.83	13.61	19.07	15.17	4.35	7.70	18.62	13.8	15.6	7.0	14.9	12.97
May	10.89	16.12	12.57	15.68	15.23	15.15	10.60	6.2	17.8	11.3	12.4	13.08
June	12.24	14.14	9.18	19.47	1.72	6.43	4.06	8.6	5.3	5.9	8.7	8.73
July	12.78	6.40	10.77	21.06	8.08	11.03	3.87	5.9	3.6	10.0	5.4	8.99
August	4.36	5.30	6.48	11.24	7.98	3.34	1.72	3.7	8.7	8.2	6.8	6.16
September	3.65	3.92	11.12	10.89	6.25	3.94	9.98	8.7	11.7	18.5	6.6	8.66
October	4.76	9.84	16.51	10.15	9.40	13.28	7.72	6.1	6.2	11.5	2.8	8.93
November	10.71	11.83	6.99	11.53	14.09	22.45	17.89	15.3	20.7	11.5	13.4	14.21
December	34.45	27.16	27.16	33.97	15.62	10.40	19.15	31.9	27.3	7.9	10.1	22.28
TOTAL	150.69	193.93	219.07	242.50	134.63	145.62	155.73	148.73	270.4	253.9	176.6	190.16

TABLE 2 Survival of bamboo cuttings and comparison of means of paired groups

Groups	Species	Treatments	Age Years	Mean survival %	Degrees of Freedom
I	Kauayan-kiling	Area kept clean	2¼	57.14	21
II	Kauayan-kiling	Area kept clean	1½	56.96	25
III	Kauayan-kiling	Area left alone after planting	1½	36.12	26
IV	Kauayan-dilau	Area kept clean	1½	59.60	5
V	Giant-bamboo	Area kept clean	1½	27.67	15

Groups Compared	Mean Difference	Computed t	Relationship
II - III	20.84	3.887	Significant at less than 1%
II - IV	2.64	0.224	Not significant
II - V	29.29	4.103	Significant at less than 1%
III - IV	23.48	1.995	Not significant
III - V	8.45	1.184	Not significant
IV - V	31.93	2.518	Significant at less than 5%

TABLE 3 Average size and weight of a bamboo culm

Species	Age Years	Diameter (inches)		(meters) Length	Weight (kilos)	
		Green	Air-dry		Green	Air-dry
Kauayan-kiling	3-4	2.22 ± 0.05	2.10 ± 0.05	7.09 ± 0.30	8.74 ± 0.63	4.63 ± 0.33
Kauayan-dilau	3	1.82 ± 0.10	1.71 ± 0.10	5.09 ± 0.44	5.26 ± 0.83	2.97 ± 0.47
Giant-bamboo	3	2.21 ± 0.13	2.11 ± 0.13	5.82 ± 0.52	11.58 ± 1.85	4.62 ± 1.08

TABLE 4 Average shrinkage of bamboos from green to air dry. (percentage of green measurements)

Species	Age Years	Diameter %	Weight %
Kauayan-kiling	3-4	5.72 ± 0.38	46.30 ± 0.18
Kauayan-dilau	3	6.13 ± 0.76	42.03 ± 3.74
Giant-bamboo	3	4.34 ± 0.81	59.18 ± 1.48

TABLE 5 Number of culms that make a ton of bamboo

Species	Age	Green	Dry	Pulp at 40% utilization
1. Kauayan-kiling	3-4	115	216	540
2. Kauayan-dilau	3	190	337	843
3. Giant-bamboo	3	86	217	543

TABLE 6 Yield of bamboos at Bislig Bay Lumber Company, Inc. Timber Concession, Bislig, Surigao del Sur

Species	Age Years	Matured Culms per Ha.	Total yield per hectare		Annual yield per hectare		Pulp at 40% utilization in tons
			Green weight in kilos	Dry weight in kilos	Green weight in kilos	Dry weight in kilos	
Kauayan-kiling (Bambusa vulgaris)	3-4	4,869	39,488—45,623	20,967—24,150	11,282—13,035	5,991— 6,900	2.396— 2.760
Kauayan-dilau (Bambusa vulgaris var. striata)	3	1,513	6,703— 9,214	3,783— 5,205	2,234— 3,071	1,261— 1,735	0.504— 0.694
Giant-bamboo (Gigantochloa aspera)	3	562	5,468— 7,548	1,989— 3,203	1,823— 2,516	663— 1,068	0.265— 0.427