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Stand Quality Assessment of Teak (*Tectona grandis* Linn. F.)

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ABSTRACT

Teak (*Tectona grandis* Linn. F.) is the most valuable wood species in Bangladesh as well as in the world. Few researches have been carried out on the stand quality assessment of teak plantation in Bangladesh. Site variations offered different shape of bole like square, an elliptical or triangle and sometimes deformation results in deep irregular vertical ridges and furrows. With the deterioration of quality of teak trees the value decreases and increases the wastage. Study was carried out on the stand quality of teak in two potential teak plantation zones of Bangladesh viz. Chittagong and Sylhet. Relative bole height is higher (about 60%) in Sylhet than that of Chittagong (about 54%). The stem form differences are found insignificant on both sites, which are around 65%. Teak trees have tendency to become straight on both sites. Not much difference was found in the presence of fluting between Chittagong and Sylhet. About 40% of the observed stems were represented by fluting on both study areas.

Key Words: Site; Stand quality; Buttresses; Fluting

INTRODUCTION

Global demand for timber is increasing; but world forest resources are decreasing. Predicted Total log production is 1.9% yearly, to reach about 1.4 billion m^3 by the year 2000 and by the year 2025 it is estimated to be 6.6 billion m^3. Teak is the premier hardwood species both in terms of properties, appearance and most demanding. Teak, the major plantation species in Bangladesh and more than 70% of total plantation in hill forests is Teak (Rahman & Mustanja, 1978). Teak was introduced in Bangladesh from Myanmar during 1871 at Sitapahar Range, Chittagong Hill Tracts. Initially, only few plantations were raised by direct sowing of seeds (Anonymous, 1959). From 1917 teak plantation started in an extensive scale, covering different part of Hill Tracts, Chittagong, Cox's Bazar and Sylhet forests. Teak was raised, prior to 1934, from nursery seedlings. From 1934, stump planting was introduced with satisfactory results. Before 1975, Teak was the main long rotation plantation species in Bangladesh, usually covering 60-70% of annual planting area, because of its high value (Moef, 1993). For large-scale commercial plantation, it is important to assess the impact of site factors on stand quality. The study was conducted on northeastern and southeastern part of Bangladesh where teak is the dominant plantation species. The study was focused mainly on stand quality of teak by considering the temperature, rainfall and soil fertility. The specific objective of this study was to assess the qualitative characteristics of plantations, which will provide vital information on growth and quality of teak plantations at different sites of Bangladesh.

MATERIALS AND METHODS

Study area. The study area is confined to Chittagong Forest Division (Latitude 21° 50' and 23° 0' North and longitude 91° 30' and 92° 10' East) and Sylhet Forest Division (Latitude 23° 55' and 25° 02' North and longitude 90° 55' and 92° 30' East) situated in the Southeastern and Northeastern part of Bangladesh. Chittagong Forest Division falls under the agro-ecological regions of Chittagong coastal plain. The Sylhet hills are low with an altitudinal range from 50 to 150 m. It falls under Eastern Surma Kusiayara flood plain. The low hills of Sylhet in the Northeast are gentle to steep in slope.

Climate. In Chittagong, moist tropical maritime climate with high rainfall concentrations prevail during the monsoon period from June to September. Average rainfall recorded (1987 –1996) is 2790 mm. Relative humidity is 70-85% throughout the year. Temperature ranges from 11.2°C in January and 34.9°C in May with an annual average temperature of 23°C. In Sylhet, moist tropical maritime climate prevails which is characterized by a period of high precipitation (monsoon) from April to September and relatively dry from November to March. With minor variations, humidity remains high (70-85%) throughout the year. Precipitation is the highest during the monsoon (May to August).

Geology and soil. The geology of Chittagong has a complicated and relatively recent tectonic history. Satellite imagery clearly shows the succession of anticlines and synclines of tertiary rocks with a north west-south east axis and local separation by a complex of alluvial plains, and Pliocene and recent alluvial deposits. The soils developed

on the unconsolidated and compacted rocks of *Dupi Tila* formations are usually moderately well to excessively drained, deep and probably the oldest ones in the area. The plain of the Sylhet district is of alluvial origin and is composed of clay and sand in varying proportions depending upon the degree of wash coming from the adjoining hills.

Sampling method. Since the sampled area was a plantation raised in rows, square plots were used to demarcate the sampling plots. Sampling was done in different age groups within beat (Table I) of forest divisions. For this purpose, transect lines along the sample plots were systematically oriented and were laid down at systematic intervals over each study area. To have a meaningful mean and variance that are components of population mean and variance, every stratum should have a minimum of two sampling units (Philip, 1996). Therefore, 40 sampling units were taken randomly, each of 20m×20m in size and were laid out systematically on a grid of 200 m×200m, from both study areas.

Measurements. For assessing the stand quality, scoring system was applied to assess all individual tree characteristics in each sampling unit. Stem form, bole quality branch habit, mode of branching and flowering were assessed in the field as tree characteristics. All trees within the sample were assessed.

RESULTS AND DISCUSSION

Bole height. Bole is the main stem of a tree starting form base or top of buttress to the lowest whorl of living branches and is one of the most important parameter for volume estimation. Mean bole height and relative bole height to total height of trees in the two different study areas were shown in Fig. 1.

The difference in mean bole height of teak trees between Sylhet and Chittagong was not significant. The relative bole height is higher in Sylhet (about 60%) than Chittagong (about 54%). It is reveled that teak trees from Chittagong have low tendency in terms of timber volume production.

Stem form and axis persistence. Regarding the quality of the tree, generally accepted that a long, straight bole with small knots desirable from a utilization point of view. Straightness is identified as the most important single factor affecting log quality of teak. For assessment of stem form or stem straightness, the severity of bends was evaluated. A bend is defined as the distance between two tops of a stem, as indicated in Fig. 2a. A bend is considered serious if the side of the stem curves goes outside the straight line (imaginary axis) drawn through the length of a bend (Keiding *et al.,* 1986). Persistence, i.e. the height of unbroken axis, is an important characteristic related to commercial value of the bole. According to (Kjaer *et al.,* 1995), a branch is considered a stem or axis if it exceeded the others by a quarter in thickness. The classes of persistence are illustrated in Fig. 2b.

The stem form differences are found not to be significant on both sites. In Fig. 3, around 65 % of teak trees have tendency to become straight on both sites. In Chittagong, teak trees have relatively poor quality and trees are wavering with few small bends as compared to Sylhet.

The axis persistence of teak trees in Sylhet is quite different from that of Chittagong. Around 10-20% of trees have tendency to become completely persistence on both

Table I. Age classes of teak in selected beats of Chittagong and Sylhet Forest Divisions

Forest Division	Range	Beat	Planting Year
Chittagong	Karerhat	Karerhat	1997-98
			1991-92
			1970-71
	Mirsarai	Hinguli	1980-81
	Hathazari	Ischamati	1952-53
Sylhet	Moulavibazar	Moulavibazar	1997-98
			1991-92
			1980-82
		Lawachara	1967-68
			1952-53

Fig. 1. Mean bole height and relative bole height to total height of trees in the study areas of Sylhet and Chittagong

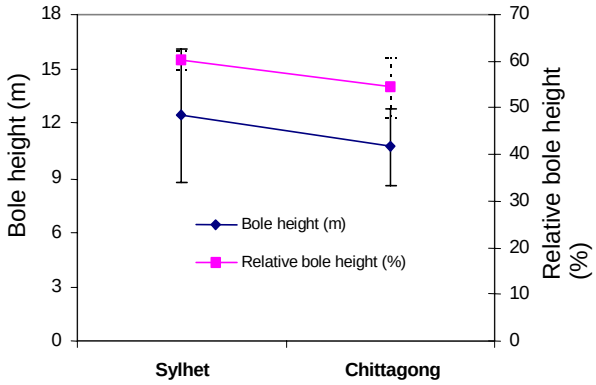


Fig. 2. (a) Illustration of a bend (b) Classes for assessment of axis persistence (after Keiding *et al*., 1986 and Kjear *et al*., 1995).

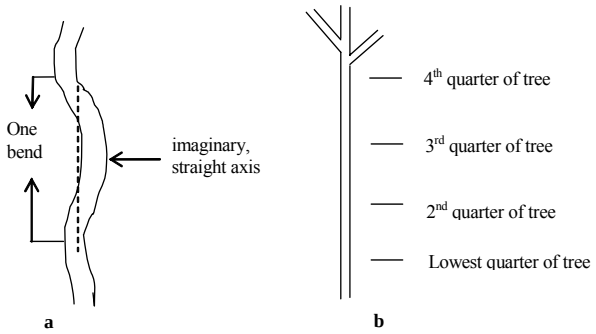


Fig. 3. Distribution of stem form of teak trees in the study areas of Chittagong and Sylhet

(Class 1, Straight tree; Class 2, Slightly crooked, few small bend; Class 3, Slightly crooked, many small bend; Class 4, Crooked trees with 1-2 severe bends; Class 5, Crooked trees with 3 or more severe bends. Axis persistence classes of teak trees of that areas are Class 1, Double or multiple stem from ground level; Class 2, Axis branches out in the lowest quarter of tree; Class 3, Axis branches out in the 2nd quarter of tree; Class 4, Axis branches out in the 3rd quarter of tree; Class 5, Axis branches out in the 4th quarter of tree; Class 6, Complete persistence)

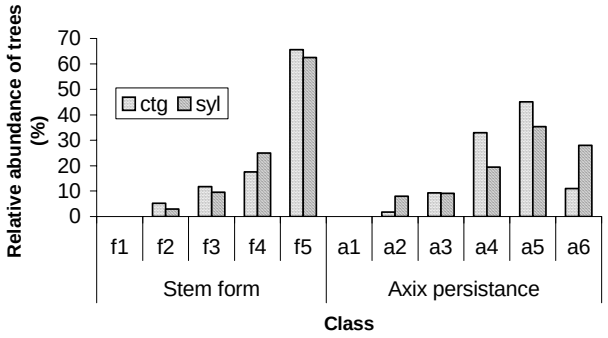


Fig. 4. Distribution of branch size of teak trees in the study areas of Chittagong and Sylhet

(Class 1, Very heavy: from ½ to ¾ of stem diameter; Class 2, Heavy: about ½ of the stem diameter; Class 3, Medium: between ½ and ¼ of stem diameter; Class 4, Light: around ¼ of stem diameter; Class 5, Very light: less than ¼ of the stem diameter. Mode of branching of teak trees of that areas are Class 1, Double limbs; Class 2, Scatter branching – pronounced; Class 3, Light forking; Class 4, Scatter branching – light; Class 5, Regular, spreading branching)

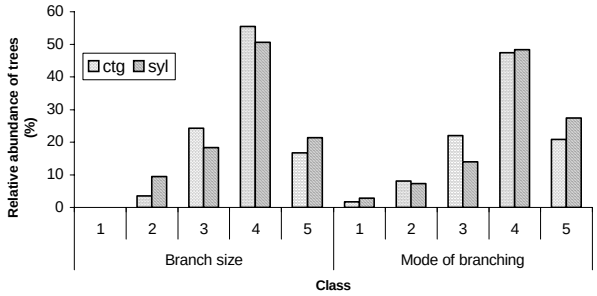
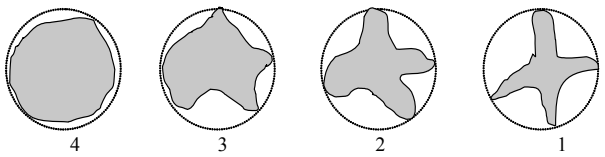


Fig. 5. Example of classes in the assessment of buttressing (according to Kjaer *et al*., 1995).

(Class 1, Stem cross sectional area is ≈ 1/3 of the area of "ideal stem"; Class 2, Stem cross sectional area is ≈ 1/2 of the area of "ideal stem"; Class 3, Stem cross sectional area is ≈ 3/4 of the area of "ideal stem"; Class 4, Stem cross sectional area is near about 100 % of area of "ideal stem")



sites. Although more than 70% of total observed trees in Chittagong were defined as class 4 and 5, and the rest were found in the lower classes of 1 to 3. Fig. 3 shows that teak trees in Sylhet have higher persistence of axis as compared to that of Chittagong. Based on the 17th year assessment the general picture is that the provenances from the Thai provenance region is considered of superior quality due to good stem form and persistence of terminal axis. The moist Indian provenances have revealed a tendency to perform below average persistence and the Indonesian provenance has improved in axis persistence (Kjear *et al.,* 1995).

Branch size and mode of branching. The branch size is a relative measure of branch diameter in proportion to the stem diameter at the foot of the branch. Branches were scored in 5 classes according to size. The branch size is classified into 5 classes according to Keiding *et al.* (1986). The teak trees in Chittagong and Sylhet seemed to have finer branches as seen in figure 4, about 70% of branches of both stands were fall into the class 4 and class 5 (branch diameter around or less than ¼ of stem diameter). The mode of branching or the grouping of different branching types was also recorded and scored in 5 classes according to Keiding *et al.* (1986). The different modes of branching are illustrated in Fig. 4.

No much difference was found in the mode of branching between the study areas of Chittagong and Sylhet. About 70% of the total observed trees represented regular spreading branching to light scattered branching (Class 4 to 5). Inferring this, both stands have more or less similar (stem quality). The moist Indian provenances have better branch characteristics than Indonesian provenances, which have intermediate or inferior branch size (Kjear *et al.,* 1995).

Bole quality. In this study, bole quality refers to the presence or absence of buttresses, flutings, etc on the stem. According to Kjaer *et al.* (1995), bole is defined as the stem or part of stem stretching from ground level to the beginning of the crown.

Buttresses and flutings. Buttressing is a feature of non-circular cross-section of the stem that typically develops by large plank like up growth of the upper side of the roots, providing support for the tree. Buttresses reduce the utilization of lower part of the stem and are considered an undesirable characteristic. Fluting is the deformation in the circular periphery of a tree, which results in the loss of wood. In most of the teak plantations of Bangladesh, the tree bole becomes elliptical, star shaped and very irregular. In older plantations about 95% of the trees are affected by fluting (Haque, 2000). It has been estimated that about 40 to 60% of timber are lost from the fluted stem during sawing (Kyaw, 2003). Banik (1992) reported that fluting in teak stem might be genetically controlled. The fluting and severity of buttressing were made according to four classes (Kjaer *et al.,* 1995). The severity of buttressing was evaluated at 1m height of the tree. Scoring of buttressing is illustrated in Fig. 5 and severity of buttressing of teak stem in the study areas are shown in Fig. 6.

From Fig. 6, it is seen that about 60% of the stem were fall in class 4 i.e. stem cross sectional area is near 100% of area of ideal stem and the rest 40% of stems on both study

Fig. 6. Distribution of severity of buttressing and presence of flutes of teak stem in the study areas of Chittagong and Sylhet

(Class 1, Around 75 % stem have fluting; Class 2, Around 50 % stem have fluting; Class 3, Around 25 % stem have fluting; Class 4, Stem free of flutings)

area have severity of buttressing on teak stem. In this study, assessment of fluting was made according to four classes (Kjaer *et al.,* 1995).

Not much difference was found in the presence of fluting between Chittagong and Sylhet. About 60% of the observed stems were free of fluting on both study areas but the rest 40% of the stems were fluted to a great extent. Based on 17th year assessment the Indian provenances have revealed a tendency towards above average fluting. The moist Indian provenances were found to be much less affected by fluting (Kjear *et al.,* 1995).

CONCLUSION

In most of the teak plantations of Bangladesh, the bole of the trees becomes elliptical star shaped and very irregular. In this study, it is found that in older plantations; about 40% of the observed trees are severely affected by fluting on both sites. Reductions in the out turn of swan timber due to fluting ranges from 40-60%. A progeny trial was done by Forest Research Institute of Bangladesh to investigate fluting behavior of teak, but no differences were found from the fluted and non-fluted mother trees. Based on the results of stand quality assessment, teak trees from Sylhet forest division area are of better qualities than that of Chittagong forest division in terms of bole height, branch size and mode of branching and fluting.

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