KNOW YOUR USEFUL TREES
" GAMAR "

By

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Gamari or Gamar is a well known furniture wood in East Pakistan, particularly in Chittagong. The botanical name for Gamar is Gmelina arborea, Roxb., and it belongs to the family Verbenaceae to which teak belongs. The generic name Gmelina (Pronounced as Melina) is named after S.Gottlieb Gmelin, a German Botanist. The latin meaning of "arborea" is "in the form of a tree."

Local names : Gamari, Gamar (Chittagong, Chittagong Hill Tracts, Sylhet), Joginichakra (Mymensingh), Ramani(Magh) Gambar, Bol-gippok (Garo), Kumhar, Gumhar, Gumhar (W.Pak.) In Burma, the plant is known as Yemani. Name used in the exotic plantations, e.g. Nigeria, is Gmelina or Yemani. In English it is known as Kashmir tree or white teak.

Distribution : The plant occurs naturally in the mixed deciduous forests of Chittagong, Chittagong Hill Tracts and Sylhet. The tree is scattered in occurrence but more frequent in moist localities. Young trees of gamar is often observed growing over sungrass in the vicinity of forest villages of Chittagong and Chittagong Hill Tracts where forests have been cleared up. There are plantations of gamar in these forest areas. The plant also occurs sporadically in the sal forests of Madhupur (Mymensingh).

In West Pakistan the plant occurs in the lower Himalayan course of the River Chenab and also planted in Changa Manga.

Geographically the plant is distributed in India, Nepal, Sikkim, Ceylon , Burma, Thailand, Laos, Cambodia, Vietnam and the Southern Provinces of China. As a fast growing timber trees of the lowland tropics, it is extensively cultivated in Africa (namely, Nigeria, Sierra Leone, Gambia, Ivory Coast) Malaya and Philippines.

Botanical description : In its natural habitat it is a medium sized deciduous tree with round bole of 20-30 feet long and 5-7 feet girth. If grown in the open, the tree develops heavy branches and wide crown with short stem which is swollen at ground level and markedly tapered. In the plantation the tree may attain a height of 100 feet in 20 years with clean straight bole and breast height girth 6-8 feet and a domed crown.

Bark : In young trees, bark is smooth, corkey, pale brown to grey coloured. In old trees bark is grey or ashy, warty, exfoliating in irregular patches which leaves lighter coloured shallow depressions on the bark and hence the name "Joginichakra" is applied to the plant. Also due to light (whitish) coloured bark the tree is known as Bol(tree) gippok(white) in Garo and in English it is called white teak. Mature bark is about ¼" thick. Inner bark (blaze) is greenish white with a chlorophyll layer just below the epidermis.

Young twigs are quadrangular, covered with wooly hairs.

Leaves : Opposite, 3-8 inch long and 2-5-6 in. broad with hairy petiole 1-4.5 in long, shape of the leaf broadly ovate with pointed tip, base of the leaf sub-ordate or cuneate, upper surface of mature leaf glabrous deep green in colour, lower surface with stellately (star-shaped) hairs, bluish-green in colur, margin of mature leaves entire but that of

young plants toothed, veins 6-10 pair, there are two glands at the junction of petiole and leaf base.

Flowers : Clusters of yellowish flowers appear at the end of hairy branches in February/March when the tree is either leafless or young leaves just appear, bracts ½ in long, linear, calyx ¼ in long united into densely hairy tube with 5 teeth, persistant in the fruit, corolla 1-1½ in long yellowish, hairy outside, united into tube with 2 spreading limbs, the upper lips deeply divided into two lobes, the lower lip about twice as long as the upper, 3-lobed, the middle lobe much longer than the lateral ones and with toothed margin. Stamen-4, didynamous, project beyond the mouth of the corolla tube, ovary 4-celled with 1 ovule in each cell, style slender, protrude out of the corolla tube, stigma unequally 2-fid.

Fruit : A drupe, about 1 in long, ovoid or pyriform seated on the unenlarged calyx, penicarp succulant, glossy outside and yellow when ripe, endocarp boney. The pulp of ripe fruits aromatic and when squeezed gives a yellow juice which leaves a long-lasting yellow stain on the fingers.

Seeds : 1-2 per fruit oblong, lenticular. There are two varieties of Gamar, Var.glaucences, C.B.cl., with leaves glaucous (bluish grey or bluish-green in colour) and almost glabrous beneath, the glaucous appearences being due to dense microscopic glands or scales and Var. Canescens, Hains, in which leaves are greyish beneath with simple and not stellate hairs. In Var.glaucescens, caylyx teeth larger triangular.

In the forests, it is often difficult to differentiate Gamar from Pitali (Trewia nudiflora, Linn). which is a large deciduous tree with leaves very similar to those of Gamar. The two species can be differentiated from the following morphological characters : Bark of Pitali light-grey or yellowish-brown,

smooth on young tree, flaking on older stem. The bark of gamar excoliate in large irregular plates leaving light coloured patches on the stem. The scars due to falling off stipules are visible on the branches and young stem and these are not found in gamar. In Gamar large gland are found on the lower surface of leaf between the midrib. On the other hand, in Pitali, there are two grandula area near the top of the petiole. In Pitali there is raised line that join the bases of each pair of opposite leaf stalks. This line is absent in Gamar.

Silviculture and Management : The plant thrives best on moist fertile valley with deep alluvium where drainage is good. On dry sandy or otherwise poor soil and on steep slopes, the growth is stunted. The plants will grow vigorously where the surface layers are alkaline or slightly acidic but will fail on very leached acid soil. It is a strong light demanding species. In its natural habitat the absolute maximum shade temperature varies under 100° to 118°F, the absolute minimum from 30° to over 60°F and the normal rainfall from 30 to 180 in. or more.

Seed : Fruits ripe in May/June. Fleshy pericarp (glossy epicarp and juicy mesocarp) is eaten by deer, birds, rodents and insects leaving hard, pointed in one end endocarp (commonly called stone) which encloses 1-3 seeds. About 640 stones weigh 1 lb. Trees 3-4 years old start fruiting.

The germinative power of fresh seed (stone) is high but if stored for a year a good proportion of the seed loses its viability. Research is needed to discover the temperature and humidity at which high viability of seed can be retained. The new technique of storage in an atmosphere of nitrogen or carbondioxide may prove useful. After collection

of ripe fruits, the pulpy pericarp should be removed otherwise the fermentation of the pulp may reduce the viability of seed. It has been found that if the fruits are slit open and the seeds are thoroughly dried by spreading in the sun they retain their viability to more than a year.

Germination : Epigeous, the hard coat of stone opens by one or two lateral valves, the radicle emerges first and the cotyledons shortly after. Sometimes 2-3 seedlings emerge from a stone. The hard cover of the stone is either left on or in the ground or is carried up over the cotyledons falling later. Seeds germinate in 2-4 weeks.

The seedlings :

Roots : Primarly root long, considerably thick, round, tapering, lateral roots moderate in number and length, more in number in the upper part of main root. Hypocotyl distinct from root and thicker, round or obscurely quadrangular, 0.3-0.7 in. long , finely hairy.

Cotyledons : Petiole 0.1--0.2 inch long, channeled or flatened above, finely hairy, lamina 0.5--0-7 inch by 0.3-0.4 inch, somewhat fleshy, elliptical, margin entire, finely hairy, midrib deeply impressed on the upper surface, lateral veins indistinct.

Stem : Erect, more or less quadrangular near the nodes, green, finely hairy; internode 0.5-- 3 in. long.

Leaves : Simple, opposite, without stipule; petiole 0.3--1.5 inches long, glabrous or finely hairy, channelled above; leaf blade 1.5--3 inches by 1.2--3 inches, margin widely dentate, base cordate or cuneate with glands near the petiole, green above, glaucous beneath, glabrous or lower surface hairy, lateral veins 3-5 pairs including two prominent basal veins.

Artificial Regeneration : Both transplating and direct sowings are suitable. For transplanting the seeds are sown broadcast in the nursery before the rains break and covered lightly with compost litter. No shading is necessary, but the bed should be copiously watered. Seedlings normally begin to appear in about 2-3 weeks. Transplanting may be done either in the first or in the second rainy season. In the former case the whole plants are picked up during the rains and re-planted in the bed 9 in. apart. In the next rainy season they are planted out with the stem pruned down to about 2 in. from the ground level and the root trimmed to a length of about 1 foot. Stumps thus obtained should not be more than 2 inches in diameter at the time of transplanting. Stump plants ½ to 1½ inches diameter are extremely tough, can stand rough handling during transport and grow much faster than seedlings. Immediately after transplanting shading is necessary for a short time.

In the direct sowing method, the seeds are sawn in lines 10-12 feet apart and an interval of about 1 foot between the seeds in the line.

Taungya system is highly recommended for gamar plantation. Spacing in high forest sites should be kept 8 ft. x 8 ft. or 9 ft. x 9 ft. For pulp wood spacing of 7 ft. x 7 ft. is suitable and for fuelwood and pole plantation, 6 ft. x 6 ft. spacing is usual.

Weeding is necessary for the first year only, after which the dense canopy of Gamar suppresses the weeds.

Double leaders, bent stems and heavy low branches should be removed in the cleaning and tending operations during the first and second years. Form of tree can be improved by early pruning in 2nd and 3rd years but a better method is to coppice the whole crop in the 3rd to 4th year. This method is suitable for plantation for poles. Thinning may be started in the 3rd or 4th year.

Growth and yield : The growth rate is very fast. The following table shows the rate of growth:

Age.	Height (in feet)	Diameter (in inches)
5	41	5.1
10	57	7.3
15	65	8.6
20	71	9.3
25	75	9.7
30	78	10.0
35	81	10.3

In the rain forest zone over 3,000 cuft. of timber per acre can be obtained after 8 years' growth.

The plant coppice very well and the coppice shoots grow vigorously. The plant can be raised from large cuttings planted during the rainy season.

Natural Regeneration : In the high forests the natural regeneration is poor. This is due to the reason that alternating heat and moisture is necessary to stimulate the germination of seeds and therefore seeds lying in shade do not get sun's heat and fail to germinate. Secondly, seeds are not buried in the ground and fail to germinate. Under natural condition germination takes place in the rainy season soon after the fall of the fruits.

Damage caused by various agencies :

(a) Parasites : In East Pakistan Gamar plantation is heavily damaged by the stem parasite Loranthus (Loranthus scurrula, L.)

(b) Insects : In Africa the plant is constantly attacked by leaf cutter ants (Atta sp.) which reduces vitality and the plants ultimately die.

Plantation in India have been severely defoliated by Chrysomelid beetle (Calopepla leavana, Latr.) The insect attacks the leaves, buds and twigs so severely that within 2 years trees 4-6 years old die.

(c) Fungal diseases: In East Pakistan and India the trees are attacked by the fungus Poria rhizomorpha. Lateral roots are first attacked by the fungus. The bark of infected tree appears white for 3-5 feet. above ground. In the final stages the sap and heartwood becomes brown coloured. The sapwood becomes brittle and breaks away in blocks when pulled by fingers. Within 12 months the whole plant is destroyed.

Root rot occurs in plant by the fungi (Ganocerma colossum and Fomes lignosus, but the damage is not extensive.

Trade name of timber : In the world market the timber is known Gumari, Gumhar and Kumbar. Gamar has been adopted as Pakistan standard name.

Wood Properties :

(a) Anatomy : Growth rings are distinct and visible due to difference in the thickness of fibre cells wall in the growth ring zone (denser fibre zone), 4-6 rings per inch. Usually the growth rings are annual and the age of the tree

can be determined by counting the growth ring numbers. Wood is normally diffuse porous but if grown under adverse condition, it becomes ring porous. Colour of wood is straw yellow to creamy white, sometimes with pinkish tingle and turning yellowish brown with age. Sapwood and heartwood cannot be distinguished from the colour. Vessels are of different sizes, visible to naked eye, solitary or in radial groups of 2-3, pores of heartwood are heavily tylosed. Parenchyma is mostly vascentric and sometimes aliform. Terminal parenchyma may be laid down if starch is withdrawn for the leaves before leaf-fall. Terminal parenchyma is normally absent when the wood is diffuse porous. Rays distinct to naked eye appear as wavy lines (bending at the pores) on end structure. Ripple marks are absent . Microscopically vessels are more than 200 microns in diameter with simple perforation plates. Intervessel pits and ray-vessel pits are small. Rays heterogenous but sometimes homogenous, 4-10 cells wide. Fibre septate, length varies from 1.01 to 1.30 mm., diameter 27.8--34.5 microns, cell wall thickness 3.0--4.78 microns and lumen diameter 20-28 microns. It has been found that fibre length varies from pith to bark within the ring and also at different height of the tree. This variation occurs upto certain age and upto certain height on the tree and then gradually fallsoff. Fibre length increases with age. Timber is without any characteristics smell or taste, medium-coarse textured, straight to interlocked grained, lustrous with smooth feel. Tension wood is sometimes present.

(b) Seasoning : The wood is very wet when freshly cut. Percentage of moisture is as high as 150 in green condition. It is extremely slow drying species without much degradation and low radial and tangential shrinkage. Drying experiment with Gamar planks was carried out at the Forest Research Institute, Chittagong and it has been found that in comparison to

its density, gamar is a very slow drying species. Very little degradation took place during drying. Once dried, Gamar timber retain its shape very well.

(c) Durability and Preservative Treatment: The wood is perishable in contact with the ground. The heartwood is durable under cover and when kept in contact with water. It is moderately durable in contact with fungal attack and its resistance to termite attack varies with the species of termite present. Wood is destroyed by Teredo. The timber stands well in brackish-water and can be used for sluicevalves. The average life of test stick is one year 3 months. The heartwood is difficult to impregnate by normal pressure method. Experiment has shown that heartwood takes 1-2 lbs. per cubic foot and sapwood 7-10 lbs. per cubic foot of creosotedieseline 50:50 mixture. Lateral penetration is 1-32nd inch and longitudinal penetration 1/16th inch.

(d) Physical and Mechanical Properties: It is moderately hard but distinctly strong and elastic timber.

Density and weight : Density based on oven-dry weight and green volume is 0.40 and that based on oven-dry weight and oven-dry volume is 0.44. Average weight at 12% moisture content (seasoned wood) is 30 lbs. per cubic foot. Weight of green log at 150% moisture content is 66 lbs. per cubic ft. Experiments have shown that fast growth does not change the density of Gamar wood, making it for rapid production of large quantities of stable utility timber within short rotation.

Mechanical properties :

(i) Hardness (in lb/impression a.side: 745
b.end : 770

(ii) Transverse strength (in lb/sq.in)
a. Breaking strength : 10,605
b. Modulus of elasticity: 1,484,000

(iii) Crushing strength parallel to grain (in lb/sq.) 5,735 Mechanical properties of Gamar wood have been tested at the Forest Research Institute, Chittagong and the strength data are yet to be published.

(e) Working qualities : The timber works very well both by hand and by machines and therefore very much liked by the carpenters. The timber saws cleanly and when quarter sawn the planks show fiddle back mottling giving wood a silvery appearance. The wood planes easily, but when knots are present and wood is much interlocking, it tends to tear near knots and patches of interlocking grain during planing. This can be reduced by reducing cutting angle from 30° to 20°. During moulding collars should be used. Nail and screw-holding properties are good but for thicker nails (12 gauge), pre-boring is necessary, otherwise, the wood may split up. It peels well on a veneer lathe without preliminary boiling and its glueing properties are good. It gives a good second class plywood and very good for tea-chest plywood. It takes a good polish but for uniform painting some filler should be used. It is too soft for turnery. It is not an ornamental wood.

(f) Pulping Properties : Pulping experiments carried out at this Institute as well as in India, Africa and Malaya show that Gamar wood has excellent pulping properties. Results obtained by using chemical and semi-chemical processes

show that yield of pulp is good. Except ~~of tear and fold~~ strength the other physical properties of unbleached sulphate pulp are excellent. The loss of yield on bleaching is low; the consumption of bleaching agent extremely low and a paper of high brightness is produced. The quality of paper can be improved by blending with small quantities (10-20%) of coniferous sulphate pulp.

Chemical analysis shows that resin content is rather high and the effect of resin can be eliminated by the use of the anti-foaming agent like terpentine. Also the holocellulose content is high. The fibre dimensions are of the same order as observed in Aspen and Birch and various species of Eucalyptus which are extensively used for the manufacture of pulp. The potentialities of gamar wood as a source of ground wood pulp is being explored. Its pale colour and good bleaching properties indicate that it may be suitable for making newsprint by the refiner process. Researches on the fibre dimension study show that Gamar pulpwood will not contain a high proportion of short fibre even when grown on a short rotation of 8 years. Thinnings from the plantation when 3 years old would contain many short fibres, undesirable for pulp but suitable for particle board. Thinnings from older trees and final crop from 7-8 years old trees would give sufficient long fibres in the mixed pulp for printing paper although paper would be too weak for use alone in newsprint or wrapping papers. At the Forest Research Institute, Chittagong, study of pulping quality for kraft paper from Gamar wood from different age groups, namely, 8, 12, 16 and 20 years was carried out. Best pulp has been obtained from 16 years old tree and pulp from 8 years old tree showed lower yield with poor strength properties. Pulp from 20 years oldtree did not show any better results.

Uses : Due to its good working qualities and much stability Gamar wood is extensively used for furniture although the wood has a dull appearance. The other chief uses of the timber are in cabinet making, door and window panels, boat and ship building, interior panelling and linings of railway carriages. It is also used for making small articles as toys, combs, picture and slate frames, mathematical instruments, carved images. This is an excellent wood for making drums and used for sounding-boards of musical instruments. This is also suitable for bobbins and and gun stocks. The suitability of Gamar wood in match industry has been tried in Nigeria with the following results : Splints absorbed paraffin readily, burned with a smokeless and odourless flame and took the match heads firmly. The splint burned when held downwards and upwards but not when held horizontally. The impact strength of match sticks was good but the shear strength was low. The species has been found suitable for making match boxes and splints.

Other economic value : The different parts of the plants have medicinal properties. The root is bitter, tonic, stomachic and laxative and has anthalmintic properties. It is useful in cough, rheumatism, fever, abdominal pains and burning sensations. The juice of leaves is used to remove foetid discharges and worms from ulcers. The flowers are used in leprosy and blood diseases. The fruit is prescribed as a tonic, to promote the growth of the hair and in the treatment of leprosy, anaemia and ulcers.

The leaves are used as foddor and the fruits are eaten by tribal people.

Wood ashes and the fruits are used for dying.

In Malawi smoke produced by burning wood of Gamar has been found suitable for curing tobacco.

Conclusion : Gamar is one of the best utility timber of East Pakistan but its supply is not plentiful as it grows scattered in the forests and the natural regeneration is very poor. It is a short lived tree and in a monsoon climate it may live upto 30-40 years of age. But the plantation of Gamar in East Pakistan is heavily attacked by Loranthus and many plants die within a short period of life. Since it is very fast growing species, raising plantations of Gamar on short rotations will be profitable. Such plantations will supply raw materials for pulpwood, fuel and match industry. In plantation Gamar produces a tall cylindrical bole. Therefore, its suitability for poles may be tested. An old stock of Gamar wood show many knots. This may be eliminated by proper pruning in plantations. Proper care should be taken to protect the plantation of Gamar from Loranthus fungal and insects attack. Extensive researches are needed to study the pulping properties of Gamar wood of our country and ultimately to recommend the proper rotation period at which gamar crop may be harvested for pulpwood. Also the suitability of gamar wood for grou ground wood pulp for making newsprint should be tested. Research project should also be taken up to find out the causes of slow drying and low penetrability of preservatives in Gamar wood.