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Volume table preparation for timber yielding tree species *Gmelina arborea* Roxb

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Abstract
The present trial was carried out in the College of Forestry, Navsari Agricultural University, Navsari, Gujarat during 2022-23 to preparation of the volume table of *Gmelina arborea*. For the trial, two hundred twenty five number of sample trees were selected randomly which were categorised into diameter class wise to prepare volume table. The biometrical parameters of *G. arborea* such as DBH, mid diameter, height, form quotient and stem volume varied in the range of 8.40-39.24 cm, 7.63-18.48 cm, 6.70-14.43 m, 0.47- 0.91and 0.036-0.835 m^3 respectively in the diameter class of 5-10 cm to 35-40 cm. In the process of preparation of volume table of *G. arborea*, trees having DBH from 5 to 40 cm, volumetric equation $V= 0.00004D^2H + 0.043$ (R^2=0.882) was developed and this equation was used for preparation of volume table of *G. arborea*. Further, for quick estimation of volume of *G. arborea* trees the local volume table can be used by farmers, foresters and wood merchants.

Keywords: Diameter, height, *Gmelina arborea*, volume, volume table

Introduction
Gmelina arborea belongs to Lamiaceae family, is an indigenous fast growing and economically important tree species found in various parts of India. *G. arborea* commonly known as Gamhar or Gmelina is naturally distributed in different regions of India including the central Himalayan region, Gangetic plains and other parts of North and South India (Chaturvedi *et al.*, 2012; Luna, 2005) [5, 13].

It is moderate to large deciduous tree with a straight trunk and attains a height of 12-30 m or more and 60-100 cm in diameter (Luna, 2005; Kumar *et al*., 2003) [13, 12]. Gamhar is well suited to wide range of climatic conditions and can grow on diverse soil types such as acidic, laterites and calcareous loams, doing poorly on thin or poor soils with hardpan, dry sands, or heavily leached acidic soils, well drained basic alluviums, however it prefers well drained soils with a pH range of 6-7.5 (Chaturvedi *et al.*, 2012; Kumar *et. al*., 2003) [5, 12]. It thrives in tropical and subtropical climate up to 1200 m elevation and with an average annual rainfall of 900-2500 mm. *G. arborea* has also shown resilience to drought conditions, making it suitable for areas with water scarcity (Sharma *et al.*, 2016; Luna, 2005) [14, 13]. More precisely it is a strong light demander in mature stage while in young stage demands shade, moderately frost and drought hardy and nature of strong coppicer (Luna, 2005) [13].

G. arborea has gained significant attention and popularity due to its multiple uses and economic value. It has a wide range of applications in various industries, including timber, furniture, agroforestry, medicinal products and paper production. It is used in the construction of furniture, doors, window frames, musical instruments and decorative veneers (Srivastava and Chaturvedi, 2014; Luna, 2005) [19, 13]. The fast growth rate and ability to coppice make it an ideal choice for sustainable tree plantations for timber production. Apart from its timber value, *G. arborea* also plays a significant role in agroforestry systems. The tree provides shade and acts as a windbreak, making it suitable for intercropping with agricultural crops. It helps to improve soil fertility, as its fallen leaves contribute to organic matter accumulation and nutrient cycling (Singh *et al.*, 2016) [18]. In addition, *G. arborea* has been utilized in traditional medicine systems for its various medicinal properties. Different parts of the tree, including the leaves, barks and roots, are used to treat ailments such as fever, inflammation, wounds and digestive disorders (Chaturvedi *et al.*, 2012) [5].

Efficient management and utilization of *G. arborea* requires accurate estimation of its volume and biomass. The forest estate lacks baseline data on estimate of growing stock of resources.

It is absolutely necessary to obtain accurate estimation of standing tree volume, above ground biomass and carbon stocks for assessing expected yields from commercial and subsistence harvesting as well as for the global climate change mitigation (Husch *et al*., 2003; Freer-Smith *et al*., 2007) [8, 6]. For timber productions, an estimate of growing stock is often expressed in form of timber volume, which can be estimated from easily measurable tree dimensions (Akindele and Le May, 2006) [1]. Volume table is a tabular statement showing the volume with respect to diameter of specific area. Globally, volume table keeps a significant role for volume calculation of standing trees (Husch *et al.*, 2003; Jayaraman, 2000) [8, 9]. Volume tables are used to estimate standing timber volume for timber sale, forest management plans and forest surveys, appraisal of damage and forest valuation in general. The variables used for volume table preparation are DBH (diameter at breast height) and height. Volume tables have a long history in forest science and are still a commonly used operational tool (Vanclay and Baynes, 2005) [20]. The local volume table is prepared based on the limited data set to show the volume. Therefore, such volume tables are applied for the confined areas. In fact, there are several factors that affect precision of the volume table. Some major factors are stand density, site quality, local climate, soil condition, altitudinal gradient, aspect, inter and intra specific competition (Avery and Burkhart, 2000) [2]. The volume table is prepared for species specific and so volume table prepared for one tree species cannot be used for another tree species (Khanna and Chaturvedi, 1982) [11].

Indian researchers and foresters have recognized the significance of developing specific volume table for different tree species by conducting studies focused on these species. Therefore, with these views and importance, the present study was carried out to prepare the local volume table of *G. arborea*.

Materials and Methods

The present study was carried out in Navsari Agricultural University campus, Navsari, Gujarat, India during 2022-23, India. In order to prepare the volume table, 225 trees distributed in the conventional block plantations, boundary plantations and scattered conditions were selected. Further trees of G. *arborea* belonged to different diameter classes D1: 5-10 cm, D1: 10-15 cm, D3: 15-20 cm, D4: 20-25 cm, D5: 25-30 cm, D6: 30-35 cm and D7: 35-40 cm was considered and various biometric parameters such as DBH (cm), Mid-diameter (cm) and tree height (m) were recorded. Further, using these data, Form Quotient and Volume (m^3) of standing trees were estimated (Behera *et al.*, 2022) [4]. After compiling all the database and arrangement, data were subjected to statistical analysis and linear volumetric equation was developed using regression equation following standard method. The developed volumetric equation was adopted for preparation of volume table.

Results and Discussion

In the present study, trees of *G. arborea* with DBH ranged from 5 to 40 cm were used for estimation of volume and DBH of trees were grouped into seven diameter classes *viz.* D1: 5-10 cm, D2: 10-15 cm, D3: 15-20 cm, D4: 20-25 cm, D5: 25-30 cm, D6: 30-35 cm, D7: 35-40 cm and D7: 40-45 cm. The biometrical parameters of *G. arborea* such as DBH, mid diameter, height, form quotient and stem volume varied in the range of 8.40- 39.24 cm, 7.63-18.48 cm, 6.70-14.43 m, 0.47-0.91 and 0.036-0.835 m^3 respectively in the diameter class of 5–10 cm to 35-40 cm (Figure 1 & 2).

The volume table of *G. arborea* was prepared by considering the volumetric equation *i.e.* $V= 0.00004D^2H + 0.043$ (R^2=0.882) where, D (DBH in cm) and H (Height in m). The volume table prepared was site specific and this was prepared by considering the diameter class and height class and their corresponding mid values. These mid values of diameter class and height class was put in the developed equation ($V= 0.00004D^2H + 0.043$) and volume table was prepared (Table 1).

The volume table of *G. arborea* was prepared by considering the volumetric equation *i.e.* $V= 0.00004D^2H + 0.043$ and considering the diameter class and height class with their corresponding mid values. Various authors prepared site specific volume table for *G. arborea* such as Singh *et al.* (2014) [17]; Gupta and Shukla (2012) [7] and for other tree species such as Behera *et al.* (2019) [3] prepared local volume table for *Tectona grandis* as well as local volume table for *Eucalyptus* spp. in South Gujarat region by Behera *et al.* (2022) [4]. Moreover, local volume tables were prepared by Shrestha *et al.* (2018) [16] in *Dalbergia sissoo*, *Terminalia alata* and *Shorea robusta* whereas *Cedrus deodara* volume table was prepared by Sharma *et al.* (2017) [15]. Similarly, Kabir (2007) [10] prepared local volume tables for *Acacia auriculiformis* and *A. mangium.*

Table 1: Volume table of *G. arborea*

	Height in m (Height range and mid value)											
DBH (cm) (Dia range and mid value)	**Diameter/ Height range**		**5-8**	**8-11**	**11-14**	**14-17**	**17-20**	**20-23**	**23-26**	**26-29**	**29-32**	**32-35**
		Mid diameter/ Height	**6.5m**	**9.5m**	**12.5m**	**15.5m**	**18.5m**	**21.5m**	**24.5m**	**27.5m**	**30.5m**	**33.5m**
	5-10	7.5 cm	0.058	0.064	0.071	0.078	0.085	0.091	0.098	0.105	0.112	0.118
	10-15	12.5 cm	0.084	0.102	0.121	0.140	0.159	0.177	0.196	0.215	0.234	0.252
	15-20	17.5 cm	0.123	0.159	0.196	0.233	0.270	0.306	0.343	0.380	0.417	0.453
	20-25	22.5 cm	0.175	0.235	0.296	0.357	0.418	0.478	0.539	0.600	0.661	0.721
	25-30	27.5 cm	0.240	0.330	0.421	0.512	0.603	0.693	0.784	0.875	0.966	1.056
	30-35	32.5 cm	0.318	0.444	0.571	0.698	0.825	0.951	1.078	1.205	1.332	1.458
	35-40	37.5 cm	0.409	0.577	0.746	0.915	1.084	1.252	1.421	1.590	1.759	1.927
	40-45	42.5 cm	0.513	0.729	0.946	1.163	1.380	1.596	1.813	2.030	2.247	2.463
	45-50	47.5 cm	0.630	0.900	1.171	1.442	1.713	1.983	2.254	2.525	2.796	3.066
	50-55	52.5 cm	0.760	1.090	1.421	1.752	2.083	2.413	2.744	3.075	3.406	3.736

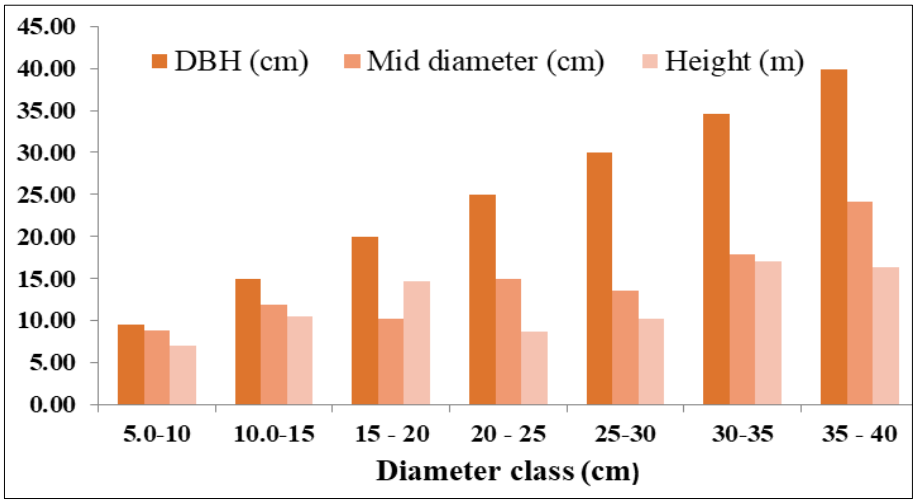

Fig 1: Diameter class wise variation in DBH, Mid Diameter and Height of *Gmelina arborea*

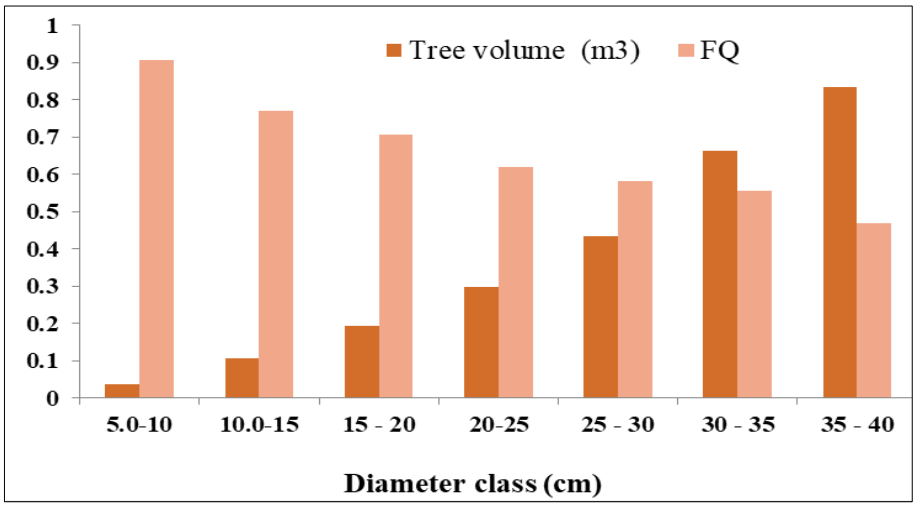

Fig 2: Diameter class wise variation in stem volume and FQ of *G. arborea*

Conclusion

The volume of standing *G. arborea* trees can be estimated by using local volume table developed from volumetric equation, $V= 0.00004D^2H + 0.043$ having DBH of 5 to 40 cm. Further, for quick estimation of volume of *G. arborea* trees the prepared local volume table can be used by farmer, foresters and wood merchants.

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