

## GROWTH OF PLANTATION GROWN *KHAYA IVORENSIS* IN PENINSULAR MALAYSIA

Ahmad Zuhaidi Yahya, M. Noor Mahat & Ab. Rasip Ab. Ghani

Forest Research Institute Malaysia, Kepong 52109 Kuala Lumpur, Malaysia

*Khaya ivorensis*, a member of the Meliaceae family, also known as African mahogany, is found naturally in the tropical moist lowlands of West Africa, parts of Côte d'Ivoire, Ghana, Togo, Benin, Nigeria and southern Cameroon. It is large tree, deciduous in drier climates that can attain heights of 40–50 m and diameter at breast height of up to 200 cm (Kinloch & Miller 1949, Lamprecht 1989). The tree is straight with long clear bole to as high as 30 m and bearing well-developed plank buttresses. The timber is moderately durable with a fine, fairly regular grain, easy to work and season, but difficult to impregnate. The timber is categorised as a medium hardwood timber with density averaging 560 kg m<sup>-3</sup> (Lamprecht 1989). The wood can be used for high quality furniture, panelling, cabinet-making and superior joinery, including other decorative works (Kinloch & Miller 1949).

A 0.3-ha stand of *K. ivorensis* was established in 1957 in the Bukit Lagong Forest Reserve, Selangor, Peninsular Malaysia (3° 14' N, 101° 38' E). The mean daily temperature in this region ranges from 27 to 32 °C. The annual rainfall is between 2000 and 2900 mm. Aspect is easterly. The soil is light reddish loam, shallow with underlying rock and granite. The drainage system is good. In the planting trial, 310 seedlings were line-planted at a spacing of 3 × 3 m (1111 seedlings ha<sup>-1</sup>). Line cleaning and cutting of secondary forests and palms were carried out for the first five years at two-month intervals. During this period (1957 until 1962), 4 weeding rounds (first 2 years) and 18 climber cuttings were done. No further treatments and thinning were carried out thereafter and the stand was re-measured for the first time in 1997.

Table 1 presents the average growth results and standing stock of the 40-y-old plot in the Bukit Lagong Forest Reserve in Selangor in comparison with data from a 26-y-old plot in the Gunung Bungsu Forest Reserve in Kedah (as reported by Darus *et al.* 1991). Early assessment shows that 180 or 58 percent of the tree population achieved a diameter at breast height of 9–14 cm (mean diameter 10.6 cm) at the age of 5 years and 4 months after planting (Table 1).

**Table 1.** Standing stock of planted *K. ivorensis*, Bukit Lagong and Gunung Bungsu Forest Reserve, Peninsular Malaysia

Age (y)	N (ha <sup>-1</sup> )	$h_{dom}$ (m)	$d_{dom}$ (cm)	$h_g$ (m)	$d_g$ (cm)	$h_c$ (m)	G (m <sup>2</sup> ha <sup>-1</sup> )	V (m <sup>3</sup> ha <sup>-1</sup> )	$V_{mai}$
5.25*	1033	-	-	-	10.6	-	-	-	-
26**	-	-	48.3**	26.2	43.6	-	-	192.10	7.39
40***	390	29.7	46.8	23.5	29.5	16.40	26.61	305.48	7.64

Sources: \* Anonymous (1957), \*\* Darus *et al.* (1991), \*\*\* this study.

## Note:

N	: number of trees ha <sup>-1</sup>	$h_c$	: mean height (clearbole)
$h_{dom}$	: mean height of 100 biggest trees ha <sup>-1</sup>	G	: basal area ha <sup>-1</sup>
$d_{dom}$	: mean diameter at breast height of 100 biggest trees ha <sup>-1</sup>	V	: volume ha <sup>-1</sup>
$h_g$	: mean height of the stand	$V_{mai}$	: mean annual volume increment (m <sup>3</sup> ha <sup>-1</sup> year <sup>-1</sup> )
$d_g$	: mean diameter of the stand		

The stand in Bukit Lagong Forest Reserve was initially planted at a density of 1111 stem ha<sup>-1</sup>. As a result of mortality caused mainly by tree competition, the density declined to 390 stems ha<sup>-1</sup> in 40 y. The dominant trees (100 biggest trees ha<sup>-1</sup>) had an average diameter of 46.8 cm and average height of 29.7 m. The overall mean diameter was 29.5 cm and the overall mean height 23.5 m. The average clear bole height was 16.40 m. The approximate standing volume (clear bole volume) was 305.48 m<sup>3</sup> ha<sup>-1</sup>, i.e. the current standing stock was produced with a mean annual volume increment of 7.64 m<sup>3</sup> ha<sup>-1</sup> y<sup>-1</sup> at 40 years. The value is lower than for the other Meliaceae species, *Azadirachta excelsa*, with a mean annual volume increment of 14.4 m<sup>3</sup> ha<sup>-1</sup> y<sup>-1</sup> at 41 y (Ahmad Zuhaidi & Weinland 1995).

Similarly, the 26-y-old *K. ivorensis* planted in Gunung Bungsu Forest Reserve shows comparable growth performance as indicated by the mean annual volume increment. The average diameter at breast height for the dominant class trees was 48.3 cm (Appanah & Weinland 1993) with the overall mean diameter of 43.6 cm and the mean height of 26.2 m. The standing stock was produced with a mean annual volume increment of 7.39 m<sup>3</sup> ha<sup>-1</sup> y<sup>-1</sup> at 26 y (Darus *et al.* 1991).

The diameter range in the population from Bukit Lagong Forest Reserve is very wide as the large difference between the dominant and overall average diameter indicates (17.3 cm).

Figure 1 shows the diameter distribution of the 40-y-old *K. ivorensis* stand.

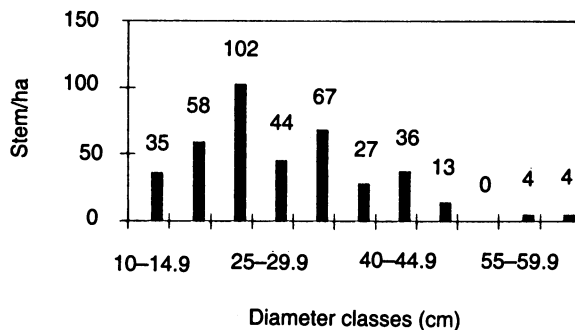


Figure 1. Diameter-class distribution of *K. ivorensis*, Bukit Lagong Forest Reserve, Peninsular Malaysia at 40 y

The wide diameter range of 12.3–62.4 cm is not necessarily a disadvantage as long as the size of the final crop trees lies within a relatively narrow range. The optimum final crop standing is assumed to be 200–250 trees ha<sup>-1</sup>. Table 2 gives the main stocking parameter for the 100 and 200 biggest trees ha<sup>-1</sup>.

**Table 2.** Stocking parameter for the two sub-populations of biggest trees ha<sup>-1</sup>

Sub-population	$h_g$ (m)	$d_g$ (cm)	$h_c$ (m)	G (m <sup>2</sup> ha <sup>-1</sup> )	V (m <sup>3</sup> ha <sup>-1</sup> )	dia. range (cm)
100	29.66	46.8	19.30	9.96	134.56	41.2–62.4
200	25.45	38.6	17.20	15.26	185.73	31.2–62.4

Note: abbreviations as in Table 1.

While the diameter range for the 100 biggest trees ha<sup>-1</sup> is fairly narrow, the range only increases by 10 cm for the 200 biggest trees ha<sup>-1</sup>. There is also a gradual descent in the average diameter for the group of 100 biggest trees ha<sup>-1</sup> ( $d = 46.8$  cm) to that of 200 biggest tree ha<sup>-1</sup> ( $d = 38.6$  cm).

The potential of the species for plantations seems to be promising. However, before the species can be planted on a commercial scale, the following aspects have to be addressed. The factors contributing to the distinct differentiation in tree size need to be determined. A tree selection programme might be needed to achieve a more uniform growth performance within the population. Observations in the 40-y-old stand in Bukit Lagong Forest Reserve, Peninsular Malaysia, show that the species is relatively free from serious pests and diseases except for an isolated attacked of shoot borer (*Hypsipyla* sp.) upon the saplings. Some silvicultural measures including line-planting under shade trees and mixed planting have been identified in reducing the risk of shoot borer attacks (Lamprecht 1989). The growth results, however, do provide some guidance with respect to realistic production targets and could be refined by conducting more studies considering different site conditions and stand treatments.

### Acknowledgements

We thank Baskaran Krishnapillay for his valuable comments on the draft, and Khalid Tahir, Aziz Mohd Nor and Razani Zakaria for their assistance in data collection.

### References

- AHMAD ZUHAI, Y. & WEINLAND, G. 1995. A note on *Azadirachta excelsa*: a promising indigenous plantation species? *Journal of Tropical Forest Science* 7(4):672–676.
- ANONYMOUS. 1957. *Khaya ivorensis*. Field Records 30C. Forest Research Institute, Kepong, Peninsular Malaysia. 24 pp.
- APPANAH, S. & WEINLAND, G. 1993. *Planting Quality Timber Trees in Peninsular Malaysia - A Review*. Malaysian Forest Records No. 38. 221 pp.
- DARUS, A., HASHIM, M. N., A. RASIP, A. G. & LOK, E. H. 1991. *Khaya ivorensis* and *Endospermum malaccense* as potential species for future reforestation programme. Pp. 60–65 in Appanah, S., Ng, F. S. P. & Roslan, I. (Eds.) *Proceedings of the Conference of Malaysian Forestry and Forest Products Research*. Forest Research Institute Malaysia, Oct 3–4, 1990.
- KINLOCH, W. & MILLER, W. A. 1949. *Gold Coast Timbers*. Forestry Department and Prince Risborough Forest Products Laboratory, England. 34 pp.
- LAMPRECHT, H. 1989. *Khaya ivorensis: Tree Species- Possibilities and Methods for their Long-Term Utilization. Silviculture in the Tropics*. German Agency for Technical Cooperation (GTZ), Eschborn. 296 pp.