Teak in Tanzania: II. The Kilombero Valley Teak Company

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The importance of teak in Tanzania has been reviewed in a companion paper (Rance, Monteuuis, 2003). Within this Tanzanian context, the Kilombero Valley teak planting project, due to its particular characteristics, deserves a special development which constitutes the topic of this paper.

On the way to KVTC. A wildlife-friendly reforestation project.
Photo O. Monteuuis.

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RÉSUMÉ

LE TECK EN TANZANIE : II. LA KILOMBERO VALLEY TEAK COMPANY

Située dans le sud de la Tanzanie, la Kilombero Valley Teak Company (KVTC) a été créée en 1992 par la Commonwealth Development Company (CDC) dans le but de produire du teck de plantation de Tanzanie destiné à l'ensemble du marché, tout en assurant un retour sur investissement convenable. Sur les 28 132 ha que possède la compagnie, 14 000 ha situés sur les districts de Kilombero et de Ulanga ont eté identifiés par la KVTC comme potentiellement adaptés à satisfaire ce projet, tout en garantissant les nouvelles règles promulguées de foresterie internationale tant sur le plan environnemental que social, telles que la certification ISO. Les 24 premiers hectares du projet ont été plantés en 1993, pour atteindre aujourd'hui une superficie totale plantée de 4 200 ha répartis en plusieurs parcelles intégrées, en fonction de la date de plantation, dans un dispositif en mosaïque et séparées par de nombreuses zones « tampons » naturelles. La productivité actuelle est estimée à 13 m³/ha/an, et à 17 m³/ha/an pour les parcelles plantées ces cinq dernières années. Cet article présente les nombreux aspects et particularités du projet KVTC, son état d'avancement ainsi que ses futures orientations.

Mots-clés : teck, production de matériel végétal, plantation, sylviculture, Tanzanie.

ABSTRACT

TEAK IN TANZANIA: II. THE KILOMBERO VALLEY TEAK COMPANY

Situated in Southern Tanzania, the Kilombero Valley Teak Company (KVTC) was set up in 1992 by the Commonwealth Development Company (CDC) in order to supply the world market with Tanzanian plantation teak while ensuring favorable returns on investment. Of the 28 132 ha that the company holds, KVTC identified 14 000 ha in the Kilombero and Ulanga districts as particularly suitable for meeting this objective while applying current international forestry, environmental and social standards of practice such as ISO certification. The first 24 ha were planted in 1993, to reach today 4 200 ha spread over several plots established according to an age-related mosaic design and separated by several buffer zones or "wildlife corridors". The overall mean annual increment (MAI) is currently estimated at 13 m³/ha/year for the whole project and at 17 m³/ha/year for the plots planted over the last five years. This paper reports in detail on the main characteristics and accomplishments of the KVTC project to date, and orientations for the future.

Keywords: teak, planting stock production, plantation establishment, silviculture, Tanzania.

RESUMEN

LA TECA EN TANZANIA: II. LA KILOMBERO VALLEY TEAK COMPANY

Situada en el sur de Tanzania, la Kilombero Valley Teak Company (KVTC) fue creada en 1992 por la Commonwealth Development Company (CDC) para producir teca de plantación de Tanzania destinada al conjunto del mercado que, a la vez, garantice un adecuado retorno de inversión. La KVTC encontró 14 000 ha en los distritos de Kilombero y Ulanga, de las 28 132 ha que posee, potencialmente aptas para llevar a cabo este proyecto cumpliendo, al mismo tiempo, las nuevas normas promulgadas por el sector forestal internacional relativas a los aspectos medioambientales y sociales, como la certificación ISO. En 1993, se plantaron las primeras 24 ha del proyecto. Actualmente, hay una superficie total plantada de 4 200 ha, distribuidas entre varias parcelas, integradas en un diseño en mosaico según la fecha de plantación y separadas por numerosas zonas de amortiguamiento naturales. Se estima que la productividad anual es de 13 m³/ha/año, y de 17 m³/ha/año en las parcelas plantadas en estos cinco últimos años. Este artículo presenta los numerosos aspectos y particularidades del proyecto KVTC, su estado actual y sus futuras orientaciones.

Palabras clave: teca, producción de material vegetal, plantación, silvicultura, Tanzania.

General information on KVTC

In 1992 the Commonwealth Development Company (CDC) identified a global shortfall in the supply of natural teak and consequently set up the Kilombero Valley Teak Company. KVTC's long-term goal is to supply the world market with Tanzanian plantation teak while ensuring favorable returns on investment.

Situated in Southern Tanzania close to Ifakara (Figure 1), the Kilombero Valley seemed to be suitable for teak production. Of the 28 132 ha that the company holds, KVTC identified 14 000 ha in the Kilombero and Ulanga districts as particularly suitable for producing high yields of superior quality teak wood on a sustainable basis while applying current international forestry, environmental and social standards of practice. This company policy is supported by recent applications for ISO 140001 and Forest Stewardship Council (FSC) certification.

Preserving the natural resources, especially as far as wildlife is concerned, as well as fighting rural poverty by offering jobs to local people, are also priorities of the project.

The first 24 ha were planted in 1993, to reach today 4 200 ha spread over several plots planted according to an age-related mosaic design and separated by a number of buffer zones or "wildlife corridors". These plots, established on flat, deep soils for the most part, can be regrouped into four main areas, two in the north and two in the south of the Kilombero river and of the main town, Ifakara. Annual rainfall varies from 1 000 mm to 1 400 mm depending on the locality and the year, with a long, marked dry season of 8 months from May to December, as illustrated in Figure 2.

The KVTC field office is near Ifakara, which is about 450 km east/south east of the capital Dar es Salaam. The furthest planted plots are located 80 km from the office and 213 km of roads (18 m/ha on average) built by the company are needed to reach the different plots. The only way to cross the Kilombero river is to use the ferry.

As in any well-managed company, optimizing the human resources has been one of the major concerns. The permanent staff has recently been reduced to 14 junior and 19 senior staff under the project manager and the development manager, both expatriates, in order to rely more on casual contractors, varying in number from 235 to 750 depending on the activity. Resorting to casual labor allows more flexibility to adapt to the variations of work activities over the year.

Planting stock production

Genetic origin of the plant material

The plant material used by KVTC so far has originated from the Mtibwa and Kihuhwi seed sources detailed in a companion paper (Rance, Monteuuis, 2003), which can be considered as the "Tanzanian land race" deriving from the same Burmese (or Indian) provenances.

KVTC purchases the seeds collected from these seed stands (ground collection at 6 US $ per kg, around 1 000 "seeds", or rather fruits). Every year, the company spends 22 000 US $ on seed purchase, as around 3 600 to 3 700 kg of seeds are needed.

Figure 1.
Physical map of Tanzania showing the approximate location of the KVTC project.

Lion walking along the road to KVTC just before sunset.
Photo O. Monteuuis.

The rationale of KVTC establishing its own seed production areas from origins other than those currently available locally may be justified due to the following reasons:

- Reduction of external seed purchase costs.
- Expectations of improving the quality of the current plantations, being aware that teak performances in a given situation can vary a great deal depending on the seed origin. This view is supported by the provenance trial established in Longuza (Madoffe, Maghembe, 1988) which shows significant provenance effects for traits such as straightness, basal area and yield, and also by the few Thailand-issued teak trees planted within the project, which produce fewer and smaller branches than the local ones.
- Better control of the cost, accurate origin, quality and availability of the seeds used, as outside supplies can stop at any time due to unforeseen circumstances.
- Possibility of selling excess seeds to any interested clients, within the country or even overseas.

Nursery

Since the beginning, stumps have been used for plantation establishment in accordance with the following procedure:

The seeds are first pretreated by being soaked in water and dried under full sun alternately several times in order to stimulate germination in nursery germinating beds. However, despite these treatments, the germination process may last from 2 weeks up to 6 months or even more, although in practice, only the seedlings germinated in less than 2 months are used. These seedlings are then cultivated for 10 to 12 months on average until they reach a suitable stage when they can be converted into stumps of 15 to 20 cm in length and at least 12 mm in diameter. Weaker stumps remain in the nursery longer. As an indication, 1 000 "seeds" (1 kg) ultimately give 170 plantable stumps which cost 0.15 US $ per unit.

Stumps can be stored and transported in much greater quantities and in more cost effective conditions than seedlings. They are not as sensitive to climatic parameters and particularly water deficiencies as seedlings which must be planted just at the beginning of the rainy season. Stump planting is not as time-restricted and can be extended to several weeks.

The main disadvantages associated with the use of stumps are:

- Must stay longer in field nursery.
- Production of multiple stems resulting from the trimming of the main original stem. Trimming the tip of the original taproot also induces the formation of secondary roots which take over the main root, but incidence on the future of the plant seems very unlikely.

The use of container-produced seedlings has recently been tested at KVTC, applying the following procedure:

- Pretreatment of the seeds to stimulate the germination process.
- Pre-germination of the seeds.
- Transplanting the germinated plants into reusable root trainer containers of $90\ cm^3$ filled with organic substrate made locally by mixing composted sugar cane wastes (filter and mud press) with rice residues including straws, axes and seed coats.
- Sorting seedlings within the trays according to size.
- Appropriate fertilizers and water supplies to ensure a uniform crop.
- Pest and disease control and treatments.

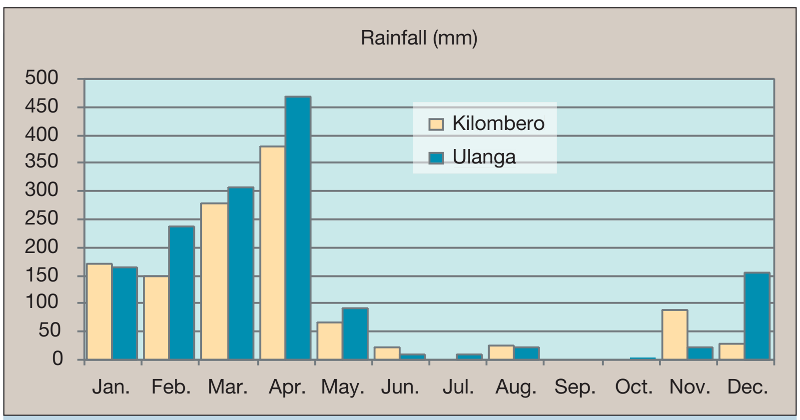
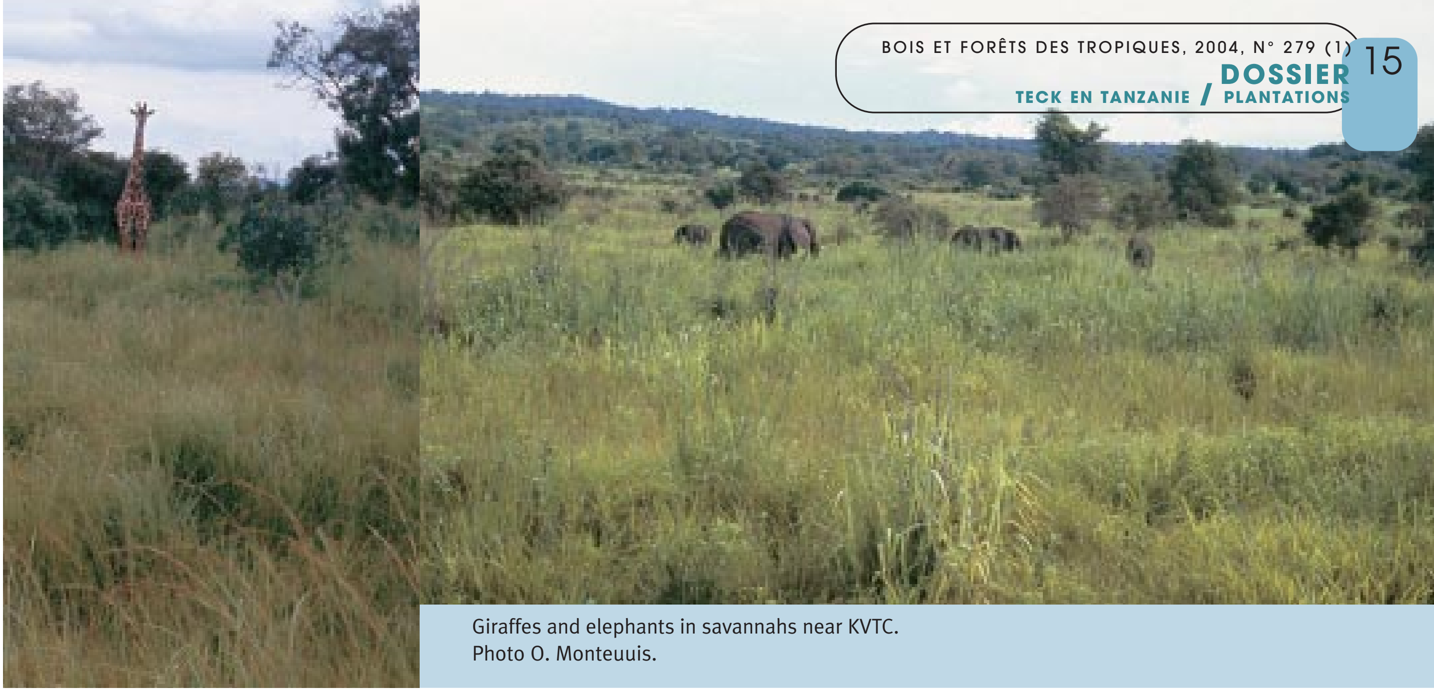


Figure 2.
Monthly average rainfall for Kilombero and Ulanga districts from 1998 till 2002.



Giraffes and elephants in savannahs near KVTC.
Photo O. Monteuuis.

The seeds can be also sown directly in the container (2 seeds per container), but unpredictable germination rates (35 % on average at present) require further manipulations such as seedling removal or transplanting in order to obtain one seedling per container. This is why the option consisting of pre-germinating the seeds, in trays for instance, in order to do early transplanting into containers of only the germinating seedlings has been preferred. The seedlings germinated at the same time are then regrouped together for greater homogeneity in the size of the plant material. The container-grown seedlings are usually 5 to 10 cm tall by the time they are field planted.

Due to the poor germination rates as well as the uneven germination characteristic of teak seeds (White, 1991) and the resulting need for “culling”, the ultimate conversion rate of seeds into plantable seedlings is approximately 17 %.

Container-raised seedlings, in contrast with those left in place, produced soon after field transfer very early lateral branches, which need to be removed. If this observation is confirmed, this unusual early production of lateral branches may result from hydric stress within the terminal bud of the main stem as a consequence of transplantation.

The results of the first trials comparing the early performance of seedlings and stumps have been very encouraging towards the use of suitable sized seedlings. The tallest seedlings at the time of planting grew the slowest, while the smallest seedlings planted grew the fastest, as reported in Table I.

However, rigorous complementary field tests combined with accurate and realistic economic analyses are needed to determine the rationale of preferring seedlings to stumps, considering that large-scale production of seedlings may be severely handicapped by the 8-month dry season and requires more sophisticated and costly nursery facilities. On the other hand, production costs can be significantly reduced by the shorter time required in the nursery to produce plantable seedlings in comparison with stumps.

At this point in time, the following aspects are worth testing in order to improve seedling performance:

- Container size – the current volume is smaller than in many nurseries. In Malaysia, for instance, cylindrical 10 x 15 cm plastic bag containers 3/4 filled with local topsoil are used.
- Seedling size: see above.
- Addition of “Aquasoil”, correctly used, in order to anticipate the planting period and extend the beneficial influence of the rainy season.

Table I.
Comparative field performances 2 months after planting of container-raised seedlings and stumps in relation to seedling height at the time of planting. The trial consist ed of 8 rows of 15 trees with alternate rows of seedlings and stumps. The trial was replicated on three sites with different seedling sizes on each site. Date of planting 19 January 2002, assessed on 19 March 2002.

Seedling height (cm)	Parameter	Seedling	Stump	Difference
Height >10	Survival (%)	53/60=88	48/60=80	5/60=8
	Height (cm)	12.6	10.7	1.9
	Diameter (mm)	6.1	4.5	1.6**
10> height >5	Survival (%)	54/60=90	49/60=82	5/60=8
	Height (cm)	14.6	9.1	5.5**
	Diameter (mm)	5.6	4.0	1.6**
5> height	Survival (%)	49/60=82	42/60=70	7/60=12
	Height (cm)	15.8	11.7	4.1**
	Diameter (mm)	6.8	5.3	1.5*

* Significant at P<0.01; ** significant at P<0.001 (t paired test).

Multiple stem production from stumps.
Photo O. Monteuuis.

However, the additional costs of all these parameters have to be realistically weighed up, and only a significant increase in yield and quality can objectively justify using seedlings instead of stumps. Table II sums up the respective major advantages and disadvantages of using stumps as opposed to container-raised seedlings.

Regardless of the option chosen, the project currently needs to produce 1 200 000 ready-for-planting plants every year.

The recent progress in vegetative propagation of teak with the possibility of mass producing clones of selected genotypes by cuttings or microcuttings (Monteuuis *et al.*, 1995; Monteuuis *et al.*, 1998; White, Gavinlertvatana, 1999) has prompted KVTC management to consider this option. The advantages resulting from clonal plantations as opposed to seedlings or stumps have been argued elsewhere (Monteuuis, Goh, 1999). In the KVTC context, the following aspects should be seriously taken into consideration for opting for cutting instead of using seed-issued plant material:

- Regular availability of reasonably priced seeds, at least for the time being.
- Satisfactory conversion rate of seeds to seedlings or stumps.
- Seed-issued plants are cheaper and better adapted (through stumps) than rooted cuttings to the local conditions of 8 months of dry season for large-scale production (1 200 000 plants/year).
- The seed-issued wood population appears unexpectedly homogenous up to age 10 for most of the commercially important traits assessed up to this stage, with the exception of wood characteristics (heartwood/sapwood ratio) not yet checked.

On the other hand, the operational use of clones will allow a reduction of plantation establishment and further maintenance costs by reducing:

- the initial density, and therefore the quantity, of the planting stock needed;
- thinning and pruning activities, which ultimately benefit only 22.5 % of the crop, due to the utilization of uniform, superior quality trees.

Intercrops can even be mixed between rows for early additional returns to produce a uniform, top grade marketable wood, with the possibility of increasing yield and quality for more difficult sites through a more refined clone x site selection.

Table II.
Major advantages and disadvantages of using stumps as opposed to container-raised seedlings.

	Advantages	Disadvantages
Stumps	▪ Can stand long period of storage in very basic conditions. ▪ Reduced transportation costs. ▪ Stump establishment is not so dependant on rainfall. ▪ Stumps are very hardy and can survive harsh treatment.	▪ Large open beds required for a long period of cultivation and maintenance (weeding) responsible for higher production costs. ▪ Interruption of the growth of the taproot and stem. ▪ Lack of uniformity in the resulting crop. ▪ Multiple stems resulting from the cut back stem. ▪ Secondary roots replace main taproot after trimming. ▪ There is a need to strip leaves for greater uniformity, which involves a serious risk of secondary infection.
Container-raised Seedlings	▪ Taproot remains intact. ▪ No interruption in growth. ▪ Requires less nursery space and time than stumps. ▪ Relatively cheap. ▪ Greater uniformity of the crop overall with the possibility of size sorting in the nursery. ▪ Weeding requirements are significantly reduced due to the sterile medium utilized.	▪ Container size and spacing must be large enough to cater for the large leaves. ▪ Very sensitive to hydric stress. ▪ Requires intensive hands-on management. ▪ Requires investment in improved infrastructure. ▪ Infield planting not very flexible in terms of timing (require adequate rains before establishment as well as after planting). ▪ Difficult to store and transport.

Plantations

KVTC has been through a very intensive learning phase over the last 11 years and has consequently refined and improved its management and silvicultural practices, which are currently as follows.

Site selection and preparation

As teak is site-specific (White, 1991; Keogh, 2001), special consideration is given to site selection in order to maximize plantation returns as far as possible. Soil analysis, altitude, slope gradient, natural vegetation and environmental assessment are the main parameters considered for site selection and site classification.

Once the site has been selected, site preparation consists of the following steps: site clearing, burning-off and pre-plant herbicide application.

Site clearing

All selected sites are completely cleared of vegetation. This vegetation is then left exposed and burnt when sufficiently dry.

Burning off

Depending on slope gradients and more recently on soil assessments, sites which are more erosion prone are treated differently in order to protect against erosion. Fuel is spread over the whole site and lit. The fire is controlled so as to achieve a clean, effective result by assessing the time of day, the ambient temperatures and the humidity. Wind speed and direction are also taken into consideration when carrying out the burn-off operation.

Pre-plant herbicide application

Taking into consideration the rainfall and timing, the cleared areas are chemically treated with glyphosate (3 l/ha of Round-up) prior to planting to ensure that all potential weeds are dead at the time of planting so as to reduce competition at the crucial stage.

Newly planted container-raised seedlings.
Photo O. Monteuuis.

Plantation establishment

Initial plantings from 1992 until 1999 were established at 2 500 stems per hectare i.e. 2 m x 2 m spacing. The reason for this dense stocking was primarily to allow for selection of the final crop and secondly to provide a balance between the establishment costs and the requirements for weeding practices. Planting activities used to last the whole rainy season, from December to the end of April. After 3 years, this initial density was reduced by thinning to 1 250 trees/ha, and finally to 625 trees/ha after 6 years.

From 2000 onwards, the plantations have been established at an initial density of 3 x 3 = 1 111 trees/ha at the beginning of the rainy season in December after the application of Round-up (3 l/ha). This change, which resulted from canopy closure experiments and from the use of a more homogenous planting stock, has noticeably reduced the establishment costs.

The planting period has been shortened to the first two weeks of December by sub-contracting the work to different contractors in order to favor good soil establishment of the planting material before the dry season.

In order to anticipate the planting time and to take full advantage of the first year rainy season, the use of "Aquasoil" hydro-absorber (5 g/plant) that can be combined with nutrients and fertilizers has been also been tested successfully.

At present, 650 ha are planted every year.

Further maintenance and practices

Further maintenance and practices consist mainly of singling, weeding, thinning, and pruning.

Singling

This activity is the result of the stump preparation process whereby the stem is removed at the root collar. The removal of the stem causes prolific coppicing and the excess stems, numbering from 2 to 6, need to be removed. The strongest growing, straightest stem is retained and the rest are removed by hand when the shoots are young and soft, the earlier the better.

Mortality recorded at this time averages 20 to 25 %. Refilling is done immediately, and ultimately plantation losses do not exceed 8 %.

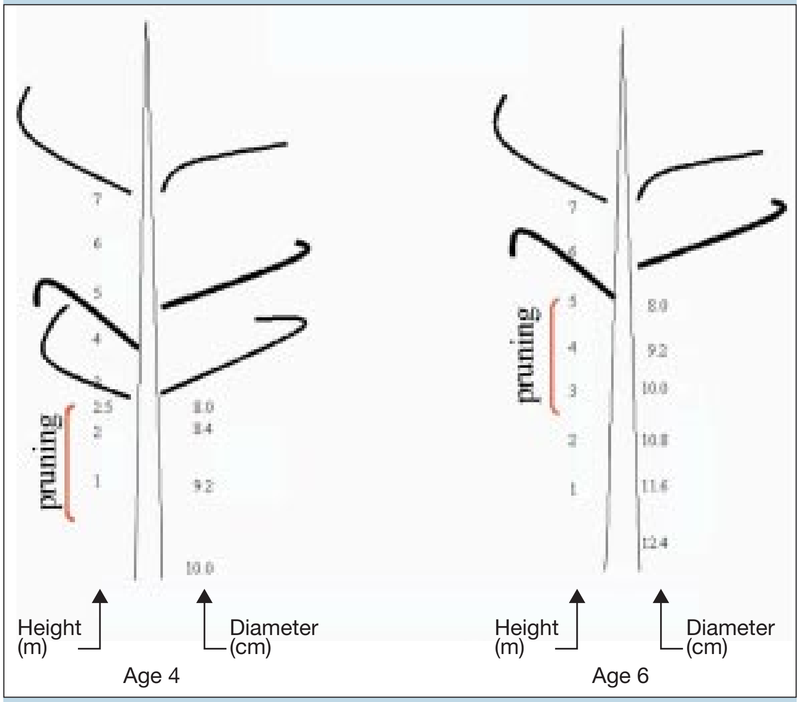


Figure 3.
Pruning teak at four and six years of age. (Drawn by W. Rance).

Weeding

The main reason for carrying out this activity is to reduce competition on the crop trees. Further reasons are for fuel management and the reduction of combustible material for fire prevention reasons. KVTC uses manual and chemical weeding methods.

Manual Weeding

KVTC aims to provide development and employment opportunities to the local communities. For this reason the company limits the use of mechanical weed management methods.

Herbicides

KVTC aims to gradually reduce its dependence on chemical weed control in accordance with the company's environmental strategy. At this stage the company uses a systemic non-selective herbicide in the form of glyphosate for a longer-term effect on weed growth.

Thinning

Thinning is based on growth and basal area measurements at KVTC. According to the forest management system used by the company, thinning is planned to take place at age 8 (density reduced to 650 trees/ha) then at age 13 (density reduced to 400 trees/ha) and lastly at age 20 to reach the final density of 250-280 trees/ha expected to be finally harvested at 30-32 years old. The three interim thinnings are planned to be utilized for commercial production.

Pruning

The plant material utilized so far produces prematurely heavy lateral branches. At this stage it is not known if this is an inherent genetic problem or a result of site interaction. The heavy branching could be a result of climatic circumstances, especially the markedly long dry season. The management considers that such heavy branching is liable to induce the formation of large nodes which may seriously depreciate log value, especially for rotary veneer production. Intensive pruning is therefore carried out:

- at age 2 to remove any multiple stems and the two large lower branches produced early by the young plants; at this stage, most of the plants are heavily branched already;
- at age 4 for stem portion more than 8 cm in diameter - usually up to 2.5 m;
- at age 6 for stem portion more than 8 cm in diameter - usually up to 5 m;
- at age 8 for stem portion more than 8 cm in diameter - usually up to 7.5 m (after thinning).

Pruning is done, as illustrated, to a fixed diameter (8 cm) with measuring gauges fixed to the pruning saws, thereby ensuring that weak trees are not over-pruned and have their photosynthesis capacity reduced as a result.

Each pruning is followed by a hand pruning operation where the newly formed epicormic shoots are "pinched" off.

However, these pruning practices may induce bark deformities and desquamation as well as callus formation close to the nodes from which the branches were removed (see picture). The intensity of these phenomena varies from tree to tree, but this may be a reaction to the wound or stress caused by pruning. Another hypothesis is that the pruning wound may facilitate the intrusion of pests and diseases responsible for these symptoms, which may ultimately have an effect on the final value of the logs, especially for rotary veneer end-use.

The projections in this Business Plan span two crop rotations, with three thinnings and four prunings and clear felling at 32 years, which may seem too long before there is any return on investment. The possibility of selling the pruned trees removed by thinning as poles or for ceiling and wallboards after rotary peeling as is done in Central America or Brazil could generate income in the meantime. Such income can offset the costs of the pruning and thinning operations which are "actually" the most expensive maintenance activities and ultimately benefit only 22.5 % of the crop.

Pruning and thinning practices may also be reduced by the use of planting stock from other origins, either different seed sources or cutting-issued selected clones, as previously suggested.

Crop characteristics

The first plots visited, more specifically the oldest ones (10-year-old, 625 trees/ha after systematic then selective thinning) had quite a uniform appearance, somewhat unusual for teak, in terms of straightness, bole length, and unfortunately heavy branching in the crown. The undercanopy was clear as a result of the regular pruning operations carried out. 10 years is, however, too early to have a reliable estimate of criteria such as fluting and wood characteristics which have a great impact on the value of teak wood. An average growth rate of around 2 m/year in the first years on the best sites (Table III) gives rise to well balanced trees in comparison with other countries where stem growth is much greater in the first years (4 m/year in Sabah, East Malaysia), but may expose the trees to risks of bending after the first thinning, as in certain sites in Costa Rica for trees with height/basal diameter ratio greater than 120.

Heavy lateral branching (left) and deformities induced by pruning operations (right).
Photos O. Monteuuis.

Table III.
Average and best diameter at breast height (DBH) and height measurements according to age and site class from 1 (best site conditions) to 4 (the least favorable conditions although still acceptable for teak planting) with a density of 625 trees/ha for all sites.

Age (years)	Site Class	Mean DBH (cm)	Mean height (m)	Best DBH (cm)	Best height (m)	Area (ha)	Area sample size (%)	Number of trees measured
9	1	16.0	17.5	27.2	26.1	9.5	10.1	600
9	2	15.2	15.2	26.7	26.3	11.0	8.7	598
9	3	9.2	10.1	17.9	18.6	12.3	8.8	677
8	2	11.8	9.9	21.5	21.3	77.0	9.4	409
8	3	8.4	7.9	16.8	17.2	15.8	10.3	1 016
8	3	13.9	14.9	23.5	27.1	34.7	14.1	3 068
8	4	8.8	9.3	24.0	25.8	47.0	10.0	2 938
7	1	15.0	15.5	24.0	25.8	26.8	12.1	2 024
7	2	12.5	13.4	21.6	19.7	11.0	10.9	752
7	3	9.8	9.2	24.2	26.2	89.3	8.8	4 912
7	3	11.7	13.6	21.2	25.6	41.4	10.2	2 637
7	4	8.2	8.8	16.0	17.4	54.2	10.4	3 523
6	1	10.9	12.4	17.3	17.9	55.3	9.8	3 387
6	4	10.3	11.9	20.0	23.5	96.6	9.2	5 555

Damage caused by elephants (left) and baboons (right).
Photos O. Monteuuis.

However, some sites in the near vicinity of these good-performing plots showed much lower performances at 6 years, which seems to indicate negative microsite effects within a range of a few meters. The incidence of such plots on the overall mean annual increment (MAI), currently estimated at 13 m^3/ha/year for the whole project and at 17 m^3/ha/year for the plots planted in the last five years, prompted the management to pay more attention to proper plant material x site matching.

Testing new origins of plant material or multiplying plants deriving from the best individuals selected within the various plots is likely to increase the yield and the quality of the crop for each site category. The ultimate solution is to concentrate on the best sites for maximizing productivity and quality, testing clonal plantations with possible between-row intercrops (Monteuuis, Goh, 1999) and not planting teak on sites which have proven to be unsuitable for this species, at least in order to meet the economic expectations.

Plantations are well maintained and the high rate of natural regeneration demonstrates that teak is well adapted to the local conditions.

Mahogany (*Swietenia macrophylla*) planted at the same time as teak demonstrated overall significantly lower performances, particularly in terms of growth and form.

Wildlife preservation is one of KVTC's highest priorities, resulting in the division of the planting area into several small plots separated by large wildlife corridors. Notwithstanding the resulting constraints in terms of plantation management and plot accessibility, the reverse side of this is the wildlife-induced damage. As an illustration, 18 ha of 2 to 5-year-old plantations have been severely damaged this year (up to 90 % of the trees) by elephants breaking the stems or crushing the plants for fun, and to a lesser extent by baboons breaking stem tips looking for borers to eat. Usually the dominant male starts and the rest of the group follows his example (see picture).

Electric wire or fences seem to be the only, albeit expensive, way to limit the damage while preserving the natural wildlife.

Prospects, conclusion

KVTC is the first private teak planting project currently existing on a large scale in the whole of Africa, and one of the very few which has embarked on this kind of activity worldwide, anticipating all the recent forecasts on teak planting (Behagel, Monteuuis, 1999; Ball *et al.*, 2000; Nair, 2000; Keogh, 2001). As such it deserves special consideration. It has to cope with environmental as well as social constraints, while keeping up with the most recent advances in several aspects of forestry. ISO certification is one example among many others. Such an innovative and dynamic management policy is worth considering as a reference for promoting the production of superior quality teak timber in sufficient quantity to meet the international demand.

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KVTC container-grown seedling production.
Photo O. Monteuuis.

One of KVTC's oldest stands.
Photo O. Monteuuis.