La lettre de l'ATIBT

SPÉCIAL PLANTATIONS EN ZONES TROPICALES

atibt

En partenariat avec

FRM

Sommaire

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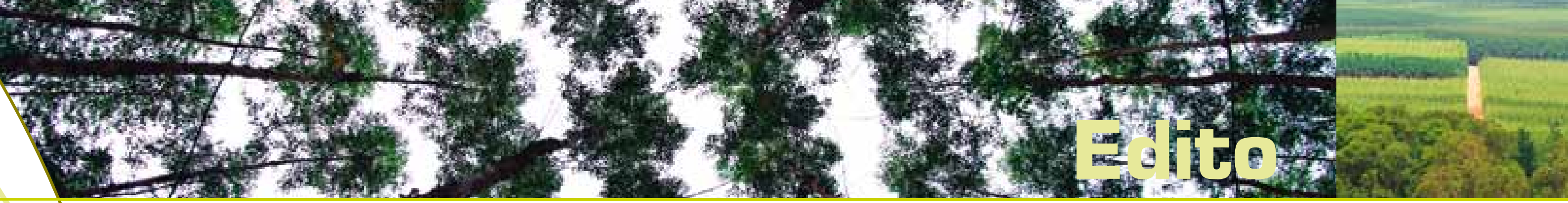

Edito

Les forêts plantées couvrent environ 271 millions d'hectares (FAO, 2006), soit seulement 7 % des superficies boisées mondiales. Mais, contrairement aux forêts naturelles, elles continuent à s'étendre et leur contribution à la production mondiale de bois dépasse dès à présent 65 %.

On peut distinguer plusieurs phases dans la mise en place des forêts plantées industrielles. Dès les années 20 et 30, l'Afrique du Sud, le Chili et la Nouvelle –Zélande ont entamé des programmes à grande échelle de plantations d'essences exotiques à croissance rapide. Après la première guerre mondiale, le Japon, la Corée et la Chine ont lancé des programmes d'afforestation de grande ampleur. Dans les régions tropicales, le boom des plantations a eu lieu dans les années 70 et 80, principalement en Amérique du Sud. Mais alors que précédemment ce secteur était essentiellement étatique, il s'agit ici d'initiatives privées qui ont largement investi dans la Recherche-Développement. Les biotechnologies développées sur un petit nombre d'espèces, mais un grand nombre de clones, ont permis des gains permanents de productivité, assurant une meilleure rentabilité aux investissements forestiers. La concentration industrielle, la sécurisation des approvisionnements en matériau bois et l'adaptation aux demandes du marché (grâce à la Recherche-Développement et à la brièveté des révolutions) sont également des facteurs explicatifs de cette success story.

Les grandes plantations monospécifiques sont bien entendu exposées à des risques, tels que les attaques d'insectes, les maladies et les incendies. Leur impact sur la biodiversité et sur les communautés humaines locales peut localement s'avérer désastreux. Certes, des efforts importants en matière de conception et de gestion des plantations ont été réalisés pour atténuer ces risques mais beaucoup reste à faire en ce domaine.

A l'opposé, le recours aux plantations intensives pour satisfaire les besoins grandissants en bois industriels de nos sociétés modernes, devrait permettre une diminution sensible de la pression exercée sur les forêts naturelles.

A l'avenir, un équilibre devra être trouvé entre la gestion durable des forêts naturelles et les plantations industrielles, tenant compte notamment du financement des écosystèmes (par exemple via le REDD) et des politiques mises en place pour la gestion durable des forêts tropicales. Dans tous les cas, les plantations devraient voir leur rôle agrandi, en particulier en lien avec la fourniture de bois-énergie, et à terme probablement pour la production de carburant ligno-cellulosique.

Enfin, tenant compte du rôle grandissant des plantations pour la production de bois d'œuvre (teck, pins, acacias et eucalyptus) et du potentiel pour les plantations en forêts tropicales semi-naturelles, nous y reviendrons plus longuement dans d'autres numéros.

Willy DELVINGT
Président de l'ATIBT

Bernard CASSAGNE
Président de la Commission Forêt

Les plantations forestières

Evolution dans les Régions chaudes

Dr. Bernard Martin - Expert consultant

Evolutions depuis les années 70

Depuis une quarantaine d'années, les plantations forestières sont l'objet d'une véritable révolution, en particulier dans les régions chaudes. Privatisation, intégration et intensification ont transformé ce secteur classiquement étatique et à faible productivité en un domaine très dynamique, attirant les investisseurs. Ce développement a surtout commencé avec la possibilité de cloner les eucalyptus, fruit des recherches du CTFT en 1973 (B.MARTIN et G. QUILLET au Congo, sur les traces d'André FRANCLET en Afrique du Nord). Outre la grande homogénéité des plantations, le clonage a permis la multiplication d'arbres exceptionnels, souvent hybrides, très difficiles à reproduire par graines. Les plantations clonales d'eucalyptus, à grande échelle, ont commencé en 1978, tant au Brésil (ARACRUZ SA) qu'au Congo (UAIC), poussant la plupart des grandes sociétés papetières à investir dans la Recherche-Développement. En concentrant beaucoup d'efforts sur un très petit nombre d'espèces, des gains génétiques et sylvicoles très élevés ont été obtenus, entraînant un important développement de la ligniculture. Parties des régions subtropicales peu boisées, plus sûres pour les industriels et plus favorables aux pins et aux eucalyptus (essences pionnières à croissance rapide bien adaptées à la recolonisation des terrains nus), les plantations forestières intensives progressent maintenant vers les zones tropicales en intégrant d'autres essences comme les acacias (Asie du Sud Est) et le Teck qui se prête bien aux biotechnologies (Asie du Sud-Est, Amérique latine).

Parcelle monoclonale d'Eucalyptus « PF1 » (hybride naturel) à 9 ans (UAIC-Congo-1990).

Dynamique des plantations.

A partir des statistiques de la FAO en 2005, B.J. Carle et P. Holmgren (2008) déclarent que les 205 millions d'ha de plantations forestières mondiales de production qui ne représentent pourtant que 5,2% de la surface totale forestière, fournissent déjà 66% de tout le bois consommé par les industries. Les perspectives vont même jusqu'à une prévision de 80% en 2030 (R.A. SEDJO - 2001), confirmant la prédominance croissante des bois plantés sur les bois naturels. En effet, la possibilité en bois, des forêts naturelles gérées durablement, n'est pas extensible, et, dans les pays développés, la demande alternative autre que le bois, augmente. De plus, le défrichement en zone tropicale se poursuit (13 millions d'ha par an) tandis que les surfaces protégées s'accroissent régulièrement (+ 32% depuis 1990). Dans ces conditions, toute augmentation de la demande en bois ne peut être satisfaite que par les plantations et comme celles-ci sont de plus en plus intensives, il suffirait d'une extension de 50 millions d'ha (à 20 m3/ha/an) au cours des 25 prochaines années, pour produire le milliard de m3 supplémentaire qui permettrait de couvrir à 80% nos besoins en bois. L'effort annuel correspondant serait de 2 millions d'ha de plantations, nettement inférieur à l'augmentation actuelle des plantations qui est de 2,5 millions d'ha/an (dont 1,5 million pour la Chine, seule). Cet effort concernera surtout les zones tropicales ou la dynamique est plus active et qui représentent déjà 30% des surfaces plantées dans le monde. Enfin, bien que le secteur public reste important dans certains pays asiatiques (Indonésie, Chine, etc.), les plantations modernes sont surtout le fait des entreprises privées, tendance qui ne fait que se renforcer.

Evolution de la demande en bois

La ligniculture se caractérise, non seulement par des rotations courtes et une productivité élevée, mais également par des offres massives de petits bois homogènes correspondant parfaitement à la demande industrielle (pâte à papier et panneaux). De plus, toute nouvelle avancée technologique, comme au Brésil avec la production de sciages d'eucalyptus de qualité (Lyptus d'ARACRUZ), contribue toujours davantage à la **promotion de ces « fast wood »** (Cossalter et al, 2003), dans un monde de matière première en pleine mutation où les conditions d'obtention priment de plus en plus sur le résultat obtenu. C'est ainsi que l'évolution du secteur privé traduit une double tendance, le secteur papetier se diversifiant

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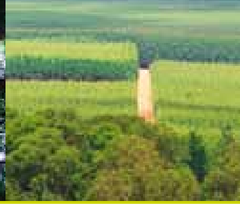


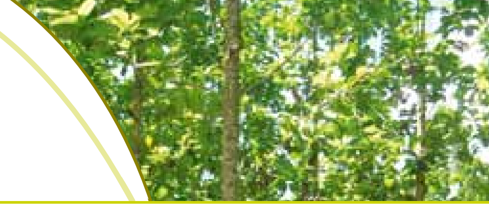
vers le bois d'œuvre et le secteur du bois d'œuvre commençant à créer ses propres plantations. Mais les progrès les plus attendus en matière de bois pourraient bien être d'ordre énergétique, renforçant ainsi la place qu'il tient dans toute politique de développement durable. Alors que déjà, 40% de tout le bois produit dans le monde est transformé en énergie (bois de feu ou de charbon de bois), des formes plus élaborées ont vu le jour dans les pays riches, aussi bien pour les particuliers (chauffage central au bois, individuel ou collectif, à partir de bûches, de plaquettes ou de granulés), que pour les industriels (centrales de cogénération produisant à la fois chaleur et électricité). En dehors des grandes centrales couplées aux grandes industries du bois, on trouve aussi la **micro-cogénération**, solution attractive pour beaucoup de petites industries forestières très décentralisées, produisant de grandes quantités de déchets de bois, et ayant besoin de chaleur (séchage de leur production) et d'électricité. La vraie révolution devrait cependant venir des **« lignocarburants »**, biocarburants dits de « seconde génération » fabriqués à partir de la biomasse et en particulier le bois. Quoiqu'il en soit, le meilleur modèle restera celui de **plantations mixtes** où tout est utilisé durablement (bois d'œuvre, petits bois et déchets). Si le pétrole cher nous fait entrer directement dans l'ère des lignocarburants, les PVD à larges disponibilités en « savanes humides » s'en trouveront très avantagés par leur main d'œuvre bon marché. A condition de respecter les règles de gestion durable, les retombées seront nombreuses **tant au plan environnemental** (réduction de la pression sur les forêts naturelles, protection des sols, lutte contre l'effet de serre par séquestration du carbone atmosphérique) **que social** (développement des zones rurales et création d'emplois directs et indirects).

Importance de la Recherche Développement (R&D).

En développant la ligniculture, les Sociétés papetières, notamment en Amérique du Sud à partir de l'Eucalyptus, mais aussi beaucoup d'autres organisations, telles que la CAFSA (Coopérative Agricole et Forestières Sud Atlantique) forte de ses 50 ans d'expérience sur le pin maritime en France, ont montré la très grande efficacité de la R&D.

Test clonal de Teck à 3 ans (SODEFOR-2001-Côte d'Ivoire)

Tout en préservant une diversité génétique suffisante et le bon état sanitaire des arbres, les possibilités d'augmenter la productivité des plantations sont très grandes, tant en matière d'amélioration génétique (sélection, croisements contrôlés, hybridations et clonage) que de minibouturage (de Assis 2001) et de sylviculture. En cas d'attaque parasitaire, le clonage s'est également révélé comme une arme très efficace pour multiplier les génotypes résistants. Les pins, plus difficiles à rajeunir, font l'objet de croisements contrôlés industriels ou de « bulk-propagation » (bouturage en vrac des meilleurs semis contrôlés) ; chez les conifères qui ne rejettent pas de souche, le développement de clones séparés est plus rare et fait appel à l'embryogénèse somatique (Australie). Beaucoup d'efforts ont également été faits en matière de mécanisation de la récolte, de débardage et de transport. Toutes ces techniques peuvent être appliquées à beaucoup d'autres espèces mais cela nécessite des efforts de Recherche. Il faut un peu moins de 10 ans pour développer des plantations mixtes ou énergétiques, accompagnées par une R&D efficace. Il n'y a donc pas de temps à perdre.



Clonal planting

of eucalyptus in Brazil

An amazing accomplishment

Edgard Campinhos - Forest Engineer

There are several techniques to propagate vegetables asexually; i.e. without using their seeds such as grafting, layering, tissue culture, rooting cuttings, etc. All these methods are called cloning which means that clones are the whole of all ramets (which are the new plants) genetically the same as the ortet or mother plant (which is the initial selected tree of the clone). These mother plants must gather characteristics e qualities that are superior and appropriate and thus there is interest in perpetuating them by the cloning process in order to offer the client qualified products. Mother plants can be selected among descendants from controlled crosses or by selection in native populations or in seminal plantings.

What happened to Eucalyptus in Brazil ?

The agronomist Edmundo Navarro de Andrade, from Estrada de Ferro Paulista (Railroad Paulista) brought from Australia and Indonesia a collection of dozen of Eucalyptus species about a hundred year ago. This collection was planted at a tree farm in Rio Claro (São Paulo) aiming to select the best species to produce fire wood for locomotives and sleepers for the railway line. Natural crosses happened among the species. Plantings were made with these hybrid seeds along the years and in several places in Brazil.

In 1966 the Federal Government created an Incentive for Reforestation and many projects were made using Eucalyptus and Pinus mainly. Among these projects there was Aracruz Florestal S/A, established at the city of Aracruz (Espirito Santo State) with the purpose of starting a Eucalyptus bleached pulp plant, presently Aracruz Celulose S/A.

Three species were chosen such as Eucalyptus urophylla, E. grandis and E. Saligna. The seeds used were those from Rio Claro`s tree farm as well as the technology for production of the seedlings which did not achieve the expected result in the region of Aracruz - sowing in seed-beds for seedling transplantation prepared with soil and manure. Diseases were frequent.

After many tests inorganic soil began to be used from subsoil enriched with N-P-K in plastic bags, sowing directly in the package, germination and growing at the sun. There were no more diseases in the nursery and the seedlings were rusticated in order to make them more resistant and to respond to the irrigation planting process. This system was developed by the company and this made possible the planting of Eucalyptus seedlings in the field during the whole year (with or without rain) as well as the permanent working of the nursery during the year. This occurred in 1969/1970 and it became possible to optimize the planting of thousands of hectares during each year, systematically perfect.

The plantings grew and they were very heterogeneous with failures and diseases specially canker (Cryphonectria cubensis) due to the low genetic quality of the seeds. But in E. grandis e E. urophylla plantings they presented excellent shape, volume and good health. We knew it would be impossible to get good results using seeds from those trees.

The company decided to collect seeds in Australia (E. grandis) and in Timor (E. urophylla) according to their origin: ecological conditions more similar to their activity areas to develop a large program of genetic improvement. E. saligna was already discharged due to ecological incompatibility. In 1973 the company started its first mission to Australia and Timor. Contacts were made with CSIRO researchers in Canberra that indicated origins more appropriate for E. grandis. The CSIRO researcher, Peter Burgess, in Coff's Harbour (NSW) at the research laboratory showed us the result of vegetative propagation by stake rooting of Eucalyptus. This research was developed by the French researchers Bernard Martin and Georges Quillet from Congo Brazaville and before that by André Franclet in North Africa. Aracruz researcher saw at this research farm one line of E. grandis containing approximately 20 15-meter-high trees, perfectly the same. These were trees cloned from the same mother tree which clones were produced by Professor Lindsay Pryor from CSIRO in Canberra. So, researchers from Aracruz could start using superior hybrids that shown up in established plantings with seeds from Rio Claro.

Back to Brazil, the researcher immediately start from B. Martin & G. Quillet publication on "Bois et Forêts des Tropiques" revue (1974). He built a nursery house with intermittent mist irrigation and begun a selection of hybrid trees (natural) and afterwards their vegetative propagation by rooting of cuttings with AIB (indol-butyric acid) and thus taking control of this technology.

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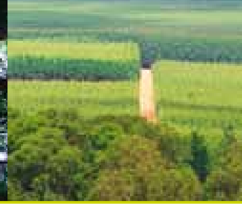


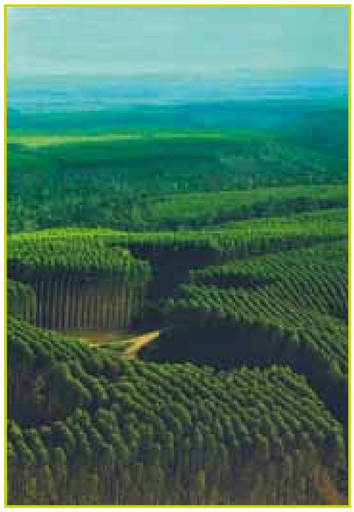
Researches of species and origins took place with the seeds brought from Australia (E.grandis) and Timor (E. urophylla). Preliminary results came after 4 years and from them decisions could be made concerning the best origins and new crops. Four more trips to Australia were taken. Afterwards family progeny tests were made as well as selection of the best subjects in each family and seed orchards were established including an orchard for production of E. grandis x E. urophylla hybrids. It became known as "Eucalyptus urograndis".

A program of genetic improvement like that takes from 20 to 25 years while a clonally propagation program by stake rooting is almost immediate especially today where the whole system is highly developed with technological variations and sophisticated nursery houses. A laboratory was also established in the company for analysis of wood basic density and pulp yield. Other characteristics of approved matrix wood were measured in the laboratories of the pulp mill. On first step, 6000 trees were selected to choose mother trees, considering volume, shape, sticks, percentage of bark, re-growing, rooting, density, pulp, extractives, etc.

On October 31st 1978, the starting day of the pulp mill in Barra do Riacho 3 million ramets had been planted. The Annual Medium Increment (IMA) from the seminal forest (with the seeds from Rio Claro) was 25m3 solid e became do 45m3 solid with the clone plantings of superior mother trees. Pulp productivity became from 5,60 t/ha/year to 12,00 t/ha/year. Another positive issue was the performance and productivity improvement of the mill with the same equipment, due to the wood quality improvement - 400,000 t/year to 500,000 t/year.

The researcher Charles Hodges from Hawaii offered Aracruz Florestal a new model of container for producing of seedlings (a plastic conic tube) that is know in Brazil as "little tube" for seedlings and cuttings, as well as all technology for its use. A system for clonal propagation by rooting cuttings was created to large scale production. These technologies begun to be used for other companies in Brazil and abroad as time moved on.

Thanks to this development and to the innovative board of directors by investing in research and technology, the research team was awarded the Marcus Wallenberg Prize in 1984 in Falun (Sweden) by H.M. King Carl XVI Gustaf. This award recognizes, stimulates and encourages forest scientific advances that contribute to development of industries attached to forests. Thus, Brazil became a world leader in the production of short fiber bleached pulp from Eucalyptus.


Situation actuelle

Des plantations d'eucalyptus au Brésil

Professeur Sebastião Renato Valverde

L'eucalyptus est une espèce arborée appartenant à la famille des Myrtacées, originaire principalement d'Australie. Plus de 670 espèces connues présentent autant de qualités de bois différentes. Au Brésil, la culture de l'eucalyptus à échelle commerciale a débuté dès 1904, avec les travaux de l'agronome sylviculteur Edmundo Navarro de Andrade et visait à répondre à la demande en bois de chauffe de la Compagnie de Chemins de Fer de São Paulo. Avec l'adoption de la loi accordant des subventions aux reboisements (1965 à 1988), la zone de plantation de l'eucalyptus au Brésil est passée de 500 000 ha à 3 millions hectares.

Ces subventions, bien que limitées dans le temps, ont contribué à une plus grande participation du secteur forestier brésilien dans le PIB, tant au niveau de la création d'emplois, que de la génération de revenus, d'impôts, de devises et d'infrastructures. Du point de vue environnemental, une diminution de la pression sur les forêts naturelles ainsi qu'une meilleure protection de la faune, de la flore, des ressources en eau et des sols, ont été observées.

Parmi la large gamme variétale, les espèces les plus plantées commercialement sont *Eucalyptus grandis, saligna, urophylla, camaldulensis, cloeziana, citriodora, pellita, globulus* et les hybrides urograndis (*urophylla x grandis*) et urocam (*urophylla x camaldulensis*).

Fort de la rapide croissance de ses plantations d'eucalyptus, atteignant des productivités de 40 à 50m^3/ha/an, soit environ 10 fois supérieures à celle des pays leaders de ce marché, le Brésil gagne des positions clés sur le marché international de produits comme la cellulose, les panneaux MDF, MDP et autres.

En termes d'améliorations technique et génétique, l'eucalyptus a été et est encore celui qui a le mieux répondu aux investissements de recherche, tout au long des quarante dernières années de plantation commerciale. Sa productivité a évolué de 20 m^3/ha/an dans les années 1970, à 40 m^3/ha/an dans la décennie actuelle. Très probablement, il arrivera à 50 m^3/ha/an dans la prochaine décennie. Il y a encore beaucoup à faire et à développer, en particulier en matière de biotechnologie et pour bon nombre d'espèces.

Les plantations d'eucalyptus se caractérisent par des risques associés élevés à long terme et par un prix du bois, faible, en raison de l'existence d'un marché encore sous concurrence imparfaite lequel, néanmoins, tend actuellement à se normaliser, étant donné l'augmentation de la demande en bois de ces dernières années et la réduction de l'offre du fait de l'arrêt de la politique de subvention.

En tant qu'espèce exotique, l'eucalyptus présente plusieurs points positifs au Brésil : il existe peu de restrictions légales quant à sa coupe, il peut être planté à divers endroits et à diverses échelles, et il est à l'origine de productions très diverses (bois de feu, charbon, cellulose, piquets, poteaux, traverses, meubles, matériaux de construction, miel, huiles, tanins, etc.).

Au début, les plantations de cette espèce se sont concentrées dans la région Sud-Est du Brésil pour approvisionner les industries de cellulose et de charbon végétal, ainsi que la sidérurgie du Minas Gerais. Jusqu'à la fin des années 1990, la sylviculture de l'eucalyptus se résumait pratiquement à une gestion en taillis simple. En d'autres termes, chaque plantation était intégralement exploitée tous les 7 ans, pour la production de rondins destinés, soit à la cellulose, soit au charbon. A cette époque, ce modèle de sylviculture montrait déjà ses limites et laissait place à une gestion à usages multiples par taillis sous futaie, régime dans lequel l'exploitation du taillis à la rotation de 4 ans pour la production de bois énergie, n'était que partielle et durait jusqu'à 18 ou 20 ans, date de la coupe rase de la futaie pour la production de grumes, l'objectif étant d'obtenir un plus grand profit sachant que le prix des grumes est plus intéressant que celui des rondins.

Une fois que la rentabilité forestière de l'eucalyptus a commencé à augmenter, sa culture s'est disséminée dans le reste du Brésil, même dans des régions à faible demande en bois. Récemment, la culture de l'eucalyptus s'est étendue jusque dans la région Nord où, paradoxalement, se trouve la plus grande forêt tropicale du monde. Outre le pôle sidérurgique à charbon végétal, dans le Sud de l'Etat du Pará, deux projets d'industries de cellulose doivent s'implanter dans cette région, grâce aux producteurs locaux.

Malheureusement, le développement des plantations d'eucalyptus au Brésil fait l'objet de plusieurs critiques infondées et basées sur des mythes comme celui qui prétend que l'eucalyptus dessèche le sol, réduit la fertilité, etc. Ces critiques ont été complètement réfutées par les Instituts de Recherche et les Universités

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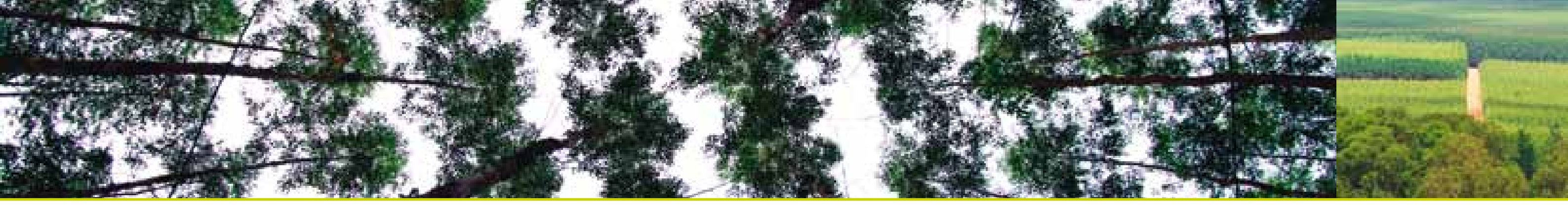

qui ont démontré leur manque de fondement par des expériences et des observations sur site.

Avec l'eucalyptus, le Brésil est le pays qui possède le plus grand avantage concurrentiel sur le marché international, grâce, aux conditions naturelles favorisant la croissance rapide des plantations, à une gestion très compétente, aux techniques élaborées de sylviculture et aux gains génétiques très élevés des programmes d'amélioration. L'exemple de l'industrie de la cellulose, une des plus fortes du secteur forestier, donne une idée de cette compétitivité : le Brésil présente les coûts de production de la cellulose, les plus bas du monde. En comparaison avec les principaux acteurs de ce marché, on s'aperçoit que le prix du bois au Brésil est à moins de la moitié du prix de son plus proche concurrent.

Bien que les perspectives du commerce international soient prometteuses, cet effort doit être poursuivi car d'autres pays ont cherché à emporter des parts de ce marché et, ainsi, à menacer une probable hégémonie brésilienne. C'est le cas de la Chine, de l'Inde et de l'Indonésie. D'où la nécessité pour le secteur forestier brésilien de ne pas s'accommoder de la situation présente et de continuer à progresser, de façon agressive et compétente, comme il l'a toujours fait. Parmi les opportunités de progrès de la sylviculture brésilienne, il y a l'utilisation toujours plus répandue et meilleure des biotechnologies forestières.

Au fil du temps, le marché des produits forestiers, tant domestique qu'international évoluent de façon significative. L'expansion des marchés existants ainsi que l'émergence de nouveaux marchés tant intérieur qu'extérieurs pour des produits issus principalement des bois de plantation… Au Brésil, les industries de la cellulose grandissent malgré la crise financière mondiale. De nouveaux produits ont fait leur apparition, comme les panneaux MDF (Medium Density Fiberboard) et OSB (Oriented Strand Board). Le bois d'eucalyptus qui était utilisé surtout pour la production de charbon et de cellulose, commence à être utilisé aussi pour le sciage, la menuiserie, la construction civile. Tout indique qu'il n'y a plus de restrictions techniques à son utilisation.

Néanmoins, l'augmentation de la demande en bois d'eucalyptus n'a pas été suivie par une augmentation parallèle des surfaces plantées. Le fait est qu'avec la fin de la politique de subvention des reboisements en 1988, et jusqu'à la fin des années 1990, le taux d'augmentation des surfaces plantées au Brésil a été pratiquement nul, alors que l'augmentation de la demande pour ce bois a continué à croître. Cela a contraint à consommer le bois d'anciens peuplements forestiers très éloignés et déclarés non viables, ainsi que le bois de jeunes plantations en pleine croissance.

Outre les débouchés concrets des plantations d'eucalyptus, les industries forestières brésiliennes ont investi, avec ces plantations, dans le marché des crédits carbone, conformément aux projets MDP du Protocole de Kyoto. Cela concerne principalement les unités sidérurgiques à base de charbon végétal, étant donné leur meilleur équilibre environnemental, en comparaison avec celles qui consomment du coke (charbon minéral). L'exemple classique est celui du projet du Groupe Plantar (sidérurgie et forêt).

En résumé, les perspectives pour la culture de l'eucalyptus au Brésil sont très favorables, d'autant plus que l'objectif national, est d'occuper sur le marché international, et pour les autres produits forestiers (MDF, MDP, OSB, etc.), la même position élevée qu'il occupe aujourd'hui pour la cellulose. En effet, comme nous l'avons présenté ci-dessus, seul le Brésil réunit à la fois une croissance forestière aussi vertigineuse et des conditions aussi favorables pour la poursuite de cette expansion. L'avenir nous le dira.

The plantations in Argentina

Past, present and future

Luis Carpineti

Brief socioeconomic panorama of Argentina

90% of Argentina's population (with 38.7 million inhabitants since 2003) live in urban areas. The population density is 13.4 inhabitants per km^2. Argentina's 2003 annual growth rate was 1.05%.The country has a great variety of natural resources but the economical situation worsened in January 2001 with the consumers and producers's loss of confidence. The efforts made in order to reach zero deficit failed. Argentina has different potential ways of development in the forest sector that are widely explored (for exemple natural and planted forests) but the current forestry policy lacks Strategic Development Plans.

Current Situation of the forestry sector

Argentina's forest plantations cover 1,11 million ha that's 3,4% of the 33 million ha of total forest area. The Law 25080 gives a frame for the development and regulation of forest activities for a period of at least 10 years in order to increase the forest surface area.

Planted Forest

Misiones, Corrientes and Entre Rios provinces as well as the delta of the Parana River cover 80% of the whole planted surface. This allowed a projection work up to 2020 in theses provinces.

Surface of the different provinces with planted forests. Information updated up to 2002

Province/region-	conifers	eucaliptus	salicaceas	others	TOTAL (Ha)
Misiones	313,721	24,911	0	46,316	384,948
Corrientes	232,461	95,773	0	810	329,044
Buenos Aires	6,905	36,920	47,826	8,118	99,769
Patagonia (Neuquén; Río Negro; Chubut y Santa Cruz	48,320	0	19,595	695	68,610
Entre Rios	11,712	90,048	15,919	13,386	131,065
Noroeste (Jujuy; Salta y Tucumán)	6,898	16,054	204	756	23,912
Centro(SantaFe Córdoba y La Pampa	34,221	12,095	2,483	0	48,799
Resto :(Formosa;Chaco; Santiago del Estero; Catamarca; La Rioja San Juan; Mendoza y San Luis	1,749	3,031	23,377	1,351	29,508
TOTALS (Ha)	655,987	278,832	109,404	71,432	1,115,655

Wood offer may be the base for industrialization and the main sector initiative.

Native forest

Some data exist since the end of 2002 (with partial information on the first inventory) which analyzed the regions of Selva Misionera, Parque Chaqueño, Selva Tucumano Boliviana, Bosques Andino Patagonicos, el Monte and El Espinal. The annual forest production is 1 m^3/ha/year but it can increase to 3 m^3/ha/year with forestry management changes in the future.

International Trade

Despite its lack of competitiveness, Argentina still imports forest industrial products. In the 1990-2000 decade the escalating demand for consumer goods increased these imports even more.

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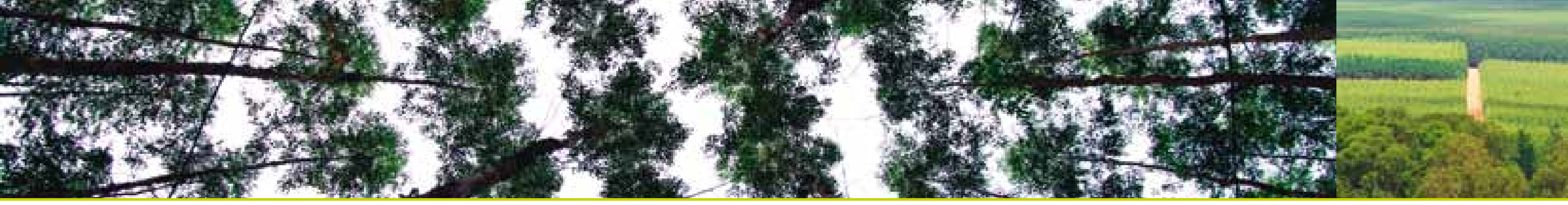


For the next decade this situation will be reversed thanks to important industrial developments with mainly Chilean capitals. In 2001 the commercial deficit of the forest sector had reached approximately US$ 560 million (exports US$ 440 million - imports US$ 1 billion). The cellulose and paper sector looms large on the deficit but at the same time and paradoxically it is the sector that exports the most.

Incentives

Some social and extra-sectorial factors can influence the development of a region, country or sector in the medium- or long-term and increase its performance.

The Law 25080 provides the incentives for the forestry sector. On the basis of the current reality in Argentina and the incentive Law the projection for forestry is analyzed up to year 2020.

1,11 million hectares were planted out of an estimated 15 million hectares of available land, which implies great expansion potential.

Gross Domestic Product (GDP) and Gross Industrial Output (GIO) projections until 2020

	Scale	2001	2005	2010	2017	2020
GDP	Million US$	68.928	68.509	77.512	87.697	99.222
GIO	Million US$	10.607	10.937	13.148	15.805	18.999
INHABITANTS	Million	37,064	38,829	41,154	43,619	46,231

Planted forests produce approximately US$ 1.5 billion and native forests US$ 175 million. The latter have great potentials for forestry, especially in the Selva Misionera and Parque Chaqueño regions.

Planted forests

Conifers in Misiones

The Misiones region offers a potential of 40,000 hectares of plantations with an annual harvest of 20 million m³. This is four times higher than the actual demand for cellulose pulp, board and sawn timber wood.

Rio Uruguay Region

In 2010 the offer of sawn timber of *Eucalyptus grandis* will exceed the demand. In 2020 this offer will double.

Today 1.7 million m³ is produced and in 2020 2.5 million m³. The company Forestadora Tapebicua has done a lot to develop seasoning of *Eucalyptus grandis* sawn timber.

Paraná River Delta

The region of the delta Parana River did not quite follow the afforestation dynamics during the second half of the 1990s. The production of cellulose pulp went from 450.000 m³.to 750.000 m³. Sawn timber production has been constant since 2006 and its projection for 2030 is of 120.000 m³.

Native Forests

It is important to point out that the native forests of Argentina have been harvested excessively since the 90s and something must be done to revert the situtation.

Industrial development of Argentina

The current industrial development of the country is far from its potential. In the next decade three big cellulose pulp projects will be developed in Argentina.

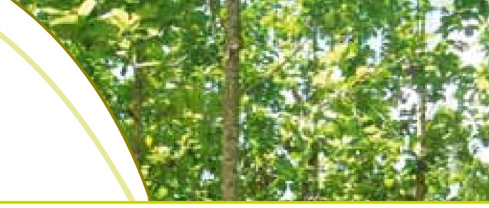
Paper and sawn timber demand in the future

	2001	2005	2010	2015	2020
Paper (million tons)	1.837	1.664	2.052	2.470	3.140
Sawn timber (million m³)	1.285	1.280	1.384	1.497	1.619

After 2001 the demand decreased dramatically.

The information presented in this paper was produced by the FAO, SAGPyA and the Secretary of Enviromental and Sustainable Development, on the base of Dr G. Braier consultancy work.

12 year-old Eucalyptus grandis clonal stand (40 m high and 35 cm diameter)



Recent development

of plantation forest in China

HOU Yuanzhao Académie Forestière de Chine

1/History of plantation development

China has a long history of artificial tree planting. However, the development of fast-growing and high-yielding (FGHY) plantations was started only since the 1960s. The program of establishing 100 million mu (1 ha = 15 mu) of FGHY plantations was implemented in the later 1980s, and the standards of World Bank were used to establish FGHY plantations with funding from the World Bank loan in the 1990s. Since the early 1990, commercial plantations for industrial raw materials have been rapidly developing.

Since the beginning of the new century, China has started to implement several major forest resources development programs throughout the country, such as the program of land conversion from farmland to forestland, the program of establishment of shelterbelt forests along the Yangtze River basin, the program of establishment of "three-north" shelterbelt forests and the program of establishing FGHY plantation bases. These programs have greatly promoted artificial tree planting in China. The Nation Wide Obligatory Tree-planting Campaign also strongly promoted afforestation in China. Up to the end of 2007, an accumulative number of 10.98 billion persons have participated in the obligatory tree-planting in which a total number of 51.54 billion trees have been planted.

2/Current status of plantation development in China

According to the 6th national forest resource inventory (1999-2003), the total area of China's existing plantations was 53 million ha, accounting for 31.5% of the forested land. The total stocking volume was 1.505 billion cubic meters, accounting for 12.44% of the total volume of the country. China's existing plantation area accounts for forty percent of the world's total, ranking the top among other countries.

Among China's plantations, about 24 million ha are timber plantations, 8 million ha shelterbelt plantations, 0.5 million ha firewood plantations, 0.5 million ha plantations for unique purposes, 19 million ha economic plantations, 1.6 million ha bamboo plantations. If counted on species, the top 4 species are Chinese fir (9.22 million ha), Poplars (7 million ha), Masson Pine (5.85 million ha) and Eucalypts (2.3 million ha), the total stocking volume amounts to more than 1 billion cubic meters, accounting for 65% of the total stocking volume of plantations.

Plantations of Poplars and Eucalypts are the most intensively managed. China's total area of poplar plantations exceeded the total area poplar plantations in all other countries, and the majority of poplar plantations are in east China. China has 2.3 million ha Eucalypt plantations, mostly grown in south China, the average annual volume growth is 15-20 cubic meters per ha per year.

However, China's plantations have problems that very few are available species for plantation establishment and plantations are simply structured. For example, the conifer plantations account for 68% of the total plantation area of the country, while the broad-leaved plantations account for 32% of the total, differing more than twice between the two types of plantations.

3/Prospects of plantation development in China

The plantation area in China accounts for about forty percent of the world's total, ranked the top among other countries. According to the national development plan, the average forest coverage in China will reach more than 20% up to 2010, more than 23% by 2020 and more than 26% by 2050, these goals will be achieved mainly by expanding plantations.

However, the level of management of China's plantations is generally low, the total stocking volume of China's plantations cannot meet the timber demand for 5 years, and there is much to do to improve the management quality. Taking the Eucalypt plantations for industrial raw materials as an example, very few plantations can reach an annual volume growth of 30 cubic meters per ha per year, due to many managerial and technical constraints. Technical constraints include frequent quality degradation of plant stocks, and large number of root-twisted plant

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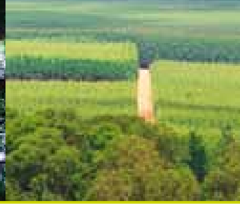

stocks etc. Managerial constraints include disconnection among stages of nursery practices, plants transport and tree planting, leading to poor quality of plantations.

In general, industrial and agricultural products have already been over produced, but forest resources, timber resources and forest environment are in scarce. China is one of the countries that have poorest forest resources, and the average per-capita forest area and stocking volume are respectively 1/5 and 1/8 of the world's average. China will continue to make great efforts to develop plantation forests.

Forest Plantation

in Indonesia

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Forest plantation is not really new to Indonesia and it can be traced as far back as 14th century when teak (*Tectona grandis*) was started being domesticated. In fact the history of forest plantation in Indonesia was started with teak when the species introduced from India for the first time. However, a serious effort toward sustainable teak forest management began in 1865 in the form of yield regulation, planting and thinning which was put in the forest business plan.

Up to early 1980s plantation forests were found mainly on Java, and covered an area of about two million hectares. They consist of teak (*Tectona grandis*), tusam or Merkus pine (*Pinus merkusii*), mahogany (*Swietenia macrophylla*), rosewood (*Dalbergia latifolia*), agathis (*Agathis loranthifolia*), cajuput (*Melaleuca cajuputi*) and other species.

In Java teak is mainly planted in the state forest land and currently covering an effective area of more than 600 thousand ha. The teak forest plantation has also grown in eastern Indonesia, namely South Sulawesi, South East Sulawesi and Nusa Tenggara. Tusam was introduced from Sumatra to Java in 1920s and since then it has been planted for large scale plantation, currently covering an area around 500 thousand ha and managed mainly for high quality rosin gum and turpentine, while timber is the secondary product. Indonesia is the third biggest producing country for rosin gum after China and Brazil. Tusam forest plantation can also be found in South Sulawesi (60,000 ha), South East Sulawesi (15,000 ha), West Sumatra (12,000 ha). Mahogany was introduced to Java from Guatemala in 1870 and it has become an important timber tree species, currently covering an area of more than 50,000 thousand ha, and perhaps it is one of the largest plantation of mahogany in the world.

For a long time forest plantations have contributed significantly to the Indonesian wood production until the large scale exploitation of natural forest (mainly dipterocarp forest) started in early 1970s. More than 30 years the natural dipterocarp forest dominated the wood production (20 million m^3 per year) and only around 20 percent of it came from forest plantation. However, since 2002 the wood production from natural forest has been steadily declining, while the wood production from forest plantations has been gaining of significant importance. In 2007 wood from natural forest was around 3.2 million m^3, whereas that produced from forest plantations was 27 million m^3.

Since the late 1980s, plantation forests have been established on islands other than Java, though mainly as short-rotation plantations for pulp and paper as well as medium fiber board. The main species planted are *Acacia mangium* (860,000 ha), *Acacia crassicarpa* (245,000 ha), *Eucalyptus pellita* and hybrid (83,000 ha), *Gmelina arborea* (15,000 ha). A. *crassicarpa* is mainly planted on peatsoil. The size of these short-rotation plantations have been steadily increased. Indonesia is the ninth biggest producing country for pulp.

Started as regreening movement at the end of 1970s to rehabilitate degraded land, community-grown tree plantations have been gaining popularity. They have contributed significantly to the log production and the economy of community-tree growers. For example, in 2006 teak log production from the community teak plantations in Java alone amounted to 758,720 m^3 and total log production of *Falcataria moluccana* was around 3,6 million m^3. Falcataria wood has been processed for block board, plywood, pallet and light construction.

Recently, Indonesian government has launched a new program called 'Peoples' Plantation Forest' which is basically community-based commercial tree plantations. In this scheme people living nearby the forest are allowed to grow forest plantations on the state forest land with the objective of increasing the income and livelihood of the local forest growers.

Efforts to increase productivity of forest plantation have been carried out by means tree breeding and silvicultural practices. Current forest plantations for a number of species such teak, Merkus pine, acacia, eucalypt, gmelina and cajuput has been using genetically improved seed or clone. Long term productivity of forest plantations particularly for short rotation has also been of concern. Research to address this matter has been

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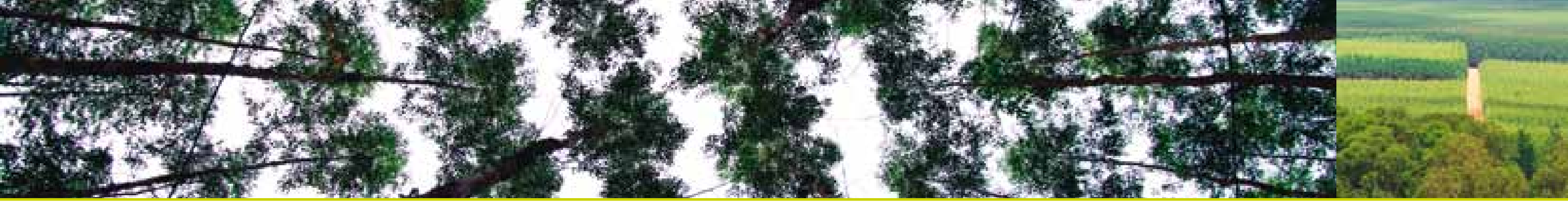


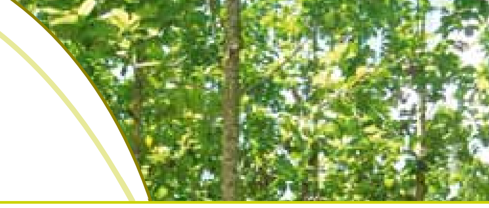
in progress (i.e. Acacia mangium). Results of this study indicated that the growth of the second rotation did not decline and in fact increased so long as proper silvicultural practices are applied which include minimum site disturbance, the use of genetically improved planting, preserving organic matter, nutrient input and proper maintenance.

Figure 1. A 54 year old stand of teak (Tectona grandis) in Cepu, Central Java. (Photo by Sugi Purwanta)

Figure 2. A 21 year old stand of Merkus pine (*Pinus merkusii*) in Toraja High Land, South Sulawesi. (Photo by Eko B. Hardiyanto)

Figure 3. A 7 year old plantation of *Acacia mangium* in South Sumatra (Photo by Punto)

Figure 4. A 41 year old stand of mahogany (*Swietenia macrophylla*) in Jember, East Java (Photo by Eko B. Hardiyanto)



Plantation forestry

in South Africa

Willem Olivier

South Africa has a land area of 121 447 000 ha of which 7,6% is classified as forestland by the Food and Agriculture Organization of the United Nations. The larger part of this area consists of open savannah woodlands utilised for domestic fuel. Only 0,28% of the country is covered by closed canopy evergreen forests and 1,04% by plantations of pine (38%), eucalypt (54%) and acacia (8%) species. The total production of all wood fuel and industrial roundwood is approximately 33 million m^3 per annum.

■

Little is known of the history of South Africa's evergreen forests prior to the settlement of the first Dutch settlers in 1652, but the original inhabitants, the San and Khoi-Khoi, did not harvest the forest trees. The Black immigrants, however, used large quantities of poles and wattles for the construction of their houses. The Europeans needed sawn timber and this led to the uncontrolled exploitation and destruction of large areas of the forests. Initially, the timber was required for housing, furniture and transport. When diamonds and gold was discovered at Kimberley and Johannesburg, the forests had to supply the mining timber. The annual harvests far outweighed the growth rates of the forests.

From the middle of the 19th century the government of the Cape Colony took a greater interest in the management of the evergreen forests. Forestry-trained staff was appointed from the 1880s onwards. This marked the beginning of the scientific management and conservation of the forests. By the time of the formation of the Union of South Africa in 1910 most harvesting of the evergreen forests was stopped.

Negligible small quantities of sawlogs are currently harvested as the evergreen forests are mostly managed for environmental conservation purposes. Once almost doomed to extinction by ruthless exploitation and mismanagement, the 336 000 ha forests are now being cared for through internationally accepted rainforest management policies.

■

The planting of exotic trees started after the first Dutch settlers arrived at the Cape. However, not many plantations were established as timber was either harvested in the evergreen forests or imported. It was only in the second half of the 19th century that afforestation was seriously considered. The first trained foresters in the Cape Colony realised that exotic plantations were the alternative to stop the destruction of the evergreen forests. More or less at the same time, farmers in the Natal Colony started planting Australian wattles for tan-bark production.

By 1900, some 26 600 ha of plantations were established of which 70% were owned by private companies and farmers. The early forestry pioneers soon found that they could not apply the European style of forest management to plantations. Initially, many different species were planted on a variety of sites. It soon became clear that pines, eucalypts and wattles adapted well to South Africa's growing conditions, but it still required extensive experimentation to find the best species and the best silvicultural practices. The rate of afforestation increased and by 1910 about 100 000 ha were planted.

The shortage of timber during the First and Second World Wars stimulated afforestation. The Government concentrated its efforts on producing pine sawlogs, whilst the private industry concentrated more on the growing of shorter rotation crops for wattle tan-bark, mining timber and pulpwood.

Little processing of locally grown timber was done during the first decades of the 20th century. At the outbreak of the Second World War only a few sawmills and timber processing factories were in operation. This radically changed during and after the War when numerous sawmills, pulp-, paper- and board mills were established.

South Africa is a relatively dry country with an average annual rainfall of 440mm. In 1972, a regulation was introduced whereby a permit was required to establish plantations. This was done to ensure that water was available for future domestic use, food and energy production and industrial development. The result was that afforestation was stopped in certain and restricted in other water catchment areas.

After a century of afforestation, a total area of 1,2 million ha were achieved by 1975.

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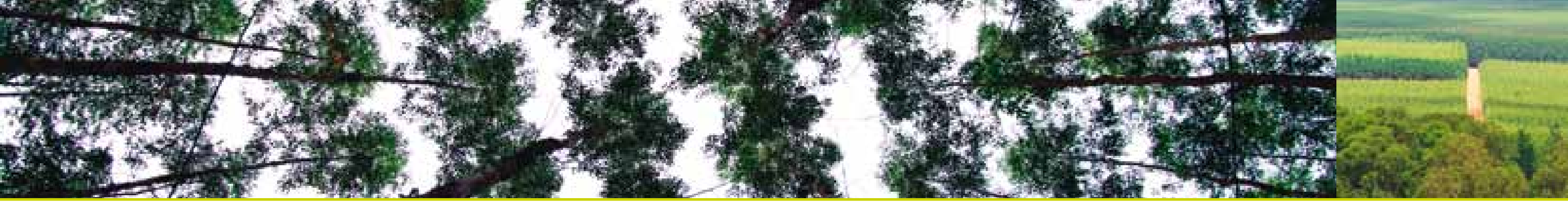


The rate of new afforestation started to decrease due to unavailability of land, low domestic economic growth, droughts, and the difficulty of obtaining planting permits.

Within the space of a few decades South Africa has progressed from being almost entirely dependent on imports, to an exporter of forest products. Since the 1980s roundwood sales from plantations increased significantly because of the increased availability of timber and production capacities. Although the larger corporate companies played a dominant role in the growth of the industry, the smaller companies and farmers also made significant contributions. Exports by Sappi, Mondi and the chipping companies sharply increased and South Africa became a net exporter of forest products.

Of historic importance are the initiatives by Sappi and Mondi, when they expanded internationally through acquisitions of pulp and paper companies outside South Africa. Whilst the pulp, paper and chip export businesses grew, the sawmilling and mining timber sectors, however, experienced problems. This was due to a shortage of sawlogs, lack of new technology, substitution of products and a decrease in the mining timber demand.

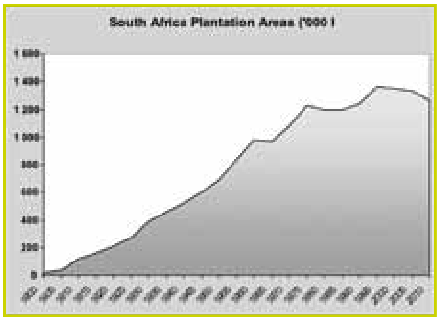
On 10 May 1994 a new era of South African history was ushered in when Nelson Mandela was inaugurated as the first democratically elected President of the Republic of South Africa. The new Government brought a new approach to the management of the forest industry. A new forestry act was promulgated with more focus on the participation of communities. The procedure for land claims by communities and restitution was formalised and the economic position of black South Africans in the forest industry was addressed through legislation. A new Water Act regulated the ownership, right to water usage and payment thereof. All of these initiatives necessitated the industry to make major changes to the way companies used to be managed.

On the operational front, the South African forester is faced with the challenges to compete economically in a global environment. The issues at hand are the increases in production costs, pests, diseases and fire damages. There is a need to increase the timber yields from existing plantations, yet to manage it in a sustainable way. The influence of HIV/AIDS has a direct influence on productivity, worker replacement, training and, eventually, increased production costs.

At the start of the 21st century South Africa has 1 266 000 ha plantations and 178 major processing plants. Some 1 600 000 ha of plantations and unplanted land are certified under the Forest Stewardship Council scheme. The annual roundwood productions from plantations are 9,0 million m^3 of softwoods and 11,3 million m^3 of hardwoods. The industry employs 630,000 workers or 4,3% of the formal South African employment sector. The annual turnover amounts to US$ 3,5 billion and contributes 1,4% to the national gross domestic product.

Dwessa forest and estuary on the Eastern Cape coast. This unique forest was already protected in the 19th century by decree of a Xhosa paramount chief.

A party of woodcutters with handsawn lumber in the Southern Cape forest near Knysna.



Graph of the growth of plantation areas in South Africa.

Mondi's pulp and linerboard mill at Richards Bay. Worldwide, Mondi produces 3,8 million tons and Sappi 6,9 million tons of products annually.

Coniferous plantations

in Queensland - now approaching 190,000 ha

Dr Garth Nikles

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Background

In the early 1900s it was recognised in Queensland there would be increasing demand and reducing supply of the excellent coniferous wood provided by indigenous species of *Araucaria* and *Agathis*. The rainforest species A. *cunninghamii* was first choice for the plantations required because of the known excellence of its wood, and its high survival and acceptable growth in early trials. While not amenable to natural regeneration commercially, it proved suitable for industrial plantations, begun in the 1920s, which gave high-quality wood. However, the area of land suitable and available for its cultivation was limited. So trials of many other coniferous species were undertaken, especially in the infertile coastal lowlands of south east Queensland. The aim was to identify species for plantations to make up the anticipated deficit in requirements of coniferous wood. *Pinus elliottii var elliottii* and *P. taeda* were chosen for plantations begun in the 1930s around Beerburrum (27° S). In some cooler, upland areas, *P. radiata* and *P. patula* were also planted.

In the late 1940s, *Pinus* plantation establishment was extended northwards into lowlands east of Gympie - Maryborough (around 26° S) and Byfield (around 23° S), and in the 1960s to the Cardwell region (around 18° 20´ S) and other areas. By the mid-1950s research showed *P.taeda* was less suitable than *P. elliottii* in the southern coastal lowlands, and identified the high potential of *P. caribaea var hondurensis* in frost-free areas there and to the north. These latter two species, and their locally-developed and more-widely-adapted hybrid, became the most important plantation taxa in appropriate locations and sites (below and Table 1).

It is notable that, from the beginning, world-class research and development (R&D) in Queensland have underpinned all aspects of plantation establishment, management, utilisation and marketing. Tree breeding was an important component of this integrated R&D, two outstanding results being that all seed requirements were met from clonal seed orchards of *P. elliottii* (by 1968) and of *P. caribaea* and *A. cunninghamii* by the early 1980s; and the majority of *Pinus* plantations established since the late 1990s has been with superior clones of *Pinus* hybrids. Photos 1-3 show the high quality of Queensland plantations.

Currently, almost all the coniferous plantation estate (Table 1) is owned by the Queensland-Government through its corporation Forestry Plantations Queensland (FPQ). However, the Government has recently announced a decision to sell the plantations.

Present status of coniferous plantations and industry

In mid-2009 the coniferous plantation estate totalled 184,000 ha (approximately) comprising 141,000 ha of exotic species and 43,000 ha of the native *A. cunninghamii.* The area of exotics comprised *Pinus elliottii* (15%), *P. caribaea var. hondurensis* (37%) and hybrids (45%) and *P.radiata* and *P. taeda* together comprising 2%. Areas of other exotics and natives such as *Agathis* species are insignificant. The plantations of both exotics and natives have a well-distributed range of all age classes. Currently, the annual planting rates are approximately 5,000 ha and 750 ha and rotation lengths 28 y and 50 y for exotics and natives respectively.

The distribution of the plantations across the 6 Forest Management Areas (FMAs) is shown by area (ha) in Table 1. The plantations are principally in the sub-tropical south east corner of the state in FMAs 1, 2, 3 and 6. The area of Araucaria plantations has stabilised at about 43,000 ha due primarily to low availability of suitable cleared land, and relatively high costs of establishment and management. With exotics, however, the log-processing industries in Queensland strongly favour expansion of the estate by around 50,000 ha.

In recent years additional land has been acquired for exotic pine plantations, e.g. nearly 5,000 ha were acquired by FPQ in 2007-2008 and more in 2008-09 (almost all in the Capricorn FMA). This expansion has been driven by the success of the plantations, increasing demand for wood products due to the rapid population growth in Queensland relative to that of most other Australian states, and the opportunity to secure land in the proximity of some existing plantations. With the new land, an estate

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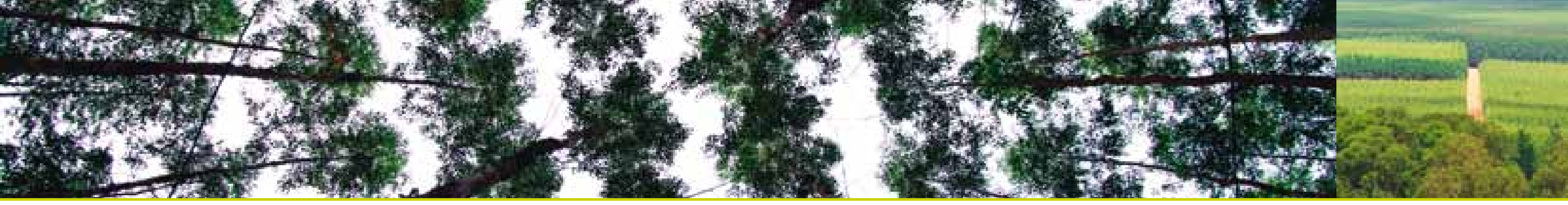

exceeding 200,000 ha should be achieved soon.

Log volumes harvested in 2007-2008 totalled 2.05 million m^3 including: exotics - 1.6 million m^3 (1.26 million m^3 of sawlogs) and natives - 0.45 million m^3 (0.42 million m^3 of sawlogs and plywood-veneer logs) with less in 2008-09 (Table 1), the latter figures reflecting the economic downturn. Logs are sold by the state to an established customer base of private owners of processing plants including: large-very large and several smaller sawmills, plywood mills, a medium-density fibreboard plant and other processors. The main products from Araucaria logs are face veneer, furniture and fine joinery including toys, while the dominant products of the exotic species are structural timbers. These industries record a direct annual turnover in the order of Aus$1 billion and add some $0.5-0.7 billion in value to timber products produced in the state. In addition, the plantations give rise to a range of other landscape, conservation, carbon sequestration, grazing and recreational opportunities.

Major elements of the current dynamics

Commercial management of the state-owned plantations, of which the coniferous resource is by far the largest component, is the core business of FPQ which aims to underpin a robust and competitive timber processing sector. The activities of FPQ are documented in Annual Reports accessible at www.fpq.net.au (see Home>Publications>FPQ Annual Reports). FPQ strives to continually improve its operations to enhance sustainability outcomes by adopting forest management systems based on recognised best practice, sound scientific principles, applied research and societal expectations. It holds independent certification to the Australian Forestry Standard for its commercial forest management.

The assistance of Dr Ken Bubb of FPQ in compiling this note is acknowledged.

Table 1. State Forest Management Areas showing current locations, main species, areas established and volumes of logs harvested from coniferous plantations of Forestry Plantations Queensland.

Forest Management Area	Location as approx. range in latitude (° S)	Main species	All-spp: area established to 2008-09 (ha)	All-spp: logs harvested in 2008-09 (final crops plus thinnings) ('000 m^3)
1. Fraser Coast	25° - 26° 30´	*Pinus* [1]	87,930	960
2. Mary Valley	26° 15´ - 26° 30´	*Araucaria cunninghamii*	21,497	198
3. Beerburrum	26° 45´ - 27° 15´	*Pinus* [1]	27,040	188
4. Ingham	17° 30´ - 21°	*Pinus* [2]	14,068	23
5. Capricorn	23°	*Pinus* [1, 3]	11,640	94
6. Burnett	24° 30´ - 27°	*Araucaria cunninghamii*	21,416	183
Relevant totals			183,591	1,646

[1] Includes large areas of the hybrid Pinus elliottii x P. caribaea var hondurensis.
[2] Almost wholly P. caribaea var hondurensis.
[3] Mostly P. caribaea var hondurensis.

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Photo 1. An unthinned commercial stand of an F2 hybrid clone (Pinus elliottii var elliottii x P. caribaea var hondurensis), selected for growth and form traits and wood properties, aged 8 y 8 mo in the Toolara State Forest north east of Gympie (Fraser Management Area), Queensland. Photo by Grant White.

Photo 2. An unthinned, 10-years-old commercial stand of P. caribaea var hondurensis derived from clonal seed orchard seed growing in the Cardwell State Forest of the Ingham Forest Management Area, north Queensland. The uniformly high quality of the trees reflects two cycles of local selection and breeding for growth, straightness, wind-firmness and branch habit. Photo by J? Ludlow.

Photo 3. A second-generation plus tree of Araucaria cunninghamii aged 38 years in a once-thinned, progeny trial planted in 1964 in the Mary Valley Forest Management Area in south east Queensland. The breeding program has delivered sufficient orchard seed since 1982 for all annual, post-harvest replanting and new planting requirements on the 45,000 ha plantation estate started in the 1920s. The plantations established since 1984/85 derive from orchard seed and are higher yielding. Photo by J. Brawner.

Since the early 2000s, much of the seed requirement has been produced by controlled pollination of flowers on grafts of the proven-best parents. Photos by Ian Last.

Development of acacia Mangium x A. Aurculiforimis

clones in Vietnam

Prof. Dr. Le Dinh Kha

1/Detection of *Acacia mangium* x *A. auriculiformis* hybrids in Vietnam

In 1943 the forest coverage of Vietnam was estimated about 43% of the total land area. Owing to long-lasting wars, it was reduced to only 28.1% in 1995. In 1998 productivity of Vietnam plantation was reported still low, only about 7-10 m^3/ha/year, even 5 m^3/ha/year at some regions, so government established a reforestation program of 5 million hectares until 2010, including 2 million hectares of production forest with high productivity.

Natural acacia hybrid (*Acacia mangium* x *A. auriculiformis*) was founded in 1993 in Vietnam, much later than the first detection of it in Malaysia (1972) and in Australia (1978). In comparison with parent species has shown acacia hybrid is having many more pre-eminent properties, as follow (Le Dinh Kha, 1996, 1999, 2001) :

- High productivity, straight trunk with small branches;
- Large quantity and heavy weight of *Rhyzobium*, good ability of soil improvement and drought tolerance;
- Considerable potential for paper pulp, and timber having intermediate mechanical and physical property from parent species.

Thus, acacia hybrid has become more and more expanded in Vietnam, especially in Central, South and Central Highland area, where the annual rainfall is 2000-25000mm and the sunny time is 1900 hours per year. At these regions, the 5 year-old plantation productivity was reported to reach 30-40 m^3/ha/year, and be 1,5 to 2 times higher than that of *Acacia mangium* and *A. auriculiformis* plantation in at the same age and in the same site.

2/Development of *Acacia mangium* x *A. auriculiformis* hybrid clones in Vietnam and some other Southeast Asian countries

Acacia hybrid has been widely planted by many householders, farm owners and forestry companies as well as plantation programs in Vietnam. They are also used for planting in some international forestry programs and projects of World Bank and Asia Development Bank in Central and Central Highlands area. Acacia hybrid is supposed to be suitable for farmers with great contribution to eliminate hunger and reduce poverty for people in remote area in Vietnam.

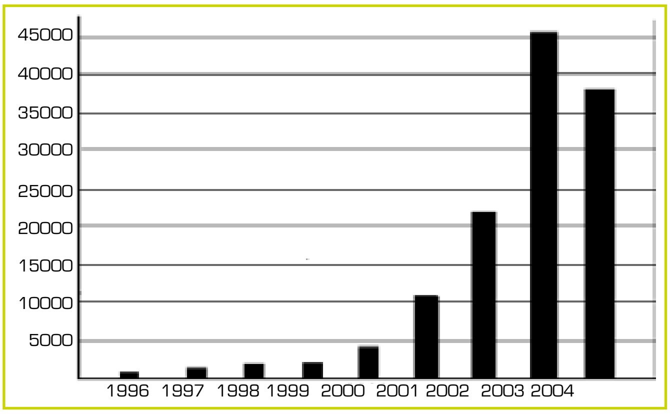

Figure 1. Development of acacia hybrids in Vietnam from 1996 to 2004

Many acacia hybrid clones were recognized as technically advanced and national varieties and become one of main forest tree varieties in Vietnam. It is estimated that acacia hybrid planting area in 1996 was 390 ha, such area has been 22,430 ha in 2002, and 37,900 ha in 2004 (Figure 1) and already up to 182,000 in total at the end of 2006. About 30 million cutting saplings have been produced annually in Vietnam. Because of planting by seedlings can cause segregation and regression which leads to slow growing and low yield of plantations, so a technical standard for vegetative propagation and planting of acacia hybrid was issued by Ministry of Agriculture and Rural Development (MARD) in 2006.

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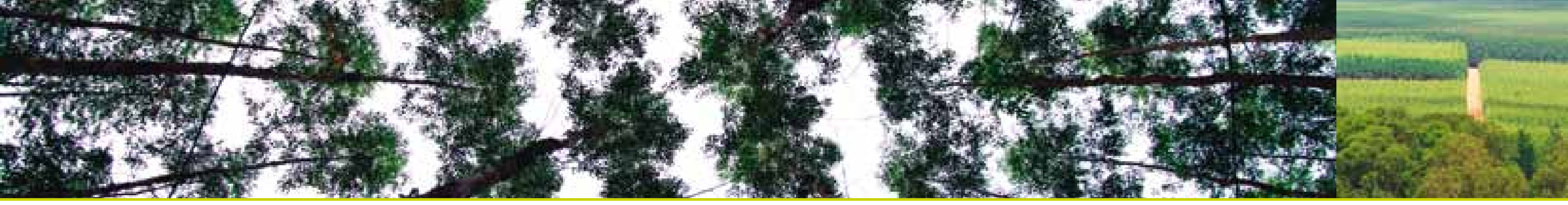

Hybrid

3/Growth of some acacia hybrid clones in Vietnam

Acacia hybrid clones planted in Vietnam are mainly national varieties such as BV10, BV16, BV32 and BV33, technical advanced varieties such as BV71, BV73, BV75, TB3, TB6, TB12 and TB1, TB7 and TB11 for Southern provinces as well as other varieties such as KL 20, KL TA 28 (BV is abbreviation of Ba Vi, TB is abbreviation of Trang Bom). These varieties are fast growing and high productivity (Tab. 1, Fig. 2). Through microsatelite marker, Butcher (2001) used alleles Am030, Am435, Am173 on loci of BV clones and found a truly genetic difference among these varieties.

Some national varieties such as BV10, BV16, BV32 and BV33 have been exported to Malaysia, Indonesia, Thailand, Laos (through Stora Enso company, Sweden), and Cambodia for trial planting, in which some were proven to have a future prospect.

Clone	D_{BH} (cm)		H (m)		Volume (dm^3/tree)		Survival (%)	Productivity (m^3/ha/year)
	$\overline{X}$	V%	$\overline{X}$	V%	$\overline{X}$	V%		
BV10	14,3	16,7	21,1	13,6	164,8	36,7	84	41,1
BV32	14,3	16,1	19,4	10,3	157,3	38,9	73	33,8
BV33	14,1	16,1	18,8	11,2	155,3	36,1	87	39,8
TB12	13,7	19,0	18,9	14,1	152,9	44,0	73	32,8
TB6	13,7	17,1	18,4	16,2	144,3	39,6	83	35,2
BV16	13,7	19,0	17,8	13,7	144,0	46,0	79	33,5
Am (1)	12,9	24,7	16,0	19,6	120,0	67,0	41	14,5
BV5	12,4	15,5	17,0	13,6	107,8	39,0	83	26,3
Aau (2)	9,4	29,3	12,2	27,9	52,0	106,9	27	4,1

Table 1. The growth of acacia hybrids in clonal test at Bau Bang (7/1999- 12/2004)
Note: (1) A. mangium, (2) A. auriculiformis

In recent researches, BV10 and BV 16 have been found the most prospective clones in South Central Coast and Southeast region, and then BV71, BV73. Some varieties of acacia hybrid can be broken by strong wind in the North, however, in low rate and still gain the highest productivity. Therefore, they remain the main forest tree varieties and were widely applied by many householders (especially in South and Central regions), forestry companies and international plantation programs in Vietnam.

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The Production of clonal Teak

in Malaysia

Doreen K S Goh - YSG Biotech Sdn Bhd., Yayasan Sabah Group, Voluntary Association Complex, Mile 2 ½, off Jalan Tuaran

The increasing restriction or total ban on timber supplies from natural forests enforced by local authorities had provided the impetus for forest plantation establishment over the last decade. Although accounting for only 5% of global forest cover, forest plantations estimated in the year 2000 to supply about 35% of global roundwood is anticipated to increase to 44% by 2020 (FAO 2000). Among the high value forest species planted today, teak is one of the most sought after due to its many attractive wood properties. Currently, the total area under teak plantations is estimated at more than 3 million hectares and is expected to rise as market demand for this timber continues to increase.

As the supply from native teak-growing countries is no longer viable, the alternative is to produce plantation teak forests on a sustainable basis to meet increasing demands. Obviously, yield and the quality of the timber arising from the type of planting materials used are the determining factors for consideration in large-scale plantation establishments. In the late 1980s' to early 1990s', there was a shift from conventional planting of teak using seeds to selected clonal materials which give a higher and more predictable harvest at the end of the rotation age. Investors who wished to maximize returns in the shortest delays were only too eager to adopt the clonal option.

With this predicted trend in mind, the Sabah Foundation Group, Malaysia, and the research and development organization, Cirad, France, jointly embarked upon a teak improvement program in 1989. The tissue culture facility known then as the Plant Biotechnology Laboratory (PBL), set up in 1992, was a pilot project aimed specifically at the in vitro multiplication of selected teak clones. Within a decade, research comprising of both nursery and tissue culture techniques development using nodal explants and meristem cultures from selected mature standing trees, followed by field verification of the in vitro-issued micro-cuttings yielded unexpectedly positive results (Goh and Monteuuis, 2001).

The simple, low cost and high throughput of the developed in vitro technology on a single elongation-multiplication culture medium using the minimal concentration of growth hormone, followed by successful ex-vitro acclimatization rates in the nursery of more than 90%, have resulted in a highly efficient process. This was further supported by the true to type performance of the in vitro-issued trees established locally and in overseas trials. The in vitro process was also highly applicable as it was possible to rejuvenate and multiply any clones from the field irregardless of the ortet age from which the explants were derived.

The first selected materials arose from cutting-derived trees which originally came from seeds obtained from Solomon Island that were grown at our research center. The attractive features of the Solomon Island-originated clones, characterized by fast growth, straight bole and high heartwood to sapwood ratio at 7 to 13 years of age, gave us the added confidence to promote the use of clonal materials even more aggressively. With the first large overseas sale to Australia at the end of 2001, the PBL project evolved into a commercial subsidiary of the Sabah Foundation Group known as YSG Biotech Sdn Bhd. To date, the company has produced several millions plantlets for not only local but overseas plantation set-ups.

To maintain our reputation as a leading tissue culture teak supplier, quality control of the propagated materials is rigorously applied at each successive step of the production process. Additionally, DNA fingerprinting and wood analyses assisted by CIRAD are applicable to certify the genetic fidelity and quality of the propagated clones, respectively (Goh et al, 2007). The sterile conditions under which the micro-cuttings are produced allow their exportation overseas in the shortest delays without any compromise in the phyto-sanitary requirements of importer countries.

Today, YSG Biotech owns one of the broadest teak resources in the world which are in the form of several seed production areas, each with a diverse genetic base. The possession of these resources provides a readily available pool of potentially new planting materials in the form of clones (standing trees) or seeds (from standing trees) (Goh and Monteuuis, 2005).

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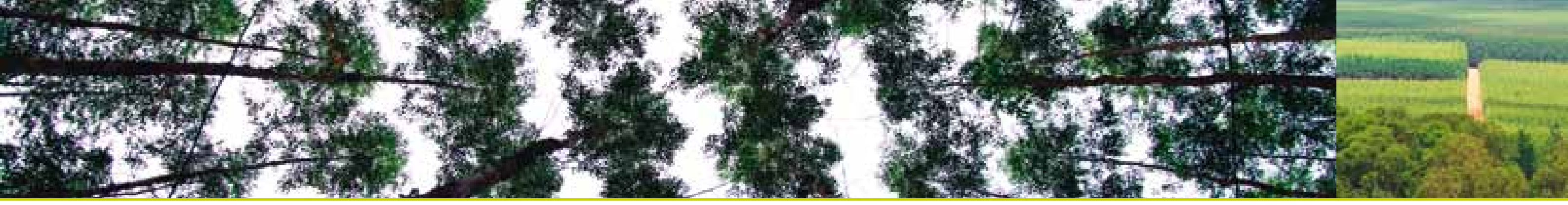

at large scale

The company earnestly continues to come up with better performing clonal materials that are adapted to different site conditions in tropical and sub-tropical teak-growing regions. The possibility to supply superior quality clonal materials and improved seed sources will undoubtedly facilitate large-scale teak planting investments with more predictable lucrative returns in the near future.

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Mass production of tissue culture teak at the YSG Biotech's lab facility in Kota Kinabalu, Sabah, Malaysia. Photo: D Goh

Figure 2. Trial plot of clonal teak issued from tissue culture propagation in Sabah, Malaysia.
Photo: D Goh

Applications des Biotechnologies
aux Plantations Forestières

Olivier Monteuuis

Les Biotechnologies ont été définies comme « toute application mettant à profit des systèmes biologiques, organismes vivants ou dérivés, afin de générer ou modifier des produits ou process à des fins spécifiques »

Appliquées au domaine forestier, les biotechnologies se conçoivent pour accroitre sensiblement la qualité et le volume du bois produit par les plantations d'espèces forestières afin de répondre à une demande de plus en plus forte. Les besoins en bois sont censés augmenter de 20% lors de la prochaine décennie, alors que la couverture forestière mondiale diminue chaque année de 9,4 millions d'hectares, ce qui correspond à la superficie du Portugal.

Les biotechnologies forestières peuvent être subdivisées en quatre secteurs d'activités distincts, qui peuvent être classés en fonction de leur relative importance sur base des informations divulguées par le domaine public :

1. Culture in vitro (34%), incluant la micropropagation, la cryoconservation, les cultures de cellules et de protoplastes, le sauvetage d'embryons,…

2. Analyses de diversité génétique (26%), incluant les aspects structurels, de génétique des populations, des flux de gènes et des effets anthropiques sur les peuplements forestiers.

3. Génétique fonctionnelle (21%) englobant les cartes génétiques, la sélection assistée par marqueurs (SAM) et la génomique.

4. Les transformations ou modifications génétiques ou transgenèse (19%).

Bien que les espèces recensées appartiennent à 142 genres botaniques, 62% des activités concernent plus spécialement 6 genres à savoir : *Pinus* (20 % des biotechnologies, transgenèse exclue), *Eucalyptus* (11 %), Picea (9 %), *Populus* (9 %), *Quercus* (7 %) and *Acacia* (6 %). Les quatre genres *Pinus, Eucalyptus, Picea* et *Populus* totalisent à peu près la moitié des activités de biotechnologies recensées, sans compter la transgenèse.

76 pays sont concernés, qui peuvent être regroupés par régions comme suit : 39 % pour l'Europe, 24 % pour l'Asie, 23 % pour l'Amérique du Nord, 6 % pour l'Océanie, 5 % pour l'Amérique du Sud, 3 % pour l'Afrique et moins de 1 % pour le proche Orient. Cet inventaire regroupe les pays développés (24, représentant 68 % de l'activité en biotechnologie) ainsi que les nations en développement ou en passe de le devenir (52 pays correspondant à 32 % des activités avec 27% pour l'Inde, 17% pour la Chine, 7 % pour le Brésil, 5 % pour l'Afrique du Sud et 4% pour la Malaisie).

Durant les dernières années, la micropropagation a été l'exemple le plus démonstratif des possibilités d'application des biotechnologies forestières, du moins en terme de plants produits et acclimatés. Le potentiel est considérable bien que, jusqu'à présent, seuls quelques milliers d'hectares aient été plantés avec du matériel issu de micropropagation,, principalement en Asie, tout en restant conscient du manque d'informations fiables sur l'utilisation des biotechnologies au profit de plantations forestières industrielles. La micropropagation peut s'effectuer (i) par bourgeonnement axillaire, classiquement reconnu comme la méthode la plus sûre pour garantir la conformité génotypique du matériel micropropagé, (ii) par bourgeonnement adventif et (iii) par embryogenèse somatique. Les avantages comparatifs par rapport aux techniques de multiplication horticoles sont des coefficients de multiplication nettement plus élevés avec la possibilité de :

(i) Micropropager des génotypes tout au long de l'année, indépendamment des conditions climatiques non nécessairement adaptées au transfert in vivo du matériel micropropagé;

(ii) Conservation in vitro en espace très réduit;

(iii) Expédier les plants in vitro dans divers pays étrangers en s'affranchissant des contraintes phytosanitaires;

(iv) Rajeunir les génotypes matures sélectionnés afin de stimuler leur aptitude au clonage conforme;

(v) Augmenter rapidement les effectifs de génotypes particulièrement précieux mais initialement trop faiblement représentés, qu'il s'agisse de graines,de cellules transgéniques,…

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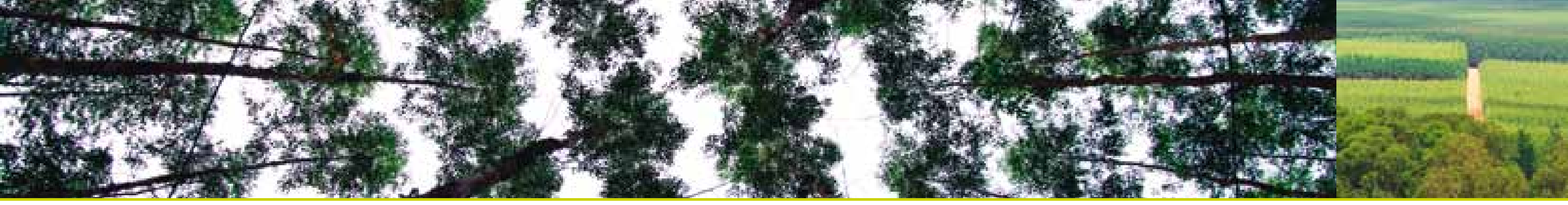

Les inconvénients sont la possible inaptitude du matériel convoité à la micropropagation, en fonction de la méthode, du génotype, de l'âge, et du coût. Ce dernier facteur est déterminant et incite à réduire le plus possible les manipulations in vitro dans les protocoles opérationnels nécessitant la micropropagation. Les unités de propagation industrielles au Brésil, au Portugal et au Vietnam par exemple n'utilisent la culture in vitro que pour rajeunir les génotypes sélectionnés matures les plus récalcitrants au clonage industriel. Ceux-ci sont ensuite gérés de façon intensive sous forme de pieds-mères pour produire à grande échelle en pépinière des boutures enracinées à moindre coût. Les vitroplants peuvent être aussi directement plantés comme populations de production de bois. Les millions de vitroplants clonés à partir de tecks matures produits par YSG Biotech au Sabah, Malaisie orientale, sont ainsi micropropagés in vitro à coût minimal, en n'utilisant qu'un seul milieu de culture, pour être ensuite enracinés et acclimatés en conditions bien moins onéreuses de pépinière avant leur plantation à grande échelle au champ pour produire du bois. Sur la base des informations disponibles, qui ne sauraient être exhaustives, les applications industrielles de la micropropagation aux plantations d'arbres forestiers ont principalement concerné jusqu'à présent les espèces suivantes : *Acacia mangium*, *A. melanoxylon* et *A. mangium* × *A. auriculiformis*; *Eucalyptus spp; Pinus spp.; Picea spp; Tectona grandis; Pseudotsuga menziesii, Larix spp*;…

Outre la micropropagation, les plantations d'arbres forestiers peuvent bénéficier de l'apport d'autres biotechnologies, et plus particulièrement des marqueurs moléculaires de l'ADN à différentes fins :

- Détermination de la provenance initiale de génotypes implantés localement et pour lesquels ce type d'information est bien souvent inconnu. Ces renseignements sont particulièrement utiles pour les analyses d'adaptabilité de certaines provenances à différents sites, ainsi qu'au niveau commercial où la traçabilité du bois vendu sous forme plus ou moins transformée est de plus en plus requise.
- Détermination de la diversité et de la filiation des ressources génétiques locales pour une gestion et valorisation optimales à travers des programmes d'amélioration génétique adaptés et le développement judicieux de plantations clonales.
- Etudes phénologiques et de flux de gènes pour optimiser les échanges de gènes et les recombinaisons, en réduisant les risques de consanguinité.
- Identification clonale par empreintes d'ADN pour la protection des droits de propriété intellectuelle.
- Et le contrôle de la conformité génotypique des clones propagés.

Exemples d'applications opérationnelles de biotechnologies, et plus précisément de micropropagation, au profit de plantations forestières industrielles : élevage-éducation de vitroplants de tecks clonés en Australie (à gauche), et pieds-mères clonés d'Acacia mangium x A. auriculiformis rajeunis in vitro pour la production en masse à moindre coût par bouturage en pépinière au Vietnam.

Australian tree species

Their global importance and the role of the Australian Tree Seed Centre

Stephen Midgley and David Bush

Australia is blessed with an extensive and diverse tree flora some of which is shared with neighbouring countries of Papua New Guinea, Indonesia and East Timor. The Australian continent is ancient, and the flora has adapted to shallow soils of low nutrient status, and must cope with climatic extremes. Grown outside of Australia, many species, particularly those from the genera *Eucalyptus, Acacia, Grevillea and Casuarina* have proven to be extremely adaptable and capable of rapid growth rates – often outperforming slow-growing local natives in terms of wood production. The world's natural forests can simply not sustain the human population's demand for fibre, fodder fuelwood, construction materials and diverse other products without tree farms or plantations. Climate change, with much of the world predicted to become hotter and drier, and/or to have protracted dry seasons, as well as the estimated additional 3 billion people that will live on our planet by 2050, will only increase the world's need for the unique natural resource that is Australia's tree flora.

Not surprisingly then, Australian trees are a common part of the landscape of many countries, where they are used in commercial plantations, as windbreaks, in agroforestry systems and as ornamentals. How did these trees arrive in these other countries and who brought them ? How did 19 million ha of eucalypt and 3 million ha of acacia plantations emerge ? One of the most significant players in this remarkable international process has been the Australian Tree Seed Centre, part of Australia's national research agency, CSIRO.

The collection and export of seed from Australian trees is not new – a small tree of *Eucalyptus obliqua*, grown from seed collected by the Royal Navy's Tobias Furneaux in 1773, was noted as growing in Kew Gardens in 1789. In 1788, the private English nurserymen Lee and Kennedy had found a ready market for "New Holland" plants and in 1790 dispatched a seed collector of their own to Sydney. Within 40 years of European settlement, Australian eucalypts were growing in Britain, France, Italy, Spain, Portugal, South Africa, Mauritius and Brasil.

The early French enthusiasm for the Australian flora saw eucalypts planted throughout the warmer parts of Europe and the French colonies. Ferdinand von Mueller and his enthusiastic French disciple Prosper Ramel (after who the rare species *E. rameliana* was named) vigorously exported seed of Australian species, particularly eucalypts, in the mid-1800s. By the 1860s, eucalypts, acacias and grevilleas were being used in many parts of Europe, Africa, Asia and the Americas. The State forest services of Australia exported seed of many species in the early 1900s and large commercial quantities began to be exported by private suppliers. Some of these early collections and introductions were from single trees and of sometimes confused taxonomy.

In 1961, in recognition of the economic and social importance of Australian species outside Australia, and the need for reliable sources of authenticated and certified seed, the Food and Agriculture Organisation of the United Nations (FAO)

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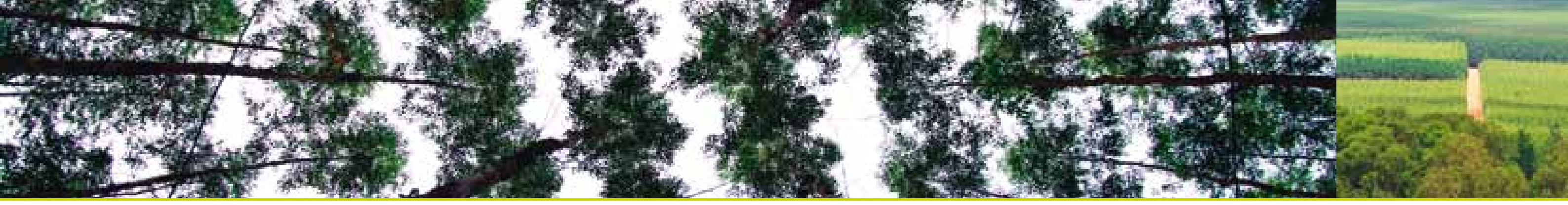
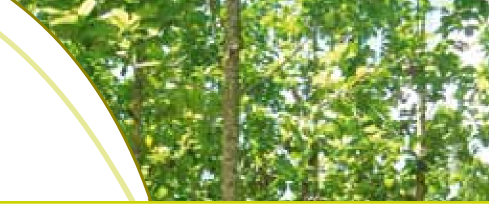


requested the Australian Government to establish a *Eucalyptus* seed and information centre. This centre developed to become the Australian Tree Seed Centre, which maintains a comprehensive collection of seeds from a wide range of multipurpose trees of Australian origin and holds about 30 000 accessions comprising 1000 species from several thousand collection sites.

In addition to the collection, documentation and dispatch of seed from often remote locations, the ATSC offers a service of professional advice on species and provenance site matching. It collates data provided by its research partners in many countries and is able to share this with others. Since the 1990s it has developed a strong research theme of germplasm assessment, breeding and domestication. This research has centred on two main areas. The first is development of tropical eucalypts and acacias. Species such as *A. mangium*, *A. crassicarpa*, *E. camaldulensis* and others have dominated new plantations in tropical SE Asia, India and other places since the 1980s. The ATSC's involvement has been aligned with Australian development assistance programs : the ability of developing countries to meet their needs for fibre, construction and fuel wood is critical both to their economic development and also to alleviating pressure on the tropical forests. Long-term collaborations with research institutes in Vietnam, China, Indonesia, PNG, India and other nations have resulted, with seed exchange, establishment of seed centres and scientific capacity to maintain them, research trials and tree breeding programs being the result.

The second thrust has been development of trees suited to marginal lands. Much of Australia and other parts of the world are very dry, and pressure from competing land uses on prime agricultural land are increasingly displacing forestry onto this lower-quality landbase. Since the late 1990s, we have undertaken germplasm collections, research and breeding programs to develop breeds of trees adapted to these conditions. The ATSC now has genetically improved seed of a variety of trees suited for wood production in low rainfall environments, and we see that this will be an increasingly important focus as the effects of climate change start to impact.

The demonstrated social, environmental and economic importance of Australian trees in a modern world, along with their proven potential for improvement through selection and breeding makes the work of the ATSC even more important. Just as breeding programs for wheat, rice and other crops require well-maintained base populations, the forestry world's breeding programs of acacias, eucalypts and casuarinas will require on-going access to natural populations of these species. The international networks, professional skills and comprehensive records of the ATSC, developed over 48 years, will continue to serve the global community - representing a uniquely Australian contribution to world forestry.



How Private Industry has met the resources of Tropical and Subtropical tree Species

Dr Dvorak - Director: Camcore & Professor of Forestry, North Carolina State University

Private forest industry has often been criticized on how it manages forests and protects genetic diversity. To demonstrate that it can be part of the solution in the protection of forest species and populations, forest industry joined forces with North Carolina State University (NC State) and the Guatemalan government in 1980 to form Camcore, an international conservation and domestication cooperative. The program has now grown to include 25 of the major pulp and paper companies and solid wood producers in the southern hemisphere on four continents (see www.camcore.org for complete membership list). Camcore represents a major success story of how private industry can make a major, positive impact on the management of forest genetic resources by working together.

Camcore works in the following way. Scientists and technicians from NC State make research seed collections in threatened tree populations in regions like Central America and Mexico and Southeast Asia. The seeds are packaged into progeny trials that serve as both genetic tests and *ex situ* conservation planting and distributed to the industrial members. The Camcore staff at NC State coordinates the seed exchange, designs and analyzes the trials and makes the results available to all of its members. The members of Camcore, in turn, agree to establish, manage, protect and measure the field trials. The Camcore staff visit the trials and conservation planting once each year in the 17 countries where it works to make sure that high quality standards are maintained. When the field trials reach half rotation age (8-10 years), the best trees are selected for the next cycle of breeding. The strength of the Camcore approach is that conservation is an obligation of membership. Each company is responsible for the success of its own field trials and *ex situ* plantings; the establishment of many trials leads to greater precision in determining the best species, populations, families and individual trees. Since 1980, Camcore has sampled over 12,000 individual trees of 42 different tropical and subtropical species at 498 different locations in Mesoamerica and Southeast Asia. A data base is maintained of the trees sampled in natural stands as well as for the progeny that are planted across as many as 16 countries. In a normal year, the program handles millions of bits of data. Camcore has established over 2500 hectares of progeny trials and conservation plantations since 1980

The species in the Camcore portfolio include those from the *Pinus*, Eucalyptus (Non-Australian), *Gmelina* and *Tectona* genera as well as lesser known broadleaf species native to Central America and northern South America. Species included in the conservation effort range from those with known economic potential (like *Gmelina arborea* and *Pinus patula*) to those that have little foreseeable value in plantation forestry but need protection. For example, Camcore began working with a little known pine species called *Pinus tecunumanii* in Guatemala in 1980. Through intensive explorations we now have found 48 locations where the species naturally occurs in Central America and have established over 180 different genetic trials and *ex situ* conservation planting of the species across a number of tropical and subtropical countries. We now have the factual information to say that *P. tecunumanii* has great potential as a future plantation species because of its good growth, adaptability, wood quality and disease resistance. A second example includes the ex situ conservation efforts for *Pinus maximartinezii.* It is a rare nut pine that is found only at one site in central Mexico. It will never be of value in plantation forestry but Sappi Forests in South Africa, a member of Camcore since 1989, has established the largest known ex situ conservation planting of the species in a well-protected area at its research headquarters near Pietermaritzburg.

Camcore and private industry are now involved in two additional important conservation activities for tree species in the tropics and subtropics. First, in South Africa, Camcore members are establishing special conservation parks to hold genetic material from many populations sampled in Camcore collections made over the years. Essentially, this is an effort to move the genetic material from the field trials to a more centralized location that can be easily protected. Each

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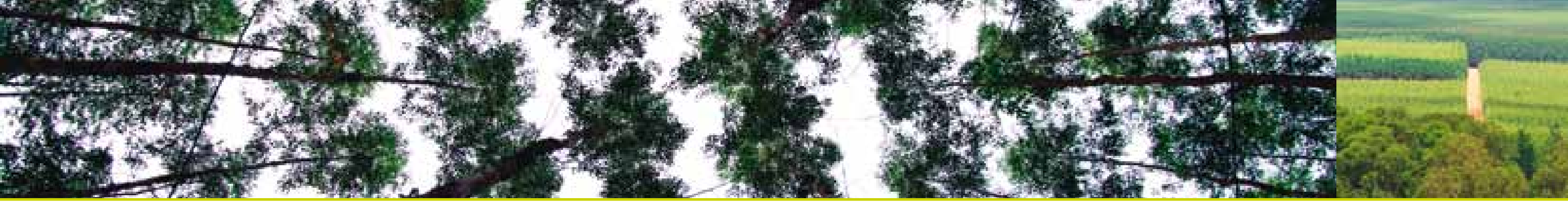
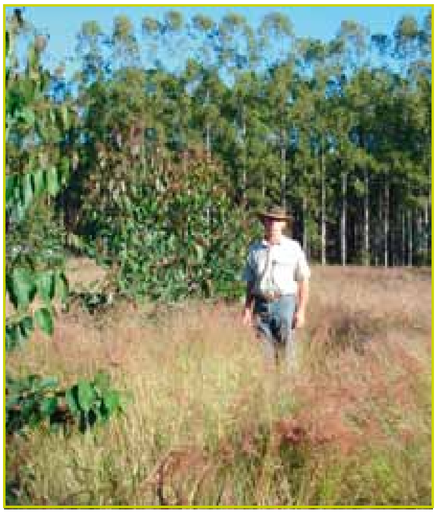


conservation park is approximately 25 ha in size and contains one-quarter hectare plots of individual populations. In turn, each population contains representation from a reasonable number of individual families to maintain its genetic integrity for future generations. The parks will not only be a holding place for genetic material, but hopefully will serve as a place where students can conduct research. Second, Camcore is returning seeds from its genetic trials and conservation plantings back to the country of origin where the collections were originally made as long as 20 to 25 years ago. Our hope is that the reintroduction of seeds to the country of origin can be used to replace genetic material lost through deforestation years ago.

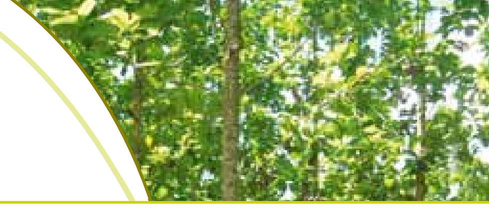
Since 1980, forest industry has invested US$40 million in the Camcore conservation and testing program. Included in these costs are financial support for the salaries of a small number of dedicated researchers at NC State, graduate stipends for students interested in conservation and tree improvement projects and the establishment and upkeep of large number of trial and conservation plantings. The Camcore program demonstrates the important role of forest industry in the management of forest genetic resources. It corporate membership continues to grow.

Selection of a *Pinus tecunumanii* tree in a natural stand in Guatemala for seed collection as part of Camcore efforts to conserve the species.

Gmelina arborea from Myanmar growing in Venezuela. Camcore members now have one the largest genetic bases in the world of this species to conduct future breeding and ex situ conservation efforts.



Camcore conservation park in South Africa established by Sappi that includes a number of populations of *Eucalyptus urophylla* (left) from collections made in Indonesia. Each Camcore industrial member in South Africa will establish a park with 6 to 7 species and as many as 40 populations of different tree species.



Stake of Intensively managed Forest Plantations

Christian Cossalter

A Brief History

The practice of planting forest trees goes back to ancient times. Chinese fir was planted in China more than a thousand years ago. However, until the middle of the 20th century, the global demand for roundwood and fuelwood was almost exclusively satisfied through the logging of natural forests.

First significant planting of artificial forests, as an alternative source of timber supply, began essentially through government initiatives, and essentially in industrialized countries of the western world. In the 1950s, governments of Japan, Korea and China also embarked on massive reforestation programmes.

The 1960s saw the launching of large-scale plantation programmes in many tropical and subtropical countries, and between 1965 and 1980 the area devoted to tropical plantations trebled. In most cases, plantations were established with financial support from foreign donors or with soft loans and they were mostly managed by state organisations.

Current Trends

Results of the Forest Resources Assessment 2000 made by FAO showed an overall increasing trend in global plantation area over the last quarter of the 20th century. For the first time, in 2005, FAO adopted a broader definition of planted forests and included in its statistics areas of semi-natural forests regenerated by seeding or enrichment planting of native species. With this broader definition the Global Forest Resources Assessment 2005 reported a global area of planted forests of 271 million hectares of which plantations accounted for 140.8 million hectares.

Asia continues to lead the world's plantation sector with 46 per cent of the global area while Europe holds a further 20 percent. A relatively small number of countries dominates the plantation business, with three, each possessing over 15 million hectares of plantations, accounting for nearly half of the world's plantation area. These, ranked by order of importance, are China, the United States and the Russian Federation. However, few of their plantations could be classified as intensively managed.

There was a significant increase between 1991 and 2005 in the area of plantations established for industrial purposes as a result of increased private-sector involvement. Companies from North America, Europe, the southern cone of South America, South Africa, New Zealand and Australia had previously dominated private investment in plantation forestry. However, the 1990s witnessed the emergence of Asian multinational investors as major players. This global trend is expected to continue. In a number of countries of the humid tropics and subtropics, plantations become an important source of wood fiber for the pulp and wood panel industries.

Economic Driving Forces

In 1995, it was estimated that forest plantation produced 22 per cent of the total global industrial wood. 10 years later their contribution to the global industrial wood production has grown to 35 percent. Global demand for wood products will continue to rise as a result of population growth and migration to urban areas on the one hand and the per capita consumption of wood and wood-based products on the other which, in turn, is correlated to the rise of living standards. Consumption will continue to shift towards paper products and reconstituted panels, a trend that favors an increased demand for wood produced by plantations, especially fast-growing plantations grown on short rotations. This later type of plantations becomes increasingly cost competitive as more wood can be grown per unit area of land and uniformity in wood quality, tree size and shape is better.

Social, environmental and political dimensions

Planting large areas of intensively-managed plantations may make good commercial sense. It is often the only option for producing, at low costs, the raw material that the pulp and panel industries need. But it does not necessary follow that it makes good environmental or social sense; or that it makes good economic sense when these and other factors creating economic distortions, such as subsidies and government incentives are taken into consideration.

Similarly, Investment in plantations should not be considered, if it can be demonstrated that they are likely to adversely disrupt the hydrological cycle or reduce water

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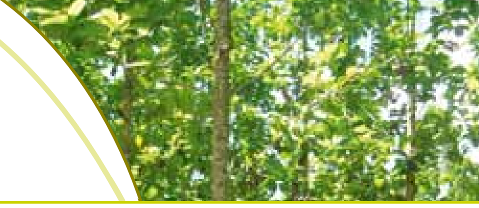
quality. Likewise, plantations should not be established if they have an adverse effect on local communities; if, for example, they are likely to lead to a net loss of employment or to local communities being deprived of firewood, grazing land and other goods and services on which they depend. All these factors should be considered together, not independently, as there may be trade-offs that are acceptable.

Politicians, financial analysts, the plantation industry and plantation experts are now much more aware of the social and environmental impacts of their recommendations and decisions than they were ten years ago. Several institutions have developed new assessment tools and international initiatives which promote the adoption of best practices when planning and managing forestry plantations. Nowadays, many projects undertake environmental and social impact audits at an early stage of development. At the same time, a growing number of buyers are insisting that their wood products come from forests that are certified as well managed.

Increasingly, plantation managers recognize the disadvantages of using fire for site preparation. Retention of logging debris on site has now become current practice for plantation re-establishment. Associate benefits include: reduced soil erosion, improved long-term soil fertility and improved tree growth.



Vers un nouveau développement

des plantations forestières au Ghana

D. van Boven , T.H.V. Wanders , G. Breukink

"The earth's forests are under pressure. Tropical forests are fast disappearing due mainly to logging, mining, hydropower and the hunger for land. Temperate and northern old-growth forests are being destroyed by the timber and paper industries. Not only is the livelihood of native peoples of the forest being undermined, every year thousands of plant and animal species disappear forever." (Source : www.tree4life.com) . Reforestation and commercial plantation forestry can be seen as important ways to diminish the pressure on natural forests. Forest plantations receive increased attention and plantations of commercially viable species are being established world-wide evenso in Ghana, the focus of this article.

Ghana has suffered greatly from past overexploitation and encroachment upon the forest reserves and the original size of forest area has been reduced by 75% since they were first measured. At the time Ghana gazetted approximately 1.7 million hectares as permanent forest reserves in, half of this area is currently productive for sustainable logging. The other half ha been severely degraded and is no longer productive.

This combination of severly degraded forest reserves and a high demand for raw material, makes Ghana an interesting country for establishing timber plantations. The government of Ghana has a presidential policy to **provide incentives for investors to contribute to reforestation** of so called degraded Forest Reserves which are managed by Ghana's Forestry Commission. The objective is to attract foreign investment for reforestation in degraded Forest Reserves. This is a long term political decision but needs to be realised by the private sector in cooperation with the government.

In 2001, the Ghana Government launched the President's special initiative on forest plantation development with a target of 20,000 ha/annum. Over the first three year period (2001-2003), 37,000 ha of plantations were developed as small-holder plantations (*Ofori, D. A.,Siaw, D. E. K. A.* Forestry Research Institute of Ghana, JAARTAL + intreferentielijst). This initiative means that new lease concepts have been designed in close cooperation with the House of Chiefs and other stakeholders. This new approach and contracts are unique for Africa with securities and guarantees for long term land use covered by legislation.

Degraded forestland Asubima, Ghana
Photo : P.H.V. Hol

As a result, Ghana will become a net importer of industrial timber after 2010. Ghana's present forest resources sustain a maximum annual allowable cut of about 1 million m3 timber, while the export-oriented wood industry has an installed capacity of around 3.7 million m3 and local demand for firewood will reach about 3 million m3 by 2020.

It is possible to obtain a land lease for 50 years. The lease is a contract between the forestry department the local landowners and the plantation development partner. The lease is split between the forestry department and the landowners. The fact that the term of the lease is 50 years will allow a plantation developer to complete one or two plantation cycles depending on the species.

Already some degraded forest reserves are leased to investors who plant it with tree species which are commercially interesting, such as Wawa (*Triplochiton scleroxylon*), Ofram (*Terminalia superba*), Emire (*Terminalia ivorensis*), Cedrela (*Cedrela odorata*) and Teak (*Tectona grandis*).

People, Planet, Profit

For any forest plantation to be succesfull the balance between people, planet and profit is essential.

Intercropping : Teak and Maïs
Photo : W. Tolkamp

People

Through the establishement of a forest plantation company on degraded forest lands, the local population can benefit on several levels : through the employment of local population in the area; through collaboration with farmers on the plantation through the set up of an intercropping system where crops which will grow in between the planted trees; through smallholder schemes with villages in the region. Local people will benefit from the exployment but also from training in nursery techniques, planting and plantation maintenance.

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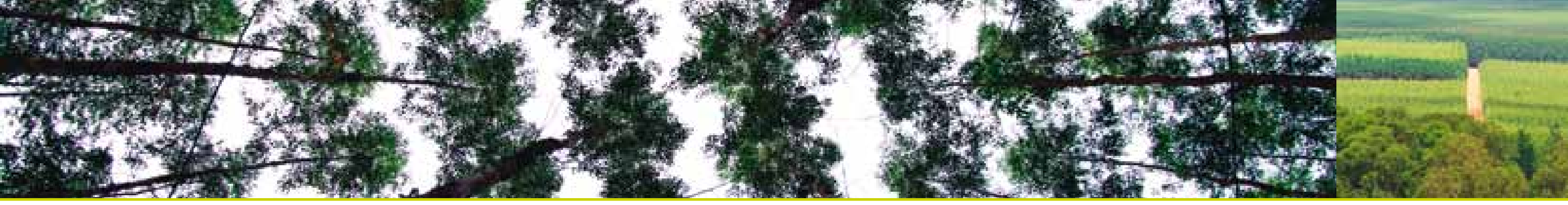


Accompanying plantation activities with a social programme will create even more commitment from farmers and local population since it generates employment, income and shows the opportunities of proper plantation management which will be crucial for Ghana to restore it's natural resource base.

Planet

Planting new forest on degraded land significantly increases the carbon stocking in an the area, thus contributing to climate change mitigation. As a result of the Kyoto protocol, reforestation has become an emerging issue and creates opportunities for sub-Saharan Africa to benefit from storage of carbon dioxide in reforested areas. The potential of reforestation has been recognised by various actors in the forestry and investment sector.

Profit

The establishment of large-scale sustainable tropical hardwood plantations will have positive socio-economic effects on the timber sector in Ghana, as well as the local population and the entire nation through the generation of employment, increase in export earnings and the attraction of (foreign) investments.

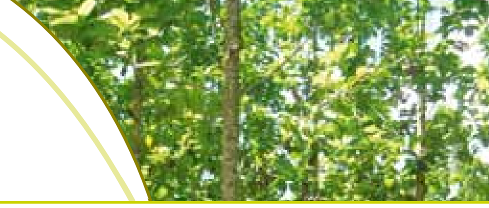
An example of a plantation company that works within the context of the abovementioned issues is FORM Ghana Ltd. In 2006 this plantation company was established, This new company has started with the creation of a nursery near Akumadan in the Ashanti region. This nursery has the capacity of 300.000 potted tree seedlings and some 600.000 stumps. With plants grown in this nursery FORM Ghana ltd. is currently reforesting the Asubima Forest Reserve at a rate of 500 hectares per year. FORM Ghana ltd.is planting mostly teak, though 10% of the area will be consecrated to the local species. This area is the buffer zone between the plantation and the water *Teak (Tectona grandis) stands Asubima*

FORM Ghana is currently in the process of becoming FSC certified. For more information please visit the website : www.formghana.com

August 2009 FORM International

D. van Boven, T.H.V. Wanders, G. Breukink

Photo : M. Vroom courses.



Avenir

des plantations forestières

Henry Chaperon - Directeur Général CAFSA

Peut-on douter de l'avenir des plantations forestières ?

L'étude de la FAO de Février 2009 répond clairement à cette question : Les forêts plantées (270 millions ha) qui représentaient, en 2005, 7% des superficies boisées du monde (4 milliards ha) ne cessent de se développer alors que la déforestation se poursuit au rythme inquiétant de 13 millions d'hectares par an.

Ces 7% de la surface forestière mondiale produisent les deux tiers du potentiel de bois industriel.

Les plantations forestières sont appelées à jouer un rôle prépondérant dans la lutte contre le changement climatique : en absorbant, d'ores et déjà 1,5 gigatonnes de Carbone, elles compensent les émissions de CO2 liées à la déforestation. Créées pour produire, les plantations sont mieux défendues par l'homme qui va mettre en place des systèmes efficaces de protection pour protéger son investissement. Les plantations forestières seront développées pour leur aptitude à produire du bois et pour leur fonction de pompe à carbone toujours mieux valorisée. Gérées durablement les plantations forestières constituent le meilleur bouclier des forêts naturelles parfois exploitées de manière anarchique.

On ne peut douter de l'avenir du bois, écomatériau par excellence et biocombustible. La croissance de la population mondiale, l'épuisement des ressources fossiles et la prise de conscience environnementale sont des facteurs favorables au développement du bois

Ce développement est soumis aux règles économiques classiques accentuées et à la mondialisation des échanges :

- Compétition intermatériaux : La pénétration du bois sur les différents marchés se fera d'autant mieux qu'il sera compétitif en prix par rapport aux autres matériaux ce qui est déjà le cas du bois produit dans les plantations

- Compétition intramatériau : Le bois des plantations forestières remplace peu à peu le bois des forêts naturelles parce que son prix, ses qualités intrinsèques, la sécurisation de l'approvisionnement des outils industriels le rendent plus attractif.

L'avenir des plantations forestières est favorisé par un certain nombre de facteurs :

- **L'afforestation ou la reforestation** de vastes étendues de territoire dans des zones peu peuplées où la forêt n'est pas en compétition avec l'agriculture : Les grandes plantations de l'Hémisphère Sud se sont créées en profitant de cette opportunité, elles ont permis par la suite la création d'une industrie forestière qui développe la surface des plantations.

- **Les gains permanents de productivité** : Ces gains sont liés au tryptique amélioration culturale, amélioration génétique et apport de la mécanisation, bien spécifique aux plantations forestières.

- **L'amélioration des conditions culturales** (assainissement, labour, fertilisation, entretien) a permis d'augmenter très sensiblement la productivité et la rentabilité des plantations forestières. Les espoirs de nouveaux gains sont limités par l'obligation que se donnent les acteurs d'appliquer des règles de gestion respectueuses de l'environnement (arrêt de l'utilisation des phytocides).

- **L'amélioration génétique reste le moteur le plus important de progrès :** Elle permet au fil des générations de gagner en adaptation, productivité et qualité du matériau. Les forêts naturelles s'adapteront mal aux évolutions brutales liées au changement climatique. L'évolution du matériel végétal à chaque cycle de reboisement et le raccourcissement des révolutions assurent le meilleur potentiel d'adaptation aux plantations forestières. On connaît les progrès de production liés au gain génétique qui permettent de doubler voire tripler les rendements à l'hectare et de raccourcir d'autant les révolutions. L'amélioration du produit bois pour une utilisation industrielle optimisée est devenue une autre cible des améliorateurs et des grands groupes industriels. Le succès le plus éclatant est celui d'Aracruz au Brésil qui produit désormais massivement du bois d'œuvre de qualité à partir d'Eucalyptus jugé, il y a quelques années, impropre à la production industrielle de bois d'œuvre.

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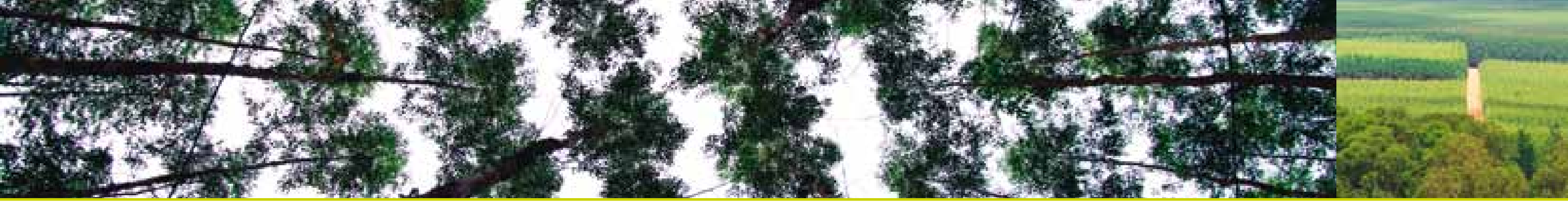

- **La mécanisation et la rationalisation des techniques accompagnent ces progrès :** Sur les 20 dernières années, elles ont permis de stabiliser les coûts de production alors que l'inflation et la raréfaction des matières premières ont augmenté ou augmenteront inexorablement le coût des autres matériaux et celui des bois des forêts naturelles. Les progrès réalisés, au cours des dernières années, dans la production de plants, l'installation des peuplements forestiers et leur récolte mécanisée sont impressionnants.

Ces gains assurent une meilleure rentabilité à l'ensemble des investissements.

La concentration industrielle et la sécurisation des approvisionnements : La performance des outils industriels est souvent liée à leur taille et à leur adaptation à une matière première homogène. Les futurs développements industriels se feront au cœur de massifs forestiers issus de plantations permettant de minimiser les coûts d'approvisionnement (transport en particulier) en bois homogènes et adaptés à la demande du marché

Les plantations forestières sont donc appelées à répondre de manière efficace à une demande mondiale accrue pour des écoproduits et des services environnementaux. Les critiques faites par les écologistes sur des grandes plantations monospécifiques méritent d'être prises en compte par la création d'éco diversité, par un accompagnement scientifique rassurant sur la durabilité de la gestion, par l'instauration d'un dialogue constructif comparant objectivement différents systèmes de production.

Plantation clonale d'Eucalyptus au Congo Brazzaville (3 ans)

Pepinière FORELITE CAFSA Sivaillan Les Lamberts 13 millions de plants par an.

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Les plantations forestières dans le monde Evolution dans les Régions chaudes p.4

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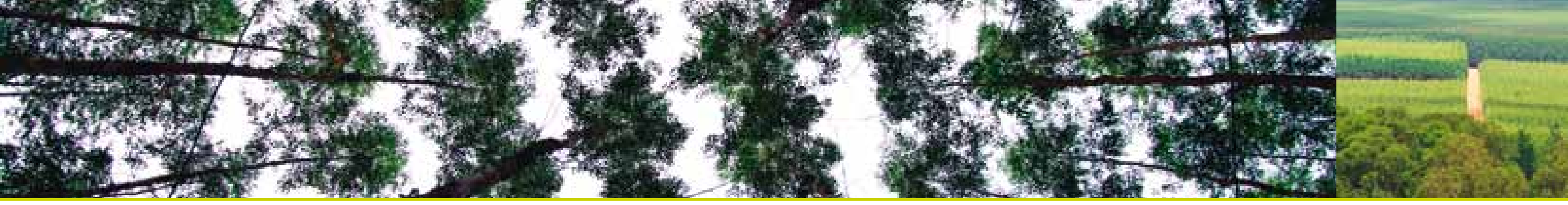

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