Private Forestry North Queensland

Prospects for high-value hardwood timber plantations in the 'dry' tropics of northern Australia

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Summaries of papers

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Figure 1. 4-yr old *Eucalyptus tetrodonta*, Darwin Stringybark, Croydon, north Qld.
Figure 2. Selecting improved planting stock of sandalwood, *Santalum album*, Kununurra, WA.
Figure 3. Edge trees of a 30-yr old stand of *Khaya senegalensis* in NT, from unimproved stock.
Figure 4. Finely carved clock from NT grown African mahogany, *Khaya senegalensis*.

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Towards a viable high-value hardwood (HVH) industry for northern Australia: some strategic issues for planning and management.

D. Ian Bevege

Abstract

Key words: *northern Australia development, economic development, niche marketing, efficiency, vertical integration, critical mass, risk management, civil society, policy and regulation, research and development*

Economic development of northern Australia has been characterised by high optimism, grand schemes, some successes, spectacular failures and inconsistent government policies. Forestry has not escaped the pattern. However some traditional industries, notably mining, sugar, beef and fisheries have survived the vicissitudes of climate, war, pestilence, economic downturn, markets and public confidence to a greater or lesser extent through adoption of coping strategies and by paying attention to the technical base of their industry, innovation, astute marketing and "cutting their cloth to suit their means". Burgeoning but as yet small, new, resource-based industries *eg* tropical fruits, aquaculture and pearling, are following a similar path, but these are also working assiduously in niche markets to assure their long term future. Emerging service industries in education and tourism are also in the business of niche marketing and the defence industry is of course the ultimate expression of this.

A successful HVH industry in northern Australia will also need to embrace an effective niche marketing strategy, domestic and international. However this will require underpinning by

- a technically proficient and efficient, vertically integrated production chain of sufficient critical mass supported by adequate risk management strategies,
- industry organisation and development ensuring smooth and predictable movement of sufficient HV product into the market to be economically attractive,
- careful attention to social imperatives and community expectations so that there is long term civil society backing for the industry, and
- careful attention to government policy and regulatory frameworks - local, state, national and international - to assure long-term government support.

"…the British Colonial Secretary, Earl Grey, enquired of the newly incorporated India and Australia Steam Packet Company whether there were any proposals by the Company to use Port Essington as a refuelling depot or if they had reason to believe that it could be of importance to shipping. The death knell for Victoria was sounded when the Shipping Company answered that the settlement lay right out of the way of the proposed route and the Company had no intentions of using it either for refuelling of for any other purpose. There now appeared no valid reason for the maintenance of the lonely outpost on the northern Australian coast and the final order was given for the withdrawal of the Royal Marines from Victoria." Peter Spillett 1972, on the abandonment of Port Essington in 1848.

"…that extreme northern country of ours, which we have called by courtesy the Northern Territory, but too often, with bitterness, our White Elephant, is a rich possession which other colonies well might envy us." but "*…without a railway I cannot see how the Territory will be a good field for enterprise. Without it must remain almost in statu quo.*" William Sowden 1882.

"Listen – this country's been settled donkey's years, and has had all the chances of development that the rest has. Yet today there's less people here and less business doin' than there was fifty years ago. Why's that? I'll tell you. It's because it's an utterly useless land. You can't grow nuthen properly on account of the climate." Andy, *in* Capricornia, Xavier Herbert 1938.

"…in little developed areas …where land development experience is limited and adaptation of methods of land use has not proceeded very far, it is not always easy at the initial appraisal to recognise all of the factors which may limit productivity or those which are likely to remain limiting. Nor is it possible to predict how the particular assemblage of factors composing the environment will interact to influence potentialities." C S Christian 1959

"…a large section of the Australian public has realized that intensive agricultural and pastoral development in tropical Australia could only be carried out by neglecting more profitable forms of development in other parts of the continent. Northern development schemes are approached more critically and the alleged secondary benefits in the form of axillary industries and an improved defence position are no longer taken for granted. The probability that agricultural development in tropical Australia will be carried out on an economic basis really depends on the level of public knowledge of the subject and on whether the Australian people wish to see the nations resources used as efficiently as possible or simply desire a particular type of development in certain parts of the continent." Bruce Davidson 1966.

"…the development of forestry in the Top End of the Northern Territory has conformed to the general pattern of European rural development projects in this region. With the possible and partial exception of mining, these development projects have failed because Europeans have lacked the ability to realistically appraise the Top End environment." Christopher Lacey 1979.

Australian Forest Plantations - An Overview Of Investment Opportunities, Support Mechanisms And Challenges - A Global, National, State And Regional Perspective

Joanne Roberts, National Plantations Strategy Coordinator[1]

Summary

Domestic investors are realising the benefits investments in forestry offer. International investors are also focusing on the potential the Australian industry can provide. It is an opportune time to consider the investment potential of the forest and wood products industries in this region, and the wider benefits the sector provide.

This paper considers plantation investment opportunities, support mechanisms and challenges in global, Australian, State (Queensland) and Regional (Far North Queensland) contexts.

There are several themes that need to be given ongoing consideration at various scales if the industry is to continue to expand in your region:

- Nationally we must support existing processors and attract new investments to use our increasing fibre resource.
- We must value-add to provide the products consumers want and to address our trade deficit in forest and wood products. If Australia does not provide the domestic wood products sought by consumers, then these products will be imported to meet the demand.

[1] This paper was prepared with the assistance of the 2020 Vision partners.

- Governments at all levels must provide consistent support and improve legislation to encourage sustainable plantation development
- As a fledgling industry for this region remember that you are part of an active global timber resource picture
- As a fledgling industry for this region remember that you are part of a local community and a regional landscape
- Actively seek the partnerships to ensure that the trees you are growing will provide the resource that the processors need - we must consolidate and develop markets.
- And, we must maximise and promote the benefits the industry creates.

What is your regional plantation future and what support do you need to implement it?

Promising high-value hardwood plantation tree species for the dry tropics of Queensland

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2 School for Environmental Science and Management, Southern Cross University
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Key Words: dry tropics, eucalypt hybrids, African mahogany, growth rates, north Queensland

Summary

It would be true to say, that to date, there has been very little plantation establishment activity in the Queensland dry tropics. This is a result of the harsh climate, poor soils, competition with other industries (eg. sugar, cattle) and a lack of understanding of appropriate species and silvicultural practices for this region. Most of the activity, which has been undertaken in this region, has focussed on tree establishment for non-timber purposes such as rehabilitation, fodder, stock shelter and windbreaks. In the past 15 years a number of small research trials investigating a wide range of native and exotic tree species have also been established. Early successes and some promising results from these operational and research plantings have lead to an increase in confidence in a few selected species, with a number of small private timber plantations established in the dry tropics region over the past 7 years.

The aim of the paper is summarise the most significant results from a number of key operational and research tree plantings in the dry tropics region. From these results, the most promising high-value plantation species for the dry tropics will be identified and discussed.

Results of recent trials of high-value hardwood tree species in the Northern Territory of Australia

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Key Words: Provenances, laterite, African mahogany, height increment, diameter increment

Summary

Exotic and native, high-value hardwood species were planted at sites in the NT over a three-year period from 1998-2001. The trials were established on private land from the Darwin rural area in the north of the Top End to Katherine, 300km to the south. The best performing species (assessed in 2004) were African mahogany (*Khaya senegalensis* A. Juss), Teak (*Tectona grandis* Lin. F) and *Terminalia belerica* (Gaertner) Roxb. Generally, the best growth was in the Katherine region on the Tippera and the river levee soil types. The soil types that appeared less favourable for tree growth are the Podzolic and Laterite that exhibit poor drainage and inhibit root penetration. African mahogany showed the best growth across a number of sites and appeared more adaptable to site (soil) variability than some other species evaluated such as *Swietenia humilis* Zucc. and *T. grandis*. Another species planted in the second year of trials on only a few sites but also performing well was *Chukrasia tabularis* A.Juss. At some sites, demonstrations areas of some species were also established to allow observations to be made on a wider range of species than just the trials allowed. Within the suite of species, *Pterocarpus macrocarpus* grew very well on the sites where it was planted.

Minoforestry – Past, Present and Future Commercial Tree Plantings at Weipa

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Abstract

Bauxite is mined at Weipa. The revival of commercial tree planting on mined land at Weipa by the Department of State Development and the Department of Primary Industries and Fisheries, with support from Comalco and the Napranum Aboriginal Council, recognises the many opportunities that commercial tree growing can provide to the local indigenous people, as individuals, to their community, to Comalco and to the State of Queensland.

In a stepped process combining learning, awareness and involvement, community leaders and members now recognise the benefits and now embrace the vision of a future forest industry based on the planned planting of valuable commercial tree species on a percentage of their lands available for regeneration after mining has ceased. They wish to further support and be involved in the development of Minoforestry on their lands.

Fortunately past forest research work provides some valuable material and species information for the selection and improvement of species suitable for the type of landscape created after mining. *Khaya senegalensis* is one species that has been selected as showing promise, *Santalum* spp are also

identified. After initial necessary developmental activities a three-year plan has been identified as being necessary and is now being developed.

An overview of trials of forest tree species in Central Coast–Whitsundays region of Central Queensland and preliminary indications of species worthy of planting or in need of further monitoring

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Key words: Central Queensland, species

Summary

Funding for forestry projects in Central Queensland has been primarily provided through short-term grants and projects. This has resulted in the establishment of over 25 trials and other demonstration plantings. However, maintenance (weed control, pest control and thinning, etc.) has not been carried out. Also, as follow up measures, stand health assessments, or investigation of wood quality have not been done there is a paucity of data to make an informed assessment of species performance. Despite this it has been possible to make some assessment of the suitability of a number of species for plantations in Central Queensland.

The only proven species for commercial planting in one region or another, when matched to site within region, are *A. cunninghamii*, *Agathis robusta*, *Corymbia citriodora* subsp *variegata*, *Eucalyptus cloeziana*, and possibly *E. resinifera* – the only species that have been monitored long enough to enable such a judgment.

Khaya senegalensis – current use from its natural range and its potential in Sri Lanka and elsewhere in Asia

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Abstract

Khaya senegalensis (Desr.) A. Juss. (African mahogany or dry-zone mahogany) has long been an important multipurpose tree in its natural range in Africa. It is valued for a wide range of non-timber traditional use products. It also provides a high quality timber and over the past decade demand for this has increased significantly with the United States becoming one of the leading importers. During the same period, prices for *Khaya* timbers have risen due to increasing demand, increasing scarcity of larger trees in natural stands and limits being placed on raw log exports in some African countries. Recent prices for *Khaya* timbers in international markets and their trends over recent years are discussed.

Khaya senegalensis was introduced to Sri Lanka about 30 years ago and in the past 10 years it has become one of the priority species for timber plantation establishment in their dry zone (ca. 1400 mm rainfall yr^{-1}). There, its plantation area is currently more than 500 ha with establishment of about 200 ha per year of new plantations planned for the near future. However, annual establishment rates in Sri Lanka are limited by a dearth of domestic seed production. The interest in *K. senegalensis* among several other Asian countries is also briefly examined with strong interest in the species having recently emerged in Malaysia.

Key words: *Khaya senegalensis*, multipurpose trees, international trade, timber value, Sri Lanka

Performance of a 16-year-old stand of teak (*Tectona grandis* L.F.) in the Darwin area in relation to that in other trials in the Northern Territory

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Keywords: Growth of teak in plantations, response to thinning.

Summary

Results of periodic measures of plots in a 16- year-old stand of teak planted near Darwin, Northern Territory (NT) in 1988 and thinned to various stockings are reported. This block planting had been established 12 years before any thinning was undertaken (2000) and showed a definite response between 2000 and 2004. However, growth probably does not represent what might have been achieved on this site because of likely inbreeding of the planting stock.

Elsewhere in the NT teak is showing the best growth and form to age 4.5 years on the river levee, in neutral to alkaline pH soils near Katherine. These characteristics are reduced when planted on acidic soils in and around Darwin. The initial growth is improved greatly if drip irrigation is used in the first few dry seasons after establishment.

Performance of a five-year-old provenance trial of *Chukrasia* in the Northern Territory, Australia.

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Keywords**: provenance variation, volume growth, suckering, termite resistance, distribution, stem form, bark character.**

Abstract

A provenance trial of *Chukrasia* A. Juss. was established at Berry Springs near Darwin in the Northern Territory of Australia to assess the potential of this species as a commercial plantation tree for the production of high value wood. The trial comprised 16 seed sources from the species natural distribution in China, Laos, Myanmar, Thailand, Vietnam, and from a local planted stand in Darwin

probably of Sri Lanka origin. In order to gauge the performance of the species, assessments of height and diameter growth; axis persistence associated with apical dominance and single stem growth; stem straightness; bark character and incidence of suckering and termite damage were made when the trial was 5.4 years old. Survival varied considerably among provenances but differences were not significant, nor for stem straightness score. There were significant differences between seed sources in growth traits with seedlots from deciduous forest environments associated with the rough corky bark *C. velutina* growing faster than the smooth barked *C. tabularis* from the moister ecological environments. The seed source from Darwin had less than one fifth of the volume of the most productive provenance. Axis persistence, bark characteristics and other traits assessed all showed significant differences.

Development of the Indian Sandalwood Industry on the Ord River Irrigation Area

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Key Words: *Santalum album*, Kimberley, Western Australia, research, plantation, management, host, hemi-parasitic.

Abstract

Since the early 1980's the authors have been involved in various capacities in trials of *Santalum album* (Indian sandalwood) for commercial production in Western Australia. As far as they are aware this species had not been tried in Australia in recent decades and perhaps not at all.

This paper describes the evolution of a new forestry industry based *Santalum album* on in the tropical area of the east Kimberley of Western Australia. This industry has evolved in a period of only about 20 years from the first trial plantings and government-sponsored research to a commercial enterprise which has attracted corporate investment on a significant scale.

Experiences with sandalwood in plantations in the South Pacific and north Queensland

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Abstract

Sandalwood is an important commercial industry in the south western Pacific. A number of sandalwood species occur across the south western Pacific, *Santalum austrocaledonicum* in New Caledonia and Vanuatu, and *Santalum yasi* in the Fiji Islands and Tonga. Communities do the majority of sandalwood plantings, manage and harvest existing stands. There is a growing interest

among villagers, other small-scale growers and Governments to expand the scale of planting in both countries. The most common type of planting is garden plantings of sandalwood by villagers. However, large investors and Governments now starting to invest in plantations across the south western Pacific.

Constraints of highly weathered soils, especially soil sodicity, to plant production in the dry tropics

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Abstract

The properties of good arable soils are briefly reviewed and compared with the characteristics of the highly weathered soils that are commonly found in the dry tropics of northern Australia. Constraints to plant growth include low fertility; shallow, gravelly profiles; high salt contents; and adverse soil chemical properties such as soil acidity and soil sodicity. The role of exchangeable cations in the soil solution is explored as a control over soil sodicity that may produce a range of soil properties that are adverse to plant growth and tree production. The origins of soil sodicity are discussed and methods of amelioration of soil sodicity by use of gypsum are explored.

Determining the climatic suitability of *Khaya senegalensis* for plantations in Australia

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Abstract

An existing profile of the climatic requirements for *Khaya senegalensis* plantations was compared to the climatic conditions of 20 successful *K. senegalensis* trial and plantation sites in north Queensland, 21 in the Northern Territory and 4 in Sri Lanka. The climatic profile for the species was revised if there were more two or more successful trial/plantation environments with climatic values outside the limits of the existing profile. The revised climatic profile was used with the Ausgrd climatic program to show areas climatically suited for plantations of the *K. senegalensis* in Australia.

Key words: *Khaya senegalensis*, climatic interpolation, species-site matching

Plantation Forestry Management Principles for the 'Dry' Tropics of Northern Australia

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Abstract

Although Australia currently has a 1.6 million ha State and privately owned plantation estate, consisting mainly of exotic pine and short rotation native hardwoods (the latter destined for the export pulpwood market), over 98% of the country's plantations are in the temperate climate of the southern States (Commonwealth of Australia 2004).

The low rainfall areas of the 'dry' tropics of north-west Queensland have previously been considered unsuitable for forestry purposes. Irregular rainfall, prolonged droughts, insect plagues, lack of suitable commercial tree species and distance to processing mills and ports are but a few reasons. There has also been the problem of land availability in inland areas. Most of the western properties are pastoral leases and until very recently legislation required that any trees planted on these leases remained the property of the crown.

However, the eastern boundary of the dry tropics is at most, only some 60 km from the north-east Queensland coast, and in the Burdekin catchment it extends to the coast. Therefore, with an increasing awareness on Queensland's east coast in minimising the environmental impacts of land use management practices on the Great Barrier Reef, and the development of coastal management plans for north-eastern Queensland to manage the reduction of these influences, such management plans and other plans have to be taken into account, even when considering dry tropics forestry development.

The 'dry' tropics of northern Australia are the new frontier for plantation forestry. Increasing environmental pressures from urban sprawl and agricultural development on the wet tropics coastal strip has limited opportunities for additional forestry development in that region.

Research into commercial timber species suitable for the 'dry' tropics has identified African mahogany (Khaya senegalensis) as a potential high value cabinet timber species suitable for large-scale plantation development. African mahogany may be able to produce commercial returns in as little as 20 years. This time frame makes it an attractive proposition for investors.

There is an abundance of land suitable for forestry purposes across the dry tropics region of northern Australia. For a successful forestry industry to exist and supply domestic and export markets, it must be able to develop a critical mass of resource. Suitable land is available to develop this critical mass in large areas of northern Australia. These areas are currently under utilised and could be used for alternative and sustainable industry opportunities.

Incentive mechanisms are urgently needed to publicise the potential of the industry and attract public and institutional investment in plantation development. The economic, environmental and social benefits of this industry to northern Australia should not be underestimated.

Evaluation of the wood quality and utilisation potential of plantation grown Khaya senegalensis (African mahogany)

Matt Armstrong & Thomas Lelievre (DPI&F), Don Reilly & Beau Robertson (DBIRD, NT)

Keywords: Australia, Northern Territory, processing, industry assessment

Abstract

Thirty-eight 32-year-old plantation-grown *Khaya senegalensis* (African mahogany) trees were harvested from two sites near Darwin, Northern Territory, for a processing, wood quality and utilisation study. The trees were transported to the Department of Primary Industries and Fisheries research mill in Brisbane, Queensland. The logs were sawn into boards of various dimensions with an overall 'green-off-saw' recovery of 39.5%. The timber was seasoned, dressed and graded strictly in accordance with AS2796, achieving graded recoveries (expressed as a % of log volume) ranging between 8.1% to 9.7% for product category 'Joinery', and 24.4% to 29% for product category 'Flooring'. Poor log form and the release of growth stresses were two significant factors that reduced recovery. The trees produced a good quality attractive timber that was equal to or better than the native African mahogany timber currently being imported into Australia, in terms of wood properties. Pith to bark basic density was relatively even, with an overall average of 636 kg/m^3. The material achieved an estimated strength grouping of (SD6) and unit shrinkage of 0.26 and 0.28 % in the radial and tangential directions, respectively. The timber was highly regarded by various industry assessors who believed that there would be good prospects for such timber on the domestic market in the future.

Known or potential threats from pests and diseases to prospective tree species for high value timber plantings in northern Australia.

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Abstract

The development of a high value timber industry in northern Australia requires high-level, long-term investment. To secure such a commitment, potential investors and growers must be confident of achieving high productivity and/or high quality end product. Pests and diseases, and their effect on tree health, can be major limiting factors to tree establishment and performance. This is especially true where native or endemic species are to be grown. Timber plantings in northern Australia are likely to be at risk from a number of pests and diseases. This includes both native and exotic species already present within the region, and species not yet present but which have potential to cause problems should they arrive. Existing and potential threats are listed and the more serious problems reviewed.

The use of exotic species in dry tropics forestry: assessments, potential conflicts of interests and the application of The Precautionary Principle.

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Extract

Weeds are amongst the most serious threats to Australia's primary productivity and natural environment. They reduce farm and forest productivity, displace native species and contribute significantly to land degradation. The cost of weeds to agricultural industries alone has been estimated at over$3.3 billion per annum'

This opening paragraph in the Executive Summary of the 1999 Revised Edition of the National Weeds Strategy produced by the Agriculture and Resource Management Council of Australia and New Zealand, the Australia and New Zealand Environment and Conservation Council and Forestry Ministers of these two countries unambiguously states the impact of weed species on our economy and environment.

In this paper we consider alien species as potential weeds in the context of forestry in the 'dry' tropics of northern Australia, give some examples of previous and current problems with introduced tree species, and suggest how similar problems might be minimized in future activities.

Our desire is that

- the best possible practice be applied to the selection and cultivation of hard wood timber species for use in the dry tropics and where species are recognised as having potential as environmental weeds that particular attention is paid to the control of propagules and the prevention of spread of 'wildings'.
- a Risk Assessment System (RAS), including the Precautionary Principle, is applied to proposed activities and the species involved, particularly where they non-native, before the commencement of projects,

and

- preference is given to the cultivation of native species.

We are particularly keen that management plans include proposed actions in the case of the financial failure and abandonment of plantations and the establishing of wildings outside the plantation area.

It is our opinion that the best outcomes in dry tropics forestry can be achieved by well-managed plantations of species of known provenance, and ecological attributes and the rigorous application of the measures described in this paper. We believe the discussions in and resulting from this workshop will substantially contribute to this goal.

[2] It is with great regret and sadness that shortly after this paper was presented, Gary Werren passed away.

Preliminary weed risk assessment for Khaya senegalensis in plantations in northern Australia

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Summary

One of the arguments used by some to question the wisdom of domesticating the species in commercial plantings is that it might become a weed.

This suggestion has never been investigated by documentation of the actual distribution of natural regeneration of the species in relation to parent tree/s sources. Nor has a record been made of the tree age when viable seed is produced, the frequency of seeding trees in a population, and the long-term fate of natural regeneration – all factors that would influence potential for weediness.

This paper reports on a preliminary questionnaire about the potential for weediness of Khaya senegalensis in the dry tropics of northern Australia. Responses to the questionnaire were received via email recording 55 individual observations from sites in south, central and north Queensland, north and central Northern Territory and northern Western Australia. Larger trees, older than ten years were observed to flower and set fruit, sometimes prolifically. Regeneration was observed under these fruiting trees, although regeneration rarely survived longer than 12 months. A farmer-initiated framework for the management of K. senegalensis in plantations is suggested to support the development of a timber industry with this species in the dry tropics.

Conservation and genetic improvement in the Northern Territory (Australia) of *Khaya senegalensis* (African mahogany) - a valuable tree species endangered in parts of its homelands

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Keywords: natural distribution, provenance variation, genetic resources, reproductive biology, conservation clone bank, gene recombination orchard, breeding strategy

Summary

K. senegalensis, a high-value hardwood timber species, was first planted in the Northern Territory (NT) more than 40 years ago. Stands established in the 1960s-1970s remain near Gunn Point, Howard Springs, other places in the NT, and at Weipa, Queensland. Also, there are widespread, mostly small plantings of the 1990s in the NT and east-central Queensland. The species is well adapted and fast growing in many parts of its vast homoclime across northern Australia. Trees salvaged in Darwin (from street, park and home-site

plantings), and stands harvested at Weipa, give high quality wood from which valuable products have been made.

The species appears to have the potential to underpin a forestry industry in northern Australia, provided constraints on the success of such an enterprise are overcome. One potential constraint is the unavailability of genetically improved planting stock. In 2001, a program of conservation and genetic improvement of the substantial sample of the species' germplasm present in stands of known provenances planted in the Darwin region in the early 1970s was commenced.

Achievements of the program, include:

a) Documentation of short- and long-term strategic plans;
b) Phenotypic selection in each of 24 provenances (from 11 countries of nativity between Senegal and Uganda, plus one secondary) and unknown sources represented in Northern Territory (NT) stands (1970s plantings, some 7 ha), all threatened;
c) Establishment of 142 grafted clones in both a 'gene recombination orchard' (GRO) and a conservation clone bank (CCB) to generate progeny with great diversity (limited flowering occurred in 2004), and ensure protection of the germplasm;
d) Preparations for establishment of first tests in 2005 of more than 400 clones from hedged seedlings (open pollinated from some 20 NT and Queensland select trees);
e) Congregation of grafts of the seemingly-best 14/142 clones at one end of the CCB to promote production of seed from them to raise plants for new clone tests; and
f) Selection of a site for a clonal seed orchard needed to allow a future option of establishing plantings via seed or seedlings.

Planting a second-cycle, base population as open-pollinated, CCB and GRO families and infusions, to enable future selection of second-generation and some infused trees for on-going improvement, will follow procurement of seed after the first general flowering which might occur in 2006. Imperatives and R and D needs for further development of the program are suggested.

Clonal Approaches To Hardwood Forestry In The Tropics

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Abstract

Although a few timber trees have been cultivated clonally for hundreds of years, it is only in the last 30 years that this approach has been more widely practised, especially in tropical species. Following research to understand the factors affecting rooting ability in tropical hardwoods, vegetative propagations techniques are now available that are applicable to almost all species. Different approaches to the selection of superior trees for cloning are examined. This paper reviews the key factors determining when and how to utilize clonal approaches to tree improvement, the choice of appropriate strategies to use, the issues of concern and some best practices. It reviews the techniques and practice of clonal forestry in a range of tropical hardwoods, as case studies, and examines some of the areas of research needed to move the approach forwards.

Key Words: Tree improvement, silviculture, vegetative propagation, plus-tree selection, *Eucalyptus* hybrids, *Triplochiton scleroxylon*.

Plantation improvement using clonal propagation - an overview of the latest technology in Australia

Peter and Ann Radke
Clonal Solutions Australia Pty Ltd

With an appendix on

Variation in tree species, and improvement and propagation options – an explanation
By D. Garth Nikles

Abstract

Key words: eucalypt, hardwood, plantation, clone, seedling, cutting propagation.

This paper discusses the current status of the hardwood plantation industry in Australia with regard to seedlings and clones. It explores the advantages of clonal forestry compared to traditional seedling plantations, the factors that affect the commercial viability of clonal propagation and clonal forestry. The latest technology available at Clonal Solutions Australia Pty Ltd is described, and the need for partnerships between breeders, timber companies and clonal nurseries is advocated.

A proposal for consideration: establish a northern Australia cooperative tree improvement program (NACTIP), with African mahogany (Khaya senegalensis) initially

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Summary

Conservation and domestication of *Khaya senegalensis* in northern Australia commenced very recently. It has involved: planting a provenance seedling seed orchard at Walkamin, Queensland (2001); mild selection in provenance trials and relatively small, unimproved stands in the Northern Territory (NT) (2001) and at Weipa, Queensland (2003); the planting of grafted seed orchards in the NT (2002), at Walkamin (2003) and Weipa (2004); and work that will lead to clone tests being planted in the NT and at Weipa early in 2005.

There is interest from Managed Investment Schemes and others in starting commercial plantings in Queensland and perhaps elsewhere soon. It results from the success of first trial plantings of *K. senegalensis* more than 30 years ago near Darwin and Weipa and subsequently elsewhere in northern Australia. Logs with high value timber have been made into excellent furniture. However, because the early and current plantings derive from genetically unimproved seed, they contain many trees with short and crooked boles. Improved breeds would increase returns on plantation investment.

The species is also emerging as of considerable interest in some countries in Asia and elsewhere. No tree improvement programs are known to be in place nor planned outside northern Australia. Therefore, the products of tree improvement in northern Australia could be used there and, potentially, in overseas plantings.

It is suggested that the work done already, and the good prospects for the species in commercial plantings, provide stakeholders with an opportunity for formal cooperation (with its many advantages) not to be missed. Provided all interested parties pool resources and plan concerted efforts, there could be rapid progress in genetic improvement of the species. It is suggested that stakeholders in a potential plantation forestry industry in northern Australia should form a cooperative and undertake tree improvement with *K. senegalensis* initially, preferably in parallel with the other R and D needed to underpin such an industry, and to do so with a minimum of delay.

The case for a Northern Australia Cooperative Tree Improvement Program (NACTIP), proposed to be based on *K. senegalensis* initially, is strong because: breeding has begun; there must be great genetic variation in *K. senegalensis*; traits most in need of rapid improvement have been identified; the reproductive biology of the species is favourable; it seems likely there will be a substantial, annual plantation program beginning in the near future; and the few resources available to each of the separate programs are limiting their development.

There are many good precedents for tree improvement cooperatives, with university-based programs being especially advantageous. Opportunities exists for establishing such a cooperative, or one based on another of the successful models, customised to suit the circumstances in northern Australia.