age trees as juvenile clones is recommended.

Figure 8. Logs from thinning of a 10-year-old, farm forestry stand in coastal lowlands north of Townsville, Queensland. Note the high proportion of dark-coloured wood of the log end. K. Harding.

Conserving the best trees across all post-1990s plantings

Maintaining a diverse genetic base is the best option for coping with changes in selection criteria e.g. following appearance of a serious pest. Conservation is practiced in most tree improvement programs (31, 32). Hazards such as cyclones and fire, as well as the need for a diverse base for recurrent selection gains, confirm the need for selecting and grafting the best trees across all plantings since the 1990s and their conservation in breeding clone banks.

Pooling old and new germplasm in a collaborative domestication program

Intuitively, pooling the best material developed in the governments' improvement program with the unimproved farm-forestry plantings and the broadly-based industry plantations nearing selection age would be a good strategy for the industry as a whole. This broad base of selected trees would enable maximum genetic gain and hedge against future changes of selection criteria. Nikles (16) illustrates how this could be achieved.

Developing and using a tree selection index

The most efficient method of selection is by index (33) supported by genomic selection. Indices are in use with many crops and animals. For Ks an initial index using weighted selection criteria such as diameter, bole length, straightness and heartwood percent is needed.

Conclusions

African mahogany forestry is potentially an important new industry with capacity to expand in northern Australia producing high-value products and benefitting the whole value chain. Having built up very valuable genetic resources, expertise, technologies and knowledge of the species to almost 'industry ready' status over the past 13 years, every effort should be made to exploit the comparative advantage these assets and knowledge provide. Priorities for some operational and R&D work suggested in this paper should be considered among such efforts.

Capitalising on current R&D, and initiating new work through all-stakeholder collaboration via an African Mahogany Improvement Alliance, are essential actions to achieve the goal of greater plantation profitability proposed in this paper and underpin expansion of the embryonic Ks industry in Australia..

Acknowledgements

We appreciate the support of our respective employing agencies and the involvement of our numerous private-sector colleagues in Ks domestication. The dedicated work by Alex Lindsay (Mareeba, QDAFF), Rod Connelly (Darwin, DOR), Nick Kelly (Mareeba), Doris Marcsik (Darwin) and Ken Robson (Mareeba previously) is recognised. 'Beau' Robertson (retired) is also acknowledged for his pioneering work at Darwin. We thank Susan House for insightful editing of an earlier draft. Funding of aspects of the work reported here was by the Queensland Government's 'National and International Research Alliances Program'.

References

1. Gavran, M. 2012. Australian plantation statistics 2012 update. ABARES Technical Report, Canberra. 11 pp.

2. Zbonak, A., Brown, T., Harding, K., Innes, T. and Davies, M. 2010. Wood properties and processing outcomes for plantation grown African mahogany (*Khaya senegalensis*) trees from Clare, Queensland (18- and 20-year-old) and Katherine, Northern Territory (14-year-old). Horticulture and Forestry Science, DEEDI, Brisbane. 40 pp.

3. Nikles, D. G., Bevege, D. I., Dickinson, G. R., Griffiths, M. W., Reilly, D. F. & Lee, D. J. 2008. Developing African mahogany (*Khaya senegalensis*) germplasm and its management for a sustainable forest plantation industry in northern Australia - progress and needs. Australian Forestry 71 (1):33.

4. Miller, F. 2011. The way forward – obstacles and opportunities for tropical plantation development. Pp 50-51. In: 11.

5. Reilly, D.F., Robertson, R.M., Nikles, D. G., Robson, K., and Lee, D.J. 2007. Testing and genetically improving forest trees for the Northern Territory. RIRDC Publication No 07/113, RIRDC Project No DNT-27A. 77 pp.

6. Dickinson, G., Marcsik, D., Reilly, D., Lindsay, A., Nikles, G. and Wallace, H. 2012. Reproductive biology of *Khaya senegalensis* in northern Australia. Report for the Smart Forests Alliance Queensland. 2012. Department of Agriculture, Fisheries and Forestry, Queensland. 35 pp.

7. Lee, D. J., Huth, J. R., Brawner, J. T., Zbonak, A., Dillon, S., K., Meder, R., Southerton, S. G., Dickinson, G. R. and Harding, K. J. 2012. Final Report. National and International Research Alliances Program. Smart Forests Alliance Queensland. Horticulture and Forestry Science, DEEDI, Brisbane. 124 pp.

8. Hung, C. D. and Trueman, S. J. 2012. Preservation of encapsulated shoot tips and nodes of the tropical hardwoods *Corymbia torelliana, C. citriodora* and *Khaya senegalensis*. Plant Cell Tiss Organ Cult 109: 341–352.

9. Karan, M., Evans, D.E., Reilly, D., Schulte, K., Wright, C., Innes, D., Holton, T., Nikles, D.G. and Dickinson, G.R. 2011. Rapid microsatellite marker development for African mahogany (*Khaya senegalensis*) (Meliaceae) using next generation sequencing and assessment of its intra-specific genetic diversity. Molecular Ecology Resources 12: 344–353.

10. Hutley, L. and Bristow, M. 2011. Landscape-level water-use of mahogany plantations and other land uses. P 40. In: 11.

11. Anon. 2011. Abstracts, 'Darwin 2011 – African Mahogany Plantation Industry Forum', Darwin, 30 August – 1 September 2011. Northern Territory Department of Resources, Darwin. 52 pp.

12. Anon. 2011. Presentation Notes, 'Darwin 2011 – African Mahogany Plantation Industry Forum', Darwin, 30 August – 1 September 2011. Northern Territory Department of Resources, Darwin. 196 pp.

13. Armstrong, M., Reilly, D., Lelievre, T, Redman, A., Francis, L. and Robertson, R. 2007. African mahogany grown in Australia – wood quality and potential uses. RIRDC Publication No 07/107. 94 pp.

14. Bailleres. H., McGavin, R., Zbonak, A. and Kennedy, M. 2012. Increasing sub/tropical eucalypt timber plantation profitability by value adding to thinnings. Presentation, Session 16, Forest Products Society 66th International Convention, 2012, Washington DC.

15. Danthu, P., Gaye, A. and Sarr, A. 1999. Long term storage of *Khaya senegalensis* seeds. International Tree Crops Journal 10: 93-100.

16. Nikles, D. G. 2011. History, status and suggested collaborative strategy for furthering the domestication of African mahogany (*Khaya sensegalensis*) in Northern Australia. Keynote Presentation. Pp 47-65. In 12.

17. Pomroy, P. C. and Lee, D. J. 2006. *Khaya senegalensis* - results from a cuttings propagation project. 11 pp. In: Bevege, D.I. et al. (eds). 2006. Where to from here with R&D to underpin plantations of high-value timber species in the 'seasonally-dry' tropics of northern Australia? Proceedings of a Workshop held May 2006, Townsville Queensland. CD ROM, Private Forestry North Queensland Association Inc., Kairi, Qld.

18. Hung, C. D. and Trueman, S. J. 2011. In vitro propagation of the African mahogany (*Khaya senegalensis*). New Forests 42: 117–130.

19. Hung, C. D. and Trueman, S. J. 2011. Encapsulation technology for short-term preservation and germplasm distribution of the African mahogany (*Khaya senegalensis*). Plant Cell Tiss Organ Cult 107:397-405)

20. Reilly, D., Dickinson, G., Lindsay, A., Wright, C. and Nikles, G. 2011. Comparison of mahogany clones planted on a range of sites in the Northern Territory and Queensland. Pp 96-101. In: 12.

21. Dickinson, G.R., Fremlin, R., Nikles, D.G., Reilly, D., Huth, J.R. and Lee, D.J. 2009. Enhancement of tree improvement and conservation outcomes with *Khaya senegalensis* (African mahogany) through base population development and expansion in Australia. 9 pp. In: Australasian Forest Genetics Conference, 2009, Perth, Western Australia. CD ROM, Forest Products Commission, Perth, WA.

22. Fremlin, R. 2011. The African mahogany breeding joint venture. Pp 69-74. In: 12.

23. Dickinson, G., Fremlin, R., Nikles, G., Wright, C., Lindsay, A., Kelly, N. and Lee, D. 2011. Performance of African provenances of *Khaya senegalensis* in Australia. Pp 91-95. In: 12.

24. Anon. 1981. Research Report No. 3. Department of Forestry, Queensland. 88 pp.

25. IUCN, 2012. Red list of threatened species – *Khaya senegalensis*. http://www.iucnredlist.org/apps/redlist /details/32171/0. Accessed 10 th July 2012.

26. Fremlin, R. 2011. Overview of African mahogany in Africa. Pp 17-22. In: Anon. 12.

27. Dickinson, G.R. 2011. The future of tropical tree improvement: greater co-operation. Journal of Tropical Forest Science 23 (3): 229–231.

28. Reilly, D., Dickinson. G. and Nikles, G. 2011. Mahogany industry, research and development in the Northern Territory. Pp 23-28. In: 12.

29. Brawner, J., Lee, D, Brown, T. and Lawrence, A. 2011. Subtropical Tree Improvement Alliance. RIRDC Publication No 11/039. 21 pp

30. Anon. 2012. New Zealand Forestry Science and Innovation Plan. 28 pp. Forest Owners Association. http:// www.nzfoa.org.nz/file-libraries-a-resources/search_result. Accessed 10 th July 2012.

31. ABARES. In prep. Australia's forest genetic resources - national report to FAO. Census tables. Department of Agriculture, Fisheries and Forestry, Canberra.

32. Gapare, W. J., Ivković, M., Wu, H. X., Dutkowski,G. W., Buxton, P. A., Stovold, T., Low, C. B., Jefferson, P. and McRae, T. A. 2012. Active genetic conservation and utilisation of native radiata pine germplasm. Final Report. Project No: PNC135-0809. Forest and Wood Products Australia Limited. 7 + 61 pp.

33. Cotterill, P. P. and Dean, C. A. 1990. Successful tree breeding with index selection. CSIRO, Melbourne. 80 pp.