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Short Cycle Tree Crops for Processed Wood Products in Low-Medium Rainfall Areas

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Abstract

Inclusion of a substantial proportion of deep-rooted perennial cover into the agricultural landscape should retard the salinisation process that is occurring in the Western Australian wheatbelt. Commercial revegetation options are needed for large-scale revegetation to be acceptable for farm businesses. The Natural Heritage Trust funded Search project identified 10-20 woody plant species endemic to Western Australia with potential to be used as feed stocks for processed wood products such as paper, medium density fibreboard (MDF) and particleboard. The industry potential of these species, as short cycle crops, is now being explored. Three of the most promising candidates are *Acacia saligna*, *Eucalyptus rudis* and *Eucalyptus loxophleba* subspecies *lissophloia*. Critical production factors being actively investigated include: biomass production of multiple coppice rotations, utility of small dimension wood components (stem diameter less than 50mm), amenability to continuous flow harvesting methods and integration into existing farming systems. The attainment of commercially viable growth rates in a water-limited environment is one of the major challenges. If key issues can be resolved, there is good potential for improved land resource protection, biodiversity conservation and diversified social and economic opportunities in low and medium rainfall areas.

Introduction

Dryland salinity is a major economic and environmental problem in the low and medium rainfall (300-600 mean annual rainfall) agricultural areas of southern Australia. The mechanisms of dryland salinity development are discussed in Clarke et al. (2002), while the issues raised by salinity, and their potential management, have been comprehensively reviewed by the National Land and Water Resources Audit (2001) and van Bueren and Price (2004).

The replacement of original native woodlands with shallow-rooted annual agricultural plants has allowed surplus water to accumulate in groundwater systems and drive the salinity problem. Conceptually, it appears logical that restoring a proportion of deep-rooted perennial cover to the agricultural landscape should retard the salinisation process. However, revegetation at any substantive scale will compromise the economic viability of farming businesses unless the revegetated land can contribute to farm profits. As such, there is considerable interest in developing commercially attractive perennial species, including new short-cycle woody crops suited to low rainfall conditions (Bartle and Shea 2002; Olsen et al. 2004).

Efficiently managing landscape water balances through manipulation of vegetation cover is unlikely to be simple in low and medium rainfall areas. In order to achieve commercial yields in this rainfall zone, it appears that woody crops need to be sited strategically, on a relatively low percentage of the landscape, in layouts that facilitate the capture of surplus water not used within annual-plant agriculture. Capture of surplus water by strategically placed woody crops would therefore perform the dual functions of increasing woody crop yield (per planted hectare), and increasing the area influenced by the woody crop. The extent to which these aims can be achieved depends on many biophysical and economic factors, as well as issues such as species selection, site selection, design of woody crop layouts, and management of surface water.

The Search Project

The Search Project was undertaken by CALM between 1999 and 2003 with funding from the Natural Heritage Trust (Olsen et al, 2004). The project had the broad objective of identifying endemic species capable of being commercially developed and linking those species to products and prospective industries in low-medium rainfall areas.

Product options were assessed on the basis of market size, the presence of established industries in Australia and the likely suitability of feedstock from short cycle crops. The most prospective large-scale products were paper, made from chemical pulp, panel boards (particleboard and MDF) and solid fuel for bioenergy. The value of chemical extractives as potentially valuable co-products of these industries was recognized but not explored in depth. An important role for bioenergy would be to consume all residues not used for higher value products.

Species were assessed on the basis of growth rate, wood density, wood colour and natural distribution. With additional input from expert collaborators, about 50 highly prospective species were selected from a total of 9,977 Western Australian species. These were subjected to progressively more intensive testing of wood properties, proceeding to the final stage of manufacturing sample panels and paper.

The following species showed considerable promise as feedstocks for paper manufacture: *Taxandria juniperina*, *Grevillea leucopteris*, *Alyogyne huegelii* and *Grevillea candelabroides*. Given the enormous scale of production needed to supply a state of the art paper mill (around 3 million dry tonnes per year), any material grown in low and medium rainfall areas would need to augment a predominantly high rainfall supply base. The potential for producing paper feedstocks in the Wheatbelt is therefore reliant on the development of a paper mill in a high rainfall zone.

About twenty species were successfully manufactured into panels, with minor variations in panel quality. One way of further prioritising species was on the basis of wood density. MDF and particleboard markets and manufacturing methods favour low density feedstocks. Lightweight panels also have lower transport and handling costs. The lower density species among those tested were *Taxandria juniperina, Eucalyptus rudis, Viminaria juncea, Anthocercis littorea, Codonocarpus cotinifolius* and *Gyrostemon ramulosus*. Other notable species, based on their performance in field plantings, included *Acacia saligna* and *Eucalyptus loxophleba* subspecies *lissophloia.*

FloraSearch

In 2002 the concept of the Search project was adopted at the national scale with the commencement of the FloraSearch Project, initiated by the Joint Venture Agroforestry Program (JVAP) and now jointly supported by JVAP and the CRC for Plant Based Management Of Dryland Salinity. Building on the WA Search Project, stage one of FloraSearch identified prospective species for processed wood products and fodder across southeast Australia.

FloraSearch has now entered a second stage. A small number of the most prospective species are being intensively explored with respect to biomass production, integration into farming systems and more detailed product quality attributes. In Western Australia three species have been earmarked for intensive development: *Acacia saligna, Eucalyptus rudis* and *Eucalyptus loxophleb*a subspecies *lissophloia*. These species are characterized by: relatively fast growth rates, ease of propagation and establishment, wide adaptability to sites and a broad genetic base to underpin genetic improvement for product feedstocks.

FloraSearch has also identified some of the key criteria for evaluating industry potential. Factors such as biomass productivity, feedstock requirements, transport distances, minimum economic processing-plant size and existing infrastructure can be combined with relevant spatial datasets and economic models to provide regional analysis to guide new industry development.

The Pathway Forward

Short cycle woody crops offer significant economic advantages over more traditional long rotation tree crops in low and medium rainfall areas (Olsen et al, 2004). However, the feasibility of short cycle crops is dependant on the attainment of sufficient biomass yields from target landscapes and the development of novel harvesting and processing technologies.

The factor most limiting biomass production by woody plants in the WA wheatbelt is water availability. To contribute to salinity retardation, woody crops need to be integrated into farming systems such that surplus water from annual crops and pastures is captured and converted into biomass. Woody crop layouts suited to capturing surplus water include spatial dispersal in belt arrays (also called alley farming) or temporal dispersal of woody phase crops within the conventional annual crop rotation (Crombie and Harper 2000). For a more detailed discussion of woody crop types see Bartle and Shea (2002) or Olsen et al. (2004). To increase the amount of water these woody crops can capture, active water management options may also be used. For example, surface run-off and shallow sub-surface water could be harvested and channeled to selected woody crop areas specifically designed for water detention and infiltration. The efficacy of the strategy of capturing surplus water from agriculture is dependent on climate and landscape geomorphology. Cooper et al (2005), in a detailed analysis of this subject, concluded that dispersed woody crops could be effective in increasing whole-landscape water use, and may be an important part of salinity management, but there are likely to be many situations in which they cannot provide a complete solution. For example, modelling studies suggest that modest reductions in recharge may have a significant effect on salinity risk in undulating landscapes, but have little effect in flat landscapes (George et al. 2001).

Commercial biomass production can be characterised by the yield and value of biomass components such as wood, bark, twig and leaves. In most instances, products are derived from the dry biomass, in which case the moisture content of the various components requires determination. Preliminary investigations of biomass productivity have been made for the three species targeted for intensive development in Western Australia. Ongoing research into the productivity of these species under repeated coppice rotations is in progress. An example of some of the results for *Acacia saligna*, with concomitant implications for overall whole plant biomass value, is shown in Table 1. Economic modeling has shown that in order to compete with existing agricultural enterprises, the target price for biomass is $30 to $40 per green tonne of whole plant biomass delivered to a processing facility (Olsen et al, 2004; Cooper et al, 2005). One key unknown is the utility of small dimension wood (down to 5mm diameter sections) for processed wood feedstocks. However, the development of co-products; such as fodder, chemical extractives and energy from residual biomass; appears to be essential to complement the wood fraction.

TABLE 1: Hypothetical biomass value (components and overall) for 4-year-old *Acacia saligna.*

Product	Value [1] ($/tonne)	Proportion of green biomass	$ value of fraction
Water	$0.00	51.6%	$0.00
Bone dry suitable dimension wood for Medium Density Fibreboard. (Assumes stem >20mm diam OB suitable)	$100.00	19.1%	$19.10
Residual dry stem and bark for Bioenergy	$18.00	21.7%	$3.90
Dry phyllodes for Fodder	$50.00	7.7%	$3.85
High value Chemical Extractive	$1,000.00	0.5%	$5.00
		Overall Biomass Value	**$31.85**

1. Note that biomass values are not based on actual market values, but are considered to be broadly indicative of what could be expected for these types of products.

Dispersed planting configurations and small mean tree size mean that conventional single-stem harvesting machinery will be prohibitively expensive for short cycle crops. Therefore, novel continuous flow harvesting systems need to be developed. These systems are expected to be somewhat analogous to those used for crops such as sugar cane. The fledgling oil mallee industry has made considerable progress towards developing this type of harvester technology (Giles and Harris 2003). However, more work is required to before commercial scale operations become possible.

The challenge of developing profitable short cycle woody crops suited to the WA Wheatbelt is large. Biomass yields are constrained by limited water availability. Woody crops need to capture surplus water from conventional agricultural systems whilst integrating comfortably into these systems. Economic success relies on whole plant utilisation to generate multiple products. New technologies are required for all components of the supply chain. However, the benefits resulting from woody crop development are equally substantial. Salinity mitigation through reduced recharge would help to protect the productive capacity of the land resource. High value biodiversity assets under threat from salinity could be similarly protected and enhanced by the increased woody plant component in the landscape. New economic and social opportunities would be afforded to local communities by way of a diversified industry base and increased employment opportunities.

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