FUTURE FARM
INDUSTRIES CRC

The University of
Western Australia (M081)
35 Stirling Highway, Crawley WA 6009
T: 08 6488 1952 F: 08 6488 2856
ABN: 87 125 594 765
www.futurefarmcrc.com.au

SUBMISSION NO. 68

HOUSE OF REPRESENTATIVES:
PARLIAMENTARY STANDING COMMITTEE ON AGRICULTURE, RESOURCES, FISHERIES AND FORESTRY:
INQUIRY INTO THE AUSTRALIAN FORESTRY INDUSTRY

Submission by Future Farm Industries Cooperative Research Centre

1. Future Farm Industries CRC makes the following recommendations to the Inquiry:

1. That the Federal Government ensures that any support for the development of the forest industry, including research grants, incorporates the farm forestry system of narrow tree belts integrated into farming systems.
2. That the Federal Government provides funding for forestry research that recognises the long rotations and consequent long term research programs required for breeding and sustainability research.
3. That forest production integrated with agriculture and its supply chain are seen as an emerging forestry sector
4. That integrated tree crops create benefits for regional communities, water and biodiversity and are not seen as an environmental cost.
5. That the Government supports investment into woody crops.
6. Extend National Plantation Inventory to woody crops such as Mallees.

2. About the Inquiry

The House of Representatives Agriculture, Resources, Fisheries and Forestry Committee has launched a new inquiry into the challenges and opportunities facing the Australian forestry industry.

The inquiry comes at a time when the industry faces change on an unprecedented scale, from changes in the availability and quality of timber resources, the decline in value of traditional products such as wood chips, the advent of farm forestry, the use of forest products in energy production and the potential use of plantations and tree crops to sequester carbon.

The Committee is keen to examine how the forestry industry can adapt to meet the challenges it faces, including improving productivity and value adding, boosting capital investment and making the industry and the communities that rely on it more resilient to change. The Committee has sought submissions by 28 March 2011 addressing the Terms of Reference.

3. About Future Farm Industries Cooperative Research Centre

Future Farm Industries Cooperative Research Centre Ltd (FFICRC) is an incorporated joint venture playing a crucial role in developing new and innovative farming systems and technologies to improve the resilience of Australian broad acre agriculture to climate change, salinity, climate variability and drought while improving productivity and profitability. Future Farm Industries CRC was established in 2007 through the Australian Government's Cooperative Research Centre Program.

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The use of perennial plants is the primary research focus of the CRC due to their ability to cope with a variable climate, including rainfall. Perennial plants with deep roots capture and effectively use water at depth when there is little rainfall and remove excess water, which could otherwise contribute to salinity by recharging groundwater during wetter periods.

The New Woody Crops Program of the FFICRC consists of an important suite of projects aimed at developing new industries based on short-rotation, woody crops, in particular eucalyptus mallees. The main target is to produce biomass for bioenergy production. There are a range of other potential products that can be produced in conjunction with biomass. The use of farm grown biomass can significantly complement production of biomass from other sources such as straw urban waste and plantation residues. The economic value of mallee eucalypt biomass is potentially significant as a feedstock for biofuels and may be enhanced further as biomass from tree crops has the potential to provide a strategic buffer for other sources of biomass that may have a more variable supply. The economic importance of this new crop is higher still if we account for regional development opportunities, improved landscape hydrology leading to reduction in dryland salinity, and benefits to biodiversity.

RECOMMENDATIONS

Recommendation 1:

That the Federal Government ensures that any support for the development of the forest industry, including research grants, incorporates the farm forestry system of narrow tree belts integrated into farming systems.

Woody crops provide an opportunity to expand the forestry industry. In particular the narrow tree belts production system is designed to add value to existing crop and livestock production systems and to supply biomass for bioenergy, char and eucalyptus oil. Woody crops:

- grow on sites with lower rainfall than existing hardwood and pine plantations,
- use a tree harvester that chips at the stump as the first step in a supply chain that delivers chipped bark, leaves and stems to a processing plant at a competitive price
- provide salinity, biodiversity and shade and shelter benefits
- are attracting interest from biomass users that require a sustainable dedicated source of woody biomass

A current opportunity plans to convert woody biomass to petrol, diesel and aviation fuel. – see Biofuels from Wood in WA attached. Narrow tree belts are not plantations and may be overlooked when considering the forest industry despite offering growth options for the forest industry.

Recommendation 2:

That the Federal Government provides funding for forestry research that recognises the long rotations and consequent long term research programs required for breeding and sustainability research.

While FFI CRC manages a successful woody crops research program – one of the challenges is sustaining the research and industry support for an emerging sector of the forest industry. Almost two decades of

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research initiated by the WA government and more recently continued in partnership with the Future Farm Industries CRC has established woody crops to the point where investors are prepared to risk capital subject to ongoing Government support.

Future Farm Industries research particularly into breeding, nutrient and water use and sustainability requires investment in research that will continue to provide valuable data over decades. With three years to run Future Farm Industries CRC is seeking institutions who may continue the industry development and research program – but few Government institutions appear interested. Attracting investment in existing programs is difficult and current research investment programs usually offer funding over 2 to 5 years which is too short to allow for the long time frames involved in forestry rotations and consequently breeding and sustainability research.

Recommendation 3:

> ***That forest production integrated with agriculture and its supply chain are seen as an emerging forestry sector.***

A large part of Future Farm Industries CRC's work on woody perennials has focussed on developing commercial drivers for the establishment of landscape scale mallee plantings and informing potential industry developers. Our aim is to highlight the benefits of establishing a woody biomass industry that begins with the profitable integration of trees into agricultural systems. Our research shows that this will enhance the commercial viability of farmers by diversifying farming systems and in the long term by providing economic, social and environmental benefit in rural regions. Mallees are particularly well adapted to the lower rainfall agricultural regions and so they potentially broaden the range new province of forestry production options. Other farm forestry enterprises include species grown for sawlogs and integrated tree crops grown for wood pulp, wood panels, fibreboard or essential oil (such as Sandalwood).

Another important focus of CRC activity is woody perennials grown for the purposes of livestock fodder production. However, it has been assumed in this submission that the inquiry does not address this suite of plants.

There is an opportunity in the next decade to develop revegetation systems that integrate forest production with conventional agriculture. The most advanced development of this type is the mallee project where mallee eucalypts are being developed as a 'woody' crop. Nearly two decades of research has shown that mallees are best incorporated into farming as short rotation coppice agro forestry tree crops. In this system these energy tree crops are planted in narrow belts and harvested on a short cycle (3 to 6 years) for the production of biomass. The most likely use for mallee biomass will be bioenergy where it will have a similar carbon value (through avoided fossil fuel emissions) as sequestered carbon.

Rehabilitation of Land and Conservation of Biodiversity

Since 1993, several organisations acting collaboratively have maintained a woody crop development program focused on eucalypt mallees, the most prospective genus for biomass production in the <600mm annual rainfall zone. The main driver for this work is to promote and encourage the planting of trees and other plants for the purposes of the rehabilitation of land or the conservation of biodiversity.

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Biodiversity conservation has increasingly become the focus of the program. This view is based on the knowledge that commercially-driven; broadscale revegetation with mallees will greatly improve protection and recovery of natural biodiversity by:

- Providing a means of better managing water and reducing salinity impacts on wetlands (it has been estimated that the costs to government of managing natural diversity recovery catchments could be halved by commercially-driven, broadscale revegetation);
- Directly providing habitat for native animals;
- Buffering conservation lands against fertiliser and herbicide drift, and wind-blown weed seeds; and
- Minimising the potential for new woody weeds to be introduced to Australian landscapes. (Mallees are all native to Australia, and are preferred for many land management purposes).

In addition, successful industry development with broadscale woody crop revegetation will:

1. Help protect roads, railways, bridges, buildings even whole towns from water and salt damage
2. Improve profitability and resilience of agriculture;
3. Support work to combat projected climate change and variability; and
4. Contribute to energy security through the development of a bio-energy source to augment other renewable energy sources.

Given the above, there are compelling reasons for developing mallee crops, particularly for use in narrow belt arrangements that will integrate well with agriculture systems and improve farm productivity.

See *Energy Tree Crops, Future Farm Industries CRC, 2011* for more detail.

Narrow tree belts have advantages over block plantation in the wheat –sheep belt

Narrow tree belts on about a 100m interval are likely to be the most attractive practice in low-medium rainfall areas. This is in contrast to, densely planted tree crops (i.e. reforestation in blocks or plantations) where biomass yield is lower on an area basis due to competition between trees. In alley farming layouts, the belts complement conventional agriculture by providing NRM benefits, as well as giving a higher yield of woody biomass. With further development and revenues from sequestering carbon they could be a profitable component of agriculture with multiple NRM benefits.

Tree belts can offer valuable shelter benefit to livestock in the 450-600 mm rainfall zone of southern Australian farming enterprises. On these farms, more than half the farm land is dedicated to livestock production. Sheep require shelter during cooler months of the season particularly off shears and at the time of lambing. Belts of trees with pasture in the alleys can provide food and shelter to livestock and prevent substantial fatalities during episodic wet and cold periods.

There is continued evidence that local communities are becoming strongly opposed to an increase in block plantations especially where the primary purpose is for carbon sequestration – that is, when there is no harvest for other products. For example the Shire of Jerramungup in Western Australia declined an application to establish block plantings of mallees (agenda item 10.3.9 of the Shire Council's 21 December 2010 meeting)

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because the "proposed plantation is contrary to the objective of the 'Rural' zone to "ensure the continuation of broad hectare farming as the principal land use in the district.""

The proportion of a farm planted to tree belts suggested by the FFI CRC would be less than 10% under current estimates. While above-ground biomass would be regularly harvested (to ground level), the below ground biomass is permanent and will grow slowly over time under a harvest frequency chosen to maintain root system vigour. It is expected that below-ground carbon and long term average above ground carbon will be recognised as a legitimate credit at the international level.

The development of tree cropping systems has aimed to address the concern of encroachment on 'prime agricultural land'. With further development tree cropping may be comparable in profitability to conventional agriculture and hence provide continuous economic return, in contrast to the once-off increase in carbon storage available from reforestation. The potential for multiple NRM benefits will also be a strong attraction to farmers.

Supply Chain

Supply chain development for successful woody crop industry development based on mallees requires work on four core components: a mallee resource; supply chain; products; and markets. An important challenge in developing the mallee industry is to ensure that these four components are developed together – no industry will start unless all the components are achieved at the same time.

Development of a woody biomass industry will also require:

- Efficient and cost effective harvest, haulage and transport of biomass is an important element of the final delivered cost of biomass both as a raw product and in processed forms. What is important here is:
    - the efficiency of the harvester in cutting and chipping a multi stemmed tree
    - the haul out distance within the farm and the distance to the landing or roadside where the chipped biomass can be transferred from bins to a truck;
    - distance to processor;
- Existing infrastructure such as roads, rail and trucking capacity and rural towns with adequate local labour supply; and
- Potential locations of processing facilities (ports, population centres, etc) and thus distance to market or, in the case of energy, appropriate entry points to the grid and/or proximity to population centres

Recommendation 4:

> ***That integrated tree crops create benefits for regional communities, water and biodiversity and are not seen as an environmental cost.***

The inquiry's Terms of Reference understate the complexity of the issues it raises. It makes the point that forestry has the ability to deliver productivity, biodiversity and natural resources management (NRM) benefits, but that such activities compromise water yield and food production and result in "environmental costs". There are two issues here.

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Firstly, the wood versus water debate is a very Murray-Darling Basin focused perspective. There are few areas of Western Australia, for example, in which these conflicts exist.

Secondly, society needs alternative energy sources and other biomass products and there are many pathways to food production, some more water efficient than others – therefore to talk simply in terms of wood products versus water and food does not consider all the actual trade-offs and synergies involved. For example, the integration of trees into agriculture is more likely to occur on marginal land than on productive agricultural land where rather than competing with agricultural production additional value is created. The assumption that the segregation of forestry and established land uses is possible or desirable fails to include the other important factors and activities that need to be considered in a balanced assessment of the opportunities for forestry development. For example there are many high priority biodiversity conservation assets in agricultural zones where some displacement of food production or reduction in water yield is crucial to biodiversity protection or recovery

Ultimately, the option to reduce food production and establish trees for carbon abatement or the delivery of local environmental benefits is a choice for farmers in the catchment of that biodiversity asset, whereas the government usually has responsibility for the asset itself. In this situation, the potential for forestry activity to help achieve biodiversity protection is large but difficult to implement unless re-vegetation is commercially driven. Planting belts of trees is the most cost-effective re-vegetation option, where management of recharge (above ground water run-off and below ground recharge) is required to protect downstream assets. Sustainable land use also maintains the long-term productive potential of the Australian agricultural landscape, which influences the capacity to maintain profitable farming systems.

The potential scale of this new industry is dramatic; dozens of biofuels/bioenergy plants are possible across the Australian agricultural zone as energy tree cropping is developed alongside existing farming activities. Such development will occur over many years, and each new renewable energy/fuel plant will be a major, sustainable, new business in a regional community. It is estimated that fabrication and installation of each commercial plant will provide at least 200 man years of work. Once operational, biomass supply, plant operation and maintenance for each biofuels facility will create approximately 100 permanent jobs (direct and in-direct), including skilled, unskilled and professional roles.

Recommendation 5:

That the Government supports investment in woody crops.

Many of the social, economic and environmental benefits of establishing new woody crops, farm forestry and plantations will be best achieved by establishing new estates in mid to low rainfall areas of the agricultural regions of Australia (450-650 mm annual rainfall in southern Australia). It is these areas where ground and surface water quality is degrading and where the nature conservation reserve system is under significant threat from the effects of deforestation.

Future forestry in lower rainfall zones will necessitate longer term investment to allow slower growing trees and other woody crops to mature. Even short rotation crops such as mallees grown for bioenergy may require two or three harvests before the cost of establishment is recovered by the grower. Return on investment, for capital outlaid, may take longer than a decade.

It is assumed the Committee will be presented with both sides of the argument regarding government intervention to encourage long term plantation investment, namely:

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- that long term investments are not 'market failure' *per se* and the market should be left to determine whether longer rotation forests should be established, and alternatively,
- that long term investments imply a market failure because of the cumulative impact of discount rates over a long period of time. Governments need to intervene by establishing plantations themselves (a declining trend worldwide) or by providing incentives to industry to compensate for the market failure.

The existence or otherwise of market failure is a moot point. Australian evidence suggests that there is little interest from the private sector in establishing new plantations where return on capital takes longer than a decade. This is evidenced by three observations.

- Firstly, the few Managed Investment Schemes that were targeting investment for saw log production and the national estate producing saw logs did not expand significantly even during the recent MIS boom.
- Secondly, there is an expectation that the rise of superannuation funds and Timber Investment Management Organisations (TIMOs) in timberland investments may see an increase in new plantations being established. There is no evidence to support this assumption and it appears TIMOs are most interested in purchasing existing estates and view establishing new estates as being the domain of government or government backed schemes. A notable exception is the Hancock Natural Resource Group's commitment to continue establishing hardwood saw log plantations once they purchased Queensland's State owned plantations. However, it is understood that this was a requirement of the transaction imposed by the Queensland Government and Hancock discounted its offered purchase price accordingly.
- Thirdly, it is envisaged that a carbon market will create the investment environment to establish long rotation plantations producing saw logs as well as sequestering carbon. However, the most common form of planting for carbon is either 'landcare' plantings or non-harvest mallee plantings, both of which are not intended to undergo harvests. To suit the expectations of the market, and the rules of the scheme, the trees must be maintained for 100 years with no additional 'productive' use.

State Governments appear to have ceased or greatly reduced their investment in establishing new plantations. It is difficult to see, if an increase in plantation production is desired, where new investment will come from.

It is clear that new forestry plantings can reduce greenhouse gas emissions and mitigate climate change. Yet much wider acceptance is needed for the concept that harvesting trees for timber, char, bioenergy and chemicals reduces greenhouse gas emissions and this needs to be underpinned by supportive government policy that provides incentives to investors.

It is apparent that Government intervention and support is required if harvest regimes are to be encouraged and plantations and woody crops with longer rotations are to be further developed.

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Recommendation 6:

Extend National Plantation Inventory to Woody Crops such as Mallees.

Information regarding the size, condition and location of integrated plantings such as mallees is difficult for industry participants to obtain because it does not form part of the National Plantation Inventory. Industry will need this type of information if it is to plan processing facilities, maximise land use planning and identify for-harvest and not-for-harvest resource.

There are at least 30,000 hectares of mallees planted nationwide and this amount could increase very quickly upon the development of markets for bioenergy, the introduction of the Carbon Farming Initiative and/or 'Price on Carbon'.

For example the increase in mallee planting to support four bioenergy plants could occur quickly as estimated below in Figure 1.

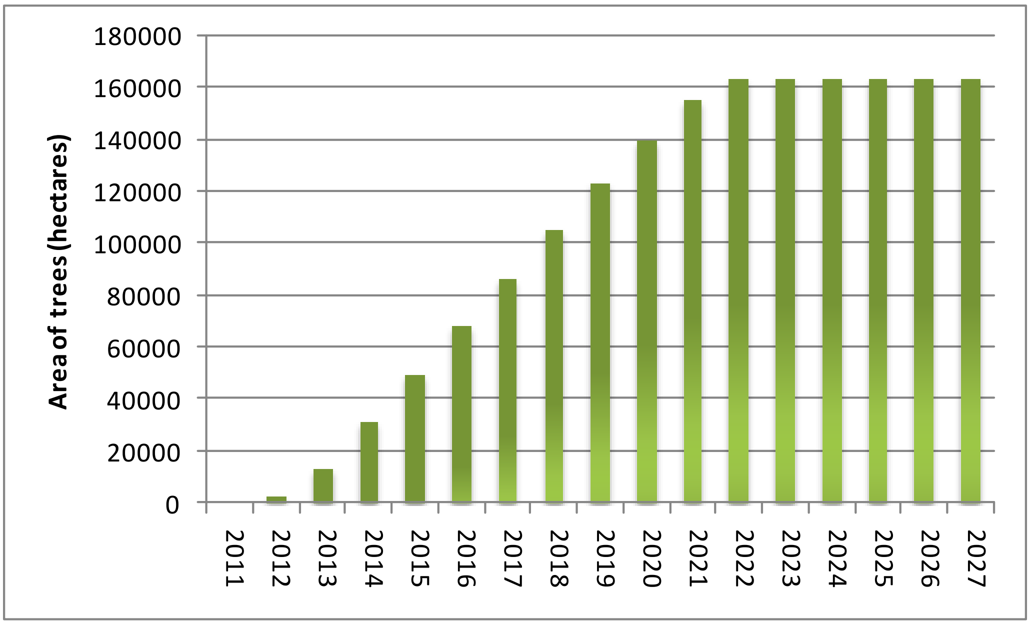

Figure 1: Schedule of cumulative area of tree plantings in three states to meet the projected future demand from electricity generators. See *Energy Tree Crops, Future Farm Industries CRC, 2011 for more detail.*

Similar to the blue gum industry a decade or so ago, large corporate owners are unwilling for their information to be published unless it is protected by being pooled with other growers data. Small dispersed owners have not captured information accurately. Therefore inventory information is hard to come by and there is a place for centrally acquired data to be disseminated by government.

Yours sincerely

Kevin Goss

CEO, Future Farm Industries CRC

ENERGY TREE CROPS

Renewable energy from biomass could be the commercial driver to large scale adoption of woody crops and to structural improvement to dryland agricultural systems in Australia.

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Energy Tree Crops

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Publisher:

Future Farm Industries Cooperative Research Centre (FFI CRC)
University of Western Australia
35 Stirling Highway
Crawley WA 6009
Australia

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Cover: An energy tree crop comprising mallees planted in belts alongside a cereal crop.

Photos: FFI CRC.

Contents

Energy Tree Crops

Energy tree crops, strategically integrated into dryland agricultural systems in narrow belts and harvested every three to eight years, have the potential to:

- Produce feedstocks for renewable base-load electricity and biofuels while reducing greenhouse gas emissions;
- Diversify farm incomes and regional economies by complementing rather than displacing existing agricultural industries and food production;
- Avoid trade-offs with water use in high-rainfall and irrigation areas;
- Provide salinity and biodiversity benefits; and
- Provide local base-load electricity generation in peripheral areas of the grid thereby reducing transmission losses.

The International Energy Agency's global estimates of future bioenergy use indicate that by 2050 bioenergy could provide 25 to 33 per cent of total global energy requirements[1]. Biomass already provides 23% of primary energy and over 75% of thermal energy needs in Finland, and 32% of Sweden's final energy use. According to preliminary Swedish Energy Agency statistics presented by the Swedish Bioenergy Association, bioenergy passed oil as the biggest energy source in Sweden in 2009 in final energy use[2].

There are compelling economic, social and environmental reasons why Australia can also be prominent in developing bioenergy industries. Energy tree cropping can be designed and laid out in such a way that it cohesively integrates with agricultural enterprises on wheatbelt farms without compromising food and fibre production or water supply security.

Mallee eucalypts are an ideal woody crop for biomass production in the extensive Australian cropping and grazing regions. After being harvested they regenerate readily by re-shooting (coppicing) from their rootstocks. Through repeated harvesting, mallee biomass can be a relatively secure long-term source of renewable energy.

Economic studies conducted by the Future Farm Industries Cooperative Research Centre (FFI CRC) demonstrate that energy tree crops have the potential to match financial returns from existing agricultural enterprises[3]. By growing mallees in skilfully designed layouts on less than 10% of the property, enough cash flow is generated from the sale of biomass to cover establishment costs within the first cycle of five years. This financial payback is achieved with minimal trade-off in cereal crop production and water use. If there was a price on carbon, the relative competitiveness of energy tree crops would be improved, but even without a carbon market such plantings are potentially viable.

Other studies have shown that mallee bioenergy is cost-competitive with other forms of renewable energy and that biomass electricity can be a strategically important base-load power complement to the currently more popular wind and solar energy sources. FFI CRC modelling of potential regional bio-electricity generation in Western Australia and co-firing with coal in regional power stations in New South Wales and Victoria, estimates that the scale of mallee bioenergy could be 163,200 ha of belt plantings providing 2.6 million tonnes of biomass per year and avoiding emissions equivalent of 1.3 million tonnes of greenhouse gases (CO_2-e) per annum by displacing the use of coal. The cumulative greenhouse gas abatement potential of this enterprise is around 9 million tonnes over a 11-year period.

Under this coppice agroforestry system model, carbon dioxide (CO_2) from the atmosphere is recycled through the trees and the solar energy used to repeatedly grow the crop is made available by burning the biomass. Instead of having to off-set fossil CO_2 emitted elsewhere, users of energy tree crops will displace fossil fuels. By perpetually producing carbon-neutral energy, energy tree cropping will achieve more, in terms of limiting fossil carbon emissions, than carbon sequestration forests over the long term and so-called 'first generation' biofuels based on food crops. In the wheat-sheep regions, farmers, food production and agriculture are not displaced by energy tree cropping. The rural economy will be diversified rather than diminished.

Woody crops are best integrated into existing farm businesses, with about 10% of the land growing woody crops and 90% producing conventional crops and pastures. The deep-rooted tree belts do not compete fully with the annual crops, because the trees also exploit moisture and nutrients that have escaped below the root-zone of the shallow rooted annual crops. Well-planned tree belts also provide additional benefits, such as wildlife habitat, shelter, salinity mitigation and erosion control.

Several belts of mallee energy tree crop on a cereal farm in regional Western Australia.

Diversifying agriculture with woody crops will make both rural economies and environments more adaptable and resilient. The commercial activities of growing, harvesting, transporting and processing biomass will require new regional industries, adding to the strength of rural communities. Energy tree crops have the potential to contribute significantly to improving the agricultural environment, to renewable energy and to mitigating greenhouse gas emissions in Australia.

This paper presents the case for energy tree cropping, backed by regional scenario modelling and farm-level economic analysis that will guide development of tree planting, biomass production and bioenergy in the extensive cropping and grazing regions of Australia.

Energy Tree Crops allow more profitable farming, supply energy and reduce greenhouse gases

The overall potential benefit of developing large scale tree planting and woody crop industries remains attractive despite the Australian Government's deferral or replacement of the Carbon Pollution Reduction Scheme. There are several motivations to proceed with such developments:

- Climate change remains an issue of national and international concern.
- Australia has adopted a mandatory renewable energy target for electricity generation – 20% by 2020.
- Renewable energy technologies are rapidly developing and will become more attractive economically as well as improving national energy security.
- Biomass for bioenergy is a major renewable energy option. It is the only renewable source that can replace fossil fuels in all energy markets (heat, electricity and fuels for transport).
- Biomass for bioenergy at sufficient scale effectively offers renewable baseload power generation.
- Second-generation woody cellulosic biofuels are substantially more efficient in energy and greenhouse gas reduction terms than first-generation biofuels based on starch, sugar and plant-oils;
- In Australia, the production of biomass using various forms of woody crops can be commercially viable.
- Energy tree crops will be mainly native species, especially mallee eucalypts, and these could provide important biodiversity benefits, including habitat, avoid the weed risk associated with exotic species and provide protection for areas of remnant native vegetation.
- Volunteer carbon sequestration by tree planting is a complementary measure being undertaken by many large companies.

Woody crops deployed in carefully designed layouts can contribute to more sustainable and profitable agriculture. Mallee eucalypts are an obvious selection for development as woody crops, but many other native species are potentially available to diversify the range of woody crops for the extensive rain-fed cropping and grazing areas. Focusing on the 450 mm to 600 mm rainfall zone growing grains and producing livestock from grazing systems across southern Australia avoids the trade-off with water yields that could potentially occur with large-scale plantations in high-rainfall and irrigation districts.

We call this energy tree cropping.

Farming trees as energy crops - good for farmers, good for regions, good for the environment

Energy tree cropping produces a renewable biomass fuel by harvesting trees as a crop. The crop extracts CO_2 from the atmosphere and through the process of photosynthesis uses solar energy to store carbon in biomass. Using biomass as a fuel converts it to usable energy and returns the CO_2 to the atmosphere. Bioenergy from tree crops can therefore replace fossil fuels and avoid the release of fossil carbon into the atmosphere.

Good for farmers and the environment

Woody crops have many features that will make them a good biomass production option in dryland cropping and grazing regions of Australia. Native tree species are robust and well suited to Australian soils and climate. They can tolerate droughts and take advantage of irregular rainfall events. They coppice readily and trees live for several decades which reduces their planting and maintenance costs. When planted in a belt and alley system they can complement the existing farming systems and diversify farm income with products ranging from biomass to oil derived from their leaves.

In some farming systems woody crops have potential to manage water and nutrient balances. They are excellent as shelter belts for sheep off-shears or during lambing. They offer aesthetics and environmental benefits, including food and shelter for fauna. Energy tree crops are also a positive factor in the carbon balance of the farm as they sequester carbon in their roots.

The two-row belt configuration is recommended in order to achieve acceptable growth rates in the long term. Widely spaced tree belts (between 70 and 80 metres apart; 1,000 trees per belt kilometre) maximise tree production per paddock hectare, while allowing crops and pastures to grow in the alleys. Careful integration of the two forms of land use will increase the total productivity of the paddock mainly due to better use of water and nutrients via the deep tree root systems.

Energy tree crops are a diversification opportunity for rural landholders. By trading in feedstocks for bioenergy, farmers can take advantage of any increase in the value of renewable energy over the long term. Tree cropping also entails a level of risk, but farmers will have the flexibility to move in and out of energy tree cropping as they choose, subject to biomass supply contracts. Farmers are accustomed to making these business decisions.

Good for regions

Trees as biomass crops have large energy balance benefits and future energy markets will be large enough to absorb very large amounts of biomass. Farmers can grow the tree crop primarily as an energy feedstock and combine it with other currently under-utilised farm residues, such as cereal straw, to improve the economies of scale for bioenergy projects and increase farm returns.

The economic activity of repeatedly growing, harvesting, transporting and processing biomass creates long term employment and contributes to regional economic development. Existing modern farming enterprises will remain dominant in the farming business, but woody crops provide an opportunity to diversify the rural economy and improve the environment.

Producing transport fuels from biomass grown in Australia will improve national energy security, and the balance of trade.

Start-up with Mallees

Mallees have been grown as a crop in the WA wheatbelt since the early 1990s, mainly as a potentially economic means of addressing landcare concerns. This existing resource, of about 13,000 hectares planted on 1000 wheatbelt farms, offers a valuable start-up supply.

Mallees are a forerunner to other energy crop species and they are an invaluable source of knowledge and experience which can be transferred, with important adaptations, to other parts of Australia and potentially overseas.

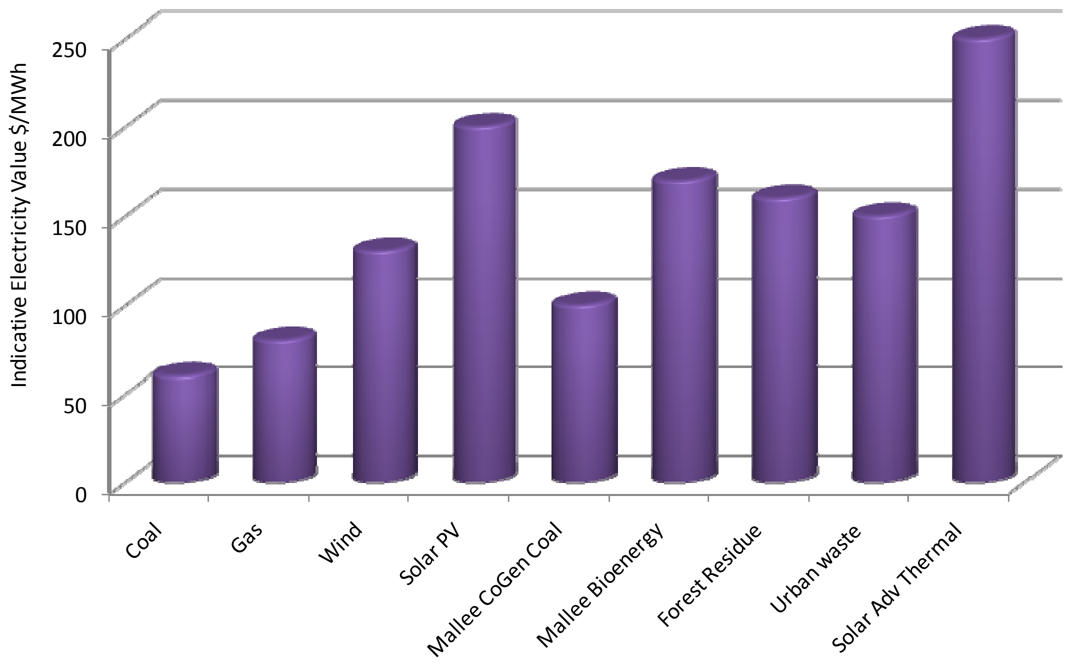
Comparing electricity costs using different fuels

For more than a decade Verve Energy, WA's leading energy producer, has been evaluating bio-energy options to expand its renewable energy portfolio. This included a demonstration 1 MW capacity integrated wood processing (IWP) plant at Narrogin that used mallee biomass sourced from wheatbelt farms as its feedstock. They found that a commercial-scale plant of at least 5 MW could be economic but there was a high risk in the marketing of the products (electricity, activated carbon and eucalyptus oil), and it relied on a fully-developed harvesting/delivery system for the biomass, which was not then available.

As part of their continuing development Verve Energy commissioned a study to quantify total benefits and costs (financial and societal) associated with both a 5MW IWP project and an equivalent 7MW bio-energy plant, compared with other renewable energy options. In the case of biomass crops, total benefits include better management of salinity that provides a range of on- and off-farm benefits. Of the eight options examined, including wind, solar PV and solar thermal, the mallee-based options provided the highest total economic (financial and societal) returns to the State.

From industry contacts, FFI CRC has been able to update and compare indicative electricity prices across energy options for meeting the 2020 Renewable Energy Target. Mallee co-generation with coal is the cheapest option and mallee bio-energy is on a par with other sources of biomass (forest residue, urban waste) and solar PV, cheaper than solar thermal but more expensive than wind. See Figure 1.

Figure 1: Indicative electricity value for conventional and renewable energy options.



The indicative electricity prices account for a realistic profit margin and return on investment to the generator. In this analysis it was assumed that:

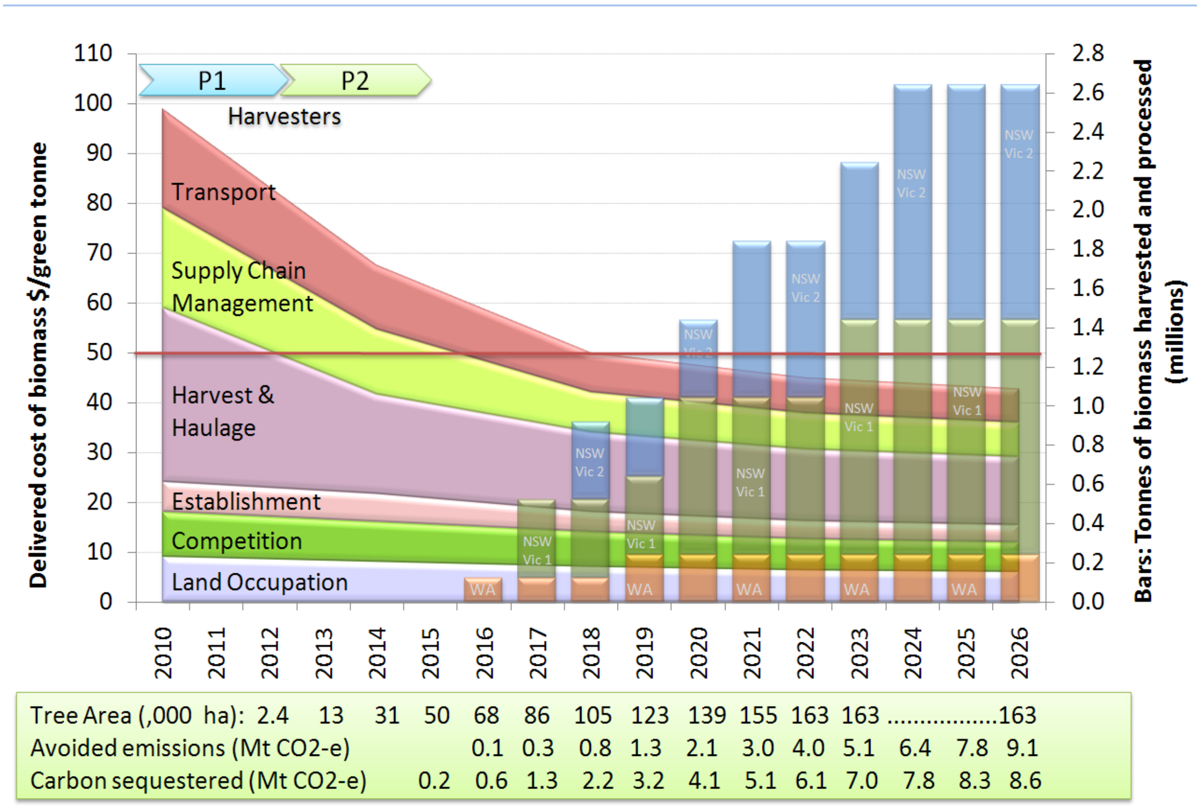
- To generate one MWh of electricity will require 0.55 tonnes of coal, one tonne of mallee biomass or 0.84 tonnes of forest residues. Mallee biomass typically has about 40% moisture.
- The generation process will be considered by the regulator as carbon neutral. A $10 carbon price will raise cost of generation from coal by $10 /MWh and gas by $5 /MWh as the generator has to pay the cost of emitting GHGs.

Electricity generation from Energy Tree Crops

Scenario modelling by Future Farm Industries CRC estimates that 163,200 hectares of short cycle mallee tree crops could profitably supply 176 MW of electricity generation using 2.6 million tonnes of green biomass per year by 2026. At full development, a total of 1.3 million tonnes of greenhouse gas emissions could be avoided on an annual basis. This is close to 9.1 million tonnes of avoided emissions (CO2-e) over an 11-year period from 2016 to 2026. Additionally, in this coppice agroforestry system, cumulative carbon sequestered in the trees (mainly below ground), amounts to 8.6 million tonnes of CO2-e by year 2026.

This scale of energy tree cropping would contribute significantly to the regional economy, generation of renewable energy certificates and diversification on the farm. Figure 2 shows how this occurs.

Figure 2: Delivered cost of farm grown biomass from mallee tree crops of WA, NSW and Vic, and utilisation by electricity generating plants.



This analysis is based on the electricity generator in WA developing two 8 MW plants each requiring 120,000 tonnes of green biomass per annum. It is likely to use a modular dedicated bioenergy system that allows an increase in generation by 2 MW every couple of years. The two generators in NSW and Victoria would each require 1.2 million tonnes of biomass per annum for co-firing with coal in conventional generators. It is assumed that the processors in WA, NSW and Victoria will ultimately pay $50 per green tonne and sign forward contracts with growers to ensure plantings and delivery.

This scenario modelling draws heavily on FFI CRC's supply chain R&D and associated analysis of the total cost of delivered biomass. In the chart this shown as a slowly declining set of all cost components over time with costs shown on left hand axis. Today's growing, harvesting and transport systems and infrastructure deliver biomass at just under $100 per green tonne. However, it is likely costs will progressively decline with technological advance and operational experience, to less than $50/gt by 2018.

The right side vertical axis shows the estimated amount of mallee biomass harvested, delivered and utilised by electricity generators in their bioenergy projects by 2026. Each bar shows the tonnage used by the processor. Below each bar is: the area of tree belts from which the biomass will be harvested; the estimated cumulative avoided emissions through displacement of coal; and carbon sequestered in the trees over the long term using the interim Carbon Farming Initiative methodology of the federal government.

Other specific assumptions in this modelling include:

- The trees are planted in belts across the 450-600 mm rainfall zones of WA, NSW and Victoria within economic transport range of the electricity plants, staggered and scheduled to match future demand and reach 163,200 ha by 2026. Each hectare has 1285 trees to give a total of 245 million trees.
- The schedule of tree plantings in three states to meet the projected future demand from electricity generators will be 19,200 ha in WA planted at 2,400 ha/yr from 2012 to 2019, and 144,000 ha in NSW and Victoria (half in each state) planted at 16,000 ha/yr between 2014 and 2022.
- The landholder grows the trees in two-row belts across 8% of the farm and gets paid enough per tonne of green biomass to recover the costs of planting as well as the forgone net income from agricultural land use in the area occupied by mallee trees and the competition with adjacent crops. Tree belts offer shelter benefits to livestock and reduce the incidence of wind erosion. They compete with adjacent crops and pastures within a few metres of the tree belts.
- For each hectare of tree belt there will be about 12 hectares of conventional agriculture in the adjacent alleys. The mallee belts may have positive as well as negative effects on production within the adjacent alley.
- It is assumed the first harvest is in the fifth year of each planting and every three years afterwards. It is estimated that the trees will yield 50 green tonnes per hectare of belt at each harvest.
- The current Prototype 1 (P1) harvester has a capacity of 20 green tonnes per hour but the more advanced P2 mallee harvester will be designed to operate at 60-80 green tonnes per hour, and at lower cost.
- The GHG emissions reduction calculations are based on the assumption that 0.51 tonnes of GHG (in CO_2-e) are abated for each tonne of mallee biomass that replaces coal in the generation process.

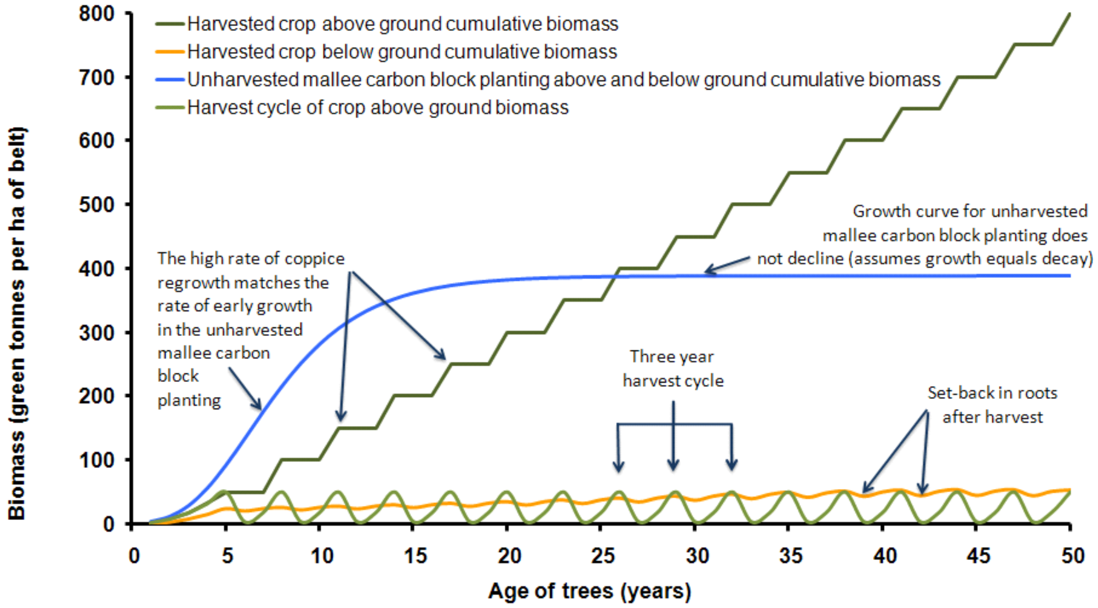
Demonstration of integrated wood processing, including 1MW electricity, at Narrogin, WA.

Cash flows from crops and Energy Tree Crops

Economic modelling by the FFI CRC has compared mallees integrated into agriculture in the WA wheatbelt with business-as-usual cropping over a 50-year period into the future. The principles of this experience can be adapted to other areas of the extensive low to medium rainfall agricultural zone, as has already occurred in NSW.

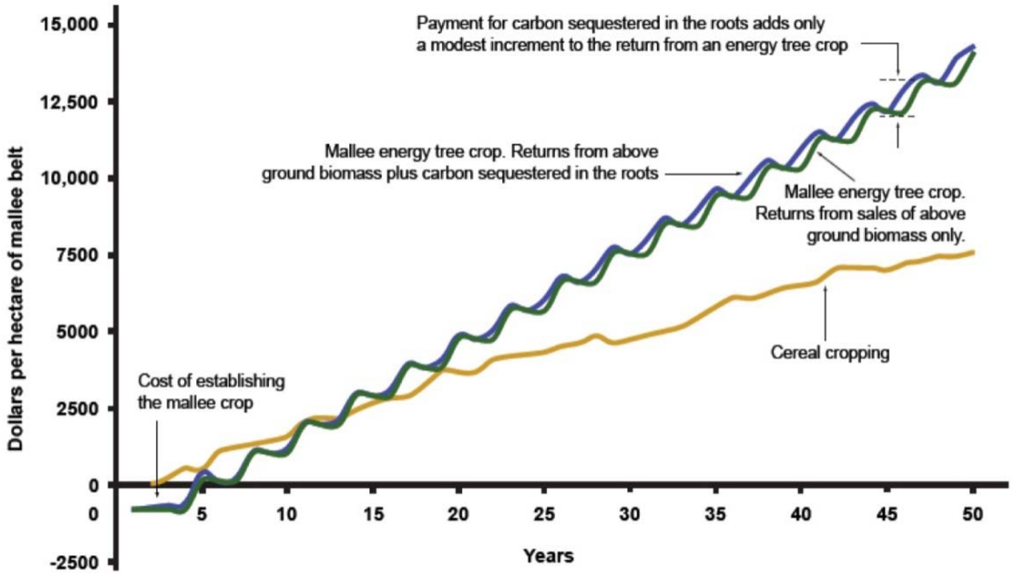
The study was based on mallees grown in two-row belts and harvested and regenerated as depicted in Figure 3.

Figure 3. Modes of mallee tree biomass production for bioenergy and carbon sequestration at Narrogin, WA.



The production of mallee biomass from this strip of land (including an allowance for the competition between the mallees and the adjacent wheat crop) was compared with annual cropping on the same strip of land. The results are presented in Figure 4 over the page, and the assumptions are outlined below. A more detailed discussion is presented in Bartle and Abadi (2010)[3].

Figure 4. Cashflow for a mallee crop harvested for bioenergy versus business-as-usual agricultural land use which involves rotation of annual crops such as grain cereals with pastures for sheep grazing.



In an analysis of this type it is necessary to make some assumptions about the yields and prices of commodities of the alternative production systems proposed for agricultural land. For instance the price of wheat was projected to follow past trends with variation in yields based on past variability in rainfall.

Historical records indicate that during the past 200 years, food prices have fallen in real terms and the terms of trade for food production have declined. In the past 50 years, this has mostly been due to improvements in agricultural efficiency. Future population growth is projected to decline to near zero by the end of this century. It was assumed for this study that agricultural practices will continue to advance as they have in the recent past. This is discussed in greater detail in Bartle and Abadi (2010)[3].

On the other hand, many industrial commodities have increased in value in real terms over this same period as wealth and consumption have increased. It is reasonable to assume that energy prices will increase substantially over the next few decades, making it likely that the price for delivered biomass will also increase.

Other, rather conservative assumptions of this analysis include:

- An annualised net present value from agriculture of $164 per hectare, derived from a cash flow configured to reflect seasonal variability.
- A realistic value of $50 per green tonne for biomass feedstock destined for renewable electricity production.
- Establishment costs for trees of $800 per hectare of belt area (a one-off cost).
- An annual maintenance cost of tree belts of $5 per hectare.
- Above ground biomass is 50% of total biomass to first harvest.
- A 30% loss of root biomass on harvest, with a net 7.5% gain by the following harvest.
- A projected rise in the carbon price from $25/tonne CO_2-e in year one to $115/tonne at year 50.
- No emissions limits are currently applied to agriculture in Australia.

As the technologies develop in the future the best market for biomass is likely to be in biofuels, where energy values are significantly higher than for electricity.

Summary: Bioenergy from Energy Tree Crops is a strong contender for future renewable energy

Many new renewable energy technologies will be developed in the future, each with their relative strengths and weaknesses. The advantages of using lignocellulosic materials for bioenergy are:

- Biomass is a potential base-load fuel for electricity generation due to the ease with which it can be stored.
- It is suited to electricity generation in rural regions, which will enable power stations to be sited at appropriate grid locations where transmission costs can be minimised.
- Biomass is a renewable source of organic material. Emerging technologies will be able to convert biomass into transport fuels that can be blended with petroleum based fuels and distributed through existing infrastructure.
- Significant transport activities occur outside the niche of battery-powered city commuting. Due to their energy density, liquid fuels are likely to remain the most appropriate form of energy for heavy road transport, air transport and personal rural transport.
- Woody crops have the potential to make an important contribution to the economic and environmental well-being of rural Australia.

Energy tree crops represent an alternative cropping enterprise for farmers and will do more to reduce carbon emissions as cumulative crop production exceeds the capacity of the same land resource to store carbon in ageing carbon forests. By 2026 it is conservatively estimated that 163,200 ha of farm planting could be supporting two 8 MW bio-electricity plants in regional WA and co-firing existing large coal-fired power stations, one each in NSW and Victoria. At this scale the advantages listed above will start to be realised.

Energy tree crops established strategically in the dryland wheat-sheep belt of southern Australia have the potential to deliver substantial benefits in renewable energy production, greenhouse gas mitigation, more diverse and resilient farming systems and regional economies, a distributed energy grid and environmental co-benefits, such as erosion and salinity control and wildlife habitat, without compromising water yields or food and fibre production.

Energy tree crops offer a classic ‘win win’ option amid the often-conflicting insecurities at the intersections of carbon, water, energy and food.

Addendum: Future of bio-energy

Global bio-energy

A number of important studies relating to bioenergy have been published in the past two years[1,4,5]. These studies have forecast the productive capacity of global agricultural land and commercial forests, and related that capacity to projected global energy demand.

Bioenergy accounts for about 10% of current global energy consumption. About half of this is fuel-wood for heating and cooking in traditional systems. However, the modern bioenergy proportion is now expanding rapidly. Sweden sources more than 30% of its total energy requirements from forestry and timber processing residue. In Brazil the proportion of ethanol from sugar cane in the national petrol supply is over 40%. These two nations have seen steep reductions in bioenergy costs as the scale of their operations has increased. Many other nations are investing heavily in bioenergy R&D.

The technical potential volume of biomass supply at 2050 is projected to be sufficient to meet total global energy demand, without compromising the required food production[4,5]. There are substantial current and projected biomass residues and these will make a major contribution to future bioenergy production. However, there is potential for large scale woody crops, especially where they are used in production systems that are complementary to agriculture, or where they utilise degraded land, to be competitive with residues and form a major component of future biomass supply. Projections by the International Energy Agency rank biomass as the largest renewable energy source with a market share up to 15% by 2030 and 33% by 2050[5].

Global corporate merger and acquisition (M&A) activity provides another insight into bio-energy's future. The recent 2010 survey of more than 250 senior executives in the renewable energy industry[6] indicated that large corporate utilities, in particular, were emphasising biomass targets in their M&A plans. The appeal of biomass projects to all companies and investors (37% of corporates looking for transactions) had risen to slightly exceed solar (36%) and onshore wind (35%). Biofuels came next, appealing to 29% of renewable energy companies and investors. They were attracted to biomass by greater potential returns and its potential to operate as a base-load power source. The lack of visibility of long term resource supply and pricing was seen as a constraint.

Bio-energy in Australia

Bio-electricity and biofuels in Australia, in contrast to Europe and the United States, are operating at very small scales. In 2009 it was estimated that biomass contributed 0.7% of total electricity and biofuels supplied 0.45% of total transport fuels.

It is most notable that bio-energy receives very little attention in media coverage and policy discussion of Australia's renewable energy future. Yet if this nation is to achieve a low carbon future there are compelling reasons why bioenergy industries will be strategically important. For example, ClimateWorks Australia's 'low carbon growth plan'[7] released in March 2010 estimated biomass/biogas and biomass co-firing to be comparable to onshore wind and geothermal on the investor cost curve for greenhouse gas abatement (in the range of $60-80 per tonne CO_2-e). For the period to 2020 biomass is predicted to be significantly cheaper per unit than solar thermal, solar PV and wind. The more recently published Beyond Zero Emissions 'zero carbon Australia stationary energy plan'[8] mapped a path to Australia's energy needs being met with 100% renewable by 2020. The technologies chosen were wind, solar thermal, solar PV and hydroelectricity. Significantly, biomass energy supply was included as back-up electricity supply to offer energy security when a combination of low wind and low daily solar radiation occurs. This would be in the form of biomass co-firing of solar thermal plants, with 15 GW electrical equivalent of biomass-fired backup heaters representing about 2% of total capacity. To achieve this more aggressive vision there would need to be $6 billion invested in bioenergy supply as part of the total of $370 billion, including a national transmission grid.

Energy Tree Crops, bioenergy and biofuels

Energy tree crops are only one potential source of biomass for bio-energy. The full range of sources can be classified as follows:

- Primary: various forms of energy crops, field residues from agriculture and forestry;
- Secondary: wastes generated in manufacturing products from agricultural and forestry feedstocks; and
- Tertiary: salvage material collected after secondary use.

In industrial systems there are two main forms of bioenergy:

- bio-electricity: commonly used where residues are readily available such as in forestry, timber mills and sugar mills, and in the future, from primary energy crops.
- bio-fuels: where starch, sugar and plant-oil feedstocks are converted to transport fuels using conventional technologies. These technologies are often referred to as 'first generation', in anticipation of emerging 'second generation' technologies to follow. Second generation processes are now being actively developed to convert the potentially large supply of low-cost cellulosic biomass from primary energy crops, both herbaceous (especially grasses) and woody crops, into the transport fuels of the future.

Primary energy crops will include:

- A range of starch, sugar and plant-oil producing species that have biomass components suitable for conversion to bio-fuels using conventional technologies, e.g. maize and sugar cane to ethanol, oil seeds and oil palm for biodiesel.
- Perennial woody and herbaceous species that produce high yields of cellulosic biomass and are able to regenerate by coppicing/sprouting under a short harvest cycle.

Lignocellulosic biomass is a renewable source of hydrocarbons. This plant material embodies solar energy that may be stored in the standing crop or in stockpiles. By using CO_2 from the atmosphere to grow biomass, the carbon emitted from the combustion of the biomass does not cause the release of fossil carbon that causes so much concern in relation to climate change.

The biomass may be burnt directly to produce heat (thermal) energy for industrial and domestic uses, or to produce super-heated steam to generate bio-electricity. However, the greatest economic potential for cellulosic biomass lies in it being converted into higher value liquid or gaseous fuels[4] — the second generation bio-fuels. The various processes by which this can be done could also produce many of the compounds that are the basis of the wider petrochemical industry (for example, plastic precursors and resins).

Energy Tree Crops complement farming for food

The term 'bioenergy' often raises concern about food versus fuel. This is due to the use of grains, sugar, and oilseeds to produce first generation biofuels. For example, the recent rapid expansion of ethanol from maize in the United States caused considerable controversy. This issue has stimulated interest in second generation fuels derived from lignocellulosic biomass such as cane bagasse, wood, inedible foliage and crop stubbles[3]. If woody crops such as mallee or willow are grown for energy, they can be established on land not used for food production, or configured in ways that allow the tree component to complement on-farm food production enterprises.

Most first generation biofuels also require large inputs of energy per unit of energy in the fuel produced. They are doing little better than converting fossil coal, oil and gas into biofuels. The energy efficiency of producing second generation biofuels is much higher than for the first generation fuels.

If the future of biomass energy is focused on second generation fuels, there remains the question of the extent to which woody crops will encroach on the finite agricultural land resource and put upward pressure on food prices. This is not expected to be a problem because not all the potential economic production of bioenergy will come from woody crops, and in occupying agricultural land their economic value is likely to be greatest where they have a comparative advantage and deliver collateral benefits as a component of the agricultural system. These benefits include diversifying rural economies, intercepting nutrient rich run-off, controlling salinity, protecting soil from episodic wind erosion events, conservation benefits and providing shelter for livestock during lambing and off-shears. Furthermore, with declining global population growth rates it is expected that advances in agricultural technology will be more than able to maintain food supply. Bartle and Abadi (2010) cite many studies published between 2003 and 2009 on this topic.

Further research

It was noted previously that there is a technical capacity to produce most of the world's energy requirements from biomass by 2050, but studies indicate that the economically viable proportion will be less, ranging from 10% (of a larger energy market) under a business-as-usual scenario, to 33% there is a global endeavour to restrict CO_2 concentration in the atmosphere to 450 parts per million in 2030[1,5].

A very important factor that will constrain the expansion of cellulosic biomass for bioenergy is expected to be the cost of producing and delivering biomass to market. In consequence, it is anticipated that bioenergy will be most successful as second generation biofuels sold into markets traditionally supplied by the oil and gas industry[5].

In Australia there has been a sustained endeavour to reduce the cost of producing biomass from mallees to enable it to compete in the energy markets. To support the development of the new industry a prototype harvester is under construction at Toowoomba, Queensland. This work is funded through the Future Farm Industries CRC by the WA Government's Low Emissions Energy Development (LEED) fund. Field trials started in early 2010. The objective of this project is to produce technology that can harvest and chip small trees at a per-tonne cost of about half that of best practice in plantation forestry; an ambitious objective given that small trees are normally the most expensive to harvest in plantation forestry. This will be achieved by combining felling and chipping into a single continuously travelling machine analogous to the machinery used in sugar cane or fodder harvesting operations.

Definitions

Alleys: The open spaces, where normal cropping and grazing enterprises occur, that separate belts of woody crops. Alleys are usually 90% or more of the total paddock area.

Belts or **tree belts**: Trees may be integrated into agricultural systems by planting in narrow belts of two rows or more with wide alleys (between 70 and 80 metres) between the belts. Belts can be linear or on the contour and there are important interactions between the belts and the crops or pastures in the alleys.

Bioenergy: Any energy product made from biomass.

Biofuels: Liquid fuels produced from biomass.

Biomass: In this context, any traded or measured plant material either in its primary form (grown and harvested crops), secondary (as the residue of agricultural or forestry crops) and tertiary (urban and industrial wastes).

Blocks or **tree blocks**: Trees planted in contiguous areas varying from less than a hectare to many hectares, as is usually employed in high rainfall tree plantations. Block plantings operate somewhat differently from belts in that there is more competition between trees and they are not integrated into an agricultural system, meaning there is less interaction between the trees and the agricultural system.

Carbon sequestration: The process of placing CO_2 into storage to prevent the CO_2 from entering the atmosphere. It includes geosequestration and biosequestration. An example of geosequestration is the underground storage of fossil CO_2 from a coal-fired power station. By contrast, biosequestration is the removal of CO_2 from the atmosphere using photosynthesis by plants. Biosequestration is typically used to offset fossil CO_2 emitted elsewhere (for example planting trees to offset air travel).

Carbon sink: A store of carbon; in this context, a long term planting of shrubs or trees on former farmland, which would then be defined as a carbon forest.

Energy crops: Biomass crops grown primarily for bioenergy and usually defined by the plant form (tree, shrub, woody or herbaceous). For example, energy tree crop, woody energy crop.

First generation feedstocks: Materials such as cereal grain, oil seeds, palm oil and cane sugar which are readily converted into biofuels using existing technologies. The sugars and starches are fermented to produce ethanol and the oil feedstocks are processed to produce a diesel substitute.

Second generation feedstocks: In the context of this paper, biomass from woody plants containing the characteristic woody material of lignin combined with cellulose. Second generation feedstocks are also called lignocellulosic feedstocks. Agricultural wastes such as cane bagasse and cereal straw are also second generation feedstocks. There are numerous processes being developed to convert these materials into a range of biofuels.

Woody crops or tree crops: Any tree or shrub grown as a crop for harvest to produce biomass for processing into energy or other industrial products. Woody crops can be grown in large contiguous areas (plantations or forests), or be dispersed as small blocks or long belts. The term ‘woody crop’ can embrace plantation forestry, farm forestry and agroforestry. In the context of agricultural regions, woody crop usually refers to small trees and shrub-form species harvested on a short cycle of less than 10 years.

End notes

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Biofuels from wood in Western Australia

Woody biomass can be used to make renewable transport fuels ("biofuels"), while simultaneously improving the sustainability of Western Australia's wheat and sheep growing regions. The Renewable Oil Corporation (ROC) is an Australian company that can convert woody biomass into liquid fuels and biochar using fast pyrolysis. ROC proposes to build the first biofuel plant in the South-West of Western Australia, which could lead to multiple plants that use farm grown woody biomass thereby boosting regional investment and employment.

The Future Farm Industries Cooperative Research Centre (FFI CRC) is developing mallee belts alongside crop and animal production on farms to provide both environmental and farming benefits. Its work on supply chain development, in particular efficient harvesting and handling, is crucial to ventures such as ROC's if mallee farmers are to realise their long held aims of a viable mallee industry and sustainable natural resource use.

1. Woody crops improve crop and livestock production, provide environmental benefits and supply biomass

Establishing belts of eucalypt trees in Western Australia's cropping and grazing country can address several long term threats to farming:

- The risk of dryland salinity can be reduced by the water use of these deep-rooted trees.
- The lack of shade and shelter in cleared farmlands adversely affects crop and livestock production through increased exposure and erosion. This can be avoided with tree belts, which provide shade and shelter.
- Loss of habitat has reduced biodiversity in this farming region. New tree belts improve biodiversity by providing habitat for a range of species including birds and mammals.

These tree belts, or "woody crops", are readily integrated into existing farms, with up to ten percent of the land growing woody crops and ninety percent or more continuing as conventional crops and pastures. The tree belts do not compete fully with the annual crops, because the deep-rooted trees exploit moisture and nutrients that have escaped below the root-zone of the shallow-rooted annual crops.

Mallee eucalypts grown in two-row belts can provide all of the benefits outlined above. They are also an ideal woody crop for biomass production. They may be strategically integrated into dryland agricultural systems. After being harvested they regenerate readily by re-shooting (coppicing) from their rootstocks. Through repeated harvesting, mallee biomass can be a secure long-term source of renewable energy. The trees have the potential to:

- Produce feedstocks for biofuels while reducing greenhouse gas emissions.
- Diversify farm incomes and regional economies by complementing rather than displacing existing agricultural industries and food production.
- Avoid trade-offs with water use in high-rainfall and irrigation areas.
- Provide salinity, biodiversity and broader natural resource benefits.

Rows of mallee eucalypts on wheat belt farm, Western Australia

This "energy tree cropping" can be undertaken in such a way that it cohesively integrates with other, existing agricultural enterprises on wheat belt farms. Food and fibre production need not be compromised. This approach offers compelling economic, social and environmental benefits that are uniquely Australian, turning problems faced by our farming communities into an innovative new enterprise.

Economic studies conducted by the Future Farm Industries Cooperative Research Centre (FFI CRC) have demonstrated that energy tree crops have the potential to match financial returns from existing agricultural enterprises, with payback of establishment costs in as little as five years. They offer farmers useful diversification, with significant environmental co-benefits.

In WA over 12,000 ha of mallee belts have already been planted for the environmental benefits outlined above. There is 16.6M ha farmed in the wheat sheep belt, of which about 1.2M ha have been identified as prospective for mallee belts. Each commercial biofuels plant requires about 10,000 ha of mallee belts to provide sufficient biomass for its operation – so there is potential for over 100 biofuels plants in WA, plus environmental benefits from tree planting that will be many times greater than what has been achieved to date.

The trigger for large scale planting and implementation of this tree cropping is a market that can purchase the biomass at a price that offers a suitable return to farmers. The market should be large, consistent and capable of taking product from a broad farming region. We believe that renewable transport fuels offer such a market, and can be the trigger for the mallee industry to move forward.

2. A market need for liquid fuels

Liquid fuels for transport represent a market across Western Australia that is worth billions of dollars each year. Markets include transport by road, air, rail and sea. Additional markets exist for liquid fuels to generate electricity and drive machinery in remote and off-grid applications.

There is considerable interest in the production of new, sustainable liquid fuels for these markets. The potential benefits are many and varied. They include greenhouse gas reduction, fuel security and reduced imports, and a desire to develop new rural industries.

The existing biofuels industry is based on “first generation” fuels: ethanol and biodiesel. In Australia the opportunities for manufacture of such fuels are limited by the availability of low value feeds such as C-molasses, tallow and waste cooking oil. To grow the industry, and to avoid competition between food and fuel, attention is being given to “second generation” fuels, which use woody material (“biomass”) as feed.

3. Biofuel technology

Renewable Oil Corporation Pty Ltd (ROC) is a privately-owned Australian company set up to develop and manufacture cost-effective, renewable liquid fuels.

ROC’s processing plants will use second generation fuel technology developed by Dynamotive Energy Systems Corporation of Canada. Dynamotive has developed “fast pyrolysis” technology, which can convert any form of woody material into a liquid known as pyrolysis oil. Dynamotive is a world leader for this technology, having already taken it from the laboratory through to commercial plants in Canada. The Canadian plants make pyrolysis oil (a competitive substitute for fuel oil) and biochar.

Dynamotive has recently developed additional technology to upgrade its pyrolysis oil into high-quality hydrocarbon fuels. These renewable fuels may be blended with fossil fuels such as petrol, diesel and aviation fuels. Small scale work with the upgrading technology in Canada has achieved outstanding results, with products independently verified by a number of international oil companies. Scale up for the process is now underway via a collaboration between Dynamotive and IFP Energy Nouvelles, Europe’s leading fuel technology company.

As part of the upgrading process, acetic acid and methanol are also recovered. These are both commodity chemicals with well established markets.

200 tonne per day wood pyrolysis plant at Guelph in Ontario, Canada.
Similar plants are proposed for Western Australia.

ROC is working closely with Dynamotive to develop biofuel opportunities in Australia. Dynamotive has invested in ROC and its President is a member of ROC's Board of Directors.

4. Rolling out biofuels plants in WA

Bringing this new biofuels industry to its full potential involves a staged approach from a demonstration unit, to Australia's first full scale plant, then to industry roll-out.

Demonstration unit

As part of the lead in for the first commercial plant, ROC intends building and operating a small demonstration unit in Australia. This unit will demonstrate the complete fuel-making process, from acceptance of chipped wood feed through to the production of transport fuels for various applications. The unit will allow us to:

- Optimise processing conditions for Australian biomass feeds to be used in the commercial plants, including the manufacture of various transport fuels to suit local customers.
- Make fuels for blending with, and substitution for, diesel, petrol and jet fuel. Also charcoal for local metallurgical and agricultural trials.
- Test these products for compliance with relevant quality standards and customer requirements.
- Conduct practical demonstrations of our products. This can include trials of our renewable fuels in petrol and diesel motor vehicles and stationary power generators, as well as trials for our renewable jet fuel.

This demonstration unit is not required to prove the technology and is not a commercial operation. The benefit of this unit is for local optimisation, demonstration and certification work, providing customers, partners and investors with a logical starting point for the commercial plants to follow.

Commercial plant in WA

Until now Dynamotive's fast pyrolysis technology has only been used at commercial scale in Canada. A similar commercial plant is proposed for Australia. This plant will operate continuously, to provide a commercial business and act as a catalyst for a much larger industry in years to come.

The Australian commercial plant will operate 24 hours per day throughout the year and process approximately 120,000 tonnes of wood per year on a green basis. It will be a customer for mallees that are harvested in coming years as that industry develops its supply and delivery systems. In this way it can provide a critical impetus for the commercial development of the mallee industry.

The current mallee industry is not large enough to supply all the biomass for a full scale biofuel plant at a competitive price. It needs several years to finalise its supply chain and initiate new plantings. Therefore our first commercial biofuels plant will also use wood residues from existing plantations. The biofuels plant will be located close to existing softwood and hardwood plantations to the south of Perth. From this location it can also accept mallee biomass grown in the wheat belt as the CRC refines and increases the output from its mallee harvest and supply work.

Rolling out further plants

The total cost for the first Australian plant will be influenced by location, feed preparation and storage, existing facilities, plant sizing and so on. ROC's cost estimates indicate a total budget of more than $100 million to build the first plant and then double its output once operation and sales are established. This technology is still in the early stages of commercial use and as experience is gained on the first plant we expect that subsequent plants will be cheaper to build and operate.

Once the first commercial plant is operational, ROC will seek to expand that plant and also set up a second plant at another location. Sufficient biomass is available as residues from WA's plantations for several biofuels plants.

Plants based on farmer-grown woody crops

FFI CRC research shows that with achievable supply chain costs, mallee biomass will be a competitive source of renewable energy, offering thousands of farmers an alternative income stream and more sustainable farm practices. Renewable fuels have a major role to play in reducing greenhouse gas emissions and creating new regional jobs. So the proposed combination of the CRC's woody crop farming system and ROC's biofuels technology provides a significant opportunity for regional Western Australia.

Prototype continuous mallee harvester undergoing field trials

The first biofuels plant will support the finalisation of the mallee supply chain and allow farmers to plant additional trees with confidence that a commercial market is available for the biomass produced. Increased supplies of mallees into the initial biofuels plants can provide a transition to additional biofuels plants that will be built and operated in the wheat belt with mallees as the sole feed supply.

The potential scale of this new industry is dramatic; dozens of biofuels plants are possible across the WA wheat belt as energy tree cropping is developed alongside existing farming activities. Such development will occur over many years, and each new biofuels plant will be a major, sustainable new business in a regional community. It is estimated that fabrication and installation of each commercial plant will provide at least 200 man years of work. Once operational, biomass supply, plant operation and maintenance for each biofuels facility will create approximately 100 permanent jobs (direct and in-direct), including skilled, unskilled and professional roles.

5. Future Farm Industries CRC and Renewable Oil Corporation

ROC combines award-winning Australian engineering and management personnel with world-class technologies. ROC will be supported in Australia by Dynamotive and also by Tecna, an international oil and gas contractor that has carried out the design and commissioning of Dynamotive's plants for ten years.

The FFI CRC is Australia's pre-eminent organisation for the practical, systematic development of new farming systems. It has decades of experience with environmental issues such as dryland salinity, and also has extensive knowledge of the growth and harvest of the mallee eucalypt trees. Most recently the CRC and its commercial partner Biosystems Engineering have successfully implemented a major development program for the mallee harvester and are ready to continue this work.

Enquiries are welcomed. Please contact:

Colin Stucley, Managing Director of Renewable Oil Corporation Pty Ltd
at cstucley@renoil.com.au or by phone on 03 9895 1200.

Kevin Goss, Chief Executive Officer of the Future Farm Industries CRC
at Kevin.Goss@futurefarmcrc.com.au or by phone on 08 6488 2555