



CARING FOR OUR COUNTRY

Transitional Year Progress Report for the Period Ending 30 May 2009

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climate change - baseline

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Introduction

AVONGRO received official notification of the success of this one-year project mid-November 2008, pulling together project partners and putting plans in place immediately. The first project meeting was held on the 11th of December, bringing together all the key and major project partners.

A project team has been established to monitor progress. Since February 23rd, fortnightly meetings have been held between the key project team members. Fortnightly CSIRO and AVONGRO have a telephone hookup or face to face meeting with the tree cropping representatives (sandalwood, oil mallees and brushwood) joining the meetings once a month at a minimum.

Background

The Avon River Basin was chosen for this study. It is 11.8 million hectares in size, almost twice the size of Tasmania with a relatively low average annual rainfall with the majority of the region receiving as little as 300mm.

Almost 8million hectares of the region have been cleared for agriculture. Over time it has come to light that the clearing of deep rooted perennial vegetation has led to severe environmental problems such as dryland salinity, wind and water erosion and biodiversity decline. Added to this is the increasing financial uncertainty of the agricultural practices which has resulted from increasing input costs, declining commodity prices and climate change. This project has set out to:

- Determine the current level of adoption of integrated tree crops;
- The potential impediments to and triggers for increasing adoption;
- Conduct field work to measure growth and carbon sequestration of the current three main tree crops (sandalwood, brushwood and oil mallees);
- Develop an interactive computer-based tool to help land managers make more informed decisions as to placement of tree crops on their farm.

Key project activities

a) Spatial data for the Avon catchment

A range of spatial data are required to estimate the growth, carbon and water balance and biodiversity outcomes of tree planting across the Avon catchment. Extensive data sets were compiled by DAFWA and supplied to CSIRO including:

- High resolution aerial photos of the Avon catchment;
- Soil-landscape mapping; description of landform, soils and geology;
- Digital elevation model i.e. topography;
- Map of salinity risk;
- Catchment boundaries;
- Location of rivers, streams and floodplains;
- Shire boundaries, location of roads and towns;
- Land tenure information;
- Pre-European and remaining native vegetation.

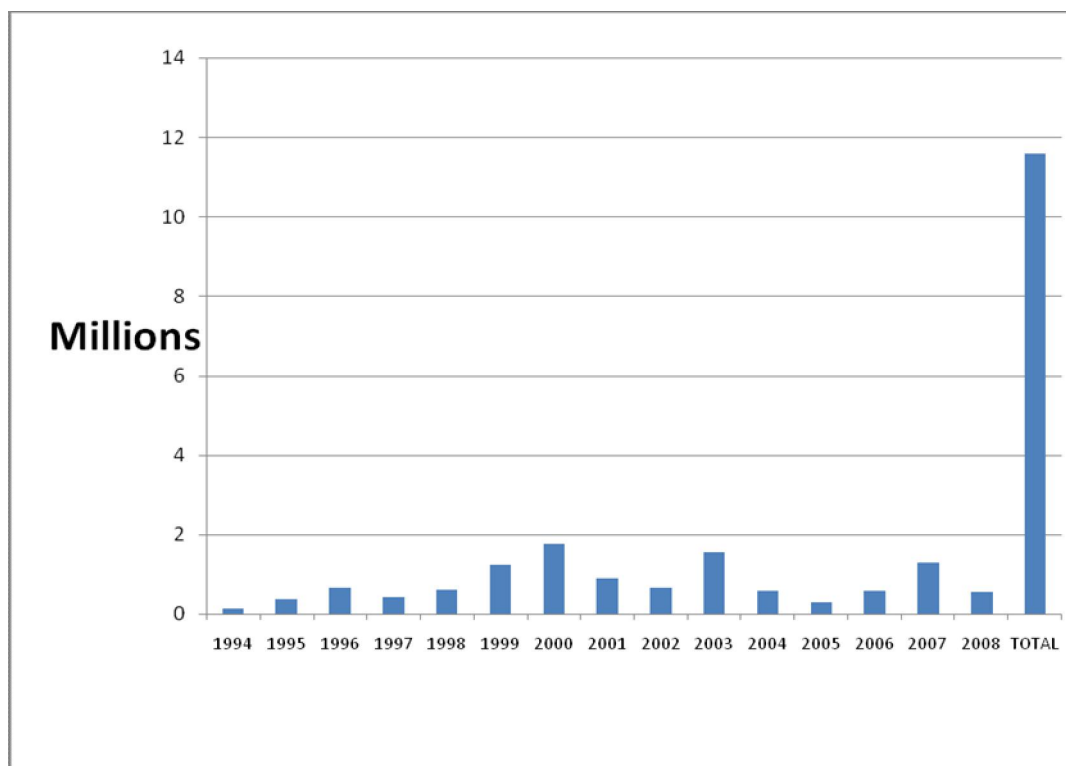
Additional information is being compiled by the project team, including the current extent of tree crops (sandalwood, oil mallees, brushwood) in the Avon in relation to number of farmers and arable hectares:

Current level of adoption of tree crops in the Avon River Basin (ARB) at May 2009:

Number of ARB land managers (including properties 100 to >1,000 hectares)	5,690
Number of ARB land managers (including properties 500 to >1,000 hectares)	4,169
Number of ARB land managers (>1,000 hectare farms)	2,781

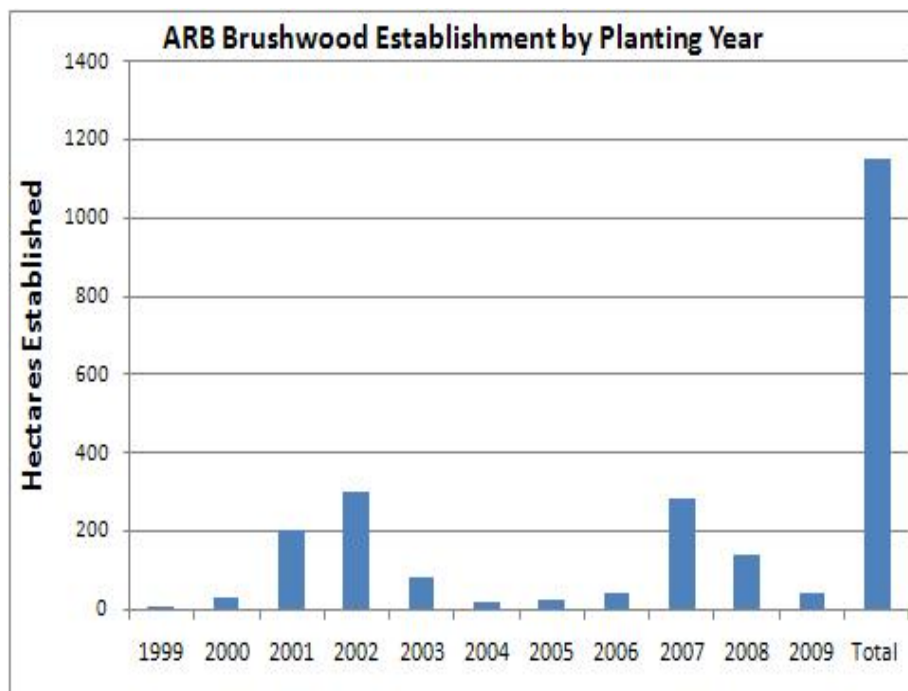
Oil Mallees

There have been approximately 7,235 hectares of oil mallees (or 11,580,000) established since 1994.



Brushwood

Brushwood has had less recognition and promotion until recently. It is estimated that there have been approximately 1,800 hectares of Brushwood established since 1999.



Figures are still being collated for sandalwood.

b) Tree growth and site specific soils data

Parameters need to be derived for each species so that a tree-growth model can be applied for the different systems. CSIRO has the necessary parameters for oil mallees from a previous project, but the model has not yet been used on brushwood or sandalwood. In order to calibrate the model for brushwood and sandalwood, trees have been measured across the Avon catchment, covering a range of site conditions that will affect growth.

The tree crop representatives compiled a list of potential sites for growth measurements, based on:

1. The land managers who agreed to participate in the project at the time of writing the original submission;
2. CSIRO's requirements for sites to be representative of a range of conditions (ie for each species to have a representative sample of ages, rainfall and soil types);
3. Other land managers the team members were aware of who could fill any gaps in the points above.

During February and March 2009, all of these sites were visited and assessed for their suitability, and a final list of 12 brushwood and 12 sandalwood sites chosen. The map below shows the location of sites that were selected: sandalwood in red, brushwood in blue.



Landholders are being interviewed about the management of the tree crops and other factors impacting growth that need to be considered during modelling. Tree measurement and soil sampling were undertaken at all sites during May 2009. CSIRO transported their soil drill rig to Western Australia and soil cores were taken to measure soil depth and texture, (important characteristics affecting soil water availability and hence tree growth). At the same time, a team measured the stem diameters, height and canopy dimensions of trees in replicate plots at each site. These measurements will later be correlated to total tree biomass by cutting down and weighing trees of different ages and sizes.

c) Modelling scenarios and validation data

The tree crop representatives have described the planting configurations, management regimes and rotations that are commonly used by growers. This information will be used to design the different scenarios that need to be simulated during modelling. Scenarios have also been designed by a CSIRO farming systems scientist for modelling annual crops, so that the economic tradeoffs between trees and traditional crops can be assessed.

Additional tree growth data has been sourced from the literature, as well as access provided to unpublished data from The Department of Environment and Conservation. This independent data will be used to validate the outputs from applying the tree growth model to the Avon catchment. This is a necessary check of model accuracy when applying an existing calibration to a new area (i.e. as for oil mallees), but is particularly important when the model is used for new calibrations (i.e. sandalwood and brushwood).

March 9th workshop:

On March 9th, land managers who had signed the expression of interest at the time of writing the original submission, other key farmers, consultants and Natural Resource Management Officers were invited to a facilitated workshop guided by Sue Middleton of GrassRoots Developments. The objectives of the workshop were to:

- introduce participants to the project and what it planned to achieve;
- gather their thoughts as to impediments to and trigger for the adoption of tree crops as part of their farming system;
- gain commitment to be the focus group for the project and engage their continued involvement.

An excellent turnout was achieved with over 30 people attending, all expressing an interest in continuing involvement in the project. For purposes of brevity we are calling them a ‘focus group’.

The key impediments are listed below. The team then met to identify potential actions to address the impediments. Team members are currently in the process of discussing proposed actions with the focus group. These will be collated and further actions discussed in the coming months.

The Triggers identified were also collated and listed below.

Impediments identified at March 9th Meeting, that we can possible begin to address or review further

Impediments	Rebuttal	Actions	Comments	Action Plan
<p>No certainty in marketing avenues and price in the future</p>	<p>Strong market data for sandalwood. Developing market info for brush. Think this point may have been specific to oil mallee</p>	<p>Collate existing market info for sandalwood and brush, and each relevant team member to check with their reps to see if this is considered a impediment for their industry</p>	<p>No one can guarantee commodity prices or market conditions into the future, but there are clear marketing avenues for sandalwood and brush</p>	<p>Sandalwood: have market review and Westcorp. Do summary market report of what information is available. Validity of long term predictions for markets. Brushwood: IDP identifies that there is enough to start an industry. Needs a summary sheet on the existing markets and market structure. Mallees: agree, need to talk about the bigger picture opportunities. Will providing market certainty make a difference? Flag the carbon possible benefits – bundle into a joint summary. Need to put out the information we have – better ways of extending the existing information.</p>
<p>No information on projected growth and profit (cost vs returns)</p>	<p>Oil Mallee – sound and developing growth data publicly available. Economic analysis has been modelled (Amir etc). Also can analyse economic situation for carbon farming under share farm deals Sandalwood – sound and developing growth and economic data available Brush – developing growth</p>	<p>Collate existing public available growth and economic data for each tree crop, run past the reference group, see what they think the gaps are</p>	<p>Oil Mallee – economics are hypothetical in a harvest regime as no existing processing / market, however there are clear under the various carbon deals on offer. Sandalwood – growth rates and economics in low rainfall (>400mm) is sketchy Brush – economics are hypothetical until local processing and harvesting is in</p>	<p>Some information exists and more will be modelled as part of CSIRO work on this project – how best to present/extend?</p>

	and economic data becoming available		place	
Attitude of farm consultants	We agree this is a issue and impediment	Somehow we need to find out from this group (consultants) why they are not promoting tree crop options, and find out what they need to be more positive and take a longer term outlook. Ideas: focus on farm advisory businesses that are currently sponsoring enviro / landcare projects and try and strengthen relationship. Also try to engage with this group via AAAC annual conference (TOM)	Challenging given these people are commercial operators with high hourly charge out rates, and a short term outlook.	Needs a specific approach, tailor made. Need to document what they think, what information do they need. Are they starting to change in any way? How we present the economics? What is the best extension method for this group? What about the costs of trying to put in a crop on unproductive land? We need to quantify the cost of inputs onto unproductive land as opposed to putting in a perennial crop. Find the ones who have shown a bit of interest and use them as a sounding board. Everyone willing to approach this group singly or in pairs. Need to ask – develop a set of questions: what is your current understanding? (of options, of economics, each industry where it is at and where it is going) do you see a role for these things in farming into the future – climate change, diversification. What do they need to include tree crops in their portfolio? Tim and Tom to make one initial visit to a sympathetic consultant.

Short term research projects	Many JVAP / RIRDC projects for oil mallee are medium / long term.	Determine / summarise key research projects currently occurring for each crop, noting timeframes	Is a valid point (short term research projects) and it will be valuable to identify current research occurring relevant to Avon tree crops	Ask reference group. Do a summary of existing research for each crop and identify gaps.
Annual vs Tree Crops	Opportunities for farmers to participate in share farm projects where it is possible to be paid up front (e.g. carbon deals, FPC strategic tree farming etc)	Summarise (or at least list the companies) of all current deals available in the Avon (carbon etc)	This impediment is very valid for the farmer that wants to manage their project themselves and not enter into a partnership arrangement	Give reference group all of the information/updates on carbon projects around at the moment – Tim to do a summary. Bethan to provide CarbonSmart info Succession planning/climate proofing/diversifying the farm business. Highlight the other benefits/perhaps no \$\$ value. MSC stories Will need a range of structures of business models for cost sharing/cooperatives/new business models. Utilisation of summer rain.
Loss of community members eg shearers, stock agents etc	Tree crop industries that involve the physical harvest of a product WILL create more jobs and business opportunities for regions compared with current agriculture , however a large scale, non harvest tree crop industry based on permanent carbon sequestration may reduce employment in regional areas in the medium to long term due to the low	Collate any relevant data or studies from any Australian or WA forest industries that show the positive employment and business development that arises from large scale harvested forest industries.	Carbon only (non harvest) project will certainly provide significant short term employment and business development via seedlings, nurseries, planting contractors, spray contractors, measuring etc etc, however a harvested industry will provide farm more employment opportunities in the medium to long term via harvest contractors, local processing, haulage etc etc.	Carbon only plantings are a real concern. Need to emphasise the benefits of tree crop industries. Summarise good information that has come out. Look at blue gum long term example. Need to extend the right information to the right people. Emphasise the 10% and these will be integrated and annual systems to be maintained. Keep promoting the benefits that can come from harvesting industries – only a small amount of land to make

	management inputs required post initial establishment			traditional agriculture more sustainable. Tim – highlight what a 10MW power plant would mean for employment. Emphasise that skills are maintained, diversify of skills. Equate to how many people annual systems employ. Use Andrew’s 1.5people per hectare? Monica to send Tim the existing studies – socioeconomic studies. Tom to look for information on how many people a typical farm employs. Helen will do figures on a Brushwood fencing panel factory.
Insurance (fire, cost of insurance)	It is certainly possible to insure trees in a carbon project. It should be possible to insure sandalwood or brush using off the shelf insurance policies	Review current available insurance options available and try to determine possible annual premiums.	Peter Jones has experience in insurance of sandalwood, Tim experience in insurance of mallee	Tim has existing policy – need to list area, value... Team members need to be clear and understand. Tim to send through the policy and the contacts for others. Tom to collate and distribute to Team members.
Labour inputs shortage and can’t use traditional machines	Some tree crops have very low management requirements post establishment, and this management can be structured to utilise labour at various times of the year, that fit in with other demands from conventional agriculture. Tree crops do allow farmers to utilise traditional machinery	To be determined	The issue of labour and time availability is real, and need further thought. The issue “can’t use traditional machines” we think relates to harvesting tree crop products, which is an issue for some tree crops.	How best to extend/present this information? Case study approach? Keep on-farm labour busy in between jobs. Use and adapt existing machines, can be utilised more during the year, sheds and sprayers. What is the time commitment per ha or per 10ha required of each tree crop. What is the labour required to get a tree crop established – each team member

	that may only be used for 2 months of the year (e.g. tractors to pull tree planters, spray rigs etc)			to collate a summary for their tree crop. Note the machinery and when used that would otherwise be sitting idle. Can speciality groups of workers be set up to work on tree crops rather than more of a farmer's time? Can a cooperative fill this role? Current status on tree planting contractors – collate a list. Tim has a starting point.
Dissatisfaction with current industry development (no market or harvester)	Assume this is specific to the oil mallee industry, and not an impediment for sandalwood and brush?			Mallees - Has support of FFI CRC to address this. Better structure. This is being extended at every opportunity. Accept that this is an impediment and try to instil confidence and support industry development. Looking at new strategies to get this message out wider. Sandalwood – no current industry on the uses for the nuts. Brushwood – people only just starting to look at this, no 'bad track record' as yet. How to get the information out.
Lack of industry confidence	Assume this is specific to the oil mallee industry, and not an impediment for sandalwood and brush?			Sandalwood – 150 industry history Mallees – as above Brushwood – as above

Triggers identified at March 9th Meeting that we can possible begin to address or review further

Triggers	Examples / Explanation (what we think the trigger means)	Actions (possible ideas to build on these triggers)	Comments
Dissatisfaction with current (annual agricultural) profitability	Drought (2 years of drought in north and eastern wheat belt), rising input costs (oil peaked at \$150 per barrel, fertiliser costs spiralled, QA (compliance, increased paperwork) etc etc	Showcase how integrated tree crops (e.g. 10% of farm) can lead to diversification and alternate sources of income to reduce 100% reliance on annual crops / pasture.	Case study of a farmer that has adopted tree crops as a way of diversifying future income base. We assume there must be perceptions that tree crops are profitable – need to collate existing economic data and examples.
Other people planting trees eg catchment group	Provides confidence that not just going alone. Seeing local examples assist with adoption, seeing local support, peer pressure, development of local knowledge etc	Support local groups with enthusiasm. Local media focusing on local examples to ensure people within a region know that others are acting / adopting.	To some extent this is happening as the various industry groups move their meets and include field visits to promising site
Active local groups – ldc's, catchment groups.	As above	As above	Tend to find life when dollars are part of the equation – otherwise often latent! Gabby and Tammin two in central.
Helpful wife re planting trees	Traditionally women have been very active drivers of landcare, may be transferring to tree crops, now the horizon has changed somewhat. Women still key players, but need to have broader outlook now. Family support for tree crops is important, e.g. many examples of a motivated family member, while a sibling may not be as enthusiastic	Link in with “Women in Agriculture” initiatives e.g. meetings with Leibe group, Facey group, DAFAWA days.. Influence the agenda for these days to include tree cropping components	Difficult to upstage their organizational abilities and generally they bring a crowd.

Personal like for tree planting	As stated by the visiting specialists at the 09 roadshow, this is a pre-requisite if something is to happen. There is passion on someone's part.	The case studies recently done seemed to include this. Be good to get perspective of economist, as often no dollars in this perspective.	Generally within farming families there are specialisations and this could be one – who is to be the tree enthusiast in the family?
Subsidies Incentives – seedling and or fencing Grant/opportunity	Reduces the farmer risk by reducing the initial capital outlay required to establish a tree crop. (seedling / establishment costs are high for tree crops, even though they are one-off costs). Allows a farmer to 'have a go' with reduced financial risk. Also reduces the need to gain a commercial return, due to not fully funding the project themselves.	Influence and lobby policy and decision makers to ensure they understand the value and need to subsidies certain tree crops in certain areas to enable future expansion and development. Quantify the true / full value of incentive programs, for example a NRM group invests in a incentive program to address a NRM issue, however in many examples the incentive program helps build a regional tree crop resource that can lead to external investment and local processing, jobs, opportunities etc. Also incentive programs play a key role in increasing skills and knowledge of farmers by allowing them to develop knowledge in the establishment and management of tree crops, need to ensure govt and NRM understands how important this is	Can we continue subsidising tree crops indefinitely? What happens if funding runs out or is not available Need to develop other methods and systems to reduce the risk / up front establishment costs to farmers to ensure that the lack of subsidies does not become an impediment. That aside it was stated by two individuals separately on the recent roadshow, that 150% pro-active tax subsidies, was a way to get trees on the consultants' radar! Forget that at our own peril.
Demonstrated profitability	Need to determine if this relates to a specific crop such as sandalwood, or is generic for all tree crops. We assume this is a sandalwood related trigger, due to the fact that that there are people in the Avon making money from sandalwood (either	If the perceived profitability of a tree crop such as sandalwood is triggering adoption by others, then we need to run with it, showcasing more examples of people making profit and the opportunities that exist to profit from this or other tree crops.	Perhaps we require annual or regular reviews of the economics of tree crops, to take into account new research and industry developments (a state wide issue, not just Avon). Again this was stated with passion at the recent

	pulling dead wood or harvesting nuts etc).	We can quantify the demonstrated profitability of carbon farming in partnership with companies etc	roadshow!
Superannuation & tax incentives	<p>Point was raised at the workshop that farmers generally do not have superannuation, so some consider a tree crop as a form of “retirement fund”</p> <p>Tax incentives needs further review (see actions and comments)</p>	<p>We as a farm forestry group need to fully understand what the tax implications of tree cropping are in WA. We need to know if all tree cropping attracts a 100% tax deduction and if this is immediate, and we need to know if a grower claims a tax deduction for land care works (e.g the establishment of a tree crop) does this effect the ability to claim or sell carbon in the future?</p> <p>We could look at showcasing some examples of tree crops as a form of super.</p>	<p>We need to be clear between ourselves that we understand tax issues in a primary production situation with regards to tree crops.</p> <p>This point also begs the question about right to harvest of planted crops and also legal ownership of the trees vs the carbon rights. Do we need a Philadelphia lawyer in tow to assist with such questions?</p>
Location and land values – (note this can also be an impediment) – land values, yields, rainfall, might trigger landowner to diversify.	A poorer performing paddock (or part there –of) is chosen for farm forestry as it underperforms in the current broadacre program. With success, it offers the prospect of improving land value.	From soil maps on the three most likely tree crops, can those areas at most risk of degradation of some sort, be earmarked for promotion campaigns to offer people both stabilisation and profit on niche parts of the landscape. It will be delicate and no doubt best done through groups!	From an oil mallee perspective, the Quairading/Brookton area appeared to get a special colour for likely wind erosion.
Use of unproductive land	Perception that it may generate income from land not suited to current ag practices	Case studies of others doing this eg Barnes at Trayning. Field days to promote these.	<p>Most application here will be for the tree crops, swamp sheek, brushwood and sandalwood.</p> <p>Needs careful promotion, as farmers and their advisors can carve us up if not done right. For instance we may need to have a fencing man in tow as well as doing different enterprises, often</p>

			requires a fence to separate them and farmers hate fencing! Leave it out and our credibility is wrecked.
Fun	With an aging workforce and a number of single people living alone, different activities are emerging as pleasures for people. There may be some work here to have a sponsor assist in setting this up and provide drinks or afternoon tea to allow for the necessary networking that makes these events energisers.	At annual field days, try to include either an example of this type of entertainment to either see or become involved with eg busy bee at so and so's place for everyone to plant five acacia hosts each. Straight away you have offered people a hook – looks tempting too!	To give people an 'out' for a field day agenda, organisers could have the usual talk and shout session, a field visit and then a planting session at the end. This would give some the opportunity to have fun and learn at the same time, while an alternative activity (ie drinking and talking) would need to be also organised to cater for those either not willing or able to participate.
No till example	The no till movement is listed as an example of how something was taken up by farmers quite quickly. Contrary to popular myth, the experience in WA has not been recorded. For	Can a history of this story be found and applied to the tree industry. However there may other cases more relevant to forestry that can be found for this project eg. Learning to use computers; what fills the void from a dying lcdc movement!	Doubts are held for this as the key issues involved here were a short term outlay – thousands, but crop returns are annual and also there was a machine involved – noise, shiny and it moves – all things foreign to forestry.
Social viability	As population drops in inland WA, is there an opportunity here for forestry to provide a get together for people to stay in touch and also do something useful for the environment and themselves?	Adding on to other catchy agendas is important eg the Facey field day, the Wongon Hills field day – to promote an aspect of tree growth.	Trees are ideally placed here as it is hard to upstage a walk in a nice bit of nature. This will need careful planning in advance to make sure it is a pleasant experience eg a track that has some good visuals, has a seat for oldies, afternoon tea and a toilet! Social benefits here too, as the different industry sectors, have plenty of industry days that almost default as defacto

			bowling club days without the whites! It could be the start of another extended family!
Tipping point – when returns > agricultural lease value	A key point here – perhaps in the ‘see-saw’ of life for many, farm forestry is off the agenda but not being discounted. What we need is a transparent see-saw that keeps pointing out the advantages of trees – both real now and likely in the future and when the prospective grower sees the benefits increase and the see saw comes down then whamo they are in!	While there are economics on the two established industries, brushwood and sandalwood, it would be good to have it presented in a number of ways, eg a pie chart, a bar chart and even from a range of perspectives, hoping that one way may make an impact on the reader. It may pay to have these included as a footnote on any notes sent out, if it is found to be a key figure for prospective growers.	These values may not be well known, so finding out what they are and then making them available for public scrutiny may be worthwhile. It may involve the consultants! Yet another reason to build bridges with the AAAC
Declining profit from traditional crops	Related to the profit point above. However it needs to be stated that forestry is a quite low capital requirement industry, once establishment has occurred and in some cases, eg sandalwood can provide small amounts of income after year 5. This can offset a drop in profit from conventional agriculture.	In the case of generational handover, when a younger son is doing more and the aging father is in the way more and more, a hectare or so of forestry can be just the ticket to allow dad and mum to be active and at the same time give the son space to do his thing. It used to be crossbred sheep on a patch of irrigated lucerne – that never worked (for an aging farmer keen to still be active), now why can't it be a patch of sandalwood, brushwood or swamp sheok?	The role of mentors will be important as prospective planters need to start small and not make too many mistakes. Need not be the formal ones recently set up but someone who has done and cares!
Changing benefits – salinity, carbon, wind erosion	Argument seems to prevail here as to what are the benefits from trees. At this stage the ‘black and whites’ are sheep shelter and wind erosion protection. The rest are rhetoric as yet.	Keep people updated as more info comes to hand. Eg at Nungarin, we know this year that FPC don't want land there, but next year they could be in!	Trees and the warts they carry are a moving feast. It is our responsibility to keep them updated. There are still many skeptics that think carbon will not get up!

Perceived threats with conventional agriculture costs	For conventional agriculture there are some concerns with the price of fertilisers and the reliance on sprays. While adopting trees does not take away from this, having trees in there is a form of diversification and to some protection for spraying on windy days, is a bit of an escape valve.	It will still be important to compare apples with apples, but in the conventional ag and trees comparison, it can be emphasised that trees have little need for capital once established and few inputs.	Taken to the extreme, this could also have trees recommended on the cheapest and hence driest land in the south west. Hopefully this is not the case. Even with trees on a property, the farm will still have a need for a harvester and sprayer and tractor!
Markets for sandalwood and brushwood	The fact that these exist is a plus that can be played upon. There is money there in the long term!	Keep any arguments against trees as enterprise specific eg oil mallee is yet to have a market. This means the need to challenge and correct people is important to have any criticism correctly applied.	Correspondingly any progress in the way of biomass development needs to be promoted. That may be code for a need to have a media friend somewhere in the press.
Drought proofing your farm	While conventional ag will fall in a hole in a drought year, it needs to be remembered that trees will continue to grow, albeit at a slower than normal pace. Hence it is not all or nothing for them and with a trend toward more summer rain, trees are ideally placed to make progress from such misfortune.	While there will be a lead time to have crops ready to complement income, there will still be benefits after 3 years or so for wind erosion and even nuts after 5yrs. Looking for opportunities to promote the usefulness of summer rain for trees is the key here.	Depending on whether a farmer has sheep, it may also help set up feedlots, by having trees around them to protect stock in strong wind situations and to protect susceptible areas from wind erosion with carefully placed oil mallee belts (2 or 4 row)

<p>Intrinsic values – a caring attitude for the environment</p>	<p>Where genuine care exists for one's property, then some just wish to plant trees to protect the environment. In most cases there will have been a trigger for this, eg sand blown over a school bus route, or a saline or blown patch that can be seen from the kitchen window. The more visible it is the more likely that a family member will be pressured to do something about it – either by another family member or someone from the public who dobs them in!</p>	<p>Trying to find the worst parts of the landscape in each shire could be a good task for budding nrmos. It would need to be carefully thought out, as it could get them off side with the owner, but it may do some good too if it was linked to funding of some sort to assist!</p>	<p>Really needs high level tax incentives to make this work! In the pastoral areas, often industry workers approach owners saying they are doing a survey of watering points and yet the real agenda is to see how degraded the landscape is – can</p>
<p>Environmental – salinity, wind erosion, biodiversity etc – industry development also</p>	<p>This is the whole gamit and has been covered in part above. However this is a plea to have a cumulative story built around all the benefits that go with good works. Included here is the critical mass issue, that is most important for the emerging oil mallee and brushwood industries and to a lesser extent the others.</p>	<p>Keep the critical mass factors updated and in the news releases. It is almost like saying 'what is the next step' with the such and such industry. People will then have the option of assisting or staying on the fence!</p>	<p>Would it be possible to have colour coded, steps in some sort of chart that distinguished the fact and fiction aspects of the various industries eg. Carbon, biomass are still fiction at Nungarin but carbon is real life at Koorda.</p>

‘The technical and economic interaction between planted trees and conventional agricultural enterprises’.

Introduction.

This review aims to give readers an understanding of those factors that are significant in the interaction between trees and crops in agriculture systems in the south west of Western Australia. The focus for the review was to study references chosen which have relevance for a Mediterranean environment, with an annual rainfall less than 450mm to have relevance to the Avon catchment, located in the central agricultural region. To assist in this process, a range of perspectives from overseas and Australia are quoted and divided into a number of sections.

- i) Why study tree-crop interactions?
- ii) Clarifying interaction and industry significance
- iii) Benefits/disadvantages and other effects
- iv) Edge effect characteristics
- v) Economics
- vi) Ideas for further research.

For the Avon region, an area of 11.8 million hectares, there are current (2008) industry plans for oil mallee, sandalwood and brushwood. All species have been successfully established in the Avon catchment, with oil mallees being the smallest with respect to required industry scale, either in block or belt design. References used for this review will concentrate on the belt design, which is the more common with oil mallee plantings. While pastures are affected by trees grown nearby, this review will focus on crops as they are the more important enterprise with respect to composition of farmer income.

Forestry size in Australia was reported as being at 5%, which is down from 9% at the time of European settlement. However coverage varies between states and in WA the forest cover is 1%, Herbohn et al (2000). This suggests that with respect to future tree plantings, it will be effectively starting from a clean slate.

In considering further promotion of farm forestry in the Avon region, the following points are provided to give context;

- The number of farmers is declining, resulting in a significant number of those remaining farmers being increasingly time as well as cash poor.
- Rainfall has been declining over the past 20 years, in particular winter rainfall (May-Oct).
- Advice given to farmers is now largely carried out by the private sector, with some input from the government sector. Consistent with this move, there is a strong emphasis on those enterprises which are profitable in the short term and a tendency for environmental budget items to be given low priority or dispensed with, in challenging economic times. Advice relating to environmental issues is most likely to come from shire employed, Natural Resource Management Officers (NRMOs), with some back up from government agencies.
- Investigations into sustainability indicators for the landscape are largely conducted within a range of projects that are managed by the Avon Catchment Council. Two project examples are, i) the soil health and land management practices and ii) identification of land management practices that contribute to soil acidity.
- There are limited market opportunities for tree products. While markets do exist for sandalwood products, brushwood and oil mallee are still in the development stages.

- Critical mass issues confront the oil mallee industry, whereby tens of thousands of trees are required to justify development of energy producing centres. To a less extent the brushwood industry faces similar issues.
- Markets are becoming more sophisticated and sensitive to knowing the environmental implications of production chains. As a result, agricultural produce is increasingly being subjected to a range of quality assurance processes.

1) Why study tree-crop interactions?

Alley farming is the growing of belts of trees in rows that are widely spaced to allow conventional agriculture to be practiced between the trees. The belts are made up of rows of trees, usually 1-4 rows wide. Distances between rows within the belts may range from 1-4m and distances between the belts ranges from 40m to 200 m.

It is important to study the interaction between trees and adjoining crops and pastures, so that an overall assessment can be made as to whether the advantages of farm forestry outweigh the disadvantages. In Western Australia, it is protection against wind erosion that is one of the major benefits tree belts provide along with livestock shelter. As cropping is the major determinant of farm income, increased protection from spray drift along with reduced wind speed thereby enabling more spray time, are other key benefits. Assistance in the fight against salinity is debatable and the topic of ongoing monitoring and research.

There is evidence from Australian research that supports the practice of alley farming, ie trees and crops/pastures grown together. Among the many benefits provided by trees are, protection from spray drift, livestock shelter and control of water runoff, Cleugh (2002).

Decreases in crop and pasture growth immediately adjacent to trees are the main disadvantages along with the loss of land to conventional annual agricultural crops.

In one of the most comprehensive reports, it is noted that decreases in crop yields can occur from 1H-3H (H= tree height) from a tree belt, with little change or a slight increase up to 10 or 20H. Yield gains were smaller than expected, especially for cereals. When all economics are considered, tree belts will generate a small gain or be cost neutral. The largest benefits are likely to occur during protection from irregular high wind events. Wind speed can be reduced up to 5H upwind and reaching to 25 H downwind, Cleugh et al (2002).

2) Clarifying interaction

Interaction is described in Wikipedia as '*a kind of action that occurs as two or more objects have effect upon one another. The idea of a two-way effect is essential in the concept of interaction, as opposed to a one-way causal effect*'. Hence in this review, the two object groups are trees or shrubs together with crops or pastures. While a number of references reviewed relate to overseas research, emphasis will be given to those studies carried out in Australia. It is also the effect that the trees have on the adjoining crops (not pastures), rather than the reverse, which will be given emphasis, as this is the perspective of most of the research.

The potential problems associated with farm forestry involve the setback that the components can cause upon each other. Such interactions as these can be one-way or two-way by the components of the system, Schroth et al (1995).

With respect to the emerging industries in the Avon catchment, it is too early to put figures on the production levels. However the major three species have recently released industry plans,

that bring with them confidence that each will progress in the future. It is the plans associated with the oil mallee, brushwood and sandalwood industries that have most relevance for the Avon region, as producing timber for sawlogs is unlikely to be ever more than a niche industry, because of rainfall limitations.

Schemes associated with carbon sequestration also exist and are on the increase in the region, more so in the western part of the district, associated with higher rainfall, but more efforts to promote schemes in the drier eastern parts are occurring. There is still considerable confusion surrounding carbon issues relating to the planting of trees and some consultants are advising their clients to wait until it is further clarified. Despite this situation, carbon remains a significant potential catalyst for an increase in farm forestry.

On the subject of design of farm forestry plantings, it is belts of trees that are most common to observe for oil mallee and block plantings for both sandalwood and brushwood. While it is the less productive land units, usually based on the presence of infertile sand or shallow rock, that are initially earmarked for farm forestry, once landholders realise the benefits, more productive land is then included for future farm forestry plans. The majority of landholders still retain some livestock and rotations of crops and pastures occur to manage this component. It is notable that the woollen breeds are slowly being replaced by other breeds as market signals show preference for meat products.

For tree belt design, the change in technology to auto-steer in tractors together with GPS, has meant that there is now a distinct trend toward rectangular blocks, whereby straight lines mark the boundaries between crops/pastures and trees. The distance between belts, is usually set to multiples of the widest implement, eg. a boom spray. Such a system allows for easier management than tree belts on the contour. It is important to remember that the disappearance of contour banks from the landscape, which is a reality, is occurring in the context of declining rainfall together with a no-till cropping system that most farmers now practice. A key aspect of no-till cropping, is stubble retention which also assists with runoff control.

3) Benefits/disadvantages and other effects

Among the more agreed and tangible benefits resulting from farm forestry, wind erosion protection features prominently. It is singled out here for special mention explaining one of the advantages of farm forestry, because wind erosion is significant in most seasons in the Avon catchment on susceptible parts of the landscape and to some extent manageable. Other advantages of windbreaks which should not be forgotten include; livestock shelter, future income from tree products, improved spray and fire management, shade protection for labour engaged in farm activities and reduced evaporation from dams.

It is in dry windy years that most benefit will come from windbreaks. Yield increases of up to 25% for crops have been realised in the 1H-20H zone, when compared to unsheltered crops. In dry years without severe winds, yield increases in the sheltered zone compensated for yield losses in the competition zone near the trees and overall yield was similar to that of unsheltered crops, Sudmeyer et al (2002).

Wind speed is reduced both upwind and downwind of windbreaks, in an area measuring 5H and 30H respectively from windbreaks. Foliage density of the trees in the windbreaks, determines the size of the wind speed reduction, <40% for a more porous break to approximately 70% for the least porous. Provided the windbreak is 20H in length, changes in wind direction of up to 30% have little effect on the protection given by the break. Yields of cereals were unresponsive to shelter, Cleugh 2003.

Consideration of other factors reveals:

i) soil water

While it is undisputed that trees will utilise soil water, it appears quite open to further debate, as to whether significant gains can be achieved with the planting of trees to alleviate soil water issues that contribute to the challenge which dryland salinity poses in Western Australia. With this in mind it is relevant to examine some of the research that relates to use of water by trees.

Under Western Australian conditions, the extent of the tree-crop competition zone is less than that observed in the east, where it has been measured to 3H. Tree roots extract water to a depth of 0.9m depth under the crop area and the different rates of wood production from inside tree rows compared to the outside rows is because of an enhanced water supply to the edge trees, Huth et al (2003).

Trees have the capacity to improve water use efficiency by reducing unproductive components of the water balance, run-off, soil evaporation and drainage, Ong et al (2002).

ii) root density

Root density has been found to be greatest in the top 50cm of the soil profile in Australian studies involving *E.globulus*, *P.pinaster* and *P. radiata*. The decrease with depth for roots was quite gradual in deep sands but density decreased abruptly in clay subsoil. It was also found that soil water content was less nearer the trees and that the soil water content was negatively correlated to root density, Sudmeyer (2002). Overseas work in Ethiopia with eucalypt trees has supported the above work, with the greatest concentration of fine roots found in the 0-60cm vertical range. Roots greater than 10mm diameter were few in number and occurred lower in the soil profile. It is suggested that most of the water transpired comes from depth, below the crops rooting zone, on the tree boundary. In drought years, the trees have the potential to explore water via fine roots to a distance of 15m, Kidanu et al (2004).

iii) nutrients

Nutrient levels N and P (labile or plant available) have been found to be at lower concentrations under tree belts when compared to those levels in the alley under crop, Grove et al (2007). The concern is that unless managed, trees will increasingly rely on nutrients from the alley soils, ie directly competing with crops.

Potassium levels were found to be higher under a tree belt than at 2H from the trees, Sudmeyer (2002).

iv) yield losses

Competition effects of trees upon crops have been measured out to 10m for oil mallees. Water is the main factor in this competition, with light and nutrients of less importance, Sudmeyer (2002). Yield decreases in the order of 20-50% have been observed within 3H of oil mallees. Crops grown in the region, 8-10m (3-4H) from oil mallees did not breakeven in an economic analysis. The effect of root pruning on an annual basis is believed to be the best for oil mallees. However this is soil type dependent and less effective on deep sands when compared to duplex soils. Coppicing mallees considered to have a similar effect on crop yields, to that of root pruning, Sudmeyer and Flugge (2005).

Models have been developed to simulate the effect of tree belts on crop yields. An APSIM model applied at Narrogin, found that from an open paddock yield of 2.9t/ha (wheat), yields were reduced by 60% at a distance of 2m from the belt and by 39% at 10m. At Merredin, from an open paddock yield of 1.8 t/ha, yield reductions of 63% and 18% were recorded for the aforementioned distances, Carberry et al (2007).

4) Edge effect characteristics

With the likely increase in the area of trees established in a tree belt form associated with promotion of the oil mallee industry, it is important to understand that within any belt, trees grow differently depending upon whether they are in an inner or outer edge zone. The belt is therefore separated into two functional components, with trees on the edge having access to water and nutrients within the field, as opposed to within the belt. As a result of this characteristic, the productivity of trees in the edge zone is often greater than those in the inner rows. Simulated trials from the eastern states have found that while 50% of the wood growth variation from year to year for the inner belt trees can be explained by annual rainfall, for those trees in the edge zone, the corresponding figure is only 11%. This is because the trees on the edge were able to use water from cropping land during extended dry periods to maintain relatively higher growth rates, Huth et al (2003). In the same study, total simulated drainage of water for a given area in which belts occupied 4% of a catchment was found to be reduced by almost double that amount, 7.5%.

5) Economics

Industry plans developed in 2008 for the three most promising tree crops for the region, reveal that there is 10,000 ha of sandalwood planted, 13,000 ha of oil mallees and 1,000 ha of brushwood. These are approximate statewide figures.

Returns from sandalwood and brushwood have been developed for the Avon region, using net present values. Using the most realistic of the scenarios listed, sandalwood can be expected to return \$3790/ha or \$5790/ha if the sale of nuts is added to wood sales. The time period is 20 years. For brushwood, returns of \$280/ha may be expected, with harvest occurring every seven years. These reports were developed by Avongro. For the majority of current plantings in the Avon catchment which are 4-row, harvest frequency is expected to be every 10 years.

While the above figures are open to scrutiny, returns from oil mallees are more debatable, as an established market for the sale of biomass is still to eventuate. However if establishment costs are ignored for oil mallees, then a price for biomass of \$40/t needs to be realised, if it is to compete with wheat at Narrogin. However at Merredin the price of oil mallee biomass would have to fall below \$8/t for the oil mallees to become unprofitable. It is also mentioned that almost all tree cropping scenarios were inferior to standard cropping systems, Carberry et al (2007). Support for this opinion is specifically mentioned for the low and medium rainfall areas of WA, where research has found that yield lost from crops adjoining windbreaks, may exceed the benefits from shelter unless unsheltered crops regularly suffer severe wind damage, Jones and Sudmeyer (2002).

Another key consideration when contemplating the planting of tree belts for wind erosion protection is the frequency of severe winds. If four or five severe wind events are anticipated every 36 years, then the benefits from having a windbreak are likely to exceed the costs of both establishment and damage. Put another way, if wind damage is expected at least once every six

years, there is an 80% probability that the windbreak will break even over a 36 year period. Root pruning further adds to the chances of achieving this, Jones and Sudmeyer (2002). Even though work to obtain figures was done on the south coast, the minimum frequency listed has a good chance of being exceeded in the central agricultural region also.

Overseas evidence points to a range of benefits being needed to entice growers to plant trees in an alley formation. These are being able to obtain tree seedlings at no cost, the possibility of inter-planting trees with food crops without adverse effects on crop yields and the possibility of earning some income from the trees, Kang et al (1990).

6) Ideas for further research

The following ideas listed as being in need of more research;

- Growth parameters of suitable tree species to assist use in the APSIM model. This work could include interactions between trees and adjacent crops.
- The amount and local distribution of surplus water as generated by agricultural systems.
- How can the capture of surplus water be maximised by the design of woody crops
- How do woody crop species compare in their water use efficiency
- Comparing yield responses under windbreaks with those without together with frequency of wind damage.

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