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Commercial Environmental Forestry: Summary of the 4-year program

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Executive Summary

The Commercial Environmental Forestry (CEF) program started in October in 2003 and finished in July 2007. It began with a vision of developing an economic proposition, based on public-private partnerships, that would facilitate the establishment of large-scale plantations in regions where they were needed to address environmental problems, especially stream salinity. The CEF program evolved its focus and objectives over the (nearly) 4 years in response to changing policy and economic drivers.

It became clear that a major consideration for investment in forestry projects in marginal zones would be risk assessment – knowing how well trees would grow and what the expected economic and environmental outcomes would be. The CEF Research and Development program invested most its resources in collating existing and new data to underpin biophysical and planning models. Predictive tools will only be of value if they are supported by robust science, to reduce investment risk and to provide confidence that the growth rates of forests and environmental benefits predicted will, in fact, be realized in the decades to come.

The CEF program was in two phases:

Phase I (2003-2006). Data gathering and technology development. The south-west Goulburn Broken catchment in Victoria was used as a desk-top case study to demonstrate the CEF concept.

This phase developed a wealth of information and capability, focusing on:

(i) ***Growth prediction and risk.*** Commercial species included sugar gum, spotted gum, blue gum and radiata pine. Environmental plantings were also studied – mixed species, multi-layered forests established for conservation, salinity or carbon benefit.

(ii) ***Environmental and economic services.*** The impacts of forests on stream salinity, stream flow, carbon sequestration, biodiversity value and forest economics.

(iii) ***Integration – The Scenario Planning and Investment Framework (SPIF) tool.*** The SPIF tool is ARCGIS software that enables users to explore the impacts of alternative forestry and revegetation options on commercial and environmental outcomes.

Phase II (2007). Application of the CEF technologies to catchments in WA (Upper Tone) and Victoria (Corangamite) in association with forest establishment programs (public and private investment). This work ran for about 6 months in early 2007.

The CEF program has greatly enhanced capacity and capability in many organisations and it is currently being applied to other projects. A key feature of Phase II was the extensive engagement with stakeholders, covering the range of interests, and which reinforced the notion that successful reforestation programs are as much a social exercise as they are one of scientific assessments.

New policy developments such as emissions trading and the increasing focus on biofuels may lead to a significant expansion of the plantation and farm forestry estate across Australia. The range of investors will include new private enterprises, forestry

companies, institutional investors and land holders. CEF has been a highly successful program and it is well positioned to add significant value for both private investors and regulatory authorities as the forestry sector seeks to take advantage of the enormous opportunities ahead.

Background

The CEF research program began in October 2003. It started with the objectives and goal:

'*Commercial Environmental Forestry (CEF) aims to develop co-investment (private and public) to underpin sustainable plantation development for commercial and environmental outcomes. CEF focusses on developing scenarios to optimise commercial forestry outcomes in low-to-medium (500-800 mm p.a.) rainfall areas by assisting with species selection, location in the landscape, plantation management and product decisions. The framework will allow plantations to be targeted for salinity mitigation, carbon sequestration and other environmental benefits. The CEF Theme incorporates a 3-year collaboration between CSIRO Forestry and Forest Products, the Department of Agriculture Fisheries and Forestry (DAFF), Victorian Department of Primary Industries, the Goulburn Broken CMA, the National Association of Forest Industries (NAFI), and the Murray Darling Basin Commission (MDBC).*

The Goal: *By 2006 develop a toolbox to demonstrate profitable forestry scenarios for multiple environmental benefits and regional economic development. This toolbox will support the aims of CEF of developing forestry co-investment (private and public) to underpin sustainable land use change for commercial and environmental outcomes.*'

The CEF program mostly achieved this goal although it necessarily evolved over time. It began with a vision of providing a new business model for especially the large, private forestry companies and focussing on salinity mitigation as a driver.

The CEF research program addressed questions relevant to scales of regions and farms, such as:

- Where are the best places in the landscape and on farms to establish trees for environmental benefits, including intercepting salt moving into rivers and enhancing biodiversity?
- What are the best tree species to plant and what will be their likely rates of growth?
- By how much will stream flow be reduced and how can the impacts be minimised?
- What are the options through site and species selection, as well as forest management, to maximise growth, carbon sequestration and product value for economic benefit?

To help answer these questions, CEF initially focussed on the following core areas:

(i) Growth prediction and risk

To deliver maximum environmental and economic benefits, trees must survive and grow well. Research has produced calibrated models to predict growth and carbon sequestration of:

- Commercial forest species – *Eucalyptus cladocalyx* (sugar gum), *Corymbia maculata* (spotted gum), *E. globulus* (blue gum), *Pinus radiata* (radiata pine); and

- Environmental plantings – mixed species, multi-layered, forests that often have been established for biodiversity enhancement by direct seeding, planting of tubestock, or by fencing of remnant native forest to encourage regeneration.

Additional research was undertaken on:

- The effects of management such as spacing and thinning on growth;
- Development of a growth data base for Australian forest species; and
- The potential impacts of climate variability and change on tree survival and growth.

(ii) Environmental and economic services

Research examined the impacts of forests on:

- Stream salinity;
- Stream flow;
- Carbon sequestration;
- Biodiversity value; and
- Forest economics.

(iii) Integration –The Scenario Planning and Investment Framework (SPIF) tool

The SPIF tool was developed to enable users to explore the effects of alternative forestry and revegetation options. Research outputs were integrated into the SPIF tool which takes the spatial outputs from biophysical models and overlays them with GIS data for the region being studied. Users of the SPIF tool can set their own criteria for environmental outcomes and for the different types of forests and management impacts.

Phase I (2003-2006)

The program established a case study in the south-west Goulburn-Broken (SWGB) Catchment of northern Victoria, the objectives for which were:

- Use the SWGB as a desk-top case study to develop the CEF concept and apply it to the region to demonstrate its application, and
- Work with the CMA, landholders, forest companies and the local farm forestry community to establish plantations.

The SWGB was chosen after extensive biophysical (spatial) assessment across many candidate regions and consultation with candidate CMA and State representatives in Victoria and NSW. The SWGB was, at the time, clearly the most attractive because:

- It is a highly salt-affected area, one of the most severe in the Murray-Darling Basin;
- This also coincided with relatively high rainfall such that it was predicted that trees could grow reasonably well (near commercial rates) and also mitigate salinity impacts. This was the only region where there was such overlap;

• The SWGB has a wealth of long-term biophysical data that could be used to calibrate various models of forestry impacts on growth, stream flow and salinity; and

• The Goulburn-Broken CMA indicated that they would be supportive, that there was no 'anti-forestry' community sentiment and they would co-invest in tree planting programs.

The R&D program of this phase of CEF was successful. It collated and collected an enormous amount of existing and new information. It developed the SPIF tool into which this information was integrated. The CEF Toolkit was launched in July 2006. Some of the main outputs from this work were:

• ***New data for growth of commercial species***. In total, the number of data sets collated was 135 for sugar gum, 80 for spotted gum, 129 data for radiata pine, and 177 for blue-gum. For sugar and spotted gums this included extensive destructive sampling, including roots, to determine biomass for model calibration. For blue gums it included an extensive data set from the forestry company Midway of 200,000 lines of data for 660 permanent sample plots of 40 trees each. These data were used to assess the impacts of climate variability and change on annual tree growth using a physiologically-based model of tree growth (CABALA).

• ***New data for environmental plantings***. The initial focus of CEF was on industrial forestry but it became clear that much of the initial private investment could be driven by environmental plantings for biodiversity, carbon and salinity benefit. This project collected, for the first time that we are aware, data on growth, carbon sequestration and water balances in these forest systems. Data were published in a conference proceedings and led to a new project in the Lachlan CMA.

• ***Consolidation of data into TreDAT***. This database was developed by CSIRO some years ago to record growth, mostly in genetics trials. Despite being an extensive repository of information it was rarely used for its intended purpose. The CEF program took the opportunity to use TreDAT as a basis for recording our new information and to build it into a useful database of tree growth across Australia. TreDAT initially had about 3000 lines of data (growth records). The CEF program enhanced TreDAT by including our new data, annual average climatic information for each site, interpolated actual climate for the growth period (from SILO Data Drill), cleaning the database, and calculating stand volumes from height and diameter measurements. Statistical analyses are continuing.

• ***Impacts on stream flow and salinity***. A major initial objective of CEF was to predict the impacts of plantations on stream flow and salinity. We used the BC2C model of CSIRO Land and Water for this assessment and to demonstrate its applicability to the SWGB case study. After calibration of the model to local, historical data, results showed how careful targeting of plantations could be used to maximise the salinity mitigation benefit and while minimising water interception. For example, of the total land available for significant salinity interception, it was shown that planting an area of only 25% of this total could

achieve 50% of the salt interception. The enhanced capability was further used to predict salinity and stream flow impacts for the whole of the Murray-Darling Basin and which was included in a report to the MDBC.

• ***Hillslope (farm-scale) modelling***. At present, most spatial models of growth and water impacts operate at regional scale. Furthermore, they do not explicitly couple water use by trees to other transfers that lead to run-off. A key challenge is to develop a predictive capability at finer scales (farm and paddock) so that the potential outcomes from planting scenarios (farm plans and scenarios) can be assessed. This project developed the FLUSH-3-PG tool that predicts tree growth, water use, and water flows at hillslope level (top, mid-slope, and bottom of hills). It used the long-term Pine Creek catchment in the SWGB as a case study. This project demonstrated the utility of the new product, although it remained it prototype stage. Nonetheless, it provides a potentially powerful new capability, with further development, to assess more explicitly growth and in-steam impacts at a fine scale.

• ***Biodiversity.*** During CEF biodiversity stimulated significant debate and because it is subjective and less well defined than say, prediction of water or carbon that are tangible commodities, developing an assessment framework for biodiversity impacts of new plantings proved a challenge. We developed a 'Plantation Biodiversity Scorecard' (PBS) that was based on the two main and accepted principles of biodiversity benefits: (i) connectivity with existing forests and (ii) 'within plantation' structural diversity that provides a range of habitats. It was based on 'best available' information and was also incorporated into the SPIF tool to predict spatially-explicit outcomes.

• ***Welfare economics.*** There are two steps in developing a value proposition for CEF: (i) quantify expected outcomes, and (ii) value the goods and services. CEF has focused mostly on the first of these, quantifying the net impacts because they are mostly a result of biophysical processes. Valuing ecosystem services is more difficult, especially when these are externalities that are not recognised by the market as having any value. A student completed a M.Sc. Thesis on Welfare Economics of CEF to try to overcome this impediment. This developed an economic framework to assess the net impacts of plantations on salinity outcomes and carbon sequestration. It could also be used for biodiversity assessment.

• ***The SPIF tool***. The SPIF tool software was developed by the CEF program. It has generated capability to:

− *Target* where to establish forests within a catchment or on a farm, for expected impacts on growth, carbon sequestration, biodiversity enhancement, forest economics, salinity reduction, stream flow impacts and stream sedimentation.
− *Assess* project design and expectations.
− *Monitor* the success of revegetation programs against targets.

It was used in the SWGB case study to demonstrate the capability of targeting at regional level and to asses on-farm proposals.

The tree planting part of this phase of CEF was not successful. In two successive years (2005 and 2006) a tender system was tried in the SWGB to develop public-private partnerships in plantation forestry. Properties where tree planting would have a positive effect were identified and a number of interested plantation companies invited to submit tenders for assessment by the Catchment Management Authority (CMA). Reasons for the trials failing included:

- The plantation companies did not want to invest in what would have been small holdings (50-200 ha), especially if they were not contiguous with their existing resource, because it was uneconomic.
- The amount that would have been offered (about $700/ha) as co-investment was not enough to make it a viable economic proposition. Experience in other regions has shown that environmental payments of more than $1000/ha are needed.
- The SWGB is close to Melbourne. It has a fragmented ownership of land that is increasingly occupied by small land holders who commute to Melbourne or are 'weekenders'. This has raised the price of land and makes it difficult for plantation companies to get contiguous blocks for planting.
- The drought persisted for the duration of the CEF program. This discouraged not only plantation companies but caused the CMA to re-assess their targets for revegetation as contained in their regional Catchment Strategy, due to the perceived negative impacts of plantations on water security.

Phase II (2007)

The last year (2007) was case study application of CEF in WA (Upper Tone) and Victoria (Corangamite) catchments. The work program started in early 2007 and continued for about 6 months.

The WA case study was part of the Strategic Tree Farming project under the Commonwealth-State National Action Plan for Salinity and Water Quality (NAP) agreement. Key objectives were to:

- Add value to that project by developing and applying a spatial tool (SPIF) to assess impacts of plantation plans on environmental and commercial outcomes; and
- Build capacity for the Forest Products Commission (FPC) and farm forestry stakeholders to facilitate longer-term investment in plantations.

The Victorian case study was selected after exhaustive engagement to identify a region in south-eastern Australia where there were good prospects of the CEF concept providing a demonstrable, additional benefit to on-going activities. The Corangamite region is outside the Murray-Darling Basin and so was not considered in assessments in CEF Phase I. Key objectives were to:

- Engage with the Corangamite CMA and local Department of Primary Industries Victoria (Vic DPI) to bring CEF into their decision making process for ecosystem service payments.

• Identify private forest companies who would benefit from and apply the CEF technologies.

The WA and Victorian projects have been highly successfully and achieved a great deal in 6 months. They involved further development of the database that underpins model predictions and work with a wide range of stakeholders. Some of the main achievements have been:

• ***New 3-PG$_2$ model***. The 3-PG model for growth prediction, developed by CSIRO, has evolved over time. In the SWGB study we used the 3-PG+ version developed by the University of Melbourne, but it became clear that it would benefit from further improvement. This was especially driven by the linking of 3-PG to spatial models of hillslope water flows (such as FLUSH and CAT). The main improvements in 3-PG were to separate the components of the water balance (transpiration, canopy interception, soil evaporation) and have a better soils module for determining plant available water. The model is available as a 1-dimensional version (Excel) or in spatial mode (C++). The new model was calibrated and tested extensively against Ensis data for water balances in forests, particularly transpiration and changes in soil water. It will now be a useful model for further applications, for example in predicting water outcomes from various configurations and management of plantations.

• ***New regional data to verify growth predictions***. An important aspect of CEF and its modelling tools is that they be well calibrated and, as far as possible, verified. In Victoria, we collected new data for growth and soil descriptions within the Corangamite case study region. In WA, new data were collected from across the south-west region. Data were used to independently test the 3-PG$_2$ model and provide robustness to predictions.

• ***CAT modelling***. In both WA and Victoria, we aimed to build on existing capability as far as possible. In Victoria, we therefore built linkages with the Catchment Analysis Tool (CAT) modelling group of Vic DPI who had previously predicted the impacts of plantations on stream salinity and flows in the Corangamite as part of the Sawlogs for Salinity Program. This required considerable testing and parameterisation of the 3-PG+ part of the CAT model and resulted in a much improved predictive capacity.

• ***MAGIC modelling***. In WA we used the MAGIC model of water and salinity impacts that had been developed by the Department of Water (DW) and which also had been used previously in the Upper Tone catchment. The MAGIC model was enhanced by linking it to explicit, spatial predictions of water use from the 3-PG$_2$ model. This enables the MAGIC model to better predict impacts at farm scale and is an advance on the more empirical approach that was undertaken in the south-west Goulburn-Broken study where rainfall (as opposed to actual evapotranspiration) was the only delineator of water use.

• ***Stakeholder engagement***. A key feature of the WA and Victorian projects has been the extent of stakeholder interactions. This involved working closely with:

(i) the existing research network (Universities, state agencies) within the immediate and wider region to ensure that CEF acknowledged previous work and was seen to be value-adding through the new, verified, outputs it was generating, (ii) the local farm forestry support networks, and (iii) private forestry interests, especially in the Corangamite.

• ***Farm plans and regional assessments***. A key objective of the two case studies was to demonstrate direct application of the CEF technology through development of tree planting farm plans. In WA, four farms and landholders were identified in the Upper Tone catchment and the SPIF tool used to assess the net impacts of tree planting on commercial and environmental outcomes. In Corangamite, farm plans were prepared for Great Southern Plantations, Sustainable Forest Management, Associated Kiln Driers, Ballarat Goldfields, Sovereign Hill Tourist Park, and three farm landholders.. The SPIF tool has also been incorporated into the risk assessment process of the Corangamite CMA for selecting proposals for environmental payments.

Outcomes

The CEF program achieved many things in its 4 year life. It started with a blank sheet and the research program evolved over time in response to a changing policy environment (for example, the greatly increased focus on water security that emerged) and the clear identification that large-scale reforestation of marginal landscapes for commercial and environmental benefit would be driven by a range of investor types, and not confined to the industrial plantation companies. It also became clear that the single largest consideration for large-scale plantation development would be risk assessment – knowing how well trees would grow and what the expected economic and environmental outcomes would be. That requires not just robust models but an extensive dataset to underpin predictions. Below is a brief list of some of the main outcomes from the program.

Capacity building

CEF was not intended to manifest change by itself, but to build capacity with other research organisations and agencies so that the pathway to adoption was extensive. Some of the main capacity building outcomes have been:

• The FPC has a long-term strategy for promoting private forestry in WA. A key requirement is a capacity for robust predictions of growth and other impacts, spatially and especially at farm-scale. The work undertaken in this project has collated existing data from the FPC, collected new data on growth and soil properties, and used it to calibrate and wherever possible verify growth predictions. FPC and other staff will be trained in use of the new 3-PG$_2$ model and the SPIF tool. The enhanced capacity is seen as a significant value-add to on-going efforts.

• The CAT model of Vic DPI was used in the Corangamite study because it had been used there before. CAT uses the 3-PG+ model to predict growth, carbon sequestration and water uptake as it affects flows of water into rivers. The CEF

program worked with the CAT model to overcome several inconsistencies and errors in model predictions. We used our extensive datasets to calibrate 3-PG+ and ensure that model predictions were the best possible. This has considerably enhanced the capacity of the CAT model for future work. For example, Vic DPI has commissioned the CAT group to assess the impacts of land use change on water security in the Corangamite and West Gippsland catchments as case studies. Vic DPI is also interested in carbon outcomes. Our work with the CAT group has provided them with a robust and verified modelling capacity, calibrated and applied to the Corangamite catchment.

• The Corangamite CMA has incorporated the SPIF tool into its risk assessment process for selecting proposals for environmental payments.

• The MAGIC model, used by WA DW to predict water and salinity impacts, has been greatly enhanced by linking it to explicit, spatial predictions of forest water use from the new 3-PG_2 model. The Strategic Tree Farming project of WA plans further plantation establishment in the Upper Tone, and the SPIF tool and enhanced MAGIC model provide a sound basis for net impact assessment.

• The CEF work has directly led to new projects, for example:

− 'Prioritisation of regional opportunities for agroforestry investment' (JVAP). This project aimed to assess opportunities across Australia for agroforestry investment, based on spatial estimation of commercial and environmental impacts. Ensis used the SPIF tool and other capability developed during the CEF program examine a range of scenarios for different species and products.

• The CEF program was the basis for two M.Sc. theses.

Capability building

CEF has also significantly enhanced research capability to facilitate large-scale establishment of plantations in Australia, including:

• Through the new 3-PG_2 model and link to FLUSH, greatly improved predictions of the impacts of plantations on water balances and stream flow, especially at hillslope scale. This capability may be particularly important to assess the impacts of plantation location, design and management on water security as the National Water Initiative is implemented.

• Positioning for any major biosequestration initiatives should tree plantations be eligible as off-sets in a national emissions trading scheme. Significant expansion of plantations across Australia will necessarily involve multiple impact assessment with water security being a major consideration. New plantings are likely to be established in the more marginal zones where land is available and not cost-prohibitive but where rates of growth must still be acceptable. The CEF data set and SPIF tool provides an excellent framework for providing impacts assessment for private investors and regulatory authorities.

Application (Commercialisation)

The ultimate success of CEF will be determined by the extent to which it is applied to on-ground works. During the course of the research program we have seen shifts in policy

and investor drivers that have indicated that the immediate opportunities for large-scale expansion will be driven less by the traditional industrial plantation companies and more by a range of investor types and emerging markets. Emissions trading and the increasing focus on biofuels may lead to a significant expansion of the plantation and farm forestry estate across Australia. The range of investors will include new private enterprises, forestry companies, institutional investors and land holders. CSIRO has already undertaken several projects to apply the SPIF tool and discussions are underway with several other organisations. We are confident that CEF has been the right program to help the forestry sector take advantage of the enormous opportunities ahead.