POTENTIAL FOR CARBON SEQUESTRATION WITH MARITIME PINE IN WESTERN AUSTRALIA.

by Dr. Andrew Rado

Department of Conservation and Land Management
CALMSharefarms Midwest

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INTRODUCTION

Carbon stored in organic matter constitutes one of the world's major carbon pools. Large scale reforestation to form an additional biosphere sink to compensate for input into the atmosphere by the burning of fossil fuels was proposed two decades ago (Breuer 1979). It has been estimated that up to 500 million hectares of tree plantations would be required to absorb the estimated annual increment of 2.9 billion tonnes of carbon emitted into the atmosphere (Sedjo 1989).

Maritime pine (*Pinus pinaster*) plantings in the medium rainfall zone (600-400 mm) of Western Australia offer enormous potential for carbon sequestration and carbon credit trading (Shea *et al.* 1998). Maritime pine occurs naturally on the northern and southern coasts of the Mediterranean sea and the Atlantic coasts of France and Portugal, which makes it well suited to the Mediterranean climate of south west Western Australia. Maritime pine performs extremely well, producing good quality sawlogs, on the infertile sandy soils, which are widespread throughout this rainfall zone. This provides very good synergies with the traditional agricultural pursuits, such as wool and grain production, which will continue on the better quality soils within these rural communities.

The original native vegetation of these areas consisted of Eucalypt, Acacia and Banksia woodland. This vegetation is now largely confined to small remnant populations. Extensive land clearing has caused significant land care issues; the most important is dryland salinity. In addition to their commercial potential Maritime pine is an excellent general farm tree contributing to landcare.

THE KYOTO PROTOCOL

As one of the Parties to the Climate Change Convention, Australia has made a commitment to limit emissions of greenhouse gases in response to the threat of global warming. The primary sources of greenhouse gases are from industrial processes that consume fossil fuels and the removal of woody perennial vegetation for agricultural pursuits. Generating carbon sinks through carbon sequestration is a real option in which organisations or nations can adopt to meet net reductions in greenhouse gas emissions. The Kyoto Protocol recognised that carbon sinks could be used to offset emissions. Under the Kyoto Protocol sinks are defined in article 3.3 – "*... resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period...*". It is however widely acknowledged that considerable uncertainty exists on the rules governing carbon sequestration. For example, the precise meanings of afforestation, reforestation and deforestation are the subject of discussion and analysis through the IPCC, and will be negotiated between countries under the Framework Convention on Climate Change. The likely outcome of these negotiations is unclear.

Despite this uncertainty, the proposed international rules for the first commitment period (2008-2012) suggest that the amount of carbon sequestered by trees will be determined by measuring the total carbon stocks in tree plantations established from 1990. It is also widely recognised that there will be subsequent commitment periods.

The recognition that products from tree crops (i.e. wood and tree crop residue) make a contribution to reducing net carbon dioxide emissions within the Kyoto framework, either directly by storing carbon or indirectly by replacing materials that result in high CO_2 emissions, substantially increases the sequestration benefit of Maritime pine.

The mechanism in which tree crop products reduce the consumption of fossil fuels is two-fold. Firstly, tree crop products may replace fossil fuels that have been traditionally used for energy production, and secondly, by replacing materials that require high energy levels to manufacture, such as steel, concrete and aluminium. Importantly, the carbon displaced via this mechanism is a permanent contribution to CO_2 emission reduction.

The purpose of this paper is discuss what Maritime pine and Western Australia offers by way of carbon sequestration projects and describe the role CALM may play in facilitating the trade in carbon sequestered by Maritime pine.

ROLE OF CALM IN FACILITATING THE TRADE IN CARBON CREDITS

Enormous potential exists for farming Maritime pine for carbon in Western Australia. Achieving carbon sequestration levels of a significant magnitude (say 1 million tonnes of carbon) requires enormous economies of scale. CALM has very high plantation expertise, which is coupled with its strong commitment to research and development, in particular in plantation site selection, nutrition, silviculture, tree breeding, growth modeling and high quality seed production and nursery propagation. Importantly, CALM has a close working relationship with the softwood plantation industry in Western Australia, due to its long involvement in plantation establishment, management and resource supply to softwood industries, such as sawmills and other processing plants. In this respect, CALM can offer a significant contribution to the development of a carbon trading mechanism using Maritime pine.

COLLATERAL BENEFITS OF TREE CROPS FOR CARBON SESQUESTRATION

The threat of land degradation, especially salinity, is the major motivation for revegetation in the dryer agricultural zone (i.e. less than 600 mm rainfall). The problem of salinity causes much more than the loss of productive agricultural land on the farm. The whole drainage system is degraded, including rivers, wetlands, water resources and biodiversity of native ecosystems retained on the valley floor. Infrastructure suffers chronic damage due to saturated foundations, but more significantly the risk of severe flood occurrences is greatly increased.

Salinity is rapidly expanding. Partial revegetation with perennial plants, including trees, is the most effective way to bring land degradation under control. At present some 9% of the 18 million ha of agricultural land WA is salt affected and this is projected to expand to 32% with four or five decades.

The Western Australian government's State Salinity Action Plan calls for some 3 million ha of revegetation over the next 30 years. Landowners recognize the desirability of revegetation and participate in State and Commonwealth Government programs to stimulate landcare activities. However, there is now a strongly emerging recognition that the scale and urgency of revegetation is beyond that which can be supported by Government programs or be financed from farm profits. Farmers are therefore seeking commercial species and carbon credits to help drive revegetation on the necessary scale.

More than 6 million hectares of cleared agricultural land is situated within the medium rainfall agricultural zone (600 – 400 mm) (Agriculture Western Australia *et. al.*, 1996). Presently, Maritime pine has the greatest potential for reforestation within this rainfall zone due to its high volume biomass production and the presence of established markets for softwood.

CALM has established four regional Maritime pine centres, which extend across the 600-400mm rainfall zone. These centres are Perth, Narrogin, Katanning and Esperance. For 1999, these regional centres will implement the planting of the target 8 million seedlings, which equates to 5000 hectares. Currently there is over 25,000 hectares of Maritime pine planted throughout the state, of which most is situated just north of Perth.

GROWTH AND CARBON MODELING

Maritime pine has a very ingenious survival mechanism that allows it to grow very well in areas traditionally not suitable for plantation development. This mechanism involves establishing an extensive root system, at the expense of its above ground growth, soon after planting. This root system explores the soil for moisture and nutrients, which is an extremely important growth strategy as it allows the seedling to survive and grow very well on poor soils in a relatively dry environment.

A standard harvesting regime for Maritime pine involves a first thinning 12 years after planting, then followed by two more thinnings at age 18 and 22 years. The plantation has a final harvest at about age 32 years.

The comparative advantage of Maritime pine for carbon sequestration is its ability to store substantial quantities of carbon in both its above (stem, bark, branches and leaves) and below ground (root system) biomass. For example, a 12 year old Maritime pine plantation contains between 30-40 tonnes of carbon per hectare within its stem wood alone. After 32 years the carbon accumulated within the stem wood alone would be between 80-120 tonnes per hectare. Stem wood is utilised to manufacture sawn timber, veneer and particle-board. In addition to the stem wood carbon component, carbon is also accumulated within the foliage, branches and root system of the tree and in the same 12 year old Maritime pine plantation (mentioned above) between 70-90 tonnes of total carbon exists per hectare.

PRODUCT DISPLACEMENT AND BIOMASS FUELS

Maritime pine residues (i.e. non-wood by-products following harvesting) may be used as fuel for energy generation. Such renewable fuels make no net contribution to CO_2 emissions but meet a demand for energy that might otherwise draw on fossil fuels. In Western Australia there is scope to use biomass to avoid emissions from coal and diesel fuel generators. New wood gasification technologies have made electricity production using wood biomass more cost effective. The economics of utilising biomass fuels becomes even more viable when their use is integrated into the production of other wood products.

There is an increasing trend in global wood consumption. Therefore, in addition to harvest residues being utilised to replace traditional fossil fuels for energy generation Maritime pine wood products may be used to displace materials which consume large quantities of energy to manufacture, such as steel, concrete and aluminium.

ROLE OF CALM IN FACILITATING THE TRADE IN CARBON CREDITS

CALM and potential carbon investors would enter into a formal agreement for CALM to act as the investor's agent (a Deed of Agency) to initiate a carbon sequestration project. Under this Deed, CALM would undertake to establish and manage the plantation, manage carbon trading transactions; to measure, monitor and verify carbon sink parameters; and to obtain secure title to carbon under an appropriate form of Deed of Grant of Profit a Prendre. The Deed of Grant of Profit a Prendre is a powerful legal document that allows CALM to secure an interest on a farm. In this respect, it secures plantation interests when landowners and CALM enter into joint tree farm arrangements. These are termed Sharefarms. The Deed does not provide CALM with ownership of land that contains the tree crop, but states that CALM is sharing with the landowner an interest on that property. The Deed is registered on the title deed and is placed over the whole location concerned – even if a portion of the location is planted. The CALM Act (Section 34B) allows CALM to use Deeds of Grant of Profit a Prendre. No other tree farming organisation in Western Australia has this option. Profit a Prendre is a French phrase meaning "sharing profits". Without this legal tool CALM could not sharefarm with landowners and would instead have to lease the land.

METHODOLOGIES FOR MONITORING CARBON SINKS

Three separate stages are identified to establish sequestration projects. Firstly, forecasting and estimating the carbon sink potential of the project is required. This means predicting the amount of carbon likely to be sequestered. The second stage is to monitor over time the actual carbon sequestered within the sink. This means assessing the amount of carbon actually sequestered. The third stage involves verification of the project and the carbon sink. This process performed by an independent certifyer. This requires determining that the claimed amount of carbon sequestered has actually occurred (ACCM 1998). Generally, the more intensive the measurement and monitoring of carbon sinks, the more expensive it is to undertake the assessment of the carbon sink. The cost and logistics of measurement, monitoring and verification mechanisms for carbon sink projects is likely to be prohibitive and may render small woodlots/projects nonviable (ACCM 1998). In this respect, CALM offers Maritime pine investors the economies of scale to co-ordinate the three stages of carbon sequestration accounting.

DEVELOPMENT OF ALLOMETRIC MODELS TO DETERMINE CARBON STORAGE

It is the responsibility carbon sequestration manager to specify methodologies chosen for measurement. These should be appropriate to the scale and nature of their vegetation sink project, as it is impractical to directly measure every tree for the purpose of determining carbon sequestered in vegetation management projects. Therefore, it will be necessary to use sampling techniques and statistical tools to provide measurements of carbon sequestration (ACCM 1998). These include the development of reliable allometric equations. Allometric equations relate tree diameter and height to total biomass. These equations can only be constructed from data obtained by detailed sampling of representative trees. Developing allometric equations for total wood biomass and carbon also requires sampling for root mass. This involves separating the roots from soil, which is a resource intensive operation (ACCM 1998). CALM is already developing a Maritime pine yield model. This model will estimate the volume of sequestered carbon in present and future Maritime pine plantings.

COMPONENTS OF MONITORING THE EXTENT OF CARBON STORAGE

Monitoring refers to regular inspection of the project site, as well as actual measurement of carbon sequestration (ACCM 1998). Measurement of carbon pools will need to be performed on a regular basis. In particular, at the beginning and end of the project, and re-calculations performed after harvests, fire or other significant site disturbances. Another approach to monitoring carbon pools may be to measure the woodlots annually. CALM has the expertise, within its Forest Management Branch, to undertake regular inventories of plantings to determine the amount of stored carbon.

CALM also has the ability to monitor changes in the product pool by directly supervising production and retaining sales records of products from the stand.

VERIFICATION OF STORED CARBON

Verification will be performed by an independent third party. CALM will liaise with the third parties to ensure the quantity of stored carbon is verified and co-ordinate the verification process.

CONCLUSION

Western Australia offers enormous potential for carbon sequestration projects. Mainly due to the extensive land base available for reforestation and the identification of a very good tree species exists which grows well in the medium rainfall agricultural zone.

Maritime pine is a sound long rotation tree crop producing high quality softwood. Coupled with the economic benefits from wood production Maritime pine is also an excellent general farm tree contributing to landcare. A typical rotation length and silvicultural regime is to thin the plantation at age 12, 18 and 22 and then perform a final harvest at about age 32 years.

Extensive data on the growth and biomass production from Maritime pine plantations has now been collected. Maritime pine situated in the 600-400 mm rainfall zone at 12 years of age will contain about 30-40 tonnes of carbon per hectare in the stem wood alone and between 70-90 tonnes of total carbon per hectare in the whole stand. Stem wood is used in the manufacture of wood products, which may replace building materials that require large amounts of energy to manufacture. The total amount of carbon sequestered within a plantation takes into account the carbon in the bark, roots, litter, branches and leaves produced by the stand. The above ground residue component of the plantation, following harvesting, could also be used as a biomass fuel.

The framework in which carbon sequestration projects will operate remains unclear. What is certain, however, is the need for massive scale implementation, good co-ordination between several agencies and scientific rigour to develop sound allometric equations. All of which can be supplied by CALM to facilitate the sequestration of carbon and future trade in carbon credits.

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