Using Harvested Plantations to Sequester Carbon from Transport Emissions – the TreeSmart Option

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Abstract

Of the many options available for the sequestration of carbon in greenhouse gas emissions, tree planting is one of the simplest to understand and one that has intuitive public support. However, many tree-planting projects for carbon sequestration are based, explicitly or implicitly, on the current guidelines developed as part of the Kyoto Protocol. This recognises that carbon is sequestered in trees as they grow, but makes the assumption that when the trees are harvested all the carbon is immediately released back into the atmosphere. While such an assumption is logically and scientifically invalid, it has been adopted for political and administrative reasons.

The TreeSmart program ignores this assumption in the Kyoto Protocol, and develops a carbon sequestration project based on harvested eucalypt plantations. This paper highlights the scientific principles underpinning TreeSmart, which is shown to be at least three times more cost-effective in sequestering carbon over the long term as the more conventional plant-and-forget tree planting schemes. The paper then shows the magnitude of greenhouse gas emissions in the transport sector (cars, trucks, public transport and planes). Acting as a Carbon Pool organization, TreeSmart then links the emissions in the transport sector with the sequestration in the harvested plantation sector. The paper demonstrates the feasibility of this approach, shows the benefits to the transport and harvested plantation sectors and outlines some challenges for the future.

Background to TreeSmart

The TreeSmart project arose as a result of two somewhat disconnected activities. Firstly, the current Directors of TreeSmart Australia had spent a combined total of 50 years in the transport planning field, where one of their major aims was to encourage people to drive their cars less, or at least more wisely, so as to reduce the adverse environmental effects of motoring. Secondly, as an ethical superannuation investment, they had become involved in agroforestry. In that field, they realised that many agroforesters faced economic difficulties in funding the maintenance of their tree farms, after having funded the initial establishment of the plantation.

With a foot in both camps, it was obvious (in hindsight) that there was a way to join the two activities. By using the trees of the agroforesters to sequester carbon dioxide from the emissions of the motorists, in exchange for a payment from the motorist to the agroforester, a mutually beneficial exchange could take place. Importantly, TreeSmart could play an important role as a Carbon Pool Broker, by linking the motorists to the agroforesters, and vice versa, thus overcoming a major barrier for the individual motorist and the individual agroforester.

TreeSmart Australia Pty Ltd has been established to act as a Carbon Pool Broker, linking travellers to agroforesters for the purpose of reducing greenhouse gas accumulation in the atmosphere.

Fundamental Concepts underpinning TreeSmart

TreeSmart is based on several fundamental concepts and assumptions:

- Greenhouse Gases and Global Warming are acknowledged environmental threats
- Transport is a major contributor to Greenhouse Gas production
- Some environmentally conscious travellers are willing to pay to reduce or remove their contributions to Greenhouse Gas accumulation in the atmosphere
- Growing trees is one way to remove CO_2 from the atmosphere
- Different forest management regimes can produce different levels of carbon sequestration
- Different business management regimes can produce very different levels of cost-effectiveness in carbon sequestration via tree growing.

Why Harvested Plantations?

One of the assumptions in the Kyoto Protocol about carbon sequestration in plantations is that if the plantation is harvested at some point in the future, then all the carbon that has been sequestered during the life of the plantation is immediately released back into the atmosphere. The credits that have been accrued during the life of the plantation must then be repaid. While re-planting the trees will allow further sequestration in a new plantation, the sequestration during the initial plantation growth is assumed to be forfeited upon harvesting of that plantation. As a result of this assumption, plantations developed for carbon sequestration purposes have therefore generally been assumed to exist in perpetuity, with no plans for harvesting.

While the Kyoto Protocol regulations for carbon trading assume that all carbon is released back to the environment at the moment of harvesting (primarily because of the current difficulties with auditing the history of the timber once harvesting has taken place, and with allocating the sequestration to the appropriate party in an international context), it is clear that carbon will continue to be sequestered for as long as the timber product is in existence. For example, Jaakko Pöyry Consulting (1999) show that many timber products have extended service life spans from 3 years (for paper and paper products) up to 90 years (for timber used in house construction). Ximenes et al. (2005) go even further and show that carbon continues to be sequestered in timber products well beyond their service life spans, depending on how the products are finally disposed of at the end of their service life. They conclude that approximately 70% of the carbon from harvested logs in Australia is in equivalent long-term storage in forest products.

Research conducted by TreeSmart (Richardson, 2005) has shown that there are several major advantages of harvesting a plantation primarily designed for carbon sequestration.

- By harvesting trees which have reached maturity (and effectively stopped absorbing carbon dioxide) and replacing them with a new planting of rapidly growing younger trees, the total sequestration can be increased over the long-term compared to leaving the original plantation in place;
- By growing the trees for eventual harvesting as sawlogs, a significant proportion of the carbon in the trees can continue to be sequestered in long-lived timber products (while the next plantation of trees starts sequestering more carbon in the new living trees);
- The wood not used for sawlogs (e.g. thinnings, prunings and other harvest and processing residue) can be used as a fuel substitute, whereby wood burnt efficiently is substituted for other fossil fuels. While the burning of the wood is carbon neutral (since the growing trees only recently sequestered the carbon that is now being released), the carbon that would have been released from the fossil fuel (that is now not burnt) is now effectively sequestered for a longer period of time. This is especially important in Victoria, where most electricity is generated by the burning of brown coal, which is a particularly significant source of CO_2 emissions. It has been estimated (Ximenes and Davies, 2004), that the release of 1 tonne of CO_2 by the burning of wood for power generation saves about 3.5 tonnes of CO_2 from being released from brown coal for the production of the same amount of electrical power;
- By having another incentive for growing the trees (i.e to harvest them), plantation owners are more likely to take better care of the trees, and undertake regular monitoring, resulting in lower mortality rates and higher growth rates in the trees;

- By having the sequestered carbon in more than one asset (i.e. living trees and timber products) the sequestered carbon is better protected from catastrophic damage by fire and other natural causes, by diversifying the portfolio of sequestration pools;
- The income derived from carbon sequestration is a valuable "off-farm" income source for many farmers;
- The encouragement of harvested eucalypt plantations provides an alternative source of hardwood timbers, compared to native forests; and
- The income obtained from harvesting cross-subsidises the costs involved in planting for sequestration, thereby improving the cost-effectiveness of the carbon sequestration.

The results of the research are succinctly summarised in Figure 1, which compares long-term sequestration in perpetual (unharvested) forests and harvested plantations. While unharvested plantations initially sequester more carbon, because they are not subjected to a pruning and thinning regime, they effectively stop sequestering carbon after about 30 years. On the other hand, the sequestration in harvested plantations, and their harvest products, keeps increasing at an approximately constant rate (with periodic fluctuations) so long as the plantation continues to be replanted after each harvest.

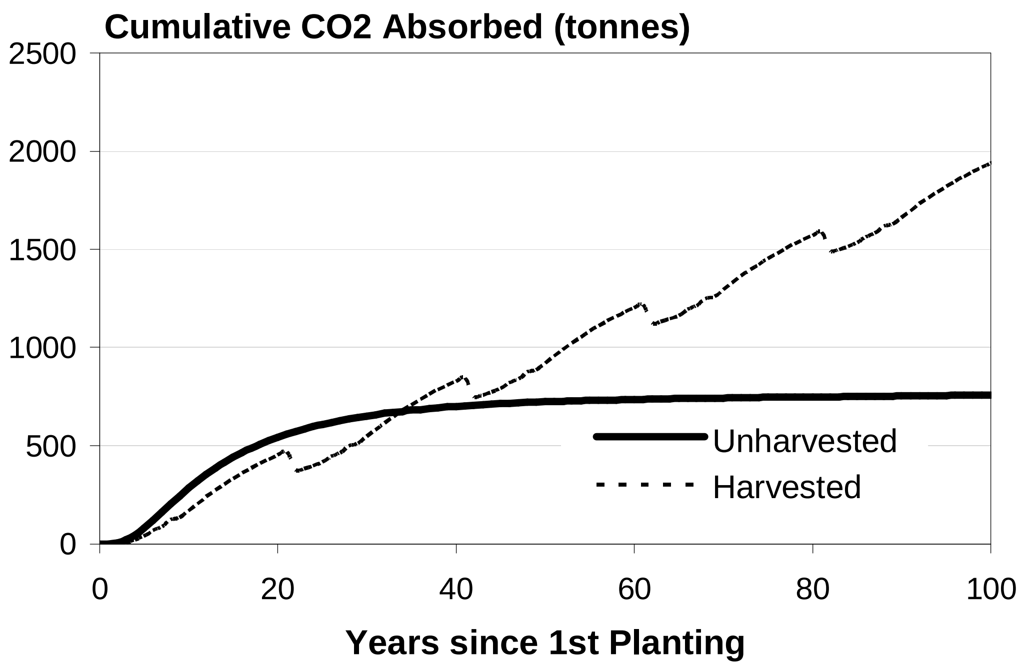

Figure 1 Comparison of Unharvested and Harvested Plantation Sequestration

Taking account of the costs and revenues of establishing and managing unharvested and harvested plantations, and assuming that all costs, revenues AND sequestered carbon is subject to a common economic discount rate (to recognise the fact that costs, revenues and sequestrations that occur this year are worth more that the same costs, revenues and sequestrations occurring in 100 years time) (Boscolo et al, 1998), it has been shown that (over a 100-year project lifetime) harvested plantations absorb more CO_2 than unharvested plantations and do so with a cost-effectiveness that is at least three to four times greater than for an unharvested plantation.

How much Sequestration is Required?

If the objective of TreeSmart is to sequester emissions from transport operations by way of tree planting, two obvious questions are how much sequestration would be needed and how many trees would need to be planted to achieve and maintain that sequestration.

TreeSmart is aimed at the travelling public, as a simple means of providing them with Carbon Neutral travelling by means of investing in the development and ongoing management of harvested eucalypt agroforestry plantations. Within the overall population of "the travelling public", there are a number of sub-groups which might be reached through different channels.

The General Motoring Public

The most general, and diverse, group of travellers is the general motoring public. In Victoria, for example, about 90% of households have one or more vehicles, with a total of approximately 2.8 million passenger vehicles in the state. Each vehicle travels an average of about 14000 kms per year, and emits about 4.3 tonnes of CO_2 per year. The total CO_2 emissions from passenger vehicles is therefore around 12 million tonnes CO_2 per year.

Commercial Vehicle Operations

The road system is used not only by private vehicles but also by commercial freight operators. Commercial vehicles account for about 38% of the CO_2 attributed to road transport vehicles. Importantly, the growth in commercial vehicle CO_2 emissions is about twice that of private vehicle emissions, at about 3.3% p.a. Because of the larger size of the vehicle and the higher annual kilometres for commercial vehicles, the annual CO_2 emissions per commercial vehicle (about 21 tonnes) is higher than for private vehicles (about 4.3 tonnes). In Victoria, there are a total of approximately 400,000 commercial vehicles, giving total CO_2 emissions from commercial vehicles of around 8.4 million tonnes CO_2 per year.

Public Transport Operations

All modes of transport contribute to greenhouse gas emissions, even public transport modes which are often considered to be "green". This is especially the case for public transport modes which are electrically powered, where the electricity is generated by the burning of brown coal (which has notoriously high emissions of greenhouse gases). Calculations have shown that trains, trams and buses have CO_2 emissions, under current Melbourne operating conditions, of approximately 0.5 million tonnes CO_2 per year.

Airline Operations

One of the “sleeping giants” in CO_2 emissions is air travel. While domestic air travel generates only about 6% of current transport CO_2 emissions in Australia, it is the fastest growing of all the transport emissions and is expected to reach 10% within the next 10 years. In addition, international air travel (which is particularly significant for Australia, given its geographic remoteness) is not even included in current greenhouse inventory accounts, because it currently lies outside the Kyoto framework. However, for Australia, international air travel probably contributes more CO_2 emissions than domestic air travel.

While aircraft generate large quantities of CO_2, these emissions are spread over many passengers on the aircraft, so that the emissions per passenger kilometre are comparable to (actually slightly smaller than) the emissions per passenger kilometre from private passenger vehicles. However, because of the large distances involved in air travel, the emissions per passenger trip can be substantial.

Based on an estimate of the current number of domestic and international air trips originating in Victoria, the average length of those trips and emissions characteristics of the aircraft involved, the total CO_2 emissions for all kilometres travelled by domestic air passengers originating in Victoria would be about 1.3 million tonnes CO_2 per year, while the total CO_2 emissions for all kilometres travelled by international air passengers originating in Victoria would be about 1.5 million tonnes CO_2 per year.

Across all the modes of transport mentioned above for Victoria, the total annual emissions of CO_2 would be in the vicinity of 24 million tonnes.

The question then arises of how many trees would be required to be planted and maintained in order to sequester this quantity of CO_2 emissions per year.

On the basis of a *E. Globulus* plantation planted at 1000sph (stems per hectare) and thinned twice to a harvest density of 250sph at a rotation age of 20 years, with 30% of the harvest volume going to sawlogs (and hence long-lived timber products) and half of the residue going to energy production which substitutes for fossil fuels (with a conservative sequestration ratio of 1:1; i.e. each tonne of CO_2 released from the burning of the wood saves one tonne of CO_2 in alternative fossil fuels), it has been estimated that the average CO_2 sequestration per year (over a 100 year life cycle) would be about 20 tonnes CO_2 per hectare per year.

Therefore, in order to sequester all of the CO_2 emissions from Victorian transport per year, a total of 1.2 million hectares of harvested plantation would need to be established. Clearly, such an undertaking is immense, given that there are currently about 150,000 hectares of private hardwood plantation in Victoria and 650,000 hectares of private hardwood plantation in Australia, increasing by about 80,000 hectares per year (Plantations for Australia: The 2020 Vision, 1997). However, the 1.2 million hectares would only be required if all the transport emissions in Victoria described above were to be sequestered on an on-going basis. Given that the sequestration subscriptions would be voluntary, a more realistic target would be a relatively small take-up rate of perhaps 1-5% (similar to what has been experienced in Australia for Green Energy). Under such an assumption, the quantity of plantations needed would be much smaller (but still large) at about 12,000 to 60,000 hectares of new plantation per year.

The Role of TreeSmart Australia

The TreeSmart project would operate in the classic style of a Carbon Pooling operation, as outlined by the Australian Greenhouse Office (2005) and shown in Figure 2. Travellers (the "carbon purchasers") would pay an annual or usage-based subscription to TreeSmart (the "carbon pool") for sequestration of their carbon dioxide emissions. TreeSmart would then pay the agroforesters (the "carbon suppliers") for the carbon dioxide sequestered in their harvested plantations, and subsequent timber products. In addition, TreeSmart would purchase additional carbon sequestration from agroforesters to hold as residual carbon rights to cover any temporary shortfalls in carbon supply, compared to carbon demand.

TreeSmart Australia would also carry out a range of carbon pool management functions including:

- Registering and tracking the supply and allocation of carbon sequestration
- Managing subscriber and forester contracts
- Monitoring and certifying carbon sequestration supply
- Marketing of the TreeSmart project

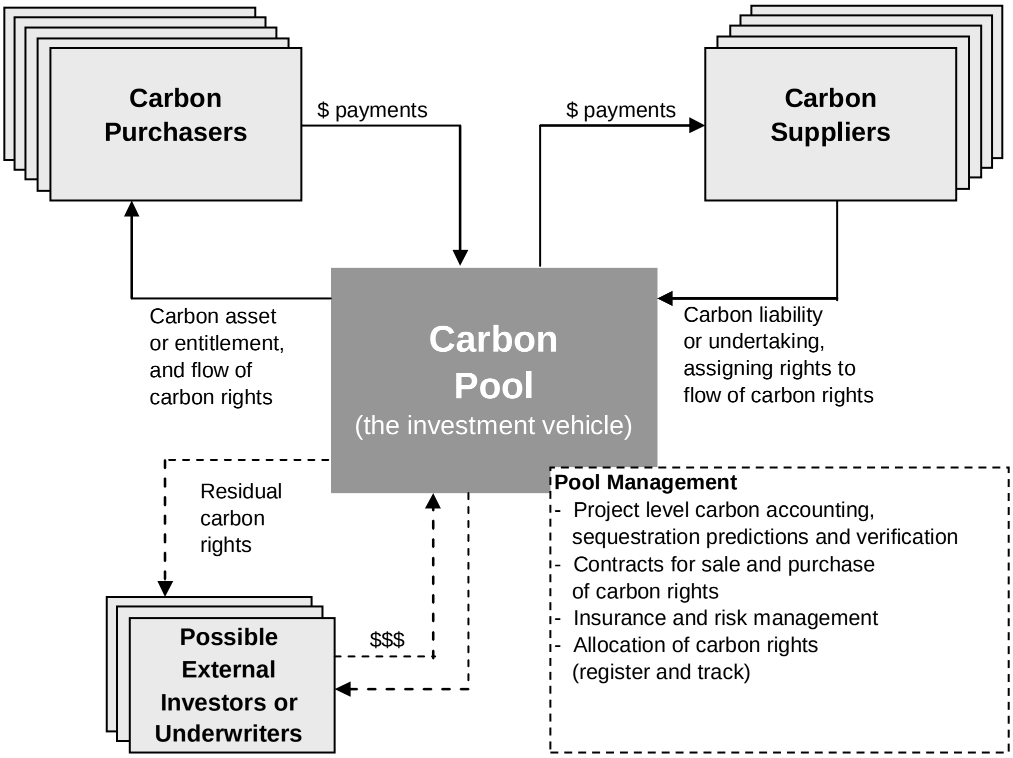

Figure 2 Participants in a Carbon Pooling scheme

Source: AGO (2005). Planning Forest Sink Projects: A Guide to Carbon Pooling and Investment Structures. ISBN 1 920640 74 5

How do Agroforesters get Involved?

The Carbon Pooling arrangement described in Figure 2 is dependent on a having a community of agroforesters willing and able to make their plantations available to TreeSmart for carbon sequestration. Such plantations can be supported by TreeSmart in two ways

Existing Plantations

The initial carbon sequestration supply for TreeSmart will be sourced from existing plantations that have been planted with the intention of harvesting in the future, but with no commitments made with respect to the carbon sequestered in these trees. Many of these existing plantations have already reached an age (5-10 years) when they are sequestering carbon at a maximum rate, and hence are ideal for immediate sequestration, without the lead-time of several years required for the establishment and immature growth phase of new plantations.

An annual rental would be paid to the agroforester for the use of the carbon sequestered in their trees. However, since plantations will be sourced from many different regions, the rate at which plantations will sequester carbon could vary significantly, depending on rainfall, soil type and climatic factors. Therefore, for equity reasons, the annual rental paid for a specific plantation will be based on a unit rate per tonne CO_2 sequestered. The payments for each plantation will initially be based on the projected sequestration rates obtained from the FullCAM modelling package (Richards and Evans, 2000), including projections of post-harvest sequestration using the TimberCam module (Ximenes and Davies, 2004). The FullCAM modelling package, developed by the AGO, is the official modelling package recognised by various government programs for carbon sequestration (e.g. the Greenhouse Friendly program), and can be customised for specific geographic locations, tree species and silviculture regimes. The FullCAM modelling will be undertaken by TreeSmart Australia, and will be verified against actual measured growth as determined through an ongoing monitoring program conducted by TreeSmart. The actual payments in later years will then be based on the measured sequestration in the previous period.

Contracts will only be entered into with foresters who commit to management and harvesting practices which maintain sequestration post-harvest. Thus plantations should be established for the purposes of sawlog harvesting and/or fuelwood production. Depending on the stated intentions of the forester, the FullCAM model will be adjusted accordingly in order to determine projected sequestrations. However, while the forester will need to state their harvesting intentions before entering into the TreeSmart contract, they will be free to withdraw from the contact at the end of each year of the contract, provided they agree to maintain the carbon already sequestered in the trees, timber products or fossil fuel substitution. While it is expected that most foresters will want to stay with TreeSmart until they harvest their plantation, there may be reasons why they want to withdraw (e.g. received an offer of a better price per tonne for carbon sequestration from another party, want to harvest early, want to sell the plantation etc). In such cases, they may withdraw and their TreeSmart annual payments will cease. They will not need to repay any payments already received, but they (and any subsequent owners of the trees) will need to abide by their intention to maintain the sequestered carbon in the trees, in timber products or in fossil fuels via a substitution of fuelwood for other fossil fuels used in energy production.

There may also be a situation where a forester changes their mind about their harvesting intentions. For example, a forester may enter TreeSmart with the intention of harvesting, but on reaching harvesting time they may decide to leave the trees in the ground for aesthetic or other reasons. Since the trees will continue to sequester carbon after their due harvest date, they would still be eligible for TreeSmart payments (if they wished to continue in the scheme) at the same rate per tonne CO_2 sequestered. However, since the growth rate of the trees would decline as they age, it would be expected that the payment per hectare would decline with increasing age of the trees. The actual payments would be based on ongoing monitoring of tree growth rates.

New plantations

Given the likely expansion of the TreeSmart program, new plantations will become necessary after a relatively short period of time. New plantations may be developed by TreeSmart itself or, more likely, third-party plantation owners will be supported by TreeSmart in the establishment of the new plantations. A one-off establishment payment will be made in the first year to kick-start the development of the new plantation, followed by the regular annual rental payment after the first year. As with the existing plantations, the actual annual rental will be based on the projected sequestration from the FullCAM model, modified by actual measurements of sequestration as the plantation ages.

How does the Traveller get Involved?

The Carbon Pooling model of Figure 2 is also dependent on a population of carbon sequestration purchasers. While there are many industrial purchasers of "carbon offset credits", the TreeSmart scheme will concentrate, for the foreseeable future, on the sequestration of transport emissions. Given the total size of this market, this is unlikely to present a barrier to growth for the TreeSmart scheme. As outlined earlier, there are several potential markets for TreeSmart subscriptions, as described below. In each case, the cost of a TreeSmart subscription will be based on a $/tonne CO_2 sequestered. The price of comparable carbon credits from other Carbon Poolers varies, depending on the method of sequestration, the regulatory environment and the geo-political situation. For example, the price of a credit from the NSW Greenhouse Gas Abatement Scheme (based on bio-sequestration in NSW Forests) is approximately $15/tonne CO_2 (June 2006 prices), while the current price of European Union credits is approximately $32/tonne (June 2006 prices). Based on the long-term cost-effectiveness of sequestration in harvested plantations, but bearing in mind the higher short-term costs of establishing and managing harvested plantations, it is expected that the cost of a TreeSmart credit will be approximately $12/tonne CO_2.

The General Motoring Public

The most general, and diverse, group of travellers is the general motoring public. Given that each passenger vehicle in Victoria travels an average of about 14000 kms per year, and emits about 4.3 tonnes of CO_2 per year, the price of an annual TreeSmart subscription for a passenger vehicle would be $50 (or "less than a dollar per week").

Commercial Vehicle Operations

Because of the larger size of the vehicle and the higher annual kilometres for commercial vehicles, the annual CO_2 emissions per commercial vehicle is about 21 tonnes. The average cost of a TreeSmart subscription for a commercial vehicle would there be about $250/year. However, given the wide variety of commercial vehicle in terms of size and annual usage (from courier vans through to B-doubles), the actual cost of a TreeSmart subscription would be tailored to the specific type of commercial vehicle involved.

Public Transport Operations

All modes of public transport contribute to greenhouse gas emissions, but trains are the greatest contributors because of their weight and the fact that they are powered by electricity generated from brown coal. TreeSmart subscriptions could be targeted at the traveller (at about 1 cent per trip, or $5.00 per year based on 5 return trips per week) or, more realistically, at the operator who could then pass on the costs if they so desired. The total cost of TreeSmart subscription for the Melbourne train fleet would be approximately $2.5 million per year, while the costs for the tram and bus fleets would be $250,000 and $750,000, respectively.

Airline Operations

The emissions, and hence for cost of TreeSmart subscriptions, for air travellers is comparable in magnitude, but slightly less than, the cost per kilometre travelled for car drivers. Domestic air travel is slightly more costly than international air travel (per kilometre) because the high-emission take-off and landing stages are spread across fewer kilometres on domestic trips. However, in total, international air travel subscriptions would be higher because of the longer distances involved. The most convenient way of charging TreeSmart subscriptions is probably on a per-trip basis, where a voluntary subscription is paid, in a similar way that travel insurance (voluntary) or a departure tax (compulsory) is now added to the price of a trip. For a typical domestic air trip from Melbourne to Sydney, the cost of a TreeSmart subscription would be about $1.50, while for an average-length overseas air trip, the TreeSmart subscription would be about $6.00.

A Practical Example – the AFG 2006 Conference

While the range of possible TreeSmart subscribers is wide, this paper will conclude with a very narrow and specific example of Carbon-Neutral Travel opportunities. As a demonstration project, TreeSmart Australia is sponsoring the 2006 AFG Conference to be a “Travel Carbon-Neutral Conference”. The emissions created by all travel to and from the conference by delegates will be offset by plantings on one of the harvested plantations signed up to the TreeSmart project. A final list of delegates will be obtained from the conference organisers with the starting location of each delegate for their trip to the conference, and their means of transport. For Tasmanian delegates, this will probably involve a car trip, while mainland and overseas delegates will probably have flown to the conference (although allowance will be made for those taking the ferry to Tasmania). During the presentation of this paper, the methods of estimating total emissions for travel to and from the conference will be outlined, as will the estimate of the number (area) of trees that have been dedicated to making the AFG Conference a "Travel Carbon-Neutral Conference". In this way, it is hoped that the audience will better understand the concepts underpinning carbon sequestration, in a context which involves the emissions generated by their own travel patterns.

Conclusions

The TreeSmart project has been developed as a practical example of "thinking globally, and acting locally". While many people are concerned about global warming, they feel helpless about doing anything about it. It's all seen as just too big a problem, and is something than someone else should do something about. TreeSmart provides a way whereby every traveller can offset their own greenhouse gas emissions, at a relatively small price (especially compared to the perceived magnitude of the problem). At the same time, TreeSmart provides a way for individual agroforesters to make contact with the carbon market. Something that could not be done individually is easily accomplished by banding together and using the services of a Carbon Pooler like TreeSmart. The income derived from TreeSmart can make a substantial difference in enabling a tree farmer to properly care for the trees over their lifetime, thus increasing growth (and carbon sequestration) and making them a more valuable commodity come harvest time. The environmental, economic and social flow-on effects in rural areas can also be substantial. Salinity, erosion and habitat issues can be addressed through managed harvested plantations, in addition to the sequestration benefits. The income derived from TreeSmart has a multiplier effect in the rural communities, with employment created in the agroforestry and support industries. TreeSmart empowers ordinary people to do extraordinary things about caring for our future environment.

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