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CARBON FORESTRY AS A DRIVER FOR LAND USE CHANGE

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Abstract

Land use change in New Zealand towards a mosaic of forested and pastoral landscapes may occur through regulatory and market drivers. The implications for natural resource research programmes and consultants in this area is quite significant. Carbon sequestration to meet the Paris Agreement limits by 2030 is likely to be the short-term driver. Longer term public expectation on water quality and animal welfare will add to this.

Government's "one billion trees" proposal together with signals that agriculture sector emissions may be brought into the ETS have heightened interest in tree planting. However, modelling the carbon and financial implications of tree planting presents several significant complications for analysts, and there has been some inconsistency in how these are addressed. Tree planting can serve multiple purposes, and these multiple objectives need to be explicitly recognised in a more integrated analysis.

This paper describes work undertaken to "demystify" small scale carbon forestry for landowners, as a step towards removing some of the barriers to participation in the Emissions Trading Scheme. Difficulties arise in addressing the 'permanence" of carbon sequestered by trees, affecting the degree to which on-farm emissions can be offset and the benefit to the landowners from ETS participation. While more demand for carbon units to offset agricultural emissions would go some way towards making carbon forestry more financially attractive to landowners, there is abundant evidence that this will not in itself lead to the desired land use change. There is a need to develop economic and financial metrics that resonate with land managers, and to understand their broader objectives.

More generally, sustainable land use and intergenerational equity requires analyses that consider ecosystem services, social license to operate, health and safety, and resilient cash flows. Through the integration of these factors, the use of NZs finite land resource may be better rationalised.

Drivers for afforestation

Trees have long been a feature of the rural landscape in New Zealand and at various times incentives in the form of grants or loans have been available to encourage tree planting. These include soil conservation subsidies available from Catchment Boards from the 1940s (McCaskill 1973) and Forestry Encouragement loans and grants begun in the 1960s (Rhodes and Novis 2004). Incentive schemes recognise the fact that planting trees involves a certain, immediate and direct cost to the landowner, but with benefits that are uncertain, delayed and diffuse (including off-farm). Deregulation of the New Zealand economy from 1984 generally brought an end to direct incentive schemes and free advisory extension services.

Research into landowner motivation for tree planting has revealed a general reluctance to take land out of pasture and a wide range of motivations when this does occur. Fairweather (1992) reviewed nine New Zealand studies ranging from small case studies to national random samples of land owners. Direct financial benefit from timber ranked behind shelter, 'best land use', and aesthetic considerations as a motivation for planting. However it was noted that the low ranking for commercial timber returns probably reflected the relative economics of agriculture and forestry in the past. Rhodes and Novis (2004) pointed out that different types of owners have been motivated by different objectives, and that over-coming a lack of direct financial investment from farmers was possible if the motivation of external investors were complementary (Table 1). Record levels of afforestation were achieved during the 1990s, often involving off-farm investors.

Table 1. Drivers for afforestation on farms

Landowner motivation[1]	**External investor motivation**[1]	**Regional/National drivers**
Sustainable land use (best productive use of land)	Diversification of their investment portfolios	Climate Change mitigation/Paris Agreement
Economic diversification, risk management	Financial return	Water quality (N, P, sediment, *E.coli*)
Financial return	Taxation advantages	Soil conservation
On-farm use of wood	Superannuation requirements	Storm flow mitigation
Shelter for livestock, crops and buildings	Personal interest in trees/positive outlook on future wood markets	Regional development – forestry and wood processing
Personal interest in trees and timber		Biodiversity
Aesthetics		

[1] Rhodes and Novis (2004)

There are also strong drivers at a regional and national level for a greater level of afforestation, including the Government's 'One Billion Trees" target and the Freshwater Management Reforms (Table 1). While economic considerations may now carry a higher weighting for landowners and the ETS potentially improves the profitability of afforestation projects, it is clearly not enough to stimulate planting. The annual area of new land planted into forest has been very low over the past decade.

Landowners may have chosen to ignore economic incentives to plant (e.g. higher returns and lower costs on some land, economic value of shelter, value of carbon units) but could find themselves faced with disincentives to maintain current land uses (e.g. nutrient limits, liability for emissions within the ETS, "license to operate"-driven conditions in supply agreements). Trees and forestry therefore need to be included as part of an integrated farm plan.

This may require a change of thinking in both agricultural and forestry analysts. We need to move beyond addressing the questions:

- *How can we reduce emissions and/or pollutants **without** changing our farm system and **without** reducing the output of our current products?* or
- *How can we **increase** emissions of pollutants - but at a lower rate than our increase in production?*

Farm resiliance and succession planning are also important considerations and we need to recognise that a farm is also a home and profit maximisation is not the sole driver for most people. When considering the multiple ecosystem services that can be derived from different land uses we need to cast the net wide enough to include all activities that are compatible with broad landowner objectives and avoid cherry-picking outcomes from each (e.g. those that are convenient to model). An obvious starting point is to integrate forestry models within the key tools used by farm advisors and regional councils such as Overseer (Wheeler et al 2008).

A major barrier to a greater integration of trees in farm management is the lack of understanding of the forestry business model in general and carbon forestry in particular. While there is enough evidence to suggest that overcoming this barrier will only be the start of any process designed to stimulate afforestation, this report discusses issues raised in a project carried out under the Sustainable Land Management and Climate Change Research Programme which aims to compile resources that 'demystify' and simplify the ETS and the business of carbon forestry for farmers, farm consultants and analysyts.

Carbon forestry in the ETS

The concept of carbon forestry is reasonably simple. Businesses that emit greenhouse gases must surrender 'carbon credit units' or NZUs to the government. They may already have some of these units thanks to a free allocation by the government, but otherwise they will have to buy them. One source is forest growers, who can claim NZUs from the government in return for CO_2 absorbed in their forests. If forests are harvested, the forest grower becomes a carbon emitter, so must surrender NZUs to the government – either unsold units earned by their trees, or units purchased in the market.

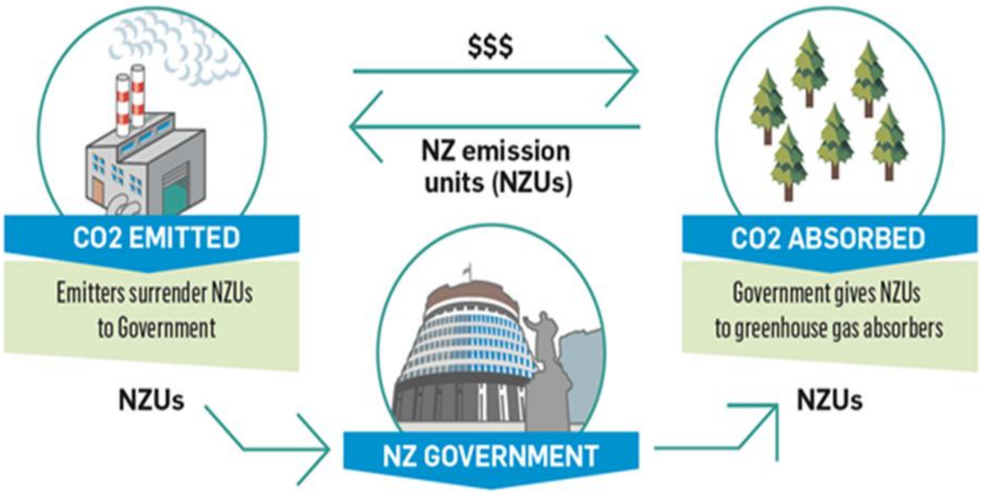

Figure 1. Emissions Trading System source: MFE.

However, the ETS has been widely criticised for not doing enough to incentivise afforestation. There are three main reasons for this:

1. Risk
The ability to earn credits from carbon sequestration in immature trees turns conventional forest economics on its head. No longer is there a long wait between the initial investment and a financial return – units can be claimed and sold immediately, generating cashflows. However units must be surrendered at harvest (or following natural disasters) so if sufficient units have not been retained to meet this liability, they will have to be purchased at the then-prevailing carbon price which is unknown. Carbon trading has been described as a loan in which the repayment terms are unknown (Evison 2017).

2. Carbon price
Integration with international carbon markets saw the ETS carbon price collapse to less than \$2/t CO_2, as a flood of units of dubious integrity was released and bought up by New Zealand emitters (including forestry companies). This also means that the future demand for NZUs has been suppressed as emitters have sufficient units in reserve. Since the maximum carbon price is capped at \$25 there is limited upside.

3. Complexity
The system may be simple in concept, but the regulatory detail required to ensure system integrity is complex. There are arbitrary definitions (e.g. distinctions between pre-1990 forests and post-1989 forests; forest width, height, canopy cover and size thresholds) and significant legal and financial consequences arising from registering land in the ETS. This complexity means that participation without expert advice (legal, taxation, carbon forestry) may be seen as too risky - and expert advice comes at a cost.

The sense that the ETS is subject to too much uncertainty and political interference also came through strongly in submissions to ETS Reviews.[1] It is difficult to provide a simple description of the system that does not gloss over critical details.

Farm forestry analysis

While movements in log prices are reported in the mainstream media there is still a perception that farm woodlots are not profitable. Net returns from a database of harvested woodlots in recent years are shown in Figure 2. Some of these woodlots were harvested with little or no return on the investment but this does not appear to be a function of woodlot size. Small, well-sited woodlots can be very profitable.

[1] http://www.mfe.govt.nz/nzets/2015-16-review-outcomes

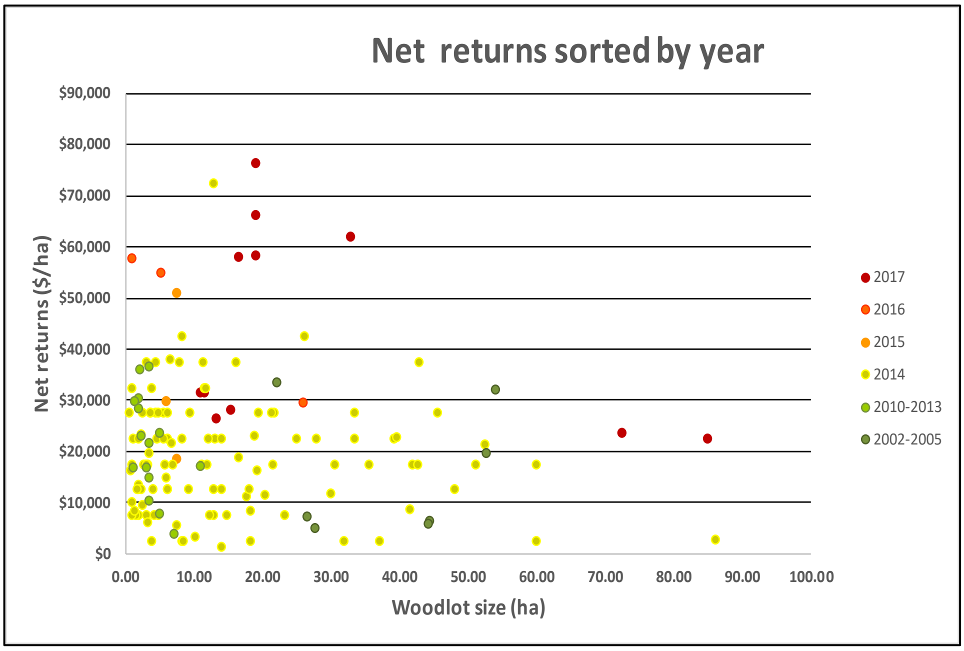

Figure 2. Net returns from harvesting of farm woodlots

Table 2 provides indicative estimates of Net Present Value (NPV) expressed as an annuity for a range of net harvest returns shown in Figure 2. While most of the woodlots in Figure 2 were likely to give a return lower than expected from average North Island sheep and beef properties, the inclusion of carbon revenues makes a big and potentially attractive difference.

Table 2. Approximate returns for different level of net harvest revenue[1]

Net harvest return $/ha	Annuity @ 8% (timber only) $ ha^{-1} year^{-1}	Annuity @ 8% (with carbon) $ ha^{-1} year^{-1}
$10,000	-180	65
$30,000	40	290
$50,000	270	520
$70,000	500	750

[1] Assuming standard Bay of Plenty establishment and growing costs

Modelling the carbon and financial implications of tree planting presents several significant complications for analysts, and there has been some inconsistency in how these are addressed. Problems arise because carbon sequestered by a stand of trees is assumed to be emitted when the trees are harvested – either instantly or gradually in the case of decaying residues. This has led to a preference in some quarters for unharvested "permanent" forests as a mitigation option but the term is a misnomer. This is illustrated by Kaingaroa forest (Figure 3), which despite ongoing harvesting appears to be a 'permanent' feature of the landscape. The issue is not whether harvesting takes place, but the size of the steady-state stock reached and the time taken to reach it.

The plantation harvest cycle does cause problems with quantifying:

1. The farm emissions that are offset by growing trees.

2. The contribution of carbon revenues to the value of the forest or project.

For example, livestock emissions will continue as long as there are livestock, but trees and forests do not grow indefinitely, whether harvested or not. Statements about farm emissions offset by growing trees therefore need to include the timeframe and – if harvesting is intended – the expected carbon liability at the end of the rotation.

(a)

(b)

(c)

(d)

(a) Natural forest with areas emitting carbon (mortality caused by slip), rapidly sequestering carbon (on old slip scars) and in carbon balance (undisturbed areas). Overall ~ carbon neutral?

(b) Kaingaroa forest in the 1960s, 30 years after establishment.
(c) Kaingaroa forest in the 1980s
(d) Kaingaroa forest in the 2000
Overall ~ carbon neutral?

Figure 3. "Permanent" forests

The stream of net revenues from carbon trading can be treated in several ways. It is important to acknowledge that there are costs involved in participating in the ETS, and benefits in spreading the fixed costs over large areas. The simplest analyses credit annual sequestration and surrender an equivalent quantity at harvest. The sum of revenue is therefore equal to the liability, and the only value is the use of money in the meantime, which can still generate a net profit. A much more conservative approach is to only sell the risk-free or 'safe' units. This involves selling up to the lowest level of carbon that will remain on site in future after harvesting (in the form of decaying harvest residues and replanted seedlings. These credits are risk-free because they are not required to be surrendered as long as the stand is replanted. Some calculations take an intermediate approach and sell credits up to the long-term average expected on-site. This may be calculated explicitly or approximated as a proportion of the pre-harvest stock (e.g. one half). The averaging accounting approach has been proposed for both New Zealand's accounting for the Paris Agreement targets and for inclusion within the ETS.

Even when the approach to the calculation is clearly stated there are still issues in communicating the result to landowners. The standard forest investment approach of a calculated NPV is not generally applied in farm management. When NPV is converted to an annuity it does provide some comparability with annual returns for other land uses, but may give a misleading impression of annual cashflows. There is a need to develop economic and financial metrics that resonate with land managers, and to understand their broader objectives.

Multiple forestry benefits

Forests can serve multiple purposes and there is increasing interest in recognising the ecosystem services provided by all land uses. (Dymond 2013). Ideally multiple land use objectives should be explicitly recognised in an integrated analysis. Focussing on a single objective runs the risk of missing opportunities for complementary land use solutions, even if a selection of co-benefits are quantified and reported.

There is also a need to protect the integrity of carbon and nutrient trading schemes. For example, while there are many good reasons to re-establish native forests and they may be the most appropriate options for the most sensitive erosion prone sites, the sequestration rate achieved by regenerating native forest is much lower than for introduced plantation species. This is the case even with the ETS Lookup tables which are conservative for plantation species but quite generous for regenerating native forest.

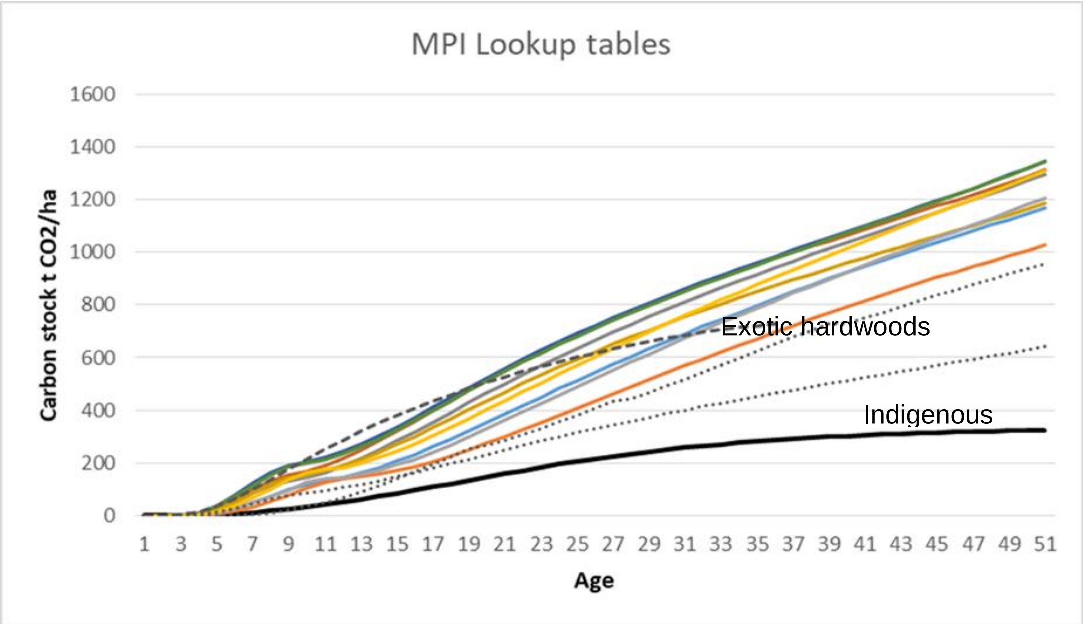

Figure 3. ETS Lookup tables – carbon stocks per hectare by age.

The low sequestration rate is an issue for those who wish to use carbon trading to fund the establishment of native forests – high fixed ETS administration and compliance costs combined with low returns due to low sequestration rates make small areas of regenerating forest uneconomic. Larger areas up to 100 ha may be economically viable, but the mandatory installation of field measurement plots in forests larger than 100 ha again adds significant costs that need to be spread over a still larger area to make the project viable. One approach to this problem is to effectively 'bundle' the full set of ecosystem services provided by native forests and attempt to attract a carbon price premium. Another approach could be to plant cheaper, faster-growing radiata pine forests as a nurse crop for native forest regeneration. This would maximise carbon sequestration in the short to medium term, while potentially allowing sequestration to continue in the longer term along with the multiple benefits from native forests. This transition is the subject of a current SLMACC research project.

Conclusions

The combination of the Freshwater Management reforms, nutrient and carbon trading, consumer and society pressure and the potential inclusion of agriculture in the ETS (which would increase the demand for carbon units to offset agricultural emissions) would appear to contribute towards making carbon forestry more financially attractive to landowners. However there is abundant evidence that this will not in itself lead to the desired land use change. If landowners enjoy their current management practices and income is sufficient to sustain that lifestyle while the property's capital value increases, there may be little incentive to take on debt for the sake of chasing theoretically higher returns. A mixture of incentives and disincentives may be required but landowners need the flexibility to make decisions for themselves that suit their own situations and goals. To facilitate this there is a need for economic and financial metrics that resonate with land managers, and an understanding of their broader objectives. Overcoming the lack of knowledge and providing investment approaches that remove the financial barrier to carbon farming are key. More generally, sustainable land use and intergenerational equity requires analyses that consider ecosystem services, social license to operate, health and safety, and resilient cash flows. Through the integration of these factors, the use of NZs finite land resource may be better rationalised.

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Two concurrent SLMACC projects are investigating land use on steep hill country:

- Alternatives to plantation forestry post-harvest of East Coast steep land – (mānuka, native forest regeneration);
- Transition from clearcut plantations on steep land to continuous cover forestry.

A further two projects are concerned with low emission alternatives to livestock grazing:

- Low emission land uses – alternative crops to livestock;
- Alternatives tree species to radiata pine and Douglas fir.

Details of these and previous SLMACC projects can be found at:

- http://www.climatecloud.co.nz/Pages/default.aspx
- https://www.mpi.govt.nz/funding-and-programmes/farming/sustainable-land-management-and-climate-change-research-programme/

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