Identifying complementarities for the dairy and forestry industries in the Central North Island

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Identifying complementarities for the dairy and forestry industries in the Central North Island

Juan J. Monge, Warren J. Parker and Stefania Pizzirani

Abstract

The aim of the study is to provoke and promote constructive discussion on how opportunities for complementarities can be generated at a land enterprise (farm or forest) and catchment level to create beneficial scenarios for the dairy and forestry industries. In that regard the study is deliberately simple in its approach: other sectors of the economy are excluded to keep the scenarios easy to understand and focused. We looked at land use on similarly-sized land areas to contrast the economic, environmental and social impacts from both industries in the region. Such a discussion will help stakeholders: comply with current national environmental policies such as the National Policy Statement for Freshwater Management (NPSFM) and the emissions trading scheme (ETS); inform pathways for achieving regional economic growth within environmental limits; and indicate how the integration of land uses at different scales can be achieved more effectively than in the past.

Introduction

It is possible to achieve greater land-use sustainability at both the farm- and catchment-level by combining the high economic returns from dairy farming with the low environmental impacts of forestry.

Dairy is New Zealand's largest export earner, followed by meat and forestry. Between 1990 and 2010, milk solids productivity increased by 60% due to increased stocking rates and increased use of inputs such as water, fertiliser and supplementary feed. Unfortunately, this intensification of milk production has precipitated an array of negative environmental impacts including reduced water quality, higher methane gas emissions, higher irrigation demands for surface and groundwater, and reduced variety in pastoral landscapes (PCE, 2013). However, these environmental costs still mostly remain externalised to the dairy business and supply chain. As a result, the economic contribution of dairying to the New Zealand economy is overstated.

Forestry, in contrast, is associated with a number of positive benefits other than the economic value of wood and wood-fibre products. For example, forestry sequesters more carbon than any other land-use option (Murray et al., 2005). In addition, a recent review of water quality in New Zealand has also shown that planted forests produce high water quality for a large proportion of the forestry-growing cycle, and that planting forests could rapidly improve water quality from land previously in pasture, thus highlighting the potential of forests to remediate degraded waterways during land-use change (Baillie & Neary, 2015). Other important benefits are also provided by forestry in New Zealand including (but not limited to) avoided erosion, reduced sedimentation, conservation of indigenous wildlife, recreation and tourism (Yao et al., 2013). There are also potential adverse impacts of forestry, particularly when best management practices are not followed and post-harvesting residues and sediment are allowed to enter waterways (Phillips et al., 2012).

Dairy and forestry production are very important in the Central North Island (CNI):

- The dairy and forestry industries in the CNI each account for 34% of New Zealand's total national effective stocked and planted area
- Around 32% and 30% of those employed nationally live in the CNI, respectively
- Exports from the Port of Tauranga account for approximately 42% and 39% of the national exported total values, respectively (Statistics NZ, 2015).

During the past decade, a significant amount of land in the CNI has changed from forestry production to dairy. The 2014 annual deforestation survey showed total intended deforestation by all forest owners was about 67,000 ha in the 2014 to 2025 period, with two-thirds taking place in the CNI (Manley, 2015). Most of the deforested area has already been converted to pasture for dairy cows, a conversion motivated by the combination of the recent high profitability experienced by the dairy industry and the potential for capital gains through increased land values. Consequently, there has been a reduction both in water quality and in the long-term (post-2030) security of log supply for

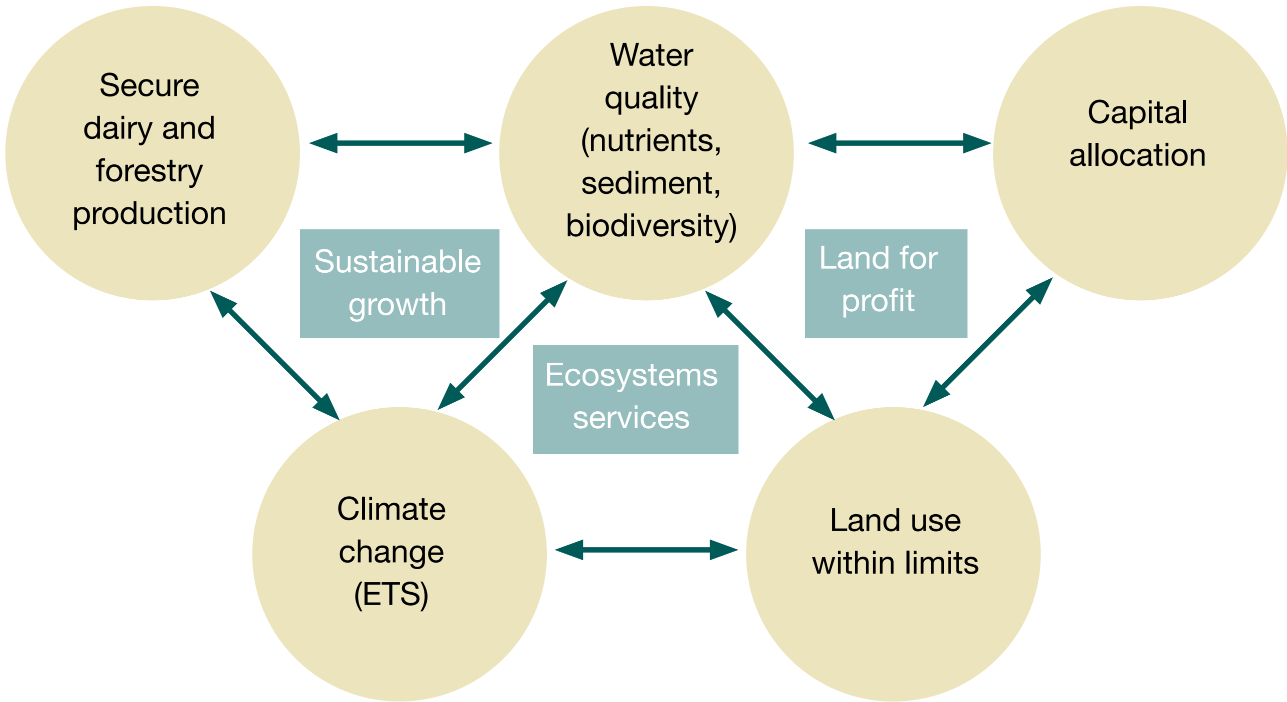

Figure 1: Policy connections – co-benefits/trade-offs

wood processors. Furthermore, as a result of national deforestation, more greenhouse gas emissions (GHGs) are being released into the atmosphere, as evidenced by the fact that 29% more CO_2 equivalent was released in 2014 than in the previous year (MfE, 2016).

Central and local governments are currently confronting the challenge of increasing regional economic growth and social well-being while also reducing the consequent environmental impacts (externalities or ecosystem services). National environmental policies that are being implemented include the NPSFM, which aims to improve freshwater quality and the ETS, which is designed to reduce GHG emissions.

The implementation of these policies has created opportunities to exploit the complementary economic aspects of dairy and forestry as land-use alternatives within environmental limits (Figure 1). It would be more advantageous for local government agencies, landowners and other investors to make evidence-based decisions about the use of land (and its management) by accounting for externalities such as water quality, GHG emissions etc. Collectively, this would improve the sustainable use of natural capital in the region and would help to ensure that land prices reflect the 'sustainable' productive value of this resource.

The CNI is an ideal region to investigate the effects of land use by the dairy and forestry industries. We carried out a case study to investigate how opportunities for complementarity can be generated at a land enterprise (farm or forest) level and catchment level to create beneficial scenarios for both industries. We kept the study deliberately simple, excluding other sectors of the economy to keep the scenarios focused and easy to understand. We looked at land use on similarly-sized land areas (28,000 ha for forestry and 95% of that as effective farm area for dairy) to contrast the economic, environmental and social impacts from both industries in the region. The summary of the land-use complementarity analysis will: (1) help stakeholders comply with current national environmental policies; (2) achieve regional economic growth within environmental limits; and (3) indicate how the integration of land uses at different scales can be more effectively accomplished.

Ecosystem services

Ecosystem services are the benefits which people derive from ecosystems and are categorised into four groups: provisioning, regulating, cultural and supporting services. We focus here on the ecosystem services generated by the dairy and forestry industries in the CNI. The relative environmental impacts identified for dairy and forestry are listed in Table 1. This list focuses mainly on services that have been valued in the literature and that are relevant to the region in question.

Comparing the economics of dairy and forestry

We carried out an economic analysis to assess the profitability of a representative dairy farm and a representative steady-state forest in the CNI to demonstrate the relative profitability of well-established enterprises, rather than to identify the best use of a hectare of land.

Table 1: Quantity and value ranges of ecosystem services generated by the dairy and forestry industries

Externalities/Services	Units	Land uses	
		Dairy	Forestry
Quantities			
Nitrogen leaching [a]	kg/ha/yr	15–115	3–28
Phosphorus leaching [b]	kg/ha/yr	0.30–1.70	0.01–0.10
Carbon emissions [c]	t CO_2e/ha/yr	8–14	
Carbon sequestration [d]	t CO_2e/ha/yr		35–55
Values			
Carbon [e]	$/t CO_2e	3–17	
Nitrogen [f]	$/kg	350–650	
Flood mitigation [g]	$/year	1–41 million	
Biodiversity [h]	$/person	69	
Recreation [i]	$/visit	4–92	
Land stabilisation (1% incr) [j]	$/ha/yr	1	
Water sediments [j]	$/ha/yr	105	
Algae in water [j]	$/ha/yr	111	
Level of water flow [j]	$/ha/yr	12	

[a] Menneer et al. (2004)
[b] Rutherford et al. (2009) and WRC (2014)
[c] Adler et al. (2013) and Smeaton et al. (2011)
[d] Beets et al. (2012)
[e] OMF (2016)
[f] Duhon et al. (2012)
[g] Bicknell et al. (2004) and Bayfield et al. (1998)
[h] Yao et al. (2014)
[i] Barry et al. (2012) and Everitt (1983)
[j] Rivas Palma (2008)

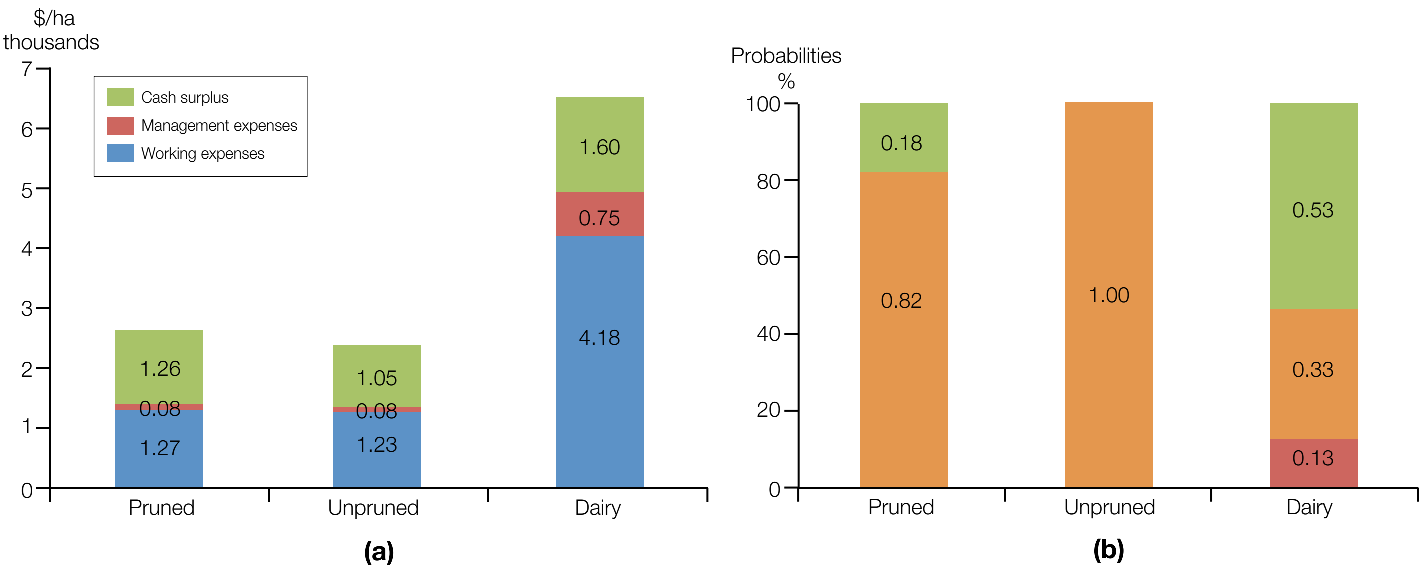

Figure 2: (a) Breakdown of per hectare expenses and surplus by land-use alternative using average yields (regional) and prices (2005–2015); (b) probabilities of experiencing an annual per hectare loss (red), a surplus >$1,500 (green) and a surplus < $1,500 (orange)

Considering pure market drivers, a hectare of dairy generates surpluses between 27% and 52% higher than a steady-state forest under pruned and unpruned regimes, respectively (Figure 2a). The profitability indicators were estimated using average milk and timber prices over the last 10 years, commencing in July 2005 (Dairy NZ, 2015a; MPI, 2015). However, the consideration of profitability alone largely ignores environmental externalities and the volatility of milk payouts over the last 10 years.

New Zealand's heavy dependence on international commodity markets exposes the dairy industry to large price fluctuations for milk solids and associated volatility in the subsequent payout to farmers. Considering the evident fluctuations of milk prices during the last decade, such volatility could result in losses for farmers (a 13% probability), affecting their ability to plan long term and acquire the lowest cost credit to stay operationally efficient (Figure 2b). Radiata pine log price data from the same 10-year period shows that although forestry generated lower returns, it is more resilient than dairy due to: (1) the combination of domestic and export markets; and (2) the relative stability of prices in the domestic market.

Value of total production (export and employment indices)

The values of total production are approximately $193 million for dairy compared to $161 million for forestry for the representative 28,000 ha. To arrive at these figures, we collected production, employment and exports statistics from various official sources and rescaled such figures to the representative area considered in this study as shown in Table 3.

The dairy industry produced approximately 595,000 tonnes of milk solids at the farm level from 576,000 ha in the CNI in 2014 (Dairy NZ, 2015b). This supported approximately 9,000 full-time equivalent employments in the region, and is valued at approximately $3.9 billion using the 10-year average dairy payout of $6.50/kg MS (including Fonterra's 2014/2015 average price of $4.60/kg MS) (Statistics NZ, 2015).

This milk was then manufactured into a wide array of dairy products including whole and skim milk powders, butter and cheese, and other products (amounting to approximately 900,000 tonnes of product) and provided approximately 3,790 full-time equivalent employments (Statistics NZ, 2015). Approximately 95% of the manufactured dairy products were exported to countries such as China, Japan, the United States and Europe among others (Fonterra, 2015). The total production of manufactured dairy products was valued at approximately $5 billion (Statistics NZ, 2015).

The forestry industry produced approximately 12.6 million m^3 of logs from 18,400 ha harvested in the CNI in 2014. This log production generated approximately 1,750 jobs in the region (Statistics NZ, 2015). In contrast to the dairy industry, 51% of the supply of raw material (i.e. logs) was destined for exportation and logs were predominantly sent to China, South Korea and Japan. Log exports from the Port of Tauranga were valued at approximately $0.95 billion (Statistics NZ, 2015).

The manufacturing stage of the forestry supply chain in the CNI is more complex than the dairy industry due to the 41 mills owned by different companies (Hall, 2015). These mills employed approximately 5,870 employees in total, which is 55% higher than total employment by the dairy plants in the CNI (Statistics NZ, 2015). Such mills can be grouped into four major manufacturing categories: saw, pulp, paper and remanufacturing mills. Sawmilling is the most fragmented sector, with most mills being privately owned and operated. In contrast, Oji Fibre Solutions mills take half the total log supply processed in the CNI region.

If all of the harvested logs from the CNI region were to be domestically manufactured, the value of wood products would be approximately $161 million from the representative 28,000 ha. Therefore more on-shore manufacture of logs would generate more New Zealand-based jobs, increase the value of exports, and place forestry products on a par with high-value dairy products. Note that there is no publicly available information on the manufactured and exported quantity and value of wood products from the CNI. We therefore relied on a bottom-up approach by using historical export prices and the technical conversion coefficients from Red Stag (for lumber) and Oji Fibre Solutions (for pulp and paper) to develop manufactured values and quantities from a 28,000 ha forest, respectively, as listed in Table 3.

Complementarities at the land-use level

An initial opportunity to quantify some of the positive and negative ecosystem services generated by the dairy and forestry industries is provided by the ETS and NPSFM, which allow for a monetary recognition of carbon and nitrogen emissions. Taking the required nitrogen reductions in Lake Rotorua (Rule 11) as an example, it is possible to visualise potential economic implications on dairy farm profitability.

The Rotorua Lakes Incentive Board will implement an integrated programme that combines nitrogen discharge allowances (NDAs), incentives and gorse conversion (Barns, 2014). Under the NDA scheme, dairy farmers are required to reduce nitrogen discharges from an average catchment-benchmark of 54 kg/ha to an established NDA of 35 kg/ha by 2032. Furthermore, the board has funding of $40 million to incentivise a further reduction of 100 tonnes of nitrogen through conversion of pasture into forest (effectively the retirement of NDAs in perpetuity). At a potential price of $400/kg of nitrogen, and a reduction of 32 kg/ha of discharge nitrogen, a landowner would receive a potential one-time lump sum payment of $12,800 for afforesting a hectare previously devoted to dairy (Monge et al., 2016).

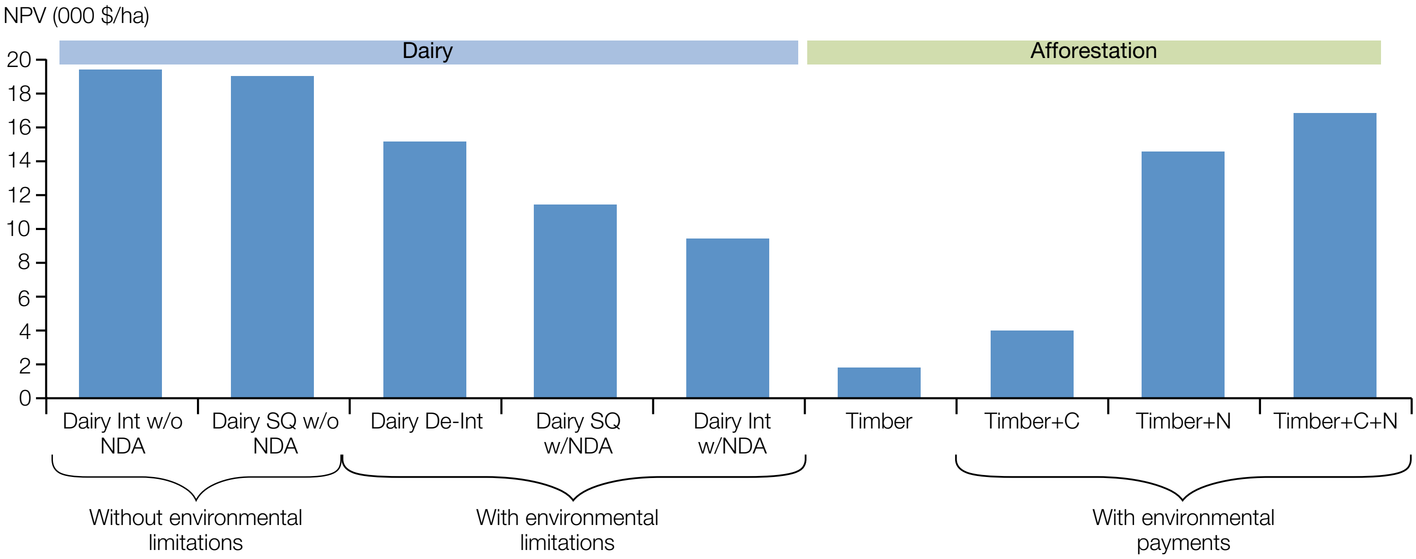

Figure 3: Per hectare net present values for forestry (with and without environmental payments), and dairy (with and without NDAs) at different intensity levels (status quo (SQ), de-intensified (De-int), and Intensified (Int)) at nitrogen (N = $400/kg) and carbon prices (C = $7/NZU)

Table 2: Sensitivity analysis of per hectare NPVs with different nitrogen and carbon prices for dairy and forestry under different intensity levels (green is the preferred and red is the least preferred land use)

Nitrogen	Forestry				Dairy w/NDA		
Price	Carbon price ($/NZU)				Intensive	Status quo	De-intense
($/kg)	0	7	15	25			
0	1,749	3,985	6,681	9,969	19,500	19,065	15,216
100	4,949	7,185	9,881	13,169	17,000	17,165	15,216
200	8,149	10,385	13,081	16,369	14,500	15,265	15,216
300	11,349	13,585	16,281	19,569	12,000	13,365	15,216
400	14,549	16,785	19,481	22,769	9,500	11,465	15,216

Dairy farmers will face the dilemma of complying with environmental regulations by either de-intensifying current operations, by including forestry, or by paying for the right to operate above the assigned NDA.

The net present values (NPVs) for both dairy at different intensity levels (with and without NDA compliance) and forestry (with and without environmental payments) are shown in Figure 3. Intensive dairy results in the highest NPV followed by dairy under current intensity levels. The NPV difference is minimal due to the decreasing marginal returns of nitrogen usage. The NPV for afforestation is very low without the recognition of ecosystem services. Even when carbon is recognised, forestry's NPV is still low (at the time of the study the carbon price was $7/NZU). It is worth mentioning that the carbon price has changed from $7/NZU to $17/NZU since we undertook the study and that there are possibilities that it might increase further. When an afforestation project receives both carbon and nitrogen payments, NPV increases considerably and is comparable to that of de-intensified dairy. Even without carbon prices, forestry and nitrogen follow de-intensified dairy closely. If a trading scheme were in place, and the farmer decided to pay for the right to operate above the assigned NDA, current and intensive dairy operations become less profitable than the de-intensification alternative.

Nitrogen reduction is inevitable, but since a nitrogen-trading scheme has not been implemented and the nitrogen price is still uncertain, we considered scenarios where the farmer pays for the right to operate above the assigned NDA at different nitrogen prices. The results of a sensitivity analysis of the carbon and nitrogen prices are shown in Table 2. Dairy is the most profitable land use at low nitrogen prices. However, forestry becomes an appealing land use at nitrogen prices above $200/kg, especially with higher carbon prices. Forestry is the best alternative at the assumed nitrogen ($400/kg) and carbon ($7/NZU) prices. With the change in carbon price from $7/NZU to a current price of $17/NZU, forestry could turn out to be more profitable than dairy even at low nitrogen prices (i.e. < $300/kg).

Simple comparative summary

Table 3 summarises the main findings from the study and applies the results to a similar area (28,000 ha for forestry and 95% of that as effective farm area for dairy) to contrast the economic, environmental and social impacts from both industries in the region.

Current economic indicators, such as dairy payouts and land values, do not take into account the full value of ecosystem services, both positive and negative, that different land uses entail. Table 3 shows how through the internalisation of a subset of the externalities and ecosystem services generated by the dairy and forestry industries (last row), respectively, such purely market-driven indicators could be corrected. Under various plausible assumptions considering regional circumstances, national statistics and current environmental policy plans, forestry as a land-use alternative could potentially receive environmental payments in the order of approximately $1,000/ha (or $1.60/m^3) from carbon and nutrient schemes. On the opposite side of the spectrum, a dairy farm could potentially be penalised with a nitrogen and carbon externality payment of approximately $680/ha (or $0.70/kg MS) if the farmer decided to operate at current stocking levels (as opposed to de-intensifying operations) with their respective high nitrogen leaching and carbon emission levels.

Conclusions

The monetary recognition of the ecosystem services generated by forests through the ETS and NPSFM will, other things being equal, result in higher reforestation and afforestation rates, which will in turn benefit regional economies. Such policies offer an opportunity to capitalise from greater domestic wood processing to grow the value of exports as shown in the Wood Council of NZ's '$12 billion of exports by 2022' strategic action plan (Wood Council of NZ Inc., 2014).

Table 3: Comparative economic and environmental indicators for a representative dairy farm and forest in the Central North Island

	Forestry		Dairy	
Area	28,000	ha/forest	26,600	grazable ha/farm
Yield/unit	678	m^3/ha	1,030	kg milk solids (MS)/ha
10-year average price	98.15	$/m^3	6.42	$/kg MS
Average surplus	28,686,180	$	39,673,900	$
Manufactured product	67,550	t pulp	37,522,559	kg whole milk powder
	275,268	m^3 of lumber	3,035,393	kg cull cow and veal
10-year average export price	737	$/t pulp	4.76	$/kg whole milk powder
	404	$/m^3 of lumber	4.90	$/kg meat
Values of manuf. products [a]	160,992,373	$/forest	193,527,714	$/land area to dairy
Land value	6,000	$/ha	36,100	$/ha
Jobs (raw material)	84	emp/forest/yr	415	emp/farm/yr
Jobs (manufacture)	280	emp/mill/yr	175	emp/plant/yr
Nitrogen discharge	3	kg/ha/yr	54	kg/ha/yr
Carbon emitted/stored [b]	11	t CO_2e/ha/yr seq	–10	t CO_2e/ha/yr emitted
Indicative environ payment [c]	1.60 (1,000)	$/m^3 ($/ha)	–0.70 (–680)	$/kg MS ($/ha)

[a] Valued at export prices and assuming that all raw-product supply is manufactured domestically to show full potentials.

[b] Considers average annual seq. rates of 35 t CO_2e/ha/yr and emissions at harvest of 647 t CO_2e/ha for forestry.

[c] Although the dairy industry is exempted from being part of the ETS, we have included potential externality payments to contrast the potential penalties the industry would incur if they were liable for the emissions generated in a farm. We have also assumed a conservative carbon price of $7/t CO_2e. Indicative figures to show the externalities generated by forestry (avoided leaching below allowance) and dairy (leaching above allowance of 35 kg/ha) at a nitrogen price of $400/kg (or perpetual annuity of $32/kg).

The high employment statistic recorded for the manufacturing stage of the forestry industry (higher than dairy manufacturing as shown in Table 3) should be considered as critical evidence considering the development of environmental policies affecting land-use change and the regional economy. Greater afforestation will also help New Zealand meet its international climate change targets, as well as reach higher standards of water quality for cultural, recreational and tourism purposes. Some biodiversity measures would also improve relative to the status quo.

The afforestation option appeals mainly to landowners who have a long-term perspective towards land ownership since short-term land values are not an immediate concern. For example, Māori landowners follow a long-term collective ownership structure and are often motivated by environmental and cultural reasons. Out of a total 1.2 million ha available as Māori freehold land, approximately 37% (441,154 ha) is within the major regions comprising the CNI (Bay of Plenty and Waikato) and 30% (347,853 ha) is in Land Use Categories (LUC) unsuitable for arable land (higher or equal to LUC 6) (PwC, 2014). Thus, Māori freehold land currently in dairy or drystock presents a great opportunity to comply with catchment-level restrictions.

This report provides evidence that profitable land use can be achieved within environmental limits and with lower GHG emissions through: (1) greater cohesive catchment- and regional-scale planning; and (2) offering more appropriate incentives for ecosystem services. The identified complementarities between dairy and forestry land uses could be exploited to achieve resilient economic growth under the environmental limits established by the ETS and NPSFM.

To support this endeavour, a more detailed economic regional analysis is recommended to fully assess the opportunities for complementarity across the full scope of land-use supply chains. Such analysis would utilise spatial economic tools such as Scion's Forest Investment Finder and regional modelling frameworks (e.g. input-output or computable general equilibrium models) to inform regional policies for use of land and natural resources within prescribed limits that would also support economic growth. Furthermore, such a study could provide a marginal analysis that would indicate where discharge rights for nutrients (such as nitrogen) could best be allocated to generate future economic returns. A more detailed economic analysis of land uses would facilitate the development of sustainable and progressive regional and national policies.

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