Turning a profit while turning paddock corners into shady oases

Integration of agroforestry systems with irrigated dairy farms

Why: To establish how agroforestry could be incorporated into the dryland corners of irrigated dairy farms for economic gain through carbon credits, with the possible benefit of shade for cows.

Where: Modelling planting exotic trees in dryland corners of two dairy farms in Waimakariri, Canterbury, one with a small number of high-value timber trees and the other with some natives and transitioning from exotics to natives over time.

Who: Kyle Wills, Dr Sandra Velarde Pajares, Dr Electra Kalaugher, Nathan Capper, Dr Istvan Hajdu and Lisa Arnold (all with WSP), Sam Spencer-Bower (farmer), Logan Robertson (Ngāi Tahu Farming Limited) and Erin Harvie (Waimakariri Landcare Trust).

What:

- Gaining carbon credits made agroforestry in the dry corners of irrigated paddocks economically viable, producing a long-term alternative income stream.
- Shade for cows was gained, with trees also slowing hot dry winds, with a benefit for pasture of reducing evapotranspiration.

More: ourlandandwater.nz/outputs/agroforestry-report

As summers on the Canterbury Plains get warmer and winds stronger, trees could offer shade and forage to dairy cows while creating biodiversity havens – and not a pine tree in sight.

The Canterbury Plains were once a patchwork of native trees – kahikatea, matai and totara, with beech forest on the slopes. Warm and dry summer winds, having dumped their moisture on the West Coast, swept over the Southern Alps, belting down the slopes east of the divide and into the treetops on woodland plains, leaving the shaded forest floor cool and moist beneath.

The landscape has changed dramatically in the centuries since people arrived. The shady forests full of wildlife are long gone, replaced by a patchwork of pasture and cropping paddocks, turning the plains into one of the most productive agricultural areas in the country. The hot and dry nor'westers in summer now pull moisture out of the soil and vegetation through evapotranspiration.

Irrigators sweep the landscape, with dairy cows and other livestock grazing out in open, mostly unshaded paddocks. With irrigator pivots too low for shade trees, and potentially three months of hot days over 25°C by the end of the century, there are increasing animal welfare concerns over heat stress. This problem already sees a reduction in milk production in dairy cows in summer.

For 25 years, the Animal Welfare Act and the Ministry for Primary Industries have advised farmers that livestock need protection from heat stress, cold stress and extreme weather, but action has largely been insufficient to prepare for the changing climate.

Agroforestry

Shady oases

Kyle Wills, a farming systems consultant with WSP, is among consultants who now see stronger legislation for the better protection of livestock, including to provide shade, as being likely in the future. This has seen him focus on the estimated 35,000 ha of dryland corners across the plains that are outside the reach of irrigation pivots.

With funding through Our Land and Water's Rural Professional Fund, Wills looked at the economic and physical benefits of incorporating agroforestry in these lower-quality pasture corners by planting them with forage trees that cows can graze under. This will allow farmers to diversify while offering shade for stock, slowing down winds, and reducing moisture loss through evapotranspiration.

The cost of establishing trees was the biggest drawback for the farmers surveyed, along with a lack of knowledge about agroforestry generally and no local examples to look at.

Wills wondered if the trees pay their own way and provide a new income stream through the Emissions Trading Scheme. Would the negatives of shading on pasture be countered by increases in nitrogen (N) in the soil from N-fixing trees in the mix, better growing conditions from a cooler and moister micro-climate under the trees, increased pasture growth downwind of the trees, and the benefits to cows of tree fodder and less heat stress?

Getting underway

Wills and his team modelled two dairy farms at Waimakariri. The Claxby Farms 647 ha property had 93% irrigation coverage and 61 ha of dry paddock corners, while the Ngāi Tahu 335 ha Hamua farm had 95% coverage and 25 ha dry corners. Both farms ran around 3 cows/ha.

Wind- and drought-tolerant forage poplars and mulberry, with honey locust to fix N, were modelled for both farms. Being deciduous, the trees would allow good levels of daylight onto pasture during spring growth.

The Claxby Farms would have a handful of high-value black walnut trees in the mix. The Ngāi Tahu farm would include natives like N-fixing kowhai and fast-growing ribbonwood to attract native birds, with the intention that natives would replace exotics over time, eventually becoming a native agroforestry setting (**Table 1**).

Table 1: Agroforestry species, their role in the system and proportion planted at each farm

Species	Claxby Farms (planted)	Ngāi Tahu (planted)	Role in agroforestry
Poplar	32.7%	25%	Forage, soil conditioner, medium canopy
Mulberry	32.7%	25%	Forage, medium-to-dense canopy
Honey locust	32.7%	25%	Forage, nitrogen fixer, sparse canopy
Black walnut	2%		Timber, high-risk high return timber opportunity with small exposure
Kowhai*		12.5%	Behave as an island for indigenous flora and fauna to be attracted to, encouraging reforestation, nitrogen fixer
Ribbonwood*		12.5%	Behave as an island for indigenous flora and fauna to be attracted to, encouraging reforestation

* Semi-deciduous

Rows of trees 20 m apart, with trees 10 m apart within the rows, would run north to south where possible to maximise both sunlight on pasture and provide wind shield to reduce evapotranspiration under the trees and downwind in adjacent pasture. Where natives were planted they were 2.5 m apart.

This would exceed the 30% canopy cover needed under the permanent forest category to qualify for carbon credits through the Emissions Trading Scheme, by around 10% canopy cover to allow for replacing trees over time. Along with providing shade for stock, some tracks and yards – unproductive areas – would now be earning carbon credits as they would be underneath tree canopies.

Ngāi Tahu chose to fence off the rows to partition their more open spaces and allow for habitat growth around the trees. While they still have some individual tree protectors, they have a higher proportion of fenced rows than Claxby. Claxby Farms went for a cheaper option of individual tree protectors and stakes to allow for more flexible management.

Claxby's costs sat at $3,974/ha. Double fencing increased establishment costs for Ngāi Tahu to $5,017/ha and sees lower financial gains long term.

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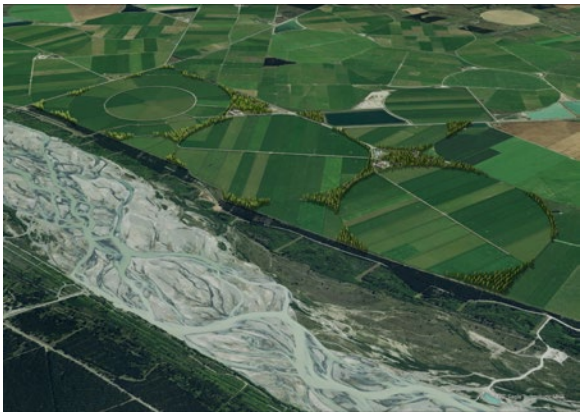


Agroforestry at Claxby Farms

A changing landscape

Modelling the economic effects saw both farms identify agroforestry as a land-use diversification opportunity that would pay for itself while seeing a new income stream, with all-important shade now provided to the cows.

Income from carbon credits climbed quickly during the first seven years, peaking at around $170,000 annually for Claxby and $70,000 for Ngāi Tahu, before a slow decline to the 35-year mark.

Carbon credits were the clincher for profitability as the projects run at a 7% loss without them. The sums were run with a carbon price of $70/$CO_2$e tonnes. This saw the internal rates of return (IRR) for Claxby sitting at 26% and an annual return on investment (ROI) over 36 years of 32%. For Ngāi Tahu the IRR was 20% with an annual ROI of 24% (**Figures 1 and 2**).

Should the carbon price drop to $20/tonne, the net present values (NPVs) would stay in the black for

Figure 1: Net modelled cashflow of Claxby Farms agroforestry

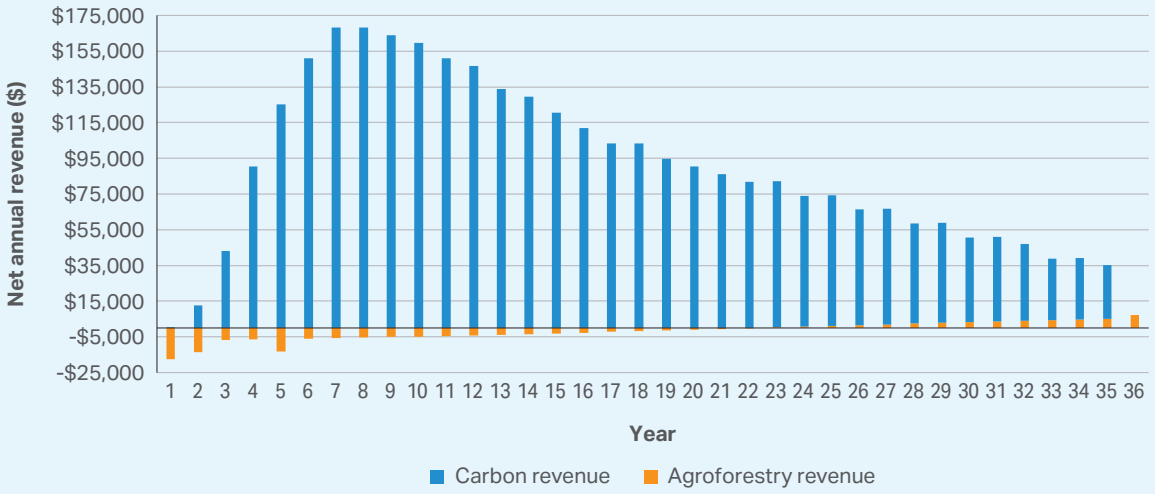
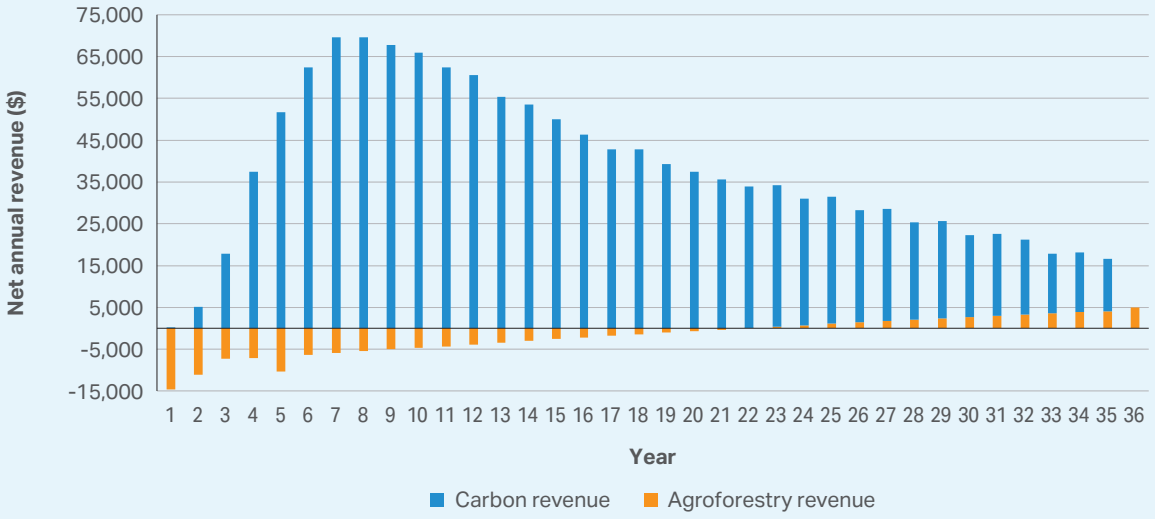


Figure 2: Net modelled cashflow of Ngāi Tahu Hamua agroforestry



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Claxby at around $123,000, but fall into the red for Ngāi Tahu by nearly $14,000.

Income from carbon credits was deemed to end at 35 years after which the trees would bring in a modest $7,300 annually for the Claxby Farm and $5,000 annually for Ngāi Tahu.

The $7,300 for Claxby and the $5,000 for Ngāi Tahu after carbon credits was from increased milk production from shade, taking into account a decrease in pasture production of 20% and increase in tree forage of 1 t DM/ha.

"This research shows a good economic incentive to look into this design further – the economics work," says Wills. He is pleased both farms are now looking at implementing this design in some shape or form.

Delwyn Dickey for the Our Land and Water National Science Challenge