National SCIENCE Challenges

OUR LAND AND WATER

Toitū te Whenua, Toiora te Wai

Photo: Tony Benny

Learn more

- ourlandandwater.nz/project/land-use-opportunities
- landuseopportunities.nz

Contact Us

ourlandandwater@agresearch.co.nz

Land Use Options in Waimakariri

Case Study from Whitiwhiti Ora: Land Use Opportunities Research

OUR LAND AND WATER · Toitū te Whenua, Toiora te Wai · National SCIENCE Challenges

Data Supermarket
Land Use Opportunities for Aotearoa

Introduction

There's a common saying, that land is lifeblood to farmers. It's popular because it captures the deep intrinsic connection and care most farmers take in their land-use decisions.

Making decisions about future land use is complex and the impact of any choice can feel as though it is looming over a farming family's very existence. Farmers are deeply affected by the problems facing the natural world and are deeply aware of where human impact is causing changes to the environment and the climate. Choosing the right response to these problems, however, is often complicated by:

- Regulations and policies that change every few years.
- The uncertainty that comes with scientific modelling — especially models that don't always tell a useful story at farm level.
- Some researchers who recommend theoretical possibilities that don't connect to the practical realities of farming.

Many of those concerned about the land and the ongoing viability of farming within Aotearoa New Zealand, know some land use change is going to occur through opportunity or necessity to respond to the growing pressures faced by land, water, and people. At the national scale, the country supports a mosaic of land uses, but as we zoom to more and more local scale, monocultures increase. Examples include dairying in Taranaki or horticulture in Pukekohe. It may be time to examine new opportunities alongside existing successes.

Developing alternative land-uses requires support to leverage collective knowledge and resources, as well as a viable supply chain. It also benefits from expert knowledge around appropriate growing conditions and feasible opportunities. A detailed investigation of the risks involved in the product, its production needs, and market are fundamental to the success of any enterprise.

About this case study

The Whitiwhiti Ora: Land Use Opportunities case study in Waimakariri brought farmers and researchers together to co-design an approach to assessing diverse opportunities when considering land-use change. It encompassed opportunities beyond business as usual. Any alternative land-use opportunities under consideration had to be economically viable, acceptable to the farmer, as well as possible given the soil and climate. The focus was on diversification over time rather than wholesale land use change.

While the work focused mostly on water quality and the impact of nitrogen (nitrate leaching) in particular, the work also took into account other contaminants (phosphorus, *E.coli*, sediment), greenhouse gas emissions, and the need to adapt to a changing climate. Workshops with farmers, industry experts, and researchers ran in tandem with the development of the Data Supermarket, which aims to make this process more accessible for similar land-use decision-making in the future.

The ultimate aim of the project was to enable farmers to make confident decisions that allow the land and its people to prosper.

How the process worked

We chose the Waimakariri location as it is an agricultural community in a nitrogen over-allocated catchment, with irrigation pressures. The catchment is vulnerable to both drought and flooding that may increase in the future.

The project allowed farmers within the Waimakariri catchment to assess potential land uses that their farms could diversify into. We worked with dairy, sheep and beef, and mixed cropping farms. The project included the catchment group, farm managers and farm business owners, regional council representatives, farm consultants, investment advisors, researchers, and experts in the proposed alternative land uses.

When making decisions, the group considered environmental benefits, climate resilience, and economic resilience in the area.

Photo: Tima Volz

Other resources

Alongside the Data Supermarket, various other resources are available when investigating land-use opportunities.

- Venture Taranaki's Branching Out project has short brochure-style documents that discuss the practical details of alternative land use choices. Land-use opportunities include avocados, gin botanicals, grains, legumes and vegetables, hemp fibre for construction, hops, indigenous ingredients, kiwifruit, medicinal plants, sheep/dairy, and trees.
- Work has also been done by Thriving Southland to shortlist seven food and fibre opportunities for the region, and feed into the region's long-term plan. Opportunities include on-farm energy and biomass, food and beverage tourism, industrial hemp, and precision fermentation.
- The Worker Requirements by Land Use dashboard is a tool to estimate the number of full-time equivalent staff needed for different land-use scenarios, and can suggest land uses that complement a selected land use(s) to smooth out seasonal variance in workforce requirements.
- Pohewa Pae Tawhiti (Visualising Horizons) is a guided process for decision making. The Process Guidelines document assists a facilitator to lead groups through the seven steps of the Pohewa Pae Tawhiti framework to explore different options appropriate to their context and land.
- Tools for Making Land Use Decisions is a learning module developed by the Our Land and Water National Science Challenge for rural professionals. It includes evidence-based insights on how to involve a broader group with land use diversification, how to help farmers and catchment groups with decision making, and the tools you can use to support change.
- The Integrated Impact Assessment (IIA) Framework shows the impact of land use changes on economic, social, cultural and environmental indicators, allowing exploration of scenarios where land use is changing for a specified region of New Zealand.
- As this case study is being produced, some resources are still in development. Please check the following pages for relevant research to be added mid-2024: Signals for Land Stewards (Stronger Signals sub-project), Synthesis Scenarios for Future Land-Use, Mosaic vs Monoculture Landscapes.

Complexity and scale

The Whitiwhiti Ora Waimakariri case study has reinforced that land use diversification is a complex issue.

With irrigation and access to a significantly sized local market as well as the benefits of being close to an international port and airport, local farmers understand that there is real potential for changes to land use in the Waimakariri catchment. However, the complexities involved add to any existing challenge for family-owned businesses. These complexities include:

- accessing capital
- identifying high value markets
- sourcing the resources needed to access or develop required infrastructure (e.g. coolstores, pack houses)
- reaching the scale required to operate the new infrastructure cost-effectively.

A corporate investor in forestry and horticulture shared their investment journey with the farmers. They noted the risks, challenges, and opportunities involved in choosing whether to change land-use. They also highlighted the need to consider different business models to get the required scale for new industries within a region. Finally, they discussed the opportunity to be followers if corporate investment can provide the required scale to enable development of the required infrastructure.

The sheep and beef and arable farms already had a range of enterprises within their farming businesses. They were therefore able to discuss additional challenges, including:

- significant capital requirements
- the need to build on-farm capacity and skills
- uncertain markets adding further risk across a range of indicators (e.g. profitability, employing skilled labour, accessing practical experts.

For all farms moving into new business area, managing additional land uses in an already complex system makes significant demands on managerial focus and skills. If there is insufficient managerial focus, there is a risk that farm performance will become suboptimal for both existing and new enterprises. There needs to be a large enough scale in the microclimate and soil niche required in any new enterprise to make the dilution of managerial focus worthwhile, or to allow additional management expertise and skills to be brought in. This emphasises the need to think of new ways and structures to create the required on-farm capacity and skills.

Finally, the scientific analyses from Plant & Food Research, AgResearch, Dairy NZ, and LWP highlighted the scale of change required for meaningful impacts on catchment freshwater.

Whitiwhiti Ora: Land Use Opportunities Case Study

What is required to replicate the process?

Another reason Waimakariri was chosen as the case study is because it has a strong catchment group trusted by and connected with the local farming community.

The first five steps of the process are therefore available to any group of farmers operating within a supportive catchment group and with access to a technically proficient farm consultant. Information contained in the Data Supermarket enables economically viable alternative land-use opportunities to be prioritised by anyone who can work GIS software.

This will enable your catchment to identify the top five feasible options for partial land-use diversification without monetary investment.

Replicable process

1. To start the process, local farmers, the catchment group, and a technically literate consultant begin with an introductory workshop. The scope for the workshop includes a range of land use change and the requirement for any change to be commercially viable. The consultant can bring maps sourced from the Data Supermarket showing possible land-use options for the district. By the end of the workshop there should be a long-list of feasible land-use opportunities.
2. The consultant can then use the Data Supermarket, Farmax, and other available tools to refine the land-use options into a list of the top six opportunities specific to the location and acceptable to farmers.
3. In a second workshop, farmers are asked to volunteer to put their farms forward as case studies. It is best if a variety of farm types can be case studies. In Waimakariri, three case study farms were involved throughout the process, one dairy, one arable, and one dryland sheep and beef.
4. The farm consultant then takes each case study farms through baseline farm modelling, involving current stocking policy and level of production. This modelling also examines some elements of soil type and micro-climates on each farm.
5. Once modelling is completed, it's time for another workshop. At this meeting, farmers from each individual case study will work with the consultant, the catchment group, and other local farmers to identify appropriate land use opportunities for their farms.

Extended process

6. Additional expertise to understand the catchment context may be required. Because this case study focused on reducing nitrogen losses, N-mitigation modelling was needed for the two dairy farm case studies. This usually requires a specialist consultant. Ecological monitoring assessments of the catchment waterways using eDNA may also be useful.

How to extend the process in your catchment

Steps six to 11 require discovery seed funding from primary industry or environmental regional development funds, industry bodies, or iwi to access external experts who can work at farm scale to create a more in-depth business case. The business case should include an examination of the impact of the climate to on farm risk (e.g. pest and disease risk).

If seed funding is available, the process for a case study farm requires an investment of time and an openness to providing farm information. Information case study farmers needed to provide included opening their books and giving a full baseline of their financials and farm system. Farmers talked to land-use experts over the phone and read up on the different options. They were also required to identify areas on their farm that were suitable for alternative land-uses and show these to the land-use experts in on-farm visits.

7. The next step is a workshop where:
   - Local experts knowledgeable about the alternative land use opportunities present on the short-listed land uses.
   - Modellers present the existing mitigation options and the potential results from stacked mitigation actions.
   - Participants split into groups to support each case study farm in building scenarios for potential new land-use options, including how much land could be reallocated to their chosen options, and where on the farm this would occur.
8. Experts in the identified alternative land-uses can then visit each case study farm where they and the farmer assess the options on the ground.
9. The land-use experts then produce individualised scoping reports, that go into more detail about the alternatives for each case study farm. For Waimakariri they were asked to report on two options, one with which farmers were comfortable and one that researchers had identified that was more of a stretch for the farm business.
10. Consultants then work with the case study farmers to produce detailed final reports on land-use scenarios for the farm incorporating capital investment, the impact on the farm's environmental footprint, and the expected return on investment. The reports should also include information about labour, key skills, and infrastructure requirements.
11. Finally, the group gets back together for a final workshop, where the results of the scoping, scenarios and modelling are presented to all the farmers involved.

Land-use opportunities in Waimakariri

Once the first six steps of the process were completed in Waimakariri, the following opportunities were identified for further investigation:

- On-farm forestry
- Fungi
- Hops
- Futuristic dairy (agrivoltaics on composting shelters)
- Apples

Whitiwhiti Ora: Land Use Opportunities Case Study

Arable shift with hops, fungi, carbon farming and crop changes

Roscoe Taggart, his parents, wife and three kids live on Taggart Farms. Roscoe has been running the farm for five years, taking over the job from his dad, who took over from his father, who bought the farm in 1958. Taggarts has been a predominantly arable farm since the early 2000s. A third of the farm is in wheat, a third in rye grass and white clover and the final third in forage crops. They also run around 4,000 store lambs.

The Taggarts take the balance between profitability and sustainability seriously, as they would very much like their young children to have the option to continue on the farm if they wish.

The case study had the Taggarts looking at diversifying into carbon farming combined with the introduction of edible fungi and hops. In addition, the case study looked at decreasing lamb numbers from 4,000 to around 2,300. These actions would meet the requirement to decrease N-loss by 5 percent by 2030 and 10 percent by 2040.

Working with a commercial forestry consultant, the farm investigated options for potential plantings that would maximise return on around 18 ha of the farm including planting hardwoods that would be entered into the ETS and also host edible fungi. They also looked into production forestry revenue, particularly around eucalyptus production, which could be entered into the ETS and potentially used as a biofuel or post material crop using coppicing. A stream runs through the farm, so the farm also examined riparian planting of 4.7 ha in indigenous forestry. Alongside fungi, the arable farm also looked into other new forage crops.

The farmers also investigated whether planting hops would be an option. Modelling for the hop vines saw a maximum debt of $7.8 million (in year one) and the farm breaking even in year seven. By year 15, the internal rate of return was 14.4 percent. At the labour demand peak in March, 25 full time pickers would be required. Due to the considerable offsite processing needs required, the farm would need to investigate working with a hop collective in a different region.

Roscoe said "Right now's not the time to take risks, but the information that was gathered was exciting, especially the hops. We could do most of the hop primary production ourselves and it would fit with the quieter times on the farm. So, once interest rates come down, we're hoping to set up a few bines as a trial with a few different cultivars and see how far we can go."

Photo: Tony Benny


Photo: Tom Swinnen

Futuristic dairy with apples

Ben McKerchar, his partner, and their kids are one of three families working as contract milkers on Larundel Dairy Farm. The farm was converted to a partnership arrangement in 2001 and Ben and his family have been there for 15 years. Ben is clear that he doesn't want to own a farm but is invested in ensuring that the benefits of Larundel's profits don't outweigh the long- and short-term impacts on the environment.

"Being part of this gave us a push to look at what a dairy farm might look like in 30 years. We were medium-term thinkers and it's pushed us out a bit and upped our environmental thinking."

The case study looked at Larundel moving to 'futuristic dairy' and introducing apple and hop crops to the land no longer used in pasture.

The 'futuristic' element examined building a large composting barn to house Larundel's 1,300 cows. It found that installing enough solar panels on the new barn's roof to power the new autonomous electric vehicles as well as the composting barn and milking system would likely be a worthwhile investment. However, installing enough solar to power the irrigation load as well as the new technology and barn was unlikely to be profitable.

Ben said, "We always look at following down the path of any technology that would benefit the farm, so we're already that way inclined. It's joined all the other new tech in the massive bubble above our heads that contains our thinking about what the farm will look like in 20 years."

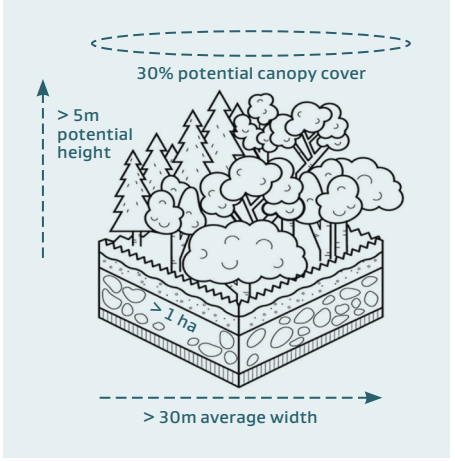
Larundel also investigated planting 50 hectares of apples and 40 hectares of hops on the farm. While hops were not for Laurendel, they remain interested in apples.

The modelling for the apple orchard saw a maximum debt of $13 million (in year three) and the farm breaking even in year ten. By year 15, the internal rate of return was 6 percent. However, there was a need for 175 full time apple pickers during the five-week harvesting season. Ben said, "The apples are something we're quite interested in, the only thing that was holding us back was the climate and that's changing. So it's in our heads now and has opened up our thinking a bit more."

Whitiwhiti Ora: Land Use Opportunities Case Study

On-farm forestry

Carbon farming is a widely discussed option for farms, especially those on more marginal land. The definition of land eligible for inclusion in the Emissions Trading Scheme (ETS) is strict and is only an option for areas over 1 ha. The diagram at right summarises the requirements for inclusion in the ETS This can make planting trees on farms difficult where tractors and irrigation access is important.



Carbon sequestration can occur using both native and exotic species, although trees grown for harvesting fruit or nuts do not qualify.

The work on commercial forestry in the Waimakariri catchment was carried out by Phil Orme from Orme & Associates.

In Canterbury, more carbon was sequestered over 12 years under hardwood forestry than for 16 years' worth of radiata.

While planting forestry is often mentioned in the context of restoring catchments with high nitrate levels, water quality experts recommend riparian planting of indigenous species, stock control, and shading streams as more important; although this kind of planting may not qualify as sequestration forest.

In the Waimakariri case study, on-farm forestry was also investigated in combination with the introduction of harvestable edible fungi.

Species	Registered as	Rotation	Stems p/ha	Value of 20 ha (at $54/ha)
Pinus radiata	Production or Permanent	29 years (production)	625–1,100	$22,449
Redwoods	Permanent	50 years with selective harvesting	600–1,100	$51,209

Table 1: Potential for Carbon Farming in the Waimakariri catchment. Source: Orme & Associates

Fungi

Edible fungi can grow on trees eligible for inclusion in the Emissions Trading Scheme. They can be grown in a range of situations ranging from very intensive to extensive. They are a long-term investment that requires soil testing and preparation. An intensive operation may require a level of development and irrigation set up similar to an intensive orchard. Maintenance of the crop involves pruning and grass management. Truffles also require soil aeration and spore enrichment along with specialist truffle hunting dogs for harvesting and skills in cleaning and grading.

Truffles and other fungi are complementary crops. This means that if they are planted near to each other the result is a longer fruiting season.

Cultivated saffron milk-cap. Photo: Mycotree

The work on edible fungi in the Waimakariri catchment was carried out by Alexis Guerin from Mycotree.

Fungus type	Pros	Cons
Bianchetto truffle on pines, oaks & hazels	› High yield, high value › Requires less liming › Quick return especially on pines	› High labour, high set-up cost (for intensive farming under 1 ha) including liming, irrigation, pruning, grass control, truffle grading skills
Périgord black truffle on oaks, hazels, hornbeams	› High yield, high value › Premium prestigious product	› Requires a minimum of 1 ha › High labour, high set-up cost including liming, irrigation, pruning, grass control, truffle grading skills › Potentially slow return
Saffron milk-cap on radiata pines	› Low management, just needs mechanical grass control › No liming required › Easier set-up, harvest and sell than truffles, quick return, low management › Popular autumn commodity	› Harvesting more time-consuming on the margins, harvest weather-dependent › Fresh, or preserved (pickled) products only
Porcini mushroom trials around the boundary on natives or redwoods	› Easier, economic set-up, with minimum maintenance required › High value, premium prestigious product › Mushrooms can be frozen or dried, extended shelf-life	› Unlikely to be an efficient way to generate edible fungi returns › Results not guaranteed, time to production could be 10 years or more › Variable production that is weather-dependent

Table 2: Fungi with potential in the Waimakariri catchment. Source: Mycotree

Whitiwhiti Ora: Land Use Opportunities Case Study

Hill country sheep-beef expansion into carbon farming and fungi

Alistair and Genna Bird are a couple who have been leasing The Grange from family for the last ten years. Currently The Grange is predominantly a store farm with lambs and calves at weaning with some forestry in the ETS. They have also got farm tourism going with on farm camping, a rentable cabin, and some horse trekking. They have two school aged children and want to give their kids the opportunity to run the farm in the future if they are interested.

However, their short-term focus is staying viable and keeping the lights on, which means they are looking to diversify and are open to different revenue streams. The case study has made them interested in diversifying into carbon farming, edible fungi and growing hops.

Working with a commerical forestry consultant, the Birds are planning to register their remaining post 1989 native vegetation in the ETS and plant another 6.8 ha in pines.

The ETS consultant then worked together with the couple and an expert in edible fungi. The farm visits identified four potential sites where fungi could be seeded on newly planted trees. Two other sites appropriate for ETS forestry had too many established trees that meant edible fungi wouldn't be easy to seed.

The Birds are now looking into planting 10 ha in pines with Bianchetto truffle spores that would be intensively managed and irrigated with stored water. They also decided to plant another 1 ha in stone pine and seed half each with Bianchetto and Périgord truffle varieties. A further 0.65 ha in two separate blocks is planned to be planted with radiata pines seeded with saffron milk cap mushrooms.

Alistair Bird said: "Fungi ticks a lot of boxes for us. We can still graze underneath and keep our income from the ETS. This could allow us to expand into destination tourism and market ourselves that way. At the moment, we're mulling it over. We haven't pulled the trigger yet, but we are really well set up to make a decision now."

Photo: The Grange

Case study farms

Three farms, one each of dairy, arable, and dryland sheep and beef, took part across the whole case study project in the Waimakariri catchment. All three farms have very different starting points in regard to water quality and profit.

Farm type	N-loss (kg)	N-loss (kg/ha)	Profit / ha (EBIT)	Alternate land-use
Drystock › 640 ha (385 ha pastoral) › ~200 Angus cattle › ~1,000 sheep/lambs	5,443	15	$170	Trees/carbon, edible fungi
Dairy › 513 ha (162 ha lease block) › 95% irrigated, › ~1,400 cows	33,817	66	$4,400	Apples, hops + solar power and autonomous electric vehicles to achieve up to 70% reduction
Arable › 747 ha (in separate blocks) › 75% irrigated › Barley, wheat, ryegrass seed, oil seed, dried peas, clover seed, specialty seeds › ~4,000 lambs	32,082	45	$3,100	Trees/carbon, edible fungi + manage and/or crop changes to reduce N

Table 3: Case study farms

Whitiwhiti Ora: Land Use Opportunities Case Study

Apples

New Zealand currently has around 10,000 ha of apple orchards. Ninety percent of apples are exported with Asia the most important market. In the last two year, apples have provided comparatively poor returns, however, prior to that returns were very good. Choosing a variety of apple crop depends on soil and climate. The premium varieties are controlled, and license fees vary between $5,000–200,000 p/ha.

All apple growers are aligned to one or more of the 40 exporters in New Zealand. Many contract for fruit packing and cool storage off-farm.

The work on apple orchards in the Waimakariri catchment was carried out by Craig Hornblow of AgFirst.

For a 50 ha orchard, in the first three years of tree growth the N-footprint is high –modelled as 200kg N/ha, reducing to 30kg N/ha once the trees reach maturity. Labour needs vary across the year, however during the five-week harvesting season, modelling showed a need for 175 full time apple pickers.

Photo: Zen Chung

Agrivoltaics on composting shelters

In some places, to meet stringent water quality requirements, it may be necessary to switch from open pasture dairy to a barn-based system. To avoid intensification, the Waimakariri group looked at a 'cut-and carry' system, where cows are housed in a large composting barn.

Challenges identified under these new opportunities included how to resource the increase in energy and labour required to achieve new processes that would be introduced: cutting and carrying fresh grass, silage feed delivery, tilling the compost bed, and brushing the cows.

The group looked at how cutting-edge technology could undertake these new processes without substantially increasing the number of workers otherwise needed for a 'cut and carry barn' operation.

The work on agrivoltaics and futuristic dairy options in the Waimakariri catchment was carried out by Sharee McNab from the University of Canterbury. She analysed the available technological solutions and found the following viable options:

- A driver-optional (autonomous) electrified vehicle to mow the paddock, load the cut grass and dose liquid fertiliser
- A robotic feed kitchen to collect feed from hoppers, mix the feed and deliver it to the cows
- Milking robots
- A small to medium electrified tractor to till the barn, spread muck, and plant crops

All of these 'futuristic' technologies require power. Luckily the large size of composting barns allow space for installing solar panels on the roof. Combined with storage batteries, solar energy generated on-farm would power a farm's new technology.

Whitiwhiti Ora: Land Use Opportunities Case Study

Hops

Hops have become a popular international crop in recent years, with 80–90 percent exported. The current international market is soft, but the industry has confidence that this is a short-term situation.

There are a variety of hops to suit different climates and soils, with wind and hail being significant risks. Growing hop vines requires shelter, specific support structures and free draining soils. Some farmers grow up to 13 different varieties with prices varying between $20–65/kg depending on varietal demand. Some varieties require a license.

Hops are commonly dried on the vine. However, hops as a crop need considerable processing, which is likely to require building a commercial relationship with an existing hop collective and processing plant.

The work on hop farming in the Waimakariri catchment was carried out by Craig Hornblow of AgFirst.

For a 40 ha hop orchard, yield was modelled as 1,800 kg/ha and at the average price of $35/kg, the gross margin was $18/kg. Labour needs varied between 1–10 FTE across the year and, during the labour demand peak in March, 25 full time pickers would be required. 200kg N/ha and between 100–200kg K/ha would need to be applied for the three-month growing period every year.

Photo: Elevate