Pastoral Sector Weed Research Strategy

2024 Progress Update

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Using science to tackle key sector challenges. An update from the *Pastoral Sector Weed Research Strategy 2018-2028.*

AgResearch scientists are developing weed management solutions to support New Zealand's food and fibre economy. Their research focuses on reducing the financial and social capital risks from weeds, and is designed to address the three highest ranking challenges identified in the *Pastoral Sector Weed Research Strategy 2018-2028.*

THE CHALLENGES

Internal Biosecurity

Herbicide Resistance

Alternatives to Herbicides

AgResearch Weeds Community of Practice

We collaborate widely involving scientists, students and rural professionals from across the motu.

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Our Expertise

Our scientific expertise includes plant population ecology, entomology, plant pathology, agronomy, and computer modelling. We are also government task force members, science journal editors, and reviewers and members of the New Zealand Plant Protection Society.

1. Internal Biosecurity

Identification, prioritisation and cost effective management of 'sleeper' weeds.

The problem

New Zealand has a vast pool of at least 22,000 exotic plant species. It is likely that next century's worst invasive weeds will emerge from this pool.

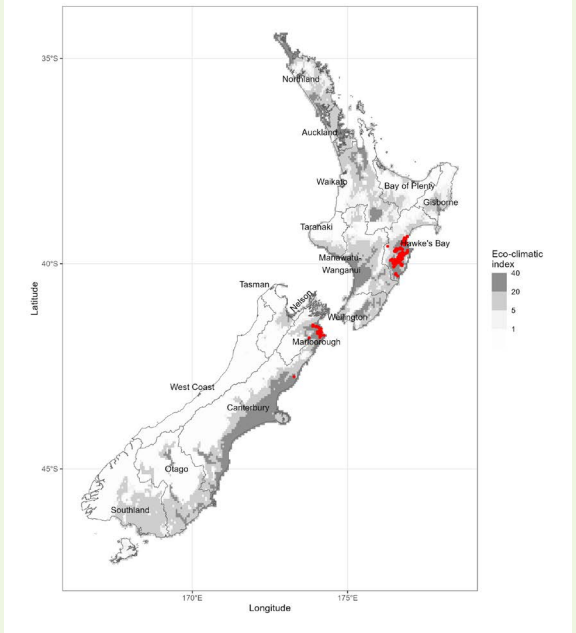
Detecting these 'sleeper' weeds is crucial for avoiding potentially huge future impacts and management costs such as those for former sleeper weeds (e.g., wilding pines, gorse and broom)

Early in an invasion, when a weed is geographically limited in its distribution, and spreading slowly, management costs are low and eradication is possible.

By contrast, regional weed control programs have traditionally aimed at already widespread weeds and have often been ineffective while emerging weeds have frequently been detected too late in the invasion process for eradication to be feasible.

Climate change, land-use shifts, or their continued planting can awaken them, accelerating their spread, leading to widespread unwanted natural resource impacts. This awakening has played out often in history, resulting in enormous losses in productivity and biodiversity and ongoing management costs.

Chilean Needle grass in New Zealand



Nassella neesiana (Chilean needle grass), is an invasive 'sleeper weed' established in sheep and beef pastures in the Hawke's Bay, Marlborough and Canterbury regions of New Zealand (red dots on the New Zealand map).

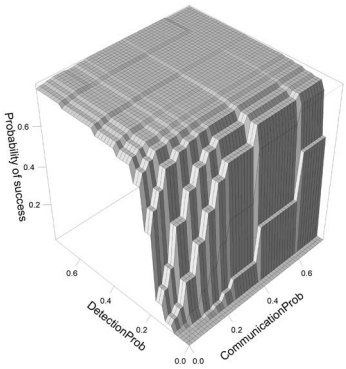
Under current climate its potential geographic range amounts to 3.96 million hectares of climatically suitable sheep and beef pasture land. All regions of the country except the West Coast include areas of climatically suitable land (grey areas on the map). Under future climate, its potential range is predicted to increase by 60% (not shown on the map).

It reduces the productivity, market value, and welfare of livestock through its sharp penetrating seeds that cause blindness and the downgrading of wool, hides, and carcasses. Invaded pastures are reduced in productivity by 25% due to the need to remove stock during the seeding period.

Using a 3% discount rate and two assumed spread rates, 201 and 100 years to 90% occupation of its potential range under current climate, we calculate national PV losses of NZ$ 192 million and NZ$ 1,160 million respectively could be avoided by stopping the plant's further spread.

The solution

We have developed two primary solutions in collaboration with our research partners.



Sleeper weed hazard assessment

In collaboration with regional councils, Department of Conservation and the Ministry for Primary Industries, we are developing a tool for the identification of 'sleeper' weeds within New Zealand's known pool of exotic plant species.

The tool is underpinned by a novel model for weediness with three algorithmically determined parameters:

- Papers published
- Global occurences
- Climate match to New Zealand

Regional weed management scenario analysis

With Manaaki Whenua Landcare Research, we have created a framework for socio-ecological scenario analysis to improve regional and national effectiveness of weed management.

We modeled the spread of Chilean needle grass under management on sheep and beef farms in Marlborough. Region-wide success (number of infested farms less than 1% of the potential maximum) depended on interactions between the probability of detection and the probability that biosecurity officers communicate to farmers about a neighbouring farm's infestation. This research reveals the benefit of investment in internal biosecurity extension.

Together, these resources bolster our ability to tackle new weeds in New Zealand promptly, curbing their environmental and agricultural impacts.

Other weed management decision support tools

Freely available web apps that use population dynamic models for specific weeds. These are used on-farm by weed managers as decision support tools and for landholder education.

- Giant Buttercup Management Decision Support Tool
- Grassland Cover Estimator
- Nassella Tussock Population Model

Climate niche models that reveal the potential geographic distributions of specific weeds in New Zealand under current and future climates.

Models for velvet leaf, yellow bristle grass, nassella tussock and Chilean needle grass have been published, such as:

- Velvet leaf
- Chilean needle grass

Universal regional pest management cost benefit analysis tool that is used by Regional Councils to comply with the Biosecurity Act regarding species' selection for regional management.

- CBA Tool

2. Herbicide resistance

Avoidance and management of evolved herbicide resistance in weeds are strategic priorities for our work.

The problem

Continuous use of herbicides with the same mode of action over several years targeting the same weed can lead to the development of herbicide-resistant biotypes of the weed.

Known cases of such 'evolved' resistance have been increasing steadily in New Zealand since the discovery in 1979 of fathen (*Chenopodium album*) in maize crops with resistance to atrazine. By 2022, there were 22 cases (species by mode of herbicide action) of confirmed herbicide resistance. Globally, as of October 2023, there were 523 unique resistance cases reported from 99 crops and 72 countries.

While the use of rotational cropping in New Zealand is very helpful in avoiding resistance evolution, there is no room for complacency as many of the different crops either use the same herbicides or herbicides from the same mode of action group. Identifying and implementing farming practices that help avoid resistance and thereby preserve the effectiveness of modern herbicide chemistries are a high priorities for farmers, growers and the New Zealand economy.

Ryegrass resistance to glyphosate and amitrole is becoming common in New Zealand vineyards

Resistance to post-emergent herbicides is becoming common for grass weeds on New Zealand wheat and barley farms

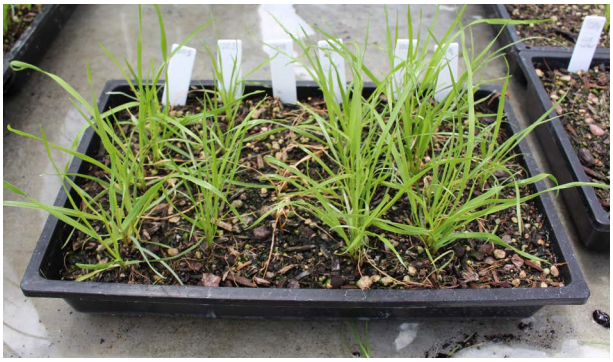
A herbicide resistance risk assessment for weeds in wheat and barley crops in New Zealand

The solution

By involving the sector directly and sharing herbicide resistance findings our research has dismantled the stigma around herbicide resistance for rural professionals. A "Grower's Leading Change Group" has embraced the resistance challenge in the arable sector to help ensure the continued efficacy of at-risk herbicides.

Management of herbicide resistance is crucial to sustain yields and the financial stability of primary production systems. Herbicide mixtures, herbicide rotations, cover crops, cultural and biological controls are key management options that also minimize herbicide use and environmental impacts.

Herbicide resistant perennial ryegrass surviving in a wheat crop.



Five accessions of perennial ryegrass from farms in South Canterbury with four demonstrating resistance to the herbicide clethodim.

3. Alternatives to herbicides

Managing weeds with less reliance on synthetic herbicides is the priority of this research.

The problem

The discovery, development, and commercialisation of synthetic herbicides of varying chemical classes and biochemical modes of action have provided farmers with a suite of herbicide products with activity against many of the most damaging pasture weeds. The efficacy and selectively of these herbicides has encouraged pastoral farmers to rely upon them for weed control. But this practice is increasingly becoming unsustainable due to the evolution of herbicide resistance in weeds, public health and environmental concerns over herbicide use, increasing industry and market requirements for residue-free farm produce, regulatory constraints on herbicide application practices, fewer new herbicides becoming available, withdrawal of herbicides from the market and the global increase in organic agriculture.

Our research has shown that many arable cropping farms in New Zealand have weed populations that contain individuals resistant to commonly used herbicides. Their detection and appropriate management will be crucial to prevent the resistance evolving.

The solutions

A "Grower's Leading Change" group has embraced the resistance challenge in the New Zealand arable sector, developing grower-led-solutions to ensure the continued efficacy of at-risk herbicides. A key practice change will be the rotation of herbicide modes of action to lessen the selection pressure for resistance. Less reliance on herbicides is also part of the solution and our research has identified options (below).

Cover Crops

Field trials have shown the effectiveness of cover crops for managing weeds and reducing the weed soil seed bank in maize.

Deferred Summer Grazing

This practice (shown on left of image) has enabled grasses and legumes to out compete California thistle in pasture.

Watch "Control of the California thistle by enhancing pasture competition."

Bioherbicides

Naturally occuring plant pathogenic fungi have potential as bioherbicides as illustrated by giant buttercup treated with the fungus *Sclerotinia sclerotiorum*.

Biocontrol

Exotic insects, such as Green Thistle Beetle, could be effective biocontrol agents for California thistle and other pasture weeds.

Mechanical Control

Mowing California thistle in pasture, and grubbing nassella tussock in modified tussock grasslands have shown to be effective.

Watch "Mowing in the rain helps control California thistle."

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This project is funded by

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Ministry for Primary Industries
Manatū Ahu Matua

Department of Conservation
Te Papa Atawhai

DairyNZ

beef+lamb new zealand

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