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# Whenua Haumanu

## RADE – Regenerative Agriculture Dryland Experiment

## Lincoln University

Regenerative agriculture (RA) is topical in NZ for its various principles around producing food sustainably while restoring the land and environment. The practice has been adopted in NZ without any formal research assessment of the total on-farm impact – soil, plant, animal and financial. We introduce a new long-term, farmlet-scale experiment that aims to comprehensively examine RA in a NZ context. The emphasis is placed on the ability of RA to operate in low and high fertility soils in dry east coast regions. The farmlet is Lincoln University's enduring resource for multidisciplinary (soil, plant, animal and economic) research and teaching in grassland and arable production on campus.

**Funding**

Ministry for Primary Industries (MPI), T.R. Ellett Agricultural Research Trust and the Fertiliser Association of New Zealand for a duration of 6 years.

**Staff involved:**

- Prof Derrick Moot (Project leader)
- Dr Alistair Black (Farmlet leader)
- Prof Leo Condron (Soils)
- Dr Jim Moir (Soils)
- Dr Charlotte Alster (Soils)
- Prof Alison Bailey (Farm Management)
- Malcolm Smith (Technician – animals/plants)
- Jason Nolan (Technician – instruments)
- Dr Sonya Olykan (Research Associate – Soils)
- Dr Annamaria Mills (Research Officer – data collation/website)

Species-rich and conventional pastures across low and high fertility soils in the Regenerative Agriculture Dryland Experiment (RADE) at Lincoln University on 02/09/2022 (Photo: A Mills).

**Site**

The RADE is located on the plant science research and teaching farm at Lincoln University. Soil type is a Templeton silt loam of various depth to gravel. Annual rainfall is about 600 mm.

**Experimental design**

Two systems of grassland-based sheep production – regenerative (RA) comprising species-rich pastures, high-residual (aka 'long-rotation' or 'long-grass') rotational grazing, no pesticides and minimum tillage and conventional (CA) comprising current best-practice pastures and grazing techniques, pesticides and tillage – are compared across soils of low and high fertility (Olsen P 10 and 20). The four treatments are laid out in five 4 x 4 Latin squares with an average plot size of 0.1 ha. Twenty plots of a treatment make up an autonomous farmlet, giving four 2-ha farmlets.

**Management**

Pastures and annual forage crops were sown between 10 December 2021 and 16 March 2023. The forage species were all suitable for intensively managed pastures at the site (Tables 1-3). Soil fertility levels are maintained with annual P and S fertiliser. No irrigation is applied. Pastures are renewed in rotation at a rate of 1-2 plots (5-10%) per farmlet per annum. An annual forage crop is grown for 6-10 months before the new pasture. Surplus feed is conserved as hay and fed on each farmlet. The sheep are specially selected from an existing RA operation and managed as closed breeding flocks.

Protocols for animal, plant, soil and management decisions are developed in consultation with our RADE Technical Advisory Group (TAG).

**Table 1 Species, cultivars and sowing rates of RA (12-species mix with lucerne) and CA (lucerne monoculture) pastures sown in Latin squares 1 (paddock H17, sown Dec 2021), 2 (paddock H19, sown Dec 2021) and 4 (Paddocks H11/12 North, sown Oct 2022).**

| System | Common Name | Cultivar | Rate (kg/ha) |
|---|---|---|---|
| RA | Prairie grass | Jeronimo | 5.0 |
| | Chicory | Choice | 1.0 |
| | Cocksfoot | Safin | 0.5 |
| | Tall fescue | Hummer | 4.0 |
| | Meadow fescue | Oakdon | 4.0 |
| | Lucerne | Kaituna or Takahe | 6.0 |
| | Phalaris | Mate | 0.3 |
| | Timothy | WGB23587 | 2.0 |
| | Plantain | Captain | 0.5 |
| | Red clover | Amigain | 1.0 |
| | White clover | Legacy | 0.3 |
| | Subterranean clover | Woogenellup | 1.0 |
| | | | **25.6** |
| CA | Lucerne | Kaituna or Takahe | **15.0** |

**Table 2 Species, cultivars and sowing rates of RA (8-species mix) and CA (annual ryegrass) annual forage crops grown for 6-10 months before pasture renewal.**

| System | Common Name | Cultivar | Rate (kg/ha) |
|---|---|---|---|
| RA | Rape | Titan | 0.8 |
| | Turnip | York Globe | 0.5 |
| | Leafy turnip | Pasja | 1.0 |
| | Annual ryegrass | Devour | 5.0 |
| | Phacelia | Unnamed cultivar | 1.0 |
| | Plantain | Captain | 1.0 |
| | Balansa clover | Taipan | 1.3 |
| | Persian clover | Lightning | 1.3 |
| | | | **11.8** |
| CA | Annual ryegrass | Devour | **25.0** |

**Table 3 Species, cultivars and sowing rates of RA (12-species mix with balansa clover instead of lucerne) and CA (cocksfoot/sub clover) pastures sown in Latin squares 3 (Paddock H13/14, sown Mar 2022) and 5 (Paddock H11/12 South, sown Mar 2023).**

| System | Common Name | Cultivar | Rate (kg/ha) |
|---|---|---|---|
| RA | Prairie grass | Jeronimo | 5.0 |
| | Chicory | Choice | 1.0 |
| | Cocksfoot | Safin or Redefine* | 0.5 |
| | Tall fescue | Hummer | 5.0 |
| | Meadow fescue | Oakdon | 3.0 |
| | Phalaris | Mate | 0.3 |
| | Timothy | WGB23587 | 2.0 |
| | Plantain | Captain | 0.5 |
| | Balansa clover | Taipan | 1.0 |
| | Red clover | Amigain | 2.0 |
| | White clover | Legacy | 0.5 |
| | Subterranean clover | Woogenellup | 1.0 |
| | | | **21.8** |
| CA | Cocksfoot | Greenly II | 4.0 |
| | Subterranean clover | Denmark | 10.0 |
| | Subterranean clover | Narrikup | 10.0 |
| | | | **24.0** |

Notes: *Safin replaced with Redefine in Latin Square 5.

**Measurements**

Response variables include soil properties, pasture and forage characteristics, animal live weight and body condition, and financial returns. Intensive animal and forage production measurements started in February 2022.

Animal measurements include:

- liveweight gain/ha
- ewe efficiency (kg lamb weaned/kg ewe mated)
- lambing (% lambs tailed)
- feed conversion efficiency (kg DM/kg liveweight gain)

Plant and soil measurements include:

- dry matter intake
- pasture growth (destructive and non-destructive)
- botanical composition
- feed quality
- light interception
- water use
- soil nutrient status

**Teaching**

The RADE is used as a teaching area for undergraduate and postgraduate students studying soil, pasture and animal sciences and farm management at Lincoln University.

**Postgraduate Students**

- Lauren Jones PhD 2022-Current. Topic: Lucerne responses to phosphorus
- Kaitlin Watson PhD 2023-Current. Topic: Phosphorus and nitrogen cycling in dryland pastures under conventional and regenerative agriculture management
- Lulu Jordan PhD 2023 – Rooting depth and volume
- Luke Robb PhD 2024 – Animal production and grazing behaviour
- Obaka Ikani PhD 2024 – Animal production and grazing behaviour
- Charlie Young BAgSci (Hons) 2022 Completed – Establishment
- Lara Noelte BAgSci (Hons) 2023 – Light use efficiency
- Jordan Shrimpton BAgSci (Hons) 2023 – Water use efficiency
- Lilly Dixon BAgSci (Hons) 2023 – Seedling recruitment
- Breanna Holt B.Ag.Sci (Hons) 2024 – TBC

**Synthesis**

The project is providing much needed baseline data on the impacts of RA and will inform the subsequent areas of research required for improved quantification of RA in NZ.

**Researchers interested in getting involved with RADE can contact Alistair Black to discuss (Alistair.Black@lincoln.ac.nz)**

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**Plot Plan**