Creating catch crop options for winter forage grazing – Lessons from a 3-year Sustainable Farming Futures project

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Introduction

Winter forage grazing

- In the NZ dairy industry winter forage grazing (WFG) is a common winter feed management option to build body condition of dairy cows prior to calving.
- Stock graze winter forage crops (WFG) outside
  - forage brassicas: kale, turnips, swedes, etc.
  - crops are grazed over the main winter months (June & July)
- However, this period also experiences higher rainfall & minimum evapotranspiration
  - max. drainage = max. potential for nitrate leaching.
  - High nitrate concentrations in ground and surface water are an environmental concern
- Monaghan et al. (2007) identified that as much as 45% of a catchments N leaching losses can occur from dairy feed wintering systems occupying just 10% of the catchment area.
- Malcolm et al. 2016a Lysimeter studies 62-84 kg N/ha.

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Background

Small plot and lysimeter experiments

- A series of experiments (2013-16) were conducted at Lincoln using both lysimeters (Carey et al. 2016, 2017) and small plot trials (Malcolm et al. 2016, 2018).
- These established that sowing a catch crop could lower N leaching through a combination of N uptake and reduced drainage from increased evapotranspiration.
- The strategy was:
    - sow a winter-active cereal (oats) ASAP after winter forage grazing (WFG) completed
    - harvest the oats as green chop silage in late spring
    - sow the second winter feed crop or restorative pasture at the completion of the harvest.
- Even though delaying of a subsequent winter feed crop could reduce yield, total feed generated in a kale-oats catch crop rotation was shown to be greater (Edwards et al. 2014).
- Reduce environmental footprint while increasing on-farm N efficiency and productivity - a win-win for farmers?
- A SFF project was proposed and funded to show that this strategy could be practically achieved on commercial WFG farms in **Canterbury and Southland**.

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Canterbury trial programme

Species and tillage series

2018: Te Pirita -Species trial on an ex-kale paddock 1st year out of long-term pasture (Waimakariri Recent soil). Sowing to achieve 300 plants/m^2 emergence (large plots -3 treatments x 4 reps).

Hororata- 2x tillage trials on ex-kale and ex-fodder beet paddocks (Lismore stony soil, Pallic). Comparing direct drill with minimum till (at least 1 top-down cultivation followed by drilling). Hororata 1 (H1) prior to drilling, received an unscheduled application of pig slurry!

2019: Te Pirita: 2x tillage trials on ex-kale and ex-fodder beet paddocks, 1st-year after >4 years pasture. Comparing direct drill with minimum till.

Mt Somers- tillage trial at on ex-kale paddock (7 t DM/ha) after 2-years fodder beet. (Ruapuna stony soil; Pallic).

Data: Measures of DM yield, N uptake by the crop over time, climate data measurements. Took a “snapshot” of available mineral soil-N pre- and post-trial (fallow treatment).

Te Pirita 2018

However…..

Southland winter forage grazing- a different story!

- In Southland, winter forage grazing (WFG) is also the most common winter feed management option to build body condition of dairy cows prior to calving.
- But Southland winter soil conditions are particularly problematic:
  - Higher rainfall and heavy textured soils means its often nigh impossible to get conventional tillage machinery on paddocks to drill a crop
  - How to deal with these puggy soils?
  - What is the best crop choice or tillage method for a particular paddock or farm?
  - How late can we drill and still get a good crop by late Nov/early Dec?


Gore 2018


KONGSKILDE
Farmax

Farmax DRP 300 Spader-drill

Specifications

- 1-1.5 ha/h at 25 cm depth (deeper = slower) but a one-pass machine – both cultivation/drill
- PTO shaft driven – driving the tractor forward rather than the tractor pulling it.
- Can be driven by 150-200 hp tractor but larger tractor preferred due to the weight to lift the implement.
- Cost $125 k on-farm vs conventional setup $50 k-100 k
- John van Vliet (the owner) has redesigned the drill and front-mounted the seed box for better drilling.

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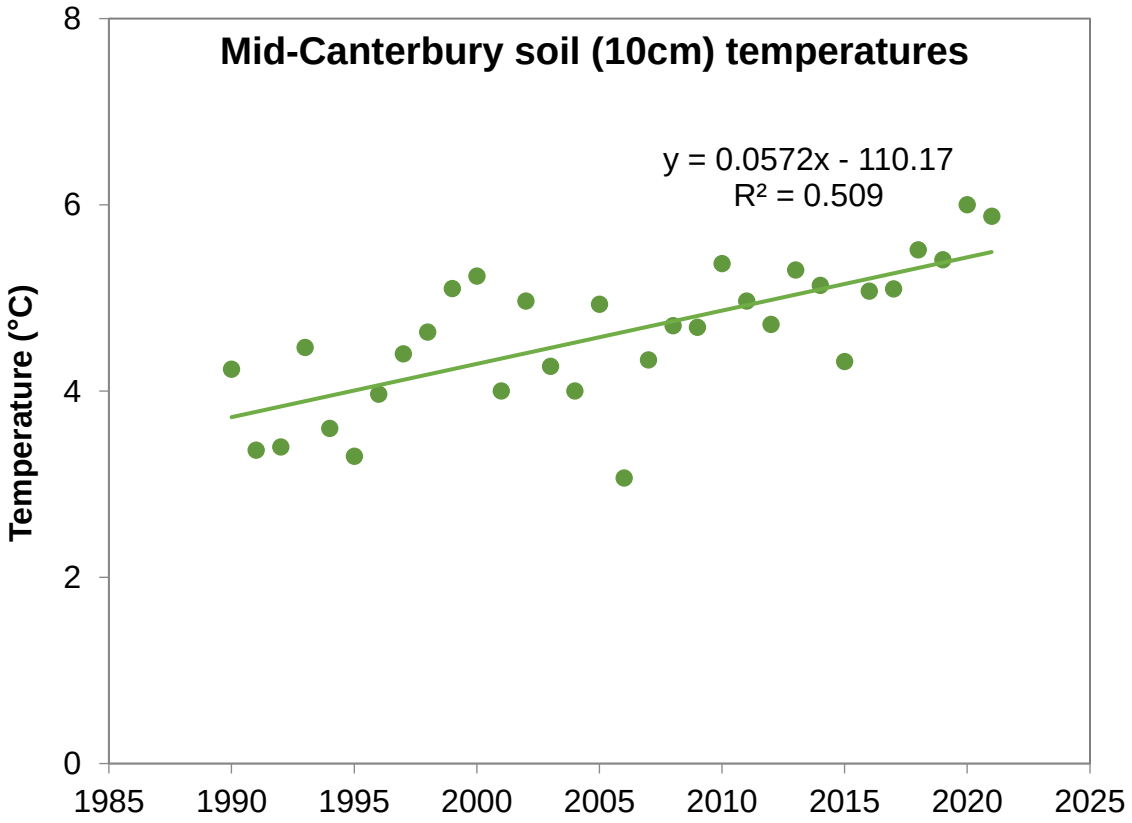
Southland trial series

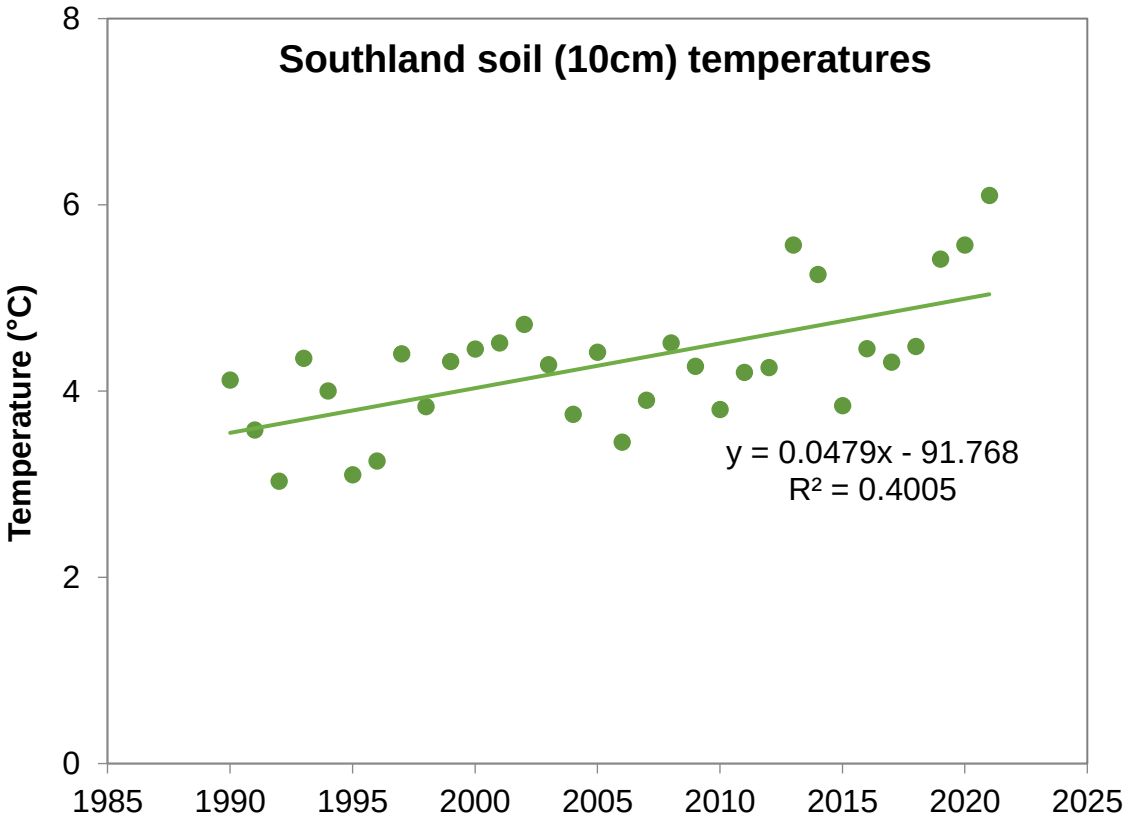
Timing-by-tillage

- A trial series was planned around comparing the spader-drill combination with minimum till/direct drill.
- MT could only be done when conditions allowed the farmer to get on the paddock
- In effect, a timing-by-tillage series (confounded)
- Still trying to achieve 300 plants/m^2
- Trials in Gore (2018) on a Claremont, deep silt loam;
  Mossburn and Lumsden (2019) on a shallow stony silt loam (Morven) and a deep silt loam (Eureka), respectively.

Climate change and catch cropping

Winter soil temperatures (means Jun-Aug)





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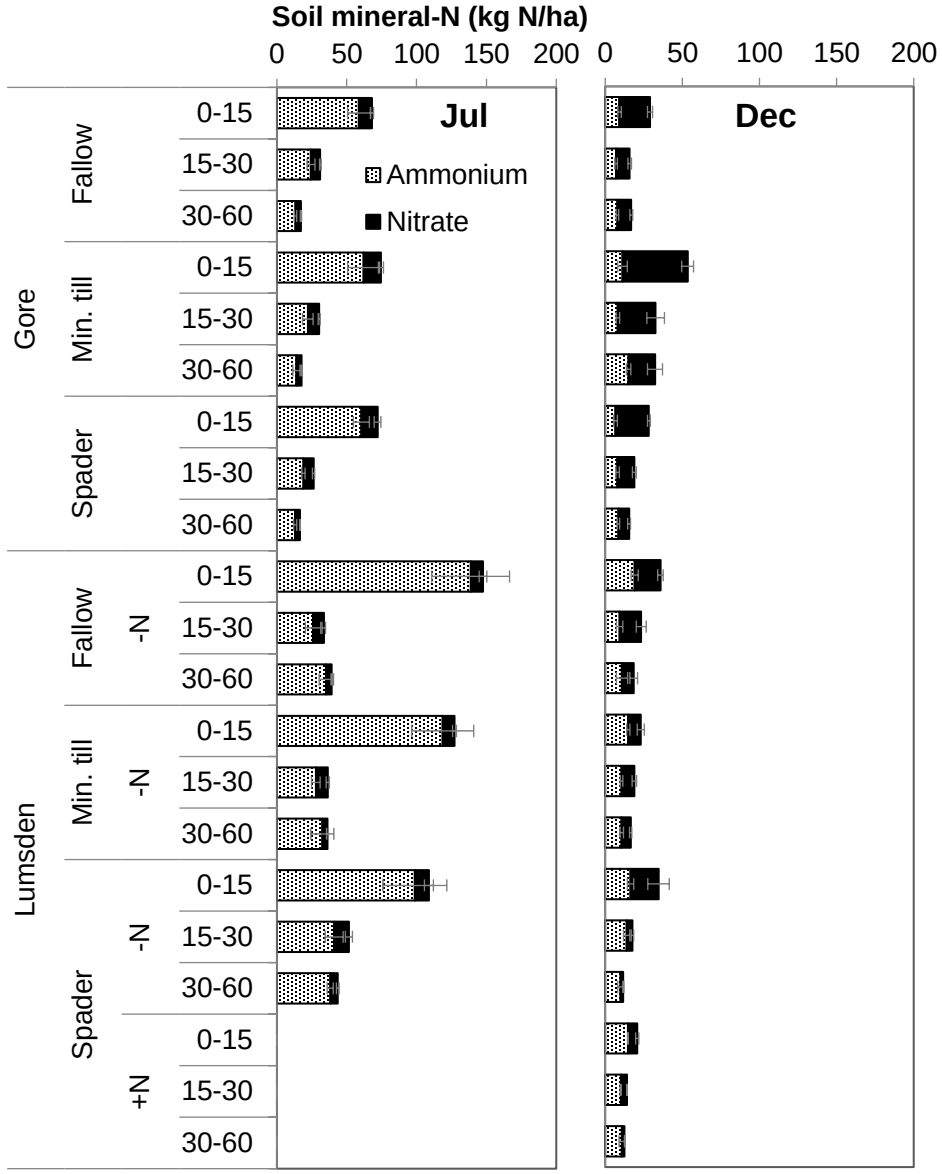
What does this mean?

To catch crop or not to catch crop

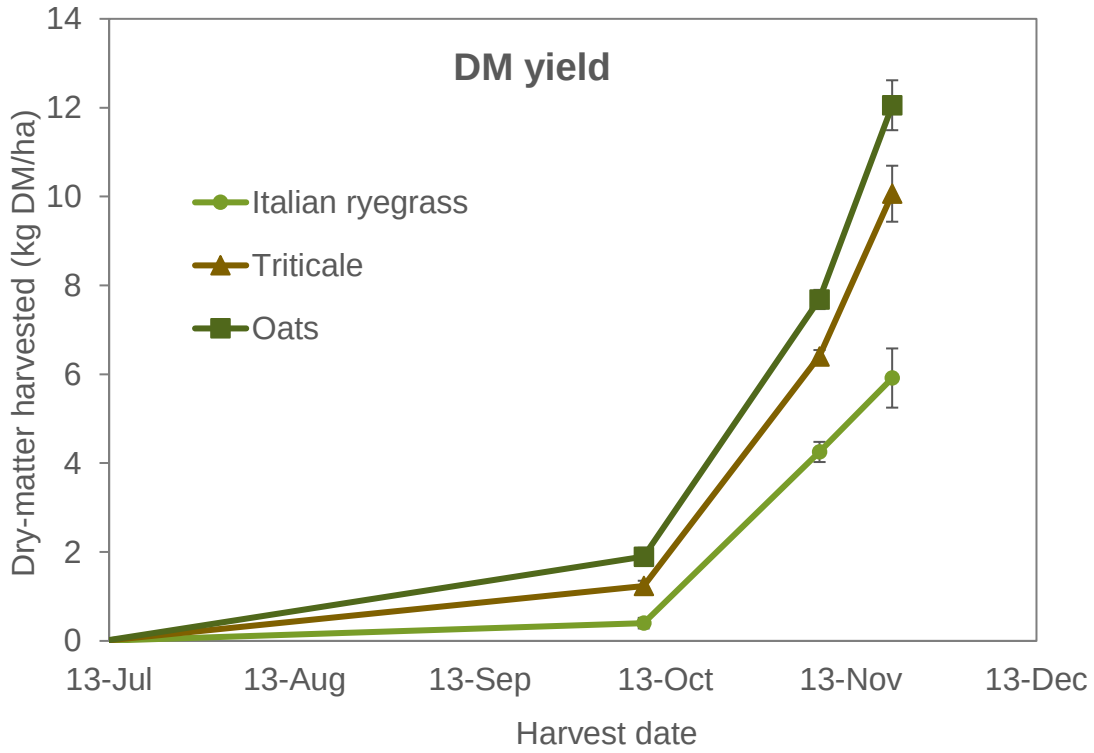
- Warming soils mean catch crops germinate and emerge earlier, achieving good yields sooner.
- However, warming soils also mean more rapid nitrification.
- In soils <5˚C most mineral-N is present as ammonium (NH_4^+).
- Without the presence of a catch crop we could expect nitrate concentrations to climb earlier in the season after WFG
- Could this increase nitrate leaching losses?

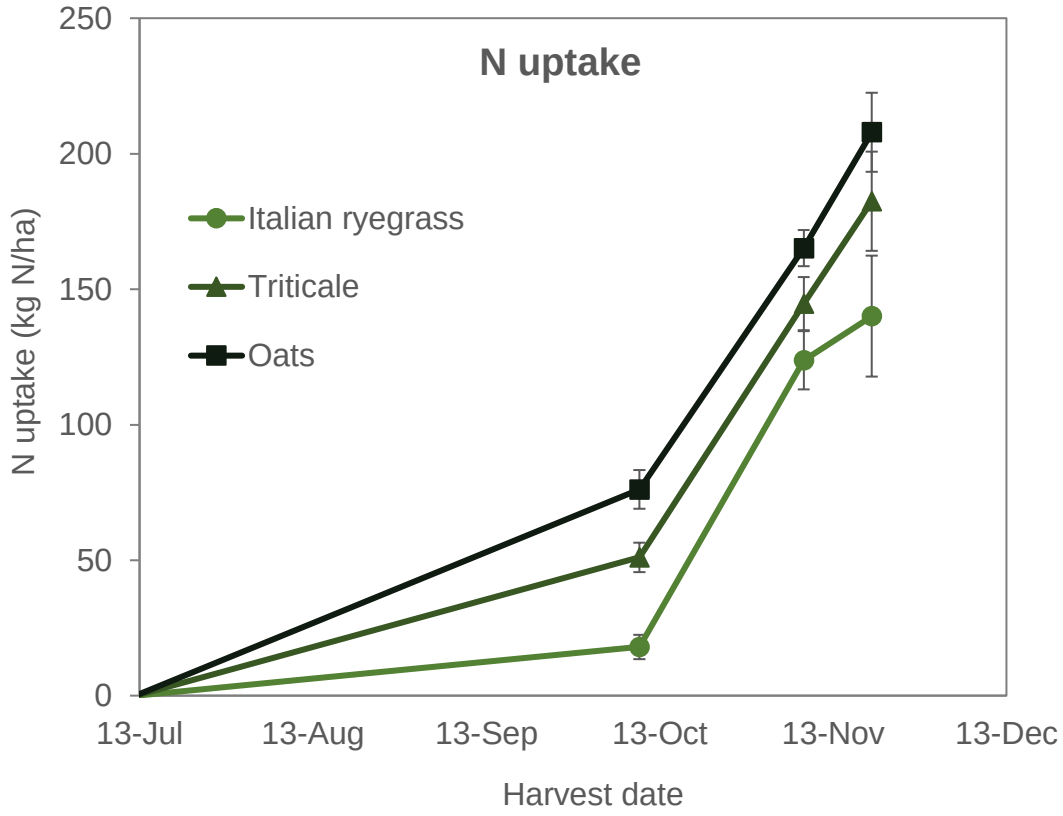


Lesson 1- Species selection

Cereals

Oats was our dependable go-to cereal catch crop – winter active, responds quickly to soil warming. Oats- Italian RG mix good option. Whole crop silage- triticale.





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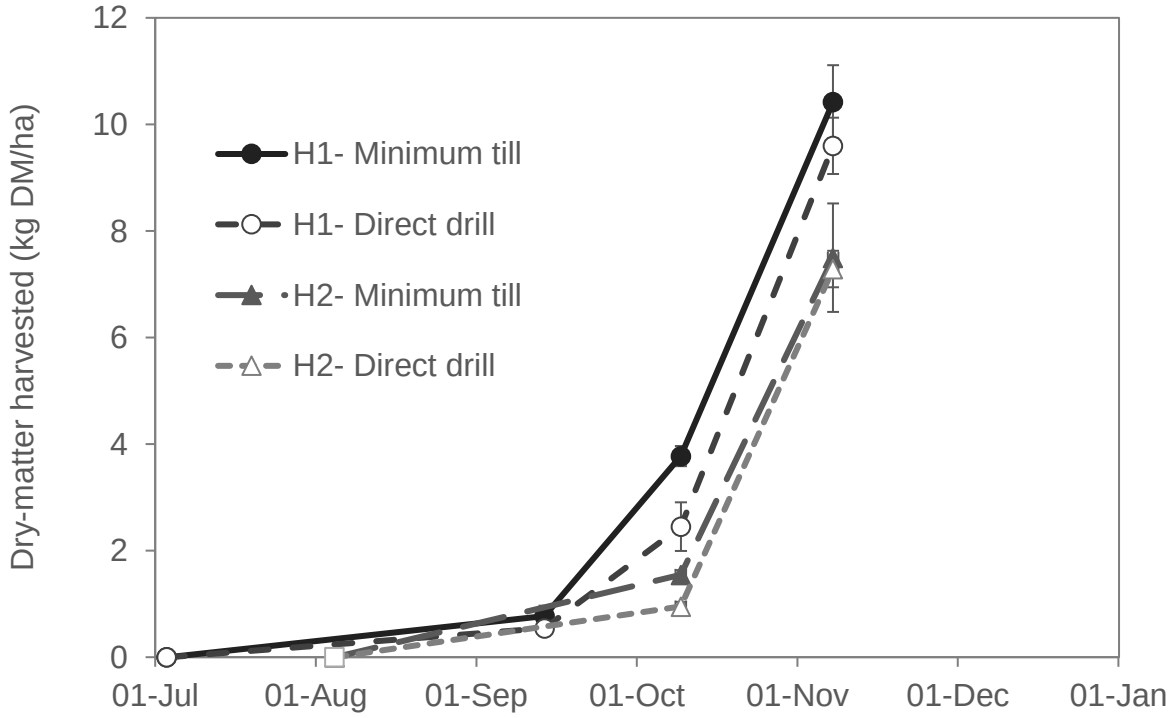
Lesson 2- Direct drill if possible

Tillage choice

- Direct drill was our preferred tillage method to minimise N mineralisation/nitrification but…
- Preparation of seed bed is important – good soil seed contact is needed to maximise emergence

DM yield Hororata (2018) ex-kale (H1) and ex-beet (H2)

Key dates: H1 cultivated 3-Jun, drilled 4-Jul; H2 cultivated/drilled 5-Aug



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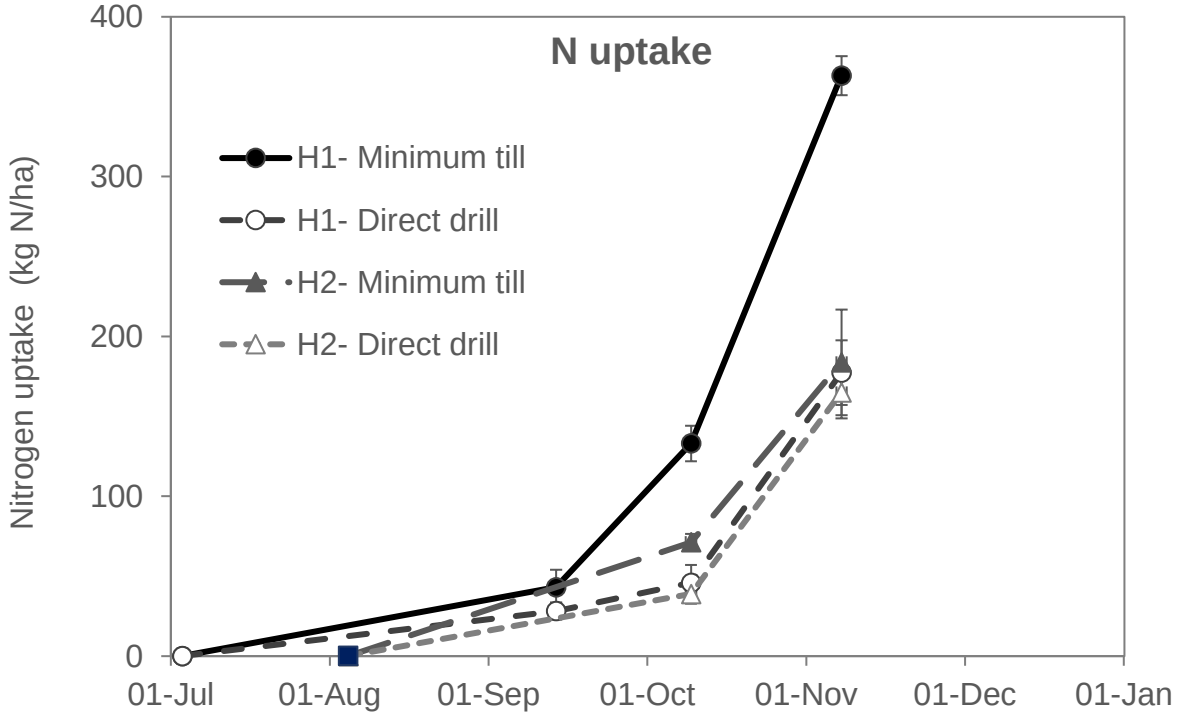
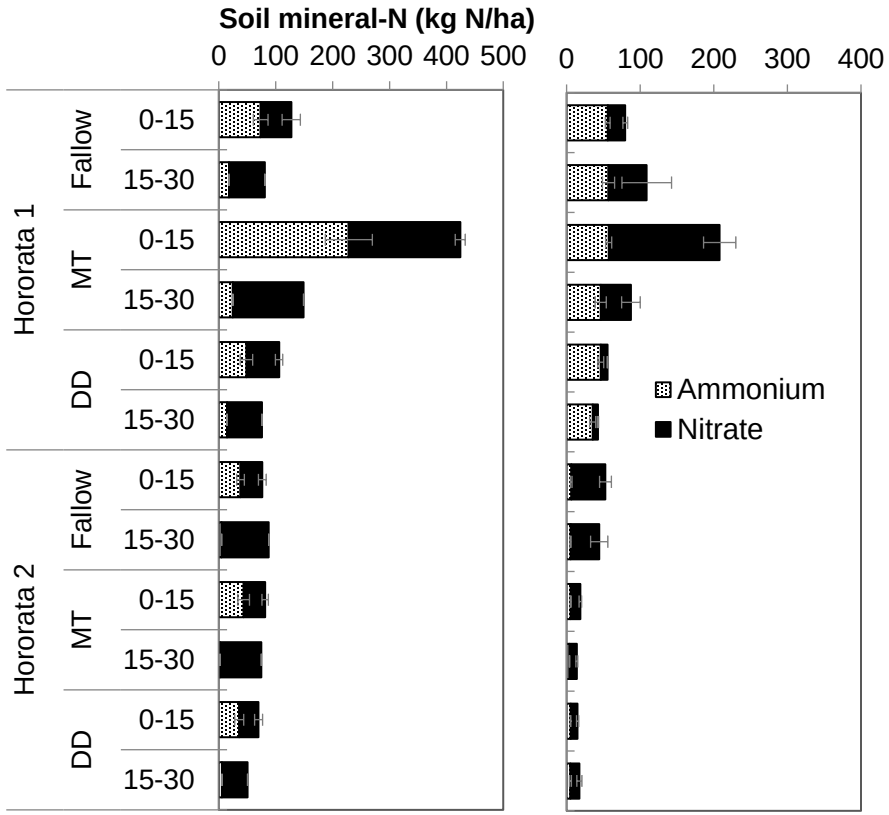
Canterbury Hororata tillage trials (2018): ex-kale (H1) and ex-fodder beet (H2)

Key dates: H1 cultivated 3-Jun, drilled 4-Jul; H2 cultivated/drilled 5-Aug





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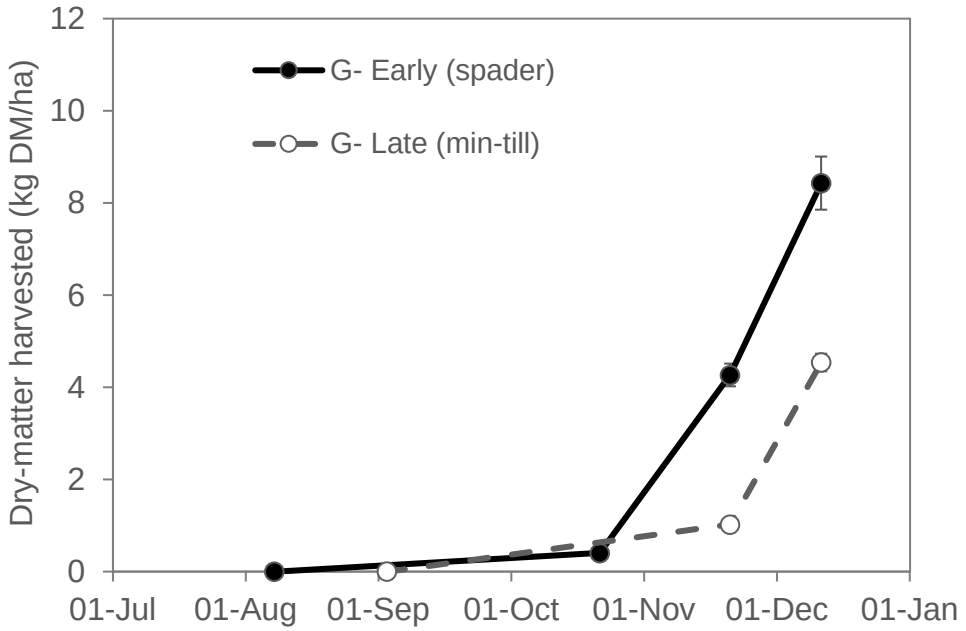
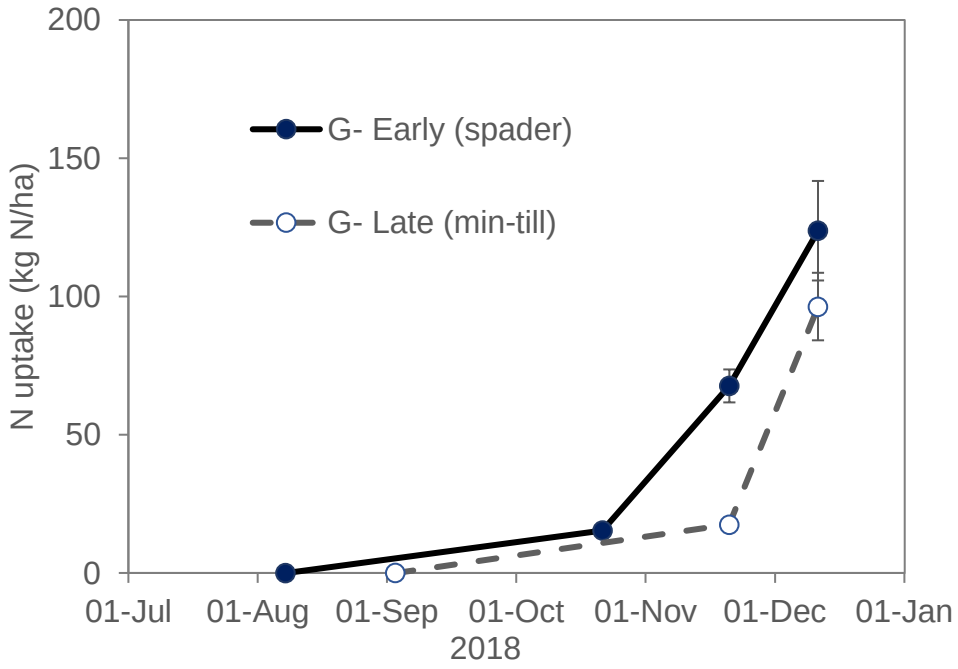
Lesson 3- Sow as early as possible

Tillage-by-timing

- Trend of warmer starts to winter mean drier, warmer soil conditions - good opportunities to drill a catch crop.



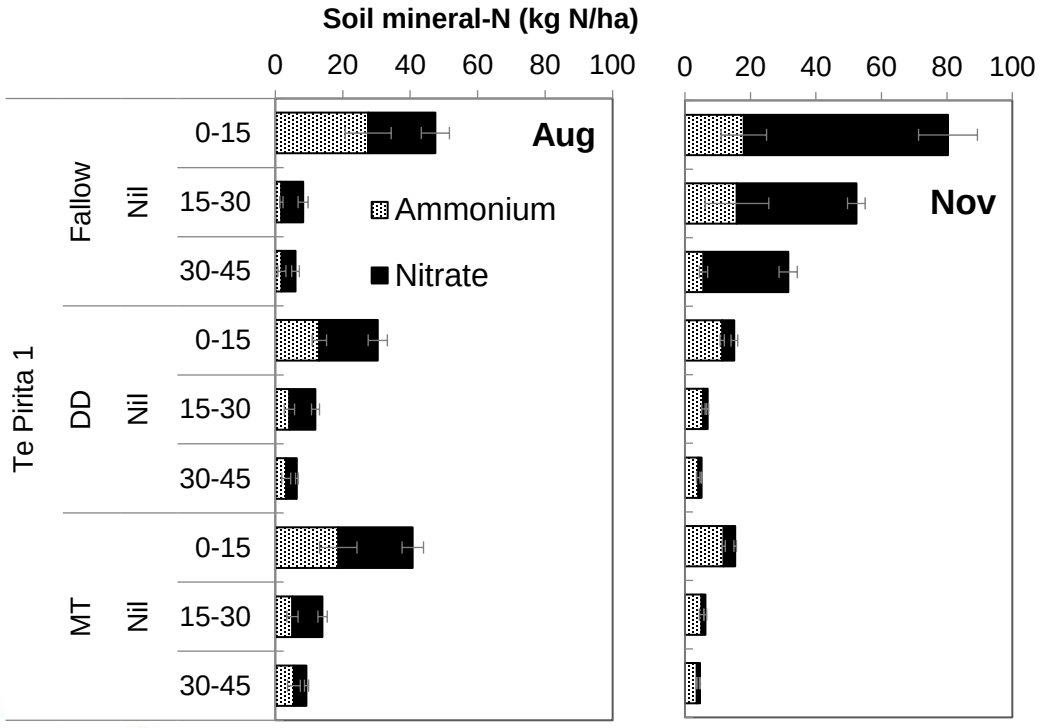


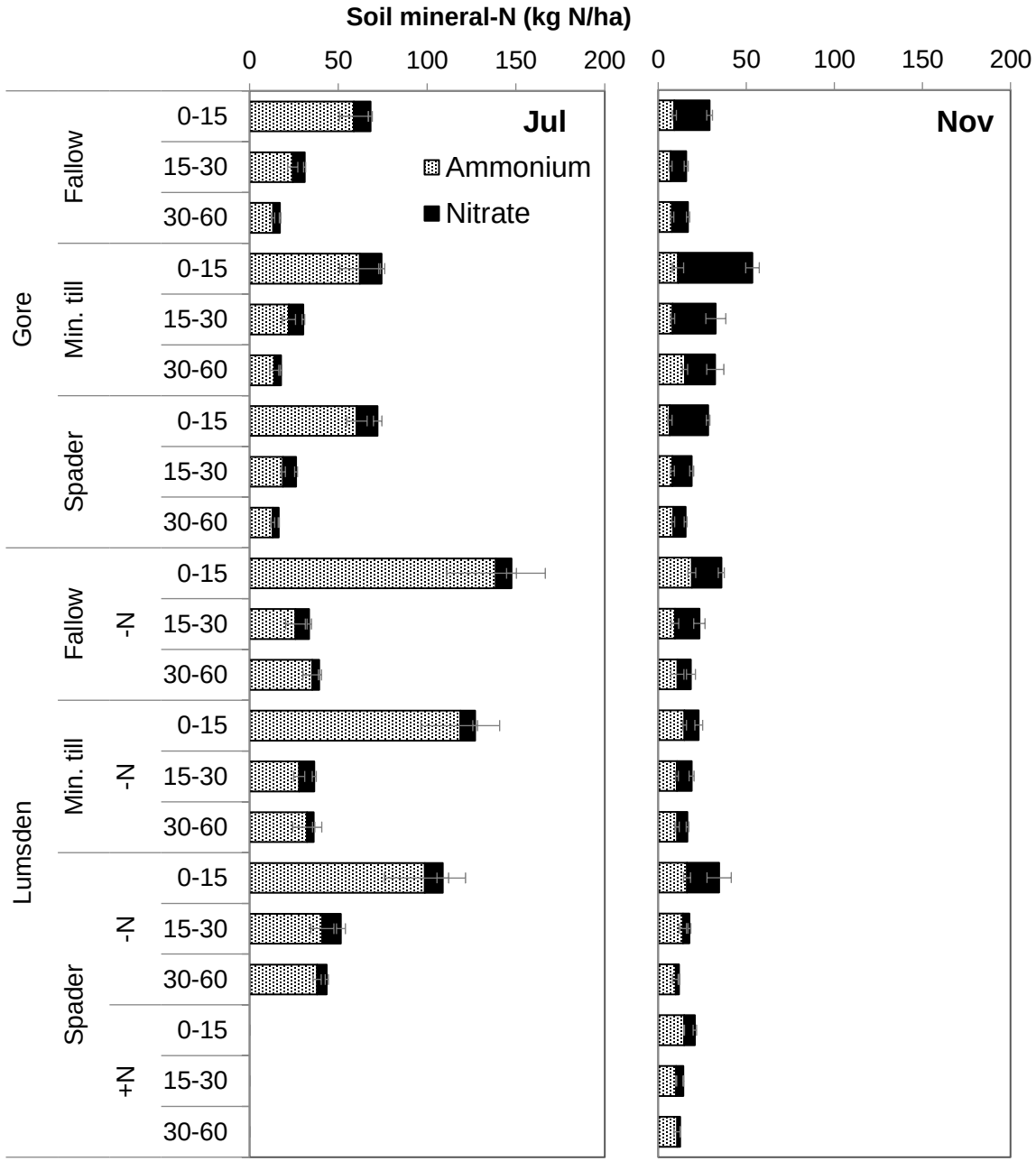
- Warmer soils also mean more rapid nitrification, what are the implications for N losses without a catch crop?

Lesson 3- cont'd

Nitrate leaching snapshot

- Canterbury 2019 was slightly drier than average over late winter-spring months.
- Significant increases in fallow treatment soil nitrate concentrations by late spring and moving down the profile.



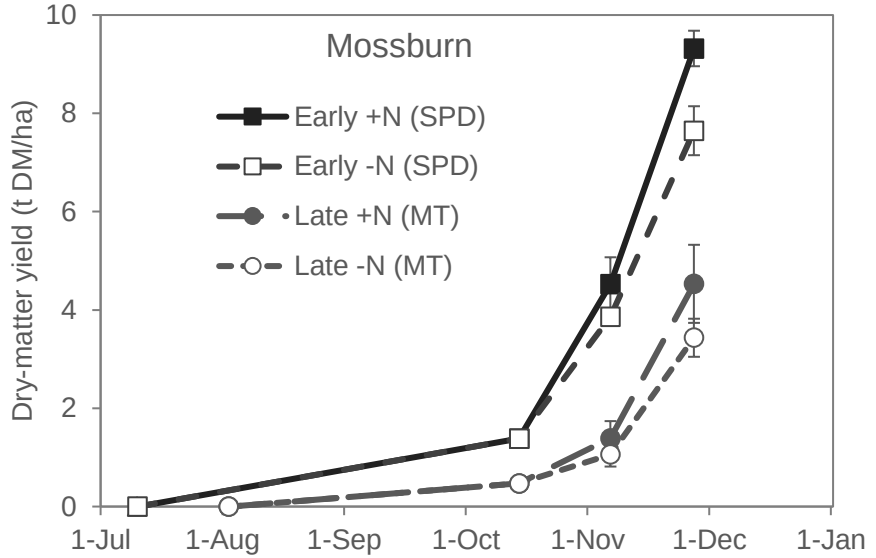


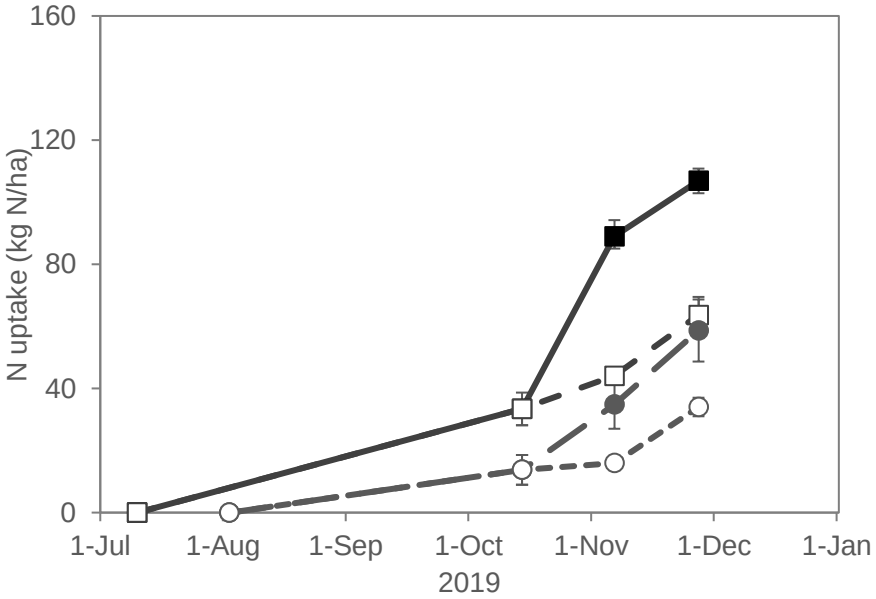
Lumsden 2019

Lesson 4- Monitor the crop

Paddock history

- Being aware of paddock history is important to maximise yield and quality (N sufficiency).
- Light WFG crops and/or repeated cropping may mean that some additional N may required to achieve targets.
- As N depletes in spring, crop may go reproductive early reducing potential yield and quality.
- Adding 40 kg N/ha at Mossburn increased DM yields by >20%
- Adding N may in fact increase N uptake overall





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Mossburn 2019
-N
+N

Lesson 5- Catch crops are profitable

Gross profit margin

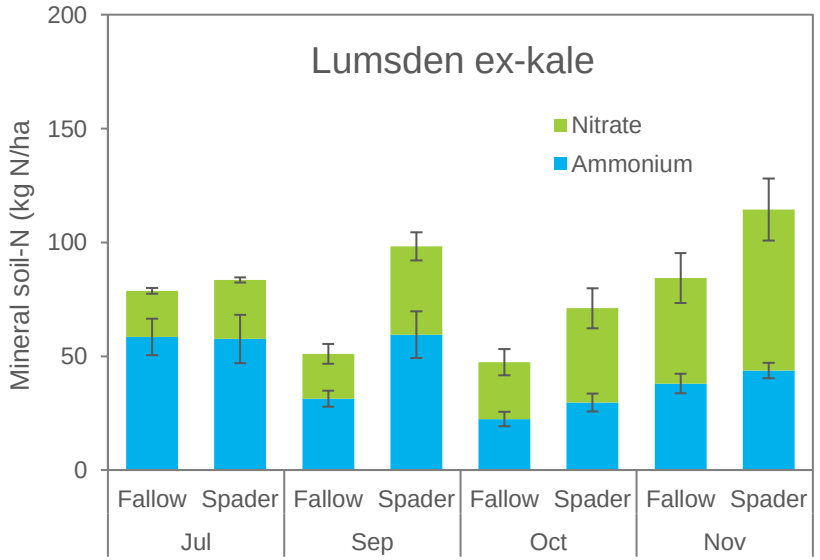
- Early crops most profitable
- Direct drill often as profitable as MT due to lower establishment costs.
- However, dependent on soil surface.
- Spader-drill establishment costs competitive- 1-pass operation.
- Application of N cost effective

Year	Site	Forage	Tillage or species/N	Yield (t DM/ha)	Revenue (NZ$/ha)	Inputs (NZ$/ha)	GPM (NZ$/ha)
2019	Te Pirita 1	ex-kale	Min. till/0 N	8.8	1760	625	1135
			Direct drill/0 N	7.4	1480	345	1135
	Te Pirita 2	ex-fodder beet	Min. till/0 N	6.9	1380	600	780
			Direct drill/0 N	4.7	940	320	620
	Mt Somers	ex-kale	Min. till/40 N	8.3	1660	690	970
			Direct drill/40 N	4.8	960	410	550
	Lumsden	ex-kale	Min. till/0 N	3.1	620	414	206
			Spader-drill/0 N	8.1	1620	414	1206
			Spader-drill/40 N	9.3	1860	486	1374
	Mossburn	ex-fodder beet	Min. till/0N	3.4	680	253	427
			Min. till/40 N	4.5	900	319	581
			Spader-drill/0 N	7.6	1520	453	1167
			Spader-drill/40 N	9.3	1860	526	1334
2018	Te Pirita	ex-kale	Oats	12.1	2420	474	1946
			Triticale	10.1	2020	558	1462
	Hororata 2	ex-fodder beet	Min. till	7.5	1500	474	1026
			Direct drill	7.3	1460	214	1246
	Gore	ex-fodder beet	Min. till	4.5	900	560	340
			Spader-drill	8.4	1680	500	1180

Lesson 6- We don’t have all the answers!

Unknowns

- We don’t have good crop establishment solutions for those paddocks that are too difficult physically for a spader-drill or similar.
- Broadcasting/light drill techniques?
- What are the effects of the spader drill on physical condition?
- Preliminary study suggests spader can promote N mineralisation/nitrification.



Timing	Tillage	Gore trial site 2018 Soil physical property measures (0-7.5 cm) Bulk Density (g/cm^3)	Macro porosity (%)	AWC[1] (%)	K_{sat}[2] (mm/day)	Soil Physical Quality Index[3]
Pre-graze		1.05	16.3	12.0	6001	0.035
Post-graze		1.23	6.3	7.6	1308	0.014
Catch crop harvest (Dec)	Fallow	1.27	4.7	6.9	862	0.011
	Conventional	0.98	16.3	11.0	2789	0.033
	Spader	**0.95**	**15.7**	**11.3**	**5138**	**0.034**
NZ target			10.0			

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Conclusions

Lessons

1. Sow a winter active (cereal) species.
2. Direct drill preferred as long as good soil-seed contact can be achieved
3. Sow early (and reap the benefits)
4. Monitor the crop (success is not guaranteed!)
5. Catch crops are profitable
6. Still require techniques to deal with the most difficult soils/conditions

Acknowledgements

Funders

Especially MPI, Ballance Agri-nutrients, Ravensdown, Agricom, Beef+Lamb NZ and Luisetti Seeds.