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Pasture & Forage Manual 2025

BARENBRUG

Better pasture together.

Welcome to the 2025 Pasture and Forage Manual, your guide to sustainable, profitable farm grown feed.

Every year we update the Manual, aiming to make sure it serves you well.

Our goal is simple – to help Kiwi farmers thrive, by delivering better products, knowledge and support to an industry that contributes more to New Zealand than any other.

That means developing leading cultivars, backed by expert advice and service, so we reduce your risk in pasture investment. Supplying the likes of *Maxsyn* and *4front* - New Zealand's current top selling perennials - we are committed to providing you confidence in every bag of our seed.

2025 sees one new cultivar from us, the well loved *Maxsyn* perennial ryegrass now with *NEA12* endophyte, which improves its already class-leading yield and persistence.

In the last year we were part of a major review of plantain (see the NZ J Ag Res. 2024, Eady et al). The high water content of plantain is proven to reduce nitrogen leaching, however it's limited persistence and variable palatability makes it difficult to see its widespread use in farm systems.

The key outcome of this review - we need to research more widely than just plantain. There are other species likely to better reduce nitrate leaching, which are easier and more profitable to use (e.g. tetraploid hybrid ryegrass).

On-farm, we're proud to provide cultivars to lighten the farm footprint. *Array* perennial ryegrass grows more feed in low soil nitrogen conditions. *Forge* and *4front* ryegrasses can reduce nitrate leaching and greenhouse gas emissions. *Maxsyn* and *Rohan* perennials lend resilience to farm systems. And our aggressive white, red and annual clovers fix atmospheric nitrogen and enhance animal performance.

We have supported New Zealand farmers for 37 years now, and look forward to doing so in the decades ahead.

The Barenbrug Team

Contents

Pasture cultivars

Pastures for the future 5
Perennial ryegrass 7
Hybrid ryegrass 21
Italian & annual ryegrass 27
Brome grasses 33
Cocksfoot 35
Tall fescue 38
Diverse pasture mixes 39
Diverse Pasture Premix 40

Clover & herb cultivars

White clover 42
Red clover 50
Annual clovers 53
Chicory 59
Plantain 62

Ryegrass endophyte

Endophytes FAQ's 66
Developing great endophytes 67
Barenbrug edophytes 70
Understanding endophyte alkaloids 71
Endophyte insect control ratings 74
Endophyte animal safety ratings 75

Pasture renewal

Renewal checklist 77
Why renew? A dairy farm example 78
Why renew? A sheep farm example 79
Rectify causes of poor performance 81
How much should you renew? 82
Benefit of correct cultivar - dairy 84
Benefit of correct cultivar - sheep 85
Soil fertility - new pasture 86
Soil structure & health 87
Renewal methods 88
Sowing date of grasses 89
Seedbed consolidation 89
Drilling method 90
Sowing depth 91
Regenerative Agriculture - pasture mixes 92

Pasture management

Big picture – what's your strategy? 95
Managing new pasture well 97
Principles of ryegrass growth 98
Using tetraploid perennial ryegrass 101
Mixing tetraploid & diploid ryegrass 102
Maximising white clover 103
Improving environmental outcomes 105
Managing pasture when it's wet 108
Preparing for drought 110
Responding to flood 112
Ryegrass heading dates 114
Using ryegrass heading dates on farm 115
Making great silage 116

Animal production

Pasture feed value 119
Feed quality & lamb growth 121
Feed quantity & lamb growth 122
Building pasture cover for lambing 123
Maximising pasture utilisation 124
Nitrate poisoning 125
Pasture palatability 126
Brassica feed values 128
Brassicas & animal health 129
Brassica grazing management 130
Fodder beet & animal health 132
Transitioning animals onto fodder beet 134
Winter feed considerations 136

Forage crop cultivars - Oats and brassicas

Greenfeed oat 139
Hattrick greenfeed oats 140
Catch-crop+ 141
Kale 142
Rape 145
Swede 147
Summer turnip 150
Leafy turnip 152
Winter turnip 152
Raphanobrassica 153
Brassica maturities 153

Brassica management

Winter crop paddock selection 155
Brassica crop rotations 156
Soil fertility 157
Establishment techniques 158
Measuring crop yield 159
Calculating crop break size 160

Forage crop cultivars - fodder beet

Fodder beet 162
Fodder beet cultivars 163
Robbos fodder beet 164

Fodder beet management

Fodder beet sowing checklist 167
Paddock selection 168
Soil fertility 169
Establishment techniques 170
Assessing crop yield 172
Environmental considerations 173

Pasture pests

Description of pasture pests 174

Pasture diseases

Description of pasture diseases 191

Brassica pests

Description of brassica pests 200

Brassica diseases

Description of brassica diseases 208
First, minimise your risk 209

Fodder beet diseases

Description of fodder beet diseases 216

Seed treatment

Seed treatment comparison 225
Seed treatment FAQ's 226
The high price of establishment failure 227
AGRICOTE Grass 228
AGRICOTE Clover 230
AGRICOTE Brassica 232

Seed information

Seed weights & sowing rates 235
Seed analysis certificate 236
Endophyte seed tests 238
Storing seed with endophyte 239
Seed certification 240
Tetraploid seeds 241

Glossary

Definition of a range of terms used in the pasture industry. 242

Pasture cultivars

Pastures for the future	5
Perennial ryegrass	7
Hybrid ryegrass	21
Italian & annual ryegrass	27
Brome grasses	33
Cocksfoot	35
Tall fescue	38
Diverse pasture mixes	39
Diverse pasture premix	40

Pastures for the future

Summary

Grazing pasture is natural – animals have done it for millions of years. And while artificially 'formulated' foods come and go, natural food will always be the most sought-after, not least because of its nutritional value to both adults and children.

At Barenbrug, we believe the pastoral industry has a great future. Our purpose is to help New Zealand farmers thrive, by providing the pastures and forages you need to farm both profitably and sustainably in the years ahead.

Pastures fit for purpose

Our latest cultivars - like *Array* and *4front* perennial ryegrasses, *Captain CS* plantain, *Forge* hybrid ryegrass, *Ruru* white clover and *Morrow* red clover - reflect the new systems farmers are using to remain profitable while adapting to changing social, climatic and environmental expectations. Key examples? Mitigating nitrogen loss and using more legumes.

In this trial with three levels of nitrogen (N) fertiliser, under the low N treatment Array perennial ryegrass yielded more, demonstrating an ability to extract more N from the soil.

Future proofing

What will the NZ farm systems of 2040 look like? That's what our researchers are asking as they develop pastures and forages that will be the engine room of future farms.

We believe real milk and real meat have a bright future, and right now we're working on plants with better nutrient use efficiency; improved climatic tolerance; higher nutritional value and stronger pest resistance.

Every year we sow 100,000's of plants close together, grazed and left to fend for themselves with minimal inputs. Only plants that thrive under this stress advance in our programme.

Pastures for the future (cont.)

What's coming?

We're researching across many areas, including resource use efficiency. Some pastures simply grow more using less water or nutrients to do so. *Array* perennial ryegrass is our first step in this direction, and we have elite plants with more attributes in the pipeline.

We're also working on non-flowering ryegrass, to improve metabolisable energy and make management easy in late spring (making life better for those allergic to pollen too); pastures with better N uptake; forages with a high water content to dilute urine and reduce N leaching; and new clovers with better suited to drought or low soil P. We haven't forgotten animals either – another goal is creating grasses they prefer.

Using genomics is expected to accelerate the rate of genetic gain in ryegrass DM yield, from about 0.7% per year to 2%.

Genomic selection lets us economically assess large numbers of plants for traits that used to be too costly to identify, like a better balance between crude protein and carbohydrate. More balanced pasture will better match animal requirements, and help reduce excess urinary nitrogen in our farm systems.

With our support

We will continue helping you match cultivars to the right situation and sharing the best management methods to maximise their benefits. Every farm is unique, and strategies that work for one system may not work for the farm next door, so we need different options.

Happily, science has shown us even small changes with pasture can make a big difference.

Legume-rich pastures need less artificial nitrogen. High performance red and white clovers fix 25 kg atmospheric N/ha for every tonne of yield grown.

Perennial ryegrass

Introduction

Throughout NZ, perennial ryegrass (*Lolium perenne*) is the grass of choice for permanent pastures. It establishes rapidly, yields well, tolerates a range of management practices and is highly nutritious. It is also compatible with clover, giving excellent all-round pasture for grazing.

Perennial ryegrass cultivars differ in total yield, seasonal growth and heading date, and are available with different endophyte options. Endophytes are fungi that can help plants survive (see page 66).

Ryegrass is naturally a diploid plant, meaning it has two sets of chromosomes. Some cultivars are tetraploids, developed by plant breeders to have four sets of chromosomes. Tetraploids in general have fewer, larger tillers, and are more palatable but less robust (see pages 101 and 241 for more).

More persistent ↕ Less persistent	Perennial ryegrass
	Hybrid ryegrass
	Italian ryegrass
	Annual ryegrass

Barenbrug diploid cultivars

Array	The superstar ryegrass, delivering a unique mix of five benefits: It's easy to eat, unbeaten for total yield in industry NFVT trials, has great cool season growth, is very persistent and extracts more soil nitrogen. Very late heading at +23 days, *Array* is available with *NEA2* or *Low* endophyte. (Refer also to page 10).
Governor	The trusty all-rounder, bred from two very popular cultivars to set a high bar for persistence in *AR37* or *AR1* ryegrass. With outstanding survival and excellent yield on the shoulders of the season, *Governor* grows feed when you need it. Heading is +8 days. Available with *AR37, AR1* or *Low* endophyte. (Refer also to page 20).
Maxsyn	The next generation in perennial ryegrass, proven as your persistent, tough, 'go to' ryegrass, with very high year-round yield. It shines in summer, staying noticeably greener. High tiller numbers help it tolerate a range of different stresses. Available with *NEA12*, *NEA4* or *Low* endophyte; heading +8 days. (Refer also to page 12).
Rohan SPR	The tough, spreading perennial ryegrass, purpose-bred to give hill country farmers persistent, easy care pasture. Its unique spreading habit helps it fill bare areas in the pasture and recover faster after adverse climatic events. *Rohan* is very fine and dense, with excellent palatability. It is late flowering (+16 days) and available with *NEA2* or *Low* endophyte. (Refer also to page 14).
Tyson	Arguably the most exciting perennial ryegrass for red meat farmers. Outstanding early spring growth (+18% in NFVT) and excellent overall yield make *Tyson* ideal for sheep and beef systems, growing more feed through lambing and calving. *Tyson* has a very early -10 day heading date. Available with *NEA4* or *Low* endophyte. (Refer also to page 16).

Perennial ryegrass (cont.)

Other diploid cultivars

AberGreen Fine, densely tillered, late heading (+17 days) high sugar grass with excellent late spring yields. Offers good ground cover. Available with *AR1* or *Low* endophyte.

AberMagic Late heading (+19 days) high sugar grass. Densely tillered; provides good ground cover and late spring growth. Available with *AR1* or *Low* endophyte.

Ceres One50 Late heading (+20 days) diploid, with good total, summer, autumn and winter production. Available with *AR37, AR1* or *Low* endophyte.

Excess High yielding, mid-season (+7 days). Suits dairy, beef and productive sheep systems. Available with *AR37* or *AR1* endophyte.

Hustle Diploid perennial ryegrass with a heading date of + 8 days. Available with *AR1* or *RGT18* endophyte.

Matrix Fine-leaved, densely tillered, high yielding, containing some meadow fescue parentage. Heading date +23 days. Available with *Standard* or *Low* endophyte.

Midway Mid-season, with strong year-round production and persistence. Good tiller density, rust tolerance, and aftermath heading. Available with *AR37* endophyte.

Moxie Early heading (0 days), with high yields. Available with *AR1* endophyte.

Grasslands Legion All round, high performance, late heading (+13 days). Suits sheep, beef and dairy farming. Available with *AR37* or *AR1* endophyte.

Grasslands Nui Common cultivar first certified in 1975. Now superseded in yield, palatability, persistence and rust resistance by many others. Available with *Low* endophyte.

Grasslands Prospect Dense, fine-leaved, productive (+12 days), selected for good seasonal growth and persistence. Available with *AR1* or *AR37* endophyte.

Grasslands Reason Mid heading (+3 days) high performance, with reduced aftermath seeding which helps it to get back to being vegetative in summer. Available with *AR37* endophyte.

Grasslands Samson General purpose (+1 days), best suited to sheep and beef grazing. Available with *AR37, AR1*, or *Low* endophyte.

Grasslands Three60 Late heading (+20) with medium - fine tillers. High autumn yield, summer leafiness, rust tolerance, and low aftermath seeding. Available with *AR1* or *AR37* endophytes.

Platform Dense, high yielding, with excellent year round production, low aftermath heading, and a late heading date (+12 days). Available with *AR37* or *AR1* endophyte.

Rely Densely tillered, mid-season (0 days), bred for a range of conditions, from dairy to lower fertility. Available with *AR37* or *AR1* endophyte.

Stampede High yielding, late heading diploid perennial ryegrass. Available with *CM142* endophyte.

Ultra Fine leaved, densely tillered, late heading (+21 days). Contains some meadow fescue in its parentage. Available with *AR1* or *Low* endophyte.

Tetraploid cultivars For more information on tetraploids see pages 101 or 241.

4front The pre-eminent tetraploid perennial for animal performance, easy grazing, and year round growth. It's better for the environment too. *4front* raises the bar as an unbeaten tetraploid perennial for total yield in the industry NFVTs. Available with *NEA2* or *Low* endophyte. (Refer also to page 18).

AberGain Very late heading (+24 days) with more prostrate growth than standard tetraploids. Marketed for high digestibility and palatability. Available with *AR1* or *Low* endophyte.

Avatar High year-round yields, bred for improved animal safety and persistence against insect pests. Late heading (+22 days); contains *NEA* endophyte. Performs best under rotational grazing.

Base Late heading (+18 days), fine-leaved, bred for high yield, good persistence and low aftermath heading. Available with *AR37* or *AR1* endophyte.

Grasslands Align High performance tetraploid, productive year-round, providing quality dry matter for modern production systems.

Vast Very late heading (+36 days), fine leaved with low winter and early spring yield (20% below *4front* in All of New Zealand NFVTs). Good persistence and low aftermath heading. Available with *AR37* endophyte.

Heading dates of perennial ryegrass cultivars*

Cultivar	Days	Cultivar	Days
Tyson	-10	*Stampede*	+14
Moxie	0	***4front (T)***	**+15**
Nui	0	***Rohan SPR***	+16
Rely	0	*AberGreen*	+19
Samson	+1	*AberMagic*	+19
Reason	+3	*One50*	+20
Excess	+7	*Ultra*	+21
Governor	+8	*Base (T)*	+22
Maxsyn	**+8**	*Avatar (T)*	+22
Hustle	+8	***Array***	+23
Platform	+12	*Matrix*	+23
Prospect	+12	*Grasslands Align*	+35
Legion	+13	*Vast*	+36

** Day 0 is typically around 22 October, but this varies year to year. See page 101 for more. (T) = Tetraploid.*

Array NEA2 perennial ryegrass

Array NEA2 is our superstar, bred for the good of both your animals, and the environment. Delivering a unique mix of high intake, yield, nitrogen uptake and persistence, this is the diploid of the future.

Easy to eat

Array is the perennial ryegrass hard-working ruminants have been hoping for. Upright, leafy and densely tillered, it's customised for easy eating and high intake.

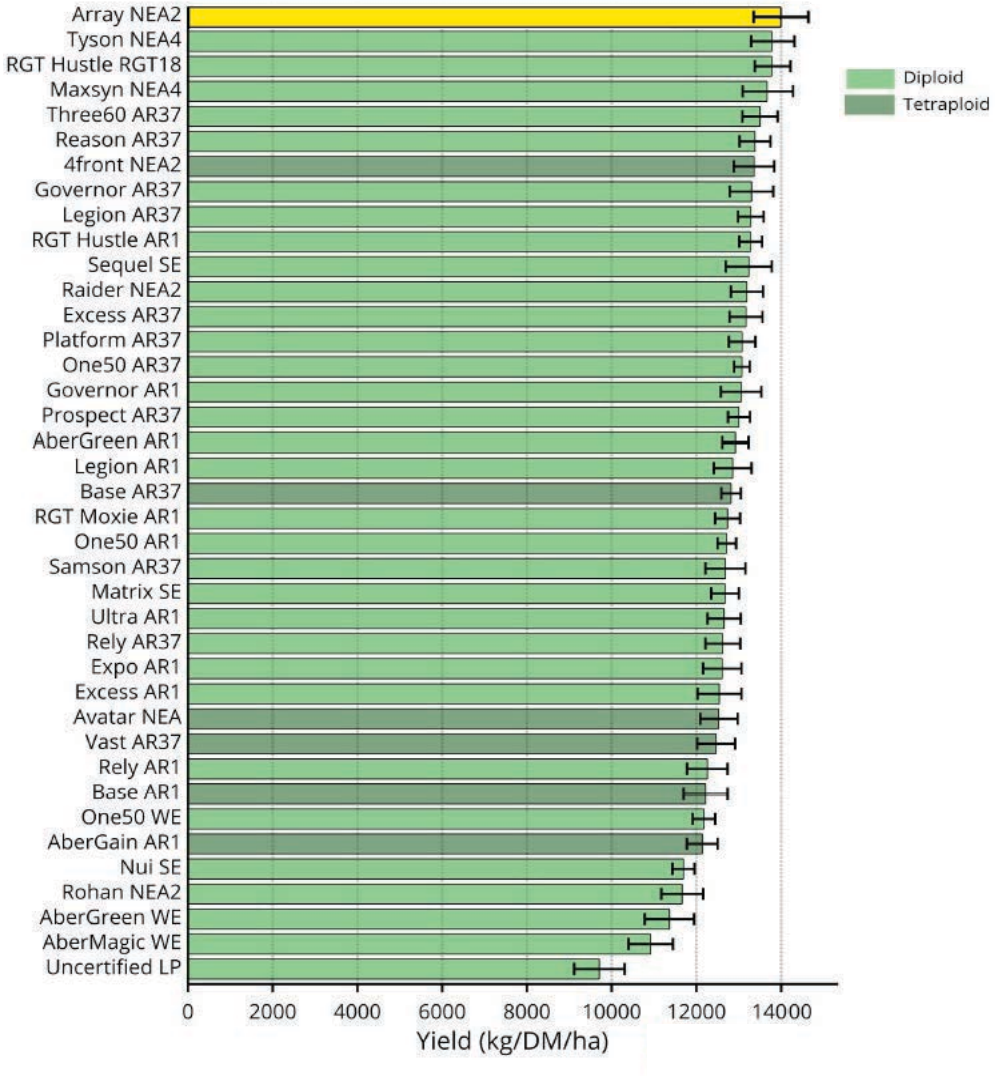
Chomping through thousands of bites every day demands a lot of physical energy! *Array* takes some of the effort out of this process, because it stands tall and literally puts itself closer to those hungry mouths.

Your animals will naturally eat more as a result, and have more time to relax, ruminate and produce meat or milk. That's better for them, and for you too.

Unbeaten yield

Nothing else yields more dry matter in the National Forage Variety Trials. That boosts your supply of home grown feed, and keeps animals well-fed.

2024-25 NFVT Perennial ryegrass summary, total yield, all New Zealand trials.



Great cool season growth

Array has the best cool season growth of any perennial ryegrass we've bred. That helps fill the gap when feed is short, and makes your farm more resilient so you can adapt to shifting climatic patterns.

Very persistent

Keep your diesel in the tank, and leave your soil undisturbed, because *Array* has our highest ranking for pasture persistence. It's as good as *Maxsyn*.

Eats N for breakfast

In trials, *Array* has grown significantly more feed under low nitrogen conditions than other ryegrass cultivars.

What does this mean for you? First, more even pasture growth at times when soil nitrogen is deficient, something that happens on virtually every farm at some times of the year. Second, a win for the environment, because you have the potential to utilise nitrogen more efficiently.

Drone photo of six leading cultivars in a low nitrogen trial. Array (second from left) was greener, grew more, demonstrating its ability to extract more nitrogen from the soil.

Happy, healthy animals

Array keeps animals happy and healthy with leafy, high energy grazing and a very late heading date (+23 days). For dairy cows and beef, *Array* provides ryegrass staggers free pasture. For sheep and deer, there is a very low risk of ryegrass staggers when grazing *NEA2* endophyte.

Get your eye in

Some farmers tell us they under-estimate *Array's* yield, because it has a unique structure – more upright and dense than other ryegrasses. You may need to adjust your eye-ometer, and graze it a little earlier.

Sowing *Array*

Dairy and cattle systems		kg/ha
High intake permanent pasture	*Array* perennial ryegrass	18-22
	Ruru medium leaved white clover	2
	Kotuku large leaved white clover	2
	Total	22-26
Dairy and cattle systems		**kg/ha**
Performance plus extra palatability and reduced nitrogen leaching	*Array* perennial ryegrass	10
	4front tetraploid perennial ryegrass	15*
	Ruru medium leaved white clover	2
	Kotuku large leaved white clover	2
	Captain CS plantain	2
	Total	31
Sheep and beef systems		**kg/ha**
Productive, efficient red meat pastures	*Array* perennial ryegrass	16-20
	Ruru medium leaved white clover	2
	Apex small leaved white clover	2
	Redefine cocksfoot	2-4
	Total	22-28

** Tetraploids are sown at a higher rate than diploids, because of their larger seed.*

Maxsyn perennial ryegrass

Maxsyn is the next-gen perennial for all farm systems, our 'go-to' grass. Now supercharged with _NEA12_ endophyte for even stronger persistence and summer growth.

Persistence +

Maxsyn with _NEA4_ endophyte had our top persistence rating. With _NEA12_ it's better again. That's what you get when top endophytes meet strong summer growth and tillering, plus plenty of daughter tillers in spring to thicken pasture.

Shines in summer

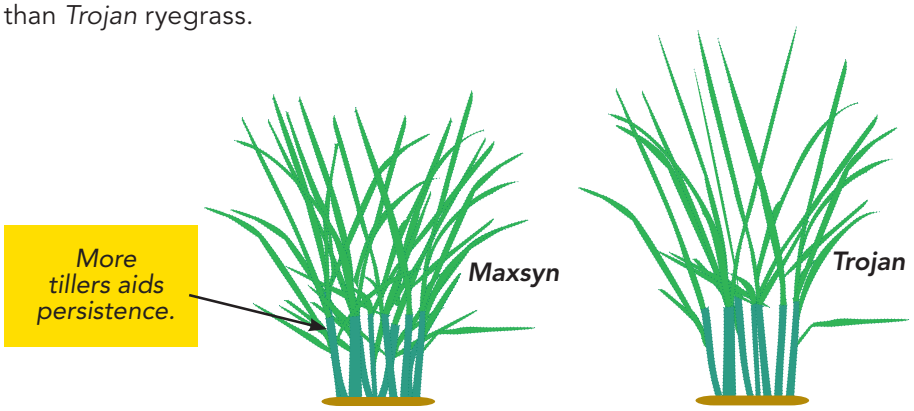
Warm season growth is _Maxsyn's_ super-power. If you've ever run short of feed in summer, you know how valuable this is. Visually you can see the difference - _Maxsyn_ stays green longer when the heat is on. _Maxsyn NEA12_ takes this up a notch, with over 5% more summer yield than _NEA4_.

Maxsyn paddock, standing out in North Waikato in January.

Maxsyn, centre, still green in Taranaki in February.

Densely tillered

The more tillers a pasture has, the more robust and persistent it is. _Maxsyn_ is denser than _Trojan_ ryegrass.



Proven

Maxsyn excelled in our breeding programme, particularly on tough sites and on difficult soils. _Maxsyn's_ persistence advantage is partly due to its strong summer growth and tillering.

But its persistence advantage starts in spring, as it is easier to graze. This encourages new daughter tillers, thickens your pasture, and helps prepare it for summer.

Greater yield

Maxsyn and *NEA4* endophyte make a great couple. The partnership with *NEA12* is even happier, and gives an extra 4% total yield to *Maxsyn* over *NEA4*.

Pest control +

Maxsyn with *NEA4* has proven to deliver excellent persistence under moisture stress, heat and insects, sometimes all at once! *NEA12* supercharges *Maxsyn*, providing a greater level of control of more insects including Argentine stem weevil, root aphid, black beetle, root aphid and porina.

Staggers risk

In most cases *Maxsyn NEA4* and *NEA12* will deliver excellent animal health.

- *NEA4*: For dairy cows and beef it provides ryegrass staggers free pasture. For sheep and deer, there is a very low risk of ryegrass staggers when grazing *NEA4* endophyte.
- *NEA12*: For dairy cows and beef, we believe it will provide ryegrass staggers free pasture in nearly every situation. There is a risk of ryegrass staggers in sheep or lambs if you graze into the base of the pasture in summer dry conditions. *NEA12* is not recommended for horses or deer

In all cases ryegrass staggers is much less likely if you sow a pasture mix with high legume or herb content, or feed supplement as part of the diet.

Sowing *Maxsyn*

Dairy		kg/ha
Next generation dairy pasture	*Maxsyn* perennial ryegrass *Kotuku* white clover *Ruru* white clover	18-22 2 2
	Total	22-26
Dairy		**kg/ha**
Next generation pasture with extra palatability and reduced nitrogen leaching	*Maxsyn* perennial ryegrass *4front* perennial ryegrass *Kotuku* white clover *Ruru* white clover *Captain CS* plantain	10 15* 2 2 2-4
	Total	31-33
Sheep, Beef, Deer		**kg/ha**
Next generation red meat pasture	*Maxsyn* perennial ryegrass *Ruru* white clover *Apex* white clover *Redefine* cocksfoot	16-20 2 2 3-6
	Total	23-30

** Tetraploids are sown at a higher rate than diploids, because of their larger seed.*

Maxsyn perennial ryegrass is owned & marketed by Barenbrug, & protected under the NZ Plant Variety Rights Act

Endophyte *NEA2, Low*
Stock Type Sheep, Beef, Deer

Rohan spreading perennial ryegrass

Rohan is our unique spreading perennial ryegrass, giving red meat farmers robust, tasty, easy-to-manage hill country pasture.

Super spreader

Rohan's spreading habit helps fill bare areas in your pasture, so you can protect your soils and keep weeds at bay (see photo below).

This also helps pasture recover from adverse climatic events, particularly long dry periods, because *Rohan* spreads to fill space where ryegrass tillers may have died.

Rohan is not indestructible. Like all ryegrasses, it performs best under reasonable management and soil fertility. But its spreading habit improves persistence.

Rohan stolon spreading across the ground.

Red meat fit

Success with any pasture comes from matching a cultivar to a particular situation. So where does *Rohan* fit? Let's look at different pasture types across your farm, based on persistence:

Pasture type	High animal performance	More density & robustness	Persistence key requirement	Toughest, non-ryegrass situations
	Increasing persistence →			
Example	*Array*/ *4front* mix OR *Maxsyn*/ *4front* mix	*Array* OR *Maxsyn* OR *Governor*	*Rohan SPR*	*Bareno* *Redefine*
Description	*Array* or *Maxsyn* provides density and robustness, tetraploid *4front* adds high palatability driving animal intakes.	*Array, Maxsyn* and *Governor* are densely tillered cultivars that provide robust, high yielding pastures.	*Rohan SPR* is a very persistent spreading ryegrass suited to hill country and tougher conditions.	Some situations are just too tough or dry for ryegrass. This is where *Bareno* pasture brome and *Redefine* cocksfoot suit.

Self managing

On semi-intensive to semi-extensive farms, it's not easy to maintain pasture quality in late spring. A continual comment from farmers with *Rohan* is that it 'always looks good' - it stays greener and leafier and is usually preferentially grazed. In farm trials, it has shown a 0.7 higher ME than some other cultivars in November and December

Three year old Rohan (green) sown beside Nui ryegrass (brown) in the same paddock in Central Otago. Rohan is much preferred by stock.

Very low stagger risk

Rohan with *NEA2* endophyte provides very low staggers risk pasture for sheep and staggers free pasture for cattle. In the 18 years we have sold *NEA2*, no ryegrass staggers have been seen in sheep or cattle on commercial farms.

Grow more in the dry

Under ideal conditions *Rohan* does not have the same yield potential as cultivars like *Maxsyn*, growing about 10% less. But under tough, dry conditions *Rohan* will probably persist better and yield more over the life of a pasture.

Sowing *Rohan SPR*

Sheep, Beef, Deer		kg/ha
Tough easy to manage pasture	*Rohan* perennial ryegrass	16-20
	Ruru white clover	2
	Apex white clover	2
	Redefine cocksfoot	3-6
	Total	23-30*

* Sub clover(s) are often added to this mix.

Tyson perennial ryegrass

Tyson is the earliest of early starters, adding more feed to the menu for hard-working mums during lambing and calving to power red meat breeding systems. Plus it has strong yield year round, and *NEA4* endophyte for better persistence.

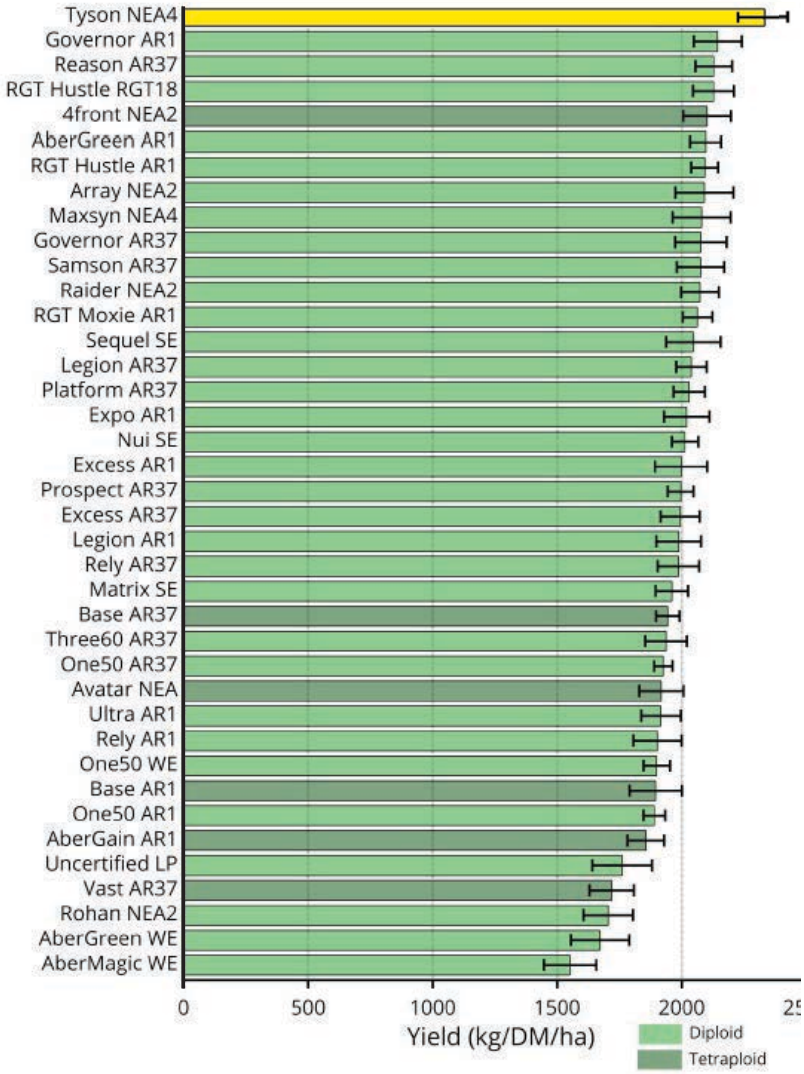
Ultra efficient

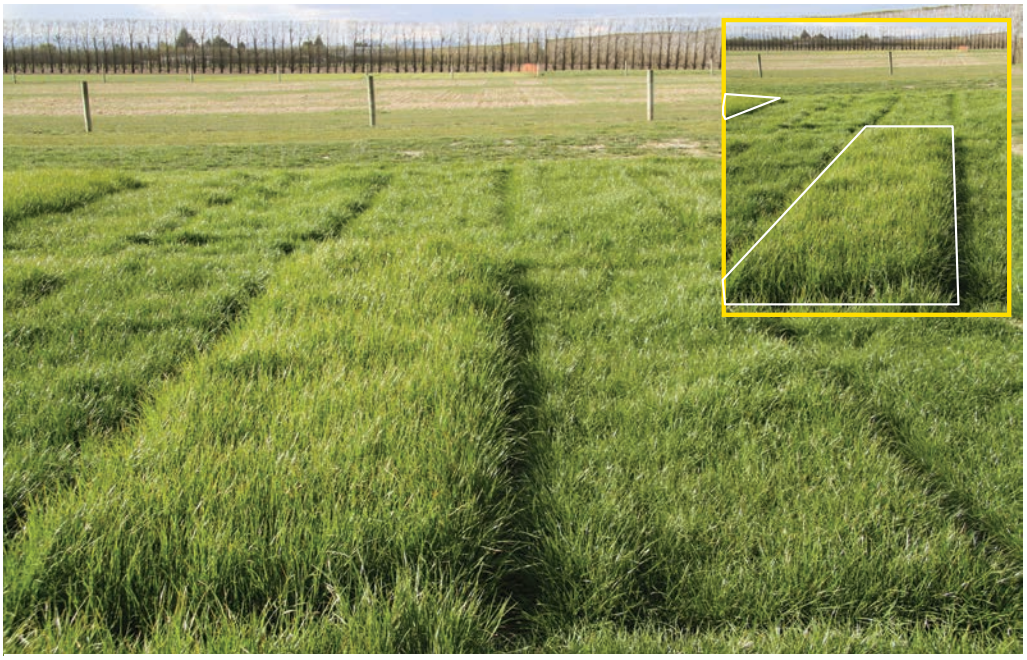
With superb early growth, Tyson is arguably the most exciting perennial ryegrass the red meat sector has seen. Feed your ewes and cows better through early lactation, and watch those lambs and calves flourish without stripping it all it off mum's back. Especially good for early weaning, with all the associated benefits:

- Meet early schedules, typically at better prices.
- Avoid the weaning check (2 weeks lost LWG) plus lambs dress out better.
- Free up extra feed for other animals, like ewes or trading cattle.

Start spring sooner

2024-25 NFVT perennial ryegrass summary, early spring yield, all New Zealand trials.





Tyson's outstanding early growth (left) is obvious in this trial. Photo taken in September.

Ahead of the pack

Tyson is the earliest heading of any perennial ryegrass you can buy, at -10 days. And don't worry about feed quality during the rest of the season – we selected *Tyson* for lower aftermath heading, too.

Capture the gains

There's no free lunch here – if you want *Tyson* to do what it can do in early spring, you have to manage it right! Set stock in spring at < 1200-1300 kg DM/ha (or 3-4 cm pasture height) for single-bearing ewes, 1500-1600 kg DM/ha (or 4-5 cm height) for twin-bearing, or 1700+ kg DM/ha for triplet-bearing through lambing.

Otherwise, *Tyson* won't have the leaves to catch enough sunlight to achieve its genetic potential, which is the science behind the saying 'grass grows grass.' Also, as pasture height drops so does bite size, and although ewes take more bites, both their pasture intake, and lamb growth rate, drop.

Fine & dense

Tyson is a fine leaved, densely tillered diploid perennial for both set stocking and rotational grazing.

Protected too

Tyson has been upgraded to *NEA4* endophyte, providing good control of Argentine stem weevil, black beetle and pasture mealy bug, with no negative impacts on animal health. It is also available with *Low* endophyte.

Sowing *Tyson*

Sheep, Beef, Deer		kg/ha
Early lamb/calf feeding pasture	*Tyson* perennial ryegrass	16-20
	Apex white clover	2
	Ruru white clover	2
	Morrow MS red clover	6
	Total	26-30

Possible additions

Captain CS plantain at 2-4 kg/ha provides extra summer feed value, lasts 2-3 years. *Redefine* cocksfoot at 3-6 kg/ha provides extra summer feed in drier conditions.

4front perennial ryegrass

4front is the benchmark in tetraploid perennials, with superior year-round growth, enhanced persistence, easy grazing and excellent animal performance. It's better for the environment, too.

Best of the best

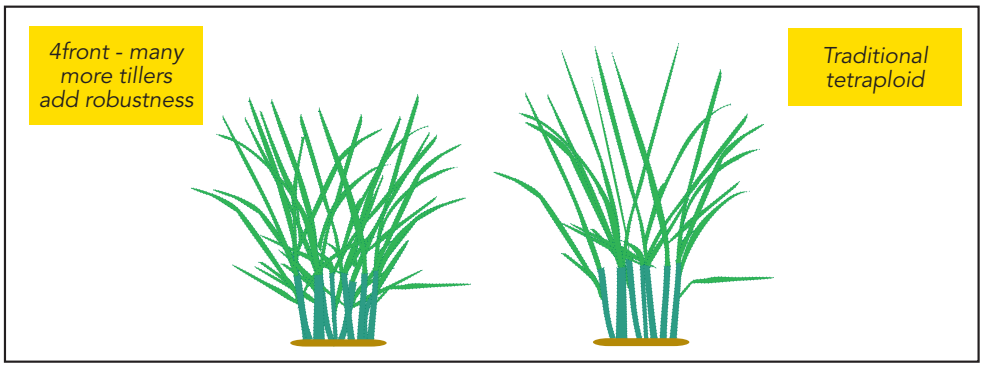
4front grows more feed than any tetraploid perennial we've bred. Equally important? It achieves this in both cool and warm conditions.

Unbeaten in NFVTs

In the 2024-25 National Forage Variety Trials (NFVT) results, no other tetraploid perennial grew more total yield across all New Zealand trials. See graph on page 10.

More tillers

The more tillers in a pasture, the more robust it is. Each tiller is an individual which can be killed by many pressures, including drought, pugging, insects and overgrazing. _4front's_ enhanced tillering helps it persist when conditions are tough.



Piece of cake!

Animals love tetraploids. That simplifies grazing management. Soft, high quality, legume-friendly tetraploid pasture makes life easier for your animals, too. Every bite takes less effort, encouraging animals to eat more for higher daily intakes. The result? More milk in the vat, and faster LWG for finishing stock.

Grazing is hard work! A cow on pasture might take 25,000 bites every day; a ewe, 40,000. _4front's_ soft leaves make a big difference to their quality of life.

Lose less N & GHG

With higher animal intakes and easier management, *4front* can help lighten your farm footprint. Tetraploid ryegrass-based pastures, or tetraploid/diploid mixes, allow farm system changes to reduce nitrogen leaching while improving pasture growth and animal intakes. This is the future of NZ farming.

A dramatic example of this is the Lincoln University Dairy Farm (LUDF). It has cut nitrogen leaching by 40% and greenhouse gases (GHG) by about 22%, using several system changes including:

- Capturing more photosynthesis – pre-grazing covers are 300 kg DM/ha higher with tetraploids, growing an extra 1.2 t DM/ha/year across the whole farm.
- Longer grazing round (average +4 days) meaning fewer grazings per paddock and 30% better nitrogen use efficiency.
- Higher cow production (+26 kg MS/cow) from fewer cows and better pasture intakes.
- Applying 170 kg/ha/year less nitrogen fertiliser.

LUDF couldn't have achieved this without sowing tetraploid ryegrass in all but one paddock. Download *"The 4front System"* from www.barenbrug.co.nz for more.

Mixing *4front* & *Maxsyn* or *Array*

4front can be sown alone on many farms, but when you mix it with *Maxsyn* or *Array* diploid perennial ryegrass, its benefits can be extended to a wider range of farm systems.

Some farmers struggle to avoid over grazing straight tetraploids, and don't get the persistence they want. Adding a denser, finer diploid ryegrass to the mix makes it more robust. Diploid plants protect the tetraploid (see page 102).

Very low chance of staggers

For dairy cows and beef cattle, *4front* provides ryegrass staggers free pasture. For sheep and deer, ryegrass staggers grazing *NEA2* endophyte is a very low risk. In extreme situations, such as drought where animals are forced to graze close to the ground, a low level of staggers might very occasionally be seen.

Sowing *4front*

Dairy		kg/ha
Top performing tetraploid pasture, with reduced N leaching.	*4front* perennial ryegrass	25-30
	Kotuku white clover	2
	Ruru white clover	2
	Captain CS plantain	2-4
	Total	31-38

Dairy		kg/ha
Top performing tetraploid/ diploid mix pasture, for greater robustness & density.	*4front* perennial ryegrass	15*
	Maxsyn or *Array* perennial ryegrass	10
	Kotuku white clover	2
	Ruru white clover	2
	Total	29

Sheep, Beef, Deer		kg/ha
Top performing tetraploid/ legume/plantain finishing pasture.	*4front* perennial ryegrass	22-25
	Ruru white clover	3
	Morrow red clover	4
	Captain CS plantain	2-4
	Laser Persian clover	3
	Total	34-39

** Tetraploids are sown at a higher rate than diploids, because of their larger seed.*

Endophyte: *AR37, AR1, LE*
Stock Type: Dairy, Sheep, Beef*
**AR37 isn't recommended for deer or horses*

Governor perennial ryegrass

Governor is our great all-rounder, persistent, growthy and dense. If you need reliable ryegrass with _AR37_ or _AR1_ endophyte, _Governor_ has your back.

Genetic legacy

The persistence of *Bronsyn*, with the high DM yield and palatability of *Tolosa*, make *Governor* an ideal diploid ryegrass for dairy, sheep and beef systems.

A true survivor

Governor is the Rambo of *AR37* ryegrasses for persistence. Fine and densely tillered, it's survived outstandingly well under grazing through drought and high insect pressure in farm trials nationwide. *Governor* is also available with *AR1* endophyte if you don't need *AR37*.

Seasonal growth

Want more feed in early spring and autumn? Most farmers do. Sow *Governor*, and you're sorted.

Staunch

With a +8 days heading date, low aftermath heading and better rust resistance than its parents, *Governor* is your dependable, hardy multi-purpose pasture.

Where to sow

Pasture type	High animal performance	More density & robustness	Persistence key requirement	Toughest, non-ryegrass situations
	Increasing persistence →			
Example	*Array/ 4front* mix OR *Maxsyn/ 4front* mix	*Governor* OR *Maxsyn* OR *Array*	*Rohan SPR*	*Bareno* *Redefine*
Description	*Array* or *Maxsyn* provides density and robustness, tetraploid *4front* adds high palatability driving animal intakes.	*Array, Maxsyn* and *Governor* are, densely tillered cultivars that provide robust, high yielding pastures.	*Rohan SPR* is a very persistent spreading ryegrass suited to hill country and tougher conditions.	Some situations are just too tough or dry for ryegrass. This is where *Bareno* pasture brome and *Redefine* cocksfoot suit.

Sowing *Governor*

Dairy		kg/ha
Top performing all-round pasture	*Governor* perennial ryegrass	18-22
	Kotuku white clover	2
	Ruru white clover	2
	Captain CSP plantain	2-4
	Total	24-30

Sheep, Beef		kg/ha
Top performing, all-round pasture	*Governor* perennial ryegrass	16-20
	Ruru white clover	2
	Apex white clover	2
	Redefine cocksfoot	3-6
	Total	23-30

Hybrid ryegrass

Introduction

Hybrid ryegrasses *(Lolium x boucheanum Kunth)*, also known as 'short rotation' ryegrasses, are a cross between Italian and perennial ryegrass. They vary in their persistence, depending on their parentage. Those with a higher proportion of perennial ryegrass (e.g. *Forge*, 75% perennial), will last longer than those with less (e.g. *Shogun*, 50% perennial).

Hybrid ryegrass grows more in winter than perennial or long rotation ryegrass. In summer wet areas, most cultivars can persist for up to 5 years. In summer dry areas, hybrids generally last for 2-3 years. Some cultivars are available with endophyte which improves their insect resistance and persistence.

More persistent ↕ Less persistent	Perennial ryegrass
	Hybrid ryegrass
	Italian ryegrass
	Annual ryegrass

Shogun tetraploid hybrid ryegrass is unique, yielding almost like an Italian in winter and a perennial in summer.

Heading dates of hybrid ryegrasses*

Cultivar	Days
Ohau (T)	+8
Forge (T)	+11
Shogun (T)	+13
Maverick GII	+17
Mohaka	+20

** Day 0 is typically around 22 October, but this varies year to year. See page 101 for more. (T) = Tetraploid.*

Hybrid ryegrass cultivars

Forge (T)	The NZ champion in 3-5 year pasture, with breakthrough genetic gain. It combines a massive improvement in year-round yield with superb cool season growth and all the grazing, production and environmental benefits of a tetraploid. Available with *NEA* endophyte. (Refer also to page 23).
Shogun (T)	The rockstar hybrid, made better! Now upgraded to *NEA12* endophyte. *Shogun* is renowned in NZ farming, setting the standard for 1-3 year pasture. It combines exceptional establishment speed and year-round yield with superb feed quality being a late heading (+13 days) tetraploid with low aftermath heading. Available with *NEA12*, *NEA* and *Low* endophyte. (Refer also to page 25).
Frenzy (T)	A fast establishing, tetraploid hybrid ryegrass with strong winter growth. It has a heading date of +16 days and is available with *NEA2* endophyte.
Grasslands Mohaka (T)	High performance late heading (+20 days) tetraploid with good cool season growth. Available with *AR37 or AR1* endophyte.
Palliser (T)	Very late heading (+25 days) long rotation ryegrass. Strong summer and autumn production, quality, and rust tolerance. Available with *AR37* endophyte.
Ohau (T)	Mid-season heading (+9 days) long-rotation tetraploid with strong spring growth. Available with *AR37*, *AR1* or *Low* endophyte.

Groundbreaking – Forge tetraploid hybrid ryegrass fuels higher animal performance for dairy, sheep and beef farmers.

Forge tetraploid hybrid ryegrass

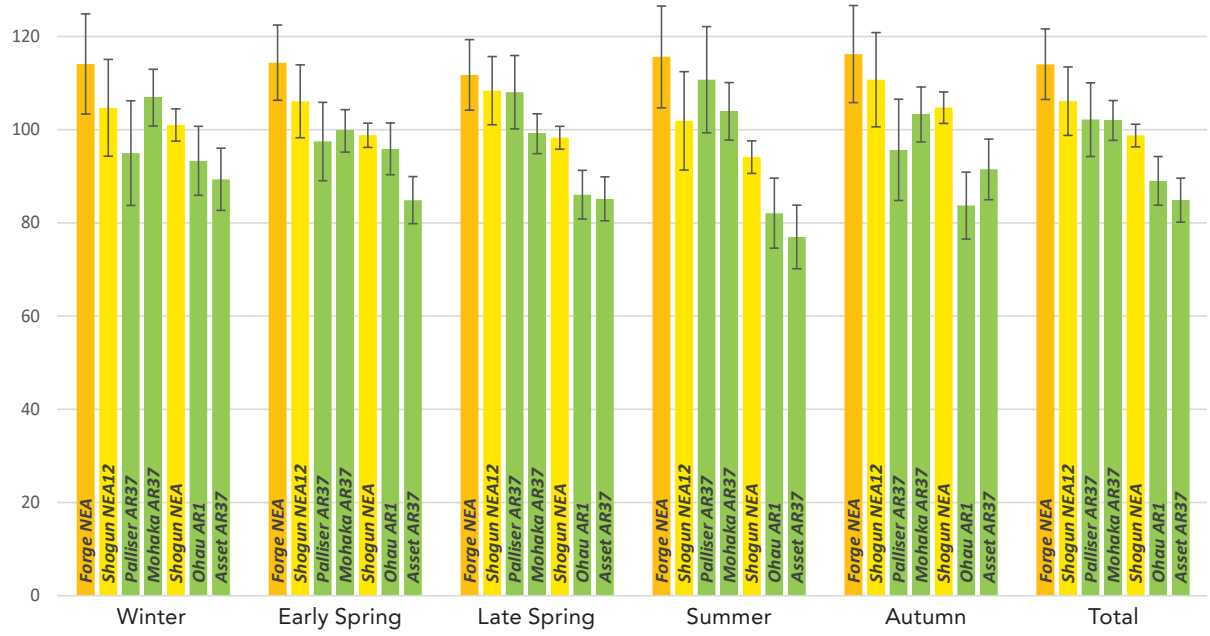
Forge NEA is the phenomenal 3-5 year pasture bred to deliver animal performance your neighbours will envy, with environmental benefits too.

Groundbreaking

Unbeaten in the National Forage Variety Trials (NFVT), *Forge* is a breakthrough in genetic gain. (Few new ryegrass cultivars ever exceed 5% yield improvement!)

Even better, *Forge* gives this extra yield and quality across every season.

2024-25 NFVT hybrid ryegrass summary: All New Zealand Trials*



** NFVT Summary September 2024. If two means differ by more than the sum of their least significant intervals (LSI), they are significantly different at 5% level. NFVT Protocol cutting times may disadvantage yield of a perennial ryegrass within a hybrid ryegrass trial.*

Feed when you need it

Growth in winter and early spring is increasingly prized in our farm systems. It provides feed when it is often most needed, and most expensive.

Nothing else compares to *Forge* when the temperature drops. In winter it grows 5 - 41% more than other hybrid ryegrasses in the NFVT system; and 7 - 28% more in early spring.

Tasty as

Animals love tetraploids – they are soft, high in sugars, legume-friendly, and easy to eat. *Forge* encourages higher intakes, optimal per head performance and improved efficiency.

Lose less N & GHG

With higher animal intakes, and extra cool season growth, *Forge* helps lighten the farm footprint.

Tetraploids can be grazed at higher covers, so you grow more pasture for the same amount of nitrogen. *Forge's* extra winter yield also better mitigates nitrogen leaching during the high-risk cool season when soils are wet. Its palatability and high feed value lifts per animal performance, which lowers both greenhouse gas emissions and animal health costs.

Forge tetraploid hybrid ryegrass (cont.)

Extra 1.4t DM/ha

Forge NEA will grow about 1.4 t dry matter/ha a year more than a high performance perennial ryegrass. What could you do with this extra feed?

- Dairy farms: Add more home grown pasture to your winter milking or early calving system. More ME/ha year-round can increase MS production, too. Just as importantly, high quality and palatability lift efficiency through more milk/cow, rather than more cows. Alternately, use the extra feed to cut supplement costs.
- Sheep and beef: Feed ewes better through lactation, and finish more lambs off mum. Capitalise on the early schedules, and avoid the weaning check. *Forge's* high quality is also great for growing or finishing stock.
- Undersowing: Direct-drill into thin, sad pastures to lift both yield and feed quality. *Forge* establishes rapidly, with fast regrowth, so it's perfect for this.

Breeding & persistence

Forge has 75% perennial: 25% Italian ryegrass parentage, so it fits between *Shogun* (50:50% parentage), and *4front* perennial ryegrass. *Forge's* persistence is very good for a tetraploid hybrid, thanks to high tiller density and a focus on persistence in its breeding.

Endophyte & animal health

In most cases *Forge NEA* will deliver excellent animal health. We believe it is safe to use for dairy cows and cattle.

There is a risk of some ryegrass staggers in sheep or lambs if you graze into the base of the pasture in summer dry conditions. The risk of stagger is much lower than for the old *Standard* (or *High*) endophyte.

Add red clover & stand clear

We've tested several combinations of *Forge* with *Morrow* red clover, as this will provide the best quality summer feed. Mixing 30 kg/ha *Forge* with 6 kg/ha *Morrow*, and 20kg *Forge* with 10 kg *Morrow*, work best, with the latter providing a bit less winter yield and more summer yield and quality.

Sowing *Forge*

Dairy		kg/ha
High performance 3-5 year pasture	*Forge NEA* hybrid ryegrass	30
	Kotuku white clover	2
	Ruru white clover	2
	Total	34
Sheep, Beef, Deer		**kg/ha**
High performance finishing pasture	*Forge NEA* hybrid ryegrass	25-30
	Morrow MS red clover	6
	Ruru white clover	2
	Total	33-38
Undersowing		**kg/ha**
Sow into thin pasture to extend performance	*Forge NEA* hybrid ryegrass	13-20*
	Total	13-20

**Sowing rate depends on how thin pasture to be undersown is.*

Other species can be added as needed e.g. *Captain CS* plantain.

Endophyte: *NEA12, NEA, Low*
Stock Type: Dairy, Sheep, Beef*
**NEA12 isn't recommended for deer or horses*

Shogun hybrid ryegrass

The rockstar hybrid you love, with *NEA* endophyte, or supercharged with *NEA12* for even more yield and animal performance.

What makes it special?

Fast, nutritious and delicious, *Shogun* is your best friend for both 1-3 year pasture, and undersowing, no matter where you farm.

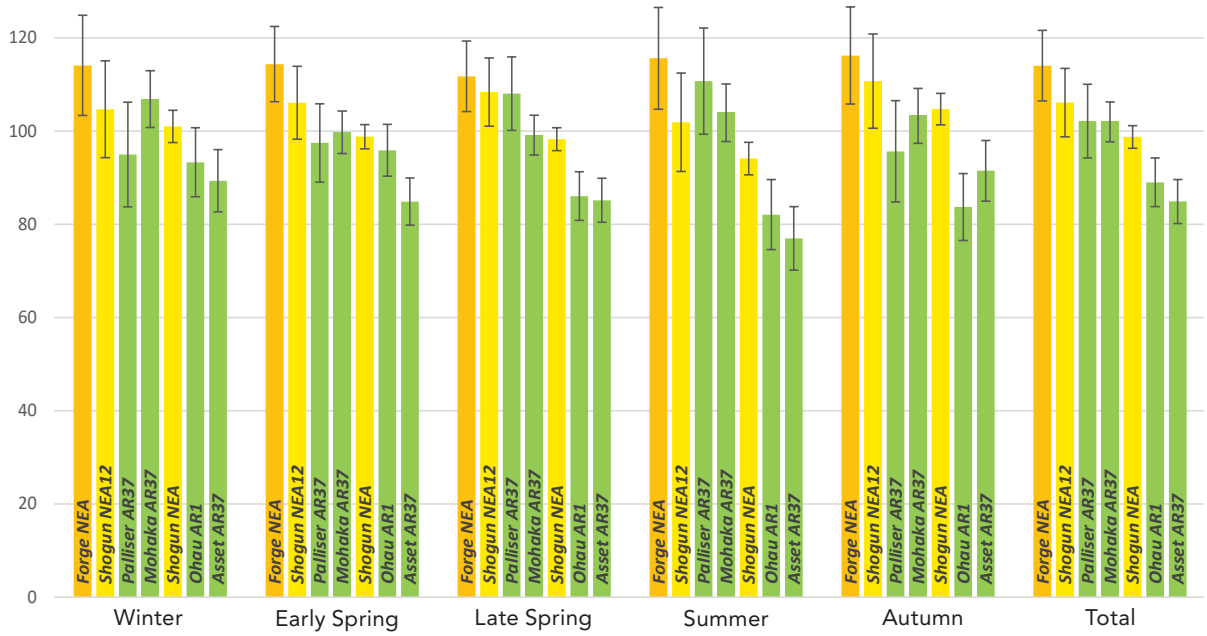
Supercharged

Shogun is now supercharged with *NEA12* endophyte, growing 7% more total yield than the *NEA* version. Normal ryegrass breeding delivers about 1% genetic gain a year, so that's 7 years' progress in one go. Imagine achieving that in your animals!

Carry more

Shogun NEA12 grows more year-round, so you can feed more animals on those paddocks. Its biggest seasonal advantage over *Shogun NEA* is during summer (growing 10% more) and autumn 8% more as shown in the industry trial results below.

2024-25 NFVT hybrid ryegrass summary: All New Zealand Trials*



** NFVT Summary September 2024. If two means differ by more than the sum of their least significant intervals (LSI), they are significantly different at 5% level. NFVT Protocol cutting times may disadvantage yield of a perennial ryegrass within a hybrid ryegrass trial.*

Shogun hybrid ryegrass (cont.)

Better protection

NEA12 gives *Shogun* a wider range of insect control, including we believe for porina. Testing has shown *NEA12* provides good black beetle control (at the same level as *NEA* endophyte) and very good root aphid control.

Faster payback

Shogun establishes very fast, more like an Italian ryegrass, so these paddocks are ready to graze sooner than ones sown with perennial ryegrasses or some other hybrids.

Make more protein

Animals thrive on *Shogun* – it's a high energy, late heading tetraploid (+13 days), with minimal aftermath heading in summer, plus you gain that extra yield.

Easy to graze

Shogun is a super palatable tetraploid. Animals love eating it, so it's easier to manage.

Endophyte & animal health

In most cases *Shogun* will deliver excellent animal health. We believe it is safe to use for dairy cows and cattle.

There is a risk of some ryegrass staggers in sheep or lambs if you graze into the base of the pasture in summer dry conditions. In this situation the risk or staggers with *Shogun NEA12* is higher, and *NEA12* is not recommended for horses or deer. The risk of stagger in both options is much lower than for the old *Standard* (or *High*) endophyte.

In all cases ryegrass staggers is much less likely if you sow a pasture mix with high legume and herb content (see suggestion below).

Sowing *Shogun*

Dairy and cattle systems		kg/ha
High performance 1-3 year pasture	*Shogun NEA12* or *NEA* ryegrass	30
	Ruru medium leaved white clover	2
	Kotuku large leaved white clover	2
	Total	34
Lamb and beef finishing		**kg/ha**
High performance 1-3 year finishing	*Shogun NEA12* or *NEA* ryegrass	25
	Ruru medium leaved white clover	2
	Apex small leaved white clover	2
	Morrow red clover	6
	Captain CS plantain	2-4
	Total	37-39
Undersowing		**kg/ha**
Undersowing with fast establishment	*Shogun NEA12* or *NEA* ryegrass	15-20*

**Sowing rate depends on how thin pasture to be undersown is.*

Italian & annual ryegrass

Introduction

Italian and annual ryegrass *(Lolium multiflorum)* are discussed together here as they are often used for the same purpose. Most commonly they are sown as a high quality short-term winter crop, to provide multiple grazings in winter and spring.

More persistent ↕ Less persistent	
	Perennial ryegrass
	Hybrid ryegrass
	Italian ryegrass
	Annual ryegrass

Annual ryegrass is usually used for a 6-8 month winter crop before sowing summer crop.

Italian ryegrass is more persistent than annual ryegrass and can be sown for a 2-3 year pasture in summer mild areas (e.g. Southland) or under irrigation. In summer dry areas it generally lasts 12-18 months.

Italian ryegrass is also widely used for undersowing into run out pasture to boost winter and early spring performance. Fast establishment makes it ideal for this role.

However, on farms in the upper North Island where black beetle is an issue, undersow ryegrass with endophyte instead (e.g. *Shogun NEA12 or Forge NEA*) as black beetle can proliferate on ryegrass without endophyte.

We do not recommend adding Italian or annual ryegrass to your permanent pasture seed mix. They establish rapidly, to the detriment of baby perennial ryegrass and clover. Italian and annual ryegrasses then die out, allowing weeds to invade.

Heading dates of Italian and annual ryegrasses*

Italian	Days	Annual	Days
Tabu+	+11	*Winter Star II (T)*	+9
Asset	+14	*Tama (T)*	+14
Moata (T)	+16	***Hogan (T)***	**+14**
Feast II (T)	+17	*Zoom (T)*	+16
Lush (T)	+17	*Dash (T)*	+24
Supercruise	+20		
Vibe	+27		

** Day 0 is typically around 22 October, but this varies year to year. See page 101 for more. (T) = Tetraploid.*

Italian ryegrass cultivars

Tabu+	The record-breaker, with explosive establishment speed and superior cool season growth, plus stock love it. *Tabu+* is unbeaten in the NFVT Italian ryegrass summary for winter yield. (Refer also to page 29).
Appeal	Very late heading (+28 days), high yielding, fast establishing ryegrass.
Feast II (T)	Tetraploid with good establishment and excellent summer quality, ideal for high quality silage. Only available *Without* endophyte.
Indulgence	Diploid with fine, dense tillers (+20 days).
Grasslands Asset	Diploid with +14 days heading date, selected for growth into the second year. Available with *AR37* or *Without* endophyte.
Grasslands Manta	High yielding diploid with strong winter growth and lower aftermath heading compared to typical Italian ryegrasses. Available with *AR37* or *Without* endophyte.
Grasslands Moata (T)	Tetraploid released in 1981, with limited persistence. Superseded in cool season growth and total DM yield by many other cultivars.
Lush (T)	Tetraploid with fast establishment and reduced aftermath heading. Available with *AR37* endophyte.
Supercruise	Fast establishing diploid providing excellent short term feed in challenging environments (+16 days).
Vibe	Diploid selected for improved persistence. Suitable for a straight sward or undersowing into run out pasture. Very late heading (+27 days).

Here we sowed a strip of Tabu+ (left) beside uncertified Italian ryegrass seed - the difference in establishment is huge.

Tabu+ Italian ryegrass

Tabu+ is our record-breaker, with explosive establishment speed and superior cool season growth.

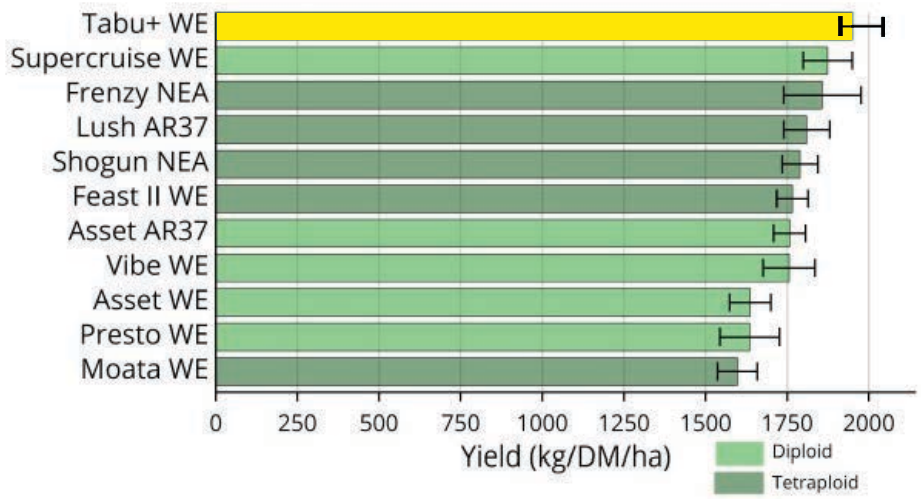
Multi-use

Tabu+ is Mr Adaptable. Sow it as an 8-12 month high performance crop; grow happy animals for 2-3 years in areas with mild summers, or undersow into run out pasture to boost winter and spring growth. For best results undersowing dense pastures, spray before drilling. Note: If you need pasture to last 2-3 years _Shogun NEA12_ may be a better option.

Unstoppable in winter

Tabu+ is the top yielding Italian ryegrass in the National Forage Variety Trials (NFVT) 12 month pasture summary, for winter growth.

2024-25 NFVT Italian ryegrass yields: All New Zealand trials - winter yield



2000% ROI

Tabu+ produced an extra 4 t DM/ha over _Moata_ as a 12 month crop. For an extra seed cost of about $60/ha, _Tabu+_ returned over 2000% on investment! That's because this extra feed is valued at about $0.40/kg DM or +$1600/ha.

Soaks up winter N

The more winter growth on your farm, the more nitrogen you capture before it leaves the soil. _Tabu+_ hits its peak in May-August, and its super-fast cool season growth pulls up more nitrogen than slower growing pastures.

Tabu+ Italian ryegrass (cont.)

Sowing *Tabu+*

Winter ryegrass crop		kg/ha
	Tabu+ Italian ryegrass	20-22
Winter ryegrass crop with annual clovers		**kg/ha**
	Tabu+ Italian ryegrass	16-18
	Laser Persian clover	8
	Total	24-26
1-2 year pasture option		**kg/ha**
	Tabu+ Italian ryegrass	18-22
	Morrow MS red clover	6
	Kotuku or *Apex* white clover	2
	Ruru white clover	2
	Total	28-32
Undersowing		**kg/ha**
	Tabu+ Italian ryegrass	10-15*
	Kotuku or *Apex* white clover	1.5
	Ruru white clover	1.5
	Total	13-18

**Sowing rate varies depending on how thin pasture to be undersown is.*

Tabu+ has explosive establishment speed and winter growth.

Annual ryegrass cultivars

Hogan (T)	The classic large-leaved, glossy green annual with exceptional performance. Very fast establishing, with rapid regrowth after grazing and late (+14 days) heading, it is mainly used as a 6-8 month winter crop. (Refer also to page 32).
Dash (T)	Densely tillered, upright tetraploid Westerwold* with fast establishment, strong winter growth and very late heading (+24 days)
Grasslands Tama (T)	Old tetraploid Westerwold* released in 1968. Low yielding, and superseded by other cultivars (+14 days).
Revel	Annual ryegrass with excellent productivity and growth, as well as fast establishment.
Winter Star II (T)	Fast-establishing tetraploid, well suited for quick winter feed production.
Zoom (T)	Tetraploid Westerwold* with late heading date (+14 days) with good winter and spring performance in the NFVT yield trials.

**Westerwold is a type of annual ryegrass that does not need vernalisation (cold period) to set seed. i.e. Westerwold cultivars go to seed straight away when sown in spring.*

Hogan is a fast establishing annual ryegrass setting a high level of performance.

Hogan annual ryegrass

Hogan sets the standard for tetraploid annual ryegrass, producing over 800kg DM/ha more (worth $320/ha) – and it looks fantastic too!

Profit plus

Hogan establishes rapidly and out grows 30+ year old _Tama_ by over 800kg DM/ha. If you value this cool season growth at $0.40/kg DM, _Hogan's_ advantage is $320/ha extra profit, i.e. a 7-8 fold return on the extra $40-$45/ha it costs to sow _Hogan_ over _Tama_.

Fast establishment

Hogan is a tetraploid bred for rapid establishment (+21% faster than _Tama_) to provide fast feed in autumn, a critical advantage particularly following dry summers.

Reliable

Hogan has been proven to perform, year in, year out, across all types of farm systems, soils and seasons, pumping out energy-rich feed from autumn through spring.

Winter crop

It is the ideal autumn sown 6-8 month winter crop, or spring sow for 12 months. If a longer term crop is required, _Tabu+_ or hybrid ryegrasses _Shogun_ or _Forge_ are better options.

Sowing _Hogan_

Dairy, Sheep, Beef, Deer		kg/ha
Winter-spring crop	_Hogan_ annual ryegrass*	30
	Total	30
Winter-spring crop with annual clovers	_Hogan_ annual ryegrass* _Laser_ Persian clover	22 8
	Total	30

** Tetraploids are sown at a higher rate than diploids, because of their larger seed.*

Brome grasses

(Pasture brome, Prairie grass, Grazing brome)

Introduction

Brome grasses suit free draining soils of moderate fertility and low aluminium in lower rainfall areas. They do not persist well on poorly drained soils.

They are palatable, including their seed heads, and offer good quality feed. Bromes are slower than ryegrass to establish and should be sown in warm conditions (late summer/early autumn or spring), into a well consolidated seedbed.

Brome grasses are all different species (not just different cultivars). They range from the erect prairie grass (*Bromus willdenowii*) which is the least persistent and best suited to rotational grazing, through to the very persistent pasture brome (*Bromus valdivianus*).

Brome grasses do not contain endophyte.

Brome grass cultivars

Pasture brome

Bareno

The standout persistent pasture for summer dry free-draining soils. In these situations it is more persistent than perennial ryegrass, very palatable, high yielding and legume-friendly. *Bareno* can be rotationally grazed or set stocked, and is 19 days later heading than *Gala*, with better summer growth. (Refer also to page 34).

Grazing brome

Grasslands Gala

Fine leaved, densely tillered species with reasonable winter production. *Gala* performs best under set stocking systems and is persistent in dryland conditions with light soils.

Prairie grass

Ceres Atom

Bred for a greater tiller density than *Matua*. It is most productive in fertile, free draining soils with PH above 5.5.

Grasslands Matua

Erect broad leaved cultivar with limited persistence under intensive grazing. It should only be used in rotational grazing or cutting systems. *Matua* has good winter production.

Bareno brome

Bareno thrives where perennial ryegrass fails, excelling on tough, summer dry sheep and beef country with free-draining soils.

Flexible

Bareno provides a palatable, persistent and flexible pasture for dryland farming that can tolerate both rotational grazing and set stocking. _Bareno's_ persistence may decline in the upper North Island, so it is less suited to this region.

Tasty year round

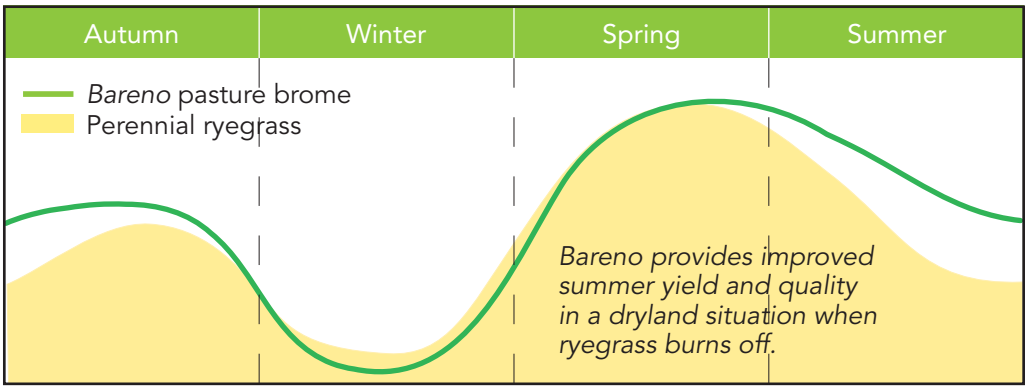
A strong feature of _Bareno_ is its palatability through all seasons:

- It remains palatable, even when seed heads are present, and stays greener and leafier than ryegrass in summer.
- _Bareno_ can support a high legume content (40% sub and white clover has been measured in spring).

High yield

On Lincoln University's Silverwood Farm, a dryland breeding property in inland Canterbury, _Bareno_ produced 12.5 t DM/ha/year, 9% more than new sowings of perennial ryegrass (11.5 t DM/ha), with excellent spring, summer and autumn growth.

Seasonal growth



Sow early

Brome grasses are slower to establish than ryegrass, particularly in cold temperatures, so make sure to:

- Sow when warm - soil temperature 12°C+ in late summer or early autumn.
- Summer fallow before sowing in dry regions.
- Direct drill – this has proven very successful.

Sowing _Bareno_

Sheep, Beef, Deer		kg/ha
Persistent and palatable dryland pasture	_Bareno_ pasture brome	25-32*
	Can be added: _Redefine_ cocksfoot Sub clover _Apex_ white clover _Morrow_ red clover	Inclusion of species depends on situation. Seek advice if unsure.

Bareno sowing rate high because brome grasses have large seeds.

Cocksfoot

Introduction

Cocksfoot *(Dactylis glomerata)* is a very persistent perennial grass that tolerates summer dry conditions, moderate soil fertility, insect attack and continual set stocking.

Cocksfoot is used to enhance pasture growth and persistence in summer dry areas. It also adds variety to the animals' diet.

Traditionally seeding rates of cocksfoot were kept low in a mix, because old cocksfoot cultivars would dominate pastures, reducing clover levels and digestibility. New fine leaved cocksfoot cultivars are much more compatible with ryegrass, giving better long term pastures.

Cocksfoot is quite slow to establish and is less digestible than most other grasses. It has limited winter growth but good summer growth.

Ryegrass plot (centre) burnt off in a dry February, surrounded by cocksfoot..

Cocksfoot cultivars

Redefine	The cocksfoot your pasture has been waiting for. Polite and co-operative, it makes friends with legumes wherever it goes. *Redefine* is big step forward in finer leaved cocksfoot (Refer also to page 36).
Aurus	Upright, medium leaved; offering some winter growth and overall total yield. Excellent disease tolerance to *Drechslera*.
Greenly II	A cocksfoot with an upright growth habit. Bred for good performance in a range of conditions
Kainui	Finer leaved, high yielding; displays good compatibility in pasture mixes and good disease tolerance.
Savvy	Medium leaved cultivar which has good tiller density and good dry matter production.

Redefine cocksfoot

The ultimate mixer! Makes friends wherever it grows.

Well-behaved

Redefine is the cocksfoot every pasture wants. Polite, controlled and co-operative, it plays nicely with other species instead of taking over.

Who should sow it?

Anyone who wants the benefits of a cocksfoot without the clumpy, aggressive behaviour and clover suppression associated with older varieties.

Redefine adds diversity and climatic resilience to pastures in summer-dry regions. It is tougher than ryegrass with more summer growth.

Even finer

Since *Kara* was released in 1980, we have made great progress developing finer, more tillered cocksfoot cultivars. *Redefine* is a big step forward. At over 5000 tillers/m², you can clearly see the difference between it and other cocksfoots.

Progress of cocksfoot tiller density*

	Kara	*Ella*	*Greenly II*	*Safin*	***Redefine***
Tillers/m²	2381	2981	3335	4241	5095
(versus Kara = 100%)	100%	125%	140%	178%	214%

** Results from 2 grazing trials at Courtenay, Canterbury. LSD (5%) = 707 tillers/m².*

Good against grass grub

Once established cocksfoot has good tolerance of all pests. Notably, it is much more tolerant of grass grub than ryegrass.

See green

Redefine lives better with clovers, meaning there's more available nitrogen, so it's nicer to eat.

This is key, because when cocksfoot is low in crude protein (look for yellow leaves), palatability and animal performance is poor.

Old cocksfoot can become low in crude protein and less palatable.

Redefine makes friends with legumes, so it's nicer to eat.

Great team-mates

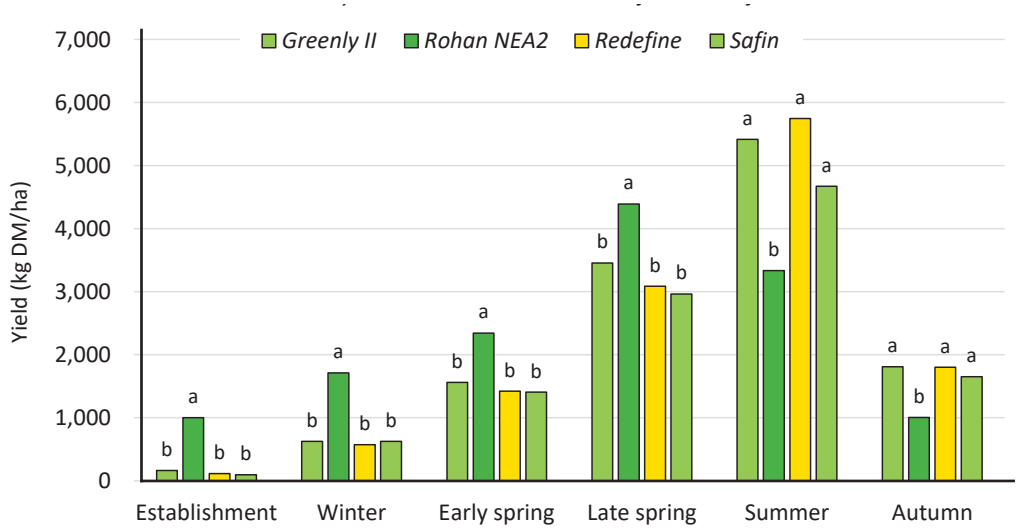
Redefine and ryegrass are ideal partners, giving more reliable pasture establishment than sowing cocksfoot as the sole grass. *Redefine* sown with ryegrass will be faster to grazing, with fewer weed issues, and will provide more feed over the first year.

Redefine will come through in the summer, and sowing rates can be adjusted to get the pasture balance you want (see below).

Value vs ryegrass

This is demonstrated by the establishment year of a dryland trial comparing cocksfoot with *Rohan* perennial ryegrass. *Rohan* established much faster, providing valuable feed through to late spring. But once the dry summer hit, the deep-rooting *Redefine* outperformed the ryegrass.

Comparative seasonal yield over first year of dryland



** Statistical significance lettering is above bars of graph at LSD 5% level. Yields with the same letter are not significantly different.*

Sowing *Redefine*

Want some contribution from *Refine* through a pasture?	Want a strong *Refine* contribution to a pasture?	For a cocksfoot-based pasture.
Redefine 3 kg/ha in pasture mix with ryegrass, white clover etc.	*Redefine* 6 kg/ha in pasture mix with ryegrass, clover etc.	*Redefine* 8-10 kg/ha with white & sub clovers etc.

Redefine strengthens pasture.

Tall fescue

Introduction

Tall fescue *(Festuca arundinacea)* suits some situations but not others. It is more tolerant of hot summers and poorly drained soils than perennial ryegrass. It is sensitive to soil temperature; sow when soil temperatures are above 12°C. It is slower to establish than ryegrass; make sure you have a good weed free seedbed.

In recent years, with the development of new ryegrass endophytes, tall fescue has become less popular.

In NZ it is mainly sown in dry areas for summer growth and good clover content, performing best on clay soils, where its deeper rooting ability can utilise more soil moisture than ryegrass. It requires different pasture management than ryegrass, and this has been its main limitation in NZ. It needs to be grazed at the correct time in spring, more frequently than ryegrass, to prevent loss of feed quality.

Tall fescue performs best under cattle grazing and can struggle to persist well under sheep grazing, where pastures are grazed very short during periods of set stocking.

Tall fescue cultivars

Grasslands Hummer

Soft, fine leaved, and early heading. *Hummer* has maintained persistence with improved palatability and grazing management. Available with *MaxP* endophyte.

Grasslands Haven

Early heading, soft and fine leaved. High annual dry matter production, with improved autumn and winter growth. Available with *MaxP* endophyte.

Grasslands Oakdon

Palatable late heading meadow fescue with strong mid spring - late summer growth. Suited to legume finishing pastures and in tall fescue mixes to improve palatability.

Nouga

Oceanic type with softer leaves, making it more palatable and providing easier grazing management.

Quantica

Soft, high yielding, finely leaved variety selected for improved animal palatability and rust resistance. Available with *MaxP* endophyte.

Diverse pasture mixes

Introduction

Pastures containing many different species have become more popular with Regenerative Agriculture. There is little science behind many mixes, and they typically lose diversity over time. Our *Diverse Pasture Premix* (see next page) contains known cultivars for those who wish to try one.

Co-existence & functionality

Multi-species pastures have been studied and grown in New Zealand for decades. We have learned much about which species grow best together. Lincoln University research shows regardless of how many species are sown, grazing decreases diversity, and no more than 3 functional groups will end up comprising +90% of species present, namely grass, clover and herbs.

Ryegrass and white clover remain the two most widely sown permanent pasture species in NZ. Ryegrass has proven to be a highly efficient photosynthesiser across most of NZ. Its growth habit, productivity, and grazing tolerance allow it to thrive in a range of climatic conditions and livestock systems.

Research has repeatedly demonstrated white clover adds significant value to our grazed systems, improving animal nutrition and overall pasture growth and capturing atmospheric nitrogen.

Even this widely used two-species mix requires careful management to maintain both productivity and sustainability. Every time another species is added to the pasture mix the level of complexity increases, and it may need different (and in many cases incompatible) management as the grazing tolerance and persistence of species varies hugely.

Varying management needs for species

Species	Grazing tolerance	Persistence
Perennial ryegrass	High	High
White clover	High	High
Cocksfoot	High	High
Timothy	High	High
Pasture brome	High	High
Phalaris	High	High
Plantain	High	Medium
Chicory	High	Low-Medium
Yarrow	Medium	Medium
Prairie grass	Medium	Medium
Red clover	Medium	Medium
Vetch	Medium	Low
Persian clover	Medium	Low
Cereal	Medium	Low
Buck wheat	Medium	Low
Brassica (e.g. kale, turnip)	Low-medium	Low
Phacelia	Low	Low
Sunflower	Low	Low
Borage	Low	Low

Diverse Pasture Premix

Diverse Pasture Premix

We produce a pre-mix detailed below, for sowing at 36 kg/ha. It comes in 25 kg bags to sow at 1.4 bags/ha, and is available in either treated or bare seed.

The *Diverse Pasture Premix* combines high yielding *Maxsyn NEA4* perennial ryegrass with the persistence of *Rohan SPR* perennial ryegrass. *Redefine* cocksfoot, *Bareno* grazing brome and timothy add diversity, while *Tabu+* gives greater cool season production. *Captain* plantain and *501 Chicory* supply pasture herbs, a lower N footprint, and in the case of *501* a deep taproot. *Kotuku* large leaved and *Ruru* medium leaved white clovers, and *Morrow* red clover have different growth habits, high feed quality advantages, and nitrogen fixation. *Laser* Persian clover and *Coolamon* sub clover are annual clovers to improve feed quality from late spring into summer and will reseed if managed correctly.

What's in a bag

Dairy, Sheep, Beef	kg/bag
Maxsyn NEA4 perennial ryegrass	5
Redefine superfine cocksfoot	3
Rohan NEA2 perennial ryegrass	2
Timothy	1
Bareno pasture brome	3
Tabu+ Italian ryegrass	2
Kotuku white clover	1
Ruru white clover	1
Morrow red clover	3
Laser Persian clover	1
Coolamon sub clover	1
501 Chicory	1
Captain CSP plantain	1
Total	**25kg**

**Mix may vary depending on availability of species*

Practicalities

Your herbicide options are limited with this mix, so choose your paddock carefully to be free of problem weeds. Good seed bed preparation and weed control before sowing are essential. There are no specific requirements for soil nutrient levels, but a good base nutrient status will help all species perform.

Clover & herb cultivars

White clover	42
Red clover	50
Annual clovers	53
Chicory	59
Plantain	62

501 Chicory

White clover

Introduction

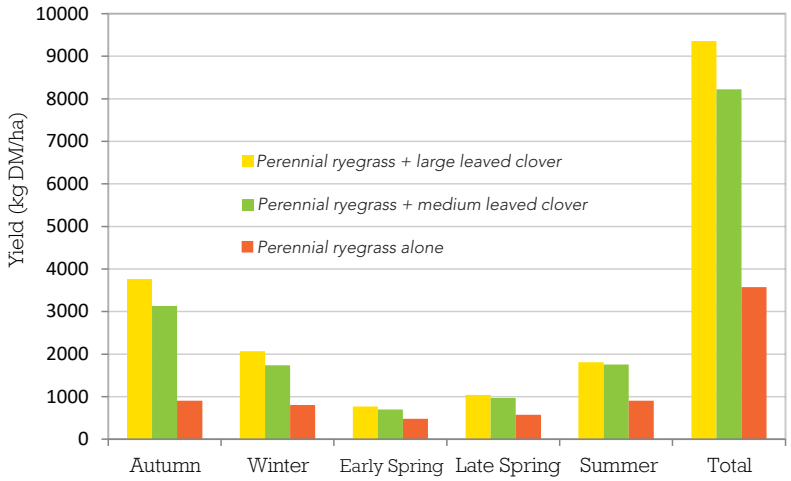
White clover (*Trifolium repens*) is the hero of our clover-based pastoral sector. Managed well, it is a loyal, beneficial companion for grasses, and nourishes animals year-round.

Animals love white clover (and other legumes), so the more you have in your pasture, the better their intake and performance. Clover also fixes atmospheric nitrogen for free.

Manage white clover the same as ryegrass – graze when ryegrass has 2.5 – 3 leaves, and maintain consistent post-grazing residuals so sunlight reaches clover at the base of the sward.

How much difference does white clover make to our pastures? This graph tells the story. Check out the yields for perennial ryegrass sown with large or medium clover compared to sown without. Not only does the clover contribute its own dry matter yield to the total, its nitrogen fixation helps the ryegrass grow more. That adds up to an extra 4.4-5.4 tonnes of DM yield, per hectare!

Synergy in action



Trial run at Courteney, Canterbury. Ryegrass sown at 20 kg/ha & clover at 4 kg/ha.

Leaf size vs stolon density

White clovers uses stolons to grow and multiply. Smaller leaf size generally means more stolons, which in turn mean better persistence in tough conditions. Larger leaf size leads to higher clover DM production. Always select the right clover for your situation – as a rule, larger leaved for cattle, smaller leaved for sheep. Mixing two different types can be a good option.

Free N & nutrient requirements

White clover fixes atmospheric nitrogen at approximately 25 kg N/tonne of clover DM growth. Established clover will share this with the pasture around it. White clover prefers soils low in nitrogen. Too much nitrogen encourages aggressive ryegrass growth at clover's expense. It also makes clovers too lazy to fix their own, which can lead to a die off in year 2. Clover needs 16 nutrients to survive, and will reveal soil nutrient deficiencies sooner than ryegrass. Soil test before sowing, and herbage test plants that are discoloured or growing poorly.

Phosphorus (P) is essential for nitrogen fixation, as the process requires a lot of energy. Potassium (K), sulphur (S), and magnesium (Mg) and molybdenum (Mo) along with an optimal soil pH of 6.0 – 6.5 are also recommended.

White clover cultivars

Large leaved cultivars
(For rotational dairy, beef or silage systems)

Kotuku	*Kotuku* is a high performance large leaved clover for dairy, beef and finishing systems. It provides significantly more summer and total yield. Fast establishment makes *Kotuku* ideal for oversowing clover. (Refer also to page 46).
AberNormous	Large leaved clover, providing high yields for dairy or beef systems.
Grasslands Brace	Large leaved, with high production and good cool season growth. Ideal for dairy, beef, lamb finishing and silage production.
Grasslands Mainstay	High yielding large leaved white clover with relatively high stolon density and persistence. Suited to dairy and rotationally grazed sheep and beef pastures.
Grasslands Legacy	High yielding large leaved white clover selected for performance in modern grazing systems. Suited to dairy or rotational grazing.
Mantra	A mid flowering white clover offering high yields, stolon density and stolon length.

Kotuku white clover was bred for faster establishment and superior growth.

White clover cultivars

Medium leaved cultivars
(For all grazing systems)

Ruru	*Ruru* is a new aggressive growing medium leaved white clover which replaces *Weka*. It grows extra dry matter in summer, with high stolon density, to provide even better animal nutrition and fix more nitrogen. (Refer also to page 48).
AberDance	Medium leaved white clover, flexible and persistent under a range of systems.
Grasslands Attribute	Medium-large leaved clover with high yield potential under a wide range of grazing managements.
Grasslands Demand	Bred in Southland. Small to medium leaved cultivar with high stolon density and good summer growth. Best suited for sheep and beef.
Grasslands Emblem	Medium leaved white clover bred for increased stolon recovery and productivity under intensive grazing systems.
Grasslands Quartz	A high yielding medium leaved white clover bred for persistence and adaptability across a range of farming systems; replacement for *Grasslands Bounty*.
Grasslands Tribute	Versatile, medium-large leaved white clover, with a high stolon density to leaf size ratio.
Quest	Medium-large leaved clover suitable for multi-purpose use.

Medium-small leaved cultivars
(For set stocking & extensive systems)

Apex	*Apex* is a persistent, high yielding clover. It has a high stolon density, very good drought tolerance, resistance to leaf rust, pepper spot and clover rot, and has good clover root weevil tolerance. In sheep grazing trials *Apex* out-yielded *Huia* by 27%, with better growth in all seasons. (Refer also to page 45).
AberLasting	Hybrid Caucasian and white clover cross, with stolons above ground and rhizomes below ground. Drought and cold tolerant with nitrogen fixation comparable to white clover.
Grasslands Nomad	Small to medium-leaved white clover bred for increased stolon recovery after summer dry.
Grasslands Hilltop	A small to medium-leaved white clover with high stolon density, bred for competitiveness in a pasture.

Apex white clover

Apex is a robust, persistent clover, bred to withstand hard grazing, summer dry conditions, and clover root weevil.

Medium-small leaf size

Apex has a medium-small leaf, with many more stolon growing points than traditional cultivars like _Huia_, for improved growth, and drought and pest tolerance.

Good persistence

A key feature of _Apex_ is improved persistence. A Waikato grazing trial showed excellent persistence into its fourth year, with the highest fourth year yields.

High yield

Why grow _Huia_ when _Apex_ outyields it by 56% in winter, 39% in spring and 27% in autumn?

Yield in three Manawatu sheep grazing trials (_Huia_ = 100)*

Cultivar	Winter	Spring	Summer	Autumn
Apex	156 a	139 a	108 a	127 a
Huia	100 b	100 b	100 a	100 b
LSD (5%)	22	18	15	18

** Woodfield et al. NZ Grassland Association 63: 103-108*

Spreading growth

Apex spreads strongly across bare ground, boosting legume content in your pasture.

Sowing _Apex_

Sheep, Beef, Deer		kg/ha
For more clover in drier or tougher grazing systems	Perennial ryegrass (e.g. _Rohan_)	18-20
	Redefine cocksfoot	3-6
	Apex white clover	2
	Ruru white clover	2
	Total	25-30

Apex White Clover is marketed by Barenbrug, & protected under the NZ Plant Variety Rights Act
Apex was bred under a cooperative programme with AgResearch Grasslands

Kotuku white clover

Kotuku is a very fast establishing, nutritious, high yielding large leaved white clover with superior summer growth.

Why *Kotuku?*

White clover is critical for feed value and nitrogen fixation in pastures. It is also a key source of protein and energy for milking and growing stock, particularly in summer. *Kotuku* has excellent seasonal growth, and outperforms all other trialled cultivars over the critical summer period.

High yield

This mixed sward trial included one entry without clover. The effect of clover on nitrogen fixation and yield is clear, with *Kotuku* showing particularly good yield.

Seasonal DM yield data 2013-2016, Courtenay, Canterbury. Trial mean = 100.

Entry	Autumn	Winter	Early spring	Late spring	Summer	Total
Kotuku	117 a	107 bc	107 ab	109 a	121 a	114 a
Kopu II	114 a	115 a	112 a	109 a	110 b	111 ab
Kotare	105 bc	106 c	108 a	111 a	108 bc	106 bc
Tribute	102 bc	105 c	109 a	107 ab	102 bd	105 c
SF Quest	106 b	114 ab	111 a	105 ac	98 d	104 cd
Mainstay	110 ab	101 cd	100 c	99 bd	102 bd	102 cd
Weka	99 cd	97 de	100 bc	106 ac	101 cd	100 de
Bounty	94 de	88 f	92 d	97 cd	102 cd	97 e
Huia	88 e	91 ef	92 d	95 d	97 d	95 e
No clover	46 f	67 g	59 e	55 e	29 e	44 f
Trial mean (kg DM/ha)	1765	721	970	1659	3101	8509
Significance	***	***	***	***	***	***

**Data from Courtenay, Canterbury, 2013-2016. Statistical significance lettering is given, yields with the same letter are not significantly different at the 5% LSD level.*

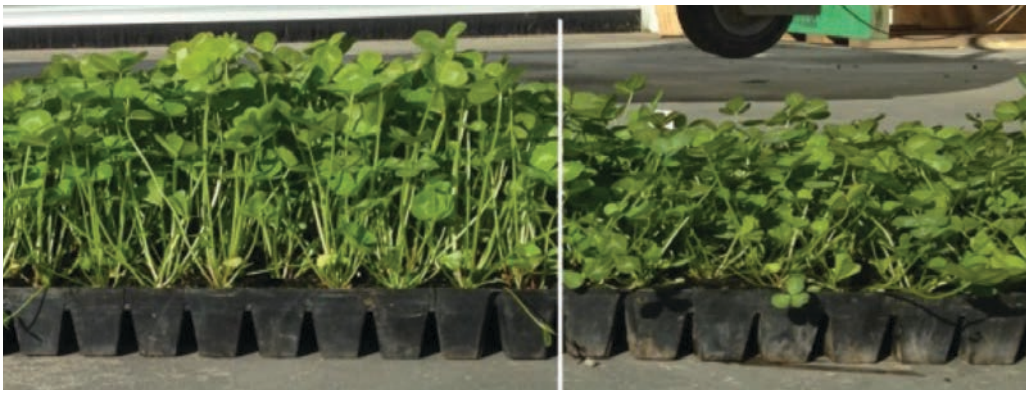
High-yielding Kotuku fuels both dairy and red meat finishing systems.

Jumps out of the ground

Kotuku jumps out of the ground quicker than many clovers. That helps it compete with fast-establishing ryegrass, and makes it easier to plan broadleaf weed control in new pasture. Weeds are best treated when small, but new clovers must have 3-4 trifoliate leaves before spraying, so the faster your young plants reach this stage, the better your herbicide results.

Oversowing advantage

Oversowing existing pastures with clover can add more clover to your system. Because it gets going so much faster than other clovers, *Kotuku* competes better with existing pasture and is perfect for oversowing.



Establishment speed of Kotuku (left) versus Mainstay.

Persistence

Kotuku has demonstrated robust persistence for a large leaved cultivar, and has a medium stolon density. This drives summer production in dairy and dry stock finishing systems.

Sowing *Kotuku*

Dairy		kg/ha
Top performing dairy pasture	*Maxsyn* or *Array* perennial ryegrass	18-22
	Kotuku white clover	2
	Ruru white clover	2
	Total	22-26
Sheep, Beef, Deer		**kg/ha**
For high palatability tetraploid finishing pasture	*4front* perennial ryegrass	30
	Kotuku white clover	2
	Ruru white clover	2
	Morrow MS red clover	6
	Total	40

Ruru white clover

Lusher, better, stronger. The new medium leaved white clover delivering more energy and protein in summer, plus extra nitrogen fixation too.

What makes it special?

Ruru is our upgraded replacement for *Weka*. It is similar in type, with more aggressive growth and higher year-round yield, particularly in summer.

System fit

All systems will benefit from *Ruru* - dairy, cattle, sheep and deer.

More free nitrogen

Higher yield means more free nitrogen for your farm, so you can save on fertiliser costs and lighten your footprint. *Ruru* grows enough extra to give you up to 14 kg nitrogen/ha/year more than some other similar clovers (based on a fixation rate of 28 kg nitrogen/ha per tonne of clover[1]).

Treat animals in summer

Plenty of clover in summer keeps animals happy and productive. *Ruru* flourishes in warm weather, guaranteeing more energy and protein when grass is not always at its best.

Spot the difference! Ruru in mid January (right) is notably ahead of Weka (left), even though both were sown in Canterbury at the same time, with the same ryegrass, and managed identically.

[1]Lucas, R. J., Smith, M., Jarvis, P., Mills, A., & Moot, D. J. (2010). Nitrogen fixation by subterranean and white clovers in dryland cocksfoot pastures. *New Zealand Grassland Association.*

Shines in summer

Combined yields over two trials at Courtenay, Canterbury*

Entry	Autumn	Winter	Early spring	Late spring	Summer	Annual
Ruru	**1584**	**648 b**	**1675**	**3286 a**	**3934 a**	**11625 a**
Weka	1586	659 b	1663	3183 b	3752 b	11479 ab
Tribute	1585	748 a	1665	3076 c	3622 b	11152 b
Mean (kg DM/ha)	1577	673	1638	3101	3739	11180
Significance	ns	***	ns	***	***	***

** Combined yields of two replicated, pure sward clover trials run 2016-19 and 2017-2018.*

Lasts in the pasture

Bred for high grazing tolerance, strong spreading growth and good tolerance of clover root weevil, *Ruru* is a stayer, not a sprinter.

Sowing *Ruru*

Dairy and cattle systems		kg/ha
Top cattle clover combination	Perennial ryegrass	18-30
	Ruru medium leaved white clover	2
	Kotuku large leaved white clover	2
	Total	22-34
Sheep and deer systems		**kg/ha**
Top sheep and deer combination	Perennial ryegrass	18-30
	Ruru medium leaved white clover	2
	Apex small leaved white clover	2
	Total	22-34

Ruru white clover spreads strongly.

Red clover

Introduction

Tap rooted, energy-rich red clover (*Trifolium pratense*) has good summer growth and drought tolerance, but little winter growth. It's happiest on free draining soils under moderate stocking rates, long summer grazing rotations or hay production. High stocking rates or fast summer grazing rotations shorten its life.

Red clover is commonly sown to boost summer growth and feed quality in summer dry perennial pastures. It does not have spreading stolons, so plant population is important. Sow diploids at 4 kg/ha of bare seed or 6 kg/ha coated seed; tetraploids at 6 kg/ha bare or 8 kg/ha coated seed.

Red clovers contain phyto-oestrogens so take care feeding them to breeding animals during mating. This mainly applies in late summer when the plants are flowering. Phyto-oestrogen levels vary with time and also between red clover cultivars. Newer options have lower levels.

N fixation

Red clover fixes atmospheric nitrogen at the level of about 25 kg N/tonne of clover DM yield, unless you apply nitrogen fertiliser, in which case it gets lazy and uses that instead.

Cultivar descriptions

Morrow MS	*Morrow* multi-stemmed (MS) clover's high stem number gives improved grazing tolerance, and a deep tap root delivers high summer-autumn yield. *Morrow* has low-medium phyto-oestrogen levels. (Refer also to page 51).
AberClaret	Bred for increased persistence, yields well under grazing and conservation. Semi-upright growth habit.
Amigain	NZ bred clover, selected for persistence in both pasture mixes and pure stands. Lower phyto-oestrogen levels than older varieties.
Grasslands Pawera (T)	A late flowering, erect, tetraploid suited to rotational grazing. Has good summer-autumn growth but little winter growth. Contains high phyto-oestrogen levels.
Grasslands Relish	Early flowering, semi prostrate red clover bred for high yield, improved persistence under grazing, and low phyto-oestrogen content.
Reaper	High yielding, large leaved, semi-erect growing diploid red clover which is suitable for grazing and for hay and silage.
Rossi	Red clover bred for persistence and disease tolerance.

Morrow MS red clover

Grow. Graze. Repeat. *Morrow* multi-stemmed (MS) red clover brings better grazing tolerance to NZ farmers, plus high yield in summer and autumn.

Great pedigree

Morrow comes from a tough family. Most red clovers wouldn't last long under intensive rotational dairy grazing on light, upper North Island soils. But *Morrow's* parents did, growing well, even after repeated droughts.

We took plants from these pastures, and selected the best of them for high yield, persistence and flowering to create a multi-stemmed red clover with improved production and persistence under grazing.

Longevity

Red clover's biggest drawback has always been limited persistence under grazing. *Morrow's* improved grazing tolerance – helped by its high stem count and semi-prostrate form – means it keeps animals happy year on year. Like all red clovers, it persists best on free-draining soils under a longer summer grazing round.

Quality + yield when it counts

High energy and high yield together create ideal late spring and summer finishing feed, giving great quality as grass energy levels drop, and driving rapid liveweight gains for lambs and cattle.

Red clover seasonal yield in dryland Canterbury*

Entry	Early spring		Late spring		Summer		Autumn		Winter		Total yield	
Morrow	6.4	a	7.0	a	7.4	a	7.7	a	5.4	a	6.8	a
Tuscan	6.1	ab	6.7	a	5.5	b	6.0	ab	6.1	a	6.1	ab
Rossi	5.2	ac	5.7	ab	5.3	bc	6.3	ab	5.5	a	5.5	b
Relish	4.3	c	4.3	b	3.7	c	5.3	b	3.0	b	4.0	c
Trial mean	4.9		5.6		5.4		5.8		4.4		5.3	
%CV	20.1		18.0		16.5		18.4		21.3		12.8	

**Data from 2 years of pure sward trial, grazed by sheep. Trial sown 2016. Yield visually scored on 1-9 basis, where 9 = highest yield.*

Heads down - excellent summer yield and feed quality make Morrow ideal for finishing.

Morrow MS red clover (cont.)

CRW tolerance

Red clover is less bothered than white clover by clover root weevil. Sow *Morrow* and you get more diverse pastures with strong legume content.

Free N

Red clover naturally fixes its own nitrogen. Based on its yield, *Morrow* can fix over 200 kg N/ha, or about about 25 kg/N per tonne of dry matter grown.

Phyto-oestrogen levels

Morrow has low-medium phtyo-oestrogen levels. Even so, take care with ewes or hoggets 3-6 weeks either side of mating. High red clover intake at this time is best avoided.

Sowing *Morrow*

All systems		kg/ha
Productive, persistent clover combination	Perennial ryegrass	18-30
	Morrow red clover	6
	Kotuku or *Ruru* white clover	4
	Total	28-40
Sheep, Beef, Deer		**kg/ha**
Two year high LWG finishing crop	*Captain CS* plantain	10
	Laser Persian clover	4
	Morrow MS red clover	6
	Ruru white clover	4
	Total	24
Tetraploid perennial ryegrass - finishing		**kg/ha**
Fantastic feed quality and animal performance	*4front* tetraploid perennial ryegrass	24
	Ruru white clover	2
	Apex white clover	2
	Morrow MS red clover	6
	Captain CS plantain	2-4
	Total	36-38

Annual clovers

Introduction

Annual clovers are a broad category of *Trifolium* species often used instead of white or red clover for their superior early season growth, and/or ability to survive extended dry periods as seed and regenerate. Sown as pure swards or in pasture mixes, these species vary widely in growth habit, seasonal yield and preferred conditions. But all support good animal performance with high value standing or conserved feed.

Characteristics

Annual clovers can be characterised by their seeding habit. If allowed, 'aerial flowering' cultivars set their seed on stems above ground (e.g. arrowleaf, balansa and Persian clovers); subterranean clovers bury their seed in the ground after flowering (see page 56).

All these clovers are very palatable, with high energy and protein making them ideal for growing and finishing animals. They fit well into dryland farm systems where their extra early spring growth helps feed animals before the onset of dry summers, or as an addition to short-term pastures to boost legume content and drive weight gain or milk production.

Typically, annual clovers are sown in autumn, establish before winter, and provide good cool season growth through spring. Persian and arrowleaf clovers can also be spring-sown in summer moist areas to provide 12 months of high quality feed.

Annual clover with Hogan annual ryegrass in North Canterbury, early November.

In some systems paddocks of sub clover are carefully managed to set seed in early summer, allowing seed to survive in the soil before regenerating again the following autumn. This limits grazing during the first spring, but enhances persistence.

All species and cultivars have differing levels of 'hard seed'. This is seed that will not germinate straight away, but rather remains in the soil and germinates over the following 5+ years. Where annual clovers are left to set seed, hard seed helps them persist.

Annual clovers (cont.)

Arrowleaf clover

Arrowleaf clover (*T. vesiclosum*) is the only tap-rooted annual clover. Roots can reach 1.5 m deep, fueling good summer yield. It can be part of a high energy finishing mix for grazing or sown for feed conservation. Bloat risk in sheep and cattle is low. Arrowleaf also shows promise as an extensive hill country legume where it is allowed to reseed for persistence.

Balansa clover

Balansa clover (*T. michelianum*) is a semi-erect, hollow stemmed, well branched annual clover which can produce large volumes of spring feed. It likes summer dry climates with annual rainfall of 350-800 mm, but also tolerates waterlogging and mildly acidic soils.

Persian clover

Persian clover (*T. resupinatum*) is semi-erect and hollow stemmed. It provides high quality bulk feed from late winter to early summer. It is mostly used as an annual crop with grass, or in a finishing mix. Persian clover tolerates mild soil salinity and some waterlogging.

System fit

Annual clovers can be used as part of a high energy, 10-24 month finishing pasture, where they are grazed and not allowed to reseed. Alternatively, they can be used in permanent dryland pastures where re-seeding is required and needs to be sustained through good management.

10 month crop

Sown in autumn, annual clovers have limited winter growth, and adding an annual or Italian ryegrass will greatly increase this. This system mainly provides quality grazing through spring until early summer.

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Winter feed				High quality spring feed for grazing or for hay/silage				Maturity	Drill next crop	

12–24 month finishing pasture

These high legume pastures drive high liveweight gains. Autumn sow annual clovers with other species (e.g. plantain, red clover, white clover). Annual clovers provide most yield in the first 9-10 months; red and white clover after that.

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Small amount of winter feed				High quality spring feed for finishing				Annual clover matures, white and red clovers drive production		

Hill country permanent pasture

Hard seeded sub and arrowleaf clover can be a persistent legumes. As annuals they must be managed to set seed.

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Small amount of winter feed			Graze during late winter/early spring		Spell for reseeding		Low quality summer feed		Hard graze	Seed germination

Sowing

Drill no more than 10 mm deep. For best results, limit competition by not sowing clover and ryegrass together in the same drill rows. Oversow hill country, preferably in wet conditions so seed is trampled in by animals immediately afterwards. This can really improve your result.

Grazing

In finishing crops, rotationally graze or set stock animals to utilise the very high-quality feed on offer through spring into summer. Rotationally graze 18-24 month crops through summer.

Need your clovers to reseed? Don't graze from flowering through to the set of viable seed. Then hard graze to a residual of 700-1000 kg DM/ha late the following summer. This creates space for newly germinating seedlings to find their feet and get cranking in autumn.

After a good strike, spell the paddock until those seedlings have developed at least four trifoliate leaves before giving the paddock a short, sharp graze. Follow that with normal grazing.

Free N

Annual clovers grow more feed than white or red clovers during late autumn and spring period, and in turn will fix more nitrogen during this time, providing free fertility for your next crop.

You can see an example of this below in a 6-week oat crop. Before oats were sown, this paddock was sown with demonstration strips of annual clovers, except in the N deficient strip seen.

N-deficient soil in strip where annual clovers were not sown in the previous year is clearly visible.

Subterranean clover

Introduction

Subterranean (sub) clover is the most widely sown annual legume in summer dry areas of New Zealand. It is normally mixed with grasses and white clover on hill country, and grows well on drier areas, slopes and soils.

Characteristics

Three different species are available:

- *Trifolium subterraneum*: most widely sown; black seeded; suits soils with pH ≥ 5.6 in low-medium rainfall areas.
- *T. yanninicum:* white seeded: best for waterlogged soils with reasonable fertility and pH (5.8-6.2).
- *T. brachycalycinum*: adapted to alkaline soils but new cultivars will grow in neutral to mildly acidic soils (pH ≥ 5.8).

Sub clover yields more in early spring than white or red clover, because it has a lower optimum temperature for growth, and can get going a month earlier.

As an annual, it must survive year to year by setting seed in late spring and early summer. Seeds germinate with rain in late summer and autumn, but seedlings can sometimes die during subsequent dry spells (known as a false strike). The amount of hard seed produced by a cultivar affects its ability to survive. Correct grazing management is vital for persistence.

Barenbrug sub clover trial.

Management

Sow sub clover in autumn at 12 kg/ha, because of its large seed size. You can oversow, but drilling 5-10 mm gives better soil to seed contact. You may need to inoculate seed with rhizobium bacteria if annual clovers are scarce in the area. Sub clovers need their own unique rhizobium.

In year 1, lightly graze paddocks, then rest them during flowering in late spring, to allow seed set (repeat this process about every 5 years).

In early autumn, graze pastures hard, to 700-1000 kg DM/ha. This creates space for sub clover seedlings to regenerate. After a good strike, spell the paddock until seedlings have developed at least four trifoliate leaves.

Zulu II arrowleaf clover

Zulu II **annual clover is a high energy legume for finishing animals or making silage from early spring through into summer. Where managed to reseed and regenerate, it also shows great potential to get nitrogen into hill country pastures.**

Yield + quality

Zulu II can transform low-yielding dry paddocks into palatable, productive pastures growing over 10 t DM/ha, with highest growth rates through spring and early summer. Feed value is excellent, with less risk of bloat than other annual clovers.

System fit

Sow *Zulu II* in autumn as a finishing crop, or as a persistent legume in hill country pasture where it is allowed to set seed in summer, to germinate in the subsequent autumns. It has a high level of hard seed which persists in the soil for many years. *Zulu II* also partners well with spring sown chicory, feeding nitrogen into this summer crop.

Management

If sown with chicory, graze the crop according to best practice for the chicory. For persistence in hill country *Zulu II* must be managed carefully to allow reseeding in the first year. Don't graze these paddocks during flowering. After seed set, remove plant residues in late summer to open up the pasture and promote better seedling regeneration in autumn. *Zulu II* tolerates moderately acidic soils. Sow treated seed.

Sowing *Zulu II*

Dairy		kg/ha
Chicory/annual clover crop	*501 Chicory* *Zulu II* arrowleaf clover	8 8
	Total	16
Sheep, Beef, Deer		
8-10 month pure clover sward (manage to reseed & build soil N)	*Zulu II* arrowleaf clover	10
Hill country oversow mix	*Redefine* cocksfoot *Ruru* white clover *Apex* white clover Sub clover *Zulu II* arrowleaf clover	8 2 2 6 4
	Total	22

High-yielding Zulu II tastes great and yields well, with excellent feed value.

Laser Persian clover

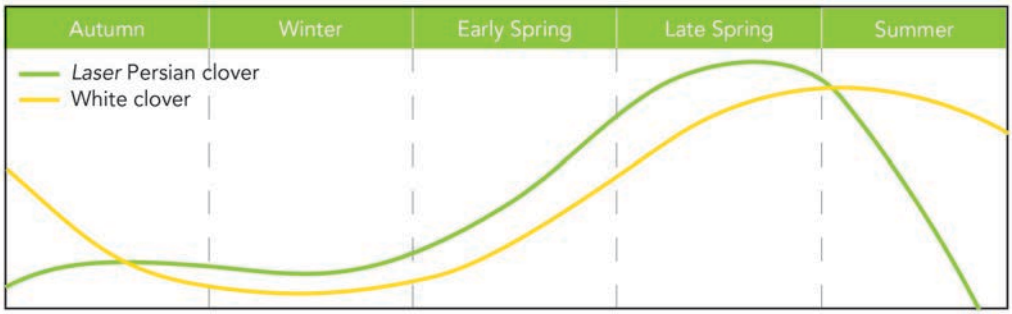
Laser annual clover is fast establishing, and produces high-quality feed from winter through early summer, for improved animal production and finishing, or silage/hay.

Later growth

Laser has a different growth curve to _Zulu II_, flowering 30 days later, and extending growth into summer.

System fit

On dairy farms, add _Laser_ to short-term pastures to improve feed quality, and extend feed supply and animal production first in autumn, then from early spring to early summer. For sheep and beef, use it to increase feed quality and accelerate liveweight gains. _Laser_ also suits hay/silage making. It establishes faster than white clover, and yields much more over 8-10 months



Management

Graze down to residuals of 2-3 cm during winter. In spring, rotationally graze to residuals of 4-5 cm to maximise animal performance, and pasture regrowth. Avoid over grazing, which removes developing stems.

Conditions

Laser can tolerate mild salinity, cold temperatures and partially waterlogged soils. Slugs and springtails are a risk during establishment. Use treated seed, slug bait if needed, and include an insecticide at spray out. _Laser_ resists clover scorch.

Sowing _Laser_

Dairy		kg/ha
12-18 month high performance crop	_Tabu+_ Italian ryegrass _Laser_ Persian clover _Morrow MS_ red clover	16-18 4 6
	Total	26-28
6-8 month winter crop	_Hogan_ annual ryegrass _Laser_ Persian clover	22 4
	Total	26
Sheep, Beef, Deer		
8-10 month pure finishing sward	_Laser_ Persian clover	10
Two year finishing crop	_Captain CS_ plantain _Laser_ Persian clover _Zulu II_ arrowleaf clover _Morrow MS_ red clover _Ruru_ white clover	10 4 3 6 4
	Total	27

Chicory

Introduction

Chicory *(Cichorium intybus)* is a short-lived, tap-rooted herb. It produces very palatable, high ME, high protein feed in summer and autumn. It can yield well in dry summer conditions, but has little winter growth.

Chicory is typically used in three ways:

- By dairy farmers in summer dry areas, particularly in the North Island, as a 6-7 month multi-graze crop to drive summer milk production. It is seldom kept for a second summer, as it sends up large seed stems and loses quality.
- By red meat farmers as a 6-30 month crop for high summer liveweight gains. In these cases, it is often mixed with red and white clovers.
- In permanent pasture mixes to enhance summer feed quality in the first year. This may not work where some broadleaf herbicides are used (e.g. for thistle control).

Chicory can mitigate nitrogen leaching. It has a high water content which dilutes the nitrogen concentration of urine, so reducing the nitrogen loading onto the soil.

Chicory cultivars

501 Chicory	A high quality multi graze summer crop. *501* establishes very rapidly, has excellent DM yield with very good insect tolerance and can be sown alone, or mixed with *Morrow* red clover. (Refer also to page 60).
Chico	Upright cultivar selected for improved winter activity.
Grasslands Choice	New Zealand bred cultivar selected for improved establishment vigour and persistence.
Grasslands Puna II	A broad-leaved chicory bred for increased persistence and *sclerotinia* tolerance.
Punter	Cultivar with strong summer and autumn growth.
Sika	Suited to a variety of farm systems, including: short-term summer fed crop, a multi-year specialist crop or as a component of pasture mixes.

501 Chicory provides high ME, high protein summer feed.

501 Chicory

501 Chicory is a fast establishing annual, growing extra feed over the critical first two grazings. It's a high energy, 6-8 month summer crop, with excellent utilisation and reduced parasite challenge

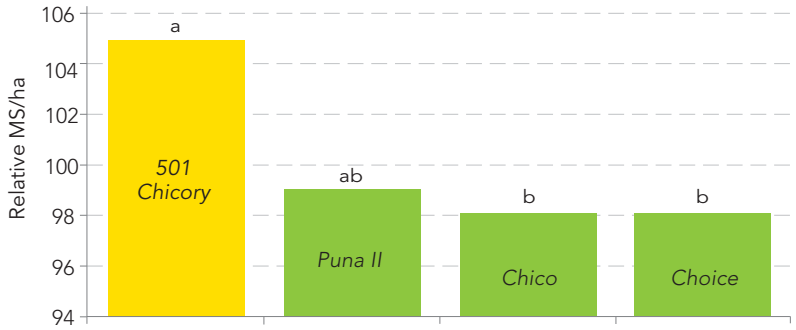
Rapid establishment

501 Chicory establishes very quickly, meaning less down time before the first grazing. In trials and on-farm across many different soil types, _501 Chicory_ growth has stood out right from the start, particularly in dry conditions.

Excellent DM yield

501 Chicory's extra yield is predicted to produce an extra 7% kg MS, giving an additional income of $400/ha (based on $8/kg MS) over some other chicories.

Modelled Chicory MS production (Relative to trial mean = 100).



Data based on yield info from the combined trial analysis of Cambridge 11-12, and Canterbury 12-13. 2 trial lines have been removed from the graph. Assumptions used were: ME of chicory is 12 MJ ME/kg DM and 132 MJ ME to produce 1kg MS.

Clean feed for young animals

501 Chicory help manage parasites in young animals. Its open, upright habit greatly reduces worm numbers, and it puts weight on finishing stock faster, so you can quit them sooner. That means fewer drenches, and less exposure to parasites.

Advantage of _501 + Morrow_

The combination of _501 + Morrow_ red clover or _501 + Zulu II_ arrowleaf clover performs well. Like _501_, these clovers are deep rooted giving them a big advantage in summer dry conditions. They also fix nitrogen, reducing fertiliser requirements for both the crop, and subsequent pasture.

High ME

Animals love chicory, red clover and arrowleaf clover, and they are very nutritious. During dry summers, they maintain an ME of around 12, whereas ryegrass pastures generally are down around 9-10.5.

Management

Sow chicory into a fine, weed-free seed bed when soil temperatures are consistently +12°C in spring. Roll before and after sowing for uniform germination. Graze when plants reach seven leaves. Targets for grazing are:

- Pre-grazing targets: 3000 kg DM/ha or 25-35 cm height.
- Post-grazing residual target: 5 cm.

Environmental gains

501 Chicory offers several valuable benefits:

- It reduces nitrogen in the urine patch the same way plantain does. Research shows cows grazing chicory have substantially lower urinary N concentrations, even more than those recorded for cows grazing plantain;
- Its deep tap root (up to 1.5 m) improves soil structure;
- It mines deep soil N and can recover excess soil N left after winter-grazed crops;
- It doesn't need insecticide sprays (unlike brassica crops);
- Facial eczema spores and worm numbers are much lower than on ryegrass pastures.

How many ha?

For dairy farms, sow 3 ha of *501 Chicory* per 100 cows to provide 3 kg DM of chicory/cow/day. Use this table to calculate how much to sow.

Chicory/cow to be fed	Area of chicory to sow	Daily area of chicory*
2 kg DM/day	2 ha/100 cows	0.1 ha/100 cows
3 kg DM/day	3 ha/100 cows	0.15 ha/100 cows
4 kg DM/day	4 ha/100 cows	0.2 ha/100 cows

**Assuming 21 day grazing rotation.*

When to resow pasture

501 Chicory will look great going into autumn. Don't be tempted to keep grazing it! Establishing your new pasture early is much more important.

Sowing *501 Chicory*

Use		kg/ha
For a chicory crop	*501 Chicory*	8-10
	Total	8-10
Chicory/red clover crop	*501 Chicory* *Morrow MS* red clover	6-8 4
	Total	10-12
Chicory/annual clover crop	*501 Chicory* *Zulu II* arrowleaf clover	8 8
	Total	16

Plantain

Introduction

Plantain (*Plantago lanceolata*) has branched, deep roots and good drought tolerance. It is usually sown with grasses and legumes, but can be oversown onto thin pastures in spring. Cultivars vary widely in their winter growth, from active to dormant types.

Plantain can improve animal intake in dry summer months when grass quality is low. But in autumn plantain can be less palatable.

A high percentage of plantain (≥30%) in the diet has been shown to increase animal water intake, dilute urine and so reduce nitrogen leaching compared to a diploid perennial ryegrass diet. But most farmers have struggled to achieve the level of plantain required to make a significant difference.

While plantain has a potential nitrogen mitigation advantage over diploid perennial ryegrass, this should be balanced against its poorer persistence, increased resowing (with associated higher GHG emissions), poorer winter growth and lower water-use efficiency.

Captain CSP yields significantly more in the cool season than other plantain cultivars.

Plantain cultivars

Winter active types

Captain CSP	A high yielding plantain with superior cool season growth, and excellent summer yield and drought tolerance too. Has properties to reduce N leaching. (Refer also to page 63).
Ceres AgriTonic	Good cool season growth and drymatter production. *AgriTonic* has an upright growth habit and higher leaf density.
Ecotain	The only environmentally functional plantain brand accepted by OverseerFM. Improves feed supply during summer and autumn.

Less winter-active types

Oasis	*Oasis* is a mid-flowering plantain variety.
Oracle	A broad leafed plantain, with strong year-round production. Good cool season growth for a late heading type.

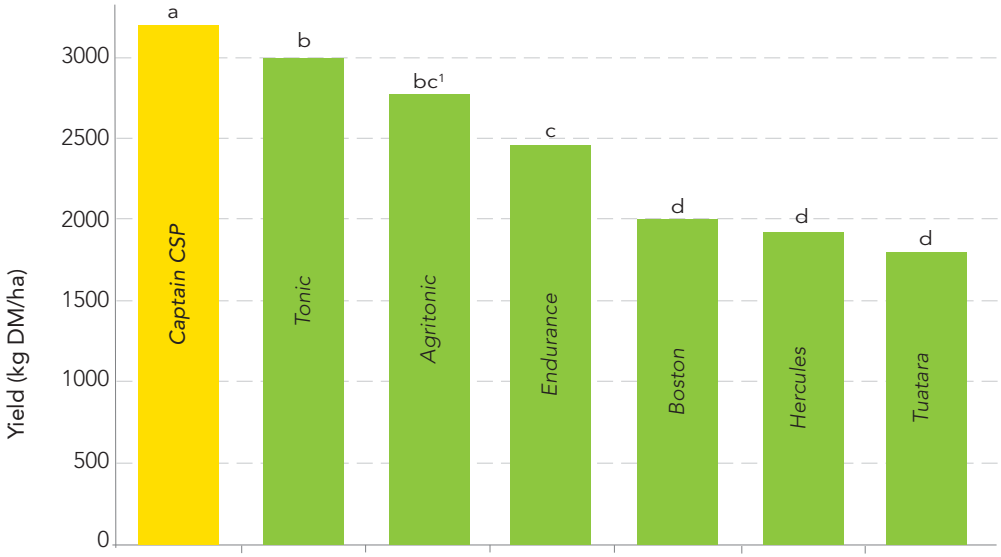
Captain CS plantain

Captain cool season plantain (CSP) has significantly more growth than other plantains during the cool season, when feed is most valuable in farm systems. It also reduces nitrogen leaching compared to diploid ryegrass.

Outstanding cool season growth

Captain CSP yields significantly more during the cool season as shown in the graph below. Plantains vary hugely in winter growth, as is clearly visible in the photo at the bottom of this page.

Cool season DM yield data combined from three one year dryland Canterbury trials sown between 2013 – 2018*



**Cool season yield is a total of autumn, winter & early spring periods. LSD (5%) lettering given on yield bars, cultivars with the same letter are not significantly different. ¹ Provisional rating, culitvar has only been in one trial.*

Reduced N leaching

Studies show plantain can mitigate nitrogen leaching compared to diploid ryegrass, primarily as its higher water content increases animal water intake, and so dilutes urine. *Captain's* superior cool season growth potentially increases N-mitigation, as nitrogen mainly leaches when soils are wet in late autumn to early spring.

Captain CSP (centre) showing its significant cool season yield advantage over other cultivars on 30 July at Courtenay 190 m ASL.

Captain CS plantain (cont.)

High total DM yield

Captain CSP grows strongly across the other seasons too. It's deep rooting, with high summer yield providing additional protein and feed quality over the warmer months, particularly in summer dry areas.

Animal performance

Plantain is easily digestible, improving animal appetite especially in dry summers when grass quality is low.

Plant type

Captain CSP is a distinctive narrow-leaved plant with upright growth habit for high utilisation. It has a deep, coarse root system, and good compatibility with other species. It persists well, and can last three years with good management.

Sheep, beef, deer systems

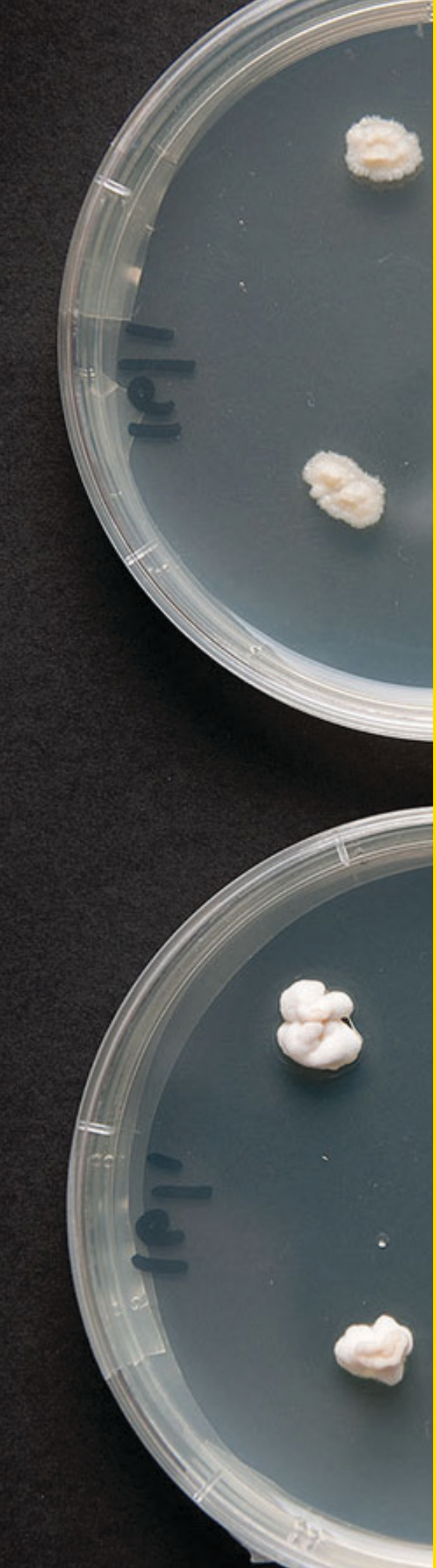
Captain CSP can be used as a high LWG finishing crop, for example mixed with red, white, and annual clovers. Here the annual clovers (Persian, arrowleaf) provide most of the legume through the first year, with red and white clovers providing it after that.

Dairy systems

Captain CSP can be used as a summer crop, or sown as part of a pasture mix to increase summer feed quality in dryland situations. *Captain* can also be used as part of a specialist high-yielding, quality 2-3 year pasture, with *Shogun NEA12* hybrid ryegrass and *Kotuku* white clover.

Sowing *Captain*

Sheep, Beef, Deer		kg/ha
Two-year high LWG finishing crop	*Captain CS* plantain	10
	Laser Persian clover	4
	Morrow MS red clover	6
	Ruru white clover	4
	Total	24
Perennial pasture mix	*Tyson* or *Rohan* SPR ryegrass	16-18
	Redefine cocksfoot	3-6
	Ruru white clover	4
	Morrow MS red clover	4
	Captain CS plantain	2-4
	Total	29-36
Dairy		**kg/ha**
Perennial pasture mix	*Maxsyn* or *Array* ryegrass	20
	Kotuku white clover	2
	Ruru white clover	2
	Captain CS plantain	2-4
	Total	26-28
Specialist 2-3 year pasture	*Shogun NEA12* hybrid ryegrass	30
	Kotuku white clover	4
	Captain CS plantain	2-4
	Total	36-38



Ryegrass endophyte

Endophyte FAQ's	66
Developing great endophytes	67
Barenbrug endophytes	70
Understanding endophyte alkaloids	71
Endophyte insect control ratings	74
Endophyte animal safety ratings	75

Endophyte growing on agar plates.

Endophyte FAQ's

What are endophytes?

Endophytes are fungi which have evolved to live in harmony with ryegrass. They live inside the seed and plant, and produce natural compounds (or alkaloids) which protect plants from pests.

Why use them?

Endophytes enhance ryegrass yield and persistence by helping protect plants from a range of insects and other pests. In summer dry pastures, ryegrass with endophyte out-grows and lives much longer than ryegrass *Without* endophyte.

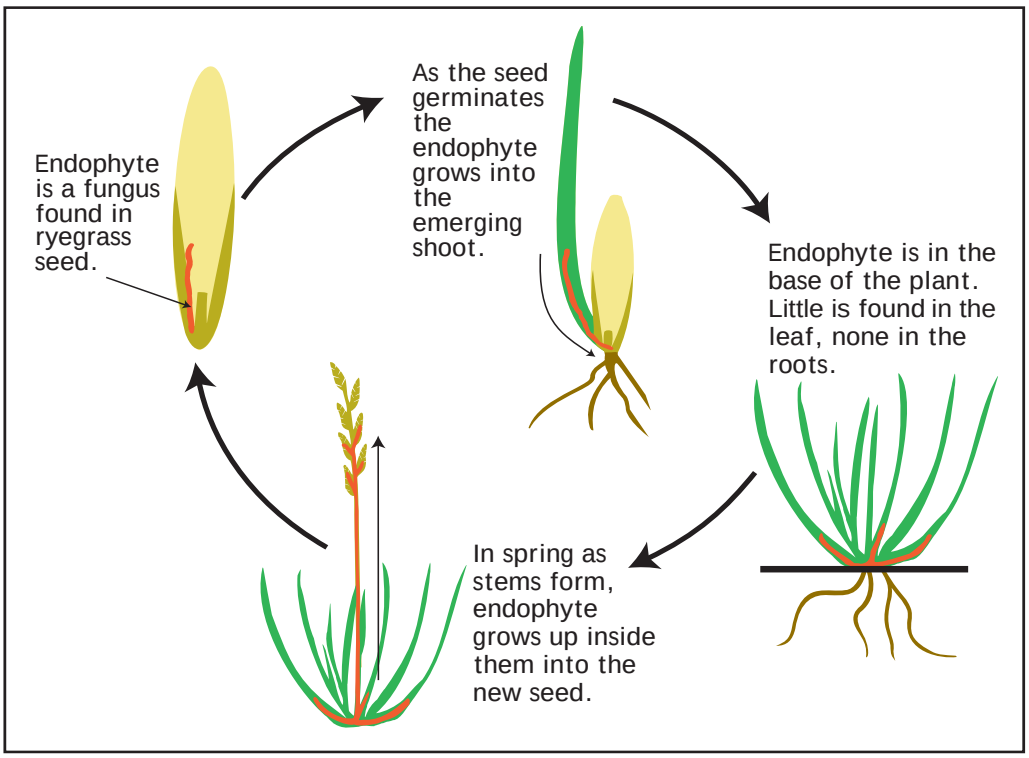
Why do you need to know about them?

Several strains of endophyte are available so it's important to know which is best for your situation. Choose the right endophyte and both your pasture and animals will benefit.

The original endophyte, called *Standard* endophyte (*SE*), depresses animal performance and causes summer ryegrass staggers. Newer endophytes are much less toxic to stock e.g. *AR1*, *NEA*, *NEA2* and *NEA4*. These greatly reduce the risk of staggers. *NEA12* and *AR37* endophytes have improved insect resistance but can cause staggers, although less frequent and severe than *Standard* endophyte.

What's its life cycle?

When you sow ryegrass seed containing an endophyte strain (e.g. *NEA*), resultant plants will always contain that endophyte. It stays inside the grass for the life of that plant. If you sow seed *Without* endophyte, those plants will never have endophyte. It does not transfer from plant to plant, or from soil to plant; it only transfers naturally from plant to seed.



Developing great endophytes

Summary

We have the biggest range of endophytes you can buy. Why? To help New Zealand farmers get the right results. That's because the best pasture comes from the happiest marriage between a ryegrass, and its endophyte. Finding the perfect match takes time, and top-class science, but it's been our passion for more than 30 years and we're not about to stop now!

Introduction

We're often asked, what is the best endophyte? After decades of research we can tell you it's not that simple. Our job is to breed the best pastures you can grow. That means pairing the right grass genetics with the right endophyte to create powerful partnerships that can work wonders on your farm.

No one size fits all

Different strains of endophyte vary in their effect on ryegrass. In one case, we even found a parasitic endophyte! It significantly depressed ryegrass yield, and made it more susceptible to disease, disastrous effects we do not want on farms. Some endophytes seem to do nothing. Others reduce winter growth, or can increase autumn growth.

Teamwork makes the dream work

A good example? Releasing *NEA12* endophyte in *Shogun* and *Maxsyn*, because we've found these to be superb marriages. The data tells the story - *NEA12* boosts the total yield of *Shogun* by 7%, and *Maxsyn* by 4%.

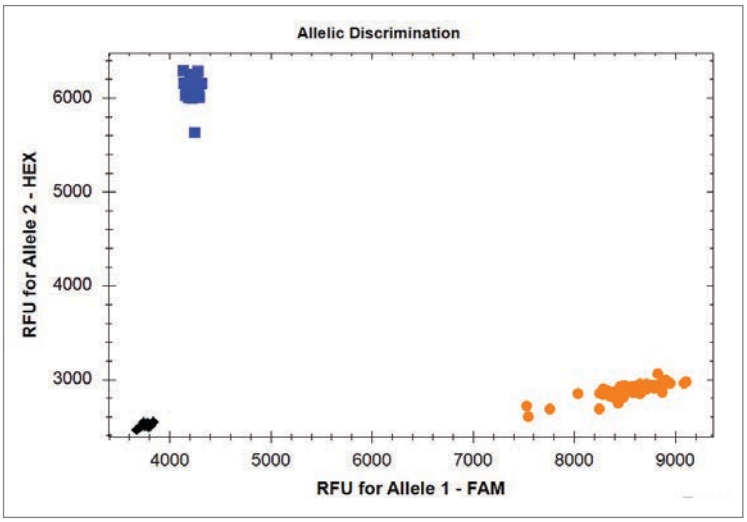
For context, plant breeding normally lifts ryegrass yield by +1% a year, so these partnerships equal 4-7 years of genetic gain in one hit. Imagine achieving that in your animals!

Likewise we released *Forge* ryegrass with *NEA*, because again, this is the right match for best performance. When we tried *NEA12* in *Forge*, yield dropped 5%.

Molecular analysis

Our endophyte R&D began decades ago with a chance discovery in ryegrass seed collected by hand in Spain, and has progressed to cutting edge biotechnology.

We have genetically screened over 400 potential endophytes.Those that reach commercialisation are genotyped and molecular markers developed so their presence can be detected in seed.



In DNA testing of endophyte, the output shows individual plants or seed with the desired endophyte blue, other endophyte orange, and without endophyte black.

Developing great endophytes (cont)

Insect screening

We assess insect control early in the development of our new *NEA* endophyte strains using in both on-farm field trials, and specific greenhouse screening.

For example in Argentine stem weevil greenhouse testing, plants of the same ryegrass cultivar with a range of endophytes are planted in pots.

Then adult ASW are placed in each pot, and confined by mesh covers so we can compare egg laying and feeding damage on each ryegrass x endophyte combination.

Animal health

To assess the ryegrass staggers risk, animal health and performance of different endophyte strains we use lambs, as they are more sensitive than cattle.

Under careful supervision and strict ethics standards, separate mobs are set-stocked for up to 8 weeks on pure swards of perennial ryegrass grown to a high herbage mass (similar to a hay crop) in February and March when the endophyte alkaloids are highest. This is not normal or recommended farm practice, but is designed to ensure we identify any effects under these worst case scenario conditions.

Lambs are assessed for ryegrass staggers and liveweight gain throughout the trial.

An animal trial in late February. Each separate 0.3ha block is a particular ryegrass x endophyte combination, and the animals on each block are monitored.

Field testing

Commercial field tests are also used to mirror real world conditions. Many are run on farms selected for known pasture persistence problems. Insect issues combine with climatic stress and typically over-grazing to further test endophyte performance.

Under severe ASW attack in Hawkes Bay, a plot of ryegrass with an NEA endophyte (left) stands out against cultivars with no endophyte (right).

ETC

Barenbrug supports the industry Endophyte Technical Committee (ETC), which is administered by the PBRA[1]. The ETC assesses the trial information companies collect on their endophytes, and summarise this into an agreed industry insect control and animal safety ratings. These are presented on pages 74 and 75.

Supply chain

Once a suitable ryegrass x endophyte combination is chosen for release, we take great care to ensure purity and endophyte levels throughout the seed multiplication process. Final production fields are closely monitored and seed is assessed for endophyte levels and seed quality. Post-harvest, specialised cool storage, further testing, and just-in-time delivery ensure the best quality seed arrives on your farm.

One of Barenbrug's four controlled humidity cool stores, this one at our Rolleston distribution hub.

[1] PBRA, For more see: www.pbra.co.nz

Barenbrug endophytes

Summary

Specify your endophyte when you order ryegrass seed for a pasture. Note: the ryegrass cultivar is also a key part of this decision, as it is the ryegrass x endophyte combination that determines pasture performance.

NEA

NEA endophyte gives excellent animal health and performance, and good black beetle control. *NEA* provides ryegrass staggers free pasture for dairy cows and beef cattle. While staggers is unlikely with sheep or deer, in dry summers if animals are forced to graze close to the ground a low level of staggers may be seen. As a matter of caution, we do not recommend *NEA* be sown for horses or deer.

- *NEA* is available in *Shogun* and *Forge* ryegrasses.

NEA2 & NEA4

NEA2 and *NEA4* endophytes are ideally suited to all farm systems nation-wide, providing persistent pasture with excellent animal health (see page 75).

Ryegrass with *NEA2* or *NEA4* have good control of black beetle, Argentine stem weevil (ASW) and pasture mealy bug (provisional rating).

NEA2 and *NEA4* provide ryegrass staggers free pasture for dairy cows and cattle. While staggers is unlikely with sheep or deer, in dry summers if animals are forced to graze close to the ground a low level of staggers may occasionally be seen. They are both a designed mix of two endophyte strains.

- *NEA2* is available in *Array*, *4front* and *Rohan*. *NEA4* in *Maxsyn* and *Tyson*.

NEA12 & AR37

NEA12 differs from other *NEA* endophytes in that it produces janthitrems, the same as *AR37*. Both provide good control of Argentine stem weevil and black beetle, very good control of root aphid, and a level of porina control.

Typically animal performance on these endophytes is very good. Ryegrass staggers has not been observed in dairy cows or cattle. *NEA12* and *AR37* can cause ryegrass staggers in sheep or lambs, which can be severe in dry summers if animals are forced to graze close to the ground. Do not sow for horses or deer.

- *NEA12* is available in *Maxsyn* and *Shogun*. *AR37* in *Governor*.

AR1

AR1 provides excellent animal performance and health in most situations. However, it gives limited insect control. It should not be sown in the northern North Island as it is susceptible to black beetle.

It is also susceptible to root aphid, but provides very good control of Argentine stem weevil and pasture mealy bug (see page 74). *AR1* is largely ryegrass staggers free (see page 75).

- *AR1* is available in *Governor*.

Low (LE)

Ryegrass with *Low* endophyte is an option for areas of very limited insect damage. However, many farmers in these areas are achieving better results sowing ryegrasses containing the right endophyte. *LE* provides little insect resistance (see page 74).

- *LE* is available in most Barenbrug ryegrass cultivars.

Standard (SE)

SE is sometimes called *'High'* or *'Wild type'* endophyte and is never recommended. *SE* can often cause severe ryegrass staggers, reduces lamb LWG, causes ill thrift in lambs, increases dags and flystrike and has been shown to reduce milk production (see page 75).

Understanding endophyte alkaloids

Summary

Ryegrass endophytes produce different alkaloids (or chemicals)

Endophyte	Peramine	Lolitrem B	Ergovaline	Janthitrems	Lolines
*NEA, NEA2, NEA4**	✓	✓ (very low)	✓ (low- medium*)		
NEA12				✓	
AR1	✓				
AR37				✓	
CM142				✓	
RGT18				✓	
Standard	✓	✓ (high)	✓ (high)		
U2					✓

**With NEA, NEA2 and NEA4 endophytes ergovaline level is low in plant leaves, but higher in plant crown where insect control is most needed.*

Peramine

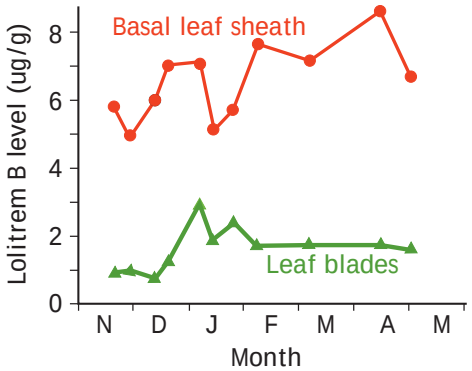
Peramine is an alkaloid produced by some ryegrass endophytes. It provides good control of the pasture pests Argentine stem weevil and pasture mealy bug. It is not known to have any adverse effect on animals.

Lolitrem B

Lolitrem B is the alkaloid produced by some ryegrass endophytes. At high levels it can cause ryegrass staggers or summer staggers in animals.

Animals grazing ryegrass with *Standard* endophyte (*SE*) are most likely to suffer staggers. Little seed with *SE* is sown nowadays, it is mainly found in old pastures. The worst staggers occurs when animals are pushed to graze into the base of plants in dry summers, or grazing the first pick of green growth following a dry spell. This is because lolitrem B is concentrated in the base of the plant (see graph).

Location of lolitrem B in pasture



Di Menna *et al*.(1992) NZ J.Ag.Res. 35:211-217

Lolitrem B is also found in seed heads (see page 66), so grazing rank seedy pasture can also cause problems.

Staggers present as tremoring in mild cases and staggering in more severe cases. Animals rarely die directly from staggers, but may die through misadventure, such as drowning in streams.

Staggers causes severe management problems if stock must be regularly handled, e.g. milking cows. A low level of staggers usually clears up within 1-2 days if animals are fed a diet free from lolitrem B. Severe staggers can affect animals for weeks.

NEA, NEA2 and *NEA4* endophytes produce very low levels of lolitrem B, so provide staggers free pasture for dairy cows and beef cattle. On sheep or deer farms, while ryegrass staggers is unlikely to occur, in dry summers if animals are forced to graze close to the ground a low level of staggers may be seen.

Lolitrem B is very stable in hay or silage so be careful buying or feeding these if they are made from *Standard* endophyte pasture.

Understanding endophyte alkaloids (cont.)

Ergovaline

Ergovaline helps protect plants against insects, including black beetle and root aphid, but high levels of ergovaline (e.g. from *Standard* endophyte) can sometimes reduce animal performance. *NEA, NEA2* and *NEA4* endophytes produce low to moderate levels of ergovaline which tests have shown are unlikely to affect animal health and performance under good grazing management.

The distribution of ergovaline through the plant differs for different endophytes. For *NEA, NEA2 and NEA4,* ergovaline levels are very low in ryegrass leaves, but are moderate in the plant crown. This is an important benefit as leaves are your animals' main diet, whereas the crown of the plant, containing the growing point, needs protection from insect damage.

Animal health trials on *NEA2* endophyte in diploid ryegrass have shown the same lamb growth as those on the same ryegrass *Without* endophyte.

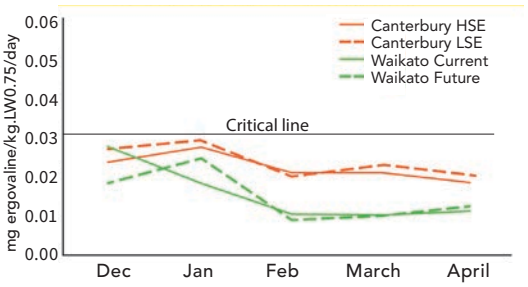
Lamb liveweight gain (LWG) in Lincoln University trials

Measurement	*Without* endophyte	*NEA2*
kg LWG/ha/day	2.37 a	2.37 a
Relative LWG	100%	100%

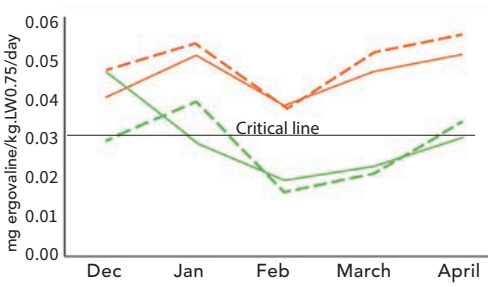
Trials run on the same perennial ryegrass cultivar either with NEA2 or Without endophyte over four separate 8 week periods in autumn 2003, spring 2003, summer 2003-04 & autumn 2004. Significance lettering is given for LSD (5%) level.

Trials suggest the ergovaline eaten by dairy cows grazing well managed *NEA2*-based ryegrass pastures is unlikely to affect animal production. A review of animal intake research[1] showed ergovaline intakes below 0.03 mg/kg $LW^{0.75}$/day have never shown any effect on animal performance, with diploid *NEA2* pastures testing at below this safe level (see graph).

Cow intake grazing diploid *NEA2* pasture*



Cow intake grazing diploid *SE* pasture*



* *Ergovaline intakes in four DairyNZ farm systems. Eady et al. 2017 Proceedings NZ Grassland Association 79:205-210*

Calculated ergovaline intakes of cows grazing *Standard* endophyte were almost double those of *NEA2*.

The concentration of ergovaline in ryegrass is highest in the plant crown and seed head. Ergovaline increases in summer with rising temperature and seed head development, and in response to moisture stress. To minimise animal health issues keep pastures leafy through late spring, and try not to graze close to the ground in summer. Use other feeds (e.g. summer crops, silage, PKE, grain) to dilute alkaloid intake and greatly reduce the risk of any endophyte issues.

[1] *Nicol & Klotz. 2016. Animal Production Science 56:1775-1786*

Janthitrems

Janthitrems are alkaloids produced by *NEA12, AR37, CM142 and RGT18* endophytes. They produce no peramine, lolitrem B or ergovaline.

Janthitrem levels follow the seasonal pattern of other alkaloids, i.e. low in winter and high in late summer and autumn, and give a wide spectrum of insect resistance (see page 74).

High levels of janthitrems can cause staggers, although this is not as severe as that caused by *Standard* endophyte (see page 75). In lamb LWG trials, ryegrasses with *NEA12 and AR37* pastures can cause ryegrass staggers in sheep typically in dry summers where animals are pushed to eat into the base of pasture. This can be severe, and will impact animal health and growth.

Similar to lolitrem B, a low level of staggers usually clears up within 1-2 days if animals are fed a diet free from janthitrems. Severe staggers can affect animals for weeks.

In endophyte trials run by DairyNZ no ryegrass staggers have been seen in dairy cows grazing *AR37*. Although on occasion *AR37* has been shown to effect milksolids (MS) production, over the whole season MS production has been shown to be similar for *AR37* and *AR1*.

Lolines

Lolines are alkaloids produced by meadow fescue endophyte (*Neotyphodium uncinatum*), and give a wide spectrum of insect resistance. They are produced at good levels in meadow fescue plants. But when these endophytes have been put into perennial ryegrass cultivars loline levels are typically much lower.

They are also translocated to the roots of the plant so can assist in deterring root feeding insects.

Black beetle have found and destroyed a trial plot of ryegrass Without endophyte at Newstead, Waikato. NEA, NEA2, NEA4, NEA12 and AR37 give good black beetle control.

Endophyte insect control ratings

Summary

These were compiled by AgResearch, Barenbrug, Cropmark, Germinal, Grasslanz, PGG Wrightson Seeds and RAGT.

These ratings are indicative and may vary slightly between cultivars. If Argentine stem weevil or black beetle are present at sowing, an appropriate seed treatment is recommended to improve insect resistance during establishment.

The ratings in this table are based in part on glasshouse studies where test plants are 100% infected with endophyte, whereas commercial seed must meet minimum standards of 70% of seeds infected.

Insect control: ryegrass, festulolium & continental tall fescue (September 2024)

Endophyte Brand	Argentine stem weevil	Pasture mealy bug	Black beetle	Root aphid	Porina	Grass grub	Field cricket
Diploid perennial ryegrass							
AR1	++++	++++	+	-[2]	-	-	Not tested
AR37	++++[1]	++++	+++	++++	+++	+	Not tested
CM142	Not tested	Not tested	Not tested	++++	Not tested	Not tested	Not tested
NEA2	+++	(++++)	+++	++	Not tested	-	Not tested
NEA4	+++	(++++)	+++	++	Not tested	Not tested	Not tested
NEA12	(++++)[1]	Not tested	(+++)	++++	(+++)	Not tested	Not tested
RGT18	(+++)[1]	Not tested	(+++)	Not tested	Not tested	Not tested	Not tested
Standard endophyte	++++	++++	+++	++	+	-	Not tested
Without endophyte	-	-	-	-	-	-	Not tested
Tetraploid perennial ryegrass							
AR1	(+++)	(++++)	+	-[2]	-	-	Not tested
AR37	(+++)[1]	(++++)	+++	++++	(+++)	+	Not tested
CM142	Not tested	Not tested	Not tested	++++	Not tested	Not tested	Not tested
NEA2	++	(++++)	+++	++	Not tested	-	Not tested
Without endophyte	-	-	-	-	-	-	Not tested
Diploid and Tetraploid Italian and short term (hybrid) ryegrass							
AR1	++	(++++)	+	-[2]	Not tested	-	Not tested
NEA	Not tested	(++++)	+++	Not tested	Not tested	-	Not tested
AR37	+++[1]	(++++)	+++	++++	Not tested	-	Not tested
NEA12	(+++)[1]	Not tested	(+++)	++++	Not tested	-	Not tested
Without endophyte	-	-	-	-	-	-	Not tested
Festulolium							
U2	++++	(++++)	++++[3]	++++	(++)	+++	+++
Continental tall fescue							
MaxP (AR584)	Not tested	Not tested	+++	(++++)	Not tested	(++)	+++
Without endophyte	-	-	-	-	-	-	-

Notes on Tables

- \- No control.
- \+ Low level control: Endophyte may provide a measureable effect, but is unlikely to give any practical control.
- ++ Moderate control: Endophyte may provide some practical protection, with a low to moderate reduction in insect population.
- +++ Good control: Endophyte markedly reduces insect damage under low to moderate insect pressures. Damage may still occur when insect pressure is high.
- ++++ Very good control: Endophyte consistently reduces insect populations and keeps pasture damage to low levels, even under high insect pressure.
- ( ) Provisional result: Further results needed to support the rating. Testing is ongoing.
- 1 AR37, NEA12 and RGT18 endophytes control Argentine stem weevil larvae, but not adults. While larvae cause most damage to pastures, adults can damage emerging grass seedlings. In Argentine stem weevil prone areas it is recommended to use treated seed for all cultivars with novel endophyte.
- 2 AR1 plants are more susceptible to root aphid than plants without endophyte.
- 3 Active against black beetle adults and larvae.

Endophyte animal safety ratings

Summary

These were compiled by AgResearch, Barenbrug, Cropmark, Germinal, Grasslanz, PGG Wrightson Seeds and RAGT. These ratings are indicative. Animal performance and health can vary under different management systems and between seasons.

The information in this table is based on animal safety trial protocols designed to expose animals to simulated worst-case scenario management. This involves forcing them to graze deep into the base of pure perennial ryegrass pastures that have been allowed to grow for several weeks over late spring/summer (similar to a hay crop) where they will encounter the highest concentrations of harmful endophyte chemicals if these are present. This management does not represent normal farm practice although similar situations may arise on farms in in rare circumstances.

Under normal farm grazing practices, the contribution of basal pasture material to total animal dry matter intake is relatively low and therefore the intake of harmful chemicals (if they are present) is diluted. Thus, the likelihood of adverse effects on animals is reduced, but the potential for problems to occur may still exist if the endophyte brand is rated < 4-star for 'freedom from staggers' and/or there are comments on animal performance which flag potential issues. Comments on animal performance have been moderated based on information from other trials (in addition to the formal animal safety testing protocols), consideration of the 'normal' grazing management practices implemented on farm (see previous paragraph), and recognition that animal diets are very seldom pure ryegrass. Other dietary components such as clovers or non-ryegrass grass species, crops or supplements will dilute the intake of endophyte alkaloids.

Ryegrass staggers & animal performance (September 2024)

Endophyte brand	Freedom from staggers		Effects on animal performance
	Sheep and lambs	Cattle and dairy cows	
AR1	++++	++++	High level of animal performance
AR37	+++	++++	Typically provides a high level of animal performance. Can cause ryegrass staggers in sheep and lambs in extreme circumstances. Lamb liveweight gain can be reduced during periods of severe staggers. While ryegrass staggers has not been observed in cattle and dairy cows, it could occur on rare occasions.
CM142	(++++)	++++	Typically provides a high level of animal performance. Can cause ryegrass staggers in sheep and lambs in extreme circumstances. Lamb liveweight gain can be reduced during periods of severe staggers. While ryegrass staggers has not been observed in cattle and dairy cows, it could occur on rare occasions.
NEA	++++	++++	High level of animal performance
NEA2 and NEA4	++++	++++	Typically provides a high level of animal performance. Lamb liveweight gain could be reduced in extreme circumstances. While no effects have been observed in cattle and dairy cows, body temperature could be elevated on rare occasions.
NEA12	++++	++++	Typically provides a high level of animal performance. Can cause ryegrass staggers in sheep and lambs in extreme circumstances. Lamb liveweight gain can be reduced during periods of severe staggers. While ryegrass staggers has not been observed in cattle and dairy cows, it could occur on rare occasions
RGT18	(++++)	++++	Typically provides a high level of animal performance. Can cause ryegrass staggers in sheep and lambs in extreme circumstances. Lamb liveweight gain can be reduced during periods of severe staggers. While ryegrass staggers has not been observed in cattle and dairy cows, it could occur on rare occasions.
U2	++++	++++	High level of animal performance
MaxP (AR584)	++++	++++	High level of animal performance
Standard endophyte	+	++	Can cause ryegrass staggers in sheep and lambs, and significantly decrease lamb growth rates in summer and autumn, and significantly increase dags In dairy cows, it has been shown to depress milksolids production through summer and autumn.
Without endophyte	++++	++++	High level of animal performance

Key to ryegrass staggers ratings:

+ Likely to cause severe staggers in most year
++ Can cause severe staggers in some years
+++ Can cause severe staggers occasionally
++++ Very unlikely to cause staggers

Pasture renewal

Renewal checklist	77
Why renew? A dairy farm example	78
Why renew? A sheep farm example	79
Rectify causes of poor performance	81
What level of renewal?	82
Benefit of correct cultivar - dairy	84
Benefit of correct cultivar - sheep	85
Soil fertility - new pasture	86
Soil structure & health	87
Renewal methods	88
Sowing date of grasses	89
Seedbed consolidation	89
Drilling method	90
Sowing depth	91
Regenerative Agriculture pastures	92

Renewal checklist

Summary

The list below can be used to check all factors behind good pasture renewal. (Many are covered in more detail in the manual.)

The key is to do all aspects well. In a good season you may get away with shortcuts in technique, but in poor climatic conditions shortcuts will be a liability.

✓	Checklist	Page
	Discuss and confirm objectives of renewal.	
	Identify poor paddocks and decide on right rate of renewal for farm (5%? 10%? 20%?).	82
	Rectify reasons for poor performance.	81
	Soil test (6-12 months in advance) and correct soil fertility.	86
	Choose appropriate sowing date.	89
	If relying on a contractor, book them in early.	
	Check for pests (e.g. grass grub, slugs and ASW).	174
	Choose appropriate renewal method.	88
	Spray out paddock prior to cultivation or direct drilling.	88
	If cultivating, prepare a good seed bed (fine and level).	88
	Choose correct cultivar and seed mix for the farm system.	84-85
	Control pests - use treated seed and insecticide if required.	225
	Choose correct sowing rate and technique.	88/235
	Check seed certificate for germination, purity and endophyte.	236
	Apply slug bait if needed.	189
	Control weeds in early establishment.	97
	Graze early to promote tillering, use 'pluck test' to determine when pasture is ready for first grazing.	97
	Avoid pugging and over-grazing new pasture.	97

Why renew? A dairy farm example

Summary

Renewing paddocks which have poor growth or high weed content can give high financial returns. In this example we have used top end renewal costs ($1330/ha), but this still returns $6290/ha net income over 4 years. This is an internal rate of return of 139%[1], one that few other investments can match.

Typical costs of renewal

Direct costs/ha	$inc. GST
Appropriate herbicide(s) applied	60
Light disc then drill	160
Maxsyn perennial ryegrass 18 kg/ha, *Kotuku* 2 kg/ha, *Ruru* 2 kg/ha (all treated)[2]	380
Slug bait[2]	100
Cambridge roll[3]	80
Establishment fertiliser (DAP 200 kg/ha) including spreading[3]	380
Broadleaf herbicide	170
Total cost	$1330

[1] Based on annual cash flow after investment (financial-calculators.com)

[2] Estimated retail prices, October 2024

[3] Average price for North and South Island-based contractors, October 2024

Typical benefit of renewal over 4 years

The benefit of renewal is in the table below, based on the assumptions:

- 3 t DM/ha DM yield per year increase from new pasture
- +0.6 MJ/kg DM higher ME (science says 0.6 - 0.9 ME increases are typical)
- 5% greater utilisation from better ME & palatability (assumed +5%).

Returns renewal vs do nothing (leave underperforming pasture) over 4 years

	Extra grown (t DM/ha/year)		Do nothing	Renew
1.	DM yield	Extra growth 3t DM/ha/year	0	+12 t DM/ha
		DM lost during renewal	0	-1.5 t
		Net increase	0	10.5 t DM/ha
		Extra kg MS[4]	0	710
2.	Higher ME new pasture	Extra kg MS[5]	0	330
3.	Utilisation	Extra kg MS[6]	0	230
	Total extra kg MS		0	1270 kg MS
	Income extra MS @ $8/kg		0	$10,160
	Cost of renewal (table above)		0	-$1330
	Variable cost extra MS @ $2/kg MS[7]		0	-$2540
	Net increase income		0	$6290
	Internal rate of return		0	139%

[4] 3 t DM/ha/year extra yield, utilisation 80%, average ME 11 conversion of 130 MJ ME/kg MS.

[5] Go from 11 to 14 t DM/ha/year yield, 80% utilised, and an 0.6 MJ ME/kgDM increase, conversion 80MJ ME/kgMS.

[6] Increase 5% pasture utilisation of 14 t DM/ha/year yield.

[7] Variable cost increase of extra MS (While most costs are fixed (e.g. land, labour, rates), a portion of farm costs increase (e.g. vat refrigeration, extra cows)). This varies between farms.

Why renew? A sheep farm example

Summary

Renewing paddocks with poor growth or high weed content can give high financial returns. In this example, we've used top end renewal costs ($1420/ha), and this returns $4830/ha additional income over 4 years, depending on the system. This has an internal rate of return of 70%,[1] few other investments can match.

This return can come in two benefits. First, increased annual and seasonal pasture production allows a higher ewe stocking rate, and produces more lambs, value $3150/ha. Second, extra DM yield allows a crop of lambs to be finished, and the increased feed quality of the new pasture allows faster lamb growth rates, valued at $1680/ha. The total value of these two operations is $4830/ha.

Typical costs of renewal

In this example after a crop, herbicide is sprayed to kill weeds prior to cultivation. Full costs are presented, but these should be partly attributed to the cost of the crop.

Direct costs/ha	$ (inc. GST)
Appropriate herbicide(s) applied	60
Primary cultivation (plough)[2]	210
Light cultivation[2]	145
Roller drill[2]	145
Rohan SPR 18 kg/ha, *Apex* 2 kg/ha, *Ruru* 2 kg/ha[3]	310
Establishment fertiliser including spreading[2]	380
Broadleaf herbicide[3]	170
Total cost	$1420

[1] Based on annual cash flow after investment (financial-calculators.com)

[2] Average price for North and South Island-based contractors, October 2024

[3] Approximate retail prices, October 2024

Cost benefit example

This example considers a case where new pasture increases growth by 4 t DM/ha, which is often achievable, but depends on the situation. The extra yield increases carrying capacity by 2.8 ewes/ha in year one, while the new pasture is still establishing, and by 4.5 ewes/ha once the pasture is established.

Typical pasture production

Farm type	Unproductive pasture	Productive pasture
Summer dry	6-10 t DM/ha/yr	10-14 t DM/ha/yr
Summer safe	10-14 t DM/ha/yr	14-18 t DM/ha/yr

New pastures typically have a higher feed quality, as you replace weeds in the old pasture with desirable species. This allows lambs to be finished faster (e.g. 200 g/day) than old pasture (e.g. 120 g/day), setting up the opportunity to trade and finish an extra 15 lambs/ha. This would vary year to year depending on rainfall and availability of store lambs.

Gross margin from extra productivity

Return/ha from extra ewes run	$	Return/ha from lamb finishing	$
First year increase[1] 2.8 ewe/ha x $194/ewe	540	First year increase[3] 15 lambs/ha @ $28/lamb	420
Second year increase[2] 4.5 ewes/ha @ $194/ewe	870	Second year increase[3] 15 lambs/ha @ $28/lamb	420
Third year increase[2] 4.5 ewes/ha @ $194/ewe	870	Third year increase[3] 15 lambs/ha @ $28/lamb	420
Fourth year increase[2] 4.5 ewes/ha @ $194/ewe	870	Fourth year increase[3] 15 lambs/ha @ $28/lamb	420
Total benefit/ha extra ewes (over 4 years)	$3150/ha	Total benefit lamb finishing (over 4 years)	$1680/ha
		Total benefit ewes + lamb finishing	$4830/ha

[1]Loss of growth of 1500 kg DM/ha with renewal. This is subtracted from 4000 kg DM/ha benefit first year, to give a net gain of 2500 kg DM/ha. A ewe intake requirement of 660 kg DM/year allows an extra 2.8 ewes/ha, each returning a gross margin of $218. (This is based on income: 1.2 lambs @ $140/lamb, plus cull ewe income @ $50, plus 5 kg wool @ $1.60/kg. Less expenses: freight $2, animal health $6, shearing expenses $5, ram purchase 20% of rams (1:50 service) @ $800 (=$4), interest 8% on capital (=$15).

[2]4000 kg DM/ha/year increased pasture with 75% utilisation. A ewe intake requirement of 660 kg DM/year allows an extra 4.5 ewes/ha.

[3]Assuming average lamb LWG on old pasture 120 g/day (i.e. 100 days to gain 12 kg), on new pasture 200 g/day (i.e. 60 days to gain 12 kg). Allowing for an extra 15 lambs/ha from 40 days extra grazing at a gross margin of $28/lamb. (This is based on lambs growing at 200 g/day, for 40 days, gain 8 kg LW; at 46% yield gives an extra 3.7 kg CCWT @ $9.20/kg CCWT ($34) plus 1 kg wool @ 1.6/kg ($1.60). Less expenses: freight ($1.70), animal health ($1.90) shearing ($3), interest ($1) gives a gross margin of $28/lamb).

Productive, high quality pastures drive stock performance.

Rectify causes of poor performance

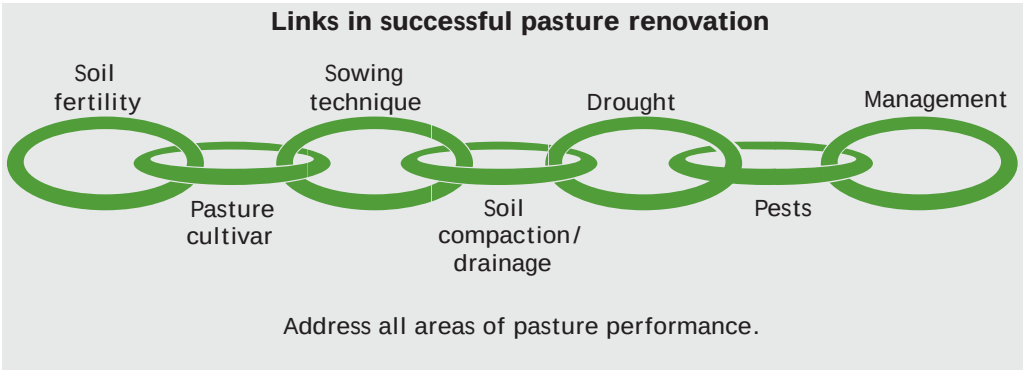
Summary

Many factors can cause existing pastures to perform poorly. These problems must be identified and corrected if pasture renewal is to succeed.

Address causes of poor pasture

Before starting any pasture renewal, the reasons behind poor paddock performance must be addressed. For example, there's little point sowing new pasture if drainage is the fundamental problem.

Several 'links' contribute to the success of pasture renewal (see diagram below).



Potential limiting factors

Some areas that may need addressing include:

Soil fertility:	Test soils, apply fertiliser as necessary (see page 86).
Low soil pH:	Add lime (see page 86).
Poor drainage:	Improve drainage.
Soil compaction:	Aerate by subsoiling, cultivation (see page 87).
Pugging:	Improve drainage or change management (e.g. feed pad, sacrifice paddock, on/off grazing; see page 108).
Renewal technique:	Use most appropriate method (see page 88).
Insect pests:	Use a crop to break insect cycle; use treated seed or insecticide (see page 174).
Pasture cultivar:	Use correct cultivar (see pages 7-64) and certified seed (see page 236).
Weed invasion:	Apply herbicide as required.
Management:	Change management to avoid pasture damage (e.g. avoid summer overgrazing by destocking or feeding summer crop)

How much should you renew?

Summary

The correct amount of renewal for your farm depends on how your pastures are performing, and how fast you want to improve this. This section covers how to assess this and plan accordingly.

Amount of renewal

Pasture renewal programmes vary widely across NZ, ranging from 0% to over 30% of the farm area each year. Dairy farm renewal averages about 8% compared to 2-5% on sheep farms

Often the amount of land renewed is a set figure in the farm's annual budget. But it shouldn't be. Renewal should be flexible, and weighed against other investments. For example on one farm we assessed, a programme to immediately renew over 30% of the property was undertaken, as the poor performance of existing pastures made this a very profitable strategy[1].

Benefit of renewal

The benefit of new pasture is the gains it will deliver over existing pasture. So it's important to estimate the current pasture performance versus potential.

Current pasture growth

Pasture growth varies widely between individual paddocks across every farm. On flat farms there is typically a 100% difference in DM yield between best and worst paddocks. This difference is much higher on hill country.

Growth differences between dairy paddocks of 4 t DM/ha are common. This means poor performing paddocks may produce 250 kg MS/ha less than better ones (based on 75% utilisation and 12 kg DM/kg MS conversion). On a sheep and beef farm the poorest paddocks could be carrying 30-50% fewer stock with slower animal growth rates.

Measuring paddock performance

Comparing the performance of individual paddocks allows you to quantify the potential gains of pasture renewal on the farm. The best paddocks show what can be achieved, with the difference between those and the worst illustrating the potential for improvement, provided paddocks share similar topography, soil type etc.

One way to find out how much individual paddocks grow is to record stock grazing days. For more advice on doing this, visit www.barenbrug.co.nz.

Alternatively you can use a plate meter or visual yield estimates from farm walks to estimate pasture cover to calculate paddock growth. Some software does this automatically from weekly pasture cover data.

Paddock performance data shows where the best gains can be made.

[1] A more quantitative approach to pasture renewal. Journal NZ Grasslands 77: 251-258 (2015).

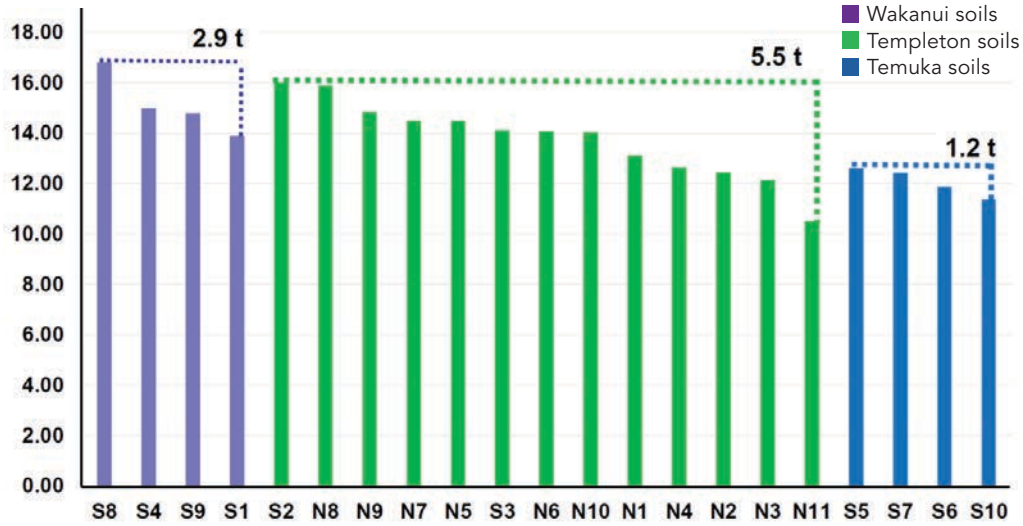
Create a paddock profile

Paddock performance data can be used to rank paddocks within their productive group (e.g. different soil type, topography etc). This example is for the Lincoln University Dairy Farm (LUDF), which has three different soils marked by different colours.

The soil types have different productivity, so you need to compare paddocks within each soil type. This identifies the potential of poorer producing paddocks within a soil type, for example N11 producing an estimated 5.5 t DM/ha less.

Just as farmers identify and cull the 'tail end' of their herd or flock to improve animal performance, here the same thing is done with pasture, renewing tail end paddocks to lift farm pasture performance.

Example of paddock performance on LUDF divided by the 3 soil types



Low hanging fruit

While the graph above shows the potential gain from renewal, it's also important to look at the cost or difficulty in realising those gains. The best return from investment in pasture renewal is from significant yield gain achieved at a low cost. Look for your worst performing paddock(s) on the most productive part of the farm.

For example on the LUDF, DM yield gains are typically much easier to achieve on the purple or green soils than the poorly drained blue soils, on which gains also rely on drainage work, which increases costs.

Evaluate success

Continuing to assess paddock performance after renewal allows you to evaluate the success of pasture renewal. Typically pasture renewal delivers good gains. If this is not the case, underlying reasons for poor paddock performance probably have not been rectified. Continual evaluation allows you to fine-tune renewal techniques to identify what works best for your particular system.

Capture benefits of new pasture

New pasture grows more so:

- More fertiliser will be required.
- A higher stocking rate may be needed.
- Change in management systems may be needed.

Benefit of correct cultivar - dairy

Summary

Sowing cheap seed, or seed of questionable origin, risks large losses in profit. In this example it saves $265/ha at sowing, but $3395/ha in operating profit is lost over three years.

Dairy farm example

This example compares sowing the high quality perennial ryegrass *Maxsyn* with *NEA4* endophyte (*AGRICOTE* treated), versus uncertified ryegrass seed, over three years. From NFVT trial results *Maxsyn* produces 3.4 t/ha more per year. This does not include the advantage of *NEA4* endophyte, or the better feed value (ME) and seasonal growth pattern of *Maxsyn*.

Cost/benefit *Maxsyn NEA4* vs uncertified ryegrass

		Certified *Maxsyn NEA4*	Uncertified ryegrass	Difference
Cost		$350/ha[1] (20 kg/ha at $17.15)	$85/ha[1] (20 kg/ha at $4.30/kg)	$265/ha
Operating profit[2]	Year 1	14,000 kg DM/ha x $0.36/kg DM[2] = $5040/ha	10,600 kg DM/ha x $0.36/kg DM[2] = $3820	$1220/ha
	Year 2	14,000 kg DM/ha x $0.36/kg DM[2] = $5040/ha	10,600 kg DM/ha x $0.36/kg DM = $3820	$1220/ha
	Year 3	14,000 kg DM/ha x $0.36/kg DM[2] = $5040/ha	10,600 kg DM/ha x $0.36/kg DM = $3820	$1220/ha
			Extra profit from *Maxsyn*	$3660/ha
			Net profit (less seed cost)	**$3395/ha**
			Internal rate of return difference from using *Maxsyn*	458%

[1]Approximate retail prices October 2024.

[2]DairyNZ Forage Value Index (FVI) handbook economic values for the 'Operating Profit' of a kg DM in a dairy farm system. The figure of $0.36/kg DM is an average taken from the four regions in August 2022 (Upper North Island $0.37; Lower North Island $0.35; Upper South Island $0.39; Lower South Island $0.31).

New cultivars grow more, persist well and are higher in ME.

Benefit of correct cultivar - sheep

Summary

Sowing cheap seed, or seed of questionable origin, risks large losses in income. In these examples $265/ha is saved at sowing but $3000/ha is potentially lost in a ewe breeding enterprise, or $2780/ha lost in a lamb finishing system over the next three years.

We compare *Maxsyn* with *NEA4* endophyte (*AGRICOTE* treated), versus uncertified ryegrass, over three years. The first example runs more ewes; the second finishes lambs faster. *Maxsyn* is assumed to yield 3.4 t DM/ha more than uncertified ryegrass, which is conservative, based on trial information.

Example: breeding ewe system

		Certified *Maxsyn NEA4*	Uncertified ryegrass	Difference
Cost		$350/ha (20 kg/ha at $17.50[1])	$85/ha (20 kg/ha at $4.30/kg[1])	$265/ha
Income	Year 1	14,000 kg DM/ha	10,600 kg DM/ha	
	Year 2	14,000 kg DM/ha	10,600kg DM/ha	
	Year 3	14,000 kg DM/ha	10,600 kg DM/ha	
	Total gross margin (GM)[2]	42,000 kg DM/ha / 660 kg DM/ewe x $194/ewe = $12,340/ha	31,800 kg DM/ha / 660 kg DM/ewe x $ 194/ewe = $9340/ha	$3000
			Net extra GM from *Maxsyn* (less seed cost)	**$2735/ha**
			Internal rate of return difference from using *Maxsyn*	374%

[1]Approximate retail prices October 2024.

[2]Gross margin (GM) = $218/ewe (Based on income: 1.2 lambs @ $140/lamb, plus cull ewe income @ $50, plus 5 kg wool @ $1.6/kg. Less expenses: freight $2, animal health $6, shearing expenses $5, ram purchase 20% of rams (1:50 service @ $800) $4, interest 8% on capital $15)

Example: lamb finishing system

		Certified *Maxsyn NEA4*	Uncertified ryegrass	Difference
Cost		$350/ha[3] (20 kg/ha at $17.50)	$85/ha[3] (20 kg/ha at $4.30/kg)	$265/ha
Income	Lamb production	200 g/day @ 19 lambs/ha[4]	175 g/day @ 15 lambs/ha[4]	
	Turn round time	60 days per 'crop' of lambs[5]	69 days per 'crop' of lambs[5]	
	Trades per year	5	4.4	
	Total lambs	5 trades/year x 3 years = 15 trades x 19 lambs (SR) = 285 lambs/ha	4.4 trades/year x 3 years = 13.2 trades x 15 lambs (SR) = 198 lambs/ha	
	Total gross margin over 3 years[6]	285 lambs/ha traded x $32/hd = $9120	198 lambs/ha traded x $32/hd = $6336	$2784/ha
			Net GM from *Maxsyn* (less seed cost)	**$2519/ha**
			Internal rate of return difference from using *Maxsyn*	346%

[3] Approximate retail prices October 2024.

[4] Increased lamb growth & stocking rate (SR) with *Maxsyn NEA4* due to increased DM yield and shoulder period growth (3.4t DM/ha from NFVT trials), improved nutritive value, later heading (+16 days) and low aftermath heading.

[5] Based on a 300 day lamb finishing system, faster lamb growths on *Maxsyn* NEA4 allows an extra 36 days/year finishing and higher stocking rate.

[6] Gross margin (GM) for lamb $32/head (Based on income: 36 kg LW lamb at 46% yield gives a 16.6 kg CCWT @ 9.2/kg CCWT =$152.70, plus 1.3 kg wool @ $2/kg =$2.60. Less expenses: lamb purchase $116, freight $1.70, animal health $1.90, shearing $3, interest $1).

Soil fertility - new pasture

Summary

Correct soil fertility is critical for optimal plant growth and to obtain the best results from pasture renewal.

Soil test prior to sowing and apply remedial fertiliser as required.

Soil fertility levels

Soil test levels for near maximum pasture production

Soil test	Soil parent material			
	Sedimentary	Ash	Pumice	Peat
Olsen-P	20-30	20-30	35-45	35-45
Sulphate-S	10-12	10-12	10-12	10-12
Organic-S	15-20	15-20	15-20	15-20
Soil test K	5-8	7-10	7-10	5-7
Soil test Mg	8-10	8-10	8-10	8-10
pH	5.8-6.0	5.8-6.0	5.8-6.0	5.0-5.5

Adapted from: Fertiliser Use on Sheep & Beef Farms (1994), J.Morton et al.

To raise fertility levels

Amount of nutrient required to lift soil test by 1 unit

Soil test	Soil parent material			
	Sedimentary	Ash	Pumice	Peat
Phosphate (kg P/ha)	4-7	7-18	4-15	6-9
Potassium (kg K/ha)	100-250	45-80	35-60	-
Sulphur (kg S/ha)	30-40	20-30	40-50	20-40
pH (t lime/ha)	10	10	10	varies

Source: Fertiliser Use on Sheep & Beef Farms (1994), J.Morton et al.

Phosphate for maintenance

Maintenance phosphate requirements

Dairy		Sheep/Beef	
Cows/ha	kg P/ha/yr	SU/ha	kg P/ha/yr
2	20-28	7	6-18
2.5	27-36	13	15-28
3	34-45	16	21-34
3.5	43-55	19	28-41
4	54-65	22	34-44

Source: Fertiliser Use on Sheep & Beef Farms (2018), J.Morton et al. Fertiliser Use on Dairy Farms (2016), A.Roberts et al.

Soil structure & health

Summary

Healthy soils support sustainable, profitable plant growth. Soil structure and biology are key physical indicators of soil quality, and play a critical role in selecting appropriate pasture renewal methods.

Earthworms and a friable soil structure are signs of soil health.

The risks

Traditional cultivation (e.g. ploughing) and particularly PTO powered cultivation (e.g. power harrowing) can degrade soil structure, disrupt biological activity, release soil N and release carbon. Fragile soils such as ash, pumice, light/sandy loams and some peats are particularly vulnerable to loss of structure, with long-term physical effects including compaction, pan formation, reduced porosity, erosion and run-off.

Soil quality & new pasture

The roots of new pasture plants cannot move freely through soils with poor or degraded structure. Rooting depth directly affects pasture persistence, because shallow rooted plants obtain less water and nutrients than those which penetrate deeper into the soil profile, and are pulled out more easily.

Do not disturb

Direct drilling or minimum tillage reduces soil disturbance and helps protect soil structure, especially on fragile or light soils. It also reduces the number of passes over the soil with heavy machinery; and minimises disruption to soil biological activity (e.g. beneficial insects, microbes). But more care, and usually cost, with insect and slug control is needed.

What's down there?

A visual soil assessment (VSA) helps identify soil quality issues and provide a practical, immediate insight into overall soil health. A VSA Field Guide can be downloaded from Landcare Research or videos are available on YouTube.

Renewal methods

Summary

Cultivation	Spray-drill	Undersow	Oversow
In spring, spray appropriate herbicide(s), cultivate & sow summer crop ▼ Feed off crop over summer ▼ Spray crop residue ▼ Light cultivation ▼ Drill seed ▼ Light graze 6-10 weeks later	Hard graze ▼ Allow to regrow (e.g. 7-21 days) & spray with appropriate herbicide(s) ▼ Graze 3-7 days after spraying, per grazing WHPs on herbicide(s); direct drill seed into pasture ▼ Plan to graze 6 weeks post sowing.	Hard graze (no herbicide) & direct drill seed into thin pasture ▼ Graze normally	Spray if particular weeds present ▼ Hard graze ▼ Broadcast treated seed on ▼ Trample in with stock

Cultivation

Positives	Negatives
■ Most consistent germination ■ Best weed control if appropriate herbicides are used ■ Can break up previous soil pans ■ Can level paddock, repair pugging ■ Can incorporate fertiliser/lime ■ Can break pest cycle	■ Most expensive ■ Buries fertile top soil, reduces organic matter in the short term, disrupts biological activity ■ Potential soil compaction, erosion ■ Releases soil N & carbon ■ Softer, more prone to treading during establishment

Spray & drill

Positives	Negatives
■ Appropriate herbicide controls competition ■ Faster than cultivation ■ Quicker to first grazing ■ Protects soil structure ■ Fewer emissions ■ Reduced environmental impact	■ Less opportunity to correct pH ■ Won't break up previous soil pans or level paddock ■ May revert to old pasture faster than cultivation ■ Insects and slugs usually need control during establishment ■ Higher risk of uneven germination

Undersow

Positives	Negatives
■ Cheap & simple ■ Italian ryegrass (e.g. *Tabu+*) can boost winter-early spring growth.	■ Doesn't work in dense pastures ■ Doesn't control invasive weeds ■ Usually only a temporary fix

Oversow

Positives	Negatives
■ Can introduce legumes & N fixation ■ Can apply with fertiliser ■ Often used for hill country to introduce new species into uncultivatable land.	■ Variable results ■ Hard to control competition

Sowing date of grasses

Summary

Sowing date affects pasture persistence. Early autumn sowing is important in summer-dry areas, so plants have time to reach a robust size, prior to the following summer.

Autumn sowing date

In autumn, late sowing means slower establishment due to the cooler temperatures. Young plants then have less time to reach a robust size (e.g. grasses >20 tillers) to help their persistence, prior to the (potentially dry) summer. Sowing into dry conditions, prior to rain, and letting rain germinate seed can allow faster establishment than waiting for rain before sowing. In these conditions research has shown *NEA2* endophyte survives well in the soil for up to 6 weeks prior to rain.

Some species, such as brome grasses and tall fescue, need warmer conditions than ryegrass to establish well, and must be sown early when soil temperatures are consistently >12°C. If farmers are serious about using these, programming a summer fallow to build up soil moisture, followed by direct-drilling, can greatly reduce the risk of poor establishment in dry autumns.

With later sowing and slower establishment, the potential to pug and damage new pastures in winter and spring is greater, because plants are smaller and weaker.

Spring sowing date

Spring pasture sowing requires reliable summer moisture for young pastures to establish, so cannot be reliably used in many regions. However, spring sowing is regularly undertaken in areas with good summer rainfall (e.g. Southland, the West Coast and some higher altitude areas), and irrigation (e.g. Canterbury and Otago).

Sowing date is a balancing act between getting new pasture in as soon as possible, and avoiding the risk of cold temperatures slowing establishment, which often leads to high weed content. As a general rule, wait until soil temperatures are >10°C before sowing ryegrass, and >12°C for brome grasses and tall fescue.

Seedbed consolidation

Summary

A level seedbed greatly improves pasture establishment, particularly for clover.

Seedling establishment

Seedbed consolidation conserves moisture and allows a seed drill to achieve the right sowing depth.

Research in the Manawatu showed sowing with a V-roller into a well-consolidated seedbed gave 50% better white clover and 25% better ryegrass establishment than sowing into a poorly consolidated seedbed.

Seedlings at establishment*

	Lightly consolidated	Well consolidated
Clover	240/m^2	375/m^2
Ryegrass	280/m^2	360/m^2

**Proceedings NZ Grasslands Association 67 (2005): p35-39. Brock J. et. al.*

In this case a Cambridge roller was weighted with concrete posts, to compact the soil until the roll form held under normal walking pressure. This research also highlighted the bad practice of using rubber wheeled rollers, which do not compact the soil well.

Drilling method

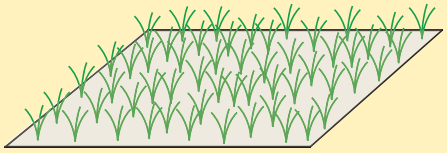
Summary

Drilling method is a critical decision when establishing new permanent pasture. Good ground cover, or density, at sowing improves clover establishment and gives much better weed control.

Drilling methods

Spreading seed evenly

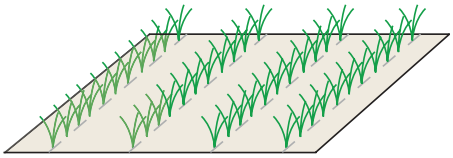
e.g. roller-drill, broadcast seed, drill with narrow row spacing



- Seed well spread over ground surface
- Good ground cover gives weed control
- More space for seedlings helps slower establishing clover

Drilling in rows

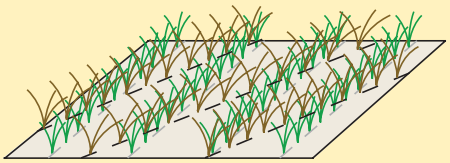
e.g. standard or direct-drill sowing in rows



- Seed placed tightly in rows
- Where ryegrass & clover are drilled together in the same row, clover suffers
- Space between rows for weeds

Cross-drill or diamond drill

e.g. sow with direct-drill in two directions



- Better ground coverage than one drill pass (better weed control)

Improve method?

Sometimes a drill or drilling method can be modified to get better ground coverage. If row drilling, for example, remove the tubes from under the seed box so seed simply sprinkles on the ground. Welding a ^ shaped angle iron under seed box can help seed spread. If direct drilling, sprinkle clover seed and 1/4 of ryegrass seed through a small seed box (with tubes removed) ahead of the main drill. Main drill coulters will help cover and sow this seed.

Bare ground between drill rows gives weeds room to germinate.

Sowing depth

Summary

Sow ryegrass/white clover seed mixes at <10mm deep to get the best establishment. White clover seed is very small and sensitive to sowing depth and establishes much faster sown at this depth. Ryegrass is less sensitive to sowing depth and still establishes well sown at 20 mm. At 50 mm, neither species establishes well.

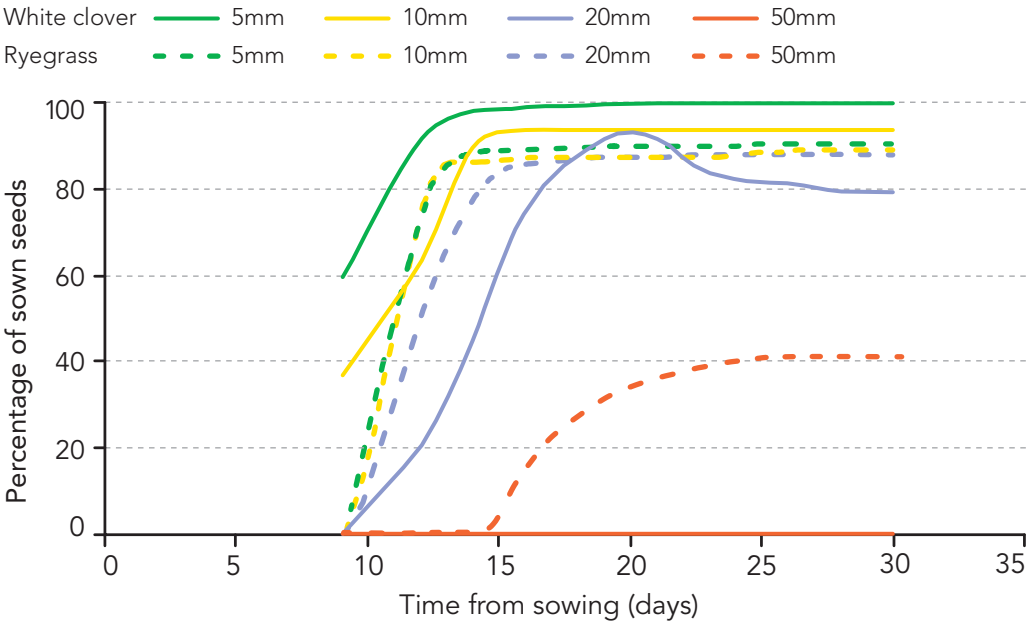
Dry conditions

The exception to sowing shallow is in dry conditions, when it is sometimes better to drill seed a little deeper into better soil moisture. In these conditions white clover may struggle, but seed can be spread on when conditions improve.

Consolidation

A consolidated seed bed is critical to allow good depth control with a seed drill. In a soft seedbed wheel tracks are pushed down, and coulter depths vary, leading to both uneven sowing depth and establishment. The same effects can occur when drilling too fast, causing uneven sowing depth.

Effect of sowing depth (mm) on ryegrass and clover establishment rate



Seedbed consolidation improves seedling establishment, achieved here only in the tyre tread pattern

Regenerative Agriculture - pasture mixes

Summary

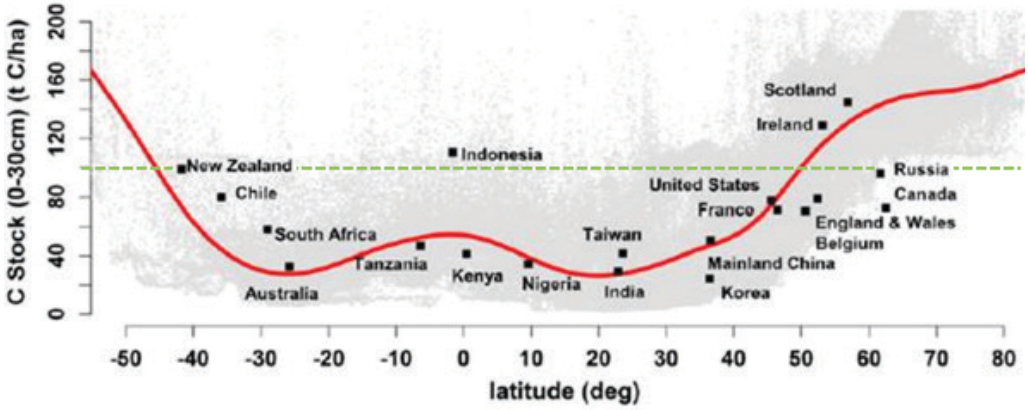
Regenerative Agriculture (RA) is presently a topic of discussion world-wide. This section looks at two aspects of RA in the context of New Zealand's grazed livestock systems - the improvement of soil and soil carbon/organic matter.

RA itself is not a specific, defined system, but incorporates several components which aim to improve soil quality and increase soil carbon. These are already well-established in NZ farm systems, i.e. using pasture, rotational grazing, minimum-till cultivation, and minimising bare soil with cover crops.

Organic matter & soil carbon

Scientists estimate NZ soils on average contain 99 t/ha soil organic carbon (SOC). This is higher than many other countries, such as areas of North America, South Africa and Australia. There are several reasons for this, including our latitude and cooler climate as shown below.

Global soil organic carbon by latitude (Minasny et al. 2017)



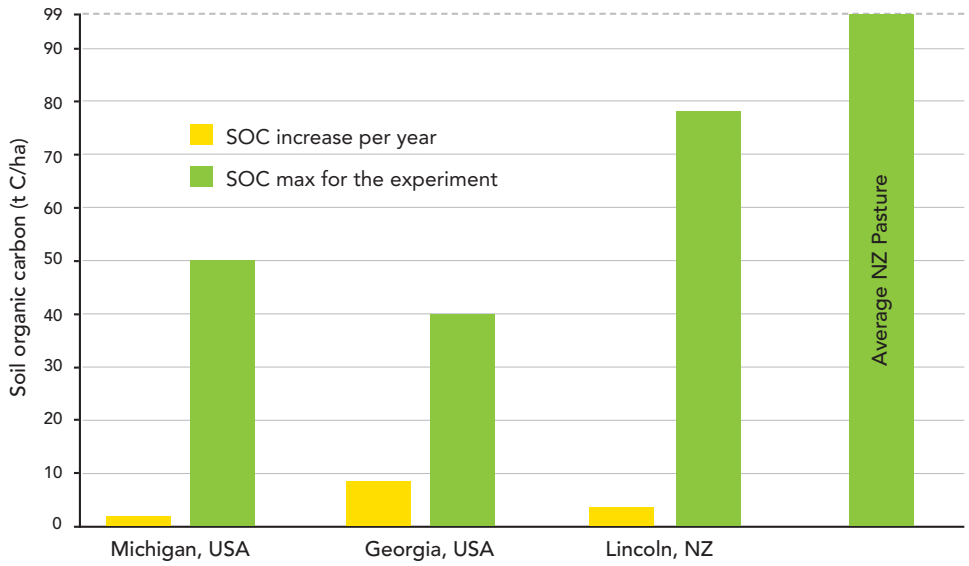
New Zealand agricultural soils are dominated by permanent pasture, rotationally grazed by stock. This is not the case in many other countries. Some overseas farmland has historically been heavily cultivated and cropped, which inevitably depletes soil organic matter. It is primarily in these 'degenerated' carbon-poor soils that RA practices have been associated with 'regenerating' as can be seen in the graph on the next page.

Grazing pasture builds soil carbon.

For example an increase of SOC of 4 t/ha/year was estimated in Michigan, USA, to 50 t SOC, through changing from set stocking to rotational grazing (Stanley et al. 2018); or an increase of SOC of 8 t/ha/year was estimated in Georgia, USA, to 40 t SOC, through conversion from cropping to sowing pasture and rotational grazing (Machmuller et al. 2015).

Diverse seed mixes for pasture

Soil organic carbon levels and increases in three experiments



In Lincoln, New Zealand, trials were undertaken to look at improving the soil carbon through sowing different pasture species into a degraded cropping soil (Francis et al. 1999). These gave an estimated increase of SOC of 5 t/ha/year, to 77 t SOC. In this trial the same increase in SOC came from sowing a pasture of just perennial ryegrass, versus a diverse pasture mix of prairie grass, timothy, tall fescue, chicory, lucerne, white clover and red clover.

While most of RA research has focused on the use of pasture, minimum-till establishment and rotational grazing, some proponents have suggested there might be additional benefits from sowing diverse seed mixes. For pastoral-based soils in NZ which are typically high in SOC, there is presently no scientific evidence that sowing a very diverse pasture seed mix will increase soil carbon.

For farmers who wish to sow a diverse pasture mix we do provide a premix option. For more information on mixing species see page 39, and for our *Diverse Pasture Premix* see page 40.

References

Francis, G. S. et al. 1999. Restorative crops for the amelioration of degraded soil conditions in New Zealand. Australian Journal Soil Res. 37, 1017-34.

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Pasture management

Big picture – what's your strategy?	95
Managing new pasture well	97
Principles of ryegrass growth	98
Principles of ryegrass grazing	100
Using tetraploid perennial ryegrass	101
Mixing tetraploid & diploid ryegrass	102
Maximising white clover	103
Improving environmental outcomes	105
Managing pasture when it's wet	108
Preparing for drought	110
Responding to flood	112
Ryegrass heading dates	114
Using ryegrass heading dates on farm	115
Making great silage	116

Big picture – what's your strategy?

Summary

Great pasture takes more than day to day decisions. Yes, they're always important. But if they're not aligned with a high level strategies of your farm system, you (and your animals) will miss out on the best your pasture could be.

First principles

Underlying everything is the need to match feed demand (animal requirements) with feed supply (pasture and crops). Pasture is the main part of this very dynamic relationship. But you can pull other 'levers' to help create the right balance for your system, year-round.

What's your demand?

This is the easier side of the formula. You can predict how much feed you need in the season ahead, with reasonable accuracy.

What class(es) of animal you run, what breed(s) you prefer, your stocking rate, calving and lambing dates – these all create seasonal feed demand on your farm. Animal feed requirements are well documented, such as these for milking cows.

Daily milking cow feed requirements: kg DM/cow/day at 12.0 MJ ME/kg DM

Breed	Kg Lwt	kg MS / cow / day						
		1.4	1.6	1.8	2.0	2.2	2.4	2.5
J	375	12.5	13.7	14.9				
J	400	12.6	13.9	15.1	16.3			
J x F	450	13.3	14.6	15.9	17.2	18.5		
Fr	500	13.9	15.2	16.5	17.8	19.1	20.7	
Fr	550	14.3	15.6	16.9	18.2	19.5	21.1	21.7

(Source: DairyNZ Facts & Figures 2021).

What's your supply?

Feed supply, on the other hand, can and does change suddenly! Feed deficits are much more common and disruptive than feed surpluses, so every farm will need contingencies to offset this risk. Among the most useful are:

Summer crops

To secure home-grown summer feed when hot, dry weather depresses pasture growth and quality. These keep your animals better-fed over summer, but that's not all. They support good pasture management, because:

1. You can pull paddocks out of rotation in times of surplus spring growth, to help pasture quality across the rest of the farm.

2. You can also prevent your animals over-grazing pastures in summer, which often compromises persistence.

Winter crops

To carry a large bulk of feed into winter when grass slows down. Pasture might reach around 4 t DM/ha maximum at this time of year, but rape might be 8 t DM/ha, kale 15 t DM/ha and fodder beet over 20 t DM/ha.

Silage/hay

For extra feed during deficits. Harvest these from surplus pasture, and you maintain high quality grass at the same time.

Silage and hay have two big benefits compared to crops – you can store and use them as needed; and you always know how much you have on hand.

Imported supplements

Include PKE, grain, baleage or hay. Typically your most expensive option, but can be very helpful in severe feed deficits.

How flexible are you?

Flexible farm systems help you balance the feed demand side of the equation in erratic weather, particularly dry summers. Key strategies include:

Trading stock

Having many animals that can be bought or sold at any time in response to the weather is a real strength for many farmers. Quitting trading stock heading into a dry summer to ease feed demand is a common example.

Farm to the season, not the calendar

For a sheep farmer, this could mean early weaning, or selling lambs store instead of finishing them. For a dairy farmer, examples include OAD milking, selling culls or drying off cows early.

Nitrogen boost

Nitrogen fertiliser can provide an economic boost in pasture growth when needed.

Management

For more on managing drought, see pages 110-111, or pages 112-116 for more on recovering from flood.

You can pull many levers in your system to help balance feed demand vs supply.

Managing new pasture well

Summary

Pasture establishment takes 12 months. Good management during this time gets new plants off to a strong start and helps them persist. A pasture is not successfully established until you have a dense, well tillered sward one year after sowing.

Do's and don'ts

	DO	DON'T
0-4 weeks post-sowing	■ Monitor closely for insect damage and/ or weed germination and treat accordingly.	■ Drive by without getting out of the vehicle and quickly inspecting the paddock. ■ Graze, or where irrigated over-water.
At 4-6 weeks	■ Graze lightly when pasture seedlings cannot be 'plucked out' by hand. Aim to remove the top 2-3 cm using young stock. ■ Apply nitrogen to encourage plant tillering (20-25 kg N/ha).	■ Pug or tread new pastures – aim to graze when soil conditions are good. ■ Delay first grazing. This is bad for tillering and clover; slows establishment, and can reduce yields by +1 t DM/ha more.
2nd grazing onwards	■ Maintain consistent residuals - new pasture grows fast and needs frequent grazing. Light grazing also helps your clover. ■ Monitor weeds.	■ Let pastures get too long. ■ Make heavy hay or silage crops; this stresses young pasture.
First year	■ Be gentle on new pasture, it is still young. ■ In extended dry periods, graze lightly, leaving at least 2-3cm residual (sheep), or 4-5cm (cows).	■ Overgraze. ■ Restock new pasture too early after dry spells - let it recover and build its reserves.

First grazing

The most critical grazing is the first 'nip-off' and should occur as soon as the baby grass plants do not pull out of the ground. Light grazing promotes grass tillering and growth. Early grazing also benefits slower establishing species, like clover and herbs, allowing light to reach them. Young clover plants are usually smaller, and susceptible to shading. If your seed is treated, check the grazing withhold period. For *AGRICOTE Grass*, this is 42 days for sowing, and 21 days for undersowing.

Space invaders

Monitor new pastures closely for emerging weeds. They compete aggressively with young grass, clovers and herbs, reducing pasture longevity. Spray early when they are still small and easier to control (typically before or after first grazing). If you do need to spray, make sure the herbicide is safe for other sown species.

Subsequent grazings

From the second grazing onwards, new pastures grow fast and need frequent grazing. Apply small amounts of nitrogen to boost growth and tillering. Keep pastures relatively short to encourage ryegrass to tiller and prevent shading of clover and herbs. Don't let them get too long (>3500 kg DM/ha), or take a heavy silage cut in year one.

First winter & summer

Graze new pastures carefully in periods of stress. In wet winters, protect them from treading damage. Otherwise, future DM yield and persistence will be compromised. In dry periods, do not overgraze establishing pasture.

Principles of ryegrass growth

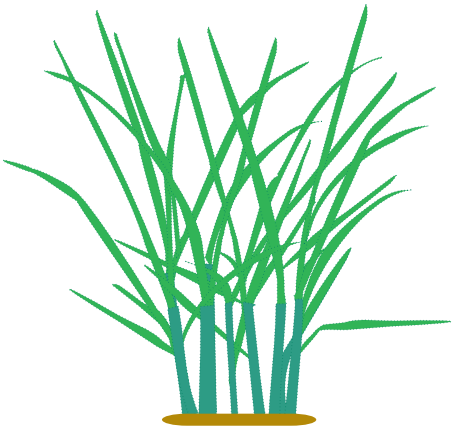
Summary

Keep pasture cover within the optimal range to achieve high growth rates, high utilisation, and high pasture quality.

The correct time to graze ryegrass is when there are 2.5-3 leaves per tiller. For rapid regrowth after grazing, keep post-grazing residuals above 5 cm or 1500 kg DM/ha for dairy or cattle systems, and 3 cm or 1200 kg DM/ha for sheep systems.

Ryegrass plant

Perennial ryegrass pasture is made up of many ryegrass tillers. Tillers are found grouped together in clumps, each clump forming a ryegrass plant.



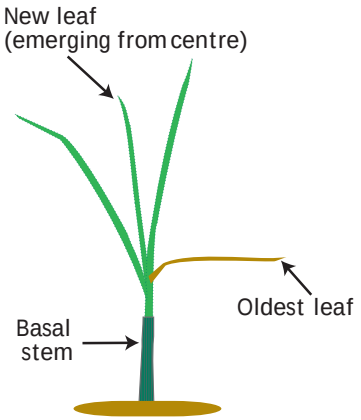
Dairy pastures typically contain 3000-5000 tillers per square metre while sheep pastures contain 8000 or more.

New tillers (also called daughter tillers) are produced year-round with peak production usually from October to December. This is why mid - late spring management strongly influences persistence.

Ryegrass tiller

A tiller has a single basal stem, a leaf sheath and a number of leaves. It can have only three live, green growing leaves at any time.

When the tiller has three leaves it doesn't stop growing. A fourth (new) leaf is produced, and the first (oldest) leaf starts to die.



Then a fifth leaf is produced, the second leaf dies, and so on. If pasture isn't grazed, dead old leaves (of little feed value) build up in the base of the pasture.

How quickly do leaves grow?

The time it takes for a tiller to produce a new leaf varies, and depends largely on temperature (in winter) or moisture (in summer). In mid-spring, perennial ryegrass may produce a new leaf every 8 days while in mid-winter it may be every 20+ days.

Tiller growth & yield

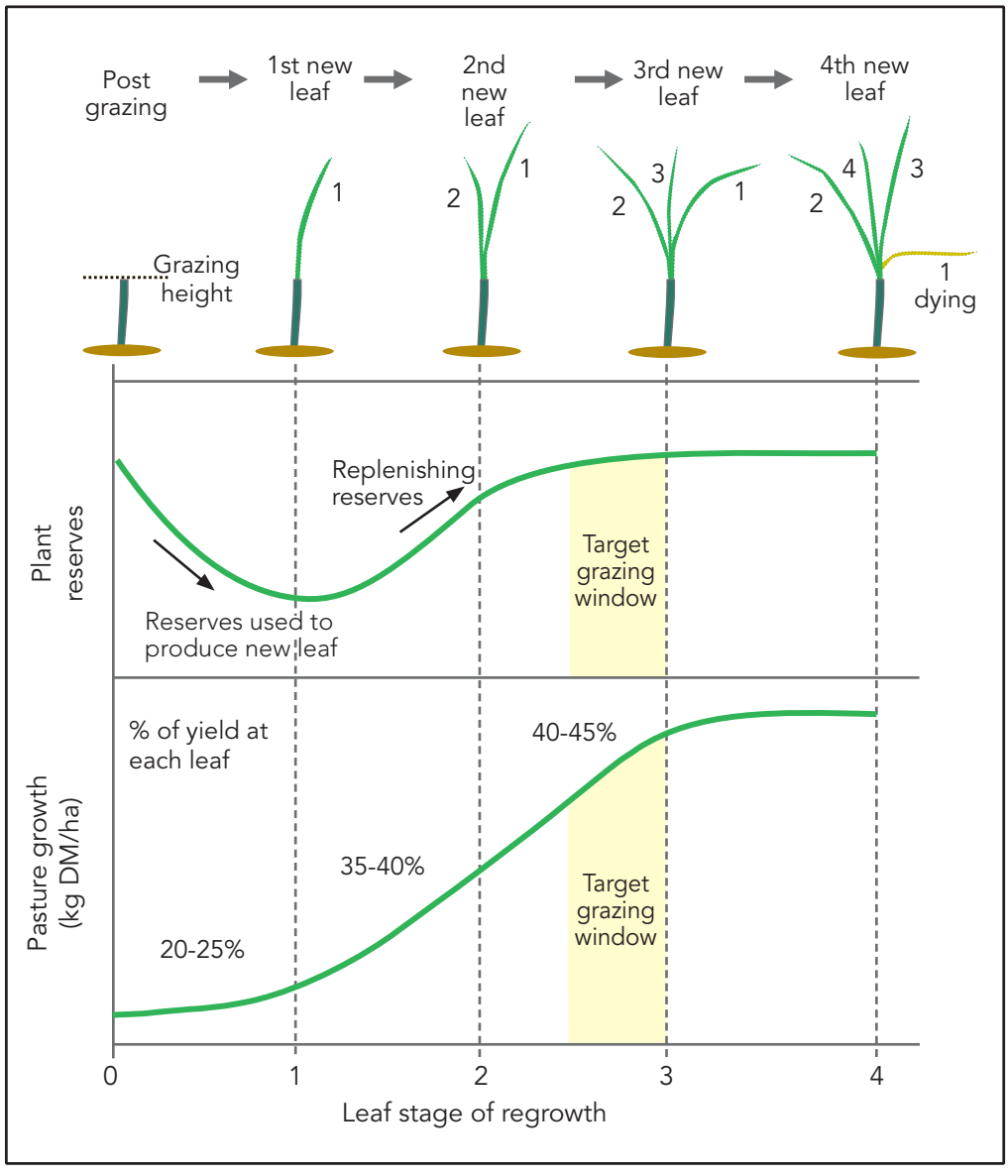
As a tiller regrows the initial growth rate is slow, and the first new leaf makes up only 20-25% of your potential pasture yield. Growth accelerates with the second leaf, and speeds up again with the third leaf. Simply put, the tiller is moving from 1 'solar panel' or leaf to 3. Grazing at 2.5 - 3 leaves per tiller captures most of this growth, with the third leaf producing 40-45% of potential yield.

Regrowth & energy reserves

Mostly we sow diploid ryegrass-based pastures and graze them earlier than ideal at the 2 - 2.5 leaf stage because this is the easiest way to maintain good residuals. Tetraploid ryegrass-based pastures can change this, because they remain palatable at higher covers. At the Lincoln University Dairy Farm grazing 0.5 leaves/tiller later (at 3500-3600 kg DM/ha) grew around +1.2 t DM/ha/year.

The regrowth cycle initially relies on the energy reserves plants store as carbohydrate in the basal stems. Immediately after grazing plants rely on these to provide energy for regrowth until the first new leaf is produced. With the first new leaf, photosynthesis then becomes the main energy to grow subsequent leaves and replenish carbohydrate reserves.

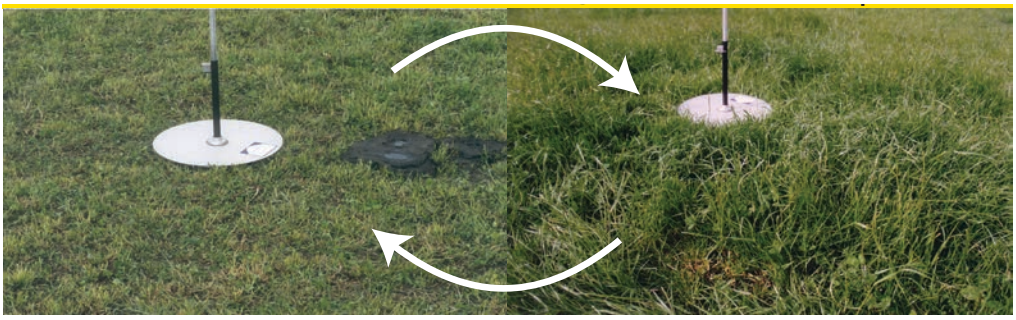
Regrowth, energy reserves & yield per leaf



Principles of ryegrass grazing (cont.)

Grazing

Ryegrass does best under a consistent grazing cycle of grazing, as summarised below. Get these in balance and management falls into place.



Good post grazing with no dead matter in the base (in good weather).

Graze at the right time with no dead matter in the base.

When to graze

The optimal time to graze for both high growth rates and high pasture quality is when tillers show an average of 2.5-3 leaves. To assess this, check several tillers in a pasture, as they vary. Find tillers with a grazed leaf (i.e. severed), then count the number of new leaves that have grown since. At the correct stage, tillers will have a third new leaf, varying from half to fully developed.

Grazing too early

Grazing before or at 2 leaves per tiller reduces both yield and regrowth as it does not allow plant reserves to be fully restored (see page 100). This is particularly important after extended summer dry periods, when plants are under stress. Nipping off the first leaf growth after rain, before tillers have 2.5-3 new leaves, can kill plants.

Grazing too late

If pasture is left to grow too long (>3500 kg DM/ha), it keeps producing new leaves, but older leaves die off. Dying leaves accumulate in the base of the pasture. These reduce pasture quality, lower pasture utilisation and can cause disease. Long or dying pasture creates a great environment for pests, diseases and fungal spores (e.g. rust, facial eczema). High covers (>3500 kg DM/ha) also compromise your clover growth and daughter tillers, because not enough light reaches the base of the pasture.

Grazing too late usually happens in periods of rapid growth, when multiple paddocks are ready to graze simultaneously. Monitor growth; if necessary remove paddocks from grazing to cut for supplementary feed, or pre-graze or post-graze mow.

Grazing too low

Grazing below normal residual height can significantly reduce regrowth and animal performance, as you are grazing into the plant energy reserves. Graze to the same height each time.

Consistency

The secret to good grazing management is keeping pastures in the right 'grazing window' - maintaining consistent post-grazing residuals, and grazing at the right time.

Using tetraploid perennial ryegrass

Summary

Tetraploid perennial ryegrasses (e.g. *4front)* are more palatable, easier to graze and can increase per animal and per ha performance.

Tetraploid perennials do not suit every farm - they are less robust and need good management to persist. Mixing tetraploids with diploids can work well (page 102).

Benefits of tetraploids

Tetraploid perennial ryegrasses are a powerful tool to lift animal performance. Dairy farmers typically find milk production rises on tetraploid paddocks, and lamb finishers achieve faster LWG. Advantages of tetraploids vs. diploids include:

- Animals love them.
- Higher per head performance.
- Higher covers, and increased DM yield, because tetraploids remain palatable longer (see page 100).
- Better environmental outcomes (see page 105).
- Higher utilisation, driving better per ha production.
- Higher ME (by 0.25 MJ ME/kg DM) and WSC content than diploids.

BUT not for all systems

Tetraploids don't suit all systems. They are more palatable, with fewer tillers than diploids, so they need to be better looked after to persist well. Tetraploids are less suited to:

- Wet farms with heavy soils - they are more susceptible to treading damage.
- Large farms where the owner(s) want every paddock the same to keep the system simple.
- Difficult, dry situations where persistence is key (a robust diploid cultivar will probably suit best).
- Farms with very high Argentine stem weevil (ASW) damage; ASW prefer tetraploids.

Getting the best out of tetraploids

Take extra care with tetraploids to avoid pugging or treading damage by cattle, especially behind break fences. During extended dry periods, avoid prolonged set-stocking or repeated grazing with all ryegrasses, but particularly with tetraploids. Their palatability means they can be easily over grazed.

Here sheep have shown much greater preference for a plot of tetraploid ryegrass over other perennial ryegrasses.

Mixing tetraploid & diploid ryegrass

Summary

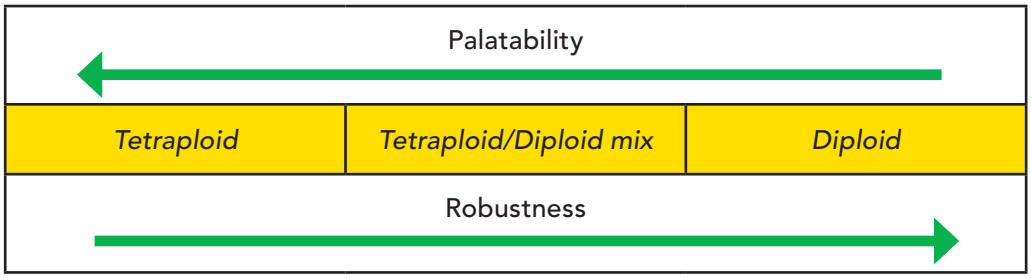
Mixing a tetraploid like *4front* with a diploid perennial ryegrass like *Maxsyn* or *Array* has proved a practical way for many farmers to drive higher animal performance than traditional pasture, with easier management.

Background

Tetraploid/diploid mixes fit a range of farm systems. They are more persistent than a straight tetraploid pasture, because diploid plants help protect the tetraploid.

On many farms the tetraploid/diploid perennial ryegrass mix is now the norm, striking a near-ideal balance between pasture palatability and robustness, growing more energy per ha and being easier to manage than straight diploid ryegrass.

Tetraploid perennial ryegrass, like *4front,* has excellent DM yield and year-round growth. But being so palatable, many farmers have struggled to avoid over grazing and don't achieve the persistence they want. Adding a denser diploid ryegrass to the mix changes the dynamics.



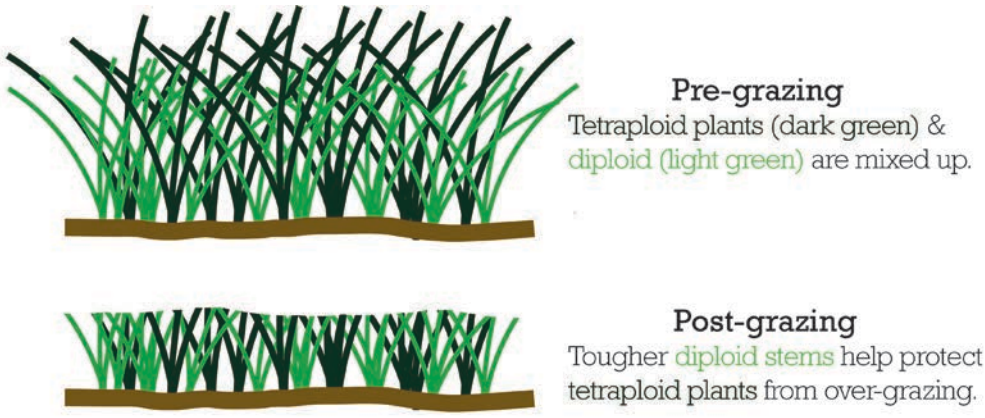
The tetraploid/diploid mix is an average of the two types, denser and more robust than a straight tetraploid, and more palatable than a straight diploid.

Palatability

4front's soft stems improve palatability and animal performance. They also hold their quality even at high covers (e.g. 3500-3600 kg DM/ha), so they're easy to graze.

Diploid the protector

Straight tetraploid pastures are often overgrazed, reducing persistence, but in a mix they are protected by the denser, less palatable, diploid plants.



Sowing rate

We have tested different tetraploid/diploid perennial ryegrass mixes. Our recommendation? Sow half the normal rate of each cultivar, e.g.15 kg/ha of tetraploid *4front* (half of 30 kg/ha) plus 10 kg/ha of a diploid like *Maxsyn* or *Array* (half of 20 kg/ha).

Maximising white clover

Summary

White clover is a key element of our farm systems thanks to its high feed value, warm season growth and natural ability to fix nitrogen.

It is more difficult to establish in a pasture than grass, however. Take care with soil fertility, sowing technique and cultivar choice. Clover content is also greatly influenced by on-going pasture management.

Soil fertility

Correct soil fertility is a must. Clover is sensitive to soil pH, growing best at 5.8-6.2. Ensure adequate levels of phosphate, sulphur and molybdenum. If lack of clover is on-going, test the herbage of clover plants present to help find answers.

Establishment

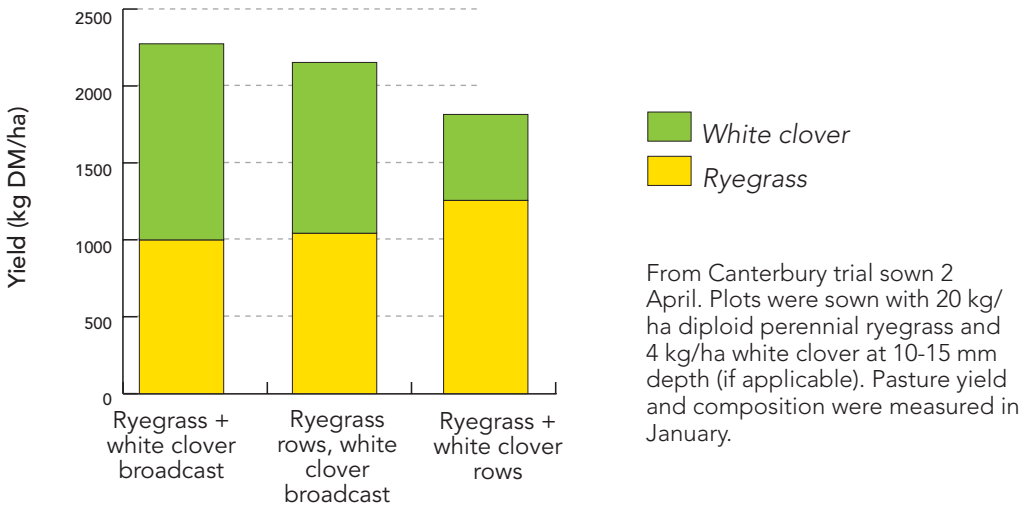
Careful establishment helps white clover thrive.

It has a small seed, requires shallow sowing (<5 mm), and is often sown too deep. Drilling ryegrass and clover in the same row through a coulter drill means competition from the faster establishing ryegrass suppresses clover (see graph below). Where possible don't sow ryegrass and clover together in rows. If cultivating, roller drills are ideal. If your drill (or your contractor's) has a separate small seed box, one option is to order your clover seed separately, sow it through this, then roll.

Sowing method & clover

In this trial, white clover and ryegrass were sown using three widely used methods. Nine months after sowing, broadcasting white clover seed gave on average 20% more clover in the pasture than drilling with ryegrass in a row.

White clover and ryegrass DM yields from different sowing methods



From Canterbury trial sown 2 April. Plots were sown with 20 kg/ha diploid perennial ryegrass and 4 kg/ha white clover at 10-15 mm depth (if applicable). Pasture yield and composition were measured in January.

Maintaining good clover

Once established, white clover will perform best under rotational grazing, so it is frequently exposed to sunlight, not shaded out under high grass covers. White clover is also preferentially grazed by stock, so continuous set-stocking often leads to over grazing and reduced clover levels.

Cultivar choice

We recommend two main clover mixes, one for dairy and cattle grazing, the other for sheep and deer. These both contain cultivars of two leaf sizes, for greater adaptability to climate, topography and management.

Kotuku/Ruru - Dairy/beef

This is a high yielding combination, performing well across a range of conditions. *Kotuku*, with its large leaf, fast establishment, and high summer and autumn growth, is complemented by *Ruru*, which has a medium leaf, high stolon density, early growth and persistence. (Refer to *Kotuku* on page 46 and *Ruru* on page 48).

Ruru/Apex - Sheep/deer

This combination has smaller leaves, and better tolerates close grazing while still providing very good warm season production. *Ruru* with its medium leaf is complemented by *Apex* with a small leaf. Both have shown good tolerance to summer dry conditions or under clover root weevil attack. (See *Apex* on page 45).

Kotuku, Ruru & Apex have many stolon growing points. Each point is a potential new plant.

Improving environmental outcomes

Summary

Every farm is unique, and so too is every plan to minimise environmental impact. Strategies that work for you may not work for your neighbour, and vice versa. With pastures, however, science has shown us even small changes can make a big difference.

Grow in winter

The wet winter-spring period is the main risk time for nitrogen leaching, so the more winter growth in the system, the more soil nitrogen is taken up. Modern plant breeding has really helped here - today's perennial ryegrasses grow 20-30% more winter DM than their 20-year-old predecessors. To soak up even more winter nitrogen, sow the highest yielding Italian or annual ryegrass (e.g. *Tabu+* or *Hogan*) or cereal (e.g. *Hattrick* oats).

Cover up

Nothing loses soil nitrogen in winter like bare ground. Post autumn or winter crops, sow *Catch-crop+* (a mix of oats and Italian ryegrass) to help catch any excess nitrogen before it has a chance to leach. Don't wait til the whole paddock is bare – sow half as soon as the crop is grazed. Earlier sowing gives much better yield and nitrogen uptake. (See *Catch-crop+* on page 141).

Min till

It means more careful weed and pest control, but establishing new pasture through minimum tillage releases less nitrogen than cultivation, and also uses less diesel. Long term it is better for soil structure too.

Mix it up

Plantain and chicory can help reduce nitrogen leaching over diploid perennial ryegrass, because they contain more water than diploid perennial ryegrass, and thus dilute the nitrogen content of urine. Tetraploid ryegrasses also have potential here, for the same reason, plus they persist better and are easier to manage, boosting productivity in many farm systems.

Graze higher

Grazing at higher covers means we capture more of the sun's energy. Typical diploid ryegrass pastures are grazed at around 2 - 2.5 leaves/tiller because this is the easiest way to maintain good residuals.

Captain CS plantain mitigates N in several ways.

Improving environmental outcomes (cont.)

Tetraploid/diploid mix pastures like *4front/Array* change the equation, as they hold feed quality longer, and still graze well at higher covers. For example, using tetraploid-based pastures, Lincoln University Dairy Farm was able to delay grazing to 2.5-3 leaves per tiller (or 3500-3600 kg DM/ha).

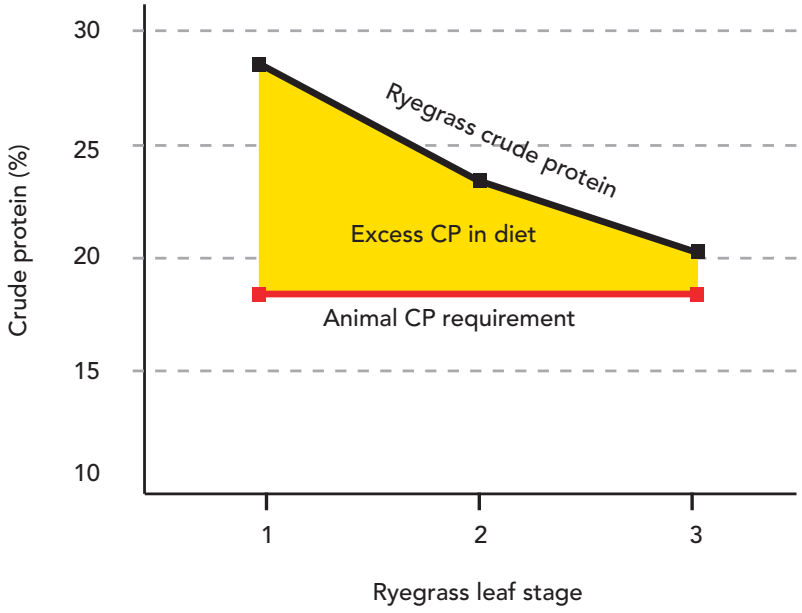
That sounds like a small change, but it compounds to return big dividends, because a ryegrass plant's fastest growth comes with the third leaf. This comprises 40-45% of the total growth available and can mean growing +1.2 DM/ha/year for the same nutrient supply.

Better balanced grass

Alternatively you could grow the same amount of DM for 100 kg/ha less nitrogen fertiliser (based on a growth response of 12 kg DM/kg N).

Grazing higher also improves pasture nutrient balance. As ryegrass grows, its crude protein (CP) or nitrogen level drops (see below). Lactating animals need about 18% CP in their diet, so a pasture with 22% protein at that time supplies 4% too much. This excess protein, excreted as urine and dung, is what causes problems with nitrogen loading of soils. Grazing 0.5 leaf/tiller later (e.g. moving from grazing at 2 - 2.5 leaves to 2.5 - 3 leaves/tiller) may reduce CP by 1.5%, dropping excess protein by over 30%. Currently this effect is not recognised in Overseer. Hopefully it will be in time, as it is significant.

Crude protein (CP) in ryegrass at each leaf stage vs requirement of lactating animal



Break later

On dairy farms, use 24 hour grazing to give cows a new paddock in the afternoon. Cows eat about 70% of their intake in the first half of the grazing. Putting them into a new paddock when ryegrass carbohydrate levels are highest and protein levels are lowest in the late afternoon means they consume less nitrogen. 24 hour grazing has no effect on cow production compared with 12 hour grazing (and is easier with half as many stock shifting decisions too!)

Feed more efficiently

Raising animal intakes puts more energy into animal production and less into maintenance. Lincoln University Dairy Farm is a great example of this principle in action.

It went from 680 cows to 560 cows, but maintained similar MS production, using tetraploid/diploid ryegrass pastures with higher ME and palatability than straight diploids to help increase cow intake. Putting more feed into milk production and less into cow maintenance also lightens the farm's environmental footprint. Plus, fewer replacement heifers are needed, further improving environmental performance.

The same principles hold for breeding ewes, cows or finishing stock. Higher production per animal or faster growth rates mean greater efficiency and a lower environmental footprint. See page 122 for an example of this with lamb finishing.

Fix for free

Legume-rich pastures need less artificial nitrogen fertiliser. Use high performance red, white and annual clovers, as they fix 25 kg atmospheric N/ha for every tonne of DM grown (and improve animal performance too).

High performance clovers - like Ruru - help cut the need for artificial N fertiliser.

Prevent pugging

Compacted, waterlogged soils release more greenhouse gases than soils with healthy structure. They are more prone to runoff and soil loss, with overland flow of sediment, phosphorus (P) and faecal material to waterways. They need more tractor work for seedbed preparation and sowing, and more fertiliser to ensure growth of subsequent crop or grass growth. See page 108 for management tips.

Reduce bare soil

Soil bared out by over-grazing is at higher risk of erosion than soil protected by pasture plants, even on flat land. Maintaining vegetative ground cover through pasture maintains and improves soil organic matter and structure, and enhances biological activity.

Managing pasture when it's wet

Summary

Pugging and treading damage can reduce pasture yield by ≥ 35%. Severe pugging by cattle can kill pastures (see photo below). Where pastures are badly damaged, repairing them is a race against time. New seed needs to be sown before weeds take over.

Severe pugging can kill a pasture. Here damage was caused by dairy cows behind a break fence (left) during heavy overnight rainfall. (Photo taken 4 months later.)

How to minimise pugging damage

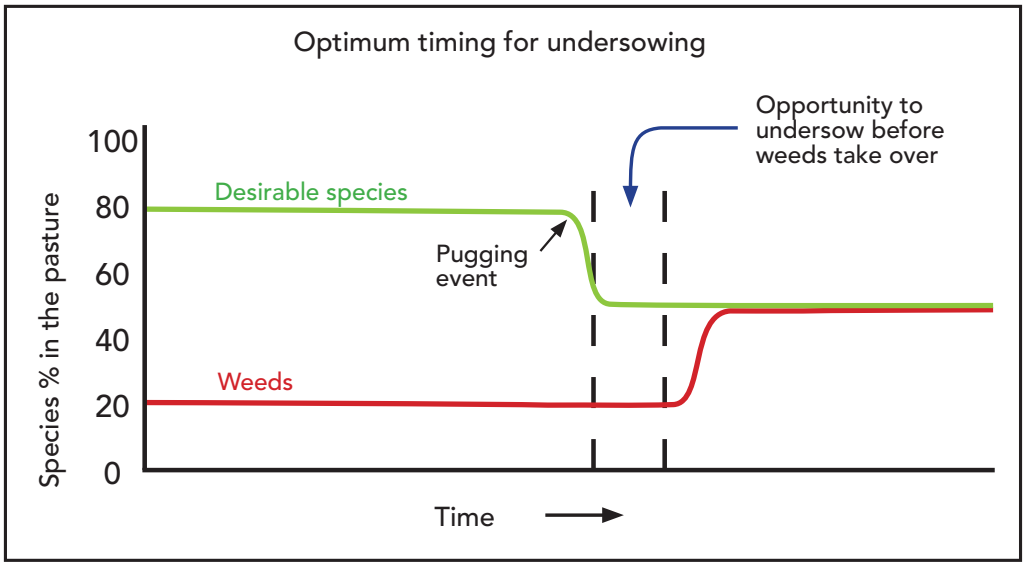
Several strategies are available:

- Draw up a wet weather management plan and make sure everyone shifting animals on your farm understands the plan.
- Graze paddocks known to be vulnerable to wet conditions (including new grass) early, i.e. autumn, in case the weather turns wet later on.
- On:off graze - remove stock from pasture after 2-4 hours grazing onto a stand off pad or sacrifice paddock (e.g. one going into crop). Sacrificing one paddock is better than damaging many.
- Spread stock out at low stocking rates.
- Don’t worry about post-grazing residuals when it’s wet. Concentrate on protecting your soils. Focus back on residuals when conditions are dry again.
- Create laneways within paddocks which are being break-fed, to limit treading damage to smaller areas.
- Avoid grazing tetraploid pastures during heavy rain. Diploid pastures are denser and more likely to persist through a pugging event.
- Keep machinery off wet paddocks - feed out a couple of days in advance.

Restoring pugged pastures

Even with a good plan, the need to feed animals in wet weather means pasture damage can happen.

- Restoring pastures after bad pugging damage is a race against time. If you don't get productive species back into the bare ground, fast growing weeds will quickly fill the gaps.
- If used at the right time (see graph below), undersowing is a useful tool for repairing damage.



- In early spring, sow as soon as soil temperatures are above 6°C for annual or Italian ryegrass, or 8°C for perennial ryegrass. Sow seed at 10–15 kg/ha for thin pasture and 15-20 kg/ha for severe damage.
- For larger areas, mark damaged area(s) on a farm map, and give the map to the contractor to undersow (provided damaged areas are level enough, otherwise surface cultivate first).
- Consider undersowing with *Tabu+* Italian ryegrass. This will give quick growth, and is ideal where the plan is to fully renovate the paddock within the next 6-12 months. *Shogun NEA12* hybrid ryegrass will provide 2-3 years' production; *Forge* will give 3-5 years. Where there are no plans to renew the pasture, undersow with perennial ryegrass.
- Where pugging is severe, consider full renovation, either through a summer crop or in irrigated areas via grass to grass in spring.
- For smaller bare gaps, e.g. gateways, grass seed can be oversown or broadcast. A higher sowing rate will be required, e.g. 30 kg/ha, because establishment is poorer than drilling.

Preparing for drought

Summary

Extended dry summers are the big killer of New Zealand pastures. We can't control the weather, but we can do things that will help as many paddocks survive as possible. The result is lower costs and a farm that bounces back from drought much quicker.

Spring

Daughter tillers

Spring is the most important time for drought management. Your aim here is to set up a robust, well tillered pasture prior to summer.

A well tillered pasture is more likely to survive a dry summer. For grasses, management through spring is particularly important, because plants are vulnerable to stress as they change from vegetative to reproductive and back to vegetative growth. Most grass tillers go to seed and die in spring, and the pasture relies on new 'daughter' tillers to survive. These daughter tillers strongly influence summer survival and autumn growth.

Consistency is key

During this time, keep pasture covers consistently in your optimal grazing range (see page 98-100).

Cutting silage early means quick regrowth and good pasture density.

Late spring usually means surplus pasture growth. Good management strategies at this time include removing paddocks from grazing to sow crop; making light cuts of silage or hay (see page 116); mowing pasture pre or post grazing or buying extra animals.

The worst thing you can do at this time is make heavy crops of silage or hay. This shades and kills new daughter tillers. If conditions turn dry at this point, you have a big problem (see photos on page 117).

Summer

Avoid overgrazing

Goals over summer? Avoid overgrazing, increase feed supply and reduce feed demand.

During extended dry periods, growth and options are limited, and your priority is simple: Protect high value pastures so they will survive and re-grow once rain comes.

Maintain residuals in the dry - ryegrass reserves are above ground, not below

Minimise the risk

The biggest risk is overgrazing, i.e. grazing below the normal residual, which removes the (above-ground) plant reserves. This comes from the tension between continued animal feed requirements and poor pasture growth. Overgrazing can kill pastures and encourages weeds.

Make sure you have a plan to protect your most valuable pastures from overgrazing. One tactic is on-off grazing, where animals are removed from pasture when the desired post-grazing residual has been achieved, and put onto to a feed pad, crop stubble, lower value paddocks, or paddock(s) earmarked for renewal.

Having strategies to lift feed supply (e.g. supplements and crops) or reduce feed demand (e.g. selling trading stock or culls, OAD milking) is also critical to keep animals fed and protect pastures from overgrazing through dry periods (see page 95).

Once it rains

Be patient

The key challenge is to be patient, and allow pastures to recover before grazing.

Once pastures receive significant rainfall, you must allow them to recover before grazing. Continue your dry weather management strategies while pastures slowly start growing again.

Ryegrass pastures can only be grazed when ryegrass plants have produced 2.5-3 leaves per tiller, i.e. when plant energy reserves are replenished for good regrowth (see diagram page 100). Grazing prior to this weakens and may kill recovering pastures.

Fixing dead pastures

For dead pastures, or those sacrificed during summer (to look after others) undersowing can be a useful tool (see page 88). Depending on feed requirements, hybrid, Italian and annual ryegrasses provide fast feed to aid recovery.

Responding to flood

Summary

Once the urgent work of cleaning up, feeding animals, and re-establishing infrastructure (e.g. fencing, water) is underway, you can turn to repairing pastures. This checklist is a guide only, as conditions vary.

Pasture recovery checklist

1. **Don't panic.** Plan, prepare and then act, with a feed budget determining the targets for the coming 12 months. A rush job generally means poor results, so do the job once and well. This is a difficult and stressful time, so it is often good to have someone with you to help work out a plan.
2. **Check each paddock.** Flood damage is typically highly variable, with farms needing different plans for different areas.

The effects of a flood vary widely across a farm.

3. **Pastures that have been under water but look okay.** If pastures have been under water for a few days, but are green and look okay, they should be fine. Fertilise and treat as a normal pasture.
4. **Thin or damaged pastures, with little sediment.** You typically want a quick solution, so look to undersow grass seed with a direct drill when dry enough. This will thicken the pasture, stop weed ingression, and restore productivity. Use treated seed for pests, and check for slugs – bait may be required.
5. **Silted pastures?** Check for signs of recovery. If no signs of grass growth are visible after a week, consider the pasture dead. Weeds like twitch/couch, browntop and creeping buttercup are much more likely to survive than ryegrass and clover.
6. **Check the smell.** Smelly silt or sediment is highly anaerobic and can depress germination and establishment of new seed. Anaerobic silts should be aerated or cultivated.

7. **Depth of sediment <50 mm.** Some existing pasture may be able to break through and start growing again. Several factors influence this so assess case by case.
8. **Sediment 50-100 mm.** Existing pasture is unlikely to grow. When the ground is dry enough to be worked, silt should be cultivated normally and sown back into pasture (e.g. in perennial or short-term ryegrass and clover).
9. **Sediment >200 mm.** Wait for it to dry, and if it's uneven look to spread it evenly across the paddock. Sub-soilers or deep ploughing can improve results through bringing buried soil to the surface prior to sowing with short term ryegrass or cereals.

   If cultivation is not possible, deeper deposits can be oversown if they are still damp. Otherwise wait until silt is dry, break up the surface and sow. Generally oversowing does not work as well as cultivation.
10. **Soil test sediment.** This will help determine nutrient content, and develop a fertiliser plan. Most flood deposits have little to no organic matter, are nitrogen deficient and may be low in phosphorus. They also have limited ability to store nutrient, so avoid large fertiliser applications.
11. **Use nitrogen to help surviving pastures.** Nitrogen can boost performance of your stressed pastures; consult your fertiliser representative for advice.
12. **Pick the right cultivars for re-sowing.** Italian ryegrass (e.g. *Tabu+*) and hybrid ryegrass (*Shogun* or *Forge*) are more vigorous than perennial ryegrass, with stronger root growth and better establishment under adverse conditions. Cereals (e.g. *Hattrick* oats) are hardy and provide quick short term feed.

Fix vital infrastructure first, then turn to pasture repair.

Ryegrass heading dates

Summary

Heading date is when a cultivar shows seed head in spring. A late heading date can mean better late spring quality.

What is heading date?

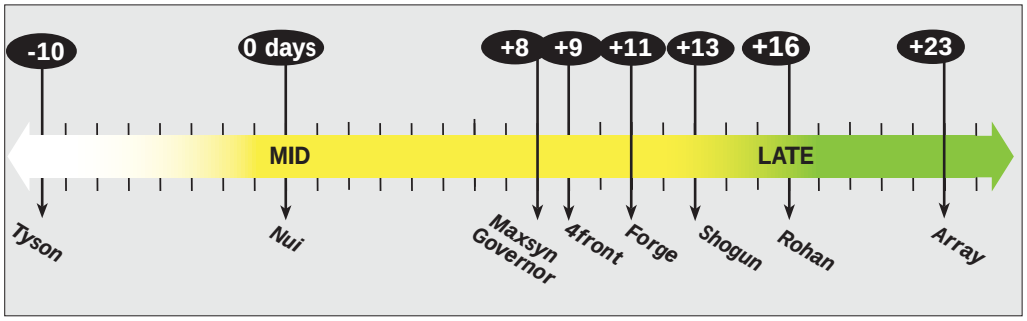
Heading date describes when a grass cultivar has 50% of tillers with seed heads emerged in spring. It is also known as 'ear emergence date' (see photo below).

Day 0 is based on traditional cultivars such as *Nui*, which typically heads around 22 October in Canterbury. But this can vary by 2-3 weeks from year to year. A cold early spring delays heading, while warmth can bring it on earlier.

A +14 day heading date means a cultivar will produce seed head 14 days later than *Nui* (Day 0).

For all ryegrass cultivar heading dates, see page 9 for perennial ryegrass, page 21 for hybrids, and page 27 for Italian and annual.

Heading dates of Barenbrug ryegrasses



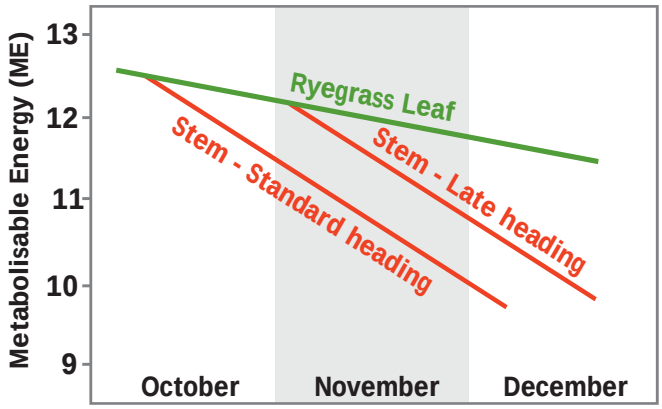
Ryegrass ear just emerging on left tiller.

Using ryegrass heading dates on farm

Summary

As ryegrass goes to seed in late spring, stems develop, fibre levels rise and quality drops as illustrated below. Late heading cultivars delay the start of seeding, thus maintaining animal intake and performance in November.

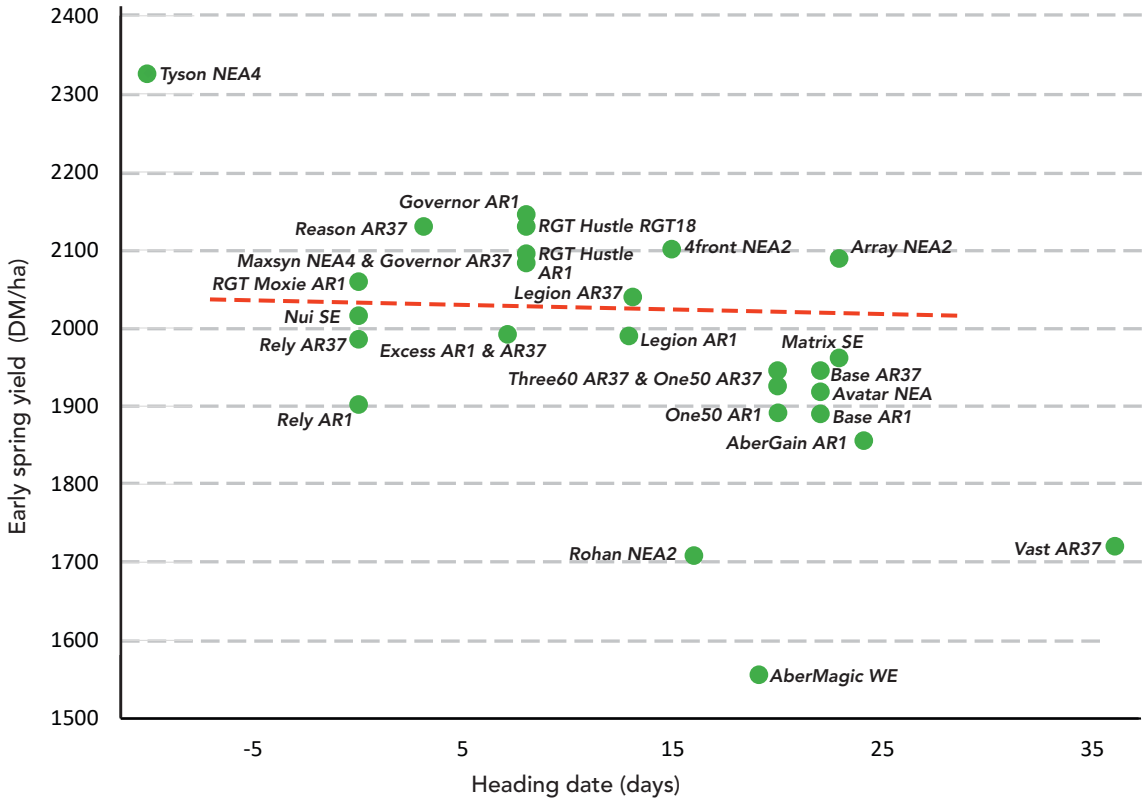
Advantage of late heading



Late heading & early growth

The first late heading perennial ryegrasses in NZ had poor early spring yield, but this is no longer the case. Recent breeding has combined early spring growth and a late heading date in a cultivar (e.g. *Array NEA2*). This is shown below by graphing the 2024 National Forage Variety Trial (NFVT) early spring cultivar yields versus heading date. Apart from a few outliers (e.g. *Tyson*, *Abermagic*, *Vast*) early growth is similar.

Heading date vs early spring yield of perennial ryegrasses*



** NFVT data for whole of New Zealand Trials 2024*

Making great silage

Summary

Making silage is a balance – when you close a paddock, yield increases but quality drops. For quality silage make light crops. Light crops also significantly improve pasture regrowth, density and persistence.

Less is more

Lighter crops, harvested earlier, produce better quality silage. For optimal ME, cut pastures before they reach 4 t DM/ha (i.e. harvest about 1.5-2.5t DM/ha). Paddocks cut earlier also regrow faster and are available for re-grazing earlier, handy when the weather changes and growth rates slow.

Using later heading ryegrasses can help silage ME, because those maintain better pasture quality in late spring. If possible cut paddocks in the afternoon, this is when water soluble carbohydrates (WSC) are highest in the plant.

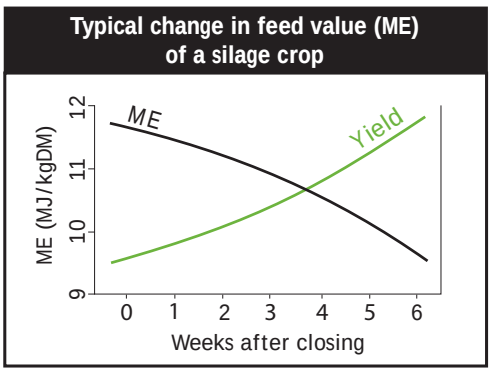
Rate of quality lost

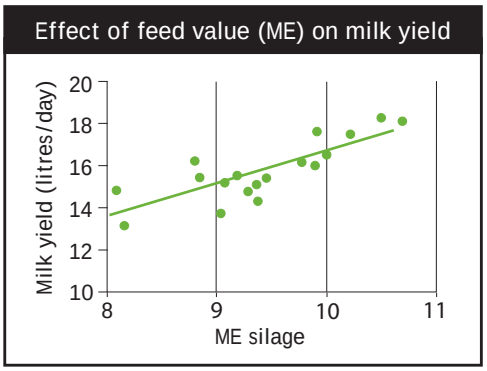
Leafy spring pasture has an ME of 12 or more. As soon as the yield exceeds 3500 kg DM/ha, quality drops.

Pastures not cut before 4 t DM/ha can lose 1 ME unit every two to three weeks, as stems, seed heads and dead matter increase. (See page 119 for typical ME values.)

Effect of silage quality

Quality may not be important for animals on a maintenance diet, but for good animal performance it's essential. Silage quality has a direct effect on dairy cow milk production, as shown in the graphs below.





Adapted from Newcastle (1975)

What causes poor silage?

Survey work has shown NZ silage averages approximately 10 ME, and that farmers are generally good at what happens after cutting (stacking, compacting, and covering). The main reason for so much poor silage is it is cut too late. Weather also affects quality. If made in good conditions, pasture typically loses 0-0.5 ME units through ensiling. Prolonged wilting and rain can increase this loss.

Nitrogen fertiliser

Applying nitrogen fertiliser to a paddock shut up for silage production helps increase growth rates, so the paddock can be grazed again sooner. Applying fertiliser after cutting can be useful to replace the large amounts of nitrogen and potassium removed in the silage.

Effect of silage on regrowth

Pasture regrowth after silage is strongly influenced by crop yield. Heavy crops are slow to recover, whereas light crops recover quickly. Light crops have a significant advantage if the farm goes into a feed deficit, because these paddocks are back available for grazing sooner.

Effect of silage on density & persistence

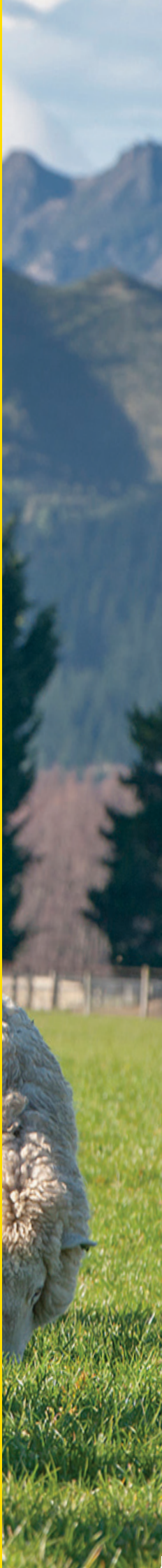
During late spring, ryegrass produces many new 'daughter' tillers, which are vital for growth and persistence in the coming year. They will not survive weeks of darkness under a heavy silage crop.

This is commonly seen after silage paddocks are allowed to become overgrown. Cut pasture is yellow and sometimes white, and pastures are thin and are slow to regrow because most daughter tillers have died. In this weakened condition they are susceptible to loss of persistence as shown below. Clover also starts to flourish in late spring and needs light the same way daughter tillers do.

These pictures show the same diploid perennial ryegrass on the same farm in the same autumn, following a dry summer. The top paddock was grazed well through spring (seen here ungrazed for 60 days). The bottom paddock was badly damaged by taking a heavy silage crop before summer (seen here ungrazed for 75 days).

Animal production

Pasture feed value	119
Feed quality & lamb growth	121
Feed quantity & lamb growth	122
Building pasture cover for lambing	123
Maximising pasture utilisation	124
Nitrate poisoning	125
Pasture palatability	126
Brassica feed values	128
Brassicas & animal health	129
Brassica grazing management	130
Fodder beet & animal health	132
Transitioning onto fodder beet	134
Winter feed considerations	136

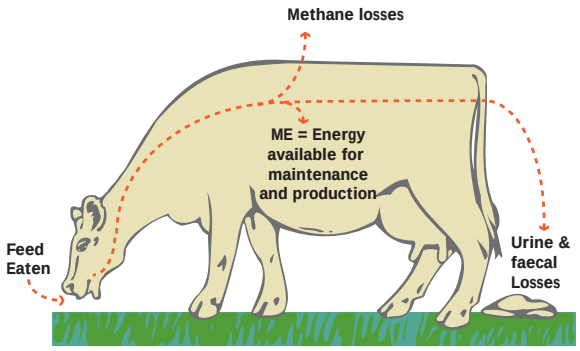


Pasture feed value

Summary

Pasture feed value is measured in several ways, the most important being metabolisable energy (ME) and digestibility. ME is the more useful unit for many applications. Feed value matters, because it drives animal intake and performance.

Metabolisable energy (ME)



ME is the energy in a feed available to the animal after allowing for faecal, urine and methane losses. It is measured in megajoules per kilogram of dry matter of the feed (MJ/kg DM).

ME is the energy available to the animal for maintenance, growth and production.

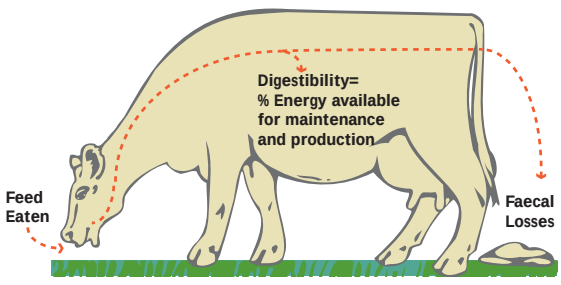
Typical ME in MJ/kg DM (these vary widely)

Pasture		Ryegrass plant	
Leafy spring	11.5-12.5	Green leaf	12-13
Leafy summer	10.5-11.5	Dead leaf	7-8
Stalky dry summer	8-9	Green stem in spring	11
Leafy winter	11-12	Mature stem in spring	8
Silage		**Hay**	
Pasture good	11+	Pasture good	10
Pasture average	9-10	Pasture average	8.5
Pasture poor	8	Pasture poor	7.5
Maize (early dent)	10.3	Straw	6.5

Dry matter digestibility

Digestibility is the percentage of energy in a feed available to the animal after faecal losses. This can be calculated as:

$$\frac{\text{DM eaten - DM excreted}}{\text{DM eaten}} \times 100$$



Typical DM digestibility values	
Leafy spring pasture	80-85%
Leafy summer pasture	75-80%
Stalky summer pasture	60-65%

Relating ME & digestibility

Digestibility and ME are related and can be approximately compared as follows:

Dry matter digestibility (%)	60	70	80
(MJ/kg DM)	8.8	10.6	12.4

Pasture feed value (cont.)

Why is ME important?

ME is a key driver of animal performance in most NZ pasture-based systems. ME has a double effect, because as ME feed values increase, so do animal intakes. Conversely, low ME feeds need extra time in the rumen to degrade. For example, it takes 45-55 hours for high fibre straw (ME 7-8) to pass through the rumen, compared with 18-24 hours for good quality grass (ME 11-12). When an animal's rumen is full, it will stop eating, so low ME feeds limit intake.

Water soluble carbohydrates (WSC)

WSC are simple sugars present in plant cells, and are an important energy source for animals. WSC content is highly correlated with ME. In most cases ME gives a better indication of animal performance than WSC, as production responses to WSC have been much smaller and less consistent than responses to ME. Increased levels of WSC can have environmental benefits at times, by reducing the amount of nitrogen lost in the urine.

Crude protein (CP)

Animals need crude protein to maintain body tissue and produce milk/meat. Ideal CP levels for lactating animals are 17-18%. For live weight gain 12% CP is needed in the diet. NZ pastures are relatively high in CP, and it does not generally limit animal production, except in summer dry conditions.

Rather than increase animal production, pastures containing high concentrations of CP (≥24%) lead to increased levels of nitrogen in the urine and dung. This increases potential N loading in the urine and dung patches and subsequent risk of nitrate leaching from the soil.

Neutral detergent fibre (NDF)

NDF is the most common measure of fibre in feed analysis. NDF measures more than 90% of the structural components in plant cell walls, including lignin, hemicellulose and cellulose. In high quality pasture, the ideal NDF is 35-40%. As it rises, for example in rank pasture, ME and digestibility fall.

Visually assessed feed quality

Nutritive value can be assessed visually, based on physical attributes. Always look at the whole paddock as quality can vary across a pasture.

- Legumes and herbs generally have higher feed value than grasses.
- Green leaf generally has high ME; dead matter, stem and seed head are significantly lower.
- Anything green and leafy is often a sign of higher crude protein content.
- High temperatures drop summer ME.

Importance of management

Good pasture management is the biggest driver to maximising feed value, and creating sustainable, efficient, profitable farm systems. Key strategies include:

- Managing pastures through late spring (see page 98 - 100).
- Grazing to the correct residuals (see page 100).
- Grazing at the right time (see page 100).
- Maximising legume content (see page 103).

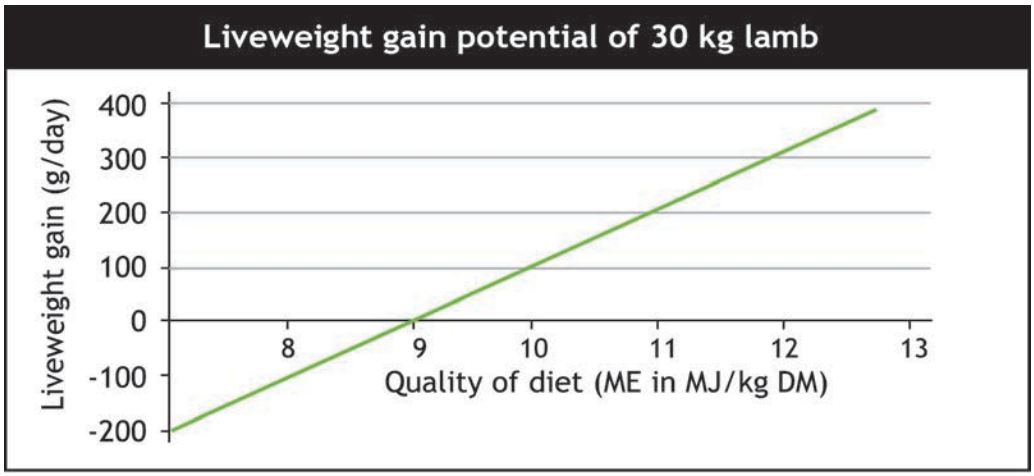
Feed quality & lamb growth

Summary

Lambs need high quality feed to grow quickly. The faster they grow, the greater their feed conversion efficiency, as less feed energy is needed for extra days of stock maintenance.

Effect of ME on lamb growth

Feed quality is particularly important in November-February, when grasses go to seed and pastures can burn off in dry conditions.



Source: 400 plus; A guide to improved lamb growth for farmers and advisors, 2010

For high LWG, lambs need a diet with ME higher than 11. This means green, leafy pastures, with low levels of dead matter or stem, and preferably high levels of clover. (See page 119 for typical ME levels.) Small increases in forage ME can have significant positive effects on animal and farm performance.

In summer dry areas, high quality summer feed may be best supplied by clover dominant pasture, chicory, lucerne or brassicas.

Feed with ME below 9 will not grow lambs. This includes hay, low quality silage, and stemmy or dead pasture.

Lambs need a diet with an ME higher than 11 for fast LWG.

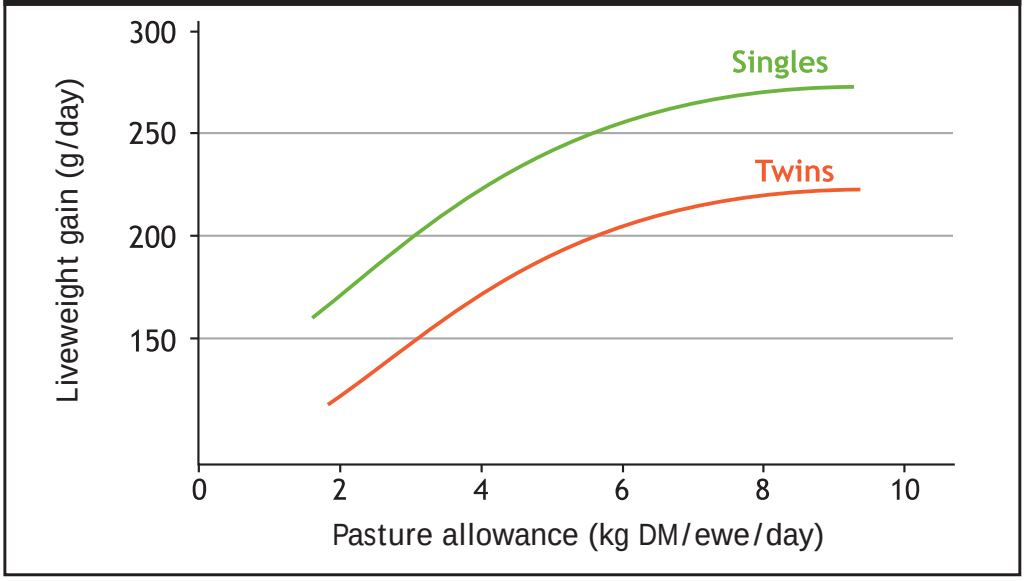
Feed quantity & lamb growth

Summary

Pasture yield at lambing directly affects lamb growth. When feed quality is generally good (March-October), feed quantity drives the performance of many livestock systems.

Effect on suckling lambs

Pasture allowance and liveweight gain of suckling lambs



Source: NZ Soc. of Animal Production. Publication No. 10, Rattray, 1987

At lambing in early spring feed quality is typically good, and feed quantity is the key driver of lamb growth. To achieve the best lamb growth, target pasture covers through lactation should be 1200 kg DM/ha+ (about 3 cm+ in height) for single lamb bearing ewes, and 1500 kg DM/ha+ (about 4 cm+) for ewes bearing twins.

Post weaning, feed quantity continues to be a key driver of lamb growth, as shown below.

Feed requirement of lambs 24-34 kg

Lamb growth rate (g/day)	100	200	300	400
Feed requirement (kg DM/day)	1.2	1.5	1.9	2.4
Days to target weight (34 kg)	100	50	33	25
Total feed consumed (kg DM/hd)	120	75	63	60

Source: 400 plus; A guide to improved lamb growth for farmers and advisors, 2010

Greater efficiency

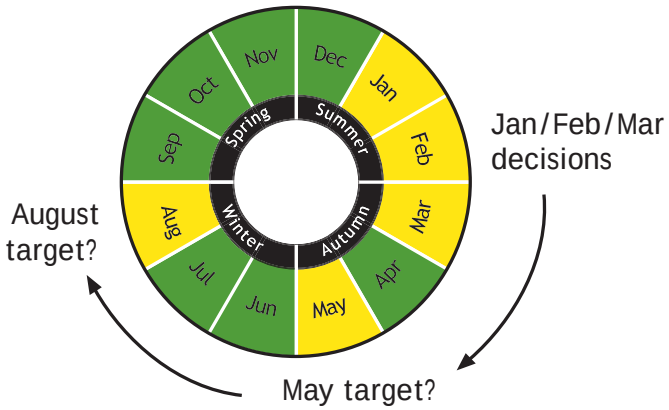
The above table shows the faster lambs grow, the more efficient the system is at turning feed into liveweight. That's because lambs growing at 100 g/ day require energy to live, breath and function (maintenance energy) for 100 days, whereas lambs growing at 400 g/day only need maintenance energy for 25 days. This frees up 75 days to utilise the feed in other ways.

Building pasture cover for lambing

Summary

The amount of pasture available in early spring influences the whole production cycle for the year ahead. Success lies in planning ahead, using three tactical reference points: the August target, the May target, and January/February/March decisions.

Key feed planning decisions



- Identify how much pasture cover is required at lambing. This is the August target. The typical minimum for set stocked single-lamb bearing ewes is 1200-1300 kg DM/ha (3-4 cm pasture height) or 1500-1600 kg DM/ha (4-5 cm height) for twin-bearing ewes. *Tyson* perennial ryegrass can increase early growth.
- A winter feed budget will determine the cover needed at the start of winter to achieve the August target. This is the May target.
- Decisions need to be made as to what to do in autumn to achieve the May target. These are the January/February/March decisions.

Four potential scenarios

1. **The autumn stock selling policy affects the May target.** Avoid holding onto animals too long. Without supplementation post-lambing, the cost will always be counted in ewe condition post-weaning, and thus conception the following year.

2. **An autumn drought halts growth.** Hold animals on a sacrifice block, and feed supplements. This should be continued even after it rains to allow the farm cover to build up. New growth should not be grazed as it emerges because it is critical to pasture recovery. (See page 114).

3. **Ewes are overfed during winter and the August target is hit in July.** Avoid this situation by rationing feed. Overfeeding ewes when they should be on maintenance leads to potential birthing difficulties and underfeeding post-lambing.

4. **Pasture growth fails to meet the budget.** Use N tactically in autumn and/or spring. Soil temperatures must be above 8°C (preferably above 10°C). Using nitrogen to reach target covers at or immediately post lambing has proved highly cost effective, especially with high fecundity ewes.

Pasture choices

Sowing different pastures can improve lambing covers in two ways. Cultivars with extra autumn growth (e.g. *Shogun* or *Forge* hybrid ryegrass, or *Maxsyn*25 perennial ryegrass) can help build May covers. Cultivars with extra early spring growth (e.g. *Tyson* perennial ryegrass) can feed animals better through lambing.

Maximising pasture utilisation

Summary

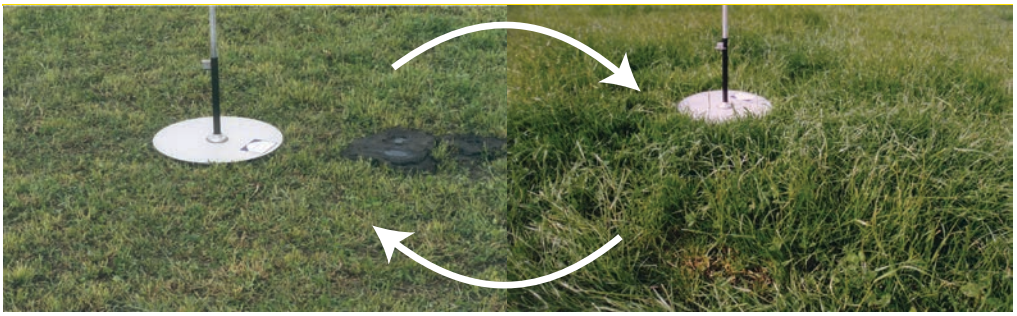
A big challenge on-farm is pasture utilisation - getting animals to eat the optimum volume of feed grown. To achieve this, focus on achieving consistent post-grazing residuals and grazing at the right time.

What is possible?

Typical utilisation of our pastures on flat to easy country is believed to be 60-70% of yield grown, with top operators reaching 75-85%. Utilisation is also affected by conditions. It is highest on free draining soils, and poorest during wet weather.

How can utilisation be improved?

Focus on what's left after grazing, the post-grazing residual. Get this right, and you'll harvest a high amount of pasture. More importantly, you'll leave the paddock in the right state to regrow leafy, quality grass for the next grazing.



Good post grazing with no dead matter in the base (in good weather).

Graze at the right time with no dead matter in the base.

Graze at the right time

Grazing at the right time (2.5-3 leaves per tiller), before the pasture loses quality at the base, produces high quality feed. With the right stocking rate and allowance, animals will graze to the right residual, perform well and achieve high utilisation needed to make the pasture system efficient.

Consistency is key

The goal is to graze to the same residual all the time. High utilisation is easier when feed supply is tight. A focus on residuals is most important during periods of excess growth and tools such as mowing or making silage are important to help achieve this.

Residuals in bad weather

In wet weather, particularly on heavy soils, achieving normal residuals is not possible due to potential soil damage. When this happens, focus on avoiding damage and, if necessary, accept a higher residual in the short term, aiming to correct this at the next grazing (see page 108).

Great pasture quality doesn't just happen – it's an outcome of good residuals.

Nitrate poisoning

Summary

Nitrate poisoning is caused by high nitrate levels in feed and is usually a problem in late autumn or winter, particularly during a flush of growth after a dry summer.

Sheep, cattle, deer and goats can all be affected. Cattle are the most susceptible and sheep the least so. Nitrate poisoning can occur with short-term ryegrasses, oats, brassicas and occasionally other new pastures with a rapid growth rate.

Symptoms

Cattle can start to show signs of poisoning 1-8 hours after consuming toxic levels of nitrate. The onset of symptoms is rapid and these include: animals appearing weak and staggering, gasping for breath, and rapid deterioration often leading to death. If symptoms are detected early, animals can be treated. However nitrate poisoning is usually fatal. Remove affected animals from the toxic feed source immediately.

How can nitrate levels be managed?

If in doubt, nitrate test pastures and crops, particularly in autumn before the first grazings of short-term ryegrass or cereals. Results are usually available in a few hours. Nitrate tests are performed at most animal health laboratories and some vets also sell test kits.

Poisoning is most likely when animals eat high volumes of grass or crop with elevated nitrate levels. Don't put hungry animals onto such feed. Before grazing a potentially toxic paddock, feed them silage, hay or something else low in nitrate concentration first. Limit their grazing time, too. Animals can tolerate moderate levels of nitrate, if they eat the feed slowly.

If possible, graze problem crops with older animals. They are less susceptible to nitrate poisoning than young ones. Crop nitrate levels are usually lower late in the afternoon, particularly on sunny days.

Nitrogen fertiliser can exacerbate nitrate levels. If high nitrates are a concern, either avoid applying N fertiliser or apply it in small amounts (20-30 kg N/ha) just after the paddock has been grazed.

What is a dangerous level?

No absolute level can be given, but generally, for pasture:

- below 25 mg/kg DM is safe
- from 25-100 mg/kg DM should be fed with caution
- >100 mg/kg DM is potentially toxic

Test kits can help manage crop nitrate levels if required.

Pasture palatability

Summary

Poor pasture palatability is caused by various factors, usually in combination. Your ryegrass cultivar is not one of them! Herbage tests can help identify where the problem lies.

Weather conditions

Most issues occur in spring during wet periods, when sunshine is low and growth rates are rapid. This reduces pasture DM (<15%), and stops animals from eating enough to their meet daily energy requirements, because they are consuming a lot of water. Water soluble carbohydrates also drop with a lack of sunshine, reducing stock intake further. The issue typically solves itself when the weather improves. Meantime, mowing problem paddocks pre or post-grazing can help maintain residuals and feed quality.

Not cultivar

While the vast majority of seed we sell produces pastures that are well grazed, very occasionally we see a palatability issue. Often these farms have 2 or 3 paddocks sown with an identical seed mix on the same day, and only one paddock has an issue. The problems we see are paddock related, not related to any cultivar.

Rising residuals

Palatability suffers when post-grazing residuals creep up. This is common in spring. Check for high levels of basal stem and dead matter in the pasture base – animals actively avoid eating this. Dead leaves also accumulate if pre grazing covers are too long (> 3rd leaf). Reset residuals by mowing, to 4-5 cm for dairy cows and 3-4 cm for sheep; or by grazing with dry stock.

Would you eat this? Dead 4th leaf close up, dead leaves in the base of new pasture .

Animal preference

Given a choice, animals can develop a distinct preference for tetraploid vs diploid ryegrass pastures. In this case, focus on grazing diploids well, possibly earlier than tetraploids. High volumes of supplement also reduce pasture intake and desirability, so feeding less of this can help.

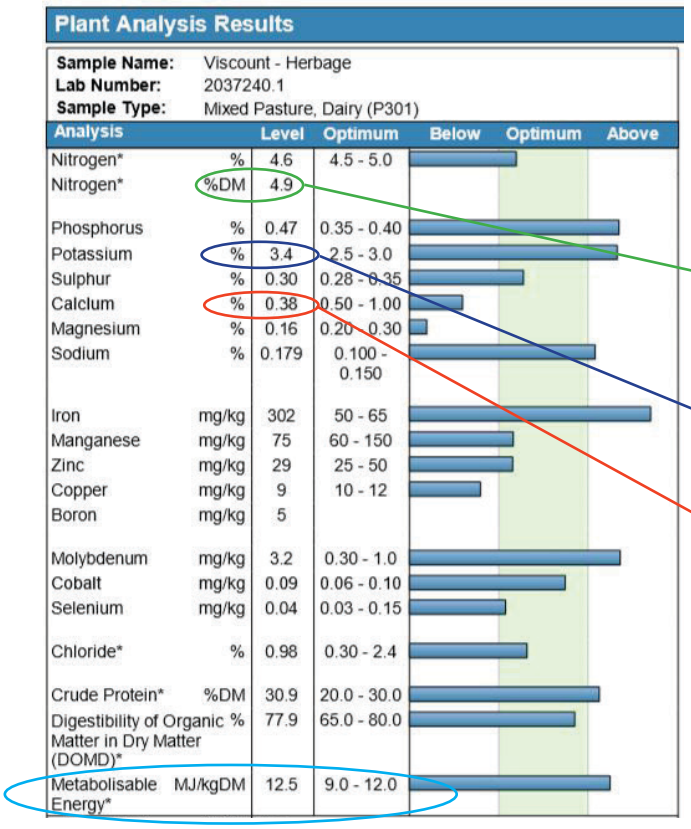
Effluent application

Animals don't like grass freshly sprayed with effluent. Also, repeat effluent applications can raise nitrogen and potassium levels in both soil and herbage, which can reduce palatability. Harvest silage from such paddocks to 'export' surplus nutrients and correct the imbalance.

Nutrient imbalance

Non-effluent paddocks can have nutrient imbalances, too. Herbage test results often reveal useful information. For example, this paddock tested below had palatability issues, even though feed quality was very good (ME = 12.5).

The test shows N was very high, K was high and calcium (Ca) was low – all known to reduce palatability. Graze or mow to restore residuals and maintain feed quality. Ideally make silage to 'export' surplus nutrients. Apply 1-2 t/ha lime to increase plant Ca uptake and decrease K levels.



Plant Analysis Results

Sample Name: Viscount - Herbage
Lab Number: 2037240.1
Sample Type: Mixed Pasture, Dairy (P301)

Analysis		Level	Optimum	Below Optimum Above
Nitrogen*	%	4.6	4.5 - 5.0	
Nitrogen*	%DM	4.9		
Phosphorus	%	0.47	0.35 - 0.40	
Potassium	%	3.4	2.5 - 3.0	
Sulphur	%	0.30	0.28 - 0.35	
Calcium	%	0.38	0.50 - 1.00	
Magnesium	%	0.16	0.20 - 0.30	
Sodium	%	0.179	0.100 - 0.150	
Iron	mg/kg	302	50 - 65	
Manganese	mg/kg	75	60 - 150	
Zinc	mg/kg	29	25 - 50	
Copper	mg/kg	9	10 - 12	
Boron	mg/kg	5		
Molybdenum	mg/kg	3.2	0.30 - 1.0	
Cobalt	mg/kg	0.09	0.06 - 0.10	
Selenium	mg/kg	0.04	0.03 - 0.15	
Chloride*	%	0.98	0.30 - 2.4	
Crude Protein*	%DM	30.9	20.0 - 30.0	
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	77.9	65.0 - 80.0	
Metabolisable Energy*	MJ/kgDM	12.5	9.0 - 12.0	

This pasture with a palatability issue had high feed quality (ME = 12.5) so grazing management is unlikely to be the cause.

But other things are going on.

High nitrogen levels in plants reduce palatability. Good spring levels are 3-4%, here they are high at 4.9%

Potassium is also high (3.4%), but not excessively so. High potassium reduces palatability.

Low calcium (Ca) can also reduce palatability.

Other characteristics

Seed head is a known palatability issue. Also check for disease, for example, rust in summer.

Finally, *Standard endophyte (SE)* pastures produce alkaloids that animals don't like to eat in summer and early autumn.

Brassica feed values

Typical feed values

These can vary widely between situations, cultivars, and time of year.

Brassica	Part of plant	ME (MJ ME/kg DM)	Protein (%)
Kale	Whole plant	11-12	14-18
	Leaf	12-13	19-21
	Top third of stem	12-13	15-17
	Middle third of stem	11-12	12-14
	Bottom third of stem	9-11	8-10
Swedes	Whole plant	12	12-14
	Bulb	12-13	10-12
	Leaf	11-12	18-20
Turnips	Whole plant	12	14-16
	Bulb	12-13	12-14
	Leaf	11-12	18-20
Rape	Whole plant	11-12	17-20
	Leaf	11-12	18-20
	Stem	11	15-17
Leafy turnips	Leaf	11-12	18-20

The above are estimates. For exact feed values in individual farm crops, we recommend laboratory testing.

With kale, the upper part of the plant has the highest feed value. However, Bombardier EG kale has significantly improved lower stem quality.

Brassicas & animal health

Summary

Brassicas can sometimes cause animal health issues, but these can be minimised or avoided through good management. Most problems are seen in the first few days of grazing, especially if animals are put onto a crop hungry (see page 130 for more on grazing management).

Monitor your animals closely, and remove them from the crop if any issues occur. Be wary of any clinical signs, as these may indicate wider sub-clinical issues. Take care even when transitioning animals from one type of crop to another.

Rape scald

Rape scald reddens the skin on ears and faces of lambs grazing rape. To minimise this, don't graze before the crop is fully mature, i.e. purple colouring can be seen on the edges of rape leaves. Animals showing signs of scald should be removed from crop and offered shade.

Nitrate poisoning

Can occur in any type of brassica crop with high levels of nitrate, and can kill animals. Test kits are available. Introduce animals slowly to the crop and supply alternative feed such as straw, hay or silage to slow brassica intake. Nitrate levels decrease during the day, so feed stock as late as possible to reduce the risk.

Red water

Caused by the SMCO (S-methylcysteine sulphoxide) content of brassicas. It is most common in kales, which contain the highest levels, but all brassicas contain SMCO. Animals with red water pass damaged red blood cells in their urine, which can lead to loss of appetite or poor growth rate. Take care with sulphur based fertilisers which elevate SMCO levels. Levels also increase when plants flower. Sheep are more resilient to SMCO than cattle.

Bloat

Can occur when feeding frosted brassica crops, as plant material breaks down more quickly. This can be avoided by shifting breaks after the frost clears (this also reduces nitrate levels).

Purple edges of a rape plant, a sign the crop is ready to graze.

Brassica grazing management

Summary

Brassicas require careful grazing management, particularly when being introduced to stock. Most animal health issues happen in the first few days of feeding.

Introducing animals

Animals coming from other feed need time to transition to brassicas, so introduce them slowly from an initial 1-2 hours a day up to their maximum allowance over 7-10 days. This helps prevent scouring, acidosis and nitrate poisoning. During transition, put animals on to the crop when reasonably full, to slow their intake.

Brassicas should not exceed 70-80% of total daily intake (30% for lactating dairy cows). Where brassicas compromise most of the daily intake, fibre (e.g. hay, straw, silage) must be supplied to help maintain rumen function. It is best to feed this before putting animals on the crop.

Match supplement to the crop being fed to ensure animals receive their complete nutritional requirements.

Trace elements such as copper, selenium, iodine and magnesium may be required; check with your vet. Offer plenty of clean water.

Stock performance targets determine appropriate brassica feeding levels.

Crop utilisation

Brassica utilisation varies widely, depending on soil type, weather, brassica type, cultivar and animal performance goals. For high weight gains, lower utilisation must be accepted. For example, utilisation of kale might be 85% for maintenance, but needs to be <75% to increase body condition score.

Crop allocation

Break feeding is best, giving more control of animal intake, utilisation, regrowth and how long the crop will last. Long narrow breaks result in less trampling and wastage, and higher utilisation. Set targets for animal performance to calculate appropriate feeding levels, e.g. +0.5 body condition score (BCS) in cows over 6 weeks; or ewe lamb growth of 250 g/day.

Setting the exact break size is critical. See page 167 for more.

Monitor grazing, as animals are the final judge of DM yield, break size and crop utilisation.

Pre-calving transition

Feeding pregnant animals brassicas too close to giving birth can lead to metabolic problems. Aim to transition animals back to a grass-based diet at least two weeks before calving.

Monitor animals

Animals and utilisation should be regularly monitored while grazing brassica crops to check they are meeting condition/liveweight targets. For example, for dairy cows in winter, the target for calving is a body condition score (BSC) of 5 for mixed age cows, and 5.5 BCS for first and second calvers. For finishing lambs in summer, growth is maximised where lambs are offered 2-2.5 kg DM/day, and consume about 65% of the crop.

If animal performance targets are not being met, they may need higher daily allowances. Monitor feeding levels to make sure animals are receiving enough. Check the amount of feed still available in the afternoon, after morning break shifts.

Some animals, no matter how much brassica they are offered, simply do not do well on these crops. These animals should be removed and put back onto pasture.

Monitor stock regularly while grazing brassica crops.

Plan ahead

Winter grazing practices are changing in New Zealand, for both environmental and animal welfare reasons. Before sowing, check paddock contour, size, slope, critical source areas (CSAs), soil type, stock access, water access, grazing pattern and nutrient loss buffer zones.

For more detail on best practice winter grazing, visit www.dairynz.co.nz, wwwbeefandlamb.co.nz or local council websites.

Fodder beet & animal health

Summary

Fodder beet bulbs are very high in water soluble carbohydrate (WSC) and low in protein. This can cause animal health issues including rumen acidosis.

Fodder beet in the diet

The daily allocation of fodder beet fed will depend on the stock class, age, desired LWG and the amount of crop available. After transitioning animals onto fodder beet, continue to feed high quality supplement as a significant proportion of the diet to minimise potential health issues. Fodder beet should make up no more than 60% of the diet for dry dairy cows, and no more than 30% for lactating cows.

Feeding high levels of fodder beet over 24 hours slows animal intake and reduces the risk of rumen acidosis compared to feeding the same amount of beet over 4-5 hours.

High utilisation rates (e.g. 90%) can be achieved on fodder beet, even with high crop allocation levels, as the feed quality of the whole plant is high.

Low levels of fodder beet in the diet are sometimes targeted due to performance levels required (e.g. maintenance feeding), or when fodder beet does not meet the nutritional needs of the stock.

Feeding supplement

Fodder beet is low in fibre (NDF) and crude protein (CP), and high in water soluble carbohydrate (WSC). This means animals on beet require more fibre and protein than those grazing brassicas, depending on stock type, age and LWG expectations.

Normally it is best to supplement animals on fodder beet with good quality pasture silage because it contains both fibre and protein, rather than supplements with low protein (straw, cereal silage), particularly for young growing animals. A feed test will help identify the right supplement for animals grazing fodder beet.

Significantly changing livestock diet raises health risks as animals adjust to new feed. This is particularly so for fodder beet due to the risk of rumen acidosis.

High utilisation rates can be achieved on fodder beet.

Feed value

Nutritional composition of fodder beet (FB) versus brassica.

	DM %	CP %	NDF %	WSC g/kg DM
FB average	14-20	11-13	11-16	500-700
FB leaves	10-15	19-23	30	100-120
FB bulb (low DM variety)	10-13	7-8	13-15	500-650
FB bulb (high DM variety)	15-20	7-8	13-15	500-700
Swedes	9-12	12-20	16-30	450-500
Kale	11-15	12-18	20-35	350-400

Rumen acidosis

Rumen acidosis is caused by animals eating diets high in water soluble carbohydrates (WSC) or starch too quickly.

Acidosis is most likely in hungry animals, during the transition period, or where crop allowance is suddenly increased (e.g. cows break out, or break size is mistakenly increased).

With acidosis, rapid fermentation of the WSC causes rumen pH to drop rapidly, often below pH 5.5. The change in acidity alters the rumen flora, with acid-producing bacteria taking over, exacerbating the problem. Low rumen pH can result in rumen stasis (no rumen contractions), reduced fibre digestion and depressed appetite, all of which affect production. In severe cases acidosis can kill animals.

Visual symptoms of acute rumen acidosis in cattle are:

- Scouring
- Reduced appetite
- Loss of body condition
- Bloating
- Dehydration
- Laminitis
- Rumenitis
- Milk fever

Clinical rumen acidosis is usually only the tip of the iceberg; with every clinical case sub-clinical cases are likely to go unnoticed. Reduce this risk through proper transition, and avoid any sudden increases in daily intake.

Transitioning animals onto fodder beet

Summary

It can take up to 3 weeks to transition animals properly onto fodder beet, and 7-10 days to transition off. Both require careful management. This information is a guide. Seek further advice if required.

Transition planning

How the crop is to be fed should determine the planting layout. Provide good access for animals and allow enough room for the entire mob to get on the crop, without over-allocating the amount of feed. This can be a challenge in very high yielding crops in early stages of transition.

One way to achieve this is to plant a greenfeed crop in a headland (e.g. 6 m wide) parallel to the rows of fodder beet. The greenfeed can be used during transition as an alternative feed source, which is not high in readily fermentable carbohydrate. Alternatively fodder beet in the headland can be lifted mechanically or manually and fed to the animals at a low level to start transition. Both options help ensure enough space is available for animals in the fodder beet paddock to manage transition.

Typically, grazing occurs parallel to the rows to make allocation of feed easier. Long narrow breaks, where animals are eating under the wire, are best as this helps ensure that animals have equal access to the crop and none is pushed to the back. It also improves crop utilisation, with less treading of the crop.

Transition in practice

Dairy cows

For mature dairy cows it is advised to start transition by allocating 1-2 kg DM/day per animal and gradually increase the amount of fodder beet offered by 1 kg DM every 2 days until the desired allocation is reached. This will take 14-21 days depending on the final allocation. In early transition a high proportion of supplement will be required, and this will decrease over the transition period as fodder beet intake increases. Supplement should be fed in the three hours before fodder beet to ensure good gut fill. This will slow the rate of fodder beet intake and minimise gorging.

For the first days of transition, fodder beet is often lifted and fed to stock (e.g. on grazed pasture) as it is hard to ensure very low intake levels of all animals when break feeding, because some dominant cows may gorge themselves.

During this early stage, monitor animals closely. Ensure they are eating everything allocated to them, and do not let a bank of uneaten bulbs accumulate in previous breaks. Individual animals transition at different rates, so even with a good transition process rumen acidosis can still occur. If animals show any signs of acidosis, remove them from the crop straight away. Drenching with sodium bicarbonate (baking soda) can help increase the rumen pH. Contact your vet for further advice.

If animals are off the crop for more than 2 days re-transitioning will be required, the speed of which will be determined by how much they were being offered previously.

R2 heifers & steers

For R2 heifers and steers it is advised to start by allocating 1 kg DM/day per animal, and gradually increase allowance as outlined above for mixed aged cows.

Transition in practice (cont'd)

R1 heifers & steers

Transition timing for R1 heifers and steers is the same (14-21 days), however feed quantities are halved. It is advised to start by allocating 0.5 kg DM/animal/day on day 1, then increase by 0.5 kg DM every 2 days until the desired allocation is reached. Vaccinate all R1s for clostridial diseases (e.g. 5 in 1) before going onto fodder beet. Young growing animals have a higher demand for protein, so this should be fed as a supplement to calves grazing fodder beet (e.g. high quality grass silage).

Deer & beef cattle

Deer and beef cattle which are to be ad lib fed on fodder beet are less susceptible to rumen acidosis once transitioned because they graze over a 24 hour period, rather than eating an allocation of fodder beet in 4-5 hours. However, deer and beef cattle do require a 14-21 day transition onto fodder beet.

Deer on Robbos fodder beet in inland Canterbury

Sheep

Sheep do not require the full 14-21 day transition phase. They can be transitioned by giving them access to fodder beet for a few hours each day for 3-4 days and then locking them on the crop. Ensure all sheep are fully vaccinated for clostridial diseases (e.g. 5 in 1) before grazing fodder beet.

Young sheep

For animals new to fodder beet, particularly younger stock, transitioning may require the bulbs to be chopped or smashed before the stock will try them. This can be done with a Cambridge roller. Fodder beet is not typically fed to lambs.

Plan ahead

Winter grazing practices are changing in New Zealand, for both environmental and animal welfare reasons. Before sowing, check paddock contour, size, slope, critical source areas (CSAs), soil type, stock access, water access, grazing pattern and nutrient loss buffer zones.

For more detail on best practice winter grazing, visit www.dairynz.co.nz, wwwbeefandlamb.co.nz or local council websites.

Winter feed considerations

Summary

When winter pasture growth falls short of what is needed to keep animals well-fed, feed must be transferred from times when supply exceeds animal demand.

This process entails considering many factors at all levels of the farm business, from day to day management to the overall farm system.

Crop type

Swedes, kale, fodder beet, rape and turnips are commonly used to supply high volumes of winter feed when animal demand exceeds pasture supply. All these crops have pros and cons which are covered in other sections of this manual.

Deciding which crop is sown is based on several factors including the local environment; availability of reliable summer moisture (either natural or via irrigation); aims of the winter feed; prevalence of snow, and targeted animal performance, to name a few.

On-farm, or off-farm?

With increasing regulations around wintering stock on crops, you may prefer to move stock to land better suited to winter crops than the home farm. For example, this might mean soils that are less prone to pugging, with less potential for sediment run-off, and paddocks with more shelter than can be provided on-farm. Such a decision may provide financial, animal health, soil quality and environmental benefits.

All grass?

This choice is strongly influenced by local winter pasture growth rates. If there is little winter growth, supplements and sacrifice paddocks must be used to ensure two things – enough feed to achieve desired animal performance through winter, and adequate pasture and other feed to meet the demands of lambing and/or calving.

All grass wintering is an ideal way of limiting mud, sediment run-off and the issue of bare paddocks after grazing a winter crop (prior to establishment of the following crop or new pasture).

There are two issues, however:

1. Available yield: limited to approximately 3 t DM/ha maximum before perennial pasture gets too long, and starts rotting underneath (maximum 4 t DM/ha for annual ryegrass). Overlong grass limits utilisation, feed quality and regrowth. So compared to 12 t DM/ha for kale, for example, all-grass wintering requires 3-4 times the grazing area.

2. Early spring covers: will be much lower at calving/lambing, because such a large portion of the farm has been grazed in winter.

The consequence of these two issues is typically a less profitable system because it necessitates lower stocking rates (with less potential income); more supplement made and fed (increasing cost), and greater restrictions either side of winter (e.g. calving/lambing later, or drying off/selling lambs earlier).

Paddock selection

Information on paddock selection is in both the Fodder Beet and Brassica Management sections of this manual (see pages 156 and 168).

Animal monitoring

Ensure all animals are healthy, with access to water; a full, balanced diet; shelter, and appropriate dry areas for lying.

Catch-crops

Following crop grazing, another crop such as cereals with or without ryegrass can be sown to soak up nutrients before they are lost, and also reduce the risk of sediment run-off. This is known as a catch-crop.

Adding catch-crops to the rotation may mean slight changes to the farm system to maximise their financial and environmental value. They replace what historically would be bare paddocks and the feed they grow will need to be utilised either via grazing or machine harvesting. Refer to *Catch-crop+* page 141 for more detail and advice.

Transition requirements

When changing from one diet to another, all ruminants require transition time to ensure they can properly digest and utilise the new feed without becoming sick. See pages 135 and 136 for more.

Adverse events

These are periods of unusually high rainfall, snowfall, wind and/or extreme cold that fall outside what is considered 'normal' for your local area. Animals need to be more carefully looked after in these events, with extra shelter, water and feed, because their maintenance requirements increase in such conditions.

Designated 'adverse events' paddocks may be necessary, where animals can either graze feed growing in situ or can be fed supplements.

Wintering plan

A specific wintering plan is now required for all winter crops, including an animal wellness plan. Check your local regulations for required details.

Staff wellness

Winter is often a tough time of year. Looking after farm staff is essential for the sake of their health and productivity – both physical and mental. Sharing details, objectives and expectations of the wintering plan will help ensure understanding and buy-in.

Communication

Where two or more people involved in crop decisions, make sure everyone knows what the desired outcome is, and what expectations need to be met.

On-off grazing

This is a very effective tool to reduce pugging damage and animal health issues caused by wet weather. In normal winter conditions, cows will eat their daily intake allowance in 6-8 hours so once that is achieved they can be removed to a better area.

Having suitable areas to stand stock off into is important – these can include races, sacrifice paddocks, and yards (ensure that they are stone-free to minimise lameness). Always check local council regulations that apply to stand-off areas.

Break sizes

This decision may vary depending on the weather, and animal performance goals over the winter feeding period. Larger break sizes (2-3 days) will reduce pugging risk, but generally reduce crop utilisation (particularly with cattle) because of preferential grazing.

Larger breaks could be an option during adverse weather events to reduce pugging.

Forage crop cultivars - Oats and brassicas

Greenfeed oats	139
Catch-crop+	141
Kale	142
Rape	145
Swede	147
Summer turnip	150
Leafy turnip	152
Winter turnip	155
Raphanobrassica	153
Brassica maturities	153

Greenfeed oat cultivars

Introduction

Greenfeed oat *(Avena sativa)* crops are easy to manage, and grow large yields of good quality winter feed quickly. Oats are usually grazed once or twice. For extra production and grazings into spring, sow with an Italian or annual ryegrass (e.g. *Tabu+* or *Hogan*).

Oats are often compared to ryegrass as a winter crop. Oats produce a larger bulk of winter feed. Italian or annual ryegrass is higher in feed value and can be grazed more times into spring, and in some situations, into the following year.

Greenfeed oats benefit the environment and grow plenty of winter feed.

Hattrick — *Hattrick* is a well proven cultivar with excellent rust resistance, high yield and good regrowth. When leafy, *Hattrick* has 80% digestibility (or 12 MJ ME/kg DM) and contains 13-15% protein. Suitable for grazing or making into silage. (Refer also to page 140).

Catch-crop+ — Catch-crop mix of *Hattrick* oats and *Tabu+* Italian ryegrass which takes up N with the flexibility and reduced costs of a 12-18 month pasture. (Refer also to page 141).

Coronet — High yielding cultivar that can be either autumn or spring sown. Has a fine stem, high leaf content and good disease and frost tolerance.

Crowa — Selected as a fast starting, high yielding early - medium maturity type, giving farmers more flexibility in grazing and green chop cereal silage timing.

Milton — Establishes rapidly, suited to autumn planting for a single winter grazing or as green chop silage. Has a high leaf: stem ratio and good yield and disease resistance.

For maximum winter growth, Hattrick should be sown early.

Hattrick greenfeed oats

Hattrick is an easy to manage winter crop. It is most often sown mixed with _Tabu+_ Italian or _Hogan_ annual ryegrass, to extend growth into spring.

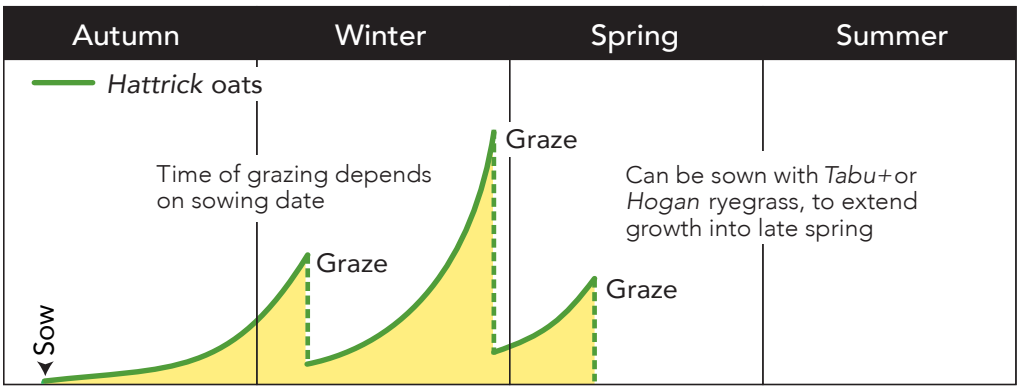
Help it thrive

Hattrick is leafy, high yielding, and more adapted to multiple grazings than some other oat cultivars. It can usually be grazed 2-3 times depending on management. For best regrowth graze at 30 cm height, leaving a 7-10 cm residual. Growth can be boosted by strategic use of nitrogen fertiliser, for example applying 30 kg N/ha after grazing.

Feed value

Leafy _Hattrick_ oats have 80% digestibility (12 MJ ME/kg DM) and contain 13-15% protein. _Harrick_ can be sown with _Laser Persian_ clover to further improve spring feed value

Growth curve



Sow early

For maximum winter yield, sow _Hattrick_ early (February/March). Protect from Argentine stem weevil with insecticide if needed.

Hattrick oats can be sown alone, but are most commonly sown with Italian or annual (e.g. _Tabu+_ or _Hogan_). Mixing _Hattrick_ with ryegrass gives you more bang for buck – better feed value, more growth through spring.

Environmental benefits

Sowing oats in late autumn (after feeding a crop) lightens your farm footprint. Soil nitrogen is taken up by the oats rather than being potentially lost via leaching. For best results, don't wait until a whole paddock has been grazed, but sow oats as soon as half the crop has been fed. Early sown oats grow faster and take up more nitrogen.

Sowing _Hattrick_

Dairy, Sheep, Beef, Deer		kg/ha
For a large bulk of winter feed	_Hattrick_ oats	120
	Total	120
For extended feed into late spring	_Catch-crop+_ _Hattrick_ oat &_Tabu+_ Italian ryegrass, see page 45 for more detail.	75
For increased late spring quality	_Hattrick_ oats	80
	Laser Persian clover	8
	Total	88

Hattrick green feed oats are marketed by Barenbrug

Catch-crop+

This dual species catch-crop mix (*Tabu+* and *Hattrick* oats) takes up nitrogen and gives you more bang for buck than cereal alone. You get better quality feed, more flexibility and save on re-sowing costs because it is a 12-18 month pasture.

Why catch-crop?

Fast-growing species such as oats and Italian ryegrass quickly cover ground left bare after autumn or winter forage crops have been grazed. In doing so, they utilise soil nitrogen and other nutrients deposited during grazing and reduce leaching. They also protect soil quality. Benefits are both environmental, and economic, as catch-crops provide home grown valuable feed.

Why oats + grass?

Our trials show *Catch-crop+* captures soil nitrogen very well, with the added gains of increased re-growth and feed quality vs. cereal alone. Rather than a 1-2 cut or graze system of straight oats, *Catch-crop+* is a high performance 12-18 month pasture, so you don't have to spend time and money resowing straight away. Yield at the first silage cut or grazing is like a straight cereal, but from the second grazing onwards, this mix has better ME and re-growth.

System fit

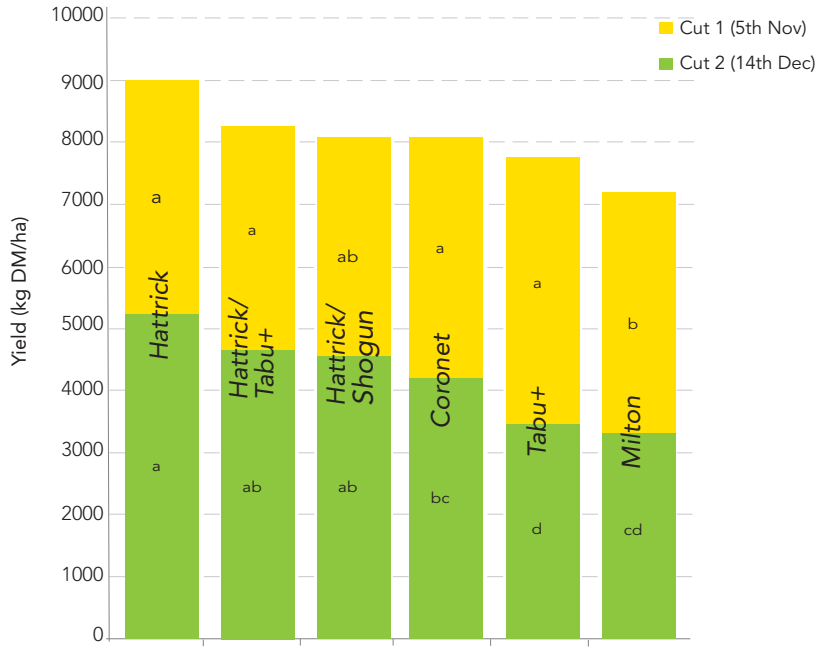
In summer-moist areas, *Catch-crop+* can provide a high yielding, high ME spring silage crop with multi-graze and/or multi-cut flexibility. *AGRICOTE Clover* can be oversown to improve feed quality and fix N.

In dryland areas, *Catch-crop+* provides summer pasture (moisture dependent), with fast response to autumn rain for high quality winter feed.

What does the data say?

Hattrick oats outyield several other oat cultivars in the first cut. Mixing *Hattrick* with *Tabu+* Italian ryegrass doesn't significantly reduce yield at the first two cuts, and provides the flexibility of continued cutting/grazing for the next 12-18 months.

Total yield, split into first two harvests, of a late-winter/early-spring catch-crop*



** Trial sown 14 Aug 2020, with cut 1 on 5 Nov 2020 (at 83 days) and cut 2 on 14 Dec 2020 (at 122 days). Statistical significance letterings given on bars for LSD 5%, bars with the same letter are not significantly different.*

Sowing *Catch-crop+*

- Sow *Catch-crop+* at 75 kg/ha. It comes in 25 kg bags, containing 18 kg *Hattrick* and 7 kg *Tabu+*, for sowing at 3 bags/ha.

Kale cultivars

Introduction

Kale *(Brassica oleracea)* is typically spring-sown for a high yielding, single graze winter crop, fed between June and August. Don't sow kale too early; frosts post sowing can 'vernalise' plants, meaning they will flower and go to seed in summer. Kale yields best in highly fertile soils with reasonable summer moisture levels. It is a popular winter feed because of its high yields (14-20 t DM/ha in summer wet conditions; 7-10 t DM/ha in dryland) and good quality (11-12 MJ ME/kg DM). Kale is deeper rooting and more tolerant of dry conditions than swedes.

It is less commonly spring sown for summer feed, as an alternative to rape or summer turnips. In this situation, kale has two benefits. First it has fewer potential animal health issues than rape, and doesn't need to mature before grazing. Second, in a good pasture growing season, spring-sown kale can be banked for autumn or winter grazing.

Taller, higher yielding cultivars of kale are more suited to cattle grazing; shorter, leafier cultivars are more suited to sheep and deer. Kale is mostly tolerant of dry rot.

Bombardier	*Bombardier* easy-graze (EG) is an intermediate kale with exceptional stem quality, so you can look after your animals with more energy per bite and less wastage. This is better for both animals and the environment. (Refer to page 143).
Coleor	Short-medium height cultivar with a high leaf to stem ratio and winter hardiness. It has distinctive purple leaves and low SMCO levels.
Corsa	Giant type kale with higher leaf percentage and disease tolerance.
Cleancrop™ Firefly	Sold as part of the Cleancrop™ Brassica System; high yielding intermediate height kale with excellent leaf to stem ratio and soft stems.
Cleancrop™ Sarge	Part of the Cleancrop™ brassica system, a high yielding, short - medium height kale.
Gruner	Giant type kale with high yields. Good frost tolerance and winter hardiness.
Kea	High yielding, leafy, intermediate height kale. Has excellent regrowth potential from a summer/autumn graze.
Kestrel	Medium height kale, with high feed quality driven by high leaf : stem ratio, and high stem quality.
Proteor	Intermediate stem height, leafy kale with reasonable yield potential. Palatable with a thin stem and a high leaf to stem ratio.
Regal	High yielding intermediate height kale. High leaf to stem ratio with good late winter leaf percentage.
SovGold	Modern New Zealand bred intermediate height kale with very high total leaf yield, and high total yield for an intermediate kale.

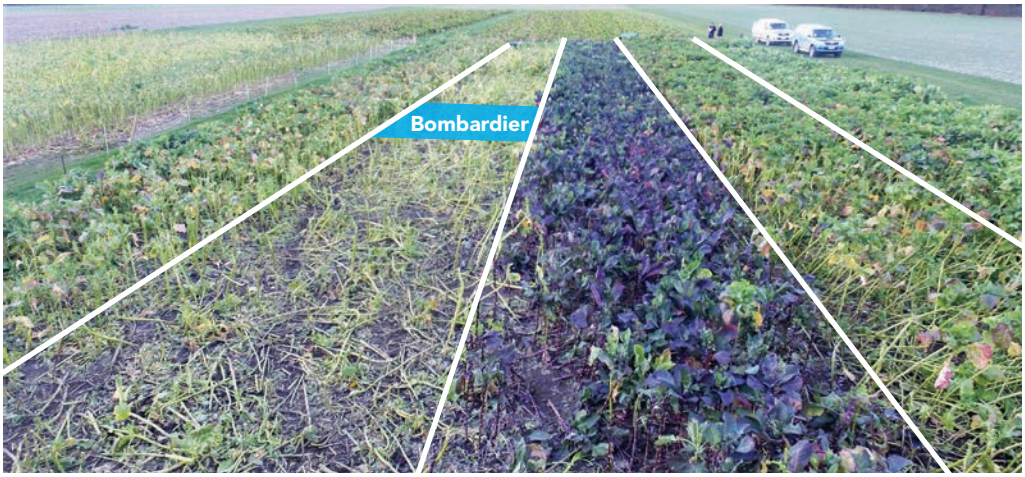
Bombardier EG kale

Bombardier easy-graze (EG) kale means you can look after your animals, with more energy per bite and less wastage, which is better for both animals and the environment.

Winter better

Wintering systems are under the spotlight, with a focus on caring for animals well, and reducing mud in crops. *Bombardier EG* kale helps you do both, because it is palatable and easier to graze right to the base, providing high utilisation with high animal performance.

This can improve animal intake particularly in adverse weather, when grazing time may be limited. Less wastage also increases efficiency, which is better for the environment.



Ewes broke into these kale trial strips overnight, and camped on the strip of Bombardier EG, ignoring the other kales!

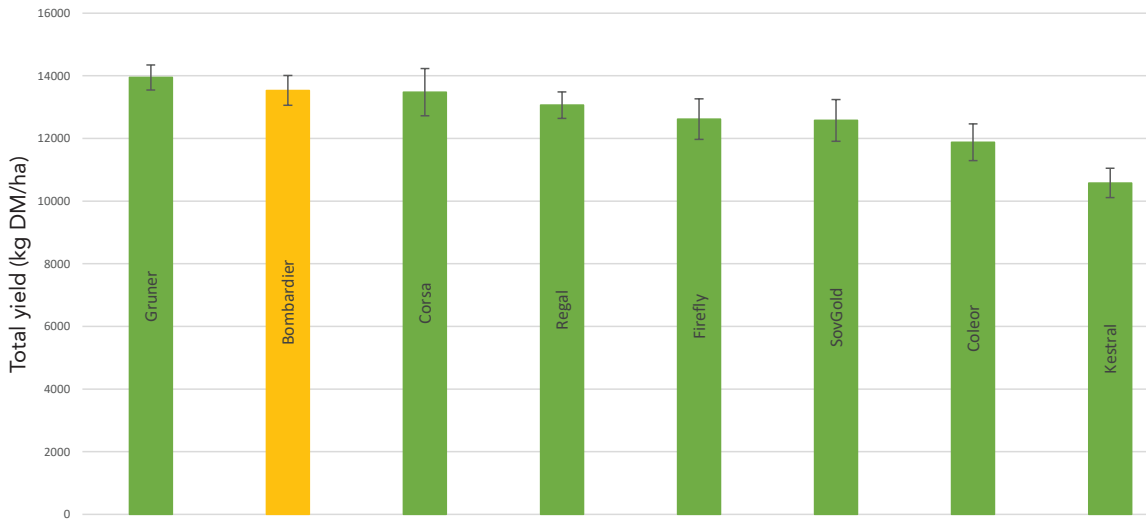
Systems fit

Bombardier EG kale suits farmers seeking higher animal intakes and performance. Examples include dairy cow grazing for increased BCS; heifer, bull and steer systems where weight gain is critical; and sheep systems for good stock performance.

Excellent yield

The total yield of *Bombardier EG* kale is very high.

Kale total DM yields 2006-2023 (combined analysis of 20 trials*)



**Combined analysis of 20 trials from 2006-2023, varieties in two or more trials are presented. If two means differ by more than the sum of their least significant internals (LSI), they are significantly different at the 5% level.*

Bombardier EG kale (cont.)

Environmentally friendly

Bombardier's superb utilisation means more efficient use of crop nutrients. High palatability and intake rates better suit on/off grazing systems to reduce mud creation. Less residual reduces the energy required for sowing the following catch crop or pasture.

More ME/bite (right to the ground!)

Bombardier has exceptional feed quality, so animals get more ME per bite. This advantage reaches right to the ground, meaning easier utilisation than other cultivars. *Bombardier* has higher ME and lower fibre in the bottom third of its stem.

Kale feed quality as metabolisable energy (ME) in MJ ME/kg DM*

Cultivar	ME whole plant	ME bottom 1/3 stem
Bombardier EG	12.4 a	11.5 a
Regal	11.9 b	10.5 b
Sovereign	11.9 b	10.2 b
Gruner	11.8 b	9.4 c
Corsa	11.3 c	9.6 bc
Trial mean	12.1	10.6
LSD (5%)	0.4	0.8

**From 5 trials run from 2006/07 to 2017/18. Cultivars were in at least two trials. Cultivars with the same statistical significance letter are not significantly different at the LSD 5% level.*

Rape alternative

With its very high stem quality, *Bombardier* can be used instead of autumn or winter-grazed rape, with several advantages.

- No ripening needed pre-grazing
- Fewer animal health problems
- More flexible grazing window.

Later sowing

Manage *Bombardier* the same as you would other kales, except we recommend a later sowing date (late November onwards). Don't sow in areas prone to high winds and crop lodging. While *Bombardier's* very soft stems are ideal for grazing they do make it more susceptible to lodging than traditional kales.

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
		Sow			Graze						

Days to graze:	100-170 days
Typical yield:	12-16t DM/ha; potentially higher in good conditions
Typical ME:	12.4 MJ/ME
Sowing rate:	5 kg/ha

Bombardier EG kale is marketed by Barenbrug

Rape cultivars

Introduction

Rape *(Brassica napus)* is a fast maturing single or multi-graze crop for summer, autumn or winter feed. Plant from early spring to late summer depending on when you need the feed.

Sow summer rape in September-November, to first graze around 70-110 days after sowing. It gives quality summer and autumn feed in dry areas, to keep your animals thriving when pasture yield is typically poor.

Sow winter rape from November-February, depending on feed requirements. It is typically ready to graze 80-120 days after sowing. An autumn grazing is possible from early sowings.

Rape is highly nutritious, but the crop must be mature before grazing during spring, summer and autumn to avoid rape scald. (For more detail see page 129).

Interval	*Interval* is a tall, late maturing cultivar with high DM yields. It is very hardy, with good tolerance to dry conditions and frost, and is suitable for summer, autumn and winter feed (Refer also to page 146).
Goliath	Late maturing rape x kale hybrid. Tall high yielding cultivar with good regrowth for multi-graze potential.
Greenland	Very late flowering, multi-graze forage rape that fits into a range of farm systems.
Mainstar	Modern early maturity rape with excellent regrowth potential and good frost tolerance extending grazing times from early summer to late winter. Very good aphid tolerance
Pillar	Multi-graze giant-type rape with good aphid tolerance and disease resistance.
Rifleman	Quick maturing, multigraze forage rape with strong aphid tolerance and leafy growth.
Spitfire	Multi-purpose late maturing, intermediate height rape. Suitable for summer, autumn and early winter feeding. High aphid tolerance.
Titan	Early maturing rape x kale hybrid. Intermediate height with very good aphid and virus tolerance.
Cleancrop™ Rape	Sold as part of the Cleancrop™ Brassica System; high yielding tall type. It has good regrowth and winter keeping ability.

Interval rape

Interval is a tall, fast establishing rape ideal for summer, autumn and winter feed. Tough and dependable, it's proven to yield very well across a wide range of conditions.

Flexible sowing date

Sow *Interval* from spring through to early autumn for a bulk of high quality feed typically in 90-110 days. Spring sowings can be grazed in summer/early autumn then left to regrow for winter feed.

High yield

Interval has performed well in trials, providing excellent DM yield.

Total winter DM yield*

Cultivar	Trial mean = 100%	
Interval	126	a
Goliath	125	a
Greenland	118	a
Winfred	92	b
Titan	88	b
Trial mean (t DM/ha)	5.3	

**Results from 2 trials in Canterbury during 2008 and 2009 (February sown, June/July harvested). Statistical significance lettering given for 5% LSD level, cultivars with the same letter are not significantly different.*

Interval has excellent DM yield and utilisation.

Utilise me!

Compared to most kales (but not *Bombardier*), rape typically has higher stem feed quality, and is better utilised by stock after 90 days. *Interval* has excellent tolerance of dry conditions. It also has strong frost tolerance and resistance to powdery mildew.

Using *Interval*

Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
	Sow										
				Graze							

Maturity date:	90-110 days
Typical yield:	5-8 t DM/ha (depends on sowing time & no. of grazings)
Typical ME:	12 MJ/kg DM
Sowing rate:	4 kg/ha

Interval rape is marketed by Barenbrug

Swede cultivars

Introduction

Swedes *(Brassica napus* var. *napobrassica)* are a high yielding winter crop, used as a single graze option typically between June and August. They are normally sown in late spring or summer in cool, summer moist climates, mostly in southern and inland New Zealand.

Swedes typically yield 10-18 t DM/ha with higher feed quality than kales; typical ME values are 12 MJ ME/kgDM. Bulb quality keeps better than turnips, especially in frosty conditions. They also handle heavy snow better than kale, which can lodge and be stripped of its leaves. Swedes are most often strip-grazed and cultivars have several maturity dates. They can be grazed by a variety of animals in a range of farming systems.

Swedes are traditionally sown into a cultivated seedbed. But direct-drilling or precision planting pelleted seed is becoming more popular. Precision planting with pelleted seed, as used for fodder beet, can increase yield by 10-15%.

Swedes are not recommended for double cropping because of the high risk of disease.

Invitation	A late maturing, high yielding, leafy, yellow-fleshed swede with excellent animal health. It has good dry rot tolerance, and club root and powdery mildew resistance. *Invitation* has high bulb keeping and leaf retention ability, and its late flowering makes it a good option when grazing into early spring. (Refer also to page 148).
Cleancrop™ Aspiring	Part of the Cleancrop™ brassica system, a soft, early maturing, yellow-fleshed swede with better dry-rot and *Alternaria* tolerance
Clutha Gold	Yellow-fleshed, high yielding swede with good clubroot and dry rot tolerance.
Earnslaw	Yellow-fleshed swede with early maturity and a soft bulb, but improved dry-rot and *Alternaria* tolerance.
Hawkestone	Sold as part of the Cleancrop™ Brassica System; yellow-fleshed swede with medium maturity. It has similar dry rot and clubroot tolerance to *Aparima Gold*.
Major Plus	Yellow-fleshed true early maturing cultivar with good overall yield.
Massie	A high yielding and disease tolerant early maturing swede with a distinctive purple colour and yellow flesh.
Triumph	High yielding, yellow-fleshed swede with high leaf retention. A palatable swede for all mature classes of stock.
Saddleback	Consistently high yielding swede with robust disease tolerance and good leaf retention.

Replicated trials, like this one at Te Anau, are critical for evaluating swedes.

Invitation swede

Invitation is a late maturing, yellow-fleshed swede, with very high bulb and leaf yield. It gives valuable winter feed with excellent animal health for sheep, cattle and deer.

High yield & disease tolerance

Invitation has excellent total DM yields with good dry rot tolerance and resistance to club root and powdery mildew. *Invitation* is not recommended as a second crop.

Total DM yield, dry rot tolerance and club root infection level.

Cultivar	Total DM yield* (Trial mean =100)		Dry rot tolerance** % of bulbs not infected		Dry rot tolerance** % bulbs badly infected		Club root*** % of bulbs not infected	
Invitation	112	a	57	a	5	a	97	a
Aparima Gold	103	b	36	ab	11	a	100	a
Major Plus	96	c	10	bc	56	b	18	bc
Dominion	92	c	6	c	71	b	23	b
Domain ◇	74	d	NT	NT	NT	NT	NT	NT
Trial mean	12.6 t DM/ha		21%		41%		60%	

From 8 Southland trials, from 2006/07 to 2011/13. **From a Southland trial in 2008/09 under moderate to high dry rot pressure in a 2nd crop paddock. * From a Southland trial in 2010/11 under moderate to high club root pressure in a 2nd crop paddock. NT = Not tested. Statistical significance lettering given for 5% LSD level, cultivars with same letter are not significantly different.◇= Provisional results. Domain was in 2 of the 8 trials.*

Late flowering

Invitation is very late flowering, so the crop stays vegetative longer into spring than other cultivars. This minimises the risk of animal health problems associated with 'bolting' swede crops, as seen in spring 2014 in Southland. No issues were reported on *Invitation* swedes.

Swede flowering scores*

Cultivar	Lack of flowering	
Invitation	7.2	a
Major Plus	6.7	ab
Domain	6.5	ab
Dominion	4.8	c
HT Swede	3.4	d
Aparima Gold	3.1	d
Trial mean	6.1	

**Results from 2 trials in Southland sown 2008 and 2012. Statistical significance lettering given for 5% LSD level, cultivars with the same letter are not significantly different. Scored on a 1 - 9 basis. Where 1 = full flowering swede crop, 4 = stem elongation, green seed head appeared, 7, small degree of elongaton, 9 = no sign of stem elongation.*

Invitation swede is marketed by Barenbrug

Good leaf yield

Invitation produces high leaf yields showing a significantly higher leaf percentage than other cultivars in trials. This lifts the overall protein level of the crop and is helpful when introducing swedes into an animal's diet, particularly for younger stock.

Bulb & leaf keeping

Invitation has shown high bulb keeping ability and leaf retention in trials, helping maintain its feed quality and quantity through to the end of winter.

Using *Invitation*

Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sow						Graze			

Maturity date:	170-250 days
Typical yield:	10-18 t DM/ha (depending on season and situation)
ME:	12-14 MJ/kg DM
Sowing rate:	Ridged 0.5-0.8 kg/ha
	Drilled 0.8-1.5 kg/ha

Invitation produces a higher proportion of leaf than other varieties, for more protein.

Invitation swede is marketed by Barenbrug

Summer turnip cultivars

Introduction

Summer turnips *(Brassica rapa)* offer nutritious, very palatable feed. They are fast maturing, can be grazed 60-100 days after sowing and typically yield 8-12 t DM/ha, for a single grazing.

They are mainly used for dairy cows as a high energy summer feed to keep them milking well when pasture growth and quality is typically poor. Summer turnips have high ME (typically 12 MJ ME/kg DM) so they complement pasture or maize silage during this time. They should comprise no more than a third of a milking cow's diet.

Summer turnips are also great for pasture renewal, breaking the weed and pest cycle, and giving you a good seedbed for autumn sown pasture.

Dynamo

Dynamo is an early maturing, high yielding cultivar that offers quality summer feed. It produces a good level of bulb, giving it an advantage in seasons when high levels of leaf diseases or pests are present. (Refer also to page 151).

Barkant

High yielding summer bulb turnip with a tankard bulb shape to reduce the risk of choke. High energy with good protein bulb and leaf.

Marco

Earliest maturing turnip available, with an interval to grazing of just 50-70 days. Highly palatable tetraploid tankard type turnip.

Ceres Rival

Early maturing cultivar with good leaf production and leaf holding ability. Ideally used for pasture renovation.

Cleancrop™ Toto

Sold as part of the Cleancrop™Brassica System; high yielding summer turnip with a tankard bulb shape for increased utilisation, can be grazed at 55-90 days.

Dynamo turnips provide high ME and protein to help maintain milk production through summer.

Dynamo turnip

Dynamo turnip is a high yielding summer crop for dairy cows. It grows large volumes of low cost quality feed with a high proportion of bulb, and good bulb keeping ability.

DM yield

In trials *Dynamo* has shown high yield, not significantly different from the other top cultivars.

Replacing a poor performing pasture with a crop of *Dynamo* makes good financial sense. It can feed your cows well for around 20 c/kg DM*.

Low cost summer feed

*Turnips for 20 c/kg DM - assumptions:

- Turnip crop yield 11.5 t DM/ha, with 12 ME.
- Lose 5.5 t of old pasture growth while paddock is in crop.
- Cost of growing crop = $1200/ha (spray out plus insecticide, full cultivation, fertiliser, treated seed, slug bait, two post emergence herbicides/insecticides).
- $1200/6000 kg DM extra yield = 20 c/kg DM

High bulb percentage

Summer turnips produce their yield in different ways. *Dynamo's* bulb makes up about 48% of total yield, so it has an advantage in seasons when pest and/or leaf disease pressure are high.

Using *Dynamo*

Oct	Nov	Dec	Jan	Feb	Mar
Sow			Graze		

Maturity date:	60-90 days
Typical yield:	8-16 t DM/ha (depending on season)
ME:	12 MJ/kg DM
Sowing rate:	2-3 kg/ha

Dynamo summer turnip is marketed by Barenbrug

Leafy turnip cultivars

Introduction

Leafy turnips *(Brassica rapa)*, or 'forage brassicas', are made by crossing turnips with other brassicas. They are usually used for summer/autumn lamb finishing, as an alternative to rape, with better regrowth. But they are not as tolerant of dry conditions.

Leafy turnips establish quickly and are ready to graze 40-60 days after sowing. They can yield 6-12 t DM/ha. Climate and grazing management greatly influence your regrowth.

Hunter Fast-establishing cultivar for stock finishing in fertile, summer moist areas. Good plant survival through multiple grazings.

Pasja II Early maturing leafy cultivar producing little bulb. Offers high yields from multiple grazings, but with reduced bolting (flowering) plants compared to *Pasja*.

Pacer Fast growing leafy turnip suited to medium-high fertility soils with summer moisture or irrigation, offering multiple grazings.

Cleancrop ™ Leafy Turnip Sold as part of the Cleancrop™ Brassica System; multi-graze *Pasja* type with reduced bolting. Superior yield and regrowth potential to *Pasja II*.

Winter turnip cultivars

Introduction

Winter turnips *(Brassica rapa)* are mainly used in drier South Island regions as a single graze winter crop. They are typically sown in January-February, and ready for grazing in 2-4 months, depending on the cultivar.

Winter turnips have better tolerance of lighter soils and lower soil fertility than summer turnips. They can also be used as late maturing summer turnips.

Green Globe Traditional late maturing winter hardy bulb turnip. Can complement an earlier maturing cultivar to provide later grazing. Bulbs are green skinned and white fleshed.

Ceres New York Medium maturing, pink/red skinned, white-fleshed turnip with good disease tolerance.

York Globe Medium to late maturing turnip with a white-skinned and white fleshed bulb.

Cleancrop™ Bulb Turnip Sold as part of the Cleancrop™ Brassica System; high yielding bulb turnip. Suits sowing from late spring through to late summer.

Raphanobrassica cultivars

Introduction

Raphanobrassica is a newer species, a hybrid between radish (*Raphanus sativus*) and kale (*Brassica oleracea*). It is a high yielding, multi-graze crop, typically providing 4 to 5 grazings over 12 months, at 50-70 day intervals.

It performs best in fertile soils and has high tolerance to turnip mosaic virus, so can be a good option where this is prevalent.

Pallaton

The only raphanobrassica cultivar. Provides a high yielding, multi-graze 12 month crop, with good drought, clubroot and aphid tolerance.

Brassica maturities

Days from sowing to grazing for brassica cultivars*

Kale		Summer turnips	
Bombardier	120-190	*Marco*	55-65
SovGold	120-190	*Barkant*	60-90
Proteor	150-220	*Dynamo*	60-100
Coleor	150-220	*Cleancrop Bulb Turnip*	80-110
Kestrel	150-220	*Rival*	85-100
Firefly	150-220	**Winter turnips**	
Gruner	150-220	*Cleancrop Bulb Turnip*	80-110
Regal	150-220	*Green Globe*	90-120
Corsa	150-220	*York Globe*	110+
Swedes		*New York*	125-140
Major Plus	150-230	**Rape**	
Domain	170-210	*Greenland*	70-84
Triumph	168-210	*Mainstar*	70-84
Hawkestone	170-250	*Titan*	70-90
Clutha Gold	170-250	*Pillar*	90-100
Invitation	170-250	*Spitfire*	90-100
Leafy turnip		*Interval*	90-110
Hunter	42-50	*Goliath*	90-110
Cleancrop Leafy Turnip	42-70	*Cleancrop Rape*	90-110
Pasja II	42-70		
Pacer	45-50		

** These are expected values, which vary. Cool, wet conditions slow maturity, hot conditions can speed it up.*

Brassica management

Winter crop paddock selection	155
Brassica crop rotations	156
Soil fertility	157
Establishment techniques	158
Measuring crop yield	159
Calculating crop break size	160

Winter crop paddock selection

Summary

Many physical, animal and staff welfare factors need to be considered when picking paddocks for winter brassicas. A specific wintering plan is now required for all winter crops, including an animal wellness plan.

The lay of the land

Land contour is a key factor. If the slope of the proposed brassica paddock is 10% or more, a resource consent may be required.

Critical sources areas (CSA) must also be evaluated. Where are potential overland water paths, low points, and other CSAs in the proposed paddock? Can these be mitigated by planting other species, or restricting stock access?

Waterways

If crop is sown close to a waterway, consent may be required. Check current rules. Best practice is to create buffer areas to reduce potential sediment and nutrient run-off during grazing.

Sowing direction

Can the crop be drilled easily across slopes or parallel to CSAs or waterways to reduce run-off risk during grazing?

Soil type

Ideally crop paddocks will comprise soils less at risk of pugging damage in winter. This reduces risk of excess mud during grazing, and allows faster re-sowing after grazing, e.g. catch-crops.

Shelter, water & space

Animals on crop become susceptible to stress in cold, wet, windy conditions. Access to good shelter is a must. Stock must also have access at all times to adequate supplies of clean fresh water, and have dry space for lying time (8 hours daily).

Plan for the worst

Ensure there is an adverse weather grazing plan. This could mean using a winter crop paddock that is set up for such conditions, or ear-marking other areas of the farm to move stock onto during adverse weather.

For more specific regional information, go to DairyNZ, Beef and Lamb, or your local Regional Council website. See also the section in this Manual on winter grazing considerations, pages 136 - 137

Brassica crop rotations

Summary

Brassicas are often best used in a double-crop system to give better year-round feed supply.

This also improves subsequent pasture renewal through better weed control and pasture persistence.

Advantages of a prior crop

Often paddocks are chosen for brassicas because of poor pasture growth. This may be due to underlying problems like poor soil fertility, drainage, weeds, pests or diseases. A prior crop (e.g. annual ryegrass) allows you to correct any issues before sowing the brassica, helping ensure high crop yields.

If the paddock has turfy, fibrous grass weeds like browntop, fescue or cocksfoot, multiple crops and herbicide applications achieve much better long-term weed control. Using a prior crop also gives time for turf to break down giving a better seedbed for the brassica crop.

Crop rotation examples

Kale or swedes

Winter ryegrass can be sown before a winter kale or swede crop to produce extra winter and early spring feed.

D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
Poor pasture		Winter ryegrass crop (e.g. *Hogan)*										Winter kale (e.g. *Bombardier*) or swedes (e.g. *Invitation*)									New perennial pasture		

Summer turnips

Winter ryegrass can be sown before a summer turnip crop to give you extra winter and early spring feed.

J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Poor pasture	Winter ryegrass crop (e.g. *Hogan*)								Summer turnip (e.g. *Dynamo*)					New perennial pasture			

Winter rape

A winter rape crop could be sown after a cereal crop.

J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Poor pasture				Cereal crop (e.g. *Hattrick*)										Winter rape (e.g. *Interval*)						Perennial pasture, leafy turnip, spring barley			

Soil fertility

Summary Brassicas need correct soil fertility levels for high yields. Every crop has different fertiliser requirements depending on initial soil fertility and yield potential. Soil test 2-3 months before sowing to allow enough time to correct soil fertility if needed.

pH Brassica crops prefer pH levels above 5.8. The ideal range is between 5.8 and 6.2. Lime takes time to work, so should be applied 6-12 months before sowing. Fine limes change pH levels faster. Correct soil pH reduces club root and increases the availability of molybdenum. Generally, 1 t/ha of lime gives a 0.1 lift in soil pH.

Phosphorus Phosphorus is important for establishment and crop yield. Olsen P levels of 20+ are recommended, and 25+ for higher yielding crops. Typically crops benefit from 25-50 kg P/ha.

Nitrogen Crops generally respond strongly to N. Requirements vary depending on soil type, fertiliser and crop history, and expected yield. Nitrogen is usually applied at, or after, sowing and again during the growing season for high yields, typically at 50-70 kg N/ha. Excessive N and applications too close to grazing can increase the risk of nitrate toxicity in animals (see page 129 for more).

Potassium Brassicas need potassium levels of 5+ on the quick test. Crop yields seldom respond to potassium applications.

Sulphur Sulphur is not usually needed for brassica crops, and generally yields do not respond to it, unless levels are very low (soil sulphate test 2-3). Take care using sulphur on brassicas (mainly kales), as this may increase SMCO levels which can cause kale anaemia or red water in stock. Soil sulphate test levels above 10 in kale crops are potentially SMCO toxic (see page 129 for more).

Boron Boron is important for bulb crops and should be applied at sowing. The most common symptom of boron deficiency is 'brown heart' in bulbs, while other crops can show hollowing, browning and rotting of stems. Deficiencies are more common on light textured soils with low organic matter content. Do not mix boron with the seed – because it is highly soluble, it can burn seedlings.

Magnesium Recommended magnesium levels in the soil are 8+. If magnesium is required, apply at sowing.

To the right, rape missed a fertiliser and urea application, and nutrient deficiency is clearly seen.

Establishment techniques

Summary

Brassicas need good establishment because of their low sowing rate. Plant population has a big influence on brassica crop yield, so using *AGRICOTE Brassica* seed treatment with both insecticide and fungicide protection is important for success.

Pre-sowing

Brassicas can benefit from following another crop (see page 156). This gives the opportunity to fix underlying problems with the paddock (poor drainage, fertility etc) and provides a better seed bed for brassicas. Longer term, new pasture sown post brassicas will benefit from fewer pests and weeds, especially grass weeds. It can also be a good idea to apply insecticide when spraying out old pasture.

Cultivation

A firm, even, weed-free seedbed is essential for cultivated paddocks. Bury previous crop or pasture residues to reduce the risk of pests and diseases. Sow seed shallow (no more than 10 mm) to ensure good, even establishment of the crop. A level seedbed with good consolidation helps achieve even sowing depth.

Direct-drilling

Direct drilling is an alternative where cultivation is not desired or appropriate. Pests can be a major issue, as the dead vegetation provides an ideal habitat, particularly for springtails and slugs. Use insecticides to reduce insect pressure, and sow treated seed. Slug bait is normally essential.

Remove as much turf as possible through hard grazing before sowing to reduce trash, and make drilling easier. N fertiliser requirements are likely to be higher as N is tied up in decaying vegetation.

Seed treatment

Insect and fungal damage can be catastrophic to seedling brassicas, and *AGRICOTE Brassica* seed treatment is always advised. Treated seed reduces the risk of crop damage and failure.

Weed control

Weeds must be controlled at establishment as they compete strongly with brassica seedlings. Pre-emergence herbicides can be incorporated into the seedbed before sowing.

Monitor weeds closely. Selective herbicides are most effective at certain weed sizes, and spraying is most effective before crop closure. If not controlled early, weeds can cause major issues in the following season's crop, so are best controlled in the first year crop by stopping their seeding.

Monitoring insects & diseases

Pests can seriously damage brassicas throughout the life of the crop. Monitor crops daily for the first 14 days after emergence, then weekly (see pages 201 to 207 for more). Leave 5-7 years between brassica crops to reduce the risk of soil-borne diseases.

Measuring crop yield

Summary

Measuring forage crop is critical for allocating the correct break size and animal allowance. Crop dry matter percentages are often assumed, and these can be very inaccurate.

Fresh weight

For leaf crops such as kale and rape join both ends of a 3.54 m length of alkathene to create a circle with an area of 1 m^2. Place this over representative areas of the crop. To quantify the fresh weight, cut, bag and weigh everything within the circle. Remember to subtract the bag weight. For bulb crops sown in rows, like swedes, harvest part of a row. Row width will determine length sampled, e.g. for 50 cm wide rows, a 2 m row sample length will give an area of 1 m^2.

In all cases

Repeat sampling at least 5 times across the paddock to gain an average fresh weight. The more variable a crop the more samples you need. The fresh weight is then multiplied by 10,000 to convert from kg/m^2 to kg/ha (10,000 m^2 = 1 ha).

For example:

Sample	1	2	3	4	5	Average
Fresh weight (kg/m^2)	8.6	9.3	9.2	9.4	9.0	9.1
Fresh weight (kg/ha)	86,000	93,000	92,000	94,000	90,000	91,000

Dry matter %

Take three samples per crop to determine the dry matter percentage. For each sample, take 2 or more whole plants which are representative of the crop, and chop into small segments. Weigh the sample to determine fresh weight, then dry at 60-90°C for 48 hrs, until the weight stops changing. Then weigh the dried sample.

The DM % can be calculated by dividing the dry weight by the fresh weight. Some labs offer DM testing.

E.g.	Fresh weight of sample	=	112 g
	Dry weight of sample	=	16.8 g
	Dry matter %	=	16.8 g ÷ 112 g
		=	15%

Crop yield (kg DM/ha)

Once you know the fresh weight yield (91,000 kg/ha) and the DM % (15%) you can calculate crop yield in kg DM per hectare.

Crop yield (kg DM/ha)	=	Fresh weight (kg/ha)	x	Dry matter % (DM %)
	=	91,000 kg/ha	x	0.15 (15%)
	=	13,650 kg DM/ha		

Crop feed quality (ME)

You can't calculate accurate feed allowances for your animals if you don't know the quality of the crop they will be grazing. Send a representative sample to a laboratory to test quality, particularly metabolisable energy (ME). You can do this when you send samples for dry matter testing.

Calculating crop break size

Summary

Poor feed allocation is mostly commonly caused by incorrect break size. Knowing the crop yield (see page 160), likely utilisation, animal requirements and crop ME is vital to set the right break size.

Crop utilisation example

Not all of a forage crop is eaten, particularly in wet weather. Utilisation also depends on animal performance goals, and for high weight gains, lower utilisation must be accepted, e.g. maintenance utilisation of kale might be 80-85%, but needs to be <75% for body condition gain.

Typical winter crop utilisation rates (vary widely)

Feed	Utilisation
Fodder beet	80-90%
Swedes	80-90%
Kale	70-85%
Pasture	80-90%

Stock requirement example

When winter crop yield is measured, a sample of what will be grazed should be sent for ME analysis. Next, you need stock ME requirements, which are available - see table below. In this example, dairy cow ME requirement depends on liveweight, and changes during pregnancy.

Cow ME requirements for 1 body condition score gain in 60 days (MJ ME/cow/day)

Breed	Lwt (kg)	12 wks pre-calving	8 wks pre-calving	4 wks pre-calving	2 wks pre-calving
J	350	86	94	107	85
J	400	97	105	119	94
J x F	450	107	116	132	102
Fr	500	118	127	144	111
Fr	550	128	138	156	119

Example of crop allocation

In this example, 100 cows (450 kg/head LW), 12 weeks pre-calving, are to be break fed kale, with the aim of adding 1 BCS over winter. Kale will comprise 70% of their diet and baleage the rest. The crop yields 14 t DM/ha, utilisation is estimated at 85% and feed quality is 11.5 MJ ME/kg DM. The width of the crop paddock is measured at 200 m.

14,000 kg DM/ha (crop yield)	x	11.5 MJ ME/kg DM (ME of kale)	=	161,000 MJ ME/ha (ME of kale/ha)
161,000 MJ ME/ha	÷	10,000 m^2/ha	=	16.1 MJ ME/m^2 (ME of kale/m^2)
107 MJ ME/cow/day (cow requirement)	÷	85% (utilisation)	=	126 MJ ME/cow/day (ME allowance)
126 MJ ME/cow/day (allowance)	x	70% (% diet kale)	=	88 MJ ME/cow/day of kale
88 MJ ME/cow/day (kale allowance)	÷	16.1 MJ ME/m^2 (kale crop)	=	5.5 m^2/cow/day (kale needed)
100 cows	x	5.5 m^2/cow/day	=	550 m^2/day (break size needed)
550 m^2/day	÷	200 m paddock width	=	2.75 m break length

Forage crop cultivars - fodder beet

Fodder beet	162
Fodder beet cultivars	163
Robbos fodder beet	164

Fodder beet

Introduction

Fodder beet (*Beta vulgaris*) is typically sown in spring (October-November) as a high yielding autumn and/or winter crop. It can be used as either a single graze option from May to August, or the bulbs can be lifted with machinery and fed to stock. Lifted bulbs can be fed immediately, or stored in a windrow if leaves are removed.

Modern hybrid cultivars are popular as a winter feed for cattle, deer, and sheep due to their high yields, high ME value (12+ MJ ME/kg DM), high utilisation (typically 90%), and a relative lack of insect pest pressure compared with brassicas. Under good management, fodder beet can yield 30 t DM/ha, but typical yields are 18-24 t DM/ha with reasonable summer moisture.

Growing fodder beet is expensive and requires attention to detail. But it can provide high ME winter feed at a relatively low c/kg DM cost if high crop yields are achieved (15-20 c/kg DM in direct costs; 20-25 c/kg DM including the opportunity cost of 8-10 t DM/ha lost pasture growth).

Fodder beet is high in carbohydrate and low in protein. This needs to be managed when feeding it (see animal production chapter).

Fodder beet cultivars can be categorised according to their dry matter (DM) content. High DM cultivars have the highest yield, have bulbs sitting further into the ground and are more suited to lifting. Medium and low DM cultivars are more suited to grazing in situ.

Robbos suits grazing by all stock types

Fodder beet cultivars

High dry matter cultivars

Enermax	Variety suited to lifting, storing, and grazing where yields exceed 20 t DM/ha. *Enermax* has a high bulb DM (19-21%).
Suga 3.0™	Specialist beet bred for harvesting and long-term storability. DM between 23-26%.
Surf	A sugar beet (20-26%) suited to be mechanically harvested. It has high yield and an upright leaf habit.

Medium dry matter cultivars

Robbos	An excellent, consistent performer, with more leaf protein for a better balanced diet, coupled with high DM yield. *Robbos* is a clean, yellow-orange beet, with 16-18% DM. (Refer also to the *Robbos* sheet on page 164).
Bangor	Modern monogerm hybrid variety ideal for grazing. *Bangor* has a medium bulb DM (16-18%).
Brunium	Medium-high DM type (16-20%) with very good resistance to *Rhizoctonia*. Suits both grazing and lifting.
Delicante	High-yielding, monogerm hybrid with a green to white bulbs. It has a medium - high bulb dry matter percentage (16-20%).
Geronimo	Fodder beet variety with a yellow-orange bulb 45-50% above ground. Bulb is typically 14-16% DM. *Rhizomania* and mildew tolerance.
Jamon	Proven to perform across all stock classes and environments in New Zealand. *Jamon* is a medium bulb DM type (16-18%) with an orange bulb.
Lactimo	A yellow-orange bulb which sits 45-50% above ground. Bulb DM typically 14-17%.
Minotaure	Meduim to high DM fodder beet (17-19%) with yellow-orange root. Can be grazed or lifted.
1505Bv	A genetic monogerm hybrid with a medium–high DM.

Low dry matter cultivars

Brigadier™	Has a soft bulb that sits high out of the soil, together with it's low dry matter (DM%), it is very well-suited to in-situ grazing.
Feldherr	High yielding monogerm hybrid fodder beet with a light orange bulb colour and low bulb DM percentage (12-15%).
Dynamo	A red bulb variety which is typically 12-14% DM and sits around 60% out of the ground, most suited to grazing.

Robbos fodder beet

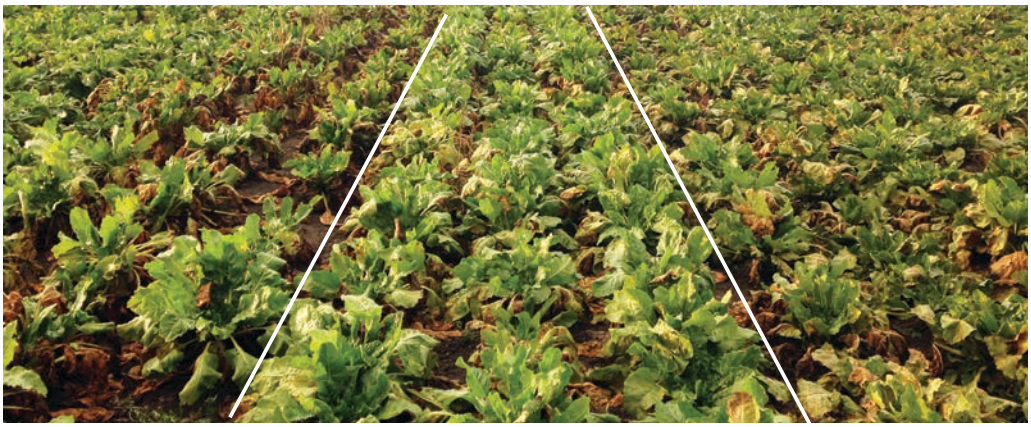
Robbos is an excellent, consistent performer with more leaf protein for a better balanced diet, coupled with consistent high DM yield.

Higher leaf protein

As fodder beet is so high in carbohydrate, *Robbos*' higher leaf protein, due to its excellent leaf quality, provides a better-balanced diet for animals.

Alternatively, this could be turned into a cost saving of around $1125/ha* by using a less expensive supplement when grazing *Robbos* crops.

Robbos leaf tested at 24.5% protein at the start of winter, versus *Feldherr, Brigadier, Monro* and *SF1505Bv* which averaged 21%.



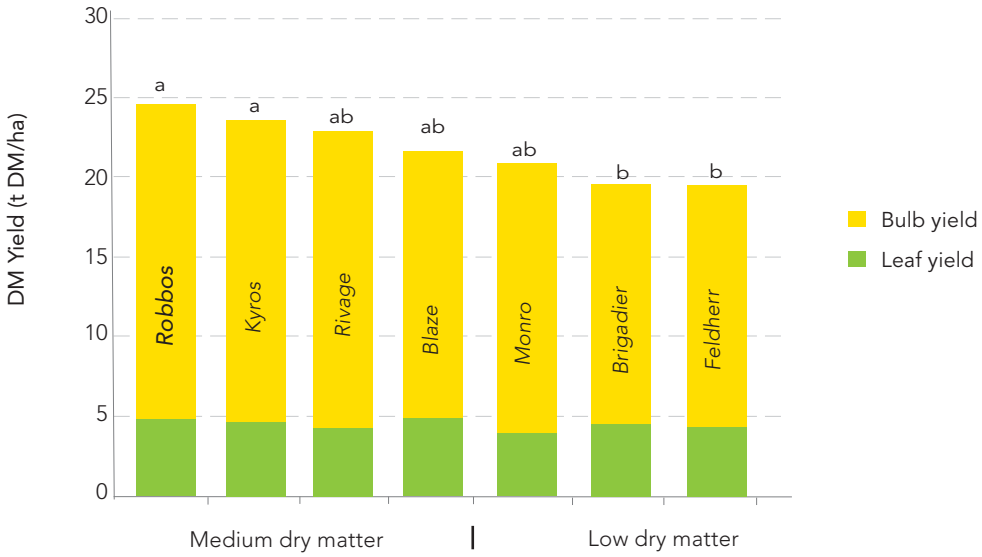
Robbos (middle 3 rows) showing excellent leaf holding ability versus Kyros (left) and Enermax (right) in Canterbury trial.

*(*Based on feeding 7.5 t DM/ha (3 kg DM/cow/day) good silage with 17% crude protein @ $0.40/kg DM, versus good hay with 15% crude protein @ $0.25/kg DM. We recommend feed testing crops & supplement before setting diet.)*

Very high DM yield

Of the grazing types, medium DM beets provide significantly more yield and stock carrying capacity than low DM beets. Among the medium DM cultivars *Robbos* has shown consistently high DM yield.

Fodder beet DM yields - medium and low dry matter (DM) cultivars



*Combined analysis of 5 trials from 2014-2017, varieties in two or more trials are presented. Cultivars with the same statistical significance letter are not significantly different at the LSD 5% level.

Palatable

Robbos has relatively soft orange-yellow bulbs, which suit grazing by all stock types. Its high leaf quality can also help with transitioning animals onto beet.

Above ground %

Robbos bulbs typically sit 45-50% out of the ground, and their good palatability make them easy to graze. The high proportion of above ground DM ensures less soil ingestion and very high utilisation.

Bulb above ground %*

Cultivar	% of bulb above ground	
Brigadier	53	a
Rivage	47	b
Blaze	46	bc
Robbos	**45**	**bc**
Kyros	44	bc
Enermax	41	c
Trial mean	44	
LSD (5%)	5.2	

**From 3 trials in Canterbury from 2008/09 to 2014/15. Cultivars were in at least two trials. Cultivars with the same statistical significance letter are not significantly different at the LSD 5% level.*

Robbos seed

Based on feedback, *Robbos* seed coating no longer has insecticide and comes in 90,000 seed boxes.

Using *Robbos*

Dairy

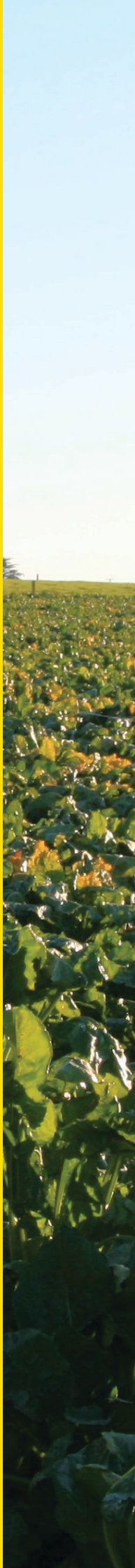
Sheep, beef & deer

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precision sown						Extend lactation, start winter transition		Winter feed		Supplement spring pasture	
Precision sown						High ME feed for liveweight gain or maintenance from autumn to spring					

Feeding method:	Multi-use. Typically grazed (can be lifted)
Typical yield:	18-24 t DM/ha average; > 25 t DM/ha with summer moisture*
Typical ME:	12-13 MJ/ME
Sowing rate:	90,000-100,000 seeds/ha

Fodder beet management

Fodder beet sowing checklist	167
Paddock selection	168
Soil fertility	169
Establishment techniques	170
Assessing crop yield	172
Environmental considerations	173



Fodder beet sowing checklist

Summary

The key to a successful crop is following best practice throughout the process from paddock selection to transition and feeding. This information is a guide. Seek specific advice.

Tick off these steps for great results.

Checklist	✓
Select paddocks per industry best practice guidelines for winter grazing, see page 168	
Check herbicides applied over previous 2 years. Certain chemical residues affect fodder beet.	
Soil test to 150 mm depth 6-12 months prior to sowing. Target pH 6.0-6.3. Lime must be applied at least 6 months in advance, see page 169.	
For a 'stale' seedbed, spray out paddock 4-6 weeks before sowing, see page 170	
Cultivate to create a firm, even seedbed.	
Apply fertiliser based on the soil test results prior to sowing and incorporate.	
Sow fodder beet in spring when soil temperatures are consistently >10°C and rising, ensuring adequate soil moisture is available.	
Sow seed at 15-20 mm depth using a precision planter, at desired sowing rate, see page 170.	
Sow at a low speed for good seed placement.	
Roll paddock immediately after sowing to increase effectiveness of pre-emergence herbicide and maximise soil-seed contact.	
Apply pre-emergence herbicide. An insecticide can be incorporated with this. Seek advice on spray programme, see page 171.	
Apply post-emergence herbicide programme. Timing is everything! Apply when fodder beet seedlings and weeds are at the correct size.	
Apply post-emergence fertiliser prior to canopy closure.	
Rogue out any bolters before they drop seed.	

Paddock selection

Summary

Industry regulations and guidelines mean many physical features need to be considered in selecting paddocks for grazing fodder beet. A specific wintering plan is now required for all winter crops, including an animal wellness plan.

The lay of the land

Land contour is a key factor. If the slope of the proposed fodder beet paddock is 10% or more, a resource consent may be required.

Critical sources areas (CSA) must also be evaluated. Where are potential overland water paths, low points and other CSAs in the proposed paddock? Can these be mitigated by planting other species, restricting stock access and/or not cultivating?

Waterways

If crop is sown close to a waterway, a consent may be required. Check current rules. Maintaining an ungrazed buffer zone of at least 5 m is recommended near waterways, with larger buffers providing more protection on sloping land. Check regional and national requirements for waterway protection in your area.

Sowing direction

Can the crop be drilled easily across slopes or parallel to CSAs or waterways to reduce run-off risk during grazing?

Soil type

Ideally crop paddocks will comprise soils less at risk of winter pugging. This reduces excess mud during grazing, and allows faster re-sowing after grazing, e.g. catch crops.

Shelter, water & space

Animals on crop become susceptible to cold stress in cold, wet, windy conditions. Access to good shelter is a must. Stock must always have access to adequate supplies of clean fresh water, and have dry space for lying time (8 hours daily). Portable water troughs can help minimise paddock damage.

Adverse weather events

Ensure there is an adverse weather grazing plan. This could mean using a winter crop paddock that is set up for such conditions, or ear-marking other areas of the farm to move stock onto during adverse weather.

For more specific regional information, go to DairyNZ, Beef and Lamb, or your local Regional Council website. See also the section in this Manual on winter grazing considerations, pages 136-137.

Soil fertility

Summary Fodder beet requires certain nutrient levels to yield well.

Soil test paddock(s) 6-12 months to a depth of 150 mm before planting. This allows time for pH or nutrient issues to be addressed. Apply and incorporate all base fertiliser before planting.

pH

The ideal soil pH is 6.0-6.3. It can take 6 months or more for lime to act (depending on incorporation, weather, and the type of lime used), so apply this as early as possible. As a rule of thumb, 1 t/ha lime raises the pH by 0.1.

Correct soil fertility results in healthy, high yielding crops.

Phosphorus

Phosphorus is essential for plant establishment and overall yield. Target Olsen P level for fodder beet is 15+. Typically crops benefit from a base dressing of 25-50 kg P/ha.

Nitrogen

Before cultivation, soil test to 150 mm deep for anaerobically mineralisable nitrogen (AMN). As a guide:

- If AMN >80 ug/g, 50 kg N/ha is required.
- If AMN <80 ug/g, up to 100 kg N/ha may be required.

Research has shown there is no yield advantage to applying more than 100 kg N/ha. Timing is important - apply 50% at sowing and 50% before canopy closure.

Potassium

Fodder beet requires soil potassium quick test levels of 5+. As a rule of thumb, if the soil test result is lower than 3, apply 100 kg K/ha. If it is 3-5, apply 50 kg K/ha.

Sulphur

If the sulphur quick test result is below 5, apply at sowing.

Magnesium

Recommended quick test soil levels for fodder beet are 8+. If magnesium is required apply 25-30 kg Mg/ha as a base fertiliser.

Sodium

If quick test soil values are less than 5, apply 150 kg NaCl/ha as a base fertiliser.

Boron

Boron is essential for root crop development. If soil test results are less than 1 parts per million (ppm), include 1.5 kg B/ha in the starter fertiliser, e.g. granular boron (15% B) at a rate of 10 kg/ha.

Establishment techniques

Summary

Fodder beet is a specialist crop and is more intensive and expensive to grow than other forage crops.

It can produce high DM yields, but these vary widely. With good establishment techniques, management and moisture, fodder beet can produce 30 t DM/ha. Typical yields are 18-24 t DM/ha. In summer dry situations yields are lower.

Pre-sowing

Fodder beet is sown at a very low sowing rate compared to other forage crops, so a fine, even, weed free seedbed is essential for optimal germination. Fodder beet is particularly vulnerable to dry conditions and competition from weeds during establishment. You can reduce this risk using the 'stale' seedbed technique i.e. prepare the seedbed 4-6 weeks before sowing.

To achieve a stale seedbed, spray out the selected paddock(s) with appropriate herbicide/s ideally 6 weeks before planting. This gives time to implement a double spray programme and retains soil moisture.

Paddocks are typically ploughed to bury existing plant material and break up any compaction or sub-soil pans, then surface cultivated to produce a fine, even seedbed. A second non residual weed spray (e.g. glyphosate) can then be applied just before sowing, or included in the pre-emergence application just after sowing.

Sowing date

This is location and season dependent, but in general October to late November is recommended, once soil temperatures are consistently above 10°C. Sowing too early (< 10°C) can result in uneven germination, making spray timings difficult. It can also risk vernalisation, causing plants to flower prematurely in late summer, known as 'bolting'. Later sowing may jeopardise germination rate (due to lack of soil moisture) and shortens the growing season, reducing yield potential.

Precision sowing

We recommend precision sowing fodder beet. This ensures seeds are planted with appropriate spacings, enabling each bulb to grow to its potential. Sow seed 15-20 mm deep, with rows typically 500 mm apart and 250 mm between plants in the rows (depending on sowing rate and planter row spacing). Drilling speed needs to be slow (5 kph) to ensure accurate seed placement. How the crop is to be fed should determine the planting layout.

A precision planter is recommended for sowing fodder beet.

Precision sowing (cont'd)

Strip tillage is becoming popular for fodder beet, to reduce soil disturbance, weed germination and wind damage to establishing plants.

Fodder beet is normally sown at 80,000 seeds/ha for grazing, or 100,000 seeds/ha for lifting. This higher rate will restrict bulb size producing a more uniform crop which is easier to harvest.

Rolling the paddock immediately after drilling with a Cambridge roller helps maximise seed to soil contact giving a more even germination, and increasing the effectiveness of pre-emergence herbicide.

Weed/pest control

Seedlings are slow to establish so the crop is very susceptible to early weed competition and pest damage. A stale seedbed will get the crop off to a good start, however it alone rarely provides enough weed control.

The first herbicide is typically pre-emergence, applied immediately after sowing. An insecticide can also be incorporated. Follow this with selective post-emergence herbicides as needed until the crop canopy closes. Seek professional advice on herbicide choice, rates, timing and plantback withholding periods.

Fodder beet is very resistant to most brassica pests, except for *Nysius*, slugs and springtails which are typically found at drilling. See page 205, 189 and 206 for more information on controlling these.

Bolters

A fodder beet crop usually has a small population of plants which flower prematurely (known as bolters). Remove these in January or February before they drop seed in the paddock. Left uncontrolled, they will each drop up to 1500 seeds which can survive in the soil for many years, and germinate as the soil is disturbed. These areas can become thick with weed beet in future years, depressing future crop yields. You can reduce bolters by not sowing fodder beet too early.

Assessing crop yield

Summary

Quantifying crop yield prior to the start of feeding ensures correct daily DM allowance and transition. DM % varies widely between paddocks, so always measure – don't estimate.

Crop allocation

For transitioning, assess crop yield at the end of the paddock where livestock will start grazing, because correct crop allocation is paramount during this time.

How to assess yield

- Determine crop row spacing: Measure across 10 rows of the crop from the centre of the first row to centre of row 10; divide the distance by 9.
- Take at least 5 separate yield samples that represent the area being measured.
- For each yield sample: Sample a 2 m^2 area. For a 50 cm row spacing remove 4 m of a row; or 4.44 m for an 45 cm row spacing.
- Measure fresh-weight: Remove soil from the bulbs by scraping with a blade, separate the leaf and bulb by cutting as close to the crown of the bulb as possible, and weigh the leaf and bulb separately.
- Collect DM sample: Select approximately 300 g of representative leaf from multiple plants and place in a sealed, airtight plastic bag. Use a corer to sample at least 12 separate bulbs and place cores into a separate sealed, airtight plastic bag. Send samples to lab for DM determination.

Calculate the DM yield for each separate sample, and plant part, then average as in the following example. The DM % comes from samples sent to the lab.

A beet corer samples the whole gradient of bulbs more accurately than chopping.

Example of calculating yield

Fresh weight	x	DM%	
30kg bulb	x	0.14 DM (i.e. 14%)	= 4.2 kg DM
6 kg leaf	x	0.09 DM (i.e. 9%)	= 0.54 kg DM
Add the average bulb and leaf DM yield together;			
4.2 kg DM	+	0.54 kg DM	= 4.74 kg DM/2 m^2
Convert to ha to determine the kg DM/ha yield:			
4.74 kg DM/2 m^2	x	5000	= 23700 kg DM/ha or 23.7 t DM/ha.

Environmental considerations

Summary

Fodder beet can have both positive and negative impacts on the environment, and these need to be weighed carefully depending on your farm system. Research into environmental outcomes is still evolving.

Impacts

Positives	Negatives
Low crude protein (N) feed. Reduces urinary N excretion by animals. Lower nitrate leaching per ha than kale in grazing trials.	Potential soil compaction under grazing due to higher stocking rates. Remedial cultivation may be required before sowing subsequent new pasture or crop.
Established crops do not need to be sprayed for white butterfly or diamond back moth (less insecticide).	Full cultivation required for best fodder beet establishment. Associated risks include loss of soil N and CO^2, topsoil disturbance, erosion and run off.
Catch-crops (e.g. oats, Italian/annual ryegrass) sown immediately post grazing soak up excess soil N and mitigate leaching.	Poorly planned and managed winter grazing can cause of loss of sediment and nutrients to waterways.
High DM% bulbs can be lifted and stored, or left in the ground and lifted when required, for feeding on pads or in wintering barns. Feed quality remains high; urine is captured away from soils.	Generally more herbicide is required.

Well-planned and managed, fodder beet provides high yields, ME and utilisation.

Pasture pests

Argentine stem weevil	175
Black beetle	177
Black field cricket	179
Clover flea	180
Clover root weevil	181
Grass grub	182
Manuka beetle	184
Pasture mealy bug	185
Plantain moth	186
Porina	187
Root aphid	188
Slugs	189
Tasmanian grass grub	190

An adult clover flea (also known as lucerne flea or springtail). *Photo taken by Trevor James - AgResearch*

Barenbrug wishes to acknowledge the help of Landcare research in producing this section.

Damage seen:
Oct-April

Argentine stem weevil (*Listronotus bonariensis*)

Introduction

ASW is a ryegrass pest throughout NZ. Damage can be significantly reduced at pasture establishment, using the correct seed treatment, and once established, through use of an effective endophyte.

Identification

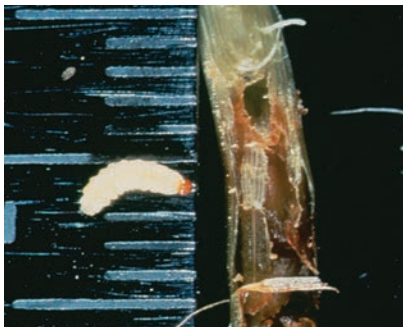
ASW larvae destroy ryegrass tillers by boring into the base of their stems. Populations can reach 500-1000 larvae/m², causing serious damage.

To find larvae, look for dead or dying central leaves in tillers, that when lightly pulled come straight out of the plant, due to being eaten at the base of the stem. The base of these stems show a small hole (if larvae are still inside) or significant damage inside as in the photo.

Larval damage mainly occurs from mid October to mid April. It is usually seen when pastures are growing slowly, and is often confused with drought stress. Younger pastures seem more susceptible than older ones.

In most areas, ASW have two generations a year, one in spring and another in summer. Generally the summer generation is the most damaging, between December and March.

Adult weevil feeding is characterised by small rectangular 'windows' 2-3 mm long on the leaf blade (shown in photo). Adults do not affect the persistence of established pasture, but can kill ryegrass at establishment.



Most damage is from larvae (on ruler in mm graduations) boring into ryegrass stems.

Adult weevil grow up to 3 mm long.

Adult ASW windowing.

Prevention & management

Establishment

New ryegrass can fail from adult ASW attack in late spring-autumn. This is most common in grass to grass or cereal to grass sowings with minimal tillage, or when undersowing into existing pasture, as ASW numbers can build up on the previous grass or cereal. Good cultivation practices minimise ASW numbers, however if turf or plant sods remain intact ASW may survive on these.

Adult ASW and larvae can kill ryegrass seedlings as they first emerge, predominately in the first few weeks after sowing. Beware dry conditions – these slow establishment, leaving plants in a vulnerable stage for longer.

Argentine stem weevil (cont.)

Prevention & management (cont'd)

Adult ASW damage in a newly sown ryegrass pasture – only an odd patch of ryegrass has established, whereas clover is untouched and even.

Seed treatment

If sowing ryegrass where adult and larval ASW are potential problems, use a suitable seed treatment (e.g. *AGRICOTE Grass*) to help protect new seedlings. Additionally, in grass to grass or cereal to grass spray-drill situations where ASW numbers can be high, add an appropriate insecticide to the final glyphosate spray before sowing to reduce the ASW population.

Endophytes *AR37, NEA12, RGT18* and ryegrass *Without* endophyte give seedlings no protection against adult ASW. Other endophytes (*NEA, NEA2, NEA4* and *AR1*) give some protection in newly sown pastures, but not as much as seed treatment.

Endophyte

Endophyte is an important tool for ongoing ASW control in a pasture. Once established, diploid perennial ryegrass containing *NEA2, NEA4, NEA12, AR1, AR37* or *RGT18* endophytes are likely to provide good ASW control in most situations.

Tetraploids versus diploids

Tetraploid ryegrass cultivars are more susceptible to ASW damage, as they are preferred by ASW, and have a lower tiller density, so they cannot withstand the same level of damage as diploids. In areas of high ASW damage (e.g. coastal Taranaki) tetraploids can be less persistent than diploid cultivars.

Biological control

A parasitoid wasp (*Microtonus hyperdae*) is now widespread, and helps alleviate damage caused by ASW, although recent evidence suggests its effectiveness has reduced since introduction.

Black beetle *(Heteronychus arator)*

Introduction

Black beetle (BB) is a pest of free draining soils in warmer regions of the North Island. Numbers vary widely from year to year, with root feeding larvae capable of causing severe pasture damage in summer. Adult BB can decimate new grass sowings in autumn, and seed treatment is essential for protection.

Identification

BB are only found in warm areas, including Northland, Waikato, Bay of Plenty, coastal Auckland, Gisborne, coastal Taranaki, Manawatu and Kapiti coast. As they live on and in the soil, they are mainly found in free draining, sandy, light ash or loam soils, and do not like heavy clays or poorly drained soils.

Adult beetles grow to 15 mm long, & are chestnut coloured when newly emerged, turning black after a day or two.

BB populations vary widely from year to year. They can increase rapidly when conditions are right, and numbers may stay high for several years. Pastures damaged by summer dry conditions can become affected due to the invasion of summer grasses, a preferred feed of BB.

Both adult and larval BB damage pastures. Adults feed on roots or on the base of plants at soil level during autumn and spring, causing patches of yellowing tillers that easily pull out. They can destroy new pasture sown in autumn, especially if spray-drilled or undersown, as the insect population is not controlled in the absence of cultivation.

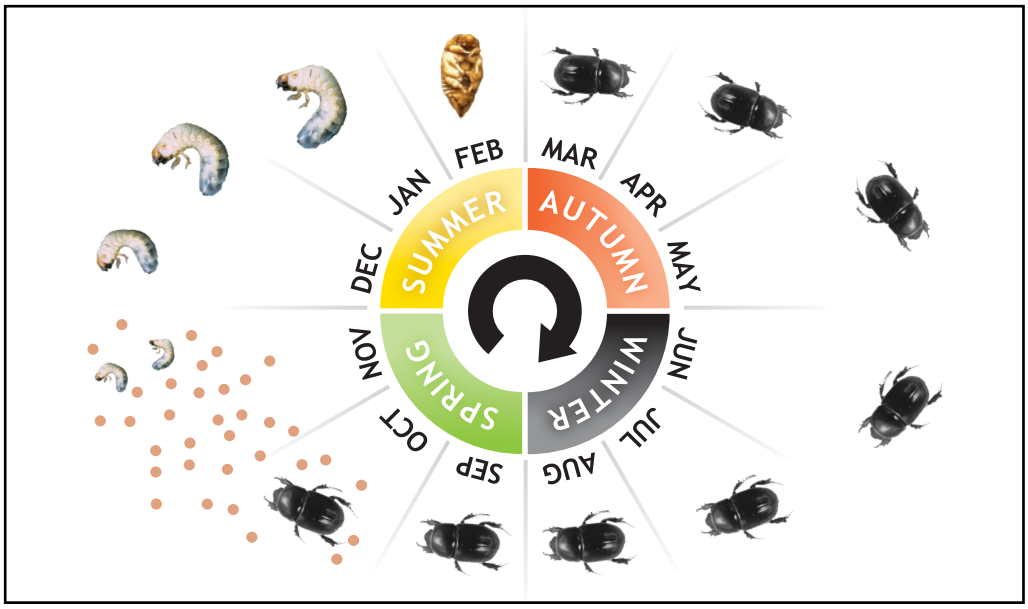
Larvae feed on plant roots December-March and cause patchy ryegrass death. Weakened plants are susceptible to pulling during animal grazing. Damage is most apparent in dry summers when larval numbers are above 40/ m². Larval damage can be severe in newly sown pastures.

Larvae are larger than grass grub with more prominent spiracles (breathing pores-orange spots) down their sides.

Adult black beetle feed on the base of plants and roots.

Black beetle (cont.)

Life cycle



Establishing pasture

When renewing pasture in an area with a high risk of BB:

1. **Consider break crops.** BB doesn't like brassicas, chicory or maize. Cropping prior to pasture renewal will reduce populations.
2. **Before sowing, eliminate any grass weeds** to remove this food source for BB.
3. **Monitor BB populations** from early February. You need to know pest numbers before finalising sowing plans.
4. **Cultivate if beetle populations are high.** Cultivation significantly reduces numbers of adult beetles and larvae. The threshold is >15-20/m² of adult and larvae.
5. **Sow ryegrass with the right endophyte.** *NEA, NEA2, NEA4, NEA12* and *AR37* are the most successful novel endophytes for control of adult BB. *AR1* is not recommended.
6. **Always sow treated seed,** such as *AGRICOTE Grass*. This is essential to protect establishing grass plants. Endophyte provides minimal protection for ryegrass seedlings during establishment.
7. **Use lime to improve soil pH.** On-farm trials by AgResearch have shown applying lime in spring to raise the soil pH to 6 resulted in up to 40% less BB larvae than control treatments.

Biological control

NEA, NEA2, NEA4, NEA12 or *AR37* endophyte all give good control of BB by reducing adult feeding, egg laying, and hence larval damage. They do not directly affect larvae. *AR1* endophyte does not provide effective BB control and should not be used where BB is a risk.

However, no endophyte gives complete resistance, and all ryegrasses may still be damaged in problem areas in summer dry conditions.

Other grasses, such as paspalum and poa annua, are a good food source for BB adults. At present no insecticides are available to control BB.

Black field cricket (*Teleogryllus commodus*)

Introduction

Black field cricket is a serious pasture pest in Northland, Auckland, parts of Waikato, Bay of Plenty, Hawke's Bay and Manawatu. It especially likes clay soils prone to cracking in dry summers.

Identification

The late nymphal stages and adults cause the most pasture damage. The young nymphs look like miniature adults but have a white band across the body which distinguishes them from native crickets.

Crickets feed above ground at night and take refuge in cracks in the soil during the day. Crickets feed outwards from the cracks, defoliating and killing pasture grasses. They are selective feeders, preferring grasses but also eating legumes, weeds and newly sown seed.

Adult crickets are typically 25-35 mm long and seen in pastures Feb-May.

Pastures are more susceptible to damage in their first year.

On heavier soils, damage shows clearly as bare patches associated with soil cracks. Damage on lighter soils is often harder to see, as seeds and seedlings eaten by crickets are often covered by pasture, but if the bare earth is revealed when the pasture is pushed away by hand, cricket feeding may be seen.

If crickets are suspected but not visible, a weak solution of household detergent in water can be used to flush them from cracks in the soil.

Prevention & management

The potential for severe long term pasture damage makes early detection very important. Crickets can quickly defoliate and kill older grasses with high grazing pressure on the crown.

Populations greater than 10/m² are considered economically damaging. At 20/m² they can consume up to 16 kg DM/ha/day, and populations can reach 100 to 150/m².

Crickets can be effectively controlled using malathion-grain baits, applied at a rate relative to the population base.

Damage seen:
Sep-Nov
March-May

Clover flea *(Sminthurus viridis)*

Introduction

Clover flea (CF) is present throughout NZ and is a particular threat to white clover and lucerne.

Identification

CF, also known as the lucerne flea or springtail, can easily be seen with the naked eye. It grows up to 3 mm long, and is greenish-yellow with irregular dark patches.

Adult females lay very small cream coloured eggs loose on the soil surface. The eggs hatch into small nymphs which resemble adults, and develop through 5-7 stages to adulthood.

Clover flea damage pattern showing on the green tissue of a clover leaf.

Clover damage appears as leaf flecking, giving a measles-like effect. Under severe attack, leaves appear white, as all green tissue is removed from the leaf leaving a transparent skeleton.

Fouling of clover by the fleas tends to reduce palatability to livestock.

Prevention & management

CF can be successfully controlled using insecticides, by combining a low rate of insecticide to kill adults and an insect growth regulator to eliminate juveniles once they hatch from eggs.

Keep your clover healthy through good pasture management. This helps it tolerate a low level of CF

An adult clover flea.

Photo taken by Trevor James - AgResearch

Damage seen:
Year round

Clover root weevil (*Sitona lepidus*)

Introduction

Clover root weevil (CRW) is present throughout New Zealand. Feeding exclusively on clover, it has a major impact on clover production and nitrogen fixation. A parasitoid wasp has been released in most areas as a biocontrol agent and has established well except in Northland.

Identification

Adult CRW are brownish-grey, up to 5 mm long with a typical weevil shape. Their damage is characterised by U shaped notches on the edges of clover leaves. As clover is adapted to defoliation, the adult weevil rarely kills clover, apart from young seedlings.

Adults can fly and actively disperse in dry conditions and when numbers are high and clover levels are low. They are present year round, most abundant in spring and autumn. Larvae are most damaging, feeding on the clover roots, stolons and nodules. Larvae mostly live in the top 5 cm of soil. They are white legless grubs from 1-6 mm long, with a conspicuous brown head capsule.

CRW is only associated with clovers, so where clover is absent, there will be no weevil.

Adult CRW on a clover leaf showing typical U shaped feeding damage.

CRW larvae cause most of the damage.

Prevention & management

Maintaining strong clover in pastures is the best way to reduce the effect of CRW. See page 103 for more detail.

Where clover is severely damaged, increased use of N fertilisers may be required to compensate for reduced N fixation.

If sowing clover into a known CRW infested paddock adult weevils will probably need insecticide control before sowing. Sow white clover cultivars with high stolon density and better CRW tolerance, or red clover which is less affected by CRW. Modern white clovers (e.g. *Ruru* and *Kotuku*) have been selected under medium to high levels of CRW. Oversowing white clover seed onto pastures can help re-establish clover following severe CRW damage.

Biological control

A parasitoid wasp (*Microctonus aethiopoides*) has been released as a biocontrol agent and is now well established throughout most of the North Island and South Island. This wasp won't eliminate CRW, but significantly reduces populations and larval damage.

Damage seen:
March-July

Grass grub (*Costelytra giveni*)

Introduction

Grass grubs (GG) are found throughout NZ. Larvae graze the roots of grass, plantain and clover causing poor growth and plant death, mainly from March-July. In severe cases, pastures can be rolled back like carpet.

Identification

GG damage is seen in mid to late autumn, typically as patchy areas of dead plants, often pulled out by stock. Damaged areas can expand outward from year to year. Adults are copper coloured beetles 1 cm long seen flying at dusk in November to December.

Patchy grass grub damage shows in pastures during late autumn.

The damage is caused by GG larvae which hatch from eggs in October-December and develop through three instars (or stages). The small first and second instar feed on roots and soil organic matter, doing little damage. By autumn they have developed into the larger and most damaging third instar, feeding 10-30 mm below the ground on plant roots. GG larvae prefer white clover but eat most other species too.

Populations typically grow over a 3-5 year cycle then crash due to disease build up in the soil. Within a single paddock, infestations can be at any stage in the cycle.

GG larvae found in the root zone.

GG larvae are best found by digging. They are translucent grubs, 25 mm long, with six legs and a honey brown head. Usually curled in a C shape, they become active only when disturbed. This can help distinguish them from Tasmanian grass grub which actively crawl away.

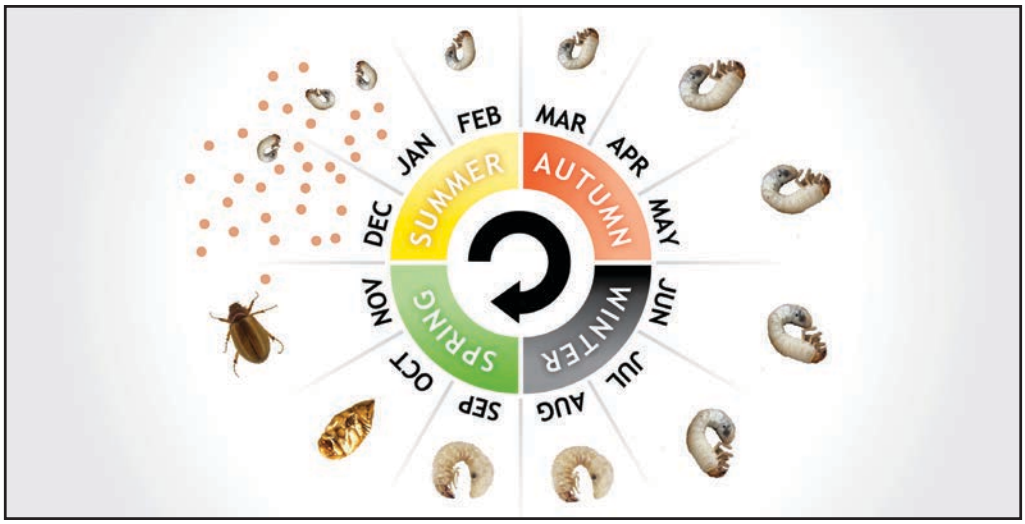
Threshold levels for economic control of grass grub have been estimated (see below).

Threshold levels for economic control of grass grub

Situation	Grass grub larvae	
	Per spade square	Per m^2
Newly sown pasture	3	75
Southland, Otago, irrigated Canterbury	8	200
Dryland Canterbury	6	150
Other regions	4	100

Life cycle

Typical one year GG cycle



Note: Larval feeding occurs right through spring in GG two year life cycle (see below).

The GG life cycle typically takes one year, but in cool or dry regions some grubs take two years to develop.

One year GG pupate in spring, emerging as adult beetles which fly in October-December, starting the larval stage again.

In dry or cool areas where some larvae take two years to become adults, they cease to feed over their first winter, and resume feeding through spring, rather than pupating. They can cause spring pasture damage.

GG larvae showing the difference between the one year life cycle (left) & two year life cycle.

Establishing pasture

If establishing a new pasture into a paddock with GG problems, use insecticide or *AGRICOTE Grass* seed treatment. Note GG primarily feed in the autumn, but control may be required for spring sowings in areas where GG have a two-year cycle. Check pest numbers before sowing to decide if control is needed.

Cultivation usually drastically reduces GG larval numbers, but also disrupts natural diseases, often leading to a resurgence of the population two to three years later. Direct drilling is often used in GG prone areas to maintain lower and more stable populations and damage levels.

Management of established pasture

For an established pasture, insecticide control has had mixed results, as soil dwelling insects are relatively difficult to kill. Best success is through applications of chemical in February-March, when GG are close to the soil surface. Mob stocking and heavy rolling when soil is damp can reduce GG populations, but effects are variable.

Manuka beetle *(Pyronota festiva, P. laeta & P. setosa)*

Introduction

The native manuka beetle is found in damaging numbers on the hill country of both islands and some lowland areas of the West Coast of the South Island, often in pastures close to manuka scrub or undisturbed bushland. Larvae damage pastures by feeding on plant roots mainly from February to May.

Identification

Adult beetles live for a few weeks in late spring and early summer. They are ≤ 9 mm long, usually a bright metallic green colour, with females laying around 30-40 eggs.

Beetle larvae, up to 10 mm long, are grey/white with a tan head. The larvae can be mistaken for grass grub (GG) due to similarity in appearance and damage caused in pasture. Larvae typically lie in a C shape but are active when disturbed.

One generation is produced annually. *P. festiva* and *P. laeta* males and females are strong fliers. Females lay their eggs over a wide area. While *P. setosa* males are also strong fliers, *P. setosa* females are not, so eggs are laid close to where adults emerge. With no treatment, patches will increase in size from year to year.

Adult manuka beetle.

Larvae feed on the roots of both clovers and grass within pastures. They focus on living roots but can survive on dying or dead roots for extended periods. Most manuka beetle species are strongly attracted to manuka or kanuka scrub where feeding can occur, however *P. setosa* do not congregate or feed on manuka.

Damage shows as yellowing foliage, usually in young pastures, 2-3 years after development from native vegetation or bush regrowth. In severe conditions, plant pulling occurs when grazing.

High larval populations reduce DM production and cause patchy damage of pastures, creating space for weeds. Pasture renewal is often required if larvae are left untreated.

Prevention & management

The risk of manuka beetle is best assessed from the previous paddock history. Early recognition of infestation means control methods have a better chance of success.

Detect damage by:

- Digging up spade squares of pasture from mid-February. More than 12 larvae per spade square can cause significant damage.
- Visual assessment of damage patches, more obvious from March onwards.

Chlorpyrifos is registered for manuka beetle larvae control via drill application.

Pasture mealy bug (*Balanococcus poae*)

Introduction

Pasture mealy bug (PMB) can sometimes be a serious pasture pest in Canterbury, and is known to occur in Manawatu and Nelson.

PMB is a small insect found in the crown and on the upper roots of a range of pasture grasses, where it sucks sap from the grass. Unlike many other pasture pests, it was originally identified on native tussock grass and is endemic to New Zealand.

Adult mealy bugs are pink, egg shaped, have no easily discernible head or legs and grow up to 5 mm in size. The crawlers (the smallest immature stage) are less than 1 mm long, and have a pink tinge to them.

Evidence of PMB is seen as white waxy spots in the base of ryegrass plants.

Identification

The best way to identify PMB is to dig up ryegrass plants in autumn, and pull them apart to look for white, waxy secretions in the plant crown and upper roots. These will appear as cotton wool-like globules.

Outbreaks of PMB are common in pastures without endophyte in Canterbury. Damage was initially mis-identified as the result of drought because affected paddocks resemble a browned off pasture. Symptoms of PMB may first become apparent in January, if it coincides with a dry spell. Damage is most noticeable in autumn and early winter where pastures remain browned off.

PMB damage tends to affect a whole paddock, rather than isolated patches. It causes widespread ryegrass death, leading to poor pasture persistence.

PMB close up.

Biological control

All endophytes are believed to give a high level of resistance to PMB.

Ryegrass with endophyte (right) has good PMB resistance versus ryegrass Without endophyte.

Damage seen:
March-Aug

Plantain moth *(Scopula rubraria & Epyaxa rosearia)*

Introduction

Plantain moth (PM) caterpillars are a significant pest of plantain nationwide.

They can cause severe damage, particularly in pure plantain crops.

Identification

PM comprises at least 2 native moth species, known previously as 'carpet moths'. Both are relatively small. *E. rosearia* are slightly larger than *S. rubraria* which have a wing length of 9-10 mm. PM are light brown with dark spots and a distinct dark brown band towards the end on the wings. This band is more obvious on *E. rosearia* while *S. rubriaria* has a more spotted pattern. *S. rubraria* caterpillars are brown but vary in tone and pattern. *E. rosearia* caterpillars are green or brown; both grow to <20 mm long.

*PM (S. rubraria) feeding on plantain.**

Damage is more likely when a mild winter is followed by a dry summer. A short generation time (7 weeks) allows for exponential population growth. PM are most abundant in late summer and largely disappear from crops in autumn.

*PM caterpillars are small, growing up to 20 mm.**

Prevention & management

Caterpillars feed on the leaves creating holes or leaf marginal notches which can combine and in severe cases leave only leaf veins. Severe damage (90% destroyed) has been reported. Damage can be highly localised.

Crop health, plant stress and growing conditions significantly influence damage severity; a healthy crop is more tolerant of PM than one which isn't actively growing.

Some chemistry is registered for control of PM caterpillars; speak to your local crop protection advisor for specific information.

*PM damage can be devastating to plants.**

*(*Photos courtesy AgResearch)*

Porina (*Wiseana* spp.)

Introduction

Porina are found throughout NZ, with species present varying between regions. Caterpillars attack most pasture species including ryegrass and white clover. *AR37* endophyte provides a level of tolerance. We expect *NEA12* and *RGT18* endophytes will too.

Identification

Porina caterpillars damage pasture in late autumn and during winter as growth slows. Caterpillars are greyish yellow with a dark brown head, and grow up to 70 mm in length. They live in tunnels in the soil, emerging at night to feed on the surface, grazing grass and clover.

Porina caterpillar grow to 70 mm long & leave their tunnels to surface feed at night.

Their tunnels are associated with bare patches of pasture, and dead plants. Tunnel entrances can be found as holes, covered in soil castings and debris held together with silken threads.

To assess numbers dig to 30 cm deep. Caterpillar populations of 2/spade square (50/m²) in March can reduce pasture production by 1500 kg DM/ha. Caterpillars at this time range from 4-30 mm in length, with a high proportion of small caterpillars suggesting damage will increase.

Porina moths are about 25 mm long and brown in colour.

Adult moths fly mainly in October-January, and do not feed. They are brown with white and black markings on the forewing. A female will scatter up to 3000 eggs, which hatch over the following two to three weeks.

Porina eggs and young larvae need good protection within pasture, therefore populations fluctuate year to year, being highest in years of good summer growth and in pastures allowed to become rank.

Prevention & management

To reduce the risk of porina damage, maintain low pasture cover during late spring to reduce survival of eggs and young larvae. Paddocks left for hay or silage, or poorly grazed and rank, are typically worst affected by porina as higher pasture covers help eggs survive.

Porina can be relatively easily controlled by insecticides. Insect growth regulators should be applied late January-early March. Organo-phosphate and synthetic pyrethroids can be used later, in which case digging in April will give a good assessment of numbers. If possible apply insecticide to short pasture.

Mob stocking in summer can control porina. Intensively graze pasture to 20-30 mm using high stocking rates (1000 ewes/ha) over a few days.

Biological control

AR37 provides pastures with a level of porina control. Initial testing with *NEA12* and *RGT18* has shown they also provide a level of control, but field trials are not yet complete.

Experience suggests pastures with these 3 endophytes will still need to be monitored for porina and sprayed when larval numbers are high (but sprayed less often than other endophyte options).

Damage seen:
March-July

Root aphid (*Aploneura lentisci*)

Introduction

Root aphid (RA) has become recognised as a pest relatively recently and the damage it causes is not well understood.

Identification

RA feeds on ryegrass roots, sucking sap and producing a white waxy substance. It has a similar appearance to pasture mealy bug which can be confusing. Both pests surround themselves with a white, waxy secretion but RA is found deeper in the soil on roots, whereas mealy bug is found in the crown of the plant. RA is also smaller than adult mealy bug, yellow-white and oval-shaped.

Adult RA are on average about 2 mm long with 2 tiny segmented antenna. The aphid is creamy or pale yellow with tiny legs visible below the body.

Numbers can be assessed by digging up a spade square of pasture 30 cm deep, breaking the sod apart and looking for the characteristic white waxy exudates. RA numbers tend to vary widely across a paddock. An average of 20 root aphid colonies per spade square may cause a reduction in ryegrass productivity.

RA is not believed to kill plants, but its damage may be additive to that of other pests or stresses such as summer dry conditions. As roots are damaged from feeding, RA will move onto new roots.

Root aphid feeding on perennial ryegrass roots.

Root aphids in a small colony.

Biological control

RA can be controlled to a significant level by ryegrass endophytes *NEA12*, *AR37* and *CM142* give very good control of RA, while *NEA2* and *NEA4* endophytes provide moderate control. Plants with *AR1* endophyte (or with no endophyte) have no RA resistance.

Damage seen:
Year round

Slugs (*Deroceras* spp.)

Introduction

Slugs are everywhere in NZ and can rapidly cause severe seedling loss in establishing pasture and crops. Take particular care with over-sowing or direct-drilling where surface trash is present.

Identification

There are eleven introduced species of slugs in NZ, of which the grey field slug is the most common. They generally live in the top 2-3 cm of the soil surface.

Slugs in base of pasture.

Slugs are present in most pastures throughout the year, causing some, but not significant damage. Populations are highest under favourable weather conditions: moist soil, moderate temperature and high humidity.

Slugs can severely damage establishing pasture and crop, feeding on germinating seed and newly emerged seedlings. Spray-drilled pastures and forage crops are particularly vulnerable.

Typical slug damage.

Slugs can move along the drill rows, killing seedling plants, and utilising the cover of surface trash. Slime trails are often visible with the early morning dew.

Check numbers by leaving wet sacks or similar objects in the paddock overnight just before drilling. Count slugs the next day. Any more than six per object are considered potentially damaging to pasture establishment.

Prevention & management

When sowing into a known slug population, molluscicide baits either at sowing or just prior, can provide economic control (refer to table). Be mindful of the surrounding areas as slugs can move in from roadsides and adjacent paddocks.

Biological control

Mob stocking can give high levels of slug control and can be used before, or immediately after sowing. To be effective aim for 1500 ewes/ha for one night, or 500/ha for three nights.

Effect of molluscicide on pasture establishment (MAF Normanby)

Treatment (autumn)	Ryegrass seedlings	Tall fescue seedlings
Untreated	269/m^2	17/m^2
Molluscicide	512/m^2	305/m^2

Source: Proc NZ Grasslands Assoc. 52: 237-240 (1990), D. McCallum et al.

Tasmanian grass grub (*Acrossidius tasmaniae*)

Introduction

Tasmanian grass grubs (TGG) are found in the lighter soils of lower Northland, Waikato, Bay of Plenty, Hawke's Bay, Marlborough and Canterbury. Larvae graze pasture plants above the ground, killing plants and leaving bare patches.

Identification

When identifying TGG, be careful to distinguish them from native grass grub.

Adult beetles are attracted to dung, laying their eggs in or near it. Thus, initial infestations are typically observed around stock camp areas.

Eggs are laid from January-March and hatch into larvae which feed on dung for 4-6 weeks before moving onto pasture. From about April onwards grubs live in tunnels, at night coming to the surface to feed through to August (as late as November in some years). New pasture is particularly vulnerable to damage. Pasture growth can be reduced by 5% per 100 larvae/m^2, and losses of carrying capacity of up to 5 SU/ha have been recorded.

TGG larvae can be distinguished from native larvae by their darker head colour.

TGG larvae are best identified by digging, and are 15 mm long whitish grubs, with six legs and a black head. (This helps distinguish them from native grass grub larvae, which have a brown head, and are generally larger in size.) When disturbed, TGG larvae start crawling like caterpillars, unlike native grass grub larvae which typically assume a protective C shape.

In autumn larvae live 10-15 cm below ground in vertical tunnels, from which they emerge at night to graze surrounding vegetation. TGG have been known to establish in shelter belts then move out into adjoining paddocks.

Populations above two grubs per spade square (50/m^2) will cause significant pasture loss and are economic to control.

Prevention & management

Insecticides are effective in controlling TGG. Populations will often be localised, making spot control with insecticide a useful approach to control.

Perennial pasture species are typically more tolerant of TGG, because larvae prefer annual grasses. Maintaining dense pasture covers during summer reduces the survival of eggs laid by adult beetle.

Pasture diseases

Ryegrass diseases

Brown blight	192
Crown rust	192
Damping off	193
Ergot	193
Net blotch	194
Powdery mildew	194
Ramularia leaf spot	195
Scald	195
Snow mould	196
Stem rust	196

White clover diseases

Clover rust	197
Clover viruses	197
Leptosphaerulina leaf spot	198
Common leaf spot	198
Sooty blotch	199
Sclerotinia rot	199

Barenbrug wishes to acknowledge the help of Ian Harvey, Plant Diagnostics and Plant & Food Research in producing this section.

Brown blight & Crown rust

Brown blight

Summary

Brown blight (BB) is caused by the fungus *Pyrenophora lolii*. It is most common in spring and autumn, but damage can occur all year.

Species affected

Ryegrass, fescue, cocksfoot.

Identification

BB causes leaf lesions of various shapes. These are small, oval, brown spots, the centres of which become light brown to white as they enlarge. Longer, dark brown streaks also appear. Infected leaves turn yellow and die from the tips.

Brown blight on ryegrass leaves.

Spread

BB survives on dead and diseased plant tissue. It is spread by wind, rain, equipment or animals. In moist conditions, spores germinate, causing new infections. BB spore banks are often found in nearby undeveloped areas (fence lines and roadsides).

Prevention & management

Timely cutting and grazing minimise damage from BB.

Crown rust

Summary

Crown rust (CR) occurs throughout NZ, but is most common in the North Island. It is caused by the fungus *Puccinia coronata*, mainly in warm, moist conditions from early summer to late autumn. CR reduces pasture growth and palatability.

Species affected

Ryegrass, tall fescue.

Identification

CR produces bright orange powdery spots (or pustules) on leaves of ryegrass or tall fescue plants.

Spread

Pustules produce orange spores that are carried by wind or rain to other leaves. These germinate to produce new pustules.

Crown rust on a ryegrass leaf.

Prevention & management

Use more resistant cultivars where CR occurs.

Rust resistance	Cultivar
Very high	*4front, Maxsyn, Array*
High	*Governor, Rohan*
Moderate	*Tyson*
Poor	*Nui*

To avoid rust, graze pastures at the correct time; don't let them get too long. Application of N fertiliser helps prevent rust. If rust is present, hard graze to remove infected pasture and apply N if possible. New growth should show little rust.

Damping off & Ergot

Damping off

Summary

Damping off covers several fungi that kill establishing plants. Causal pathogens are *Pythium* and *Fusarium spp.*

Species affected

Ryegrass, clover.

Identification

Young plants wilt and die from lesions at and below soil level.

Spread

Infection is common in autumn and winter particularly during cold wet weather. Fungal spores are widespread in the soil and can become very active when climatic conditions are suitable.

Prevention & management

All the fungi are soil-borne and spores can build up over successive years. *AGRICOTE Grass* seed treatment provides early control.

Damping off in ryegrass caused by Fusarium.

Ergot

Summary

Ergot is caused by fungi in the *Claviceps* genus. *Claviceps purpurea* is the most well-known. It occurs in summer when ergots (or *sclerotia*) develop on grass seed heads. It can reduce yield and produces compounds toxic to stock.

Species affected

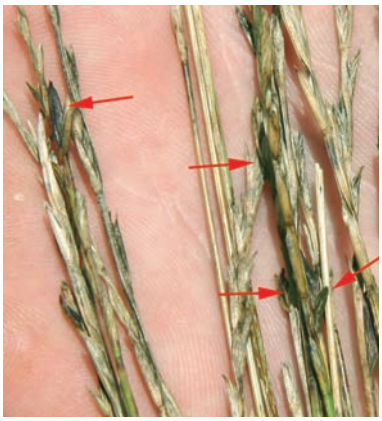
Many grasses, including ryegrass, paspalum, cereals and brome species.

Identification

Ergots are dark purplish-black, replacing a seed in the seed head. They are usually hard and larger than normal seed.

Spread

Ergots drop to the ground and lie dormant through winter. In spring they germinate to produce a fruiting body which releases spores which infect developing florets. It is also spread in infested hay.



Ergot turns seeds dark with a purplish tinge as indicated by arrows.

Prevention & management

The goal when seedheads have ergot is to prevent animals eating these. A good solution is to mow the pasture, and leave seedheads on the ground for several weeks so animals won't eat them at the next grazing.

If there is a reasonable amount of green leaf in the pasture, pastures can be carefully grazed with sheep. Sheep are selective grazers, and avoid eating seedheads (unlike cattle which graze from the top down). Break the paddock into blocks and monitor sheep as they graze. Let them eat the green leaf but shift them before they eat the seedhead. Remove them immediately if they show any symptoms of ergot toxicity,

Don't make hay or silage from pastures with ergot. It will still be present when you feed it out and can cause health issues particularly if used as a maintenance feed.

Ergot in seedheads can remain toxic for months if no action is taken. Seedheads gradually fall and disappear. When this happens, the risk is over.

Net blotch & Powdery mildew

Net blotch

Summary

Net blotch (NB) is common throughout NZ, caused by the fungus *Pyrenophora dictyoides* usually in autumn. It can seriously affect winter pastures.

Net blotch on ryegrass leaves.

Species affected

Perennial ryegrass, tall fescue.

Identification

NB produces a network of short dark brown bars which run across the leaf blades. These enlarge and become dark brown, solid spots. In heavily infected plants, leaf tips yellow and die back. NB is more severe in long dense swards in moist conditions.

Spread

NB is spread as wind-borne spores produced by lesions. The fungus survives on infected stubble. Wet, humid weather favours NB spread.

Prevention & management

Graze pasture before it becomes long and rank to reduce the chance of NB and lower severity of the disease. Apply N based fertiliser after grazing to boost regrowth and reduce the incidence of NB. Under severe infection, fungicides may be economical.

Making silage will not remove NB; Instead, it will make the silage less palatable.

Powdery mildew

Summary

Powdery mildew (PM) is caused by the fungus *Blumeria graminis.* It usually occurs in spring and autumn. It is normally a minor disease in NZ, only causing significant yield reductions under heavy infection.

Powdery mildew on a ryegrass leaf.

Species affected

Perennial ryegrass, tall fescue, cocksfoot.

Identification

PM causes patches of fine, white-coloured fungus (mycelium) on leaves and leaf sheaths. Older leaves are infected before younger leaves and can yellow and die under heavy infection.

Spread

PM survives winter as fungal mycelium or cleistothecia on infected plants, stubble or hay. Air-borne spores produced in spring land on susceptible plants, causing new infections. Spores are also released after rain in autumn. Infection is worst in shaded areas with poor air circulation.

Prevention & management

Graze pasture to remove affected growth and promote fresh regrowth. Do not allow pasture to become overgrown.

Ramularia leaf spot & Scald

Ramularia leaf spot

Summary

The fungus *Ramularia pusilla* causes *Ramularia* leaf spot (RLS), most commonly in spring and autumn, when it can seriously reduce yield and quality.

Species affected

Ryegrass, prairie grass.

Identification

Rounded leaf spots, grey to brown in colour, sometimes with red edges, appear on the leaf surface. Part of a paddock can appear yellow as leaves become infected and die.

Spread

Numerous microscopic egg-shaped spores are produced on older lesions. These spores are readily wind borne and can rapidly spread infection to new sites. Wet humid weather helps spread RLS.

Prevention & management

Pasture should be grazed before becoming long and rank, to reduce the chance of RLS becoming established and lower the severity of the disease. Under serious infection, fungicides may be economical.

Ramularia leaf spot on ryegrass leaves.

Scald

Summary

Scald, caused by the fungal species of the *Rhynchosporium* genus, typically occurs between April and October, from Manawatu and Hawke's Bay south.

Species affected

Ryegrass, cocksfoot.

Identification

Scald causes irregularly shaped lesions or scald-like blotches on leaves and leaf sheaths. These often appear grey with brown edges. Lesions can join to affect most of the leaf. Infected leaves often die from the tip down; heavily infected plants are unpalatable to animals.

Spread

Spores produced on dead leaves are splashed, blown or carried to new leaves. The disease then persists in cool, sheltered areas. It is most severe during cool, wet periods in early spring and autumn.

Scald on ryegrass leaves.

Prevention & management

Sow resistant ryegrass cultivars. All Barenbrug cultivars have good resistance to scald. If the disease is noted in winter conserved feed, timely grazing can reduce losses.

Snow mould & Stem rust

Snow mould

Summary

Snow mould is caused by the fungus *Microdochium nivale* and can sporadically cause serious disease. It can be a problem in establishing autumn sown pasture following cereals. Long, rank pasture swards can also become infected in winter, especially under snow.

Snow mould in Italian ryegrass.

Species affected

Ryegrass, brome grasses.

Identification

Plants begin to die from infection in the crown. Leaves display large, dark lesions that quickly kill the whole blade.

Infected tissue produces masses of spores. The fungus can survive in soil and on debris, especially that of infected cereals, for many months.

Prevention & management

Don't let pasture become long and rank in winter. Do not drill autumn sown pasture in paddocks where snow mould is known to have infected cereal crops.

Stem rust

Summary

Stem rust (SR) occurs throughout NZ, caused by the fungus *Puccinia graminis,* mainly in warm, dry conditions in summer and autumn.

Stem rust on a ryegrass stem.

Species affected

Ryegrass, tall fescue.

Identification

SR produces brick-red powdery spots (or pustules) on leaves and stems. These are often fringed by papery remnants of leaf epidermis.

Spread

Pustules produce reddish brown to orange spores that are carried by wind or rain to other plants. These germinate to produce new pustules.

Prevention & management

Use resistant ryegrass where SR occurs. To avoid SR, graze pastures at the correct time; do not allow them to get too long. N fertiliser may help prevent SR.

If rust is present, hard graze to remove infected pasture and apply N if possible. New growth should show little rust.

Clover rust & Clover viruses

Clover rust

Summary

Clover rust is caused by a complex of rust species in the *Uromyces* genus and is sometimes found on clover throughout NZ. It can reduce forage quality.

Rust on clover petioles (left) & leaf.
(photo: MAF, Lincoln)

Identification

These rust pathogens produce yellow, brick-red or orange pustules on the underside of leaves and on the petioles. Pustules on petioles can cause characteristic twisting.

Prevention & management

Graze infected plants.

Clover viruses

Summary

Several viruses that attack clover are often seen together, including:

- White clover mosaic virus
- Alfalfa mosaic virus
- Soybean dwarf virus
- Clover yellow vein virus
- Bean yellow mosaic virus
- Watermelon mosaic virus

Alfalfa mosaic virus on white clover.

Identification

Symptoms are not always obvious and include leaf mottling, distortion, crinkling, size reduction and plant stunting. Some viruses may cause yellow patterns on leaves or cause them to turn red. Damage depends on clover species, age, location and the virus present. Moderate loss of forage quality and production is possible. Stress from virus infections may lead to plant damage or death from other pathogens or pests.

Spread

Viruses are spread by mechanical damage (mowing, trampling and feeding by stock), aphid feeding and seed.

Prevention & management

Little can be done to eliminate virus infections in clover. Sow cultivars well adapted to your region to reduce plant stress and virus susceptibility.

Leptosphaerulina & Common leaf spots

Leptosphaerulina leaf spot

Summary

This clover disease is caused by the fungus *Leptosphaerulina trifolii* and is very similar to common leaf spot. However, the pathogen only sporulates on the dead tissue in the bottom of the pasture.

For more detail on common leaf spot identification, spread, prevention and management, see common leaf spot below.

Leptosphaerulina leaf spot of clover.

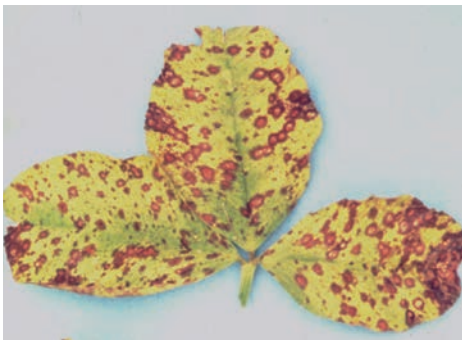
Common leaf spot

Summary

Common leaf spot (CLS) is caused by the fungus *Pseudopeziza trifolii* and mainly occurs in the cooler, moister winter months. This disease is common throughout NZ. Quality of conserved feed may be lost.

Identification

First symptoms are buff coloured, circular spots varying in size, with a darker fringe, on the upper leaf surface. In severely infected pastures, leaves can curl up and turn brown. CLS occurs mainly in cool, moist conditions and is worsened by infrequent grazing.



Pseudopeziza leaf spot of clover.
(Photo: MAF, Lincoln)

Spread

Spores produced by the fungus are forcibly ejected into the air, and spread infection to new sites.

Prevention & management

Timely grazing or cutting minimises damage of infected pastures.

Sooty blotch & Sclerotinia rot

Sooty blotch

Summary

Sooty blotch (SB) is caused by the fungus *Polythrincium trifolii* and is common on white and red clovers. It can appear in early summer but is most common in late summer and early autumn, rarely causing economic loss.

Sooty blotch on the underside of a clover leaf.

Identification

SB causes stunting and partial defoliation. Raised dark green patches appear on the upper surfaces of leaves. Beneath these patches are black spots which produce numerous dark spores. Infected leaves first look healthy, but then become dry, discoloured and die.

Spread

During summer, spores of SB are spread via wind and water. In spring, infection occurs from sexual spores released at the end of winter from fruiting bodies in the trash.

Prevention & management

There are reports of toxicity to grazing stock. Diseased clover plants may also have higher levels of coumestans (flavonoid oestrogens) that can cause reproductive disorders in grazing animals. Timely grazing or cutting can minimise damage from this disease.

Sclerotinia rot

Summary

Sclerotinia rot is caused by the fungus *Sclerotinia trifoliorum*. It usually occurs in late autumn and winter, particularly on pure swards of clover. Generally it is not serious.

Sclerotinia rot on clover.

Identification

Leaves or petioles become flaccid and light brown. Disease spreads by white mycelium through into surrounding plants. Patches of clover can rot, causing a light brown slimy mass of decaying vegetation. Tufts of white fungus develop on affected tissue. These eventually turn into black bodies called sclerotia.

Spread

Sclerotia remain in the soil for several months.

Under moist conditions sclerotia germinate to produce small, fruiting bodies which eject spores into the air, spreading infection. These require dead tissue to become established. The growing fungus produces phytotoxic enzymes that rot the host tissue.

Prevention & management

Graze at the right time to prevent clover becoming rank and wet. Fungicides are not economic.

Brassica pests

Aphids	201
Diamondback moth	202
Greasy cutworm	203
Leaf miner	204
Nysius (Wheat bug)	205
Springtails	206
White butterfly	207

Diamondback moth damage on kale leaves.

Barenbrug wishes to acknowledge the book 'New Zealand Pests and Beneficial Insects' edited by R.R. Scott and Landcare research in producing this section.

Aphids (*Brevicoryne brassicae*)

Introduction

Aphids are pests of brassica crops throughout NZ, but occur more frequently in the South Island. They damage plants by sucking plant juices and transmit several plant viruses.

Identification

Of the many aphid species present in NZ, the most significant for brassicas are the grey cabbage and green peach aphid.

Adult females can be both winged and wingless.

Wingless adults are around 2 mm long and 1 mm wide, tapering at each end. They range from yellow to dark green or grey in colour, and can be covered in a whitish waxy powder.

Winged adult aphids have 2 pairs of strongly veined wings which extend well beyond the body when the insect is at rest. They are around 2 mm in length, and range from yellow through to grey, with more pronounced black markings on the back and virtually no white waxy powder.

Aphids damage plants by sucking plant juices, targeting mostly young leaves. This causes leaves to yellow and curl. Affected plants are stunted and wilt, especially in hot weather. Aphids are also important vectors of some plant viruses, with the major types transmitting turnip mosaic virus (see page 215), stunting growth.

Aphids on the emerging leaves of rape.

Heavily infested brassica crops may become unpalatable to stock, worsening feed losses. Aphids are most active from October to January, with populations doubling every few days in favourable conditions.

Prevention & management

Sow seed treated with *AGRICOTE* Brassica to control aphids during establishment. There are also more aphid tolerant cultivars available, which offer some control against attack. Remove alternate hosts such as wild turnip from the surrounding area to limit damage caused by an aphid outbreak.

The use of systemic insecticides offers good control in the face of high insect pressure, especially if used according to flight periods and applied early.

Diamondback moth *(Plutella xylostella)*

Introduction

Diamondback moth (DBM) occurs throughout NZ, often in association with white butterfly (see page 207).

Identification

Adult DBM is a small, slender, grey insect with a wingspan of 7-10 mm. When the wings are folded along the body a line of yellow diamond-shaped spots are visible, hence the name.

Adults are nocturnal, and the female lays up to 100 light yellow oval eggs, usually on the underside of leaves.

On hatching, the 2 mm long larvae are pale green with a dark head. Fully grown larvae vary in colour, but are mostly green and 7-9 mm long. They are widest in the middle, and taper slightly towards each end.

Diamondback moth.

DBM pupae are up to 7 mm long and are pale green but change to pale creamy-brown colouring with darker markings. These are enclosed in loosely woven cocoons often found on the underside of leaves in the crop.

Larvae cause damage by feeding on leaves, with young larvae boring into the leaf and feeding on the internal leaf tissue, which appears as white markings on the leaves. As they grow they emerge to feed on the underside of leaves, with damage appearing as holes in the leaf.

DBM larvae often cause damage to brassica plants.

It can be hard to distinguish between DBM larvae and white butterfly caterpillars (see page 207), with the only major difference being in their behaviour when disturbed. DBM larvae tend to drop off leaves on a thread when disturbed, while white butterfly caterpillars tend to rear up and be quite aggressive. As DBM tend to drop off the leaves onto the soil surface, care must be taken when inspecting crops to ensure the full extent of infestation is recognised.

Forage crops are usually attacked by DBM through the summer. Damage is more noticeable in autumn when the pest population is high and plants are growing more slowly.

Prevention & management

Many brassica crops can compensate for early damage, and if left untreated DBM can be minimised by natural enemies. Two parasitoid wasps have become established in NZ as active biological control agents.

Monitor crops weekly. Insecticide application can achieve good DBM control.

Greasy cutworm (*Agrotis ipsilon aneituma*)

Introduction

Greasy cutworm (GC) is found in open areas below the snow line throughout NZ. Generally considered a minor pest, it can be a serious problem in some crops including brassicas, cereals and maize, as well as pasture at establishment.

Identification

Adult GC are brown to greyish brown moths with darker patches on the forewings and a wingspan of around 50 mm. The peak moth population occurs between October and April, but they can be seen year-round.

Larvae appear greasy, ranging in colour from light grey to dark brown, and are 50 mm long when fully grown. During the day they lie in burrows just below the soil surface, and emerge at night to feed. This species normally overwinters in the soil as pupae, although some larvae overwinter in warmer areas.

There can be up to three generations per year in warmer areas, but only two in cooler areas, with each lasting for 4-28 weeks depending on climate, locality and feed supply.

GC larvae damage in summer turnips.

Prevention & management

The main period of activity for GC is October to April. Although insecticide can give adequate protection against GC, prevention through good cultivation and good weed control also helps to keep this pest at low levels. Direct drilled crops are most likely to be affected by GC.

Granular insecticide sown with the seed or later worked into the top 15 cm of soil is the best method of controlling this pest.

Greasy cut worm damage on new pasture.

Leaf miner *(Scaptomyza flava)*

Introduction

Leaf miners (LM) are flies found throughout NZ. The larvae live in leaf tissue, in the mines or tunnels they create as they feed. They have a wide range of host plants, including most brassicas.

Identification

Adult LM flies are small, about 2-3 mm long and are usually black with or without yellow areas on the body or the legs.

LM larvae are small, yellowish-green headless maggots with black rasping mouthparts.

Their eggs are laid on or in leaf tissue and the larvae feed on this after hatching. 'Mines' are created according to the feeding habit of the miner, usually by feeding within the leaf, while the two outside layers remain intact. This can result in large windows of damage in the leaf.

LM damage as seen in turnip-moderate damage on left, high damage on right.

At completion of the feeding stage, the larvae leave the mines and drop to the soil or leaf litter to pupate.

Mining damage can occur on young seedlings and mature plants. The fly breeds year round unless interrupted by poor conditions. Under dry conditions pupae may remain dormant in soil for up to 300 days.

Plant damage is directly related to the extent of tissue destroyed by mining, reducing photosynthesis, crop development and crop yield. Mining damage can also lead to early leaf senescence and fall, further reducing harvestable yield.

Prevention & management

A number of parasitoids have been developed against LM in NZ, including the wasp *Asobara persimilis* which has shown significant levels of parasitism in localised populations.

Remove alternative hosts such as fathen and sow thistle to prevent population build-up and minimise damage. Good seed bed cultivation also minimises outbreaks.

Insecticides can be applied to reduce damage by LM. As larvae feed on the inside of leaf tissue, use an insecticide that penetrates the leaf cuticle.

Nysius (Wheat bug)

Introduction

Nysius huttoni (wheat bug) is found throughout NZ, particularly in Central and North Otago and the East Coast. It damages emerging brassica crops by feeding on the young stems.

Identification

Eggs when first laid are creamy white but turn to deep orange by the time of hatching. There are five wingless nymphal stages, with the first being around 0.5 mm long and pale to dark orange, while later stages are up to 2 mm long and grey to brown-grey.

Adults are about 4 mm long and usually pale green initially, but change to a dull brownish grey as time progresses. Adults have a dappled appearance with a conspicuous silvery triangle at the tail end.

There can be up to four generations in a year. During summer the insects are active fliers. This period also coincides with the major period of damage to brassica crops, as they emerge.

Nysius damage brassica crops by puncturing around the base of seedlings, which causes an open wound to form in the tissues. Young seedlings can die quickly, while the damage has a ring-barking effect on older seedlings. The full extent of damage may only be seen at later stages in growth, where the plant may break off at ground level in strong winds.

Typical Nysius damage on brassica stem *(photo: P. Addison, Nufarm).*

Adult wheat bug
(photo: P. Addison, Nufarm).

Prevention & management

Seed treatment, such as *AGRICOTE Brassica*, offers the best early protection against this pest. If seed has not been treated, an application of insecticide at the final spray out or at early emergence is recommended to avoid large crop losses at this stage.

Springtails *(Bourletiella sp.)*

Introduction

There are several species of springtails; the only one that damages brassicas is the garden springtail *(Bourletiella hortensis).* They are found throughout NZ, with little known about their lifecycle.

Identification

Garden springtails (GS) are soft-bodied, brown to black and up to 1 mm long when fully developed. The bodies are globular and have a springing device which is folded under the body when not in use. Mouthparts are adapted for chewing, and eggs are laid in the soil. Several generations may be produced in a single year.

Typical GS damage on seedlings seen as scalloping of leaf edges.

GS are hard to detect with the naked eye against the soil or plant surface, so to test if they are present in a crop, a piece of white card can be used to pick them up. Place the card on the soil surface and while tapping around it, watch for GS jumping onto the card.

The nymph is similar to the adult in every respect, just smaller.

Damage to brassicas can occur as soon as the plant cotyledons emerge, which can result in stem damage even before they grow above the soil surface. Peak GS populations occur in spring and autumn.

Adult springtail.

Damage to seedling leaves appears as scalloping of the edges of the leaves or as small pits or shot holes. The latter damage can also be caused by wind blown soil particles as the plants emerge.

Prevention & management

AGRICOTE Brassica seed treatment or application of a suitable insecticide offer the best early protection against this pest.

Early detection is essential. To avoid damage, preventative sprays should be applied at or just prior to crop emergence.

White butterfly *(Pieris rapae)*

Introduction

White butterfly (WB) is found throughout NZ. The caterpillar causes damage by feeding on the leaves of brassica crops.

Identification

The adult WB has four broad cream to white wings with black spots and a grey to black body. The female has 2 pairs of black spots on the forewings, while the male has one pair of spots. Their bodies are about 20 mm long with a wingspan around 50 mm.

Typical WB damage on kale leaf.

Females lay 300-400 eggs on the underside of leaves of the host plant. They are laid singly on more than one plant, initially creamy white but changing to orange just before they hatch.

Caterpillars are dull green with small hairs giving a velvety appearance. During the five larval stages, they grow from 2 mm to 30 mm long. In later stages, an orange-yellow stripe can be seen along the back. It can be hard to distinguish between DBM larvae and white butterfly caterpillars (see page 202). The only major difference is their behaviour when disturbed. DBM larvae tend to drop off leaves on a thread when disturbed, while white butterfly caterpillars tend to rear up and be quite aggressive.

Caterpillars feed on the outer, older leaves of the brassica crop initially, but as they grow move into the centre of the plant. Feeding commences from the leaf margin towards the central leaf vein, with feeding damage mainly occurring from October to May.

Adult WB.

WB pupa are around 15 mm long, with a hardened outer shell, and gain protection by hiding where their colour blends in with the background (i.e. in leaf litter or on fence posts or sheds).

Prevention & management

Natural predators like hoverflies, harvestman and parasitic wasps can keep WB populations in check.

Good seed-bed preparation helps prevent infestation, because the removal of old brassica crop debris prevents over-wintering and localised build up in paddocks.

If damage is apparent insecticides can be effective in the control of WB.

Brassica diseases

First, minimise your risk	209
Alternaria leaf spot	210
Bacterial leaf spot and black rot	210
Bacterial soft rot	211
Club root	211
Damping off	212
Downy mildew	212
Dry rot	213
Powdery mildew	213
Ring spot	214
Sclerotinia	214
Viruses	215
White blister	215

Dry rot in swedes.

Barenbrug wishes to acknowledge the help of Plant Diagnostics and Plant & Food Research in producing this section.

First, minimise your risk

Summary

Good planning and crop rotation reduce the risk of disease. Always monitor growing crops for signs of disease so you can take appropriate action early. This chapter will help you identify a disease and its importance.

Rotate crops

After brassicas are grazed, remaining residue (stubble, root and dead leaf) creates an ideal environment for disease build up. These pathogens are often soil-borne, and are waiting to infect their next host.

Rotating crop paddocks through pasture is the best way to break this disease cycle.

How long that break needs to be depends on the disease (e.g. *Sclerotinia* can persist in soil for 4 years), and the tolerance level of the following crop (e.g. kale is more disease tolerant than swedes).

Cultivate well

After the crop is finished, plough all trash into the ground. Work early and well to get the best breakdown and burial of crop residue before resowing.

Keep crops healthy

A healthy crop can better withstand disease. For example good leaf growth will compensate for minor leaf damage.

Use treated seed

Good seed treatments (e.g. *AGRICOTE Brassica)* provide seedlings with fungicides to reduce the chance of diseases such as *Fusarium* and *Pythium*. They also contain insecticide, reducing insect tissue damage, which can be an entry point for disease to infect plants.

Use treated seed.

Bury crop trash well.

Leaf spot & Black rot

Alternaria leaf spot (ALS)

Summary

Two *Alternaria* fungi, *A. brassicae* and *A. brassicicola,* cause these leaf spots on most brassica species.

Identification

A. brassicae causes light brown circular spots with large yellow margins on leaves in autumn and early winter, *A. brassicicola* causes dark circular spots with narrower yellow margins on leaves in summer.

ALS on kale.

Importance

ALS reduces leaf photosynthesis, reducing crop yield, and feed quality.

Spread

ALS spreads via water splashed or wind-borne spores produced by lesions on crop residue or weeds. Wet, humid weather favours spore production. Infected seed can also be a source of disease.

Prevention & management

Sow clean seed to minimise infection, and cultivate well to work in all brassica crop residue. Graze early if forage becomes infected to contain the spread of the disease. There is no risk to animals grazing infected brassicas.

Bacterial leaf spot and black rot

Summary

Two common bacterial leaf diseases in brassicas are bacterial leaf spot (*Pseudomonas* syringae pv. *maculicola*) and black rot (*Xanthomonas campestris* pv. *campestris*). Both affect a range of brassica crops. *Pseudomonas syringae* is primarily a leaf pathogen whereas *Xanthomonas campestris* systemically infects the plant.

Identification

Pseudomonas syringae pv. *maculicola* is typically seen as light brown-black spots with narrow to wide yellow halos. *Xanthomonas campestris* pv. *campestris* causes V-shaped lesions on the leaf edge where the veins turn black. Black internal stem staining also occurs. Infected leaves become yellow and die prematurely.

Black rot. Photo: Plant Diagnostics Ltd

Importance

Damage to leaves can be severe and reduce feed quality and yield.

Spread

Both these bacterial pathogens can survive on crop debris in the soil and can be seed-borne. In addition, *Pseudomonas* syringae pv. *maculicola* can also survive on weeds. Warm, wet, windy conditions help disperse spores, which enter the host tissue through wounds or natural openings.

Prevention & management

Sow machine cleaned and certified seed to minimise infection, and allow at least a 3-year rotation following an outbreak using non-host crops like ryegrass.

Bacterial soft rot & Club root

Bacterial soft rot (BSR)

Summary

BSR causes secondary damage following infection by other pathogens (e.g. dry rot) or through tissue damaged by insects or weather. It is caused by the bacterium *Pectobacterium carotovorum* and *Pseudomonas marginalis pv. marginalis.*

Secondary BSR of swede following dry rot infection.

Identification

BSR produces a soft, watery light brown-grey rot often with an unpleasant odour. Although similar to *Sclerotinia* infection, no white mycelium are associated with the damage and no sclerotia are produced.

Importance

In favourable conditions, BSR can cause considerable damage on top of the original infection or damaging agent.

Spread

BSR is mostly soil-borne and enters the host through rain splash from wet soil onto damaged areas. It then spreads by direct plant contact, animal/machinery movement and by insects.

Prevention & management

Minimise plant damage and carry-over of host debris to reduce the risk of BSR. Good crop rotation and cultivation practices are essential to limit damage caused by this disease.

Club root (CR)

Summary

CR, caused by the fungus *Plasmodiophora brassicae,* can affect most brassicas, causing galls to form on roots and reducing yield.

Identification

Symptoms include plants wilting in the heat of day and recovering in the evening. On inspection of roots, infected plants have swollen galls ranging from a few cm in diameter to the size of a clenched fist. As CR progresses, lower leaves turn yellow and droop permanently, the plant may die, and yield is severely affected.

CR symptoms on roots of young swedes.

Importance

CR is the most destructive disease of brassicas and severe outbreaks can completely destroy crops.

Spread

CR can remain dormant in the soil for many years as spores. In the presence of susceptible hosts (other *Brassicaceae*), these spores germinate, infecting the host through root hairs or wounds. Common host weeds are wild turnip, shepherd's purse or hedge mustard.

Prevention & management

Minimise CR with good crop rotations and avoiding multi-cropping of the same species. Good weed control, good drainage and liming to increase soil pH also limit the development of CR. If CR is a likely issue, choose a cultivar with known CR tolerance.

Damping off & Downy mildew

Damping off (DO)

Summary

Seedling brassicas can be attacked by DO pathogens, which covers a range of fungi that cause death and gaps in establishing crops. Causal pathogens are *Pythium, Fusarium spp* and *Rhizoctonia solani*. Early infections are known as damping off, while those of *R. solani* occurring later are known as wire stem. *AGRICOTE Brassica* provides early control of DO.

Identification

Young plants wilt and die from lesions at and below soil level. Infections of *R. solani* at later growth stages result in young plants turning purple and surviving only by the vascular strands (or wire stem), eventually dying.

Gaps in swedes caused by DO.

Importance

Infection is common in second year brassica crops where gaps in establishment occur.

Spread

All the fungi are soil-borne and spores, mycelium or sclerotia can build up over successive susceptible crops in the same ground. Wet, cold conditions encourage infection.

Wire stem in swedes.

Prevention & management

Seed treatment with fungicides, such as *AGRICOTE Brassica,* provides early control of damping off. Long rotations between brassica crops will also reduce risk of infection.

Downy mildew (DM)

Summary

DM is caused by the fungus *Hyaloperonospora parasitica,* which infects seedlings, leaves, flowering stems and seed pods.

Identification

On seedlings, DM can infect cotyledons and show up as black dots, yellowing and reddening, with purplish grey sporulation on the cotyledon underside. Young leaves can show similar symptoms. On older leaves, DM appears as lesions with leaf yellowing, often accompanied by black speckling. Affected leaves die off prematurely.

DM symptoms on kale leaf.

Importance

DM can greatly affect feed quality and yield.

Spread

DM can remain in the soil as free-living oospores or in trash. In spring, these spores infect leaves, with rapid build up in mild, moist weather. DM may also be introduced via seed.

Early symptoms of DM on underside of swede leaf.

Prevention & management

Sow machine cleaned and certified seed to minimise infection, cultivate well and control weeds. Good crop rotations are a must, especially in areas with high levels of DM present. If infection does occur, grazing affected plants limits spread of the disease within the crop.

Dry rot & Powdery mildew

Dry rot (DR)

Summary

DR, also known as black leg, is caused by the closely related fungi *Plenodomus lingam* and *P. biglobosa*. It can be highly destructive in swede, rape and kale, and occurs throughout NZ, most commonly in the lower South Island

DR symptoms on leaf of young swede plant.

Identification

DR appears as small brown lesions on leaves in summer and autumn. On stems and bulbs, DR develops into large brown-black dry and cracked lesions. On stems, black streaking can develop on the surface tissue. In wet weather, lesions ooze a rose-pink spore mass. Infected leaves die, bulbs collapse, and stems break at the lesion.

Importance

DR can be very destructive, causing high crop losses in some instances.

Spread

DR over-winters in infected crop residue, and spores can spread up to 1-2 km after rain. DR enters bulbs and stems through growth cracks or insect feeding wounds. Although not common, infected seed can introduce DR into new areas.

Advanced DR on swedes.

Prevention & management

Use cultivars with higher DR tolerance in problem areas, and sow only treated, certified seed. Good crop rotations are essential, with at least a 3 year break before resowing a brassica species. Where DR was noted in a first crop, do not follow with the same crop in the second year. Cultivate thoroughly to ensure full breakdown of crop debris before resowing.

Powdery mildew (PM)

Summary

PM is caused by the fungus *Erysiphe cruciferarum* and is a common minor disease of brassicas, mostly in late summer and autumn.

PM resistant (left) vs. susceptible cultivar (right).

Identification

Powdery fungal growth occurs on upper and lower leaf surfaces. Leaves can become yellow and drop prematurely.

Importance

Sometimes causes damage in summer sown forage crops going into winter.

Spread

PM survives winter as a fungus on infected plants, weeds or crop debris. Air-borne spores produced in spring can land on susceptible plants, causing new infections. Spores are also released after rain in autumn.

Prevention & management

Normally, no control is required. The best prevention is to use PM resistant cultivars. Good cultivation and crop rotations ensure low levels of crop debris and weeds for PM to survive on.

Ring spot & *Sclerotinia*

Ring spot (RS)

Summary

RS, caused by the fungus *Neopseudocercosporella brassicae*, occurs sporadically.

Identification

It produces dark spots scattered across the leaves with characteristic rings of dark fruiting bodies. Lesion margins are yellow, and leaf yellowing and early leaf drop occurs as RS progresses. RS is easily confused with *Alternaria* (see page 210), and needs microscopic examination to differentiate.

Early RS symptoms on kale leaf.

Importance

Can cause significant damage in some seasons to some crops.

Spread

RS overwinters in crop debris, on weeds or volunteer brassicas. Spores are produced in spring, infecting leaves and seed pods. Seed transmission is not deemed significant.

Prevention & management

Use certified machine cleaned seed to ensure no new source of infection. Good cultivation and crop rotations ensure low levels of crop debris and weeds for RS to over-winter on. Graze infected plants early to limit disease spread.

Sclerotinia (SC)

Summary

SC, also known as watery soft rot, is caused by the fungal pathogen *Sclerotinia sclerotiorum,* with many hosts including all brassicas. Infection occurs from air-borne spores or from over-wintering sclerotia (dormant survival spores) in the soil.

Watery soft rot/sclerotinia on swedes.

Identification

SC causes a soft watery rot of stems and bulbs. It produces extensive white mycelium under humid, wet conditions, and black, overwintering sclerotia develop on and in diseased tissue.

Importance

In many crops, only scattered infected plants are seen. But SC can build up in areas where consecutive susceptible crops are sown.

Sclerotia in kale stems.

Spread

It can survive in the soil for several years, and spreads by physical contact with infected tissues or by air-borne ascospores. These ascospores are produced from sclerotia in the soil and infect flower petals, which subsequently infect crop leaves when they fall. Thus, patches of infection can occur in dense moist crops. Sclerotia are often the same size and shape as brassica seeds, so contaminated lines can account for introduction into a crop.

Prevention & management

Sow machine cleaned and certified seed and maintain good crop rotations to minimise SC. Good cultivation is also essential, to ensure crop debris is broken down and out of the planting zone when re-sowing into crop.

Viruses & White blister

Viruses

Summary

The three main brassica viruses are turnip yellows virus (TuYV), formerly beet western yellows virus; cauliflower mosaic virus (CaMV) and turnip mosaic virus (TuMV). All are common in brassica crops throughout NZ.

Identification

TuYV is characterised by colouring in the leaves, especially purples and reds, which eventually turn yellow. CaMV and TuMV cause similar symptoms to each other (tests are often required to differentiate). Infected plants show patterns, distortion and mottling in the leaves. They are stunted and often die if infection occurs early.

BWYV on swedes.

Importance

Early infection with any of these viruses can cause severe crop losses.

Spread

All are introduced into crops by aphids. The two main aphid species in brassicas, the green peach and grey cabbage aphid, are the main vectors. The main sources of these viruses are nearby weeds and brassica volunteers.

Prevention & management

Good aphid control is necessary to limit viruses. Seed beds should also be kept free of host weeds and volunteers, such as wild turnip. Seed treatments such as *AGRICOTE Brassica* can give seedlings up to 6 weeks protection, often long enough to cover the critical period when aphids are flying. Aphicides can be used, but correct timing is hard to achieve.

White blister (WB)

Summary

WB is a common oomycete disease of weed brassicas that can spread to crops, and is caused by the fungus *Albugo candida*. WB does not generally cause major damage in brassica crops although radish can be heavily infected.

WBR symptoms on underside of turnip leaf.

Identification

White blisters form on the underside of leaves that produce white spores. Chlorotic spots occur on the upper leaf surface. Infection of the seed stalk and head produces twisting and swelling (called 'stag's head'). Leaf infection is often found with downy mildew (see page 212).

Importance

WB is uncommon in leafy turnips.

Spread

Spores are readily airborne, with cool wet conditions favouring WB development. Seedlings are particularly susceptible. WB over-winters on volunteers and weeds. Seed can be contaminated by oospores of the pathogen.

Prevention & management

Sow machine cleaned and certified seed to minimise infection, and control weeds. If young crops are infected, a light grazing may reduce infection.

Fodder beet diseases

Alternaria & Stemphilium leaf spots	217
Bacterial leaf blight	217
Beet rust	218
Cercospora leaf spot	218
Downy mildew	219
Fusarium	219
Phoma	220
Powdery mildew	220
Rhizoctonia	221
Ramularia leaf spot	222
Beet mosaic virus	222
Virus yellows complex	223

Alternaria sp. on a virus-infected beet leaf

Barenbrug wishes to acknowledge the help of Ian Harvey and John Fletcher (Plant & Food Research) in producing this section and providing photographs and Plant Diagnostics Ltd for contributions

Alternaria/Stemphylium & Bacterial leaf blight

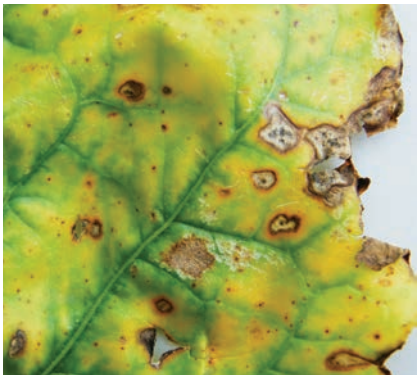
Alternaria & *Stemphylium* leaf spots

Summary

Lesions caused by *Alternaria brassicae*, *Alternaria tenuis* and *Stemphylium botryosum* commonly affect leaves already weakened by other causes such as virus.

Identification

Infection begins as small dark spots in already yellowed areas of leaves, especially at leaf margins. Lesions are dark brown to black and can appear velvety black with heavy sporulation. Old leaves weakened by age, disease or stress are colonised first.



Alternaria sp. lesions on a virus-infected beet leaf.

Importance

These fungi exacerbate damage from virus infections and deficiencies, significantly reducing green leaf and DM yield.

Spread

Spores produced on the lesions are readily dispersed by wind. Cool, humid conditions favour infection.

Management

Alternaria and *Stemphylium* mostly occur in mature crops with older, senescent foliage, so management is difficult. Monitor irrigation and fertility to reduce plant stress and limit potential disease development. Some fungicides are registered for *Alternaria* control.

Bacterial leaf blight (BLB)

Summary

Bacterial leaf blight (BLB) is caused by the bacterium *Pseudomonas syringae* p.v. *aptata* and can affect both leaves and bulbs.

Identification

Dark greasy leaf lesions, often with lighter brown areas and centres, commonly occur on leaf margins where bacteria have accumulated. Seed borne infection can cause seedling blight.

Bacterial leaf blight.

Importance

Commonly occurs in fodder beet crops. Severe infection reduces green leaf area and bulb dry weight.

Spread

Primary infection often arises from seed-borne inoculum or via volunteer host plants and crops. Water splash, stock and machinery spread the disease. Bacteria can also survive on crop debris.

Management

Always sow seed from a reputable source. Avoid excessive foliage wetness and follow good crop rotation practices.

Beet rust & Cercospora leaf spot

Beet rust

Summary

Beet rust (BR) is a foliar disease caused by the fungus *Uromyces beticola*. Heavy infection cuts bulb yield.

Identification

BR produces orange-brown pustules on both surfaces of beet leaves, sometimes in a circular pattern. In some cultivars, lesions surround the pustule.

Rust pustules on a fodder beet leaf.

Importance

Typically not a major problem in feed crops. Infection is restricted to older leaves. However, under prolonged moist, mild weather, BR can cause substantial leaf damage and DM yield loss.

Spread

U. beticola survives between crop cycles on infected plants (mostly volunteers) and in crop debris. Spores are produced in spring and transported by wind.

Management

Control volunteers. Fungicides are available.

Cercospora leaf spot

Summary

The fungus *Cercospora beticola* affects both leaves and bulbs, with potentially serious yield losses. High temperatures and humidity, typically in late summer, increase damage.

Identification

Small round leaf spots (3-5 mm diameter) are first found on older leaves then transfer to younger leaves. Tan to light brown centres have reddish-brown borders. In heavy infections, spots coalesce and leaves turn brown but stay attached to the plant.

Cercospora leaf spot.
(Photo: M. Braithwaite, Plant Diagnostics Ltd.)

Importance

CLS occurs sporadically but can result in significant DM loss.

Spread

CLS survives between crops via residues, soil, seed and infected plants. Spores are produced in spring and transferred by wind, water splash, insects and equipment. Spread is greatest when leaves are wet at night and days are warm and humid.

Management

Rotate crops every year. Sow seed only from reputable sources. Use treated seed. Keep infected residues 100 m away from other susceptible crops. If irrigating, avoid prolonged leaf wetness; water from mid-day when leaves are dry. Fungicides are available.

Downy mildew & Fusarium

Downy mildew

Summary

Downy mildew (DM) in fodder beet is caused by *Peronospora variabilis*.

Identification

DM mainly affects younger leaves as rosettes. Systemically infected leaves are stunted, distorted, thickened and light green with curling margins. Such plants usually die. In cool, humid weather masses of fruiting structures and spores turn leaves purplish grey.

Red beet rosette infected with downy mildew.

Importance

Occasionally seen in fodder beet crops; reduces plant density.

Spread

Initial infection stems from infected and contaminated seed; over-wintering spores in the soil or from nearby infected crops or volunteer plants. Spores can also spread via wind over long distances.

Management

Rotate crops to eliminate volunteer hosts and soil-borne inoculum. Use seed from a reputable source. Seed treatments can be used.

Fusarium (damping off, root/bulb rot)

Summary

Various *Fusarium* spp. cause beet damping off and root and bulb rots.

Identification

For damping off symptoms, refer to *Rhizoctonia*. Bulb rot presents as white to pink masses of spores at soil level and on the bulb. Internally, brown tissue necrosis is similar to that of *R. solani*. Root rots show as dark brown lesions and tip die-back.

Bulb rot caused by Fusarium spp.

Importance

Damping off caused by soil-borne *Fusarium spp.* together with other pathogens can occasionally cause significant plant loss at establishment. *Fusarium* bulb rots can occur in the absence of break crops.

Spread

Fusarium spp. can be both soil-borne and rain-splashed. Spores can remain viable in the soil for many years without a host, and can also be spread by stock and machinery.

Management

Allow at least 3 seasons between crops if infection occurs. Restrict movement of soil via machinery and livestock from infected fodder crops.

Phoma & Powdery mildew

Phoma (damping off, leaf spot and crown rot)

Summary The fungal pathogen *Neocamarosporium betae* (formerly *Phoma betae*) can cause a range of symptoms in fodder beet crops.

Identification For damping off symptoms, see *Rhizoctonia*. Leaf spots are light brown and round to oval, often with concentric rings. Small, dark fruiting bodies form in the necrotic tissue as lesions age. Bulb rot manifests as brown to black necrotic crown rotting.

Phoma leaf spot on beet.

Importance Occurs occasionally.

Spread Infection is mostly seed borne but the fungus can survive in crop debris and soil for 12–20 months. Spores spread by water splash.

Management Always use seed from a reputable source, and rotate crops for 1-2 seasons if disease occurs.

Powdery mildew

Summary Powdery mildew (PM) is caused by the fungus *Erisyphe betae.*

Identification First signs are small white powdery patches on the upper surface of older leaves. Severely infected plants turn greyish-white. Leaves then yellow and eventually die.

Early powdery mildew infection on a sliver beet leaf.

Importance Currently minor in fodder beet.

Spread PM requires a living plant host to survive winter. During spring, wind-blown spores infect new leaves, plants and crops under dry, warm conditions.

Management Infection under ideal conditions is relatively rapid, with control becoming less effective with time. Fungicides are available.

Rhizoctonia

Rhizoctonia (damping off, foliar blight and bulb rot)

Summary

The soil borne fungus *Rhizoctonia solani* is a major disease in fodder beet, causing seedling damping off, foliar blight, and bulb rot, leading to leaf and plant death.

Identification

Infection by *R. solani* is difficult to differentiate in the field from other causes of damping off and bulb rot. Laboratory identification is possible.

Damping off of beet seedlings caused by Rhizoctonia solani.

Damping off: Early infection is characterised by dark lesions at soil level that increase in size to girdle the young stem. Plants then wilt, collapse and die.

Bulb rot: At and below ground level, the fungus invades through small wounds and cracks, progressing to cause large areas of dead tissue. Plants wilt and can eventually die. The pathogen can progress to kill petioles and leaves. Sometimes, smoky-coloured fungal strands (hyphae) can be seen growing in internal cracks in the affected bulbs.

Importance

This is a major disease of fodder beet throughout NZ.

Spread

R. solani commonly occurs in heavy, poorly drained wet soils. The pathogen survives in the soil as fungal threads (mycelium), resting structures (sclerotia) and in plant debris. Second year crops are especially vulnerable to infection. Cultivation and movement of soil from infected paddocks on machinery and livestock also helps spread the disease. Note: *R. solani* has a wide host range, The strain associated with beet (AG 2.2) also infects maize and grasses.

Internal bulb rotting caused by Rhizoctonia solani.

Management

Correct crop rotation is critical once the disease has been identified in a paddock. Select free draining paddocks to help reduce the risk.

Ramularia leaf spot & Beet mosaic virus

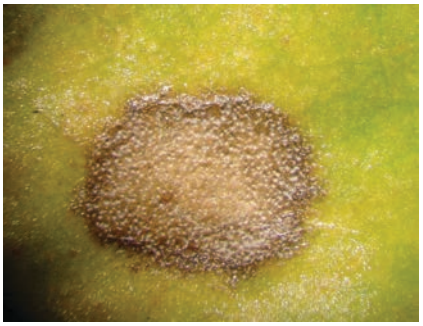
Ramularia leaf spot

Summary

Ramularia leaf spot (RLS) is caused by the fungus *Ramularia beticola.*

Identification

Symptoms are similar to *Cercospora* leaf spot. Older leaves are infected first. Light brown round to angular spots (4-7 mm) mature to dark brown, with silvery grey margins turning white upon sporulation. Lesions then become entirely white. Infected leaves turn yellow and die.



Ramularia leaf spot of beet.

Importance

Occurs only sporadically.

Spread

Spores spread via wind and water splash. Mild temperatures and humid conditions favour spore germination.

Management

Weather affects RLS severity; warm, dry conditions help crops recover. Dense crops are more susceptible to damage, as are those deficient in sulphur. Fungicides are available.

Beet mosaic virus

Summary

Beet mosaic virus (BtMV) can be present in association with other viruses and causes less damage than viruses within the virus yellows complex, but can be harder to control.

Identification

Light green chlorotic spots appear on younger leaves first, in a circular pattern often with sharply defined margins. Chlorotic rings develop on older leaves with or without green centres. Infected leaves become stunted and distorted.

Importance

Up to 7% incidence of infected plants detected in infected crops in a 2016 survey in the North Island and up to 16% in the South Island, although its current importance and incidence is not known BtMV is aphid and mechanically transmitted.

Spread

Aphids are the primary source of infection. Feeding aphids acquire and transmit the virus very quickly (within minutes of starting feeding). However, aphids only retain the virus for a few hours after ceasing feeding. The virus can also be transmitted by sap between plants.

BtMV infection of leaves.
(Photo: John Fletcher, Plant & Food Research Ltd.)

Management

BtMV can occur on beet weed hosts, so good weed control is important for disease management. Over-lapping crops of beet and volunteers can also be important sources of infection. Spraying aphids to control disease transmission is not practicable. Insecticidal seed treatment may offer some early protection. No source of resistance is readily available.

Virus yellows complex

Virus yellows complex

Summary

Virus yellows complex (VYC) describes a disease caused by members of the *Polerovirus* genus. This includes beet chlorosis virus (BChV), beet mild yellowing virus (BMYV) and potentially beet western yellows virus. Other viruses within this group may also be involved and mixed infections are common. Virus yellows complex commonly occurs on beet in NZ. Secondary fungal infections particularly by *Alternaria* and *Stemphylium* are often associated with these viruses.

Identification

Yellowing of the leaves between veins spreads within foliage. Leaves become thicker and brittle leading to death. Note that symptoms can be confused with nutrient deficiencies. Secondary interveinal necrosis also occurs as the plants age.

Importance

Virus yellows complex can cause major losses in fodder beet and in sugar beet. Large patches of plants in crops can be affected. These virus diseases cut leaf quality, palatability and yield.

Spread

Virus yellows complex is only spread by aphids, mainly the green peach aphid. Aphids can acquire the virus after feeding on sap for 5–10 mins on infected plants but usually take an hour or more to become highly infectious. Most transmission takes place 6–12 hrs after feeding starts, although aphids can retain the virus for up to 17 days.

VYC infection of fodder beet leaves.
(Photo: John Fletcher, Plant & Food Research Ltd.)

Management

Because of the time it takes for virus infection to be transmitted by aphids, insecticide can be effective. Insecticidal seed treatment controls aphids during crop establishment. This should be followed by close crop monitoring to detect any build-up in aphid numbers, and timely application of insecticide if needed.

Controlling weeds that can harbour aphids helps reduce the risk of infestations, together with aphid control in neighbouring beet crops. Aphids from these sources can colonise beet crops and spread infection through the stand.

No good source of resistance is reported to be available for virus yellows complex in fodder beet.

Aphid flights mainly occur in late spring (Nov to early Dec) and autumn from mid April to late May. Thus delayed sowing and monitoring of crops in autumn can help manage this disease.

Seed treatment

Seed treatment comparison	225
Seed treatment FAQ's	226
High price of establishment failure	227
AGRICOTE Grass	230
AGRICOTE Clover	230
AGRICOTE Brassica	232

Seed treatment comparison

Summary

Seed treatment technology allows a coating to be applied to seeds before sowing. It reduces the risk of losing new pasture or crop at establishment. Barenbrug markets four *AGRICOTE* seed treatments for grass, clover, and brassicas.

Importance of seed treatment

By protecting newly-emerged seedlings from pests and disease, seed treatment insures against paddock failure. Such losses can be $3350/ha or more (see page 227). Seed treatments can also reduce the need for spraying.

Grass seed treatments

Seed Treatment	Insect protection			Fungal pathogens		Additives
	ASW	Black beetle	Grass grub	*Fusarium*	*Pythium*	Nutrients
AGRICOTE Grass	✔	✔	✔	✔	✔	
Superstrike	✔	✔	✔	✔	✔	
Gaucho		✔	✔			
Poncho	✔	✔	✔			
Prillcote				✔	✔	Lime

Clover seed treatments

Seed Treatment	Insect protection	Additives		Other nutrients	Weight build up
	Nematodes	*Rhizobia**	Nutrients		
AGRICOTE Clover			Lime, molybdenum	Phosphorous, nitrogen, zinc, manganese	75%
Superstrike	✔	✔ *	Lime, molybdenum		75%
Prillcote		✔ *	Lime, molybdenum		75%

* Presence of rhizobia after innoculation depends on many things and is not guaranteed.

Brassica seed treatments

Seed Treatment	Insect protection				Fungal pathogens			Additives
	Spring-tails	ASW	Aphids	*Nysius*	*Fusarium*	*Pythium*	*Rhizoctonia*	Nutrients
AGRICOTE Brassica	✔	✔	✔	✔	✔	✔	✔	Molybdenum
Superstrike	✔				✔	✔	✔	Molybdenum
Ultrastrike	✔	✔	✔	✔	✔	✔	✔	Molybdenum
Gaucho	✔	✔	✔	✔				Molybdenum

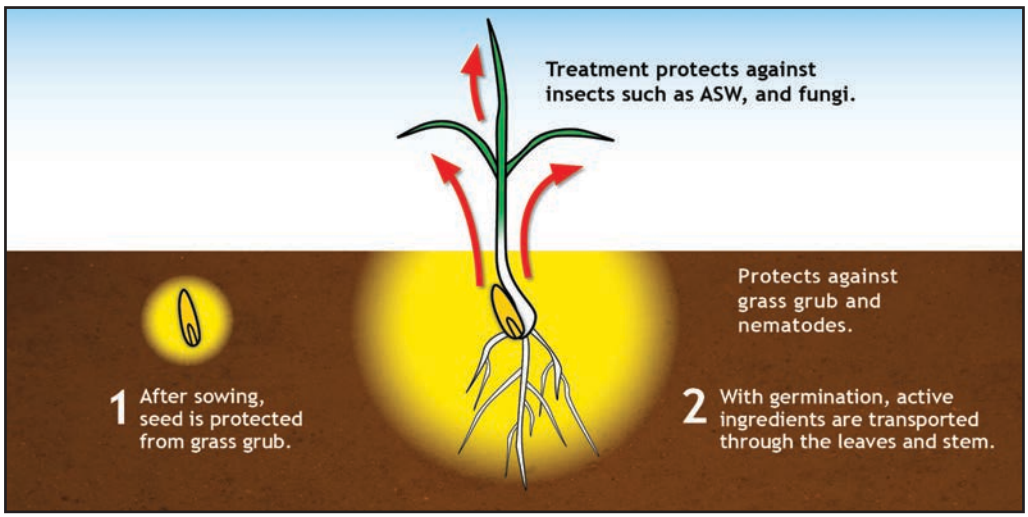
Seed treatment FAQ's

What is seed treatment?

Seed treatment is the process of treating individual seeds with a mix of fungicides and/or insecticides (and sometimes nutrients) to protect and enhance establishment.

How does it work?

AGRICOTE treatments contain enough insecticide and/or fungicide to last approximately 6 weeks post-sowing, the time that young plants are most vulnerable to insect attack and disease. The active ingredients are systemic. As well as protecting the seed itself, they 'grow' through the seedling as it emerges. Grass seedlings have little protection from their endophyte until approximately 6 weeks after sowing. So plants rely on seed treatment for protection during that time.



How do you use it in a programme?

Seed treatment is proven technology, but is not a silver bullet. It gives good control of low to moderate insect pressure. Where insect numbers are likely to be high, a wider control programme is needed.

Grass-to-grass renewal

In grass-to-grass (or cereal to grass) pasture renewal via spray-drilling, Argentine stem weevil (ASW) can be present in very high numbers. Generally, we advise adding an insecticide when spraying out to reduce the ASW population. Then use *AGRICOTE Grass* to protect establishing seedlings from surviving and newly hatching ASW.

Brassica crops

Insect pests like springtails can be present in huge numbers, many thousands per square metre. Seed treatment will kill springtails nipping seedlings, but by the time many springtails have each nipped a seedling, the crop will be seriously damaged. Monitor newly sown brassica crops daily for the first 14 days, and use an appropriate insecticide if pest pressure is high.

Slugs in direct-drilling

Seed treatments provide no protection for slugs, which can be a major problem in new pastures, particularly where they are direct-drilled. Monitor paddock for slugs, and bait as necessary (see page 189 for recommended treatment options).

Are there H&S needs?

Safe handling is a must. We sow handling and sowing instructions in every bag of AGRICOTE treated seed. Also a Stewardship Guide for treated seed is available at www.nzgsta.co.nz

High price of establishment failure

Summary

Resowing after a pasture or crop failure caused by pest or disease damage is costly in itself. But loss of valuable feed is the largest cost for a farm system.

Introduction

Farmers rely on new pastures or crops being available for grazing by a certain time, and plan accordingly. If anticipated feed yields are not achieved, the implications can be serious.

The cost of establishment failure may be $3350/ha or more. These examples show the loss in dry matter production is often 80-90% of the total cost of establishment failure. Resowing is a significant, but lesser, additional cost.

Example: Cost of pasture failure

What happens	Autumn sown pasture fails to establish
Cost of lost DM	Loss of 5 t DM/ha production (April – September; supplements required to fill feed deficits) = $2000/ha*
Cost of resowing spring	= $1350/ha (to respray, lightly cultivate, purchase seed, resow, control slugs, spray weeds see page 78)
Total cost of failure	= $3350/ha

**Pasture has a high feed value during the feed deficit period, DM valued typically at 35-40 c/kg DM.*

Example: Cost of brassica crop failure

What happens	Spring sown swede crop fails to establish. Resow into rape in summer
Cost of lost DM	Loss of 6 t DM/ha in winter crop yield (using rape instead of swedes) = $2400/ha*
Cost of resowing into rape	= $1200/ha (to respray, lightly cultivate, purchase seed, resow, control slugs, spray weeds, apply insecticide, apply fertiliser.)
Total cost of failure	= $3700/ha

**Pasture has a high feed value during this feed deficit period, DM valued typically at 40 c/kg DM.*

Insect damage on establishing pasture - bare seed (left) vs treated seed.

Grass

Summary

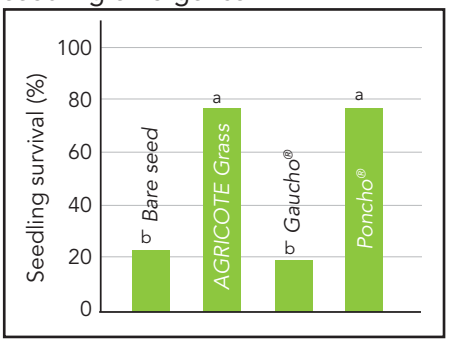
AGRICOTE Grass contains insecticide and fungicide, to help prevent damage from Argentine stem weevil (ASW), black beetle, grass grub and damping off diseases. *AGRICOTE Grass* is recommended where pests are a problem, because endophyte provides only limited protection for seedlings.

Argentine stem weevil (ASW) control

Adult ASW can be a major pest, particularly in grass to grass renewal or autumn sowing in dryland paddocks (see page 175 for more). In these cases it is important to protect all grasses with seed treatment - annual, Italian, hybrid and perennial ryegrasses, cocksfoot and tall fescue.

In an AgResearch trial, ryegrass seedlings were exposed to adult ASW attack just as they emerged. The results (right) show that *AGRICOTE Grass* and *Poncho* gave excellent control of ASW adult attack, significantly better than *Gaucho* or bare seed.

Ryegrass survival of ASW attack at seedling emergence*



** Treatments with the same letter are not statistically different.*

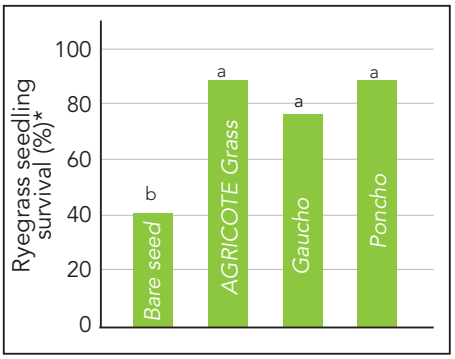
Severe adult ASW damage in a newly sown ryegrass pasture.

Black beetle (BB) control

BB can badly affect establishment in the upper and coastal North Island, particularly in dry seasons.

In an AgResearch trial, ryegrass seedlings were exposed to a high level of pressure from adult BB. The results (right) show all three seed treatments gave excellent control of adult BB attack, significantly better than bare seed.

Ryegrass survival of BB attack at seedling emergence*

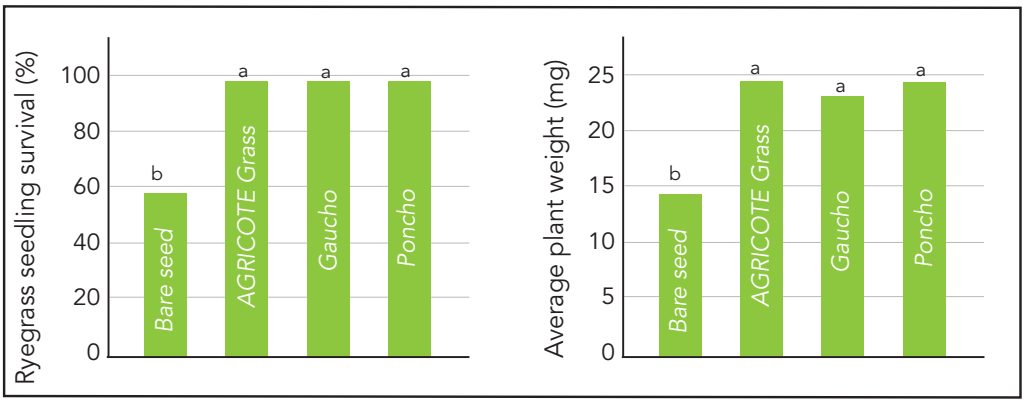


** Treatments with the same letter are not statistically different.*

Grass grub (GG) control

AGRICOTE Grass gives excellent control of GG. In an AgResearch trial, ryegrass was sown into vials, and an actively feeding large grass grub larva (3rd instar) was placed into each vial when seedlings were just emerging, then again 7 days later, and 14 days later. The results show all three seed treatments gave excellent control of GG larval attack, significantly better than bare seed.

Ryegrass survival & plant size after three 7 day periods of GG attack*



** Treatments with the same letter are not statistically different.*

Typical patchy pattern of grass grub damage in establishing pasture.

Fungal pathogens

AGRICOTE Grass contains fungicides that control the fungi responsible for 'damping off' (*Fusarium* and *Pythium)* which can kill seedlings during establishment.

These fungi are most active in autumn and winter, and attack plant tissue leaving lesions at or below ground level. Newly sown ryegrass is most susceptible to being killed by damping off. This can cause poor, patchy pasture establishment.

Sowing rate

AGRICOTE Grass has no effect on seed weight, so use normal sowing rates.

Withholding period

A 42 day stock withholding period applies for new pasture sowings; 21 days when undersowing *AGRICOTE Grass* into existing pasture.

Clover

Summary

AGRICOTE Clover provides fungal protection, plus key nutrients (molybdenum, phosphorous, nitrogen, zinc, manganese and calcium) known to enhance clover seedling vigour, root development, and rhizobial activity for the best start in life. *AGRICOTE Clover* is suitable for both white and red clover.

Bare clover seed, left, compared with coated seed.

Rhizobia

Based on research rhizobia are no longer included in *AGRICOTE Clover*. Why? In almost all situations rhizobia are no longer required, as resident levels of clover rhizobia in NZ soils are more than adequate to ensure good clover nodulation. There are typically 3 million rhizobia in a single teaspoon of our soils.

Rhizobia have spread throughout NZ since their introduction. They are freely distributed by the wind, and move in soil and dust attached to equipment, plant material, seed and stock hooves. They can survive in soils without host clover plants for 20+ years.

Use of clover seed inoculated with rhizobia should however still be considered in the following three uncommon situations as an insurance against nodulation failure:

- Undeveloped grasslands with no evidence of resident clover;
- Virgin pastoral land cleared directly from scrub;
- Paddocks cropped with maize continually for over 10 years.

Weight build up

AGRICOTE Clover has a 75% weight build up, as per the table below.

Product	Sowing rate	Lime build-up	Bare seed sown
AGRICOTE Clover	4 kg/ha	75%	2.3 kg/ha
AGRICOTE Clover	5 kg/ha	75%	2.9 kg/ha

Key nutrients

AGRICOTE Clover contains the essential nutrient molybdenum which both clover and rhizobia use for nitrogen fixation, and root nodulation. Phosphorous, nitrogen, zinc, and manganese all enhance root development and photosynthesis to encourage clover germination.

Lime is incorporated to help correct soil pH, and improve root development.

Witholding period

There is no stock with-holding period for *AGRICOTE Clover*.

Newly emerged clover seedling - at this stage they are vulnerable.

Brassica

Summary

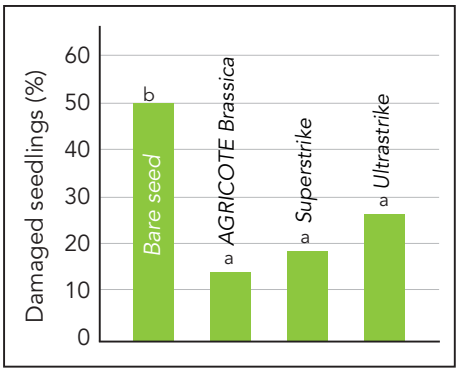
Establishment is a critical time for brassica crops because plant density determines potential yield, and it is also the time plants are most vulnerable. *AGRICOTE Brassica* improves establishment by protecting crops from insects and fungal diseases.

Nysius control

AGRICOTE Brassica gives excellent control of *Nysius*. Data supporting this comes from a trial run by AgResearch. *Dynamo* turnip seed was sown and *Nysius* were added when seedlings were just emerging, then again 7 days later.

All three seed treatments tested gave very good control of *Nysius* damage compared to sowing bare seed (see graph). Under high insect pressure in this trial, *AGRICOTE Brassica* greatly reduced the number of damaged plants from 50% (bare seed) down to only 11%.

Damaged seedlings after 2 separate 7 day periods of *Nysius* attack*

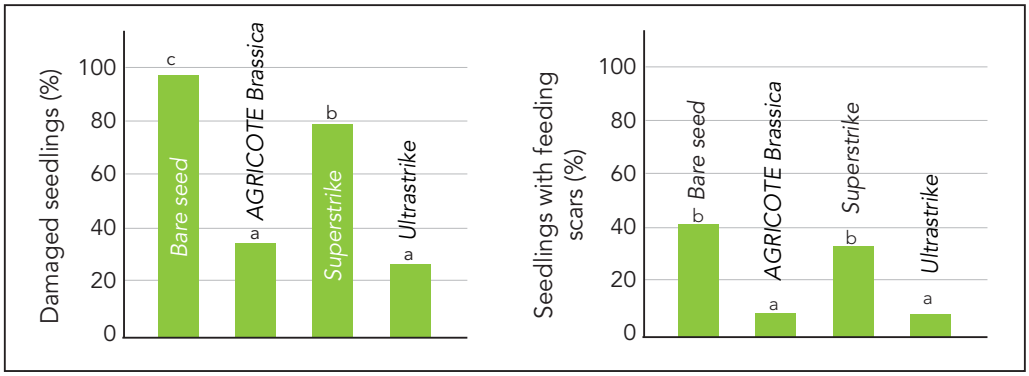


** Treatments with the same letter are not statistically different.*

Springtail control

AGRICOTE Brassica gives excellent control of springtails. In an AgResearch trial *Dynamo* turnip seed was sown into pots and springtails were added when seedlings were just emerging (which is when most springtail damage occurs).

Damage and scarred seedlings after 7 days of springtail attack*



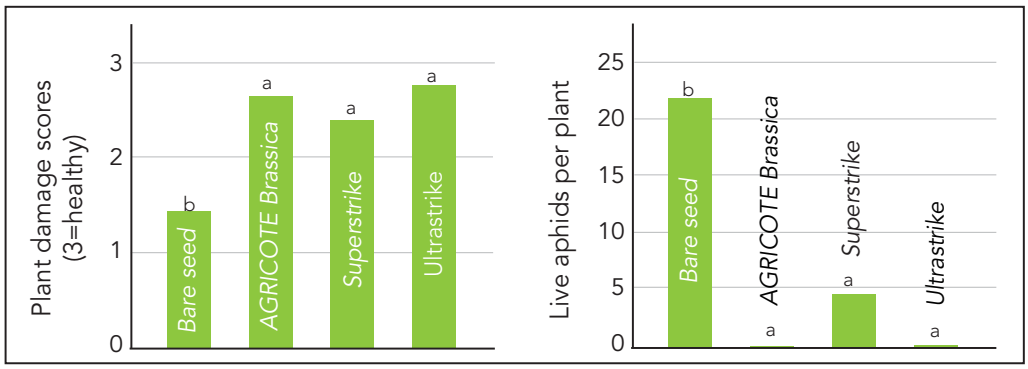
** Treatments with the same letter are not statistically different.*

Results show *AGRICOTE Brassica* provided a high level of springtail control. It greatly reduced the number of plants damaged from 98% (bare seed) down to 34%, and reduced the feeding scars from 41% (bare seed) down to 7%. Feeding scars can later result in stem break in kales or rapes.

Aphid control

AGRICOTE Brassica gives seedlings excellent protection against aphids during establishment. In an AgResearch trial, *Dynamo* turnip seed was sown into pots. Twenty aphids were added to each pot 8, 15 and 22 days after emergence. At the end of the trial plants were visually scored for damage on a 1-3 scale.

Plant health scores and live aphid numbers after three separate 7 day periods of aphid attack*



** Treatments with the same letter are not statistically different; 20 aphids were put on each plant, however numbers increased on bare seed as aphids bred.*

Combined results from the three aphid feeding periods show plants had little plant damage when *AGRICOTE Brassica* was used. This treatment also killed all aphids.

Fungal pathogens

AGRICOTE Brassica contains fungicide to protect establishing seedlings from 'damping off', a disease complex caused by soil-borne *Fusarium* and/or *Pythium* fungi in the North Island, and *Rhizoctonia* in the South Island. Damping off can lead to poor, patchy crop establishment.

These fungi are present in most NZ soils, and build up in successive crops, so they are worse in second year or subsequent crops.

Newly sown brassica seedlings are most susceptible to damping off. Typically they wilt and die, showing small lesions at or below soil level. Plants may initially survive *Rhizoctonia*, but later may turn purple and die due to 'wire stem' damage.

Sowing rate

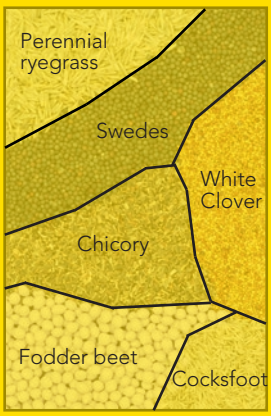
AGRICOTE Brassica treatment results in a 5% weight increase. Normal sowing rates apply as a 5% reduction in the amount of seed sown is offset by the increased success in establishment.

Rape establishing with the help of AGRICOTE Brassica.

Seed information

Seed weights & sowing rates	235
Seed analysis certificate	236
Endophyte seed tests	238
Storing seed with endophyte	239
Seed certification	240
Tetraploid seeds	241

Key to seed in photo



Seed weights & sowing rates

Summary

Sowing rates for individual situations vary. The following are general guidelines.

General seed weights and sowing rates (kg/ha) for bare seed

	Species	Seeds/g	As main species in a mix	As component of a mix
Grasses	Ryegrass (all types) diploid	500-600	18-22	10-12
	Ryegrass (all types) tetraploid	250-400	30	13-18
	Tall fescue	400	22-25	n/r
	Cocksfoot	1000-1200	5-8	3-6
	Pasture brome clipped (*Bareno*)	100-110	25-30	n/r
	Prairie grass clipped (*Atom*)	100-110	25-30	n/r
	Grazing brome clipped (*Gala*)	100-110	25-30	n/r
	Timothy	3000	6-8	1-2
	Phalaris	500-550	n/r	2
Legumes	White clover	1500-1800	n/r	3-4
	Red clover diploid	500-550	10	3-4
	Red clover tetraploid	300-350	12	4-5
	Lucerne	400-500	10-12	n/r
	Subterranean clover	100-160	10-15*	5-8*
	Persian clover	750-900	8-12*	5-7*
	Balansa clover	870-1100	5-10*	2-5*
	Arrow leaf clover	650-750	5-10*	2-5*
Herbs	Chicory	600	8-10	1-2
	Plantain	500	10	2-4
Brassicas	Kale	150-250	4-5	n/r
	Swedes	275-400	0.75-1.5	n/r
	Turnip	350-550	1-3	0.5-1
	Rape	250-400	4	0.5-3
	Leafy turnip	300-450	4	0.5-3
Forage crops	Fodder beet (grazing)*	36	80,000-100,000 seeds/ha	n/r
	Oats	26	100-120 kg/ha	80 kg/ha

n/r = not normally recommended
**Coated seed*

Seed treatment

Seed treatment can affect seed weight and sowing rate. There are two main types of seed treatment - a film coating (e.g. *AGRICOTE Grass*) which has little effect on seed weight or sowing rate; and a lime based seed coating (e.g. *AGRICOTE Clover*) that has a significant weight build up, and increases seed weight and sowing rates (see page 225 for more).

Seed analysis certificate

Summary

All seed has its own line number, printed on the side of the seed sack, and each line of seed has its own seed analysis certificate. The seed analysis certificate describes the quality of a line of seed, laboratory tested in a standard way.

The National Seed Laboratory, run by AsureQuality, produces a certificate for ALL certified seed. Certificates are available on all certified Barenbrug seed lines.

What does the seed analysis certificate show?

Identification of seed	■ Cultivar tested ■ Merchant reference number, also known as seed line number (branded on seed sacks)
When tested	■ Date of test
Standard tests	■ Purity (% pure seed, contaminants) ■ Germination (% live seed, hard seed (in legumes), abnormal seedlings, fresh and dead seed).
Other tests (sometimes given)	■ Endophyte % in perennial, Italian, or hybrid ryegrass (either in seed or from seedling grow outs). ■ ELISA test for the presence of lolitrem B contaminant. See endophyte seed tests on page 238.

All New Zealand grown Barenbrug seed lines have an official National Seed Laboratory seed analysis certificate.

Further information

For further information on the seed certification system see page 240.

Grow out tests confirm live endophyte levels. Individual seedlings are cut and pressed in squares on a special paper, and when a live endophyte is present its antigens react with the paper, showing up when it is dyed.

AsureQuality Kaitiaki Kai

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Seed Analysis Certificate

Test number issued by lab (quote this in any queries)

Final Report

Lab reference: SL24-9321

Sample Officially Drawn

Certified Seed
Kind Of Seed: Lolium perenne (Perennial Ryegrass)
Cultivar: Array
Class: First generation
No. Of Containers: 14
Weight: 10,500 kg

Species and variety of seed

Reference No: 202453378/2
Region Of Production: C1894C1D
Merchant's Reference: 26078B
Dressing Code: A72

MPI number

Seed line number (number branded on the sides of bags)

Date Of Sampling: 06 June 2024
Date Sample Received: 07 June 2024
Date Of Testing Completed: 24 June 2024
Date Of Issue: 24 June 2024

Date test completed

Results

Purity Result			Germination Result					
PURE SEEDS	INERT MATTER	OTHER SEEDS	INTERIM COUNT	FINAL COUNT	FRESH SEEDS	HARD SEEDS	ABNORMAL SEEDLINGS	DEAD SEEDS
100.0 %	Trace	0.0 %	94 % in 6 days	96 % in 11 days	0 %	0 %	2 %	2 %

Purity result (%)

Final germination result (%)

Other Seeds Found In Working Sample
None found.

Other Seeds Found In Bulk Search
No additional seeds found.

Kind Of Inert Matter
Soil, sterile florets, chaff.
Bulk: Larvae (dead).

Inert matter found in purity analysis

Other Determinations
0.2% KNO3.
Soil 0.01% in 60.49 g.

SL Cousins

Sue Cousins
Laboratory Manager

Endophyte seed tests

Summary

ALL Barenbrug ryegrasses containing endophyte are tested prior to sale and have a current test at time of sale. The type of endophyte contained in the seed is stated (e.g. *NEA2*).

Levels are given for the percentage of seed containing endophyte:

- *NEA, NEA2, NEA4, NEA12, AR1* or *AR37*: 70%+ of seed contain stated endophyte
- *LE* or '*Low* endophyte': less than 70% of seeds have endophyte

Endophyte level

A seed either has, or does not have endophyte, and this endophyte level for a line is given as a percentage e.g. a level of 80% means 80% of seeds contain endophyte and 20% do not.

For seed to be sold as containing an endophyte, a level of 70% or more is required. This may be *NEA, NEA2, NEA4, NEA12, AR1, AR37* or another endophyte.

Seed classed as *LE (Low* endophyte) contains less than 70% of endophyte.

Endophyte levels in stored seed can drop over time. To maintain high endophyte levels in commercial seed, Barenbrug uses controlled storage (see page 239), with continual re-testing of endophyte levels.

Testing seed for endophyte

Two main tests are available.

1. Seed test:

This tests the seed directly. It is a quick test for presence of endophyte, but does not indicate whether the endophyte present is dead or alive. It is used on newly harvested seed, usually up to 4 months old, in which the endophyte is almost certain to be alive.

2. Seedling grow out test:

This is used on seed post harvest. Seed is sown and the tiller of the resultant seedling is tested for endophyte at 3-6 weeks of age. This test is more accurate for older seed as only live endophyte will grow into the seedling.

ELISA testing

The ELISA (Enzyme Linked Immuno Sorbant Assay) test is a specific test for *AR1* or *AR37*, to ensure they are not contaminated by *Standard* endophyte.

The ELISA test determines the presence of lolitrem B in a seedline. Seed with *Standard* endophyte always contains lolitrem B. Seed with *AR1* or *AR37* doesn't contain any lolitrem B.

The result of the ELISA test is reported as a grade that runs from 1 to 6.

Grades 1-5 are all acceptable for 1st Generation seed, and mean less than 5% contamination. Grade 6 is not suitable for sale.

Storing seed with endophyte

Summary

Endophyte levels in ryegrass seed drop off over time. On-farm, store seed with novel endophytes in a cool, dry place. Sow seed within one month of purchase.

Endophyte in seed

Seed is a living organism and should always be stored in cool, dry conditions. This is very important for endophyte as its levels in ryegrass seed drop over time more quickly than seed germination levels. This speed of decline in endophyte is influenced by humidity, temperature and endophyte strain.

On-farm storage

More planning for seed purchase is now required when dealing with novel endophytes such as *NEA, NEA2, NEA4, NEA12 and AR37*. Ideally seed should arrive on farm within 2-3 of weeks of sowing, and should be sown within one month.

Store seed on-farm in a cool, dry place until sowing. Don't carry seed containing novel endophyte over between seasons on-farm as it is likely to be lost. Only order as much seed as is needed in the current season.

Just-in-time inventory

Barenbrug has set up cool store seed distribution at Rolleston and Hamilton to provide a just-in-time inventory. Seed is kept in low temperature and low relative humidity storage as long as possible, and delivered within 3 days of ordering.

Storage between seasons

Not all seed can be sold in the year it is harvested, due to the limited time between harvest (particularly of late heading cultivars) and farmer pasture sowing requirements.

Endophyte levels are safely maintained between seasons in our low humidity, low temperature storage. All seed with *NEA, NEA2, NEA4, NEA12 or AR37* endophyte carried over is placed in cool storage after cleaning, and endophyte levels are re-tested prior to sale to ensure they meet the required standard.

Seed at Barenbrug's Rolleston distribution plant stored at low relative humidity and temperature to safely maintain endophyte levels.

Seed certification

Summary

Seed certification is an industry programme to ensure cultivar identity.

It is run by AsureQuality for the New Zealand Seeds Authority (NZSA).

What does certified seed mean?

A crop must be grown to specific standards (e.g. to grow *4front* the paddock must have been free from any other ryegrass for at least the previous two seasons). This eliminates the risk of contamination.

Each paddock has an ID, with data relating to seed certification held in a geospatial information system. A crop must pass a field inspection of crop purity by AsureQuality staff before harvest.

After harvest, cleaning and packaging, the resultant seed is tested by the National Seed Laboratory and must be of sufficient purity (e.g. for perennial ryegrass of first generation a minimum of 98% pure seed and a maximum 0.7% other seed). Full guidelines for certification requirements are available from the National Seed Laboratory.

(See also seed analysis certificates on page 237).

Seed analysis certificates are available on request for all certified 1st Generation cultivars.

During the certification process seed crops - like this Kotuku white clover crop at Methven - are regularly inspected by AsureQuality.

Tetraploid seeds

Summary

Some ryegrass, red clover and brassica cultivars are tetraploids. Tetraploids have larger seeds than diploids, so they must be sown at higher rates.

In perennial and hybrid ryegrass, tetraploids need different management for best performance (see pages 101-102 for more).

What is a tetraploid?

Ryegrass, red clover and brassicas occur in nature as diploids, meaning each cell in the plant has 2 sets of chromosomes. Tetraploids have been developed by plant breeders using controlled mutation from a standard cultivar (diploid) to double the number of chromosomes in each plant cell.

This practice was first developed in Holland in the 1960s and has now become common in plant breeding. It does not involve gene modification.

Size difference between 200,000 tetraploid perennial ryegrass seeds (left) and diploid perennial ryegrass seeds (right). This is why tetraploids need to be sown at higher rates.

Tetraploid characteristics

Tetraploiding creates larger cells, leading to larger plants and larger seeds. Their increased cell size means tetraploid plants have a higher ratio of soluble carbohydrates (cell contents) to fibre (cell wall), typically improving animal preference and performance over diploid cultivars.

Tetraploids can be identified by their large, dark leaves, and may visually appear superior to diploids. However, they tend to have 10-20% less dry matter content. Tetraploid seeds are larger than diploid seeds and because of this a higher sowing rate is required to obtain a similar number of seeds per hectare.

Feed value

Tetraploid perennial ryegrasses are more palatable and digestible than diploids, increasing animal intake. However, they are less robust, and don't fit all farm systems (see pages 101-102).

Annual & Italian ryegrasses

Tetraploiding annual or Italian ryegrass appears to have little affect on their palatability because they are already very palatable.

Glossary

Definition of a range of terms used in the pasture industry.

Glossary

Term	Definition	
501	A Barenbrug chicory cultivar.	61
4front	A Barenbrug high performance tetraploid perennial ryegrass.	18
Aftermath heading	The amount of continued seeding after the main heading. Cultivars with more aftermath heading may require more topping.	
AgResearch	Government research and development organisation.	
AGRICOTE	Seed treatment available from Barenbrug.	225
Alkaloids	A type of chemical, often used in association with the chemicals produced by endophyte fungi.	71
Alternaria leaf spot	A fungal brassica disease (species *Alternaria*).	210
Annual ryegrass	Fast establishing, winter active ryegrass, which generally persists for only 9-12 months.	27
Apex	A Barenbrug, medium leaved white clover cultivar.	45
Aphids	Pest of brassicas, often a vector of viral diseases	201
AR1	Novel endophyte producing peramine.	70
AR37	Novel endophyte producing janthitrems.	70
Argentine stem weevil (ASW)	Insect attacking endophyte-free ryegrass, cereals and maize, found throughout NZ.	175
Array	A Barenbrug diploid perennial ryegrass with high yield, persistence and N efficiency.	10
Bacterial leaf blight	A bacterial brassica disease.	210
Bacterial soft rot	A bacterial brassica disease.	211
Bareno	A Barenbrug cultivar of pasture brome.	34
Black beetle	Pasture insect pest in warmer North Island areas.	177
Black field cricket	Pasture insect pest in North Island areas.	179
Bloat	A build-up of foam in the rumen of animals grazing pastures low in fibre, usually high in clover content. Can be fatal.	129
Brome	Genus of dryland grass. Includes the species pasture brome, grazing brome, and prairie grass.	33
Brown blight	A fungal grass disease (species *Drechslera*).	192
Captain	A Barenbrug plantain cultivar.	64
Cercospora leaf spot	A fungal clover disease (species *Cercospora*) occurring more commonly in the North Island.	218
Certified seed	Seed which has passed seed certification.	240
Certification	A quality control system in seed production. To ensure cultivar identity and purity is maintained.	240
Chicory	A tap rooted grazing herb that produces high yields of quality summer forage over multiple grazings.	59
Clipped seed	Some seeds, such as bromes, have a long awn (like a hair) making it hard to drill. This is removed (clipped) by mechanical means when seed is cleaned.	

Glossary

Term	Definition	
Clover flea	Insect pest of clover and lucerne throughout NZ. Also called springtails.	180
Clover root weevil	Insect pest affecting clover production through NZ.	181
Clover rust	A fungal clover disease (species *Uromyces*).	197
Clover viruses	Viruses affecting clover.	197
Club root	A fungal brassica disease (species *Plasmodiophora*).	211
Common leaf spot	A fungal clover disease (species *Pseudopeziza*).	198
Crown rust	A fungal grass disease (species *Puccinia*).	192
Cultivar	A named line of a plant species, e.g. *Maxsyn* and *Governor* are different cultivars of perennial ryegrass.	
Cultivation	Ploughing and tilling soil before sowing. To kill resident vegetation, and remove any compaction.	88
CV (%)	The Coefficient of Variance (CV) is a statistical measurement assessing how variable a trials data is. In yield trials for a single cut the CV is usually below 20%, and a figure below 10% is very good.	
Damping off	A fungal brassica disease occurring at establishment.	193
DairyNZ	The research and extension arm of the dairy industry, owned by NZ dairy farmers through Fonterra.	
Diamondback moth	Insect pest of brassicas throughout NZ.	202
Digestibility	Feed value measurement defined as the percentage (%) of food absorbed by the animal and not excreted.	119
Diploid	Species having two sets of chromosomes per cell. Most ryegrass and red clover cultivars are diploid.	241
Direct drilling	Drilling seed directly into the soil without cultivation. (Also see spray and drill and undersowing).	88
Downy mildew	A fungal brassica disease (species *Peronospora*).	212
Dry matter (DM)	The weight of forage when its water content is removed. Pasture yield is assessed as kilograms of dry matter per hectare (kg DM/ha).	
Dry rot	A fungal brassica disease (species *Leptosphaeria*).	213
Dynamo	A Barenbrug summer turnip cultivar.	151
Ear emergence	When a grass seedhead appears out of the stem of a grass plant (see also heading date).	114
Endophyte	A term used in pastoral agriculture to describe the symbiotic fungi commonly found in forage and turf grasses, which can produce alkaloids that provide benefits to the grass plant (e.g. a level of insect control) which improve plant persistence.	66
Endophyte level	The percentage of seed in a ryegrass seed line containing live endophyte fungus.	238
Ergot	A fungal grass disease (species *Claviceps*).	193
Ergovaline	Alkaloid produced by some ryegrass endophytes.	71
Feed value	General term for the nutritive value of a pasture, most often measured as metabolisable energy (ME) or digestibility.	119

Term	Definition	
Festulolium	A perennial pasture species created by crossing ryegrass and a fescue, which can be either meadow fescue or sometimes tall fescue.	
Flowering date	See 'heading date'.	114
Forge	A Barenbrug hybrid ryegrass cultivar	23
F-test	The F-test is a statistical test of trial data to check the variability of a trial, and whether an LSD test (see separate entry) can be used. Four results of an F-test are possible. 'NS' meaning 'not significant' and an LSD test can't be applied. For the other three results an LSD test can be used: '*' = significant at the 5% level; '**' = 1% level; '***' = 0.1% level.	
Governor	A Barenbrug diploid perennial ryegrass cultivar	20
Grass grub	Insect pest of brassicas and pastures throughout NZ.	182
Grass staggers	Nervous disorder due to a magnesium (Mg) deficiency in lactating animals, usually in spring. Note: not to be confused with ryegrass staggers or summer staggers caused by *Standard* endophyte.	66
Greasy cutworm	Insect pest of brassicas throughout NZ.	203
Hattrick	A Barenbrug multi graze, forage oat cultivar.	140
Heading date	The average date of ear emergence of a cultivar in spring. Important determinant of spring feed quality of grasses, because later heading gives better late spring quality.	114
Hogan	A Barenbrug tetraploid annual ryegrass cultivar	32
Hybrid ryegrass	Also called 'short rotation ryegrass', a ryegrass usually produced by crossing Italian or annual ryegrass with perennial ryegrass. Intermediate to Italian and perennial ryegrasses in growth and persistence.	21
Inflorescence	A flower head or seed head.	
Interval	A Barenbrug rape cultivar.	146
Invitation	A Barenbrug swede cultivar.	148
Italian ryegrass	Fast establishing winter active ryegrass. More persistent than annual ryegrass.	27
Janthitrems	An alkaloid produced by some endophytes (e.g. *NEA12*) that offers resistance to a range of pests. Janthitrems can cause ryegrass staggers in grazing livestock.	73
Kotuku	A Barenbrug large leaved white clover cultivar.	46
Laser	A Barenbrug Persian clover cultivar	58
Leaf miner	Insect pest of brassicas throughout NZ.	204
Leaf sheath	Base of a ryegrass tiller, close to the ground.	98
Legume	A plant with rhizobia on its roots, that fixes nitrogen from the air. Legumes may need inoculation with rhizobia before sowing.	42
Leptosphaerulina leaf spot	A fungal clover disease (species *Leptosphaerulina*).	198
Lime	Calcium carbonate. Applied to soil to increase its pH.	86
Line of seed	A line of seed is that which originated from the same seed crop. The number of the seed line is branded on the side of the sack and allows traceability of any line of seed sold	236
Lolines	Alkaloids produced by meadow fescue endophyte (*Neotyphodium uncinatum*) that in sufficient quantity can give a good insect resistance.	

Glossary

Term	Definition	
Lolitrem B	Toxin produced by *Standard* endophyte that causes summer staggers or ryegrass staggers in stock.	71
Long rotation ryegrass	Another name for hybrid ryegrass	22
LSD test	Least Significant Difference (LSD) is a statistical test of trial data to check whether differences are real, or whether random variability could have caused them. The LSD test is used at the 5% level, meaning you are 95% certain treatment differences given are real. LSD lettering, using a, b, c's etc. shows statistical differences. E.g. 110a, 102b, 100b means 110 (as an 'a') is 'significantly' higher than 102 (as a 'b'), and 102 and 100 (both 'b's) are 'not significantly different'.	
Maintenance	Term used in animal feeding and soil fertility. Maintenance is the energy required by an animal to undertake its basic functions (breathing, moving, eating etc). Also the level of fertiliser needed to maintain soil fertility at its present level.	119
Manuka beetle	Pasture insect pest found throughout NZ, particularly bush area.	184
Maxsyn	A Barenbrug perennial ryegrass	12
Metabolisable energy (ME)	The energy in a feed available to an animal. Measured in megajoules per kilogram of dry matter (MJ/kg DM).	119
Mixed sward pasture	A pasture containing several different forage species e.g. grass and clover.	
Morrow	A Barenbrug red clover cultivar	51
NEA, NEA2 & *NEA4*	Novel endophytes producing peramine and reduced levels of ergovaline. They greatly improve animal health and performance over *Standard* endophyte.	69
NEA12	New novel endophyte from Barenbrug producing janithrems. Greatly improves animal health and performance over *Standard* endophyte.	69
Net blotch	A fungal grass disease (species *Drechslera*).	194
NFVT®	National Forage Variety Trials. A co-operative industry system for testing pasture cultivars.	
Nitrate poisoning	Toxicity in stock caused by eating forage with excess nitrate levels. Can be fatal.	125
Nysius	Insect pest of brassicas throughout NZ.	205
Oat	Winter forage crop. Also see *Hattrick*.	139
Oversow	Used for renewal of hill and high country which cannot be cultivated, seed is broadcast onto the ground surface.	88
Palatability	Term used to describe the preference animals show for different plants or pastures.	
Pasture mealy bug	Pasture insect pest, mainly found in Canterbury.	185
Pasture renewal	Any method of establishing new pasture species.	77
Peramine	Toxin produced by most ryegrass endophytes. Protects against Argentine stem weevil.	71
Perennial ryegrass	The most commonly used permanent pasture grass in NZ. May or may not contain endophyte.	7
Perennial pasture	Pastures sown with perennial plants as opposed to pastures sown with short term species (e.g. annuals, Italians).`	

Term	Definition	
Permanent pasture	Long-term pasture. 'Long term' in northern NZ in summer dry areas with high insect levels may be only 5-10 years.	7
Persistence	How well a cultivar survives over time, under pressures from climate, grazing and insects (see permanent pasture)	7
Phyto-oestrogens	Chemicals in red clover that can temporarily reduce animal fertility. Generally affect sheep as red clover levels are highest in autumn, when sheep mating occurs.	50
Plant pulling	On some soils, particularly peats, grass plants may be pulled out of the soil by grazing stock. Plant pulling decreases grass persistence.	
Plant variety rights (PVR)	An intellectual property protection system for plants and endophytes. Similar to copyright on a book.	
Plantain moth	Plantain specific pest throughout the North Island.	186
Point analysis	Method used to measure plant persistence. 100 points are placed per plot, and the percentage that hit that species recorded.	
Porina	Insect pest of pasture throughout NZ.	187
Powdery mildew	A fungal grass and brassica disease (species *Erysiphe*).	194,213
Prostrate growth	Plant having a low or flat growth habit.	
Pugging	The effect of animals trampling pastures in wet conditions.	108
Pugging tolerance	The ability of a cultivar to tolerate the effect of animals trampling pastures in wet conditions.	
Ramularia leaf spot	A fungal grass disease (species *Ramularia*).	195
Rape scald	Reddening of skin on ears and faces of lambs grazing rape.	129
Red water	Condition resulting from high levels of SMCO in brassicas, causing loss of appetite and sudden death in grazing animals.	129
Redefine	Companion cocksfoot from Barenbrug, extremely fine leaved.	36
Rhizobia	Beneficial bacteria living on the roots of legumes, that fix nitrogen from the air in return for nutrients supplied by the legume.	230
Rhizomatous	Plant with rhizomes.	
Rhizomes	Underground growing stems from which daughter plants can evolve e.g. lotus, twitch, phalaris.	
Ring spot	A fungal brassica disease (species *Mycosphaerella*).	214
Robbos	A Barenbrug fodder beet cultivar.	164
Rohan	A Barenbrug spreading perennial ryegrass cultivar with dense, fine leaved habit, bred for persistence in sheep and beef farm systems.	14
Rotational grazing	Pasture grazing by stock in large mobs or herds for short periods, usually at high stocking rates, with stock regularly moved onto new pasture areas.	
Root aphid	Pasture pest throughout NZ.	188
Ruru	High performance medium-leaved white clover from Barenbrug, supersedes *Weka*.	48

Glossary

Term	Definition	
Rust	See crown rust, stem rust or clover rust.	192,197
Rust resistance	The ability of a cultivar to withstand the effects of the fungal disease known as rust.	192
Ryegrass pulling	See plant pulling.	
Ryegrass staggers	Nervous disorder caused by ingesting ryegrass infected with some endophytes. Causes ungainly movements or staggers in stock. Also known as summer staggers.	66
Scald	A fungal grass disease (species *Rhynchosporium*).	195
Sclerotinia	A fungal brassica disease (species *Sclerotinia*).	199
Seeding	The presence of seed heads on a plant.	
Seed certification	A quality control system in seed production. Ensures cultivar identity and purity is maintained.	240
Seed dormancy	A period of time when a seed is alive but not ready to germinate	
Seed weight	The weight of a particular seed, usually given in seeds/gram.	235
Set stocking	The continuous grazing of a mob/herd of stock on an area for an extended time. Also known as 'continuous stocking'.	
Shogun	A Barenbrug hybrid ryegrass cultivar.	25
Short rotation ryegrass	See hybrid ryegrass.	21
Short-term ryegrass	A cumulative term for Italian and annual ryegrasses.	27
Slugs	Brassica and pasture insect pest at establishment.	189
SMCO	S-methyl cysteine sulphoxide, a compound produced in brassicas that damages the red blood cell membrane, resulting in leakage of haemoglobin into urine (resulting in 'red water').	129
Snow mould	A fungal grass disease (species *Monographella*).	196
Soil fertility	The level of nutrients in a soil available for plant growth.	86
Sooty blotch	A fungal clover disease (species *Cymadothea*).	199
Species	Different types of plants, for example cocksfoot and perennial ryegrass are different grass species.	
Spray and drill	The direct drilling of seed into an existing pasture after spraying (usually with glyphosate), with no cultivation.	88
Springtails	Insect pest of brassicas at establishment.	206
Statistical significance	Where data is statistically analysed and it is 95% likely there are real differences between treatments, these treatments are regarded as 'significantly different'. Also see LSD test.	
Stem rust	A fungal grass disease (species *Puccinia*).	196
Stolon	A runner which spreads along the surface of the ground, from which daughter plants can evolve. White clover has stolons which are important for its persistence.	
Stolon growing point	Node on a stolon from which new leaves or roots develop. High numbers of these aid persistence.	

Term	Definition	
Stolon growing point density	The number of stolon growing points in a unit area. A term usually related to white clovers.	42
Stoloniferous	A plant with stolons.	
Summer staggers	See ryegrass staggers.	66
Tabu+	A Barenbrug Italian ryegrass cultivar.	28
Tall fescue	A perennial grass more tolerant of hot summers, poorly drained and saline conditions than perennial ryegrass.	38
Taproot	The predominant, single deep root of some plants. This can enable them to source water and nutrients from deep in the soil, e.g. red clover, chicory, lucerne.	
Tasmanian grass grub	Insect pest of pasture.	190
Tetraploid	A plant that has four sets of chromosomes per cell. Also see diploid.	241
Tiller	The individual units of a grass plant. Grasses are made up of tillers, each tiller having a single stem, roots and leaves.	98
Tiller density	The number of tillers per unit area.	98
Tip awns	Small hairs on the tip of seeds, smaller than awns.	
Topping	Removing poor quality pasture such as seed heads and rank growth, usually by mowing.	
Tyson	A very early-heading Barenbrug diploid perennial ryegrass cultivar.	17
Undersowing	The drilling of seed into an existing pasture, without spraying or cultivation. Only recommended on thin pastures with low grass density, to boost grass population and growth.	88
Vernalisation	The cold temperature of winter that triggers (or *vernalises*) spring seeding in most pasture species in NZ.	
Viruses	Viral diseases of clover and brassicas.	197,215
Watery soft rot	A fungal clover and brassica disease (species *Sclerotinia*).	199
Westerwold ryegrass	Type of annual ryegrass which go to seed from a spring sowing. They do not require a cold treatment (vernalisation) to go to seed. E.g. *Tama, Progrow.*	31,
Wheat bug	See *Nysius.*	205
White blister rust	A fungal brassica disease (species *Albugo*).	215
White butterfly	Insect pest of brassicas throughout NZ.	207
Zulu II	A Barenbrug arrowleaf clover cultivar	57

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RRP $59.95