



## Why the interest in evaluating a range of annual legumes?

Pasture-based farming systems typically have a low or very low clover base – no doubt because white clover does not like our hot, dry summer conditions; legumes typically make up less than 10% of Northland pasture composition. Would sowing annual clovers substantially improve the legume content of Northland pastures, especially July–December?

*40 years ago, Dr Tony Taylor found annual legumes could be 46% more productive in Kaitiā compared to Palmerston North – e.g. early April to late October in Kaitiā balansa clover produced 9.3 tonnes of dry matter per hectare as a pure sward compared to 7.6 tonnes in Palmerston North.*

## The project

### **Focus** – Assess the integration of various annual legumes into grazing systems

The annual legumes were:

- typically planted with companion species – e.g. Italian ryegrass (to supply feed Jul–Aug before annual legumes “take off”), red clover (to supply feed Jan–Mar after annual legumes have flowered)
- sown on a paddock-scale on seven central and northern Northland farms with a range of soils, stock policies and microclimates
- sulla, Persian clover, balansa clover, berseem clover, a small amount of arrowleaf clover plus faba (tick) bean.

*Factors that could impact on the success of the paddock sowings (e.g. seed germination, soil fertility) were monitored.*

Pasture growth of the annual legume seed mixes was measured throughout the 7–12 month trial period; some sites had grazing exclusion cages. Feed quality, plant parasitic nematode levels, soil nitrogen levels, soil legume seed levels, soil moisture and temperature were also measured.



## Seed quality

To determine that high quality seeds were used, germination tests were carried out at Lincoln University.

*Clover seed germination rates can be disastrous - germination rates of 0-20% were recorded in Kaitia 30 years ago.*

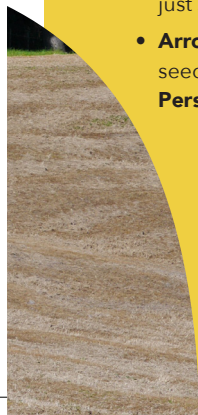
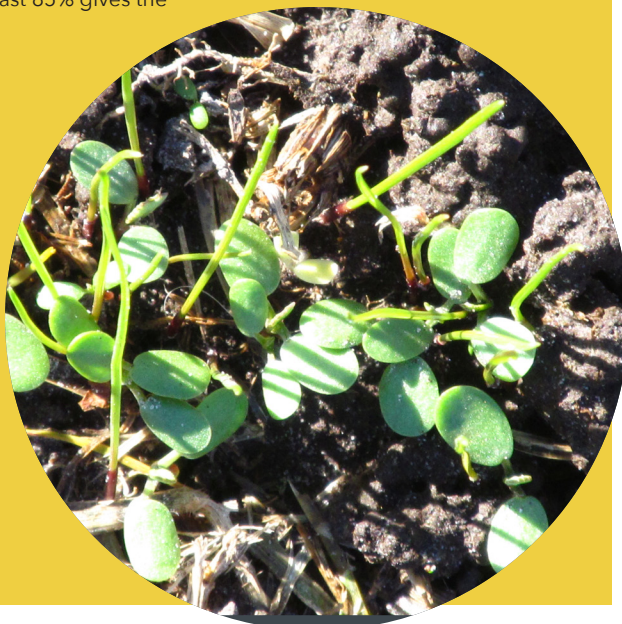
### Seed germination data by variety and cultivar

Variety / cultivar	% germination	% hard seed	% "viable or useful" seed
Tick bean	88	0	88
Sulla	82	7	89
Lotus	64	9	73
Berseem clover	83	1	84
Arrowleaf clover	64	32	96
Balansa clover	75	21	96
Lusa Persian clover	85	3	88
Turbo Persian clover	87	5	92
Rossi red clover	85	5	90
Rubitas red clover	64	33	97
Relish red clover	80	5	85
Sensation red clover	75	12	87
Tribute white clover	82	8	90

Of the 31 seed samples, 27 were bare seed and four samples were coated.

Defining an "acceptable" germination as at least 85% gives the following results.

- **Lotus seed** was not high quality.
- **Berseem clover** was not high quality, but was pretty close.
- **Relish red clover**, when 'rounded up', just scraped in.
- **Arrowleaf clover** and **balansa clover** seed were high quality seed, with **turbo Persian clover** not far behind.



## Case Study

### M Jagger, Whangarei Heads – dairy

#### **Focus** – Paddock-scale sowing and evaluation of sulla, plus two annual clovers (Persian and balansa)

Sulla, a palatable, short-lived perennial legume, had quite a bit of research undertaken on it in New Zealand 25 years ago.

Within a paddock, half was sown as sulla only, whereas the other half had red clover sown as well. With the annual clovers, each was sown separately with an annual ryegrass and red clover seed mix.

Pasture yield – 10 April 2015 sowing to 25 March 2016 (just under a 12-month period)

	Pasture mix	Growth (kg DM/ha for the period)
Sulla	Sulla only	9,037
	Sulla plus red clover	14,590
Annual clovers	Persian clover plus annual ryegrass and red clover	14,116
	Balansa clover plus annual ryegrass and red clover	14,861

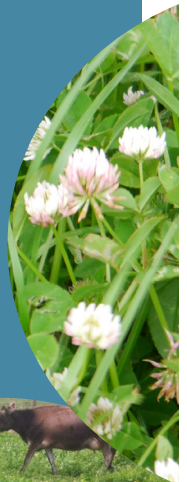
#### Sulla

After very good establishment Apr-Jun, sulla plant populations declined steadily:

- June – 94% presence in pasture
- October – 41% presence in pasture
- March – 0% presence in pasture.

Median growth rates 30–50 kg of DM/ha/day Jul-Aug; growth really dropped away after September as the plant population declined sharply.

Huge growth surge of red clover Nov–Jan such that pasture became 100% red clover.





## Annual clover

Balansa and Persian clovers were sown in separate halves of a paddock @ 6 kg/ha with an annual ryegrass @ 8 kg/ha and red clover @ 5 kg/ha sown into half of each of the annual clover areas.

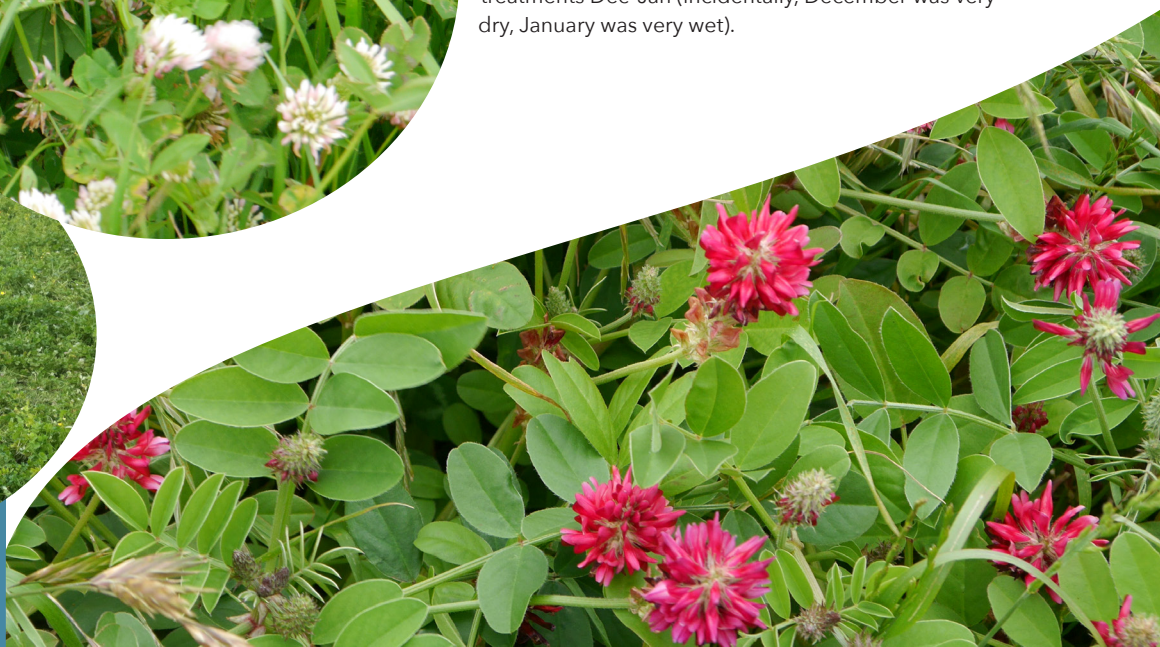
This "light" sowing rate of the annual ryegrass resulted in 85% pasture composition and drove high pasture growth rates (peaking @ 85 kg DM/ha/day) from June to the end of January.

The annual clovers failed to contribute any substantial amount of pasture growth, due to their low to very low plant populations - Persian, which peaked @ 21% of pasture composition early November (40 plants per square metre), averaged just 7% Aug-Oct.



## Conclusions

- After a promising start, *sulla only* showed disappointingly poor growth after the end of August. Even with a strong white clover (self-sown) presence after January, *sulla only* showed the poorest production by a big margin.
- Although *sulla plus red clover* and the two annual clover mixes produced very similar total growths (14.1 t DM/ha and 14.9 t DM/ha) there was a seasonal component - *sulla plus red clover* production being considerably below that of the annual ryegrass and clover treatments Sep-Nov. The very strong red clover base in the *sulla plus red clover* resulted in triple the pasture production compared to the other treatments Dec-Jan (incidentally, December was very dry, January was very wet).





## Case Study

### G Cookson, Kawakawa – bull beef

**Focus** – To see whether high (> 200 seedlings per square metre) legume plant population could be obtained from oversowing legume seed then mulching to improve mid-winter to early-summer growth and pasture feed quality

Seed mix (Italian ryegrass @ 15-20 kg/ha plus Persian clover @ 5-6 kg/ha) was oversown onto:

- high fertility, stock camp areas which had very strong kikuyu presence
- growth areas “outside” of the stock camp areas.

Grazing exclusion cages were placed onto this “outside” stock camp areas; measurements such as soil fertility were taken from these areas too.

Yield and composition		% composition		
Cut date	Daily growth pasture (kg DM/ha/day)	Italian ryegrass	Persian clover	Other clover (and weeds)
18 Aug	13	93	1	4 (2)
15 Sep	44	92	4	4 (0)
18 Oct	46	95	4	0 (1)
17 Nov	46	90	7	1 (2)
15 Dec	52	78	3	11 (8)
20 Jan	29	85	0	13 (2)

20 January data shows 85% Italian ‘ryegrass’ pasture composition – this was actually kikuyu – prior to this January cut it was Italian ryegrass.

Italian ryegrass performed well.

Really no production from Persian clover – highest composition figure just 7% in mid-December. Major problem was low Persian clover plant populations, e.g.:

- 18 August – 40 plants/m<sup>2</sup>
- 15 December – just 3 plants/m<sup>2</sup>.

Factors potentially impacting on the Persian clover plant population:

- soil fertility – would not have negatively impacted (pH 5.7, OlsenP 35, potassium 7)
- plant pests – only slugs, and seen at low to very low population numbers
- pugging damage – not severe enough to cause a major decline in plant numbers
- grazing management – probable that the grazing round of 25-35 days Aug-Nov too quick to “hold” a good Persian plant population.



# Pokapu Incorporation, Moerewa – dairy

**Focus** – To compare seasonal and total pasture growth when companion Italian ryegrass was sown at two distinctly different sowing rates – 15 kg/ha and 6 kg/ha

## Case Study

### Growth and pasture composition

Paddock	1	2	3
<b>Seed mix (kg/ha)</b>			
Italian ryegrass	15	6	15
Persian clover	6	6	6
Red clover	4	4	4
White clover	0	2	0
Total sowing rate	25	18	25
<b>Total pasture growth from 18 August up to 24 February (kg DM/ha)</b>			
	8,879	7,460	7,662
<b>Daily growth rates (kg DM/ha/day)</b>			
Aug-Sep	51	29	48
Oct-Nov	52	59	36
<b>Italian ryegrass population as % of pasture</b>			
Mid Sept	88	48	92
Mid Oct	93	54	78
<b>Persian clover population as % of pasture</b>			
Mid Oct	5	24	2
Mid Nov	13	49	4
<b>Persian clover plants/m<sup>2</sup></b>			
Mid Dec	13	24	9
Mid Jan	2	6	0.5



The “high” sowing rate of Italian ryegrass drove high growth rates for most of the winter and spring – e.g. the Italian ryegrass contributed 88% of the 51 kg DM/ha/day for Aug-Sep growth in Paddock 1. In turn, the lower Italian ryegrass population in Paddock 2 resulted in much lower daily growth in that Aug-Sep period. The higher Persian clover content in Paddock 2 did not “compensate” for the reduced Italian ryegrass content.

While the Persian clover presence Oct-Dec was much higher in Paddock 2 compared to the other two paddocks, its plant population numbers were not high enough to fuel greater pasture growth rates.



# Case Study

A and M McCahon, Te Kopuru – dairy

## Focus – Growth and feed quality of sulla with companion species

A paddock of free draining sand was drilled on 15 May 2015 with:

- 8 kg/ha of sulla seed
- 2 kg/ha of red clover seed
- 3 kg/ha of balansa clover seed
- 3 kg/ha of Persian clover seed.



8 September

Area	Pasture mass (kg DM/ha)	Growth sulla plants (kg DM/ha/day)
High sulla population	3,579	31
Typical sulla population	2,598	22
Low sulla population	2,738	24
Typical of paddock		26



	% sulla	% grass	% weed	% clover
High sulla population	68	8	12	12
Typical sulla population	74		26	
Low sulla population	17	69	13	1
Average of three areas	53	26	17	4

Averages – soil moisture 46%, soil temperature 12 °C at 12 noon.

13 October (35 day regrowth period)

Negative impact of grazing/cutting sulla shows in growth of only 11 kg DM/ha/day.

	% sulla	% grass	% weed	% clover
Average and (range)	56 (55-57)	33 (19-41)	2 (2-3)	9 (2-22)

	Pasture mass (kg DM/ha)	Growth (kg DM/ha/day)	% dry matter
Typical fenced off area	8,107	54	24.2
High sulla population	15,171	100	29.6



## 20 November

The paddock had last been grazed 9 September – 72 day spell.

		Prairie grass and sulla	Area within paddock with better prairie grass and balansa clover populations
Growth	kg DM/ha/day	88	76
	Total kg DM/ha	6,323	5,494
	Sulla	34	0
Dissection by % of dry weight	Balansa clover	0	46
	Grass	54	48
	Weed	11	6

*Prairie grass was not sown – was “self-seeded”.*

## Feed quality – sample 24 November

Testing was by “wet chemistry” to get the most accurate results for the annual clovers.

Sample	Red clover	Persian clover	Balansa clover	Sulla	Prairie grass	Sulla
Description	100% vegetative	100% vegetative	Mid-late flowering	Strongly in flower	Very mature (70% seed head)	Very mature (190-day growth)
Dry matter %	16	14	17	15	36	19
Crude protein %	26	20	16	16	10	9
Metabolisable energy (MJME/kg DM)	12	12	9.6	10.5	8	10



Earlier sampling, 22 October, showed:

- regrowth for balansa clover had a metabolisable energy (ME) level of 11.0 – high feed quality
- prairie grass, all vegetative material (no seed head) – high quality, ME 11.6.

At a similar stage of growth, an earlier sample from M Jagger showed sulla ME 13.3 and with very low fibre levels – very high quality feed.



## Case Study

# I Stanisich, Waiharara – dairy

## **Focus** – Evaluation of faba (tick) bean (grazing and silage) and three annual clovers as grazing crops

### Faba (tick) bean

Faba (tick) bean is typically used in New Zealand as a legume grain crop. Faba was drilled on 19 May @ 350 kg/ha. Growth estimates were made from quadrat cuts in various areas of a paddock.

By 26 August, crop had 98 days growth; by 23 September, crop had 127 days growth; by 21 October, crop had 155 days growth.

	26 August		23 September		21 October	
	"Taller" areas of crop	"Shorter" areas of crop	"Taller" areas of crop	"Shorter" areas of crop	"Taller" areas of crop	"Shorter" areas of crop
Height of plants (m)	0.68	0.3	1.56	0.35	2.1	0.35
Yield (kg DM/ha)	6,358	2,350	10,340	2,350	12,600	2,000
Growth (kg DM/ha/day)	64	24	81		81	
Plant population/m <sup>2</sup>	35	18	22	18	20	15
Dry matter % of plant material	9.7	12.1	15.6		18.6	
% of paddock	35	65	80	20	70	30
Presence of nodules on roots (pink/red colour inside)	High	Nil	High	Nil	High	Nil

*Pink/red colour inside nodules indicates good nitrogen fixation activity/levels.*



Two major problems for the crop were disease and not being able to harvest the crop as it became mature mid-late November.

## Disease

Chocolate spot fungus (*Botrytis fabae*) – forms lesions on leaves causing major growth depression and eventually plant death.

Root rot – caused by a combination of fungi – *Rhizoctonia solani*, *Fusarium oxysporum* and a *Pythium* species.

The faba paddock contained two soil types:

- kaikino peaty sand – loss from chocolate spot 30%
- very free-draining Houhora sand – loss from chocolate spot 90-95%.

*Research indicates a 30% loss alone from chocolate spot is severe. Luckily, Houhora sand made up just a small portion of the whole paddock!*

## Inability to harvest mature crop mid-late November

Strong winds mid-November caused severe damage by blowing over those plants that were very heavy.



## Berseem annual clover

Berseem annual clover, also evaluated, performed better under grazing than other annual clovers. Results of berseem sown in kaikino peaty sand soil follow.

August		October	
Pasture growth (kg DM/ha/day)			
64		53	
% composition			
Berseem clover	61	Berseem clover	32
Italian ryegrass	25	Italian ryegrass	64
Weed	14	Weed	4



## Case Study

# G & T Ussher Awanui – bull beef

## **Focus** – Establishment and production of:

- Faba sown alone
- Mixes of annual clovers with very light rates of companion species – 4 kg/ha of Italian ryegrass and 9–13 kg/ha of annual clovers

The treatments were paddock-scale, not replicated.

## Clover

In April, four clover establishment regimes were implemented in two paddocks – target rate was 200 seedlings per square metre by 1 June.

Results at 1 June were disappointingly low (dry conditions April till mid-May hindered germination):

- sprayed and mulched – 63 clover seedlings/m<sup>2</sup>
- sprayed only – 83 clover seedlings/m<sup>2</sup>
- mulched only – 23 clover seedlings/m<sup>2</sup>
- no spray and no mulch – 21 clover seedlings/m<sup>2</sup>.

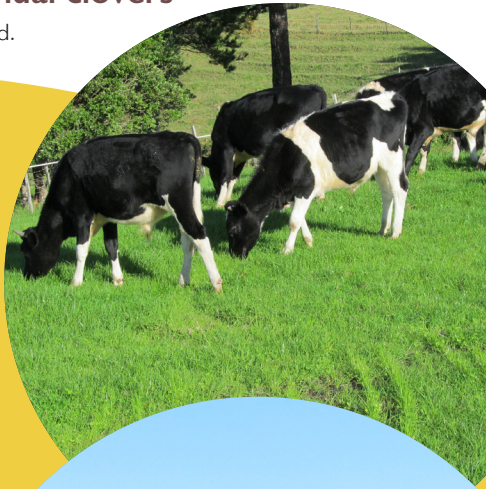
## Faba (tick) beans

Faba (tick) bean was sown on 20 May. From a sowing rate of 220 kg/ha, following a good germination and with very moist soils, a good plant population of 35 plants/m<sup>2</sup> was achieved.

- Best (10% of the paddock) grew 7,550 kg DM/ha (sampling ceased 15 November when paddock was grazed by bulls).
- Worst (20% of the paddock) area had nil plants after 60 days, largely due to soil wetness.
- Balance of the paddock (70%) had 6,400 kg DM/ha – faba made up 4,400 kg DM/ha, balance being ryegrass (Italian and perennial).

Problems did arise:

- pests, largely birds (e.g. peacocks), but also wild pigs
- wet to very wet soils in areas of the paddock had complete failure of faba
  - no nodulation of the beans – by August, the crop became very nitrogen deficient.



# All farms soil legume seeds – Autumn 2016

**Focus** – To measure legume seed levels in the soil to determine self-seeding rates and the effect of management of having a “spell” at the flowering period on soil legume seed levels

White clover soil seed amounted to 45 kg/ha  
Total clover seed amounted to 62 kg/ha  
Total legume seed amounted to 85 kg/ha

## Autumn 2016 white clover and total legume counts

	Sites with management to assist maximum flowering 12 sites (kg/ha)	Sites with no management at flowering time 10 sites (kg/ha)
White clover seeds (and range)	83 (36-141)	16 (0-39)
Total legume seed (and range)	159 (64-391)	23 (0-47)

Management to assist maximum flowering was generally temporary electric fencing across part of a paddock (i.e. no grazing) during flowering period (part of October, November and early December).

Non-grazing at flowering time did show increased levels of perennial clover but was not successful with annual clovers. Sulla showed nil soil seed;

Lusa Persian (a moderately hard seeded cultivar) showed nil soil seed in two sites and a moderately-high level of 50 kg/ha in one site that had no grazing at all.

Being a hard seeded variety of clover it was expected that there would be soil seed from balansa, but of nine paddocks sown with balansa, only one paddock had a low (4 kg/ha) level of soil seed – all the other paddocks had no balansa soil seed. The low plant populations of balansa in almost all paddocks was a major contributing factor to the disappointing results.

Spelling from grazing during late spring did result in much higher soil seed populations of white clover plus naturally occurring annual legumes (such as suckling clover).





# Financial cost:benefit analysis – dairy

Two major assumptions are used.

- The benefit from using annual clover is only for the first year (i.e. there is no carryover benefit into subsequent seasons).

*Seed mix was based on just 3 kg/ha of Italian ryegrass and a high 15 kg/ha of annual clover.*

- The species sown resulted in a net gain of 2,000 kilograms of dry matter per hectare during the year.

*2,000 kg DM/ha, coupled with a slight improvement in feed quality, gives an additional 158 kg of milksolids (MS) per hectare.*

Costs	\$/ha
Spraying	107
Mulching	150
Drilling seed	115
Seed	182
Slug bait	30
<b>Total cost</b>	<b>584</b>

With additional production of 158 kg milksolids, the benefit depends on the milksolids payout ...

Cost \$/ha	584	584	584
Milksolids payout (per kg)	4.00	5.00	6.00
Net benefit (\$/ha)	+48.00	+206.00	+364.00

A payout of \$3.70 “just covers costs”, so for a payout under \$4.00/kg MS the use of annual legumes is “not on” unless you achieve > 2,000 kg DM/ha increased pasture growth. However, for a \$6.00+/kg MS payout, there are substantial financial benefits from successful use of an annual legume.



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# Annual legume evaluation



NORTHLAND  
2015–2016