

Project Number: 408090

Optimization of subterranean clover for dryland pastures in New Zealand

Sustainable Farming Fund 2016-2017

Ministry for Primary Industries
Manatū Ahu Matua



PROGRESS REPORT FOR MILESTONE M3771



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June 2017



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Case studies of hill country development

Aim: Case studies of pasture development and management for at least two farms successfully using sub clover.

INTRODUCTION

For research projects to deliver successful on-farm extension there needs to be a combination of high data integrity research, on farm-demonstration and the promotion of successful case studies. Research shows that case studies have high currency and relevance for farmers and are therefore instrumental in creating practice change.

The purpose of the 'Sub 4 Spring' case studies is to increase awareness and move to adoption of sub clover technologies. This is done by highlighting the experiences of farmers who have successfully incorporated sub clover into their farm system in recent years, and those farmers who are responding to the outcomes of this research and want to assess sub clover for themselves.

These case studies document farmers experiences with the on-farm establishment and use of sub clover. Some of their experiences were successful and some were not. Either way there have been valuable lessons learnt and ideas formulated to improve sub clover establishment and growth in the future.

THE CASE STUDIES

For this Milestone, three case studies have been completed in the last year:

1. Waiau Station, Wairoa, Hawkes Bay – Dave Read and Judy Bogaard. The format of this case study is a diary written by Dave Read and it is presented in this report. This farm is a Sub4Spring demonstration site and was the focus of the Wairoa Field Day on 9/11/16.
2. Tempello, Marlborough – Jo and David Grigg. This case study was presented as 'Tempello: The Sub Clover Farming System' at the B+LNZ FarmSmart Day on 6/7/17 at Addington Raceway, Christchurch, by David and Jo Grigg and Derrick Moot. It will also be published in a 2017 issue of the NZ Institute of Primary Industry Management (NZIPIM) *The Journal*, with a working title of 'Sub fits the bill for dry hills' written by Jo Grigg and edited by Dick Lucas.
3. Westend Station, Southland – Mike and Frank O'Brien. This case study was compiled by Sonya Olykan from information and photos provided by Kieran O'Brien, and is presented in this report. Kieran decided to trial sub clover in the 2017 season after reading the Sub4Spring blog.

The documentation of these case studies will help to promote techniques being used by farmers in different environments to introduce and manage sub clover in a working farm system. They highlight the impact of seasonal differences in the successful establishment of sub clover.

Case Study 1: Waiau Station, Wairoa

Location: Waiau Station, owned and farmed by Dave Read and Judy Bogaard, is located at 61 Rangiahua Rd, RD3, Waiau 4193. GPS coordinates of the homestead are -38.949876, 177.335777.

Case study site: 12.6 ha paddock called 'Trig'

Topography: Land Use Capability class is VI and VII hill country – steep to very steep slopes (Lynn *et al.* 2009¹). See Plate 1. Estimated altitude 100 to 200 m a.s.l.

INTRODUCTION

The following case study is based on a diary kept by farmer Dave Read that describes his experiences with oversown sub clover after recognising that his grazing practices were unsustainable. He identified that sub clover was already a resident component of his hill country paddocks.

The diary provides background information dating back to 2008 but mainly focuses on Dave's efforts to introduce new cultivars of sub clover, which started in May 2016, with guidance from the Lincoln University Dryland Pastures Research team.



Plate 1: Weaned cows in 6th break of Trig, 20 Mar 16. Photo: Dave Read.

¹ Lynn, I. H., et al. (2009). Land Use Capability Survey Handbook - a New Zealand handbook for the classification of land. AgResearch, Hamilton; Landcare Research, Lincoln; GNS Science Lower Hutt. pp 163.

SUB CLOVER DIARY – DAVE READ

Before I start I would like to thank Gavin Sheath, Derrick Moot & Dick Lucas: they have all been extremely generous with their time.

2008/2009

A prolonged dry spell from August till April convinced us that 12 su/ha was unsustainable on our class VI & VII hill country, with at least one third north-facing. Reduced to about 10 su/ha. About this time Trevor Cook started facilitating our discussion group.

2011

By about now Trevor's message to feed ewes 4 weeks pre lamb & through lactation started to gain traction for us. It resulted in us attempting to maintain covers at or above 1200 kg DM/ha right through spring.

About this time I began to notice a patch of sub-clover [I didn't know what it was at that time] in my heifer calving block which had had only cattle spring-grazing for about 12 years. It was right beside the track in an old erosion scar; I used to admire it on dewy mornings when travelling out to check my heifers. After doing some research and talking to Dick Lucas, I discovered that Gavin Sheath had done work on sub clover in the North Island and that he visited Wairoa occasionally.

Nov 2011

Jude & I spent a very informative afternoon with Gavin, looking at a couple of sites out on the farm. By now I knew to look for the little white trumpet flowers that are so different from the pompom white clover flowers. I was starting to see the odd plant on a lot of my sunny faces. A result of our lighter spring stocking and my heightened awareness of it. The previous owner told me his family had spread some seed in the 1970's with their super. Gavin identified it as Mt Barker. He advised us to graze it lightly over the flowering period with cattle, rather than shut it up completely as they do down south to get a good seeding. In our environment grass would be too much competition, forcing the sub up to the light and meaning its burrs would be unable to bury in the ground. This would produce predominantly "soft" seed that would all germinate at the first rain. Gavin thought that what we had was possibly better than anything we could buy. When originally sown it had quite a wide genetic base which over the last 40 years had adapted to our conditions & management. Its survival under hard sheep grazing was a testament to its hardiness. However he warned us that promoting it would be a long process, as it only expanded 20-30 cm a year. At this time I was getting enthusiastic about its potential, I had read about the Grigg's success with it in Marlborough and the impressive stock production gains they had achieved. I had a vision of it cascading over the sheep tracks on my steepest hills!

2012-2015

We identified the 10 paddocks with the highest proportion of steep north facing country. These were set stocked with yearling cattle plus a few dry fattening R2 heifers over the mid-August till Christmas period. In a dry year the numbers were reduced, as these cattle were predominantly part of our system of "buffer mobs", ready for sale in a dry spring.

We made slow improvement in the amount of sub present, but nothing dramatic [less than 5% coverage in most cases]. Despite this the cattle on this country manage to put on in excess of 750

g/day over the four month period. When we got enough rain in the autumn to germinate these blocks were destocked until the sub got to the four true leaf stage. This was not the problem that I thought it would be; the shady/lower slope country came away a lot quicker than the steep dry country and we really didn't miss 10% of our area being out of production for a few weeks. Also because we have moderately good soil fertility and have de-stocked a lot if the dry was serious, the good country tends to explode as soon as we get a soaking. This will be an area for more management changes if we manage to establish sub on all the sunny third of the farm. We do feed willow and we could increase this on the shadier country once rains come.

Mid-Mar 2015

100 mm of rain after a prolonged dry spell: huge germination of sub clover.

Mid-April 2015

Hot windy weather, any rain followed by wind. Sub-clover only surviving on sunny slopes with an easterly aspect. Although our sub is adapted to our conditions will it survive if we get dryer?

May 2015

Went to AgInnovation in Fielding. Dick Lucas persuaded me to try some new varieties of sub. Trialled the four varieties I could source at short notice. Sowed by hand on some steep country, no proper preparation, I thought it was too late in the season. Sowing followed by very nice rain. Good germination on the steepest country especially on bare sheep tracks, a poor result on easier hill with more pumice, probably too much grass cover?

Sept 2015

Gavin & Andrew Johnston, visited. Andrew arranged a field day with Derrick Moot.

Nov 2015

During the field day we identified a suitable paddock [Trig: 12.6 ha] for sowing autumn 2016. A high percentage of North facing dry country with minimal resident sub present plus quite a bit of easier dry pumice country that should be able to produce more [but looks shocking at present].

Dec 2015

Ordered seed: Monti, Denmark, Woogenellup, Leura + a dash of Antas. I wanted to sow a wide range of varieties, mixed, so that some of what I sowed might be suitable in each microclimate on our hills. I had been advised against anything that was too hardseeded [over 3]. I included a dash of Antas, but I think our country is probably too harsh for it. Dick Lucas thought it may have a place on our pumice country where its poor burr burying ability may not be such a disadvantage, due to the softer soil. With its distinctive big leaf we will be able to easily track its survival. The key will be varieties that can re-seed themselves year after year as I only want to sow once.

EVENT LOG FOR 2016

Site preparation, seed sowing and post establishment treatments

The following events were carried out and recorded by the farmer, Dave Read.

Date	Event
13/3/16	Started break grazing the paddock with 200 R2 & R3 recently weaned cows
23/3/16	Sowed first half of Trig with a 10 kg/ha mixture of the following sub clover cultivars: Monti, Denmark, Woogenellup, Leura + a dash of Antas
24/3/16	Trampled seed in with a mob of 500 ewe hoggets
25-26/3/16	Two days of steady rain – 60 mm
29/3/16	Sowed second half of Trig
9/4/16	Established sub clovers at first trifoliate stage (15 days since rain)
27/4/16	Plants 5 weeks old and at 4-6 trifoliate leaves
4/5/16	Two very hot dry weeks. Sub clover plants are 6 weeks old but have no new growth
13/5/16	Paddock grazed lightly by 200 weaner heifers for two days
7/6/16	Set stocked small number of light weaners and light ewe hoggets
14/6/16	All hoggets removed, plenty of feed left on damper slopes but hoggets had grazed sunny slopes close

DAVE'S DIARY ENTRIES FOR 2016

13 Mar 2016

Started break grazing Trig with 200 R2 & R3 recently weaned cows (see Plate 2). A lot of rank old grass but a good bottom in any places with a bit more moisture. Cows were given approx. 0.75 ha/day, tried to get some good feed in each day's break along with the rough dry feed on worst dry faces. Mob took 17 days to clean up whole paddock. Was only able to back fence three times as we were limited for water as the cows made the first dam so muddy they were too scared of getting stuck to get in. Hot, dry weather apart from two good day's rain at Easter. Tricky to get the breaks with an even amount of feed: steep broken country, need to get a vantage across the valley to plan out breaks, made harder by the huge variation of quantity & quality of feed [a range of 1200 kg/ha dry dead grass - 3500 kg/ha of reasonable quality]. We have been so impressed with the job that these cows are doing that we have continued to break graze them until ewes are able to be worked [end of May] and joined with cows to make a working mob.

Break grazing took approx. 1 hour/day, used belt to hold reel while running poly wire & laying pegs. No need for a gym subscription!

Next year: Weigh cows at start of break grazing to see how much condition [if any] we are stripping off them. A Pack frame set up for carrying pegs would be useful.

23 Mar 2016

Sowed first half of trig with a “fiddle” [last used early 1960’s to sow bush burns!]. Test runs established that a setting of 2.5 seemed to give about 10 kg of sub/ha with a 6 m spread [3 m either side]. However some of trig is so steep that spread uphill was probably not much. Used an electric peg with a rag tied on it on each spur to get a rough gauge for my 6 m. With the fiddle was able to shut off on any shady slopes where there would be too much competition from grass & where white clover was. Jude had to make a new cloth top to the fiddle as the old one was not going to last another day! *Sowing took 3 hours for 40 kg, sowing approx. 60-70% of the total area.*



Plate 2: Cows in 7th break, 20 Mar 16. Photo: Dave Read.

24 Mar 2016

Brought in a mob of 500 ewe hoggets to tramp the seed in. Our ewes are all being flushed, so not able to use them. A hot afternoon, after one lap they were all panting. The pumice soil was so dry they were not compacting it at all, in fact probably fluffing it up even more.

Next year: Will sow each break the day before the cows graze it, they can graze & tramp in one pass.

25&26 Mar 2016

A beautiful steady two days of rain [60 mm].

29 Mar 2016

Sowed last half of Trig. Walking the whole paddock revealed more resident sub than we had thought present in the spring. We had quite a big strike in late January when we had 50 mm followed by

some cooler weather + a bit of follow up rain in early February. These plants died on the driest faces, and we had been unable to see much elsewhere during late Feb/early Mar. However quite a few plants must have survived [by staying very small?] because the plants I was seeing now were more developed than the newly germinating plants on the first half of the paddock, which only had their two cotyledon leaves.

9 April 2016

15 days since rain, clover plants at the first true leaf stage.

27 April 2016

Plants looking good.

27 April 2016

Plants 5 weeks old, 4-6 true leaves.

4 May 2016

Plants 6 weeks old. Two very hot dry weeks, plants have made no new growth, but still alive. Soil is very fluffy anywhere there is no old grass to hold it together.

13 May 2016

Grazed paddock lightly with 200 weaner heifers for two days. The shady slopes were getting long grass, starting to fold over. Weaners did a small amount of damage on worst pumice slopes by disturbing soil.

7 June 2016

Set stocked small number of light weaners & light ewe hoggets.

14 June 2016

Removed all hoggets, plenty of feed on damper slopes but hoggets grazing sunny slopes.

Next year: After four true leaf stage set stock with low CS cows to control grass. They shouldn't run around so much and they will not be looking to strip mine clover [hopefully].

Very depressing, way less sub than on previous visits. The sunny slopes are still very dry, even the Californian thistles are yellowing off. Since germination we have only had one fall of rain greater than 20 mm. There has been a lot of hot weather and wind. In May we have had 40 mm [35% of normal] we are still getting some days into the lower 20 degrees. I hope that, just as after the January rain, there is more sub surviving than it looks, otherwise we try again next year.

[See Figure 1 for monthly rainfall from July 2015 to June 2016]

30 June 2016

Grazed for two days with 600 ewe hoggets & 20 dry R1 heifers.

14 July 2016

57 mm rain 23 June with follow up rain every 3-4 days + warm temps. Soil moisture has recovered even on driest faces. I may have been overly pessimistic: there appears to be more sub than before [still a lot of bare ground with browntop? a very fine grass] germinating. On the farm as a whole sub seems to have fared a lot better on steeper siltstone country. Is this just a result of this year's very dry autumn/early winter, or is it what we should expect every season?

22 July 2016

Have realized that in determining which paddocks should be grazed primarily to benefit sub clover, that if that treatment is detrimental to moist areas in the paddock [for example this year sub areas were not ready to be grazed, but moist areas were getting too long], then we need to decide not on the basis of area alone, but on value of feed produced over a year on each area. It would be very beneficial to assess what species are present in each aspect, then sit down with a pasture specialist and work out what management is needed at each season to shift the composition to a more economically favourable one, and identify when we are likely to face a conflict between management of dry/moist areas.

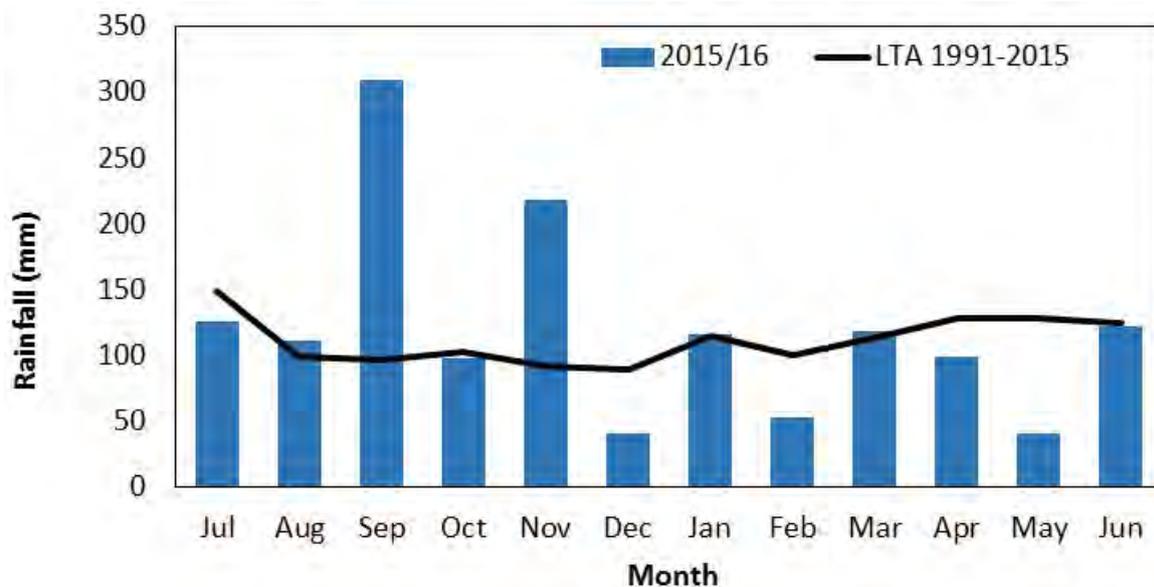


Figure 1: Rainfall at Waiau Station from July 2015 to June 2016 (data from by Dave Read).

28 Aug 2016

Two weeks the longest spell without rain & mostly a small top up every few days & apart from brief cold spells it has been warmer than normal; the spring flush of growth has kicked in. 31 R1 Heifers set stocked 22 Aug on sown block. Bare ground is filling in with Browntop? and Lotus hispidus? There will be enough sub plants to get a reasonable cover after one self-seeding [I hope]. Still disappointing compared to what there was. Plants are behind in size (Plate 3 and Plate 4) compared to resident sub in other paddocks (Plate 5) where it is looking good in pumice areas as well as mudstone. The resident plant I washed & photographed had way less other roots entangled with its root system. So is it bigger because: less matt of roots to contend with; germinated earlier and

managed to survive the dry; or got off to a better start because the seed was buried in a burr? Could we improve the start of sown seeds by getting better compaction? Is the fact that the resident plant I photographed came from a small, but almost pure patch of Sub clover a worry in the autumn it must have been essentially bare ground & that is a risk on our steeper slopes?

It is noticeable that the areas break grazed before the Easter rain have way more winged thistles than the areas grazed later. Do we actually need to bare out the ground to get good germination of resident seed [once there is a good seed bank]? This season it would appear not. Will the germinating seed be able to survive shading until it is strong enough to be grazed?

6 Sept 16

33 Heifers dosed & weighed [220-230kg]: eid individual weights

17 Sept 16

Added 4 cows. Some sub flowering: Monti [by Derrick's ID chart].

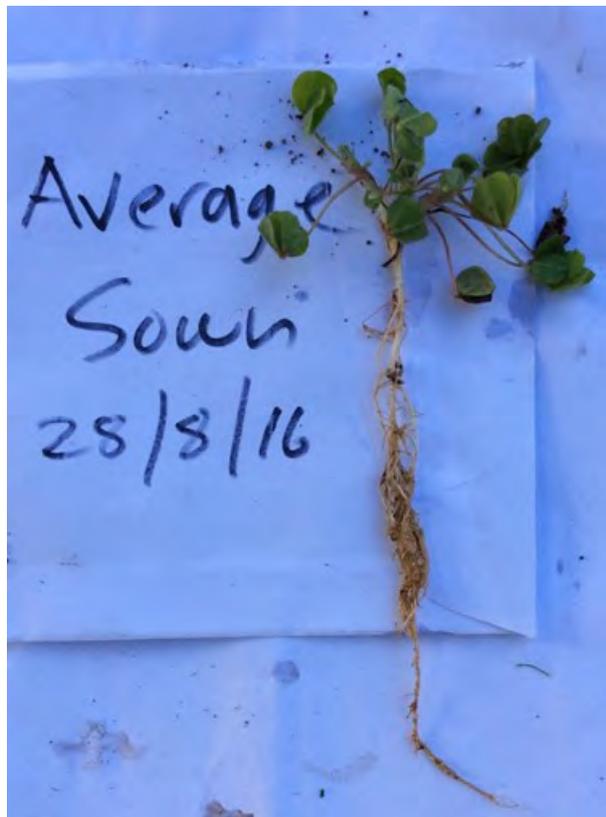


Plate 3: Average sown sub plant from Craig's trig (28 Aug 16, Photo: Dave Read).



Plate 4: Best sown sub plant from Craig's trig - note dense web of other roots. (28 Aug 16, Photo: Dave Read).



Plate 5: Resident sub clover in Horse Paddock - taken from a small almost pure patch (28 Aug 16, Photo: Dave Read).

12 Oct 16

Removed 4 cows. Dry faces are getting grazed out a bit low, but fertility patches are still longer than I would like. Perhaps a mix of older cattle all through spring would improve this?

Once we get a good bank of hard seed perhaps we can set stock some early lambing ewes with R1 heifers + some cows. Remove ewes [sometime in October?] to shady country to control the later spring flush of growth as this country warms up.

Will having the early flowering Monti in the mix make this sort of management too difficult?

Since the start of August, 12 days is the longest that we have gone without rain. Great for the dry sunny faces, they are really starting to fill in. Resident Mt Barker is flowering strongly, Prevalence of Rats tail has diminished a lot, especially where we have been calving heifers for 11 years now [1st season round there Spring 2005] . Much more sub than I had thought in mid-winter.

I am looking forward to Derrick identifying what other varieties of sub have established. Of course the real test will be what manages to re-establish its self this autumn.

2 Nov 16

Removed 34 R1 heifers have averaged 1.0 kg/d over 57 days: 6/9/16-2/11/16

34 heifers av 250 kg at mid-point at +1.0 kg/d= 6.7 kg DM/d = 9166 kg consumed

4 cows at 450 kg for 26 d [due 15 Oct] at +1 kg/d=15 kg DM/d = 1560 kg

Total = 10.7 T

Feed consumed = av 15 kg DM/d over 57 days

In late Aug we were predicting only 12 kg/d due to extremely dry winter & poor species on dry faces.

What has it grown? Covers are higher now than when R1 heifers went in. Would guess that 6.6 ha of sunny slopes have gone from 1000 kg/ha to 1200 kg/ha. 6 ha of easier country from 1200 to 2000 kg so net gain of about 6 T would give a total grow of 16-17 T over 57 days= 22-24 kg DM/ha/d.

We have struggled to control fertility patches, while the sunny faces have been grazed out possibly a little too hard. I am removing the stock completely now as I feel that the heifers are hitting the sunny faces too hard. Perhaps older cattle would do a better job?

2017: RE-ESTABLISHMENT OF SUB CLOVER

10 Feb 17

60 mm rain over two days, followed by hot weather but little wind.

17 Feb 17

60 mm rain over two days, followed by mainly cooler weather.

19 Feb 17

A strike of seed.

22 Feb 17

18 month heifers spread through sub paddocks. Ewes and 2-tooths rotation sped up - 2 days max per paddock.

27 Feb 17

Squeezed up 18 month cattle. Set stocked some cows and calves as feed getting away [still dry underneath, however].

2 Mar 17

Looks like two separate strikes, older [from 10 Feb] has three true leaves now. Growth so much faster this year than last [strike occurred in late March].

7 Mar 17

Sowed the following sub on grazed out and paddocks where cows weaned:

- ♣ Campeda 15 kg
- ♣ Denmark 15 kg
- ♣ Monti 15 kg
- ♣ Woogenellup 15 kg
- ♣ Narrikup 15 kg

8 Mar

67 mm gentle rain.

9 Mar

Seed germinating!

10 Mar 2017

60 hours from start of rain. Longest root 10 mm, no shoots yet.

Because we have broadcast but not tramped in the seed some of the roots are still on the surface, so I guess survival is dependent on continued damp weather [which we are still getting]

NEXT YEAR: use broadcasting the day cows go in break so that they graze out and tramp in in one go. Save some seed to sow later in season when a forecast for rain and cows will make a mess. Try some plantain too?

[January 2017 at Waiau Station was very dry, with only 5 mm rainfall (Figure 2), after a relatively dry November and December (28 and 57 mm respectively). In contrast from February to May the monthly rainfalls were greater than 200 mm so there was plenty of soil moisture for the sub clover seedlings germinating and establishing after the March sowing].

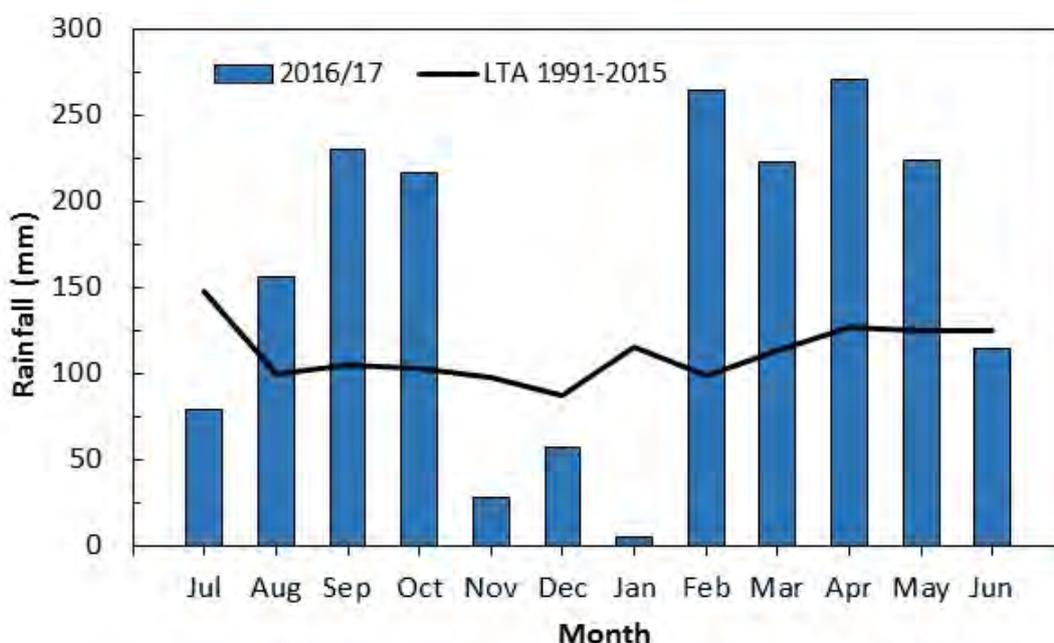


Figure 2: Rainfall at Waiau Station from July 2016 to June 2017 (data from by Dave Read).

11 Mar 17

Sheep on 1 day shifts re-introduced into resident sub paddocks.

15 Mar 2017

We have been really lucky in having a week of cool weather with frequent showers, as those seedlings lay for a couple of days with their diddles just laid out flat on top of the soil!



Plate 6: Sown sub clover one week after sowing on ground that had been bared by weaned cows in Mangawhero (14 Mar 2017, Photo: Jay Jay).

23 Mar 2017

We have had three strikes of similar quantities of seed: some new seedlings coming up among the older ones. Also, especially after the last rain, seedlings coming in drier zones. Now this can't be an effect of hardseededness, as there has not been time between strikes to crack more seeds nor has there been big day/night temperature variations. I remember Gavin mentioning a secondary mechanism for avoiding false strikes in sub clover, but I can't remember what it was called or how it acted?

The 9 days of cool drizzle mitigated my mistake of not tramping in the seed I sowed in March. However I have been surprised by the sub that I broadcast this year: bare ground - no problem, but dead patches with only a very thin cover of dead grass lying on the ground and the density of plants is probably only 10% of the bare ground. What is going on here?

I am back on the diary entries again - should be a much better season than last year and I am looking forward to what sub can do in the spring after a good start in autumn.

4 May 17

Lots of feed. We have kept weaners set stocked in sub blocks and are now working our way round with 200 cows on daily shifts behind a wire~ making a bit of mud on wet days: broaching is more of a problem than pugging as they are on pumice country². On more extensive steeper land ewes are now on maintenance with 2-3 day shifts. I don't think they are doing any harm to the sub. Great to see what the sub can do when starting earlier in the season.

² Pugging and broaching are the visible impacts of grazing management on wet soils.

Case Study 2: Tempello, Marlborough

Location: Tempello Station, owned and farmed by Jo and David Grigg, Brancott Rd, RD2, Fairhall, Marlborough.

Case study site: Tempello Station

Topography: A mix of managed flats, lower hill country and high country.

Introduction

Many farmers in east coast New Zealand are aware of the economic and environmental success of the legume based dryland systems developed in Marlborough using lucerne at “Bonavaree” (SFF 05/132) but fewer are aware of the sub clover story at “Tempello” (SFF 10/069). These highly successful farms have developed from close and ongoing communication between scientists at Lincoln University and these leading farmers.

Tempello Station is a 4800-hectare property that lies between the Awatere and Wairau Valleys, climbing from 100 m, just out of Renwick, up to 1000 m in the hills south of Blenheim³. On the Tempello hill country, sub clover was increased in the pasture using sub division and stock management only.

A number of the Griggs’ experiences with sub clover have been documented. A paper describing the role of sub clover in increasing pre-weaning lamb growth rates at Tempello was presented to the 2008 NZ Grassland Association conference in Blenheim (Grigg *et al.* 2008⁴).

Also a number of Dryland Pasture Research blog posts have featured Tempello:

- ♣ ‘Tempello Dryland Blog – Subterranean clover’ (17/10/12)
<https://blogs.lincoln.ac.nz/dryland/2012/10/17/tempello/>
- ♣ ‘Tempello Dryland Blog – Sub clover (October)’ (12/11/2012)
<https://blogs.lincoln.ac.nz/dryland/2012/11/12/tempello-dryland-blog-sub-clover-october-2/>
- ♣ Tempello Dryland Blog – January’ (1/3/13)
<https://blogs.lincoln.ac.nz/dryland/2013/03/01/tempello-dryland-blog-january/>

This case study documents the farmers’ experiences with sub clover over the last 12 or so years.

³ Article by Tony Benny, 24/3/2015, ‘Clever clover management boosts output at Tempello’ retrieved from <http://www.stuff.co.nz/business/farming/sheep/67436211> on

⁴ Grigg, J., Grigg, D. and Lucas, R. (2008) ‘Maximising subterranean clover in Marlborough’s hill country is key to weaning 80% of sale lambs prime’ NZ Grasslands Conference Proceedings 70: 25-29. Can be retrieved from: <https://www.grassland.org.nz/viewpublication.php?pubID=281> ‘Adaptive Farming Systems’ section.

B+LNZ presentation

This case study was presented as 'Tempello: The Sub Clover Farming System' at the B+LNZ FarmSmart Day on 6/7/17 at Addington Raceway, Christchurch, by David and Jo Grigg and Derrick Moot. The FarmSmart presentations were livestreamed on the day and available on the B+LNZ Facebook page: <https://www.facebook.com/beeflambnz/>.

Article in NZIPIIM's *The Journal*

'Sub fits the bill for dry hills' written by Jo Grigg and edited by Dick Lucas will be published in the September 2017 issue of the NZ Institute of Primary Industry Management (NZIPIIM) *The Journal*.

Case Study 3: Westend Station, Southland

Location: Westend Station is located at 383 Lake Monowai, Otautau, Southland. GPS coordinates are -45.795, 167.625. The station is owned/managed by Mike and Frank O'Brien.

Case study sites: Two sites on the farm were drilled with a mix of sub clover in March 2017.

Topography: Westend Station has flat terraces, altitude ~140 m a.s.l., and steep hill country that ranges in altitude from 160 to 465 m a.s.l.

INTRODUCTION

After reading the Sub4Spring blog in March 2017, Kieran O'Brien contacted Prof Derrick Moot to discuss the idea of trialling sub clover on his property in Southland. He was interested in the potential benefits that could be gained from getting earlier legume growth in the spring. His other reasons for considering sub clover were related to problems with grass grub and clover root weevil in his white clover based pastures. He also saw the 'end game' as the establishment of sub clover in his hill country pastures.

The area of Westend Station that is effectively farmed consists of 430 ha non-cultivable hill, 140 ha undeveloped oversown flats, 510 ha moderately productive more recently developed flat paddocks (Site 2), 505 ha of productive flat paddocks, 85 ha of very gravelly river flats (Site 1) and 85 ha of forestry. Other areas of the station, about 810 ha, are in native bush, QE Trust, and scrub.

The Southland climate is not one traditionally identified for sub clover so this Case Study offers an opportunity to investigate a number of questions in this environment:

- ♣ Will sub clover successfully establish and grow, especially during a late spring and summer when soil moisture is unlikely to be limited?
- ♣ Which sub clover cultivar will grow the highest yield and provide the earliest spring feed?
- ♣ Does a pre-spray of herbicide suppress the grass sufficiently to promote sub clover establishment and growth? Will a light spray of herbicide do the job?
- ♣ What grazing practices will promote sub clovers establishment and growth and allow it to re-establish in the following year?

Climate

Southland is the first part of New Zealand that is affected by weather systems moving onto the country from the west or south. The western ranges of Southland are amongst the wettest places on earth, where annual rainfalls can exceed 8000 mm. However the drier eastern lowlands and hills have annual falls between 1200 mm and 800 mm. Dry spells of more than two weeks are not common (Macara 2013)⁵, which highlights this as 'white clover' country.

Compared to the rest of New Zealand temperatures in Southland are lower, with frosts and snowfalls occurring relatively frequently each year, and there are fewer sunshine hours (Macara, 2013).

The nearest climate station is Monowai (Agent no. 5436, GPS -45.748, 167.616) approximately 5 km from the farm house at an altitude of 158 m. This station has been operating since 1920 and provides rainfall data.

⁵ Macara, G. R. (2013). The climate and weather of Southland. NIWA Science and Technology Series No. 63, NIWA.

Rainfall in 2017

Annual rainfall at Monowai is around 1200 mm and reasonably consistent throughout the year without any consistently drier months during the summer based on the recent long term monthly rainfall averages (Figure 3).

In 2017, after rainfall of 156 mm in January, the months of February, March and April were relatively dry, with about 40 mm falling each month, followed by 105 mm in May (Figure 3).

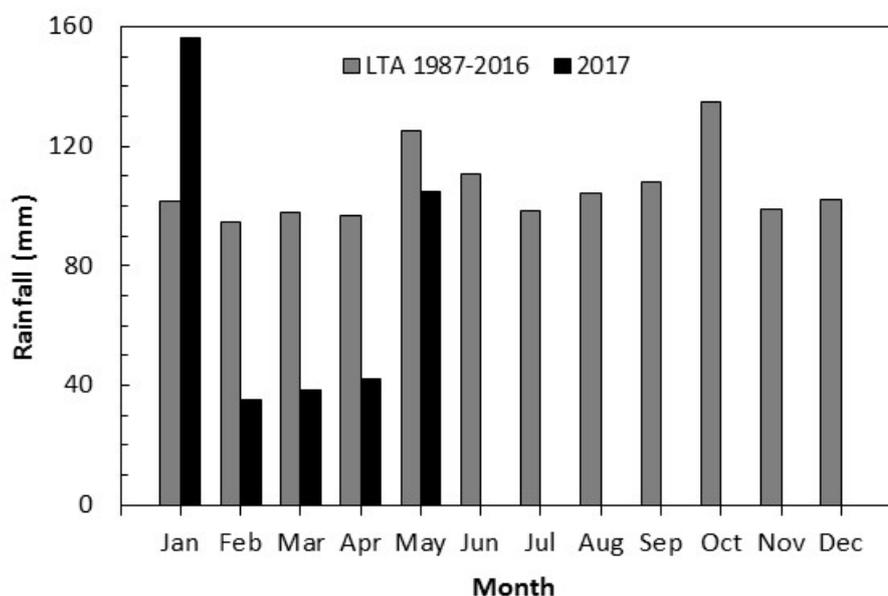


Figure 3: Rainfall at Westend Station in 2017 compared with the long term average (LTA) from 1987 to 2016. (Data from the Monowai weather station, GPS -45.748, 167.616, 158 m asl).

Site selection

After investigating a range of sites the farmer decided on two that were flat for ease of drilling and herbicide application to see if killing off the grass competition helped the establishment of sub clover.

Sub clover cultivars

Originally the aim was to plant a mixture of Antas, Denmark and Leura but it was difficult to get hold of Leura seed so the following mix of sub clover cultivars was sown:

- ♣ 3 kg/ha Antas (Hardseededness rating 3, late flowering)
- ♣ 3 kg/ha Denmark (Hardseededness rating 2, late flowering)
- ♣ 2.25 kg/ha Bindoon (Hardseededness rating 3, early flowering)
- ♣ 2.25 kg/ha Coolamon (Hardseededness rating 5, mid flowering)

As noted by the farmer, the mix includes a range of seed hardness and flowering date (sub clover cultivar information from Moot *et al.*, 2016)⁶.

⁶ Moot, D. J. and the DPR Team (2016) Guide for subterranean clover identification and use in New Zealand. Lincoln University. SFF Project 408090, Report M3779.

SITE 1 - VERY LIGHT STONY SOIL

Soils

The soils at this site, which is next to the Waiau River, are silts with gravel throughout with a very thin layer of top soil (K. O'Brien, *pers. comm.*, 2017).

This site has a high natural fertility as shown by the soil analysis results from samples collected in September 2014 (Table 1). The key soil nutrient characteristics to look at for clover are pH, phosphorous, sulphur and molybdenum. From a sub clover perspective the soils at Site 1 have an appropriate pH and Olsen- P values. There is no information about the sulphate-sulphur or molybdenum levels in the soil.

It is likely sulphate-sulphur will be very low as soil tests from the neighbouring paddock with the same soil type have sulphate-sulphur levels of 3 ppm (K. O'Brien, *pers. comm.*, 2017).

Site history

This site was sown into cocksfoot, white clover and red clover in the spring of 2015 but the plants shrivelled up, possibly because of a hot dry spell around Christmas⁷, and never recovered (K. O'Brien, *pers. comm.*, 2017). By early 2017 the paddock had sparse weed grasses and the resident white clover re-established (Plate 7). The farmer was planning to drill some Italian ryegrass into the paddock to provide some spring feed.

Table 1: Results from the analysis of soils collected from Site 1 in September 2014⁸, Westend Station, Southland.

Nutrient	Amount	Comment ⁹
pH	6.2	Medium
Olsen P	39 ug/ml	High (i.e. >30).
Calcium	9 me/100g, MAF QT 10	Medium (i.e. 6 – 12 me/100g)
Magnesium	0.83 me/100g, MAF QT 16	Low (i.e. < 1 – 3 me/100g)
Potassium	0.23 me/100g, MAF QT 4	Low (i.e. < 0.5 – 0.8 me/100g)
Sodium	0.04 me/100g, MAF QT 2	Low (i.e. < 0.2 – 0.5 me/100g)

Site preparation

A log of events used to prepare Site 1 are described in Table 2.

⁷ Rainfall in December 2015 was 54 mm.

⁸ Soil samples were collected by a Ballance consultant and analysed by Eurofins NZ Laboratory Services.

⁹ Based on the interpretation of results as agricultural soils using criteria described by Hills Laboratory 'Soil tests and interpretation' retrieved from <https://www.hill-laboratories.com/file/fileid/15530>.

Table 2: Events used in the preparation of Site 1, Westend Station, Southland.

Date	Event
9 -12/3/17	Hard grazed with sheep.
12/3/17	Direct drilled and rolled 2 ha with 8 kg/ha S/S 'Supercruise' ryegrass ¹⁰ and 10.5 kg/ha bare sub clover seed (see mix of sub cultivars noted above). See Plate 8. 17 mm of rain.
15/3/17	Mob of cows and calves put in paddock for 4 days.



Plate 7 Site 1 before drilling. The pasture consisted of sparse weed grasses and re-established white clover (photo: Kieran O'Brien).



Plate 8: Post drilling view of site 1 (Photo: Kieran O'Brien).

¹⁰ 'Supercruise': diploid Italian ryegrass with a pasture life of 6 months to 2 years. S/S: seed treated with Superstrike.

Outcomes

Sub clover seedlings emerged within two weeks of sowing and looked healthy and vigorous (Plate 9).

A close look at Plate 10, an area of about 0.5 m², indicated that the sub clover population at this location was at least 40 plants/m² at 5 weeks after sowing (19/4/17). About 140 sub clover seeds were drilled/ha so the establishment rate is about 30%.

It was not possible to identify what the sub clover cultivars were at this early stage. The white clover population was much larger from stolons surviving the October 2016 drought and/or seedlings from the white clover seed bank.

By June 2017 the farmer reported that he was starting to see some grass grub damage after not finding many grubs before sowing. He suspects that the dry conditions at the time of sowing may have forced the grubs deeper into the soil.

A dig in June found approximately 8 grass grubs in a spade spit and it is possible that sub clover plants have been lost. The ryegrass seed sown at the time was treated and sown at 8 kg/ha so may also be susceptible to the grass grubs. Cocksfoot is grass grub tolerant and may be a solution to the grass grub problem if it persists.

Photos taken in June 2017 indicate that the site still has a reasonable population of sub clover as well as white clover. It will be interesting to see how the legumes are looking by spring and identify if any particular sub clover cultivar has been more successful than the others on this site.



Plate 9: Newly emerged sub clover seedlings at Site 1 two weeks after sowing (25/3/17, Photo: Kieran O'Brien).

Close-up photos of the sub clover plants in June showed small black spots on the leaves indicating that the disease ‘pepper spot’ was present on the sub clover and white clover plants (Plate 11).

Pepper spot is a common disease of sub clover caused by the fungus *Leptosphaerulina trifolii* and the symptoms appear as many, very small, brown pin spots on the surface of leaves, which can cause leaf burn symptoms in more severe cases (Dear and Sandral, 1997)¹¹. This disease is favoured by the cool most weather conditions that are predominant in Soutland.

The Australian literature, as summarised by Nichols et al. (2014)¹², does not provide any information about possible sub clover cultivar resistance to pepper spot.



Plate 10: Five weeks after sowing the sub clover plants are well-established (circled in black). There are also many resident white clover plants filling the gaps (19/4/17, photo: Kieran O’Brien, black circles added by Sonya Olykan).

¹¹ Dear, B. S. and G. A. Sandral (1997). Subterranean clover in NSW - identification and use. Agricultural Research Institute, Dubbo. *Agfacts*. **P2.5.16**: 36pp.

¹² Nichols, P.G.H., et al. (2014). Genetic improvement of subterranean clover (*Trifolium subterraneum* L.). 2. Breeding for disease and pest resistance. *Crop & Pasture Science* **65**: 1207–1229.



Plate 11: Close up of sub clover plants at Site 1 show a black spot on the leaves that indicate a possible disease issue. (4/6/17, Photo: Kieran O'Brien).

SITE 2 - RUNOUT PASTURE IN 6 YEAR OLD Paddock

Soils

Most of the soils on the flats at Westend Station are classified as 'Monowai' but K. O'Brien (*pers. comm.*, 2017) notes that there is definitely variation between them. The Monowai is classified as a Firm Allophanic Brown Soil¹³. These soils are shallow, silty loams and can be extremely gravelly. Potential rooting depth is 15 to 35 mm. The soils are well drained and have low available water (50 mm in the top 100 cm).

This site was originally in native pasture and was turned over for the first time in 2009. It has been through two brassica crops and has had significant fertiliser input. Soils were collected from the site and analysed in September 2010 (Table 3).

Table 3: Results from the analysis of soils collected from Site 2 in September 2010¹⁴, Westend Station, Southland.

Nutrient	Amount	Comment ¹⁵
pH	5.8	Low-Medium
Olsen P	26 ug/ml	Medium (i.e. 20 - 30 ug/ml)
Sulphate-S	12 ppm	Medium (i.e. 10 - 20 ppm)
Calcium	5.4 me/100g, MAF QT 5	Medium (i.e. 6 -12 me/100g)
Magnesium	0.55 me/100g, MAF QT 8	Low (i.e. < 1 - 3 me/100g)
Potassium	0.20 me/100g, MAF QT 3	Low (i.e. < 0.5 - 0.8 me/100g)
Sodium	0.15 me/100g, MAF QT 5	Low (i.e. < 0.2 - 0.5 me/100g)
Boron	1.6 ppm	

From a sub clover perspective the soils at Site 2 have an appropriate pH level and amounts of Olsen-P and Sulphate-S values. There is no information about molybdenum levels in the soil.

Recent site history

This 2 ha site had been through a peak grass grub cycle. There was little clover or perennial ryegrass left, as it had reverted to weed grasses, and obvious urine patches (Plate 12). This site is described as being a low legume environment with weed grasses that simulate the farm's hill country pastures.

Site preparation

A log of events used to prepare Site 1 are described in Table 4.

¹³ Soil information from SMAP: <https://smap.landcareresearch.co.nz>. Landcare Research NZ Limited, 2011-15.

¹⁴ Soil samples were collected by a Ballance consultant and analysed by NZ Labs.

¹⁵ Based on the interpretation of results as agricultural soils using criteria described by Hills Laboratory.



Plate 12: Site 2 before drilling. The pasture consists of weed grasses. Urine patches are clearly visible. (Photo: Kieran O'Brien).

Table 4: Events used to prepare Site 2, Westend Station, Southland.

Date	Event
10/3/17	Entire 2 ha area sprayed with 1.5 L Chlorpyrifos. Glyphosate applications: <ul style="list-style-type: none"> ♣ 1 ha no Glyphosate, ♣ 0.5 ha sprayed with 1 L/ha of 470 active glyphosate, ♣ 0.5 ha sprayed with 3 L/ha of 470 active glyphosate. Dug four holes for grass grubs – none present. No sign of slugs under rocks.
12/3/17	Cows and calves fenced into area to tidy up grass. Removed on 15/3/17. The site received 17 mm of rain.
15/3/17	Direct drilled and rolled with 10.5 kg/ha bare sub clover seed (see mix of cultivars described earlier). See Plate 13.
18/3/17	Check on gyphosate effectiveness: no obvious difference between 1 and 3 L rates (Plate 14)

Outcomes

About a week after the spray was applied the effect of the glyphosate could be seen (Plate 14).

By the end of March, two weeks after sowing, the sub clover plants had emerged and were at the spade leaf stage and looking healthy (Plate 15).

By early May photos taken in the sprayed area of Site 2 showed that the sub clover plants were well developed (Plate 16) and white clover was also present. The farmer observed that most of the white clover plants had shrunk with the cold so he believed that the visible clovers were mainly sub clover. A close look at Plate 16, an area of about 0.5 m², confirms this and indicates that the sub clover population at this location in the sprayed area of Site 2 was about 120 plants/m².



Plate 13: Site 2 post drilling (15/3/17, Photo: Kieran O'Brien).



Plate 14: The effect of glyphosate on the Site 2 pasture is clearly visible a week after application (18/3/17, Photo: Kieran O'Brien).



Plate 15: Newly emerged sub clover seedlings, spade leaf stage, two weeks after sowing at Site 2 (30/3/17, Photo: Kieran O'Brien).

In Plate 16 there are clear leaf markings on some of the sub clover leaves (possibly Bindoon or Coolamon), faint markings on others, possibly Antas, and no leaf markings on others (Denmark). It will be easier to identify the different cultivars in spring when the leaf markings will be more obvious and there will also be flowers present. The presence of flowers will help to separate between Bindoon and Coolamon, whose leaf marks are similar, as Bindoon flowers have a strong, wide red band while Coolamon's have no red band. See Moot *et al.* (2016)² for more information about identifying sub clover cultivars.



Plate 16: Close up of a sprayed area in Site 2 showing well established sub clover plants (circled in black) 8 weeks after sowing. Identified white clover plants are marked with a white W. (10/5/17, Photo: Kieran O'Brien, details added by Sonya Olykan).

The white clover population was estimated at 30 plants/m². Sub clover at this sprayed location in Site 2 was clearly the dominant legume.

By early June 2017 the farmer reported that this site was looking better and there was no grass grub. Both sprayed areas looked alright but sub clover plant populations across the site were still variable. No difference in vegetation cover was obvious between the two spray rates (Plate 17 and Plate 18). Sub clover in the unsprayed area (Plate 19) had struggled from the start with the pasture competition and trash at the bottom of the sward and as a result sub clover populations were lower than in the sprayed areas.

The site was grazed with approximately 1050 ewes/ha for less than a day on 11th May. This 'quick' graze helped to open up the sward to let more light in.



Plate 17: Pasture at Site 2 in the area sprayed with 1 L/ha of glyphosate after grazing (4/6/17, Photo: Kieran O'Brien).

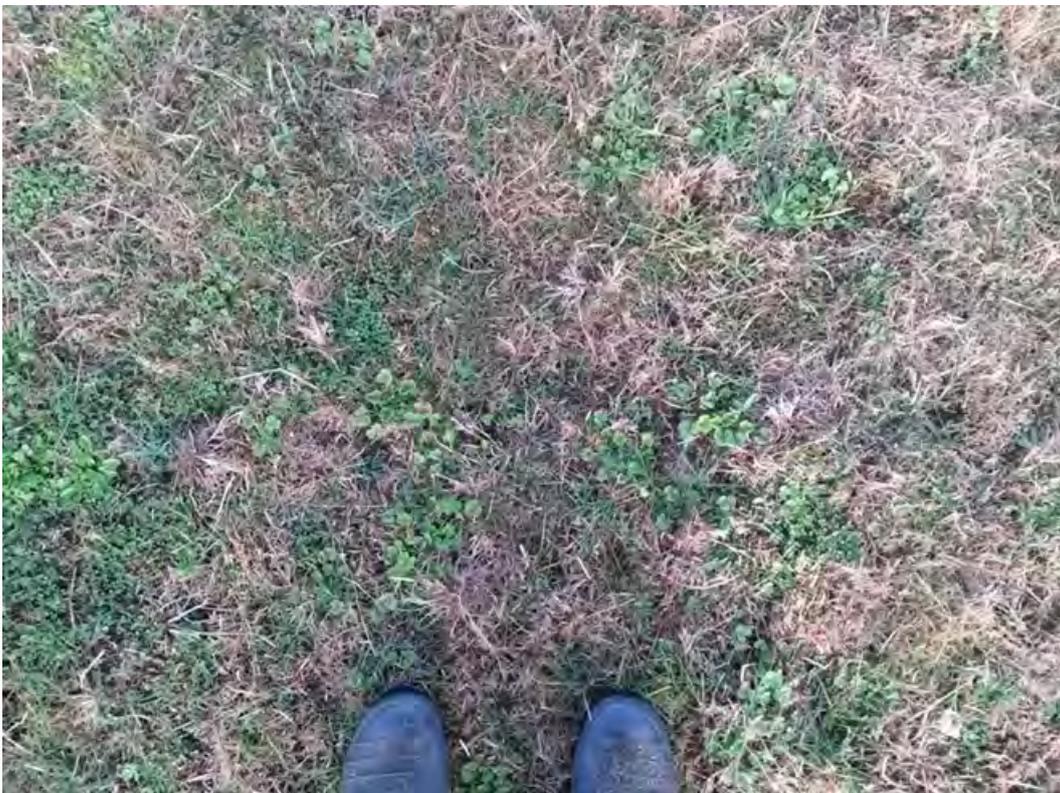


Plate 18: Pasture at Site 2 in the area sprayed with 3 L/ha of glyphosate after grazing (4/6/17, Photo: Kieran O'Brien).



Plate 19: Pasture at Site 2 in the area unsprayed area after grazing (4/6/17, Photo: Kieran O'Brien).

SUMMARY

Establishment

There was adequate establishment of sub clover at the two sites, with Site 2 being particularly successful. Estimates from photographs indicate 40 plants/m² established at Site 1 and 120 plants/m² at Site 2. The farmer noted that there was variation in the populations seen on site.

Effect of spraying

Site 2 had three herbicide treatments (0, 1L or 3L Gallant/ha) and early observations indicate that applying herbicide has helped the sub clover to establish. No difference in the effect of the herbicide rate was observable.

Role of grazing

The farmer noted that grazing opened up the sward, particularly in the unsprayed area of Site 2. It is important that growing pasture grasses are kept in check to give sub clover a chance to establish in the autumn and early winter. Sub clover plants can be grazed once they are at the 3 to 4 trifoliolate leaf stage and have had the opportunity to get a firm hold in the soil.

Cattle are recommended for grazing pastures with young sub clover as they are less likely to target the clover, compared with sheep which may graze them too hard.

From now (June) the sub clovers paddock can be spelled over winter and the subs left to grow until the feed is required in spring.

Sub clover health

The suspected presence of pepper spot on the sub clover plants will be investigated and an update will be provided.

RECOMMENDATIONS

The Lincoln University DPR team, in collaboration with the farmer, will look to undertake the following:

- ♣ Formalise a grazing regime for the two sites through to the end of the sub growing season (January 2018).
- ♣ Observe sub clover flowering and seed set.
- ♣ Monitor impact of sub clover plant diseases.
- ♣ Address the grass grub problem.
- ♣ At each site in spring (before grazing):
 - assess sub clover cultivar mix at the two sites – which one(s) have survived? Is there a dominant cultivar?
 - take herbage cuts to look at dry matter production and the pasture components. How variable is it? Effect of spray still showing up?
- ♣ Assess reestablishment of sub clover next year – has the introduction of sub clover been a success? Is it worth following through with these sites as they are or will something else need to be done? How can the techniques used be improved to establish high populations of sub on the same sites and then on hill country sites? Could other pasture species be introduced e.g. plantain, cocksfoot, tall fescue, or timothy? Cocksfoot and tall fescue are most tolerant of grass grub.