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Te Whare Wānaka o Aoraki
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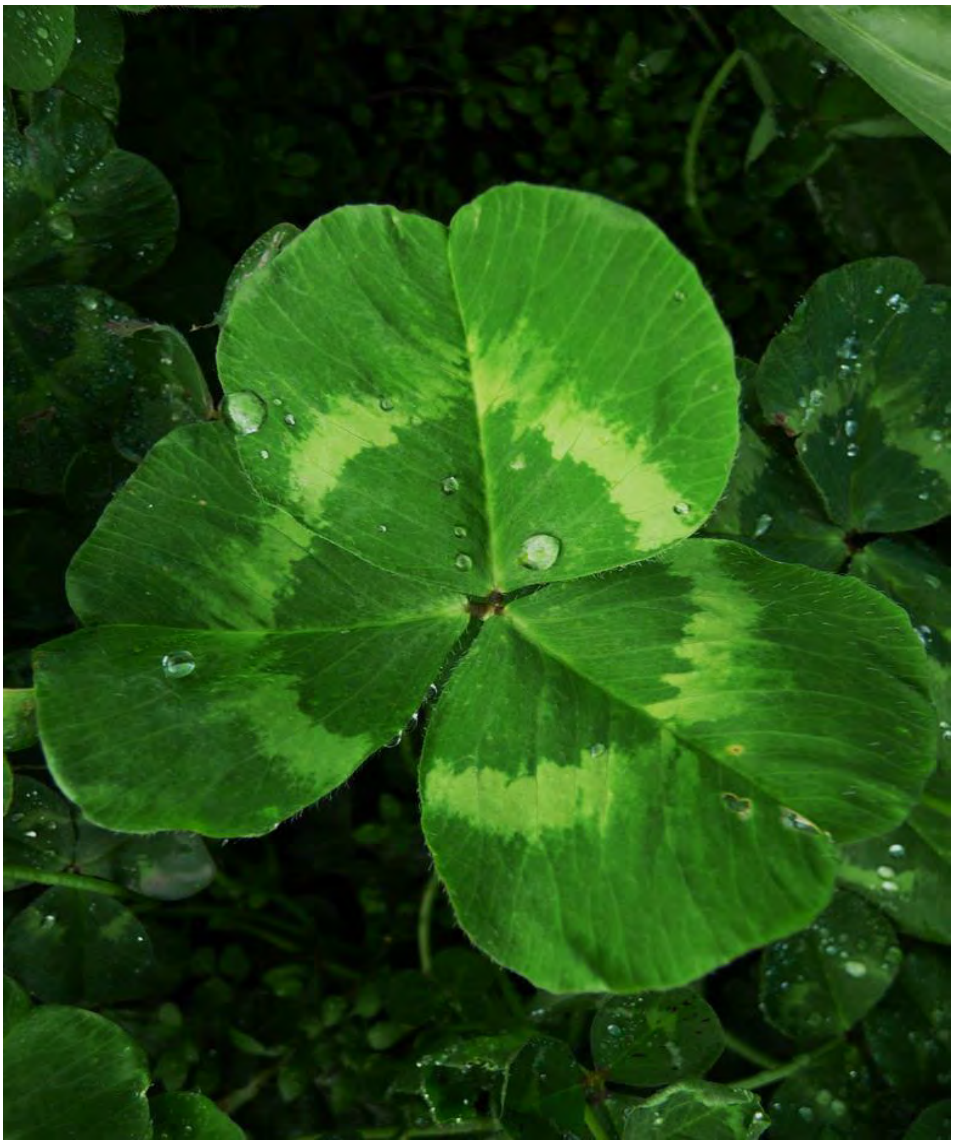
Legumes for Dryland Pastures



Dick Lucas presentation to Beef + Lamb NZ
Farmers Seminar
Palmerston North
11 May 2015

Sub clover runners spreading through the danthonia dominant pasture on an uncultivated west face at Mt Benger on 2/10/2013.

Cover photo: 'Antas' sub clover leaf on 20/5/2013

Contents

That's the easy bit….can we get the rest?

Basics for Dryland Lamb Producers

Principles for fast lamb production

- Ewes bearing twins and triplets need top quality feed in late pregnancy and throughout lactation

- Legume rich pastures or lucerne will give faster twin lamb live weight gain (LWG) than grass dominant pastures

- Sheep will select a diet of about 70% legume (lucerne or clover) and 30% grass when given a free choice

- Therefore, twin lamb LWG pre-weaning is directly proportional to the % clover dry matter (DM) on offer

- With over 50% clover on offer LWG of twins pre-weaning should be well over 300 g/hd/day

- This assumes bite size (= DM intake) is not limited by forcing ewes to eat a lot of lucerne stem or grazing pasture mass down to below 1200 kg/DM/ha.

How to get legume rich pastures

- Pasture legume content will not magically increase by continuing with the standard policy of annual superphosphate application and "good" grazing management if well adapted legumes are absent from the nitrogen deficient pasture.

- Choose an appropriate legume for your environment; **lucerne if you can grow it**, annual clovers such as sub if you have regular dry summers; perennial clovers such as white, red or Caucasian in summer moist or irrigated.

- Sow pastures with high legume rates (e.g. 10 kg/ha sub clover) and low grass rates (e.g. 2 kg/ha cocksfoot or 5 kg/ha ryegrass)

- Young pastures will be legume dominant, ideal for twins; as nitrogen (N) builds up with N fixation by legumes, grasses will become more vigorous and competitive

- Therefore appropriate management is vital to maintain legume content (e.g. manage sub clover for high seed production if sub drops below 20% on offer in early October)

- Avoid the use of N fertilisers if legume dominance is desired as N fed grass is very competitive for light, water, phosphorus (P), sulphur (S), potassium (K) and some trace elements.

- Pasture legumes fix N in proportion to their DM production; for every 1 t/ha of legume DM grown about 25 kg N/ha will be fixed

- So if a sub clover/ryegrass pasture produces 8 t DM/ha/year with 3 t/ha/yr clover and 5 t/ha of grass we can assume at least 75 kg N/ha was fixed

- Maintain soil pH at >5.6 for most clovers and >6.0 for lucerne, 'Antas' sub clover and strawberry clover

Clover canopy at 25 cm high in Alice's Block at Mt Benger, North Canterbury on 20/5/2013.

Contrast of sown clover dominant pasture in Alice's Block at Mt Benger, North Canterbury with unimproved in background on 20 May 2013. The seed mix included 10 kg/ha sub clover + grasses and plantain.

Alice's Block at Mt Benger in North Canterbury

Up until recently we were pessimistic about flying sub clover seed onto hill country but recent success in Alice's Block at Mt Benger has given cause for cautious optimism. We must also remember that sub clover was broadcast on a lot of hill country in the 1950's and '60's.

Alice's Block (25 ha) was fenced off from a larger 236 ha steep hill block in 2011. About 20 ha of this area was able to be cultivated. This bush/bog area was disced with a 'dozer and a second discing with offsets. Area had good fertility but thick matagouri, danthonia, browntop. There was a little striated clover and a presence of 'Mt Barker' sub clover. It had never been fertilised and carried <2 ewes/ha.

- Summer 2011/12: 1 t lime/ha applied and 3 kg/ha rape + 3 kg/ha 'Woogenellup' sub was flown on with 150 kg/ha of sulphur super 20. The 20 ha of disced cultivatable land was harrowed in the 1st week of Feb.

- 100 steers grazed rape/clover pasture for 6 weeks between June and mid July 2012.

- Not grazed in spring to allow 'Woogenellup' sub clover to set seed.

- Cattle grazed Jan 2013 then the block was lightly disced to cut up rape stalks.

- 1 Feb 2013: cocksfoot, ryegrass, plantain, white clover flown on with 5 kg/ha 'Antas' sub clover + 5 kg/ha 'Monti' sub clover.

- Grazed 500 ewe lambs (20 lambs/ha) over mating 1 May to 6 June.

- Set stocked with 100 twin bearing ewes on 29 July 2013. (4 ewes/ha)

- Tailed plus added 250 single bearing ewes 23 Sept until 6 Oct 2013 and then closed to allow clover to set seed.

- About 3 t DM/ha of legume dominant pasture was present on 1 Nov 2013. This indicated the 25 ha block could have carried double the stocking rate of twin bearing ewes in Aug/Sept (up to 8 ewes/ha).

- The sub clover establishment in the 20 ha disced area was outstanding (Plates 1 &2) but what generated the most excitement was the sub cover establishment from broadcast seed onto the 5 ha uncultivated (no herbicide) steeper areas of the Block (Plates 3 & 4).

- Maybe only 3 or 4 out of every 100 sub clover seeds established from broadcasting seed on the steep hill but with correct management it may be the best way forward.

Sub clover establishment from February broadcasting of seed on hill (no herbicide or cultivation) on Alice's Block west face at Mt Benger, North Canterbury. Photo: 2/10/2013.

A mixture of sub clover cultivars on the uncultivated west face of Alice's Block at Mt Benger, North Canterbury, with danthonia and striated clover (right) on 2/10/2013.

Nitrogen supply and water use efficiency by dryland pastures

- Nitrogen drives grass productivity once other nutrients such as P, S, and K have been brought up to moderate levels and soil pH has been amended with lime

- Soil N supply can be gauged by the colour of grass dominant pastures (yellow-green through to dark green) and the prominence of urine patches

- Yellow-green N deficient grass in October, growing at 40 kg DM/ha/d uses water at the same rate (say 4 mm/d) as dark green urine patch grass growing at more than 100 kg DM/ha/day

- Therefore, N deficient grass in spring has a water use efficiency of 10 kg DM/mm water used BUT the grass in the dark green urine patch has an efficiency of over 25 kg DM/mm water used

- Healthy legumes can fix all their own N from the nitrogen gas in the air through their root nodules which contain rhizobium bacteria

- Legumes therefore have high water use efficiency of over 25 kg DM/mm water used, similar to grass in a urine patch

- Legume dominant pastures in summer dry areas will therefore use the limited soil water more efficiently than N deficient grass dominant dryland pastures

- Dryland pastoral farms, typically with N deficient grass dominant pastures and less than 10% clover use scarce water inefficiently and must do better by increasing total legume production or the farm could go broke

Sub Clover Cultivars

There are large differences between sub clover cultivars so it is important to select the best for each site. Mixtures of two contrasting sub clover cultivars are often recommended so that variations in soil depth, winter wetness and hill aspect can be covered. For example a wet tolerant cultivar such as 'Monti' may be sown with 'Woogenellup' on a hill block with wet gullies.

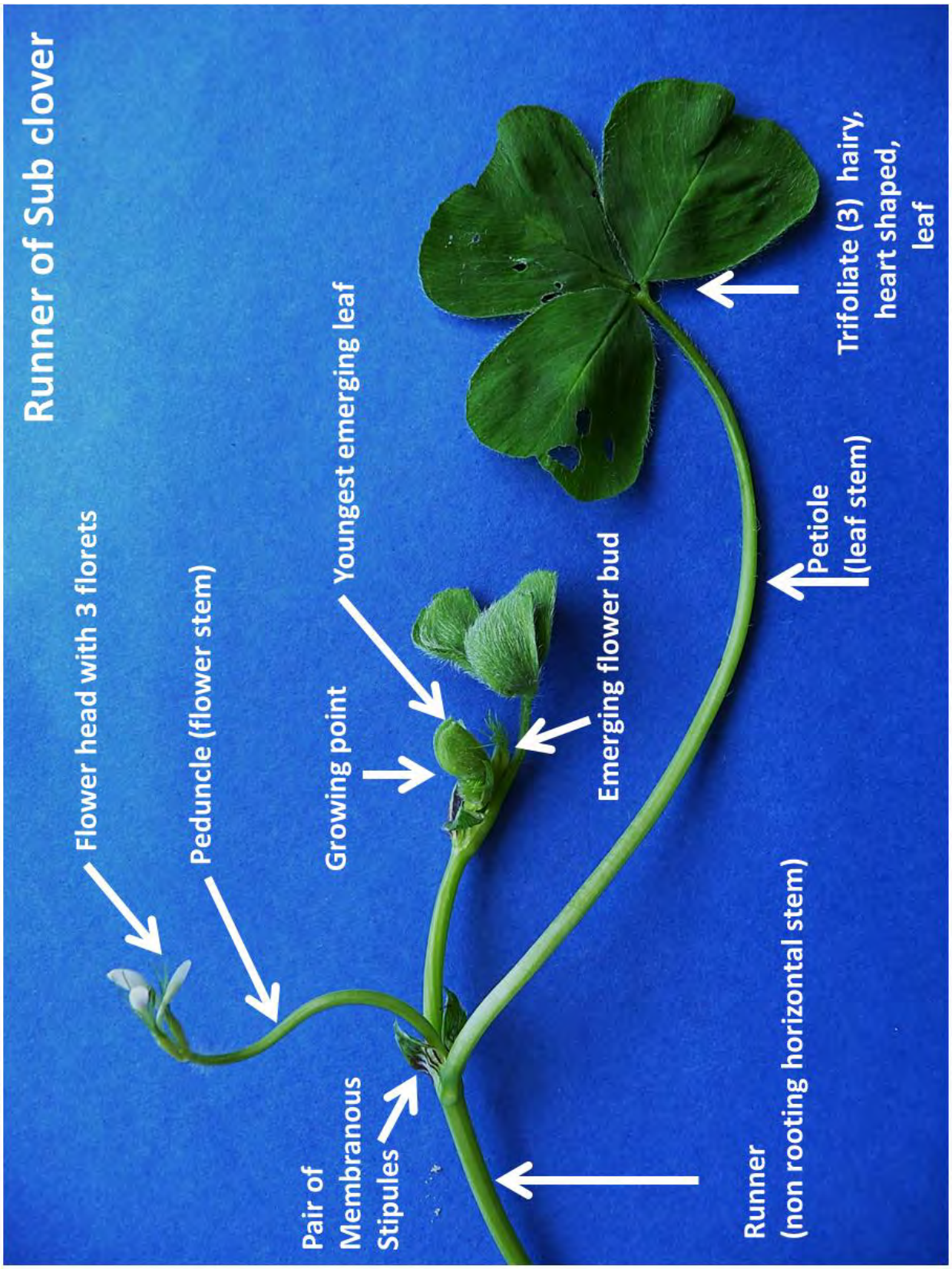
It is important to be able to identify the cultivars which thrive on different sites. Features which differ between cultivars are:-

- hairiness of runners (stems), petioles (leaf stems), and peduncles (flower stems);
- leaf markings,
- stipule colour(structure at base of petiole),
- flower colour,
- flowering time,
- seed colour.

Each subterranean clover cultivar belongs to one of three sub species, either

- *Trifolium subterraneum* sub spp *subterraneum* or
- *T. subterraneum* sub spp *yanninicum* or
- *T.subterraneum* sub spp *brachycalycinum*.

Most cultivars belong to the subspecies *subterraneum* (e.g. 'Campeda', 'Woogenellup', 'Denmark', 'Mount Barker', 'Rosabrook' and 'Leura'). These have black seeds and are adapted to well drained soils with pH (H_2O) down to about 5.4.



The morphology of a sub clover runner.

Identifying Sub Cultivars

'Campeda' flowers earlier than most other cultivars available in NZ. It is therefore suited to lower rainfall (<600 mm) areas, shallow stony soils and north facing steep hill pastures. It has a hard seed rating of 5 which provides protection from 'false strikes'. It has hairless runners, red striped stipules and a faint orange band on its flower.

'Woogenellup' has hairless runners but may have hairy petioles and peduncles; stipule has red stripes; light leaf markings, large light green leaves with long petioles. It is very productive but has a reputation in Australia for false strikes because of its very low hardseededness rating of 1.

'Denmark' has hairless runners, petioles and peduncles; light leaf mark, small leaves. It persists well under intensive grazing and has a hardseededness rating of 2. This cultivar is later flowering than mid/late season flowering 'Woogenellup' and mid-season flowering cultivars 'Campeda' and 'Monti'.

'Rosabrook' flowers at the same time as 'Denmark' and is tolerant of red legged earth mite (RLEM). It has a more obvious leaf mark than 'Denmark' and slightly hairy runners. Stipules are green. Its hardseededness is rating is 5. The obvious red band on its flower means it could be confused with 'Mt Barker' but 'Rosabrook' is much less hairy than 'Mt Barker'.

'Mt Barker' has very hairy runners and red stipules, brown flecks on leaves in winter and a red band on its flower tubes. 'Mt Barker' is very soft seeded and susceptible to false breaks with a hardseededness rating of 1. It has a similar late flowering time to 'Denmark'.
'Mt Barker' is the oldest sub cultivar in NZ. It will be surviving on many hill farms where it was over-sown 50 to 60 years ago. By adopting grazing management aimed at encouraging sub clover, it may become more productive in some paddocks where its seed is present in sufficient quantities in the seed bank. However, the introduction of new, improved cultivars should lift dryland pasture productivity considerably.

'Mt Barker' sub clover in late autumn/winter with a 10cm x 10 cm scale. Note that the brown leaf marks disappear in spring.

'Leura' is the latest flowering sub clover cultivar available in NZ. It is best suited to deeper soils in areas with >700 mm/yr rainfall or >800 mm/yr on NW facing hills and higher rainfall stony soils where pastures regularly brown off in summer. 'Leura' runners are hairy and its stipules are green. 'Leura' has a hardseededness rating of 2.

'Monti' flowers about the same time as 'Campeda' and has hairless runners and petioles; a green stipule with red stripes; leaves may have some brown flecks in late autumn/winter; seeds are cream/white. 'Monti' is a newly released cultivar which flowers earlier than 'Woogenellup' so is

adapted to lower rainfall areas with its shorter active growth season. This cultivar has a hardseededness rating of 2. 'Monti' belongs to the *yanninicum* sub-species of sub clover and cultivars derived from this sub-species can tolerate periodic wet soil conditions better than other sub clover sub-species.

'Napier' is a later flowering *yanninicum* sub clover adapted to higher rainfall areas with winter wet soils. 'Napier' has a hard seed rating of 5 and a similar flowering time to 'Denmark'. Its seeds are cream/white.

'Antas' sub clover runners are weakly hairy or hairless; green stipules at petiole bases have red stripes. This cultivar has a strong leaf mark, very large leaves and long petioles. Its seeds are black. Currently, there is limited experience with highly productive 'Antas' in NZ. It has a similar later flowering time to 'Denmark'. 'Antas' belongs to the *brachycalycinum* sub-species of sub clover and is best adapted to well limed soils or soils with a natural pH (H_2O) of >5.8. Its hardseededness rating is 3 and its burr burial rating of only 1 (Table 1) will affect its persistence.

Flower of 'Monti' sub clover on 23 Oct 2013 at Lincoln University

Improved top flowering annual clovers

'Bolta' balansa clover tolerates wet soils. It flowers about the same time as 'Woogenellup' sub clover. There is more NZ research on balansa clover than on the other top flowering clover species. Like other top flowering species balansa is vulnerable to traditional set stocking in spring. It must therefore be rotationally grazed in spring to allow the plant to grow at maximum rates during its stem elongation phase. In the first spring after sowing it should be spelled to set seed before the longest flowering stems are 30 cm high. After 10 to 12 weeks the mature seed formed in the earliest flowers will shed and over 1 t/ha of mainly hard seed can drop onto the soil surface. This seed should last for 3-5 years but the balansa seedling populations after the autumn break will decline over time if the pasture isn't managed to allow some re-seeding to replenish the seed bank at 3 year intervals.

Balansa clover is hairless and develops distinctive leaf markings on about 10% of plants. Leaf margins have obviously serrated edges. Its flowers, borne on hollow stems, are similar to white clover but florets turn pink after bee pollination.

'Bolta' balansa in flower and leaves showing typical balansa leaf markings and serrated leaf margins

Arrowleaf clover cultivars have a wide range of flowering times. 'Cefalu' is early flowering at about the same time as 'Leura' sub clover and 'Arrotas' is the latest flowering about 6 weeks later. Arrowleaf clover is not tolerant of wet soils and its seed is very hard so seed softening may take several months. This means that few seedlings will establish in the first autumn after the initial late spring/summer seed production. However, arrowleaf clover can be very productive, especially in warmer 700-1000 mm rainfall environments which have dry summers. Seed should be inoculated with group C rhizobia with the first sowings. Later flowering cultivars, such as 'Arrotas', grow rapidly in late spring/early summer which is ideal for weaned lamb feed.

The flower and the distinctly pointed (arrow shaped) leaflets of arrowleaf clover at Lincoln University

Persian clover like balansa is tolerant of wet soils but requires higher pH than balansa. Cultivars have a wide range of flowering dates, similar to arrowleaf clovers. There are two sub species within the Persian clover species. One is described as a hay type with hollow stems and soft seeded. The other sub species is reputed to be better adapted to perennial pastures because it produces some hard seed. Up to now we have had no experience with Persian clover in grazed perennial pastures. In the meantime, it is a very impressive species when grown as a pure stand. It will yield over 10 t DM/ha of nutritious forage and fix over 250 kg N/ha.

Persian clover in flower

Volunteer adventive annual clovers

It is assumed the adventive annual clovers came to NZ many years ago as impurities in white and red clover imports. Suckling, cluster and haresfoot clovers have small seeds while striated clover has larger seeds about the same size as red clover.

To some extent these species can be regarded as indicators of the suitability of the environment for the introduction of more productive clover species. For instance, cluster clover is the main adventive species on the stony soils at Lincoln Universities Dryland Research, Farm Ashley Dene near Burnham in lowland Canterbury where sub clover is the most productive legume after lucerne. Striated clover dominance is also an indicator of the need for sub clover introductions. Suckling clover is widely adapted throughout NZ but not usually dominant so it is not a good indicator of what improved species to sow. Haresfoot clover is most likely to be the dominant adventive clover in the high country because of its later flowering and cold tolerance. It may indicate sites where sub clover may not persist.

These clovers fix nitrogen (N) in a similar manner to more productive legume species and the general “25 kg N/t legume DM produced” formula holds true. We assume that vigorous growth of an adventive clover indicates that strains of Rhizobia in the soil will be suitable for other annual clovers. No problems have been reported with sowing un-inoculated bare seed of sub or balansa clovers where good populations of vigorous adventive clover have been present. However, new sowings of arrowleaf clover should be inoculated with Group C inoculant.

Identifying your adventive annual clovers:

Suckling clover is an early flowering adventive clover. It has distinctive yellow flowers, thin red stems and the middle leaflet has a longer stem than the two side leaflets.

Suckling clover flower

Cluster clover is not common at higher altitudes. It is hairless and looks a bit like white clover but it has no stolons. Leaves are smaller than white clover and some leaflets will have a brown spot and some a light coloured central spot. Unfortunately, the leaf markings are variable and some forms will have no leaf markings for identification purposes. The small pink flower clusters form a ball in the leaf axils and there is no flower stem (peduncle).

Cluster clover flower and leaflets showing the pale dot present on some plants

Striated clover can become dominant in low fertility sites. It has fine hairs all over its plant parts. The leaves have no distinguishing marks and feel like velvet. Pink flowers develop into harsh feeling seed heads.

Hairy striated clover in flower

Haresfoot clover is another hairy annual legume. Haresfoot clover has a distinctive green-grey appearance due to its hairiness. Young plants form a prostrate rosette with rounded leaves but later in the season, as stem elongation occurs, the new leaves also elongate. Pink flowers and seedheads resemble a hare's foot.

Flower head of haresfoot adventive annual clover. Note hairy elongated green-grey leaves

Managing sub clover after sowing to rapidly get a high producing, persistent clover dominant pasture

The best way to rapidly build up a sub clover seed bank is through early spelling in the first spring after autumn drilling or broadcasting seed at 10 kg/ha. Newly sown sub clover/grass pasture should be grazed no lower than about 1200 DM/ha through late autumn and winter. It's OK to lamb on it but at a lower stocking rate than normal. The new paddock should be closed to reseed about a week after flowers become obvious. For mid/late flowering cultivars this will be in the first week of October in lower altitude Canterbury. Do not take a last few days grazing to 'clean up the green leaf' before spelling the paddock as that will result in runners being eaten and seed yield will be greatly reduced. There needs to be 6-8 weeks of soil moisture available to the sub plants to get maximum seed set. Check the seed burrs for fat ripe seeds.

During the late spring spell from grazing, sub clover runners can grow a further 20 to 30 cm in length. This means that individual plants will have the potential to get to about 60 cm in diameter. These runners can colonize vacant space by pegging down seed burrs. Each burr will contain 3 or 4 large seeds. Seeds are about ten times the weight of a white clover seed. Each sub clover plant will have about five runners each with six burrs containing mature seeds. So each spelled plant can produce over 100 seeds.

It is suggested that cattle will be best to clean up the standing hay sub clover/mature grass in December/early January. Once the paddock has been grazed hard by cattle keep on top of summer grass growth with sheep. Aim to create some bare ground during February so that the fluctuating soil surface temperatures will more rapidly soften hard seed to give a good strike of sub clover with the first significant autumn rains. If all goes well the pasture should then provide excellent ewe lactation feed in the second spring season.

On some hill country it may not be necessary to reseed the sub clover if there is sufficient sub present in the old pasture. Grazing management alone, perhaps helped by some judicious chemical topping, may achieve a sward which can regularly produce over 40 % clover in spring. Assess the suitability for this approach by measuring the frequency of sub clover presence in the pasture. Do this by **walking over it, do not ride**. If sub

clover is under your boot more often than two thirds of your steps there may be enough present to bring it back to full potential through management only. This will require hard summer grazing, briefly spell the paddock after autumn sub clover germination until seedlings have three or four leaves, control grass competition by keeping pasture mass to under 2 t DM/ha through winter, lamb on paddock but get off it a week after flowers are visible. Time the spelling of the pasture to your prediction of when there is 6-8 weeks of soil moisture remaining before the summer dry sets in. Graze the standing hay with cattle in summer. This pasture rejuvenation process may be successful without herbicides but strong grass competition may need to be challenged by more than 'hoof and tooth'.

Runner damage caused by overgrazing prior to close-up in early October. Flowers from recovery growth of these sub clover runners (photo taken 22/10/2013) may be too late to form seed burrs.

Selecting your sub clover cultivars

Table 1 lists the characteristics of 12 sub clover cultivars. Currently, all seed is imported from Australia and most cultivars have been selected for Australian conditions. There has been much more research done on sub clover in Australia than in New Zealand so to a large extent we have to extrapolate Australian findings to our conditions.

The four cultivars highlighted in green in Table 1 have been proven under New Zealand conditions for at least 20 years while the seven cultivars highlighted in yellow are newer and relatively unproven.

'Tallarook' is no longer available. It was widely sown with 'Mt Barker' in the 1940s and '50s and has persisted in areas where summer droughts are not frequent. If 'Tallarook' type sub is present it is an indication that late flowering cultivars should be successful in that environment.

Because our experience with the newer (yellow highlighted) cultivars is limited we strongly recommend that an older (green highlighted) cultivar be included with all sowings of the newer cultivars. Note that the green subs have low hardseededness ratings of 1-2 while the newer cultivars generally have higher hardseededness ratings. Greater hardseededness provides an insurance against 'false strike' where seedlings germinating in February may not survive autumn drought conditions. However, under cooler summer conditions in New Zealand seed 'softening' may be much slower than in Western Australia. Until we have more farmer experience and research information avoid sowing sub cultivars with a hardseed rating of over 3 without including an equal quantity of a 'soft' seeded cultivar.

Note that a sub clover seed is about ten times heavier than a white clover seed. Sub clover seed rates are therefore much higher (10 kg/ha) than those for white clover (2 kg/ha). The number of sub clover seeds sown per m^2 ranges from about 90 to 180 due to differences in seed size between individual cultivars. However, with mixtures of two complementary cultivars a mix of 5 kg/ha + 5 kg/ha = 10 kg sub/ha is used.

Suggested sub clover 50:50 mixtures which attempt to cover variations in climate, topography and/or drainage are:

1. ‘Denmark’ plus ‘Narrikup’ or ‘Campeda’ for sites which normally get dry in mid-November but can dry out in late October or stay green until early December.

2. ‘Leura’ plus ‘Rosabrook’ or ‘Coolamon’ for higher rainfall areas which dry out later than mid-December in an average year.

3. ‘Monti’ or ‘Napier’ plus ‘Woogenellup’ or ‘Denmark’ for poorly drained sites which get very wet in winter/early spring.

4. ‘Antas’ plus ‘Denmark’ where high rates of winter growth are desired

Note: ‘Mt Barker’ could be substituted for ‘Denmark’ or ‘Woogenellup’ but seed is unlikely to be imported

Table 1 Agronomic data for subterranean clover cultivars registered in Australia. Data from long-term means of irrigated plants from an early May sowing in Perth, WA (adapted from Nichols *et al.* 2013).

Subspecies: B, brachycalycinum; S, subterraneum; Y, yanninicum.
Min. growing-season length (months) is minimum target environment for reliable seed set.
Burr burial: 1, little or no burial; 9, strong burial.
Relative hardseededness: 1, least hard; 10, most hard, based on laboratory screening in a diurnally fluctuating 60/15°C temperature cabinet for 16 weeks, using the procedure of Quinlivan and Millington (1962).

Cultivar	Subspecies	Days to first flowering	Min. growing season length (months)	Burr burial rating (1-9 rating)	Hardseededness (0-10)	Seeds/m^2 sown at 10 kg/ha
Tallarook	S	163	9	5	1	135
Denmark	S	142	7.5	5	2	141
Leura	S	147	8	5	2	135
Mt Barker	S	137	7.5	3	1	120
Woogenellup	S	130	7	3	1	93
Antas	B	138	7.5	1	3	100
Campeda	S	123	6	6	5	123
Coolamon	S	133	6.5	7	5	130
Monti	Y	110	5.5	6	2	101
Narrikup	S	126	6.5	7	3	185
Napier	Y	140	7.5	6	5	88
Rosabrook	S	142	7.5	6	5	161

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Cocksfoot Grazing Experiment 2002-2011

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Background

- Established At Lincoln University, Canterbury. Reps 1 – 4 on 18/2/2002.
- Reps 5 and 6 sown in 2002/03.

Table 2 Species, cultivar and bare seed sowing rates.

Common name	Acronym	Cultivar	Sowing rate
Balansa clover	Bal	'Bolta'	6 kg/ha
Caucasian clover	Cc	'Endura'	8 kg/ha^{+}
Subterranean clover	Sub	'Denmark'	10 kg/ha^{+}
White clover	Wc	'Demand'	3 kg/ha
Cocksfoot	CF	'Vision'	4 kg/ha
Perennial ryegrass	RG	'Aries' ARI	10 kg/ha
Lucerne	Luc	'Kaituna'	8 kg/ha^{+}

$^{+}$ = seed was inoculated prior to sowing

- Dry matter production and botanical composition were measured from exclosure cages cut to 25-30 mm every 20-90 days.
- For lucerne, five quadrats cut per plot pre and post grazing.
- Live weight production from Coopworth ewe lambs and hoggets. A 'put and take' system is used. 'Core' animals are weighed 'empty' after being held overnight in a stock yard before and immediately after grazing periods of 3-6 weeks of rotational grazing.
- In Years 1 to 7, treatment plots were stocked with hoggets in early spring and replaced with weaned lambs in late spring/early summer. However in Years 8 and 9, ewes rearing twin lambs were put on to plots in spring.
- Pastures are de-stocked over winter (Jun-Aug) except for ewes used to clean up pastures in preparation for the subsequent spring.
- Seasonal LW production is separated into 'spring' (Jul-Nov), 'summer' (Dec-Feb) and 'autumn' (Mar-Jun).

Key points - annual live weight production (Year 2 – Year 9)

- In five of the eight years reported, lucerne pastures gave superior total annual live weight production (See Figure 1).
- Over the eight year period, CF/Sub has given the most consistent **SPRING** live weight production of the grass-based pastures (338 - 1022 kg LW/ha).
- A combination of pastures is required to ensure LW production is maintained in different seasons and across years due to variable rainfall.

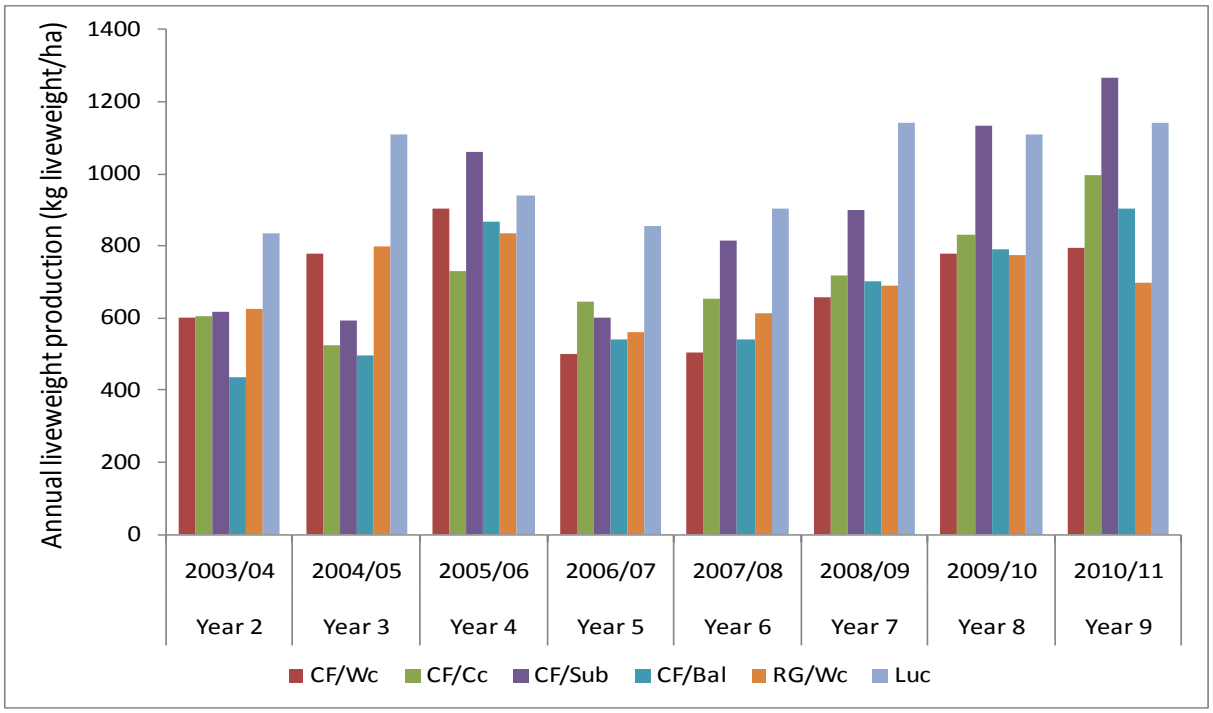

Figure 1 Annual live weight production (kg LW/ha) from the Cocksfoot Grazing Experiment at Lincoln University, Canterbury from six dryland pastures. Note: in Years 8 & 9 pastures were grazed by ewes with twin lambs at foot and liveweight production was measured on animals "weighed full" prior to weaning.

Key points – dry matter yield and botanical composition (Year 1 – Year 9)

- Total annual dry matter yields ranged from 5.7-18.5 t DM/ha (See Figure 2).

- Lucerne produced 12.8-18.5 t DM/ha/y in eight out of the nine years.

- Cocksfoot with subterranean and white clover complement lucerne production in environments with unpredictable and variable summer rainfall. Production from CF/Sub pastures was highest in spring and CF/Wc pastures provided feed in moist summers.

- Sub clover contributed more than 2.4 t DM/ha/yr in 6 of the 9 years and more than 3.4 t DM/ha/yr in 3 of those 6 years. Over the nine years average sub clover yield was 2.7 t/ha annually.

- Invasion of unsown species is most apparent in the RG/Wc pastures. In Year 2, the contribution of the sown ryegrass to total annual DM production was 65%. By Year 5, it had decreased to 44% and in Year 9 to 12%. By the end of Year 9 unsown grasses and dicot weeds accounted for about 80% of the total annual yield.

- In contrast, in Year 9 sown species still contributed >60% of total DM in all of the cocksfoot based pastures.

- In spring, 2007 there was evidence of grass grub damage in several plots. In 2008 the problem was more widespread. Grass grub population counts showed CF/Wc and CF/Bal pastures had 130 grass grubs/m^2, CF/Cc 97, RG/Wc 67, CF/Sub 52 and Lucerne with 13. However the variation in grub counts between reps was large. The following year, counts showed the grub populations had changed to 120 grubs/m^2 in CF/Cc and RG/Wc, 103 in CF/Wc, 75 in CF/Sub and CF/Bal and 36 in lucerne.

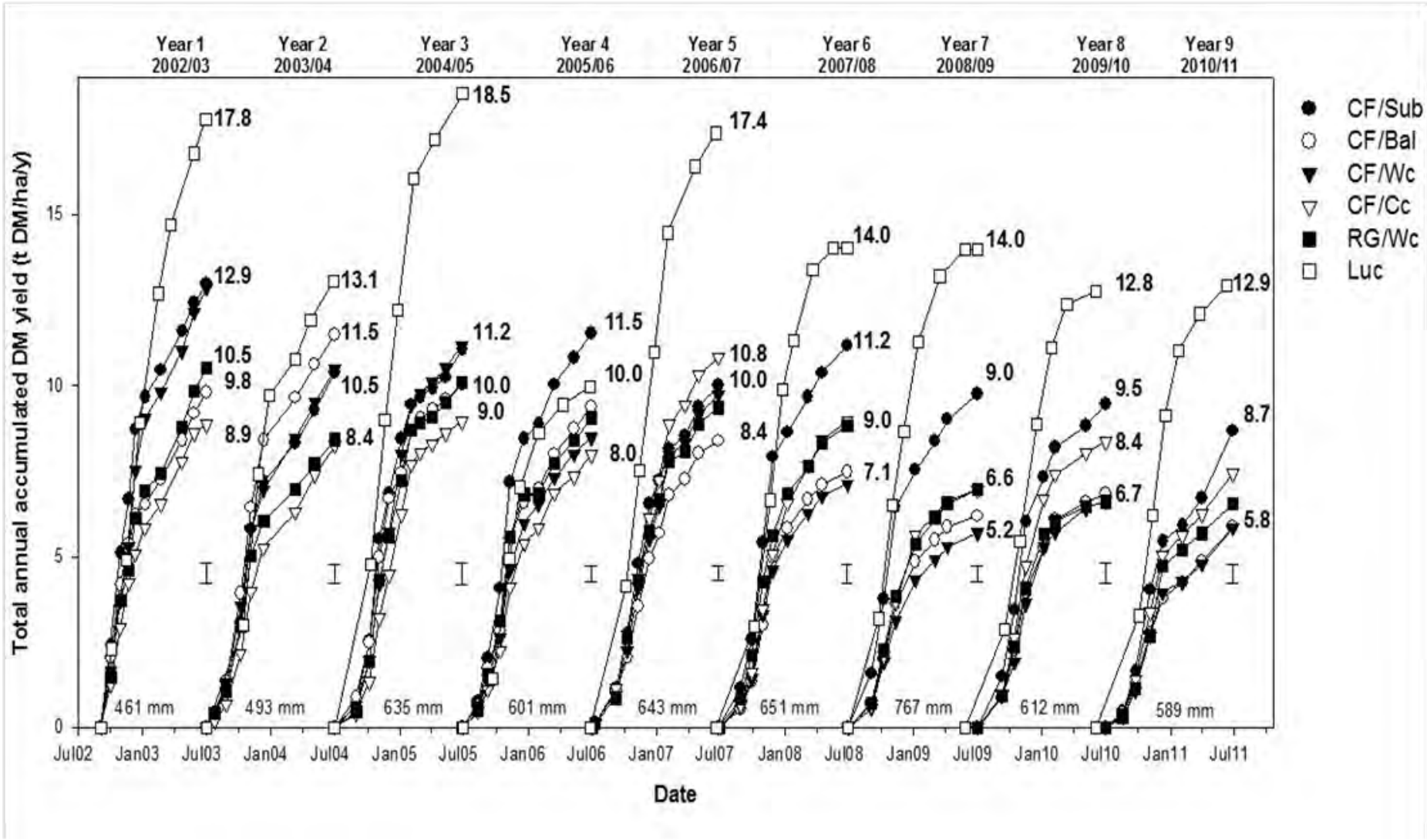

Figure 2 Accumulated total annual DM production (t/ha/yr) from the Cocksfoot Grazing Experiment at Lincoln University, Canterbury. Annual rainfall totals are also shown.

Lucerne – sow and graze it wherever it will thrive.