

Castlepoint Field Day  
3 April 2012

# Legumes for Hill Country



**Derrick Moot & Dick Lucas**



New Zealand's specialist land-based university



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# Clarence MAXclover FITT Experiment

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## **Productivity of Annual Clovers**

If nitrogen fertiliser use is to be avoided pastures with high legume content are necessary for efficient use of scarce soil water in drought prone areas. The average grass dominant pasture with less than 5% legume and obvious urine patches will produce about 10 kg DM/mm water used. Spring growth of pasture with about 30% legume may be at about 20 kg DM/mm water used. High water use efficiencies can only be obtained from high rates of N fertiliser or by growing pure legume stands. Efficient water use of 30+ kg DM/mm water may then be achieved.

In summer dry areas, the first choice is the deep rooted perennial lucerne, but for a range of reasons lucerne may not be suitable on all sites so we are exploring annual clover options. Sub clover is the main annual clover in Australia and New Zealand but other species may have a place in our pastoral systems. The main advantages of sub clover are its large seed and vigorous competitive seedling; it is self pollinated so it does not need bees for seed production and its prostrate growth form allows it to tolerate set stocking.

The top flowering annual clover species have smaller seeds than sub clover which allows for lower seeding rates and their tall growth habit makes for easy seed harvesting in contrast to sub clover where the seed burrs are buried in the soil. However, the top flowering species require bee pollination so they need to be spelled from grazing for a period in spring to allow the seed bank to be replenished for clover regeneration in subsequent years.

In theory a wider range of legume species in a pasture should be able to most efficiently exploit the climatic, topographic and soil variations of hill blocks. Some of the top flowering species have advantages over the range of sub clover cultivars which are currently available. One or two of these may be worth including with a sub clover on some sites. For instance arrowleaf clover will provide superior feed into summer after the latest flowering sub clover has died off, or balansa clover may be very successful on sites where the soil is very wet throughout winter into spring.

## **Experimental details**

The site at Clarence Bridge north of Kaikoura on Derrick and Ben Milltons' Waipapa farm was ideal for testing the potential productivity of a range of clover species. It is about 1 km from the coast at an altitude of about 50 m facing east on a slope of about 10 degrees. Annual rainfall is over 800 mm with mild winters and few frosts. However, the clovers in the experiment were flattened by snow in late winter of 2011.

A firm cultivated seed bed was prepared in a fenced off strip at top of a winterfeed paddock and clovers were hand sown on 26 March 2011 at approximately 90 kg/ha to 20 m x 3.5 m plots. Two x 0.1 m<sup>2</sup> samples were cut from each plot for dry matter yield measurement on 31 August, 157 days after sowing. Plots were grazed in common by ewes and lambs from 5 to 20 September. Subsequent spring and summer measurements will be reported in the FITT final report through Beef and Lamb NZ.

## Results and Discussion

All clovers established well (Table 1) with the exception of 'Woogenellup' sub which was patchy and appeared to suffer from a pest attack as observed on some sites further north in the same season. However they had all formed a good leaf canopy by the end of May. The high seeding rate (approx. 90 kg/ha) was chosen to establish the seedling populations which are achieved in well managed clover dominant pastures where a large seed bank has been generated.

**Table 1** Establishment score of seedling ground cover (1-10) on 4/5/2011 (39 days after sowing), total dry matter (DM) yield on 31/8/2011 (158 days after sowing), weed content (%) in harvested samples cut on 31/8/2011 and clover recovery score (1-10) 22 days after grazing. "G" = indicates significant grass presence in regrowth and "F" indicates the clover was flowering on 12<sup>th</sup> Oct.

Clover	Seedling establishment score	Total DM yield (t/ha)	% weed	Clover recovery
'Cefalu' arrowleaf	5	6.9	7	3 G
'Bolta' balansa	7	7.2	3	4 G
'Nomad' white	9	4	20	7
'Arrotas' arrowleaf	5	5.9	3	4 G
'Prima' gland	8	6.8	8	1 F
'Woogenellup' sub	4	6.4	6	5 FG
'Hamua' red	8	4.9	7	9
'Lightning' Persian	10	8.3	2	3

Note: For visual seedling establishment scores 1 = poor and 10 = abundant.

For visual scores of post grazing clover recovery 1 = few new leaves produced and 10 = many new leaves produced

Dry matter yields cut on 31 August ranged from 4.0 t for 'Nomad' white clover up to 8.3 t/ha from 'Lightning' Persian (Table 1, Figure 1). If 25 kg N are fixed for each ton of clover DM grown it can be assumed that the Persian clover injected about 200 kg N/ha into the grazed pasture system. The average rate of production per day for the annual clovers for the 158 day period from sowing to harvest was 44 kg DM/ha/day. The two perennial clovers, white and red, grew at an average rate of 28 kg DM/ha/day. These high rates of production were achieved in a mild climate on a fertile soil. However, the ability of annual clovers to grow rapidly in the cool season was well demonstrated.



**Figure 1** Pre-graze height on 29/8/2011 of 'Nomad' white clover (left) which yielded 4.0 t/ha at a canopy height of 15 cm and 'Lightning' Persian clover which yielded 8.3 t DM/ha at a canopy height of 35-40 cm.

The weed scores reflect, to some extent, the relative ability of each clover to compete with other species. In general fast establishing taller species were most competitive.

We have had limited experience with grazing the top flowering clovers. Gland clover was the earliest in this experiment. It was at the early flowering stage during grazing and was very slow to recover (Figure 2). The stems of all the top flowering annual species (gland, balansa, arrowleaf and Persian) had started to elongate in late August and grazing at that stage reduced their ability to rapidly recover a leaf canopy. Earlier grazing may have delayed stem elongation to get more leaf production in September. The perennial clovers and the most prostrate annual, sub clover, were better adapted to grazing under the management used in this experiment.



**Figure 2** Pre-graze height on 29/8/2011 of 'Prima' gland clover (left) which yielded 6.8 t/ha but which showed poor recovery following grazing (right) on 12/10/2011 which was 22 days after grazing.

# Annual Clover Options

*Dick Lucas and Hollena Nori, Lincoln University*

## Sub clover

- In general sow 50/50 mix of two contrasting cultivars to allow for climatic and site variability. Sow in autumn with at least 6 kg bare seed/ha, preferably 10 kg/ha. Keep your ryegrass sowing rate below 10 kg/ha. Sub clover can be over drilled successfully into clover deficient pasture but tends to be more vulnerable to weather conditions when broadcast than the smaller seeded clovers.
- Management for a good seed set in the first spring after sowing is the best time to build the sub clover seed bank. The sooner the seed bank is loaded the sooner your pasture will give spring lactation pastures with over 50% clover on offer. Livestock prefer to select a diet of 70% legume and 30% grass; they produce maximum milk and live weight gain if they can approach that ideal clover/grass balance. To get a good seed set do not graze lower than 1500 kg DM/ha – that is keep pasture height above about 5 cm with at least one layer of clover leaves. Once the sub clover is defoliated below that, the seed yield and quality (seed size) will be greatly reduced. Ideally, if it is a good season, spell new sub clover paddocks for up to 6 weeks from the time of full flowering. That should give a seed crop at least 20 times the amount sown.
- Nitrogen fixation by pasture legumes is vital to the dryland pasture system. Conservative estimates of the amount of nitrogen (N) fixed by clovers in grass/clover pastures show that 25 kg of N is fixed for every ton of clover DM grown. If the contribution of the clover roots is included then it is probable that the clovers contribute 45 kg N/t clover herbage DM grown. Hence all farmers who prefer to avoid N fertilisers should rejoice at the sight of their legume dominant pastures!

## Sub Clover cultivar options

- **‘Campeda’**: mid flowering date, mix with later cultivar if paddock normally dries out before mid November. Some hard seed is produced so it is less vulnerable to false strike in autumn. We have well balanced mixtures of ‘Campeda’ and ‘Denmark’ sub clovers with both cocksfoot and ryegrass on stones at Ashley Dene, the Lincoln University dryland farm.
- **‘Woogenellup’**: mid/late flowering date, soft seeded and vulnerable to false strike but high yielding. Does well at “Tempello” in Marlborough. (see photo on front page).
- **‘Denmark’**: late flowering, prostrate to tolerate close grazing, high seed yield. Disease resistant. Has persisted well for 10 years with cocksfoot on Templeton soil at Lincoln (pages 18-21).
- **‘Leura’**: latest flowering available. Is contributing well at Tom Costello’s in North Canterbury.

## New on the Australian market and recommended for NZ conditions based on Australian experience

- **‘Napier’**: late flowering, is in the *yanninicum* sub species of sub clover. This means it is better adapted to wet soils in winter/early spring than most sub clover cultivars which are in the *subterraneum* sub species. Cream/amber seed colour. High yielding, taller than ‘Denmark’ so may be less tolerant of hard set stocking. Limited seed supply at present.
- **‘Rosabrook’**: late flowering and prostrate growth form similar to Denmark. Has been selected for tolerance to red legged earth mite (RLEM). If RLEM is shown to be a significant challenge to sub clover in NZ this tolerant cultivar should be used. Suggested that we can test its usefulness by sowing 50/50 mix with ‘Denmark’ to see if ‘Rosabrook’ dominates after 4-5 years – that would indicate we have RLEM challenges.

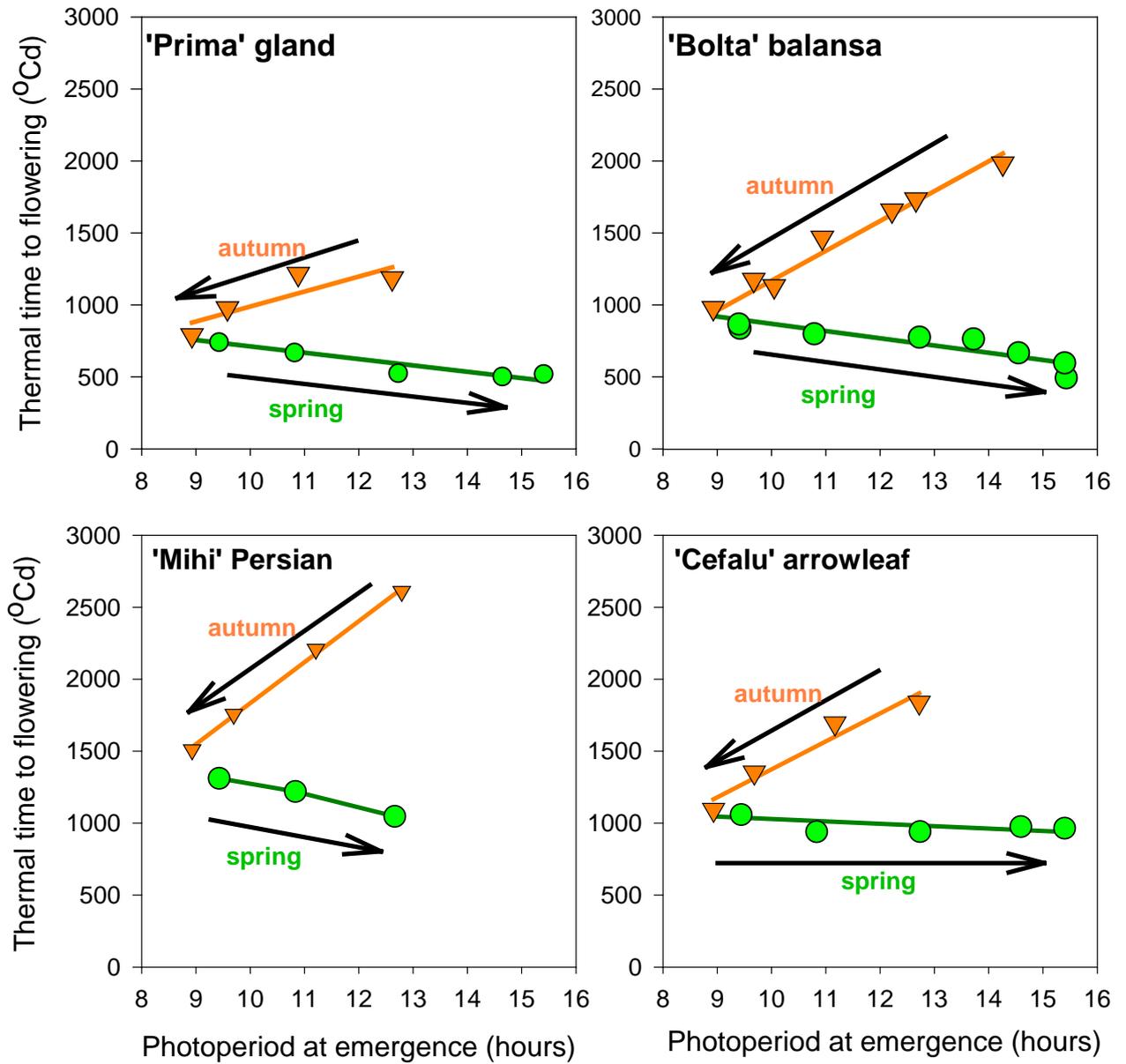
## Top flowering annual clovers

- Top flowering annual clovers have much smaller seeds than sub clover. Lower seeding rates of 2 to 5 kg/ha are therefore recommended. The smaller seeded species may be more successfully established from broadcasting than sub clover. When drilling they must be sown shallow, (<10 mm) and competition from resident pasture and weeds minimized. When broadcasting seed, 20 to 50% bare ground is ideal and if possible trample seed in after spreading. Keep grass seeding rates at a minimum when sowing these small seeded clovers; sow more clover and less grass but spend the same amount per hectare on seed.
- Because stock eat flower stems of the top flowering species it is essential to let these annual clovers set a large amount of seed in their first spring. This will load the seed bank for the following 3 to 5 years.
- Use herbicides on top flowering annual clovers with caution. We do not have wide experience but “Gallant” grass killer was observed to adversely affect arrowleaf clover.
- **‘Prima’ gland clover**: early flowering and therefore has lower maximum DM yield potential. As with most other top flowering species gland clover is very hard seeded and needs some bare ground in summer to encourage seed softening. So hard summer clean up grazing is an important part of managing these clovers for persistence.
  - *Gland clover is one of the few annual legumes which tolerates RLEM. It can therefore be sown with other legumes to provide an indication of the severity of RLEM attacks. It is well adapted to dry north and west faces where other sown legumes struggle to establish and lower yielding volunteer annuals such as cluster and haresfoot clover may be the only legumes present.*
- **‘Bolta’ balansa clover**: mid flowering, very tolerant of wet soils in winter/early spring. Susceptible to RLEM at seedling stage. High growth rate in early spring. Potential for use in mixtures with sub clovers in paddocks with variable drainage which dry out in summer. Balansa paddocks need hard grazing in summer to ensure some hard seed is softened. Balansa is faster away in late winter/early spring than sub clover. Hay made at the late flowering stage and fed out on hill blocks in autumn is one way to spread seed on hill country.

- **Persian clovers:** Persian clovers are later flowering than sub clovers and have high yield potential. Persian is very tolerant of water logging and grows well in clay soils. Tall growth form is ideally suited to hay or silage.
  - *There are two sub species of Persian clover. One has very soft seed and is susceptible to false strikes and is unlikely to survive in the seed bank of a permanent pasture. The sub species suited to permanent pasture has a moderate level of hard seededness (e.g. 'Prolific', 'Nitro Plus', 'Kyambro'). We have no experience with these cultivars in grazed permanent pastures at present (Autumn 2012).*
- **Arrowleaf clovers:** 'Arrotas' is the latest flowering annual clover on the NZ market. It is unlikely to complete its full life cycle and will not set seed in low rainfall areas with low water holding capacity soils. But on sites which normally stay green till early summer its deep tap root helps it to provide good feed for weaned lambs well into January. 'Arrotas' seed is very hard and is not mature till late summer and therefore has little chance to soften on bare soil surfaces before autumn rains come. Hence, after a good seed crop, it will appear to miss a year as seed will soften in the following summer to germinate in the second autumn after its initial sowing.
  - Earlier flowering arrowleaf clover cultivars such as 'Cefalu' are later flowering than 'Leura' sub clover so they will provide quality feed into December.
  - Arrowleaf clovers are slower growing in the cool season than other annual clovers but compensate with very rapid growth in late spring/early summer.
  - Arrowleaf clovers do not tolerate wet soils. Chris Dawkins ("Pyramid", Marlborough) has had good late spring production from the 'Arrotas' component in the better drained areas of his ryegrass/sub clover/'Arrotas' trial paddocks.

### **Why sow annual clovers in autumn?**

- The data for four annual clovers in the graphs on Figure 3 provides evidence to explain why annuals sown in spring rapidly bolt to seed before they have a chance to produce much dry matter. In contrast annual clovers sown in early autumn may produce over 10 t DM/ha before first flowers appear in spring.
- For example, Bolta balansa clover sown in February requires about 2000 degree days (°Cd) before it will flower in the following October. The declining day length (photoperiod) during autumn inhibits flowering and the clover uses the large amount of energy (2000 °Cd) for vegetative growth. As day length increases in spring it accelerates the onset of the reproductive phase and shortens the life cycle of annual clovers. If balansa clover is sown in November it will flower after an accumulation of only 600 °Cd. These plants will be less than a third the size of the February sown plants because they have had much less time for growth before entering the reproductive phase.
- The flowering and seed production phase of an annual clover's life cycle is followed by death and decay of the plant. The species then survives dry summers as dormant seeds until autumn rains encourage germination of a new generation of seedlings.
- Once annual clovers start to flower their stem to leaf ratio increases and the nutritive value of the dry matter declines. It is therefore important that annual clovers should be sown in late summer/early autumn to produce maximum DM yields.



**Figure 3** Time to flowering in four annual clover species in relation to photoperiod at emergence in Lincoln University. Triangles are data collected in autumn and circles are spring data.



**Figure 4** Balansa clover (top) and gland annual clover (bottom) in flower at Lincoln in spring 2010.

# Practical Lucerne Grazing Management

*Professor Derrick Moot and Malcolm Smith*

Email: [Derrick.Moot@lincoln.ac.nz](mailto:Derrick.Moot@lincoln.ac.nz)

## 1. Getting started (Paddock 1)

One of the most difficult things to understand when grazing lucerne is what stocking rate to use and when to start grazing. At Lincoln University we have been faced with this dilemma over many years and we don't always get it right. This guide summarizes our experiences to date;

- Start spring grazing of lucerne when it is about 15-20 cm tall – the first paddock grazed and sprayed in the autumn clean-up round is likely to be the first one ready for grazing in spring.
- Put ewes with lambs at foot onto lucerne as early as your management allows i.e. lamb onto older stands with some fibre available or start drifting stock on when lambs are no more than 2 weeks of age. The younger the lambs are on lucerne the better!
- Stock at 10-14 ewes plus lambs (180%+) per hectare in one mob to commence grazing in the first paddock (Paddock 1) of a six paddock rotation. e.g. if you have 30 hectares of lucerne that is 300-420 ewes and lambs all being put on the first 5 ha when it is 15-20 cm tall in spring or about 1500 kg DM/ha. (And then you can wonder where all your stock have gone as they come off lambing blocks letting those areas recover).
- The exact number of animals to put on is location and spring dependent and will take a year or two to work out for yourself. For us it is 12-14 ewes plus twins per hectare for 10-12 weeks.
- Paddock 1 needs to be consumed in 3-4 days. There will be little post grazing pasture mass (PGPM) because all of the herbage on offer is leafy rocket fuel (all herbage ME=12+ and protein 26%+).
- Animals grazing lush lucerne are most prone to health issues as guts adjust – but it is really important to start grazing lambs on lucerne as young as possible. Ensure fibre and salt are available. Ewes that have previously been on lucerne are likely to take to it with little adjustment.
- If you find you are losing lambs or ewes (usually the best ones) check your vaccination programme is up to date and consider 10 in 1 vaccine. Fast growing animals are more prone to clostridia disease from rapid bacterial growth in the rumen that causes sudden death. This is often mis-reported as bloat because they blow quickly after death.

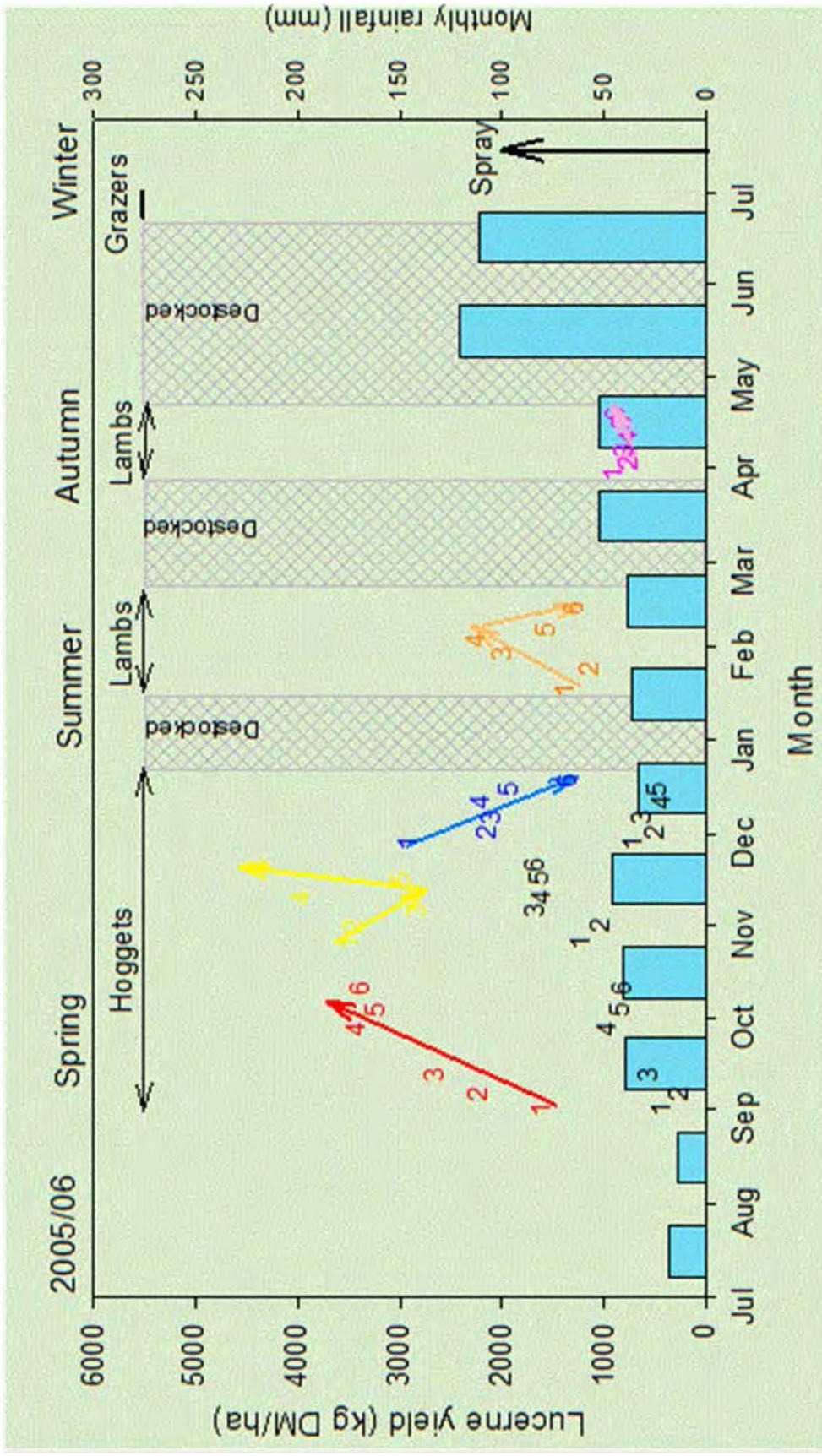
## **2. First rotation (Paddocks 2-5)**

Having started ewes and lambs on lucerne the next issue is when to move them onto Paddocks 2-6. This is a combination of observation and experience and not always easy to get right the first year you start grazing. Some tips:

- The lucerne continues to grow in front of you as you are grazing a paddock- so you are building a wedge or bank of feed ahead of you – managing this is the key to maintaining lucerne quality to maximize animal growth in this vital spring period.
- As you open the gate to Paddock 2 the ewes will usually walk (not run) because they know they are getting good quality feed and won't have to hunt for the tasty legume amongst grass. But make sure there is fibre and salt on offer.
- Paddock 2 will be taller and contain more dry matter than when you started in Paddock 1.
- Figure 6 is an example of one years grazing management from our six paddock rotation for the 'MaxClover' experiment at Lincoln. Grazing of hoggets started in Paddock 1 in early September 2005. The dry matter increased from 1500 kg DM/ha to 2200 kg DM/ha before entry to Paddock 2.
- Paddock 3 was about 2600 kg DM/ha upon entry. The PGPM is shown as less than 500 kg DM/ha for these first three paddocks.
- Paddocks 4-6 were all around 3300 kg DM/ha upon entry and the PGPMs were closer to 1000 kg DM/ha.
- To get an idea of how much to leave behind after grazing test the herbage as animals go in. Either squeeze or bend a stem until you can find where the woody part begins - this is low quality (ME=8, Protein = 12%) that is maintenance feed at best so not recommended for fast growing stock!



**Figure 5** Hoggets grazing lucerne in spring 2007 at the MaxClover Grazing Experiment at Lincoln University, Canterbury, New Zealand.



**Figure 6** Yields in paddocks 1-6 as stock begin grazing the MaxClover experiment at Lincoln University in 2005. Values at the bottom of the 1st, 2nd, and 3rd grazing cycles are post grazing pasture (stem) mass (PGPM) when stock were moved to a new paddock.

### **3. When to go back to Paddock 1?**

When you enter Paddock 4 you should look to see if recovery in Paddock 1 is 10-15 cm tall. How this grows over the next two weeks dictates paddock rotation. If regrowth is rapid you may not want to graze Paddock 6 but drop it out of the rotation for hay or silage or increase the mob size to cope. As a guide, the time of return to Paddock 1 after leaving should be between 30 and 42 days (or you will have grown too much stem).

- Ideally Paddock 1 will have about 3300 kg DM/ha upon entry the second time (Figure 6 shows this was similar to Rotation 1 in Paddocks 4, 5 and 6). In our example, Paddocks 1–5 were all grazed at reasonable yields for the second rotation but Paddock 6 was starting to become too heavy/stemmy.
- The PGPM for Paddocks 1-6 shows about 2000 kg DM/ha was grazed or about 70% utilization. Herbage analyses indicate this level of DM utilization will see over 80% of the total ME and CP consumed. There is no point in making growing animals eat the lower quality residual.
- The amount of regrowth in the second cycle will depend on in season rainfall. In our 2005/06 example the monthly average rainfall was around the long term mean of 50 mm. This was sufficient to keep lucerne growing in Paddock 1 for a third rotation with another 3000 kg DM upon entry.
- For Paddocks 2-6 this level of in season rainfall is inadequate and meant growth was reduced. Paddock 6 only 1200 kg DM/ha was available for grazing in late December.
- Conveniently our experimental plots were destocked from late December until mid January – beach time for dryland farmers!
- The average summer rainfall until May was inadequate for much regrowth so only a single summer rotation was possible with lambs before a clean-up graze in April followed by destocking and a winter weed spray in mid July.

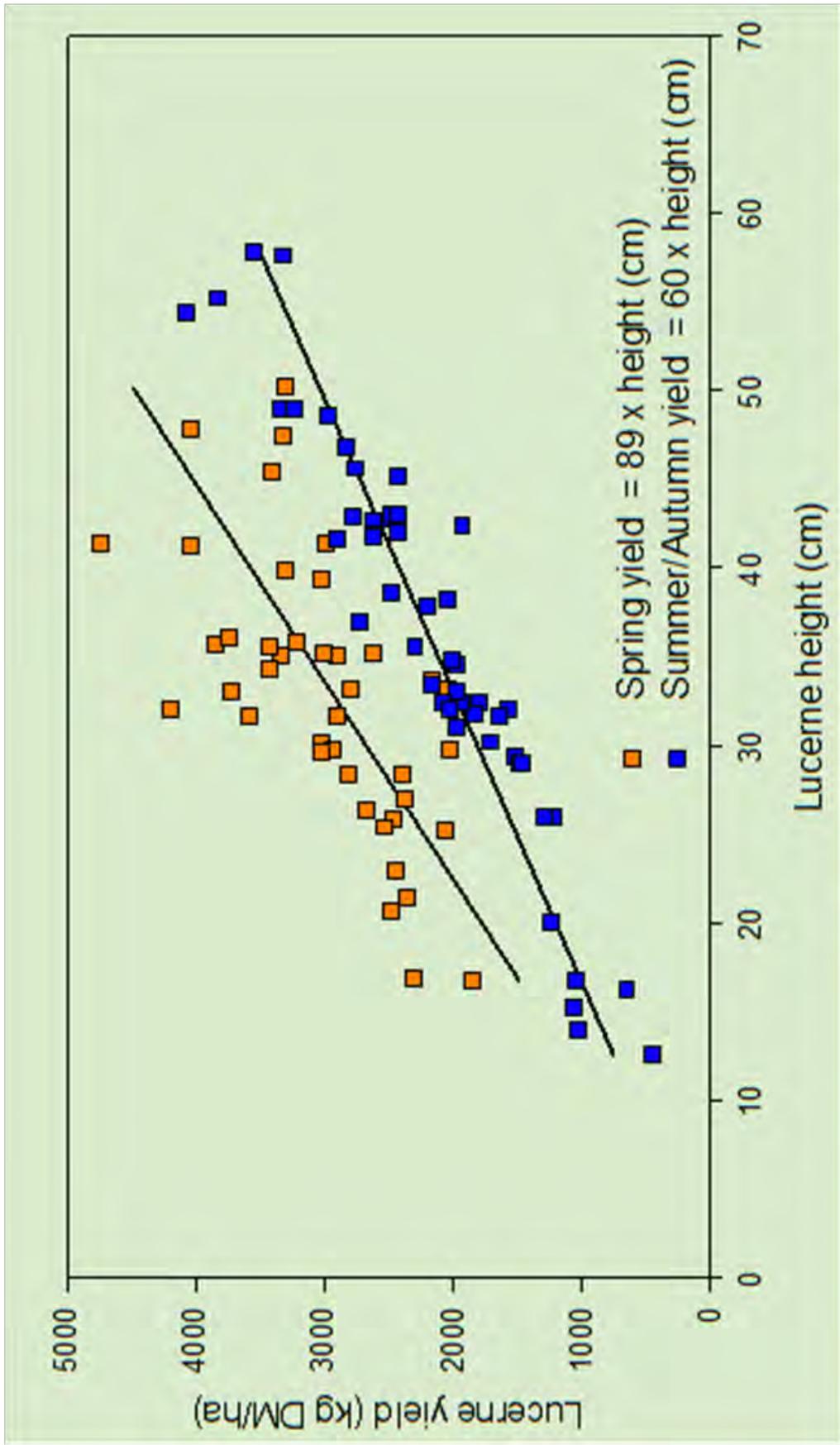
### **4. Annual Production Summary**

- Figure 6 shows the timing of production from each paddock varied across the season. However, when the total dry matter yields were accumulated each grew 10-11 t DM/ha.
- For spring, Paddock 1 produced 7.8 t DM/ha (1.5+ 3.4+2.9) across the first three rotations compared with 8.8 t DM/ha (3.4+4.2+1.2) for Paddock 6. If we converted these to herbage quality the difference would be smaller with the higher yield from Paddock 6 resulting from more stem production, particularly in the second rotation.
- The annual rainfall for this season was 600 mm which is similar to our long term average. Of note, the 230 mm of rainfall in May and June did not result in any significant autumn lucerne growth. At this time the moisture would be accumulated in the soil for use the following spring.
- Ideally the stock on these experimental plots would have been ewes and lambs. However, the small size meant hoggets and weaned lambs are more appropriate.

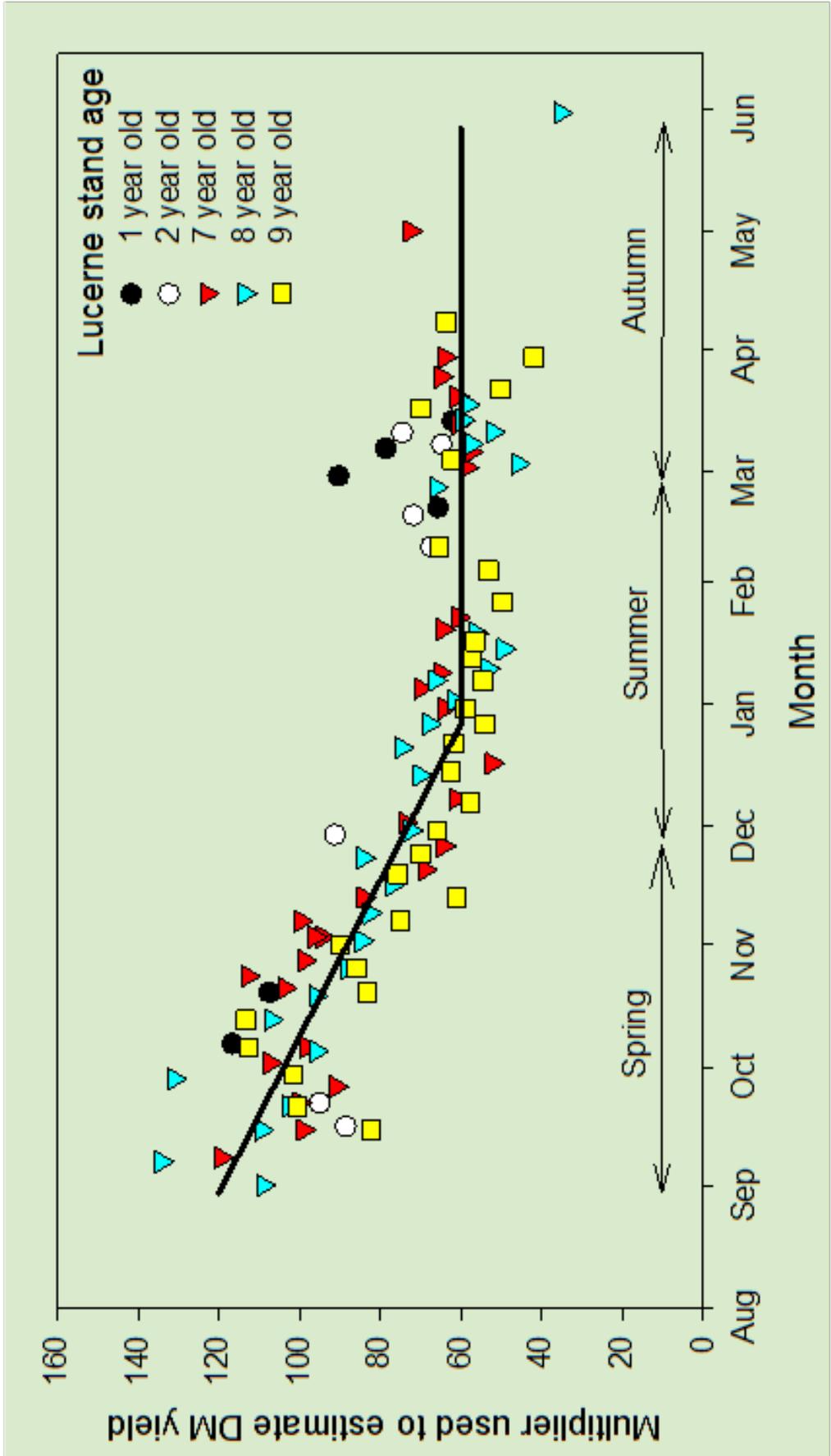
## **5. Estimating Dry Matter Yields**

One of the key questions when determining stocking rate is assessing current herbage yields. Over the life of the 'MaxClover' experiment and other Lincoln University experiments we have examined the relationship between yield and height and can show a distinct seasonal relationship.

- Figure 7 shows that in spring the lucerne yield can be estimated by multiplying the height (cm) by 90 to get an estimate of yield (kg DM/ha). For example, when a paddock is ready for grazing at about 35 cm height it contains about 3200 kg DM/ha.
- Figure 7 also shows that for summer and autumn the relationship is lower with the multiplier being 60. Thus, that same 35 cm height equates to 2100 kg DM/ha.
- Figure 8 gives a picture of the multiplier on a calendar basis. The overall pattern of a higher multiplier in spring than summer held for stands of many different ages. At Lincoln the highest multiplier of 100 is appropriate in the main growth period of September and October but it then declines to be about 60 from December on.



**Figure 7** Lucerne dry matter yield estimated from height measurements in Spring (orange squares) and Summer/Autumn (blue squares). Changes in the multiplier used to predict dry matter from lucerne height over a year.



**Figure 8** Changes in the multiplier used to predict dry matter from lucerne height over a year.

# Cocksfoot Grazing Experiment



## 2002-2011

### 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.

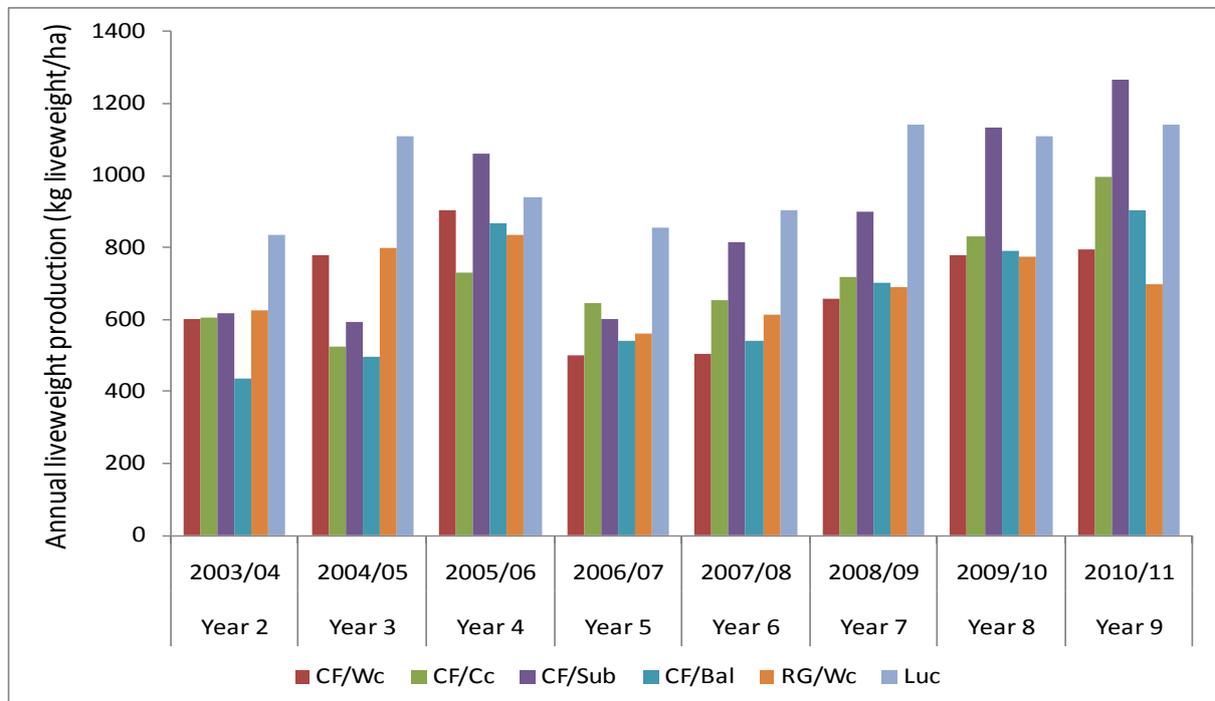
Common name	Acronym	Cultivar	Sowing rate
Balansa clover	Bal	'Bolta'	6 kg/ha
Caucasian clover	Cc	'Endura'	8 kg/ha <sup>+</sup>
Subterranean clover	Sub	'Denmark'	10 kg/ha <sup>+</sup>
White clover	Wc	'Demand'	3 kg/ha
Cocksfoot	CF	'Vision'	4 kg/ha
Perennial ryegrass	RG	'Aries' ARI	10 kg/ha
Lucerne	Luc	'Kaituna'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

<sup>+</sup> = seed was inoculated prior to sowing

- Dry matter production and botanical composition were measured from enclosure 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)**

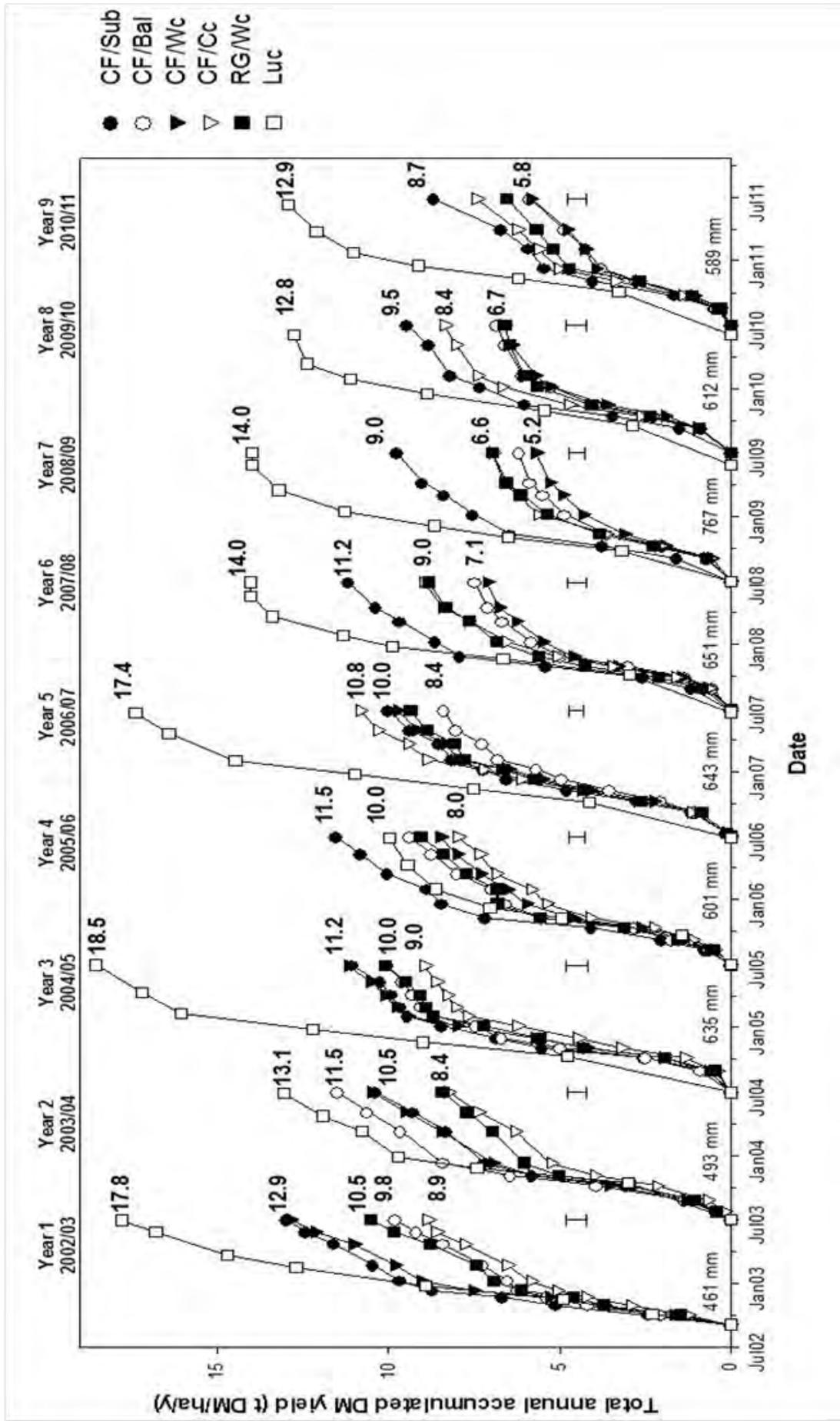
- In five of the eight years reported, lucerne pastures gave superior total annual live weight production (See Figure 9).
- Over the eight year period, CF/Sub has given the most consistent **SPRING** live weight production of the grass-based pastures (338 - 1022 kg LW/ha).
- A combination of pastures is required to ensure LW production is maintained in different seasons and across years due to variable rainfall.



**Figure 9** 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 10).
- Lucerne produced 12.8-18.5 t DM/ha/y in eight out of the nine years.
- Cocksfoot with subterranean and white clover compliment 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<sup>2</sup>, 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<sup>2</sup> in CF/Cc and RG/Wc, 103 in CF/Wc, 75 in CF/Sub and CF/Bal and 36 in lucerne.



**Figure 10** Accumulated total annual DM production (t/ha/yr) from the Cocksfoot Grazing Experiment at Lincoln University, Canterbury. Annual rainfall totals are also shown.

