Lucerne

For the Future

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MAF

Lucerne for the Future

NEW ZEALAND FARM ENVIRONMENT AWARD TRUST AND MAF STUDY SCHOLARSHIP 2008

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NEW ZEALAND FARM ENVIRONMENT AWARD TRUST AND MAF STUDY SCHOLARSHIP 2008

An Annual Scholarship partnership programme between the New Zealand Farm Environment Award Trust (NZFEA Trust) and MAF was established in 2008

This Scholarship is awarded to a farmer to study and report on an issue that will add value, stimulate debate and promote the improvement of long term sustainability of New Zealand farms.

The NZFEA Trust is extremely grateful to MAF for this Scholarship which provides top farmers with an opportunity to provide insights on sustainability back to the farming community.

The Scholarship is presented to a past Supreme Winner from the Ballance Farm Environment Awards programme.

David Ward was chosen as the 2008 Scholarship Awardee. David and Hilary Ward farm a fully integrated 425 ha property. They grow a range of crops and run a flexible livestock policy of finishing weaner deer and trading lambs. Cropping takes up 390 ha of the farm.

David chose as his study topic:

'Lucerne for the Future'

David has not set out to present a scientific publication. Rather the aim of this presentation is to stimulate interest in lucerne (alfalfa, *Medicago sativa* L.) which David believes may be useful in the ongoing quest for sustainability in our farming systems.

The publication will outline some current observations on the possible use and value of lucerne in a farming system. A number of the observations are based on David Ward's experience and are not an attempt to write a scientific study paper.

The publication also provides a brief literature review, provides details of known current usage, indicates where David suggests further research is required and documents a number of case studies from farmers who currently use lucerne.

David has been assisted in this presentation by Dr Derrick Moot, Professor of Plant Science, Lincoln University and he is most grateful for that help. The literature review provided by Professor Moot is based on scientific publications and his personal opinion of past, present and future uses for lucerne to benefit New Zealand.

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1 Overview

When I first looked at lucerne for the dairy industry it became very apparent that lack of understanding the growing, harvesting and grazing lucerne had become a New Zealand wide pastoral issue.

Lucerne lost a lot of support in farming systems during the 1980's but with improved varieties, management, disease resistance; we now have a plant capable of producing up to 50% more DM than pastoral methods currently in place, in the same climatic conditions.

In New Zealand we have some of the world's best scientists, experts and farmers who have the ability to show that with the best knowledge and practices there is a substantial potential for use of lucerne in pastoral farming systems.

I believe lucerne can be used effectively to complement pastoral systems where up to 30% of the area can be planted in lucerne as cut and carry silage, haylage, or grazing, when considering its ability as a stock finishing option.

Based on overseas data, lucerne may have the ability to become a nutrient harvester of N. The large tap root of lucerne gives it the ability to harvest N to a greater depth in all soil profiles when compared with most other plants. For this reason it may be extremely suitable for dairy effluent systems and around catchment areas, perhaps utilising the N before it moves through the root zones.

This would need to be linked to cut and carry options but suggests exciting prospects for N management, especially in sensitive areas. However, clearly, more research needs to be done to better quantify evidence as only small trials have been done in New Zealand.

We are now seeing a resurgence of interest from farmers especially on the east coasts of both islands for climatic reasons. Holding back its advance is a lack of knowledge transfer to field reps and consultants.

Hopefully the work here will help expand that knowledge base and reassure farmers of the positive development of the plant and management systems since its fall from favour in the 80's.

I believe that the lucerne plant has a very important roll to play into the future of New Zealand pastoral systems for sustainability and profitability.

David Ward

2 Executive Summary

The area of lucerne grown in New Zealand has declined since the 1980's. However, lucerne remains an integral component of feed supply in many farm systems, particularly east of the main divide in both islands. The benefits associated with increased direct grazing by ewes and lambs for animal production and sustainable land use have been demonstrated most recently in Marlborough and Central Otago. These were aided by research at Lincoln University which has redefined appropriate grazing management systems to add flexibility but minimize potential animal health issues.

The higher spring water use efficiency of lucerne compared with grass based pastures increases the amount and quantity of feed available to dryland farmers. This advantage in spring leads to rapid liveweight gains in stock directly feeding on lucerne. A lack of regionally based productivity and technology transfer opportunities may be limiting the uptake of recent research and on farm results to a wider audience.

The dairy industry in New Zealand has farmers who were, or are, direct feeding lucerne to cows but the practice is not widespread. The current role of lucerne is predominantly as a supplement in all farm systems. The opportunity exists to develop grazing systems for the dairy industry based on those currently used overseas with pure stands or grass mixtures. Lucerne may also have a role in nutrient management regimes, such as for nitrate capture in sensitive environmental regions, but research in this area is currently lacking in New Zealand.

3 Review of Lucerne in New Zealand

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June 2009

3.1 Background

Periodically the area of lucerne grown in New Zealand has waxed and waned since the early 1900's. Through the 1950's the area grown increased but it declined again through the 1970's. In 1984 the total area of lucerne grown was about 180 000 ha down from 220 000 ha in 1975 (Douglas, 1986). Overall, about 36% of the lucerne was used for grazing and the remainder solely conserved. Since then Statistics New Zealand has not separated lucerne out in its survey of land use so accurate figures are no longer available. The data on seed production shows a continued downward trend (Rolston, 2003) but the relevance of these figures is compromised by the increase in the amount of seed imported from Australia and North America. Equally, the research data available for lucerne is predominantly 20-30 years old reflecting the lack of recent research in New Zealand. A series of post graduate studies at Lincoln University around the turn of this century identified farmer issues that had restricted the use of lucerne on-farm. To overcome these a refined grazing management package has been advised which adds flexibility to animal grazing (Moot *et al*., 2003). This success has received popular support on the east coast of New Zealand and in Central Otago with thousands of hectares being transformed to provide profitable dryland sheep and beef farming. Lucerne provides high quality feed, either directly grazed or as a supplement in sheep, beef, dairy and deer production systems. It has been used extensively overseas to mitigate the effects of nitrate leaching but currently this potential remains unexplored in New Zealand.

The suitability of lucerne to contribute to New Zealand farming systems differs across regions due to changes in soil types and climatic zones. The New Zealand Department of Statistics (1979) summarized this 30 years ago and in the main their observations are still relevant. Their descriptions are summarised in the first part of this document. This is followed by quantification of the potential yields and growth rates expected in different regions under different management and soil types summarised from 40 years of research. Discussion then centres on how to establish the crop and manage it in a grazed system; including mitigation of animal health issues. The quality of lucerne relative to other crops is outlined along with nutrient requirements and potential capture of nitrates in sensitive ecological zones.

3.2 Historic and potential use of lucerne in the North Island

This section is based on an historic review (Department of Statistics, 1979) and personal observations from Professor Moot. In the latest known statistics lucerne represented less than 30 000 ha in the North Island with the majority in South Auckland and the Bay of Plenty for conserved feed.

North Auckland – Generally the soils of this region are considered unsuitable for lucerne due to a heavy and tight subsoil. An exception is the light Red Hill sandy soils and the immature volcanic soils near Auckland, Whangarei and Kaikohe. It is likely that any lucerne grown in this region would be for hay and silage rather than direct grazing.

Bay of Plenty – Historically lucerne was a valuable crop in the Galatea area where dry summer conditions restrict pasture growth. On the light coastal soils lucerne offers an alternative to pasture grazing or for conserving as hay and silage.

Central Plateau – Lucerne has been shown to out yield pasture on the free draining soils of the volcanic plateau. The use of lucerne in this region did not commence until after the 1950s. In some regions lucerne is still cut and carried with limited direct grazing. There is potential to expand the area of lucerne grown. It may also be useful as a deep rooted species to capture nitrates in a cut and carry system in environmentally sensitive areas such as around Lake Taupo. This would reduce the potential for high nitrate concentrations that could occur under a grazed system (see Section 3.11).

Waikato – Historically lucerne has been grown in Waipa, Piako, Matamata and Otorohanga with an emphasis on supplying feed for horses as small bales or as chaff. Lucerne has been grown as a high crude protein source to balance maize silage production. The area of lucerne grown is likely to vary in relation to the price and availability of other protein sources and the frequency and duration of droughts. The humid conditions often experienced in this region can enhance leaf diseases and poor stand management coupled with summer rainfall often leads to grass weed invasion.

Taranaki – The high rainfall of north and central Taranaki limits the role of lucerne in this region with annual and grass weeds making it difficult to maintain stands. Equally, the lack of cold hard winters favours weed growth in lucerne stands. Maintaining soil fertility with phosphate and potassic fertilizers has been recommended to keep stands vigorous. In south Taranaki summers are considerably drier and lucerne stands have been more common. Around, Patea, Hawera, Eltham and the coastal belt of Waitotara County the light free draining volcanic soils are suited to lucerne and dairy cows have previously been fed directly on it (McKay, 2009, Pers. Comm.). During summer there are often periods that are conducive to lucerne hay or silage production and weed control is easier than in north Taranaki. The potential for hot dry summers that severely restrict ryegrass production means farmers are aware of lucerne but currently the area grown is small.

Wairarapa – This region is typically dry over summer with no growth from ryegrass based pastures. Therefore, large reserves of supplementary feed are required. Lucerne has the potential to significantly change the farming systems of this region particularly if direct grazing systems are adopted. This is because lucerne utilizes vital spring water more efficiently than grasses (Moot *et al*., 2008) and provides high quality feed for rapid live-weight gain in spring (Avery *et al*., 2008). Direct feeding may allow farmers to finish more animals quickly in spring and therefore reduce the need for conserved feed.

Hawkes Bay – Regions around Woodville and Dannevirke have previously been recommended as having soils particularly well suited to growing lucerne as a conserved feed. In the drier regions of Central and Northern Hawkes Bay lucerne is well suited and used extensively for hay and silage. The area of direct feeding is low but there is potential for expansion in the future with some interest in dairy grazing. There is further potential to expand the area of lucerne grown to assist finishing of stock and provide supplementary feed for summer dry conditions. The success of direct feeding in Marlborough (Avery *et al*., 2008) has generated interest from this region that is stimulating some change elsewhere. This is because the dry summer conditions and lack of summer and autumn rainfall in Hawkes Bay make growing conditions similar to Marlborough. In both regions spring provides the most reliable soil moisture conditions and lucerne growth is rapid as spring temperatures rise (Mills *et al*., 2008).

Poverty Bay – The soils of the flat regions around Gisborne, Ruatoria, Tologa Bay and Mohaka and free draining pumice ash soils are suited to lucerne production. Much of this region uses lucerne conserved as hay or silage as feed for dry summer and autumn conditions. Direct feeding could increase animal growth rates in spring and reduce the need for conserved feed.

3.3 Historic and potential use of lucerne in the South Island

The summary in this section is based on a historic review (Department of Statistics, 1979) and personal observations from Professor Moot. Around 150 000 ha of lucerne were reported as growing in the South Island in 1979 with about 50% of this in Canterbury.

Marlborough – This is traditionally a strong lucerne production area due to extreme dry summer conditions and the resulting high levels of conserved feed required. Much of the free draining valley floors and flat land has been changed from lucerne to grape production. Where climate or water supply limit grape production lucerne remains viable and useful as a high quality supplement feed. Direct feeding of lucerne on “Bonaveree” farm near Lake Grassmere has shown the potential of lucerne for grazing to allow lamb and cattle finishing (Avery *et al*., 2008). Seed production is possible in the region but the majority of seed used in New Zealand is now imported. This region could expand seed production if sufficient bee populations are maintained.

Canterbury – This region experiences severe dry summers, equivalent to those in Marlborough. Lucerne use remains a source of feed on many dryland farms with up to 10% of an individual property commonly used to grow lucerne for conserved feed to be used in winter or in drought conditions (Kirsopp, 2001). A few farmers directly graze lucerne and have increased the area planted to ≥30% to allow this. On specific sites lucerne/grass mixes are used with *Bromus* species and cocksfoot (*Dactylis glomerata* L.), which proves suitable for sheep and deer grazing, particularly on the limestone soils of North Canterbury. Central Canterbury has traditionally been the home of lucerne grazing but recent dairy conversions have meant the area used for sheep on dryland pastures has decreased. Lucerne is also used as a specialist forage crop; i) integrated into dairy systems as supplementary feed ii) used for lamb finishing and iii) used in its traditional role as a high quality supplement made into hay, baleage or silage for feeding as a supplement during summer or winter. Examples of these are given in Section 4. In many cases the first crop in spring is cut for hay or silage and subsequent regrowth is used for grazing. A survey of farmers using lucerne in this region indicated 75% of dryland farmers grew lucerne and of these the average area on their farm was about 20% (Kirsopp, 2001). Lucerne was seen to have the capacity to produce 50% more dry matter (DM) but was frequently grown on potentially yield limiting soils with a pH of <6.0. With optimum use of phosphorous and potassic based fertilizers dryland lucerne should persist for 7-10 years.

In South Canterbury there is potential to increase the sowing of lucerne on well drained clay downs and the alluvial soils throughout the Waimate region. Essentially, where land can be cultivated, lucerne can be used in a pure stand and increasingly as the legume component of grass mixes to replace the poor performing white clover. White clover fails to thrive and persist in dry conditions (Knowles *et al*. 2003) particularly once its tap root dies after about 18 months (Widdup *et al*., 2003).

Irrigation is increasing in Canterbury with the potential to more than double lucerne yields in dry years. However, severe weed ingress can occur when crops are irrigated too frequently and immediately after cutting or grazing.

MacKenzie District – The majority of lucerne in the MacKenzie District is conserved for feeding out during the long (100+ day) winter. It is unusual to get more than two cuts off dryland lucerne in this region with any autumn regrowth usually grazed. There is some use of lucerne/cocksfoot mixes in this region and the Hakataramea Valley where the lucerne is seen as part of the legume component of the pasture. The longevity of these stands is dependent on grazing management. Lucerne does not survive under continuous set stocking and so some spelling for regeneration of root reserves is necessary (Moot *et al*., 2003). An unknown in much of the high country region is the area of lucerne that would be restricted by aluminium sub soils. Lucerne roots are sensitive to aluminium and grow sideways rather than down if they encounter high aluminium levels in the subsoil.

North and Eastern Otago – The use of molybdenum minerals has previously been recognised as the key to ensuring success of lucerne in this low rainfall area. Molybdenum is essential in the symbiotic relationship between plants and rhizobia bacteria for nitrogen fixation. The Waitaki area was once a major lucerne growing region but the availability of irrigation has changed the land use. The irrigated land is suitable for dairying on predominantly ryegrass and white clover pastures. On rolling hill country lucerne is used predominantly for grazing with some used for conserved feed where possible.

Central Otago – The hot dry summers and cold winters mean large areas of lucerne have been grown predominantly for winter feed. In this region one heavy cut is expected in November. A second cut is hoped for, particularly if rain falls in December, and then potentially some autumn grazing. Annual yields are restricted by the low (300 mm/yr) rainfall. Some farmers in the region have moved to direct feeding of lucerne for finishing lambs and cattle at high animal growth rates for short periods of time. This offers an alternative land use to the traditional extensive sheep breeding and store lamb systems of the region.

Otago/Southland – In most cases lucerne is grown for hay or more easily silage. There is a constant battle to keep grass weeds at bay because of the higher rainfall and this restricts the lucerne area grown. In this region lucerne has the potential to act as a feed buffer in dry years.

3.4 DM yield and seasonal growth rates

Sections 3.2 and 3.3 outlined the general use of lucerne in different regions of New Zealand. However, the range of locations, soil types and management options available to lucerne growers means there is considerable variation in the yield potential and yields achieved across the country. These are also impacted by irrigation and crop management. Unfortunately, there is little recent data on lucerne yields in New Zealand, except from Canterbury. Where possible, this section provides details of seasonal and annual yields that farmers could expect moving north to south in New Zealand. Some commentary is provided on the site and soils from which yield data were obtained as a reference. Specific details are available within each of the papers as referenced.

In the Waikato, on a Horotiu sandy loam soil, lucerne monocultures had dry matter (DM) yields of 15.9 t/ha/yr (Elliot, 1967). At Whatawhata, on a Dunmore silt loam (free draining volcanic ash) six lucerne cultivars were grown on a 20° north facing hill slope at a sowing rate of 11 kg/ha. Yields measured over five years (annual rainfall 1197-1633 mm/yr) averaged 10.8 t DM/ha in the first year and 8.2-13.6 t DM/ha/yr for the next four years (Figure 1).

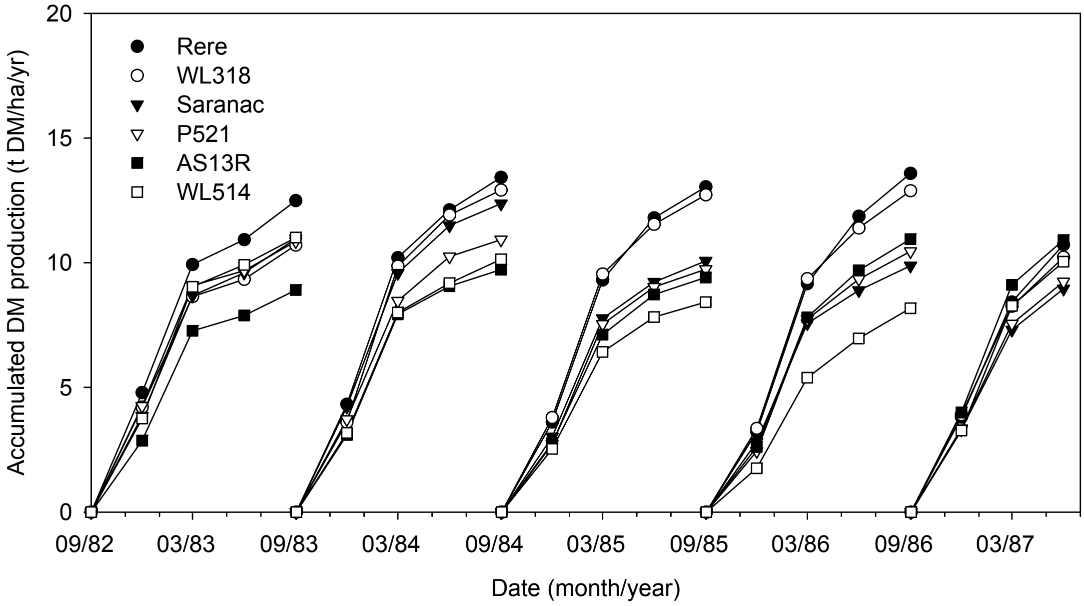

Figure 1 Accumulated DM production of six lucerne cultivars over five growth seasons near Hamilton (McGowan *et al.*, 2003).

In Taupo, dryland 'Kaituna' lucerne (established at 12 kg/ha) on a deep, free draining, pumice based Oruanui sand soil, produced 7.6 t DM/ha/yr in Year 2 and 11.5 t DM/ha/yr, in Year 3 (Betteridge *et al*., 2007). In Wairakei (Central Plateau), yields of 'Wairau' lucerne ranged from 10.3 to 15.7 t DM/ha (Baars *et al*., 1975). In most cases this represented at least a 100% advantage over the comparative pasture. This was a flat land site on free draining volcanic based (Atiamuri sand) soils that have low water holding capacity. In these situations the yield advantage for lucerne is likely to come from its nitrogen fixing ability, whereas grasses are usually nitrogen deficient, particularly in spring (Moot *et al*., 2008).

At Palmerston North, dryland 'Wairau' lucerne produced 18.4-23.0 t DM/ha/yr over six years on a recent Manawatu fine sandy loam soil (Table 1). Lucerne was harvested eight times annually in the first three years and then six times each year for the following three years (Theobald and Ball, 1983). The use of lucerne in this region has reduced over the years. Farmers could utilize it as an option in grass mixes, particularly on the sand country that rapidly dries in summer months, and where ryegrass fails to persist.

Table 1 Annual total DM yields (t DM/ha/yr) of pasture on hill and flatland and of 'Wairau' lucerne grown on a flat site at Wairakei (central North Island) between 1966-1971 (Baars *et al*., 1975).

	Pasture		Lucerne
Year	Flatland	Hill	Flatland
1964/65	4.32	11.05	Not measured
1965/66	4.70	8..43	Not measured
1966/67	7.04	10.55	13.12
1967/68	6.70	9.37	10.31
1968/69	7.90	7.94	14.74
1969/70	5.09	8.78	13.53
1970/71	4.46	6.97	15.74
Mean	**5.74**	**9.00**	**13.49**

In Marlborough, dryland lucerne yields at Dashwood were 6.0 to 9.5 t DM/ha on a sandy soil and 2.5 and 6.5 t DM/ha on a stoney soil (Hunter *et al*., 1994). The amount and timing of rainfall will have a dominant affect on the production pattern (Avery *et al*., 2008).

In Canterbury, a mean annual dryland yield of 6.5 t DM/ha was reported for a very stony Lismore soil (Hayman, 1985) and over 20.0 t DM/ha on a deep Wakanui soil (Brown *et al*., 2003). The impact of irrigation has been shown to be dependent on soil type and season. Hayman (1985) reported yield increases of 30-370% depending on soil type with the greatest increase from the shallowest Balmoral soil in an exceptionally dry year. Other research has also quantified yield responses to irrigation on Lismore (Hayman, 1985), Templeton (Martin, 1984) and Wakanui (Brown, 2004; Hoglund *et al*., 1974) soils.

At Invermay Research Station on the Taieri Plains, Cullen (1960) grew a series of lucerne/grass mixtures which yielded around 13.0 t DM/ha. The practice of lucerne grass mixes is more common in low rainfall (<600 mm/yr) environments where the grass growth is restricted by soil moisture. The choice of companion grass is dependent on soil type with *Bromus* species such as Prairie grass (*Bromus willdenowii* L.) appropriate on high pH soils and cocksfoot used in dry wind prone regions such as the Hakatarmea Valley.

Yields of lucerne grass mixes have also been reported by Martin (1984) and McKenzie *et al*. (1990).

3.5 Establishment

To achieve high yields and persistent lucerne stands successful establishment is important. Establishing any pasture including lucerne requires careful planning and appropriate preparation. Lucerne can be established successfully by conventional cultivation and direct drilling with expected costs similar to those for grass based pastures. The majority of lucerne in Canterbury is spring sown. For an October sowing, yields of 18 t DM/ha/yr have been reported when soil moisture was non-limiting (Wynn-Williams, 1982).

Recommendations for successful establishment include rectifying any nutrient deficiencies and particularly raising the pH to 6.0-6.4. Routine use of soil testing is recommended for lucerne crops. In many situations a standard 7.5 cm soil test is inadequate to detect nutrient deficiencies in lucerne crops. This is because lucerne is accessing nutrients from greater depths in the profile. For established stands a herbage test of actively growing material is also recommended, particularly in spring, to identify any nutrient deficiencies.

High sowing rates (12-15 kg/ha) of lucerne may be required if seed bed preparation, weed control or soil moisture conditions are unfavourable. Experiments have shown no total yield differences from lucerne sown at 3 to 16 kg/ha (Palmer and Wynn-Williams, 1976; Wynn-Williams, 1982). Furthermore a cash cover crop may be used to boost first year returns. Barley (*Hordeum vulgare*) and rape (*Brassica napus* spp. *biennis*) can be used with reduced sowing rates of the cover crop to aid the lucerne establishment (Wynn-Williams, 1976; Moot *et al*., unpublished).

Inoculated seed is required and modern cultivars offer resistance to many of the pests and diseases that previously affected stands in the 1980's. Free draining soils are ideal for lucerne but heavier soils are appropriate provided water does not pond for more than a few days at any time of the year. Fertilizer recommendations usually are potassium based with molybdic super used to assist nodulation of the establishing plants, with Boron and Zinc also included in lucerne fertiliser mixes.

Ideally, establishing lucerne stands should be left to flower before cutting or grazing the first time. If weeds are present selective pre or post emergence herbicides can be used or hard graze the establishing crop when it is about 0.15 m tall (Janson, 1982) and then leave it to flower.

3.6 Seasonal grazing management

Having successfully established a lucerne stand it can be used for grazing or conserving as hay, baleage or silage. This section outlines the management required for production and persistence of a lucerne stand. The principals described and underlying physiological basis are similar regardless of location. Understanding the different plant processes that affect lucerne growth and development are the keys to stand longevity and feed quality. This section outlines the seasonal grazing management recommended for direct grazing lucerne to maximize animal live-weight gains without compromising lucerne stand performance.

Shoot growth rates increase with temperature, but rates are higher in spring than in autumn at the same temperature (Moot *et al*., 2003). In spring, roots lose weight as stored sugars and nitrogen are used to stimulate early season growth but in autumn shoot growth is reduced as roots are recharged with nitrogen and carbohydrates (Teixeira *et al*., 2009). Understanding this change in plant priorities allows flexible grazing management to be used on a seasonal basis. A second consideration is the time of flowering. This has previously been used as a guide for grazing management but research indicates there is no need to wait for flowering before commencing grazing in spring (Moot *et al*., 2003). This increased flexibility has assisted dryland farmers to use lucerne for ewes and lambs from about 3 weeks after lambing (Avery *et al*., 2008). This section outlines how these simple mechanisms can be used to develop seasonally based management objectives to maximise both animal and plant performance.

3.6.1 Winter (June–August)

Objectives for winter management of lucerne should be weed control and ensuring that crop regrowth is as early and vigorous as possible in spring. Ideally, a 'clean-up' graze of any residual autumn herbage in late June/early July can be used to remove any overwintering aphids. This graze should be followed 7–10 days later by appropriate contact and residual activity herbicides. Lucerne crops should then be left until spring defoliation.

Lucerne should not be grazed in winter. This is because the potential for rapid stem elongation, and consequently early spring regrowth is generated over the entire winter period whenever the air temperature is above 5 °C (Moot *et al*., 2003). When stands are less than 400 kg DM/ha, the impact of any grazing can be enormous. The small amount of available grazing removes the plants growing point, preventing rapid stem elongation and consequently leaf area expansion. This results in a delay in spring growth and reduced yield potential.

Set stocking should also be avoided at all times. Set-stocking of lucerne crops results in the continual removal of newly developing shoots, stresses the plants and allows weed invasion. In grasses the growing point that produces new leaves is below ground so grass based pastures can be set-stocked. In contrast, the elevated growing point for lucerne is removed by grazing livestock and this needs to regenerate after each grazing. Consequently, lucerne should never be set stocked.

3.6.2 Spring (September–November)

In spring, the aim is to maximise live weight gain of stock. Flowering is delayed by the short photoperiod so grazing or cutting should be based on crop height and yield rather than waiting for flowering or basal bud development. For dryland systems, where lucerne makes up a high (>30%) proportion of the farm cover, early spring grazing is inevitable. In these circumstances, grazing must commence in some paddocks before they reach their maximum DM yield. To ensure this early grazing has minimal impact on stand persistence, it is preferable to begin grazing older stands that are targeted for renewal. Waiting until herbage is 0.20-0.25 m high provides a compromise between the need for early grazing to meet animal demands and capturing the rapid spring growth. The aim is for ewes and lambs to be introduced to the lucerne when lambs are 2-3 weeks of age and starting to eat herbage themselves. These ewes with lambs at foot should be rotationally grazed on stands at a stocking-rate that enables all herbage to be removed within 4-7 days (Moot *et al*., 2003). For example, over an area of 30 hectares about 300 ewes with twin lambs can be rotationally grazed on six 5.0 hectare breaks. The resting period before they return should be about 35 days at this time of year. During the first spring rotation, the lush high quality of lucerne can increase the risk of animal health issues such as red gut (Section 3.7) and strategies to minimise this potential are needed.

An advantage of lucerne growth in spring is that it uses water more efficiently than grasses (Moot *et al*., 2008). Therefore, for dryland farmers that have a limited amount of soil moisture, lucerne will grow more dry matter per millimetre of water used and has deeper roots with access to more water than grass based pastures. For example, Figure 2 shows lucerne produced ~6.2 t DM/ha from 250 mm of water used in spring when grown on a Templeton silt loam soil at Lincoln. The comparable ryegrass pasture grew produced less than half this yield from 220 mm of water used.

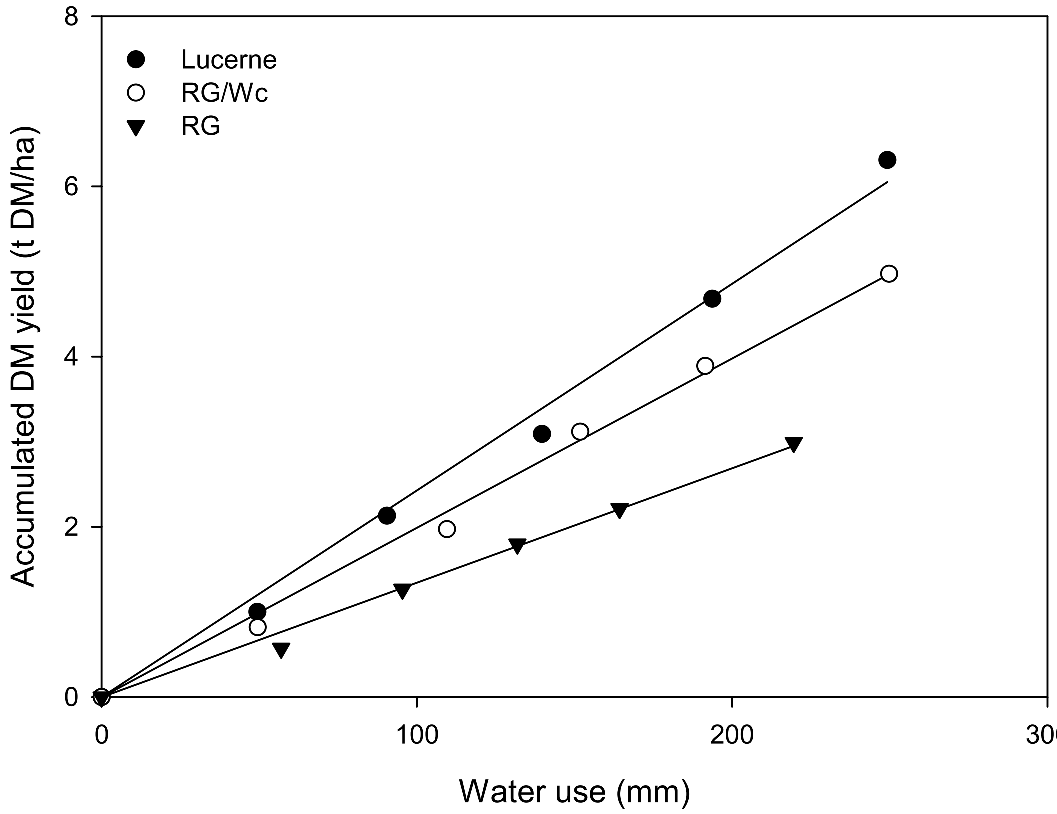

Figure 2 Spring water use efficiency (kg DM/ha/mm) of lucerne (24 kg DM/ha/mm), perennial ryegrass/white clover (RG/Wc, 20 kg DM/ha/mm) and perennial ryegrass (RG, 13 kg DM/ha/mm) pastures grown on a Templeton silt loam soil at Lincoln, Canterbury between 29/9-9/12/1993 (Moot *et al*., 2008).

3.6.3 Summer (December–February)

From the commencement of grazing until the lucerne stops growing or sometime in February, the objective is to maximise animal live weight gain of priority stock. In the absence of water stress, lucerne growth is rapid and crops may be grazed 2 or 3 times in rotation. If crops have become drought stressed, with an expectation of continued dry weather, any accumulated herbage can be hard-grazed to avoid the loss of current production through leaves dropping (senescing).

To maximise animal live weight gain, farmers should aim to graze priority stock solely on lucerne for 6 to 8 weeks at an allowance of 2.5–4.0 kg DM/hd/d (Moot *et al*., 2003; Avery *et al*., 2008). Stock graze the highest quality top leaves and stem first, followed by the less palatable lower stem which may be left. Continue to rotationally graze for no more than 7–10 days. Residual stem can then be grazed by dry or low priority stock, mown or left standing. Optimum grazing management during this time allows 35±4 days regrowth from when stock leave a paddock until when they re-enter.

Where lucerne can be irrigated, the optimum frequency and timing of water application is dependent on how much water the soil can hold. Irrigation also encourages weed seed germination so after defoliation, when demand for water is low, delay irrigation until new leaves grow and are ready to expand and out-compete germinating weeds.

3.6.4 Autumn (March–May)

In autumn, priorities change from stock performance to managing the stand for persistence and production in the following year. During autumn the ratio of shoot to root production decreases (Moot *et al*., 2003). To maximise this, the crop should be allowed to reach 50% flowering in early-autumn (February–March). For dryland crops, a lack of rainfall may not allow this ideal management during autumn. Delaying the grazing of any autumn regrowth after significant rainfall will assist the plant in recovering below ground reserves. Thus, the ideal management for lucerne (and all pastures), after the rainfall that ends a prolonged summer dry period, is to spell the crop to maximise growth for the remainder of the season. Lucerne growth usually ends in a period of successive hard frosts in late autumn, which damage the vulnerable growing point at the top of the plant. The last clean-up of residual herbage should occur before the end of June in most areas of New Zealand, even if frosts have not stopped growth, before the cycle recommences for the following year.

3.7 Animal Health Risks

When direct grazing lucerne some animal health issues can develop. These are most likely when the lucerne is lush in early spring. At this time the rapid passage of lucerne through the rumen can cause ‘red gut’. Fibre sources such as palatable weeds, straw, patches of grass and/or lignified portions of lucerne stems reduce this risk. Also, on high quality legumes bloat can be a problem, particularly with cattle. To minimize the opportunity for losses, stock should have access to salt or mineral blocks (lucerne stores sodium in the roots and is thus deficient in the foliage; Douglas, 1986). Also, hungry stock should never be put onto lucerne to prevent them from gorging on high quality feed which can cause bloating. When lucerne is lush, after rain, or during early spring, feed hay or give livestock access to adjacent grass or weedy areas for roughage. Bloat capsules and oils are useful when bulls or steers are grazing fresh lucerne but are not usually needed for the clean-up grazing after ewes and lambs. Lucerne can be used for flushing provided the foliage is free of aphids and leaf diseases. On some dryland farms two-tooths and ewes are routinely mated on wilted lucerne (Avery *et al*., 2008). This practice started initially because no other feed was available for flushing in dry years.

3.8 Dairy/Beef grazing

Most of the literature related to grazing management reflects experiences from grazing ewes and lambs, beef cattle and deer. There are fewer examples of direct feeding of lucerne by dairy cows in New Zealand. However, this is common practice in some South American countries. For example, in Argentina, Basigalup and Ustarroz (2007) report 4.7 M hectares of lucerne is grown and, in the Pampa region, over 90% of the lucerne grown is used for direct feeding to dairy and beef cattle. Compared with confined feeding, the lower operational costs, higher utilization *in situ* and healthier animal products for animal consumption were highlighted as advantages for direct feeding. Danelón *et al*. (2002) state that lucerne is the most popular forage for dairy cows in Argentina. Crops are strip grazed at about 69% efficiency but this may be improved by mechanical mowing and wilting prior to grazing. The addition of corn silage supplementation before grazing lucerne may also be used to reduce the incidence of bloat (Bretschneider *et al*., 2007). These well developed feeding systems offer research areas for exploration to assist New Zealand dairy farmers to further utilize lucerne in the diet. Because lucerne is high in nitrogen a large scale adoption of direct feeding may reduce the reliance on nitrogen fertiliser but pose issues for nutrient capture. These are explored in the following sections.

3.9 Nitrogen (N) fixation, forage quality, nitrogen losses

Being a legume, lucerne fixes its own nitrogen and this reduces the requirement for nitrogen fertilizers. The amount of nitrogen fixed will depend on the amount of herbage grown.

3.9.1 Nitrogen (N) fixation

At Lincoln, accumulated N yield (kg N/ha/yr) of irrigated lucerne was 860 kg N/ha averaged across 21.4 t DM/ha which equates to 25 kg N/t DM (Hoglund *et al*. 1974). In dryland conditions a yield of 14 t DM/ha contained 470 kg N/ha or 30 kg N/t DM accumulated (Tonmukaykul *et al*., 2009). This figure is similar to several others reports for legumes in general (Peoples and Baldock, 2001) and shows the benefits of having nitrogen fixing plants within a pasture system. The fixed nitrogen could potentially be released into the soil once a lucerne crop is ploughed up. Following a lucerne crop with a cereal grain crop or greenfeed allows the nitrogen to be used and reduces inorganic N requirements for the following crop.

3.9.2 Forage quality

Lucerne is a high quality forage that can be used to produce fast growth rates of many classes of livestock. Nutritive value of lucerne alters throughout regrowth and as the stand age increases. As regrowth occurs the ratio of leaf to stem material decreases and the stems become lignified (woody). Forage quality is highest for the first spring regrowth because it remains vegetative. When a stand has less than about 1500 kg DM/ha (20 cm tall) it could all be considered as palatable with a metabolisable energy (ME) content of at least 12.0 MJ/kg DM and a crude protein (CP) content above 30% (Brown and Moot 2004). As the yield increased to over 4.0 t DM/ha, the ME of the palatable leaf remained constant and above 12.0, and the CP was about 26%. The stem fraction retained an ME of 8.0 and CP of about 10%. The main change over time is in the proportion of stem herbage. Selective grazing enables livestock to have ME and CP intake significantly above the mean of the feed on offer as the stand matures (Figure 3).

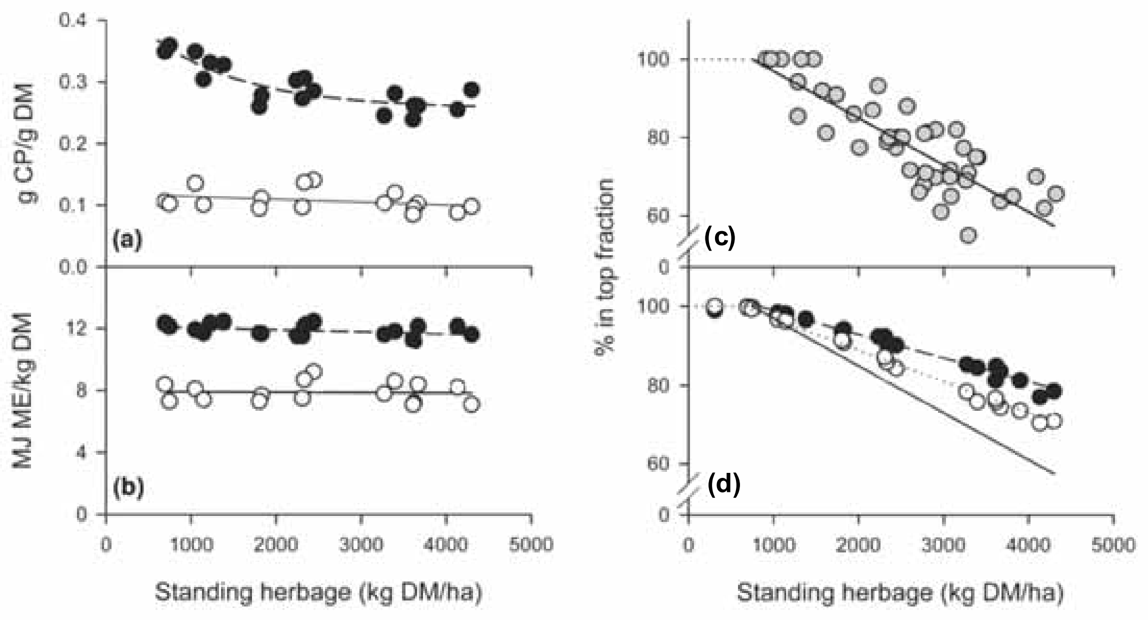

Figure 3 Relationship between (a) crude protein (CP), (b) metabolisable energy (ME) content of palatable (●) and un palatable (○) fractions of 'Kaituna' lucerne herbage in relation to above ground yield (kg/ha) and (c) is the percentage of total herbage in the palatable fraction as standing yield increases throughout regrowth and (d) is the percentage change in CP (●)and ME (○) in the palatable fraction of lucerne regrowth over several regrowth cycles at Lincoln University, Canterbury (Brown and Moot, 2004).

3.10 Nutrient content and quality of hay

The majority of lucerne grown in New Zealand has traditionally been conserved as hay or silage. How much lucerne is conserved is unknown because separate statistics for the crop are no longer kept. For many farmers the appeal of conserved lucerne is that it provides high quality feed that can be stored for later use. The quality of this feed is usually higher than that required for maintenance of livestock. Farmers who direct graze lucerne have a reduced need for conserved feed (Avery *et al.*, 2008). Despite this the main use of lucerne currently remains as conserved feed. In New Zealand a summary of the nutrient content of hay and silage shows an average CP of 21% and ME of 10 MJ/kg DM for both forms of conserved feed (de Ruiter *et al*., 2008).

For lucerne herbage potassium values are higher than found in most other temperate plants. This is because sodium is stored in the roots so a higher concentration of potassium is found in the herbage. Analyses of lucerne hay showed lower critical values associated with the increased proportion of stem. Despite the available potassium in the majority of alluvial based soils (e.g. in Canterbury) there still appears to be a need for potassic based fertilizers with deficiency occasionally observed in the field. For heavily irrigated crops sulphur deficiency can occur although the symptoms often appear similar to nitrogen deficiency.

In addition to N, the mineral content of lucerne hay and silage have been extensively reported, particularly in the USA (e.g. Undersander *et al*., 2000). For actively growing lucerne the young leaves and tops of plants should be sampled to detect any nutrient deficiencies. This is particularly important for lucerne crops that are continuously conserved whereby no nutrients are returned in animal excreta.

During the hay making process some changes in herbage quality can also be expected. Conditioning of lucerne cut for hay (whereby stems are crushed/bent/broken by rollers to allow stem material to dehydrate more rapidly than intact stems under field drying conditions) can reduce the amount of time the lucerne is at risk of being rained on. Rain reduces the quality and quantity of hay due to washing out of soluble carbohydrates. Conditioning, or physically damaging the stem to allow rapid water loss, can cause losses of higher quality leaf and less lignified stem material. This can account for about 50% of the total mechanical losses during the harvesting process. Losses during haymaking occur from respiration (up to 10%), leaching (up to 30%) or rain (sometimes complete crop loss) and mechanical (raking 5-10%) or shatter losses.

3.11 Lucerne for nitrate capture

The most recent estimate of nitrate leaching under lucerne in New Zealand was measured as 10-24 kg N/ha/yr and 0.8-2.0 kg N/ha/yr of ammonium in the Taupo catchment (Betteridge *et al*., 2007). However, data was only from about 25% (0-0.6 m) of the depth that lucerne roots could be expected to be extracting leachate and moisture from (Mathers *et al*., 1975; Daliparthy *et al*., 1994).

The ability of lucerne to extract rather than leach nitrate has been highlighted by several international studies including clean up of N contaminated sites (e.g. Russelle *et al*., 2007). This was due to its deep taproot which allowed extraction of N at soil depths greater than other pasture species. It was also shown that the N_2 fixing lucerne cultivar removed >60% more soil and manure N, and produced 76% more DM yield annually, than a non-N_2 fixing lucerne cultivar. The lower yield of the non-fixing cultivar was caused by the N deficiency when the crop was grown in low soil N areas of the old feedlot due to the patchy N distribution. In the topsoil, soil N levels decreased by an equivalent of 170 kg N/ha.

Lucerne has also been used to prevent excess build up and deep percolation of nitrate N from feedlot operations (Schman and Elliot, 1978). The deep roots and perennial nature of the lucerne meant N removed was almost three times (1 500 kg N/ha) that obtained from the annual crops (600 kg N/ha). Nitrate was maintained near the soil surface and thus minimized deep leaching. An additional benefit from the use of the lucerne was that despite the high nitrogen uptake it did not accumulate nitrate levels to a point that they were toxic to livestock.

The ability of lucerne to reduce nitrate leaching from dairy effluent has been investigated in the USA and Europe (e.g. Lamb *et al*., 2005; Yamada *et al*., 2007). In Massachusetts nitrate-N concentrations under lucerne grown at two sites coped with the application of 112 kg N/ha/yr of liquid dairy manure with no increase in soil N levels (Daliparthy *et al*., 1994). Their 1.2 m suction cups highlighted the advantage of lucerne in drying the soil profile in times of high evapotranspiration making it able to store more moisture and nitrate in autumn than other cropping systems. The application of 336 kg N/ha/yr as liquid dairy manure did increase leaching. In Minnesotta, it was found that a first year stand of lucerne derived 20-25% of its N from biological N fixation (BNF) even when annual N up to 840 kg N/ha was applied in four split applications as ammonium nitrate (Lamb *et al*., 2005).

Russelle *et al.* (2007) investigated lucerne as a phytoremediation agent for an anhydrous ammonia spill. They estimated that total inorganic soil N and nitrate levels in soil solution declined to low levels under lucerne. Over 3 years, it was estimated that lucerne removed 540 kg of inorganic N and total

N removal averaged 972 kg N/ha compared with 287 kg N/ha in annual cereal grain (grain only removed).

Overall the advantages of lucerne as a crop able to extract nitrate from depth in a profile are well documented. Reports of nitrate accumulating under lucerne crops in field conditions are less prevalent suggesting this is not considered a major issue. Lucerne is used in New Zealand to receive effluent (e.g. Section 4.4) but the potential role of lucerne to utilize nutrients particularly from diary shed effluent has not been investigated.

3.12 Lucerne for adaptation to climate change

The predicted biological impacts of climate change for agriculture include direct effects, from increased ambient CO_2 levels, and indirect effects related to the change in climate and consequently weather patterns. The availability of additional CO_2 for plant growth is expected to benefit temperate plants like ryegrass more than tropical plants like maize (*Zea mays*) and white clover (*Trifolium repens*) more than ryegrass (*Lolium perenne*) (Hodgson *et al.,* 1992). Analyses for lucerne are restricted, particularly in New Zealand. However, Erice *et al*. (2006) reported that photosynthesis was stimulated by elevated CO_2 and this resulted in greater dry matter accumulation during the regrowth period. In most cases this CO_2 "fertilization" has also improved water use efficiency (Aranjuelo *et al*. 2006) but the impact on nitrogen fixation may interact with crop water status (Chaves *et al*., 2006).

The climate change scenarios for the east coast of New Zealand indicate drier conditions with warmer winter temperatures. The future climate is likely to be similar to conditions experienced within the climate variability (Salinger, 2003). Thus, utilizing lucerne for dryland situations offers a practical buffering capability for these farmers (Avery *et al*., 2008). The benefits of such change are likely to be enhanced by any future climate change.

From a grazing perspective lucerne offers the potential to grow animals rapidly with high quality feed (Avery *et al*., 2008). Analyses of the benefits of such systems in terms of green house gas emissions have not been quantified. Compared with grass based pastures, lucerne has shown reduced methane emissions per kg of intake, although these were still greater than from other less agronomically competent forages (Waghorn *et al*., 2002). This suggests greater use of lucerne on-farm offers a viable medium term feed source for reducing methane emissions. Furthermore, dryland farmers utilising lucerne may also reduce their overall stocking rate (Avery *et al*., 2008). The combined benefits of such changes need to be quantified against other green house gases such as nitrous oxide and the fate of nitrate (Section 3.11).

4 Farmer Case Studies

4.1 Background

The following section reports four on-farm examples of lucerne use in New Zealand. They represent the flexibility and versatility of the crop in a range of different New Zealand farm systems. Each system is unique, but not exclusive, and many other farmers are also making substantial improvement in on-farm performance by using a higher proportion of lucerne in their farm systems.

4.2 David Adams - Springston

Growing lucerne for a neighbouring dairy operation is proving to be an ideal semi-retirement project for former cropping farmer David Adams. For many years David used to graze dairy stock on his 115 ha Springston, Canterbury farm, for the neighbouring Turner family and the supplying of feed is just a continuation of that relationship. The change from grazing stock to supplying feed occurred three years ago when David sowed 60 ha of lucerne in one hit. In the past two years he has drilled a further 30 ha and says staggering the drilling means the paddocks won’t all be running out at the same time.

4.2.1 Establishment

David Adams has used Pioneer varieties including ‘54Q53’ and these have been drilled into old cereal or Italian ryegrass (*Lolium mutlifolium*) paddocks. He believes it is important to take extra care in establishing lucerne in order to prevent weed populations from dominating the stand. For this reason the paddocks were sprayed before being conventionally cultivated. He feels conventional cultivation breaks the sub-soil and allows the roots of the lucerne plants to penetrate deeper into the soil. Conventional cultivation has also enabled him to level the paddocks out. Prior to drilling the lucerne, David carried out soil tests on all the paddocks to ensure the pH was within the optimum range. He had been working on lifting soil pH’s for the last 10 years to get them to the 6.2-6.3 they are at today. Drilling in mid to late October, he combined the lucerne seed with 12 kg/ha of uncoated barley seed.

The barley served to provide the lucerne plant with some cover in the early stages of establishment and also means that the first cut, which was taken in early January, was a high quality mix of cereal and lucerne. The second cut was taken in late summer after which the crop was allowed to flower. David says it is very important to allow at least 75% of the crop to flower in late summer or early autumn so that the plant can build root reserves to regenerate new shoots early the following spring.

After flowering the lucerne is either grazed off by calves or cut for baleage and then grazed. David says he gets a good months worth of grazing off the lucerne over the early part of winter, with the calves getting a fresh 2 ha break every day so as not to put too much pressure on the plant. For weed control in the first-year stands, David uses a mild chemical such as Spinnaker (a.i. 240 g/litre imazethapyr) at a rate of 400ml/ha as this is not so hard on the young lucerne plants which are still in the establishment phase.

4.2.2 Management

David says that once established he normally gets four cuts off each paddock. Over summer the lucerne is cut, turned into baleage and sold to the Turner brothers' large-scale dairy operation on Rakaia Island, just a few kilometres from Adam's farm. The first cut is typically taken in mid November with the second cut taken around 40 days later depending on the weather. The third cut is taken in January and the fourth is taken after the crop has been allowed to flower. Over winter the lucerne is lightly grazed by around 320 calves.

David says he is getting around 15 t/ha/yr of dry matter off each paddock as well as one grazing and so to replace nutrients a total of 900-1000 kg of 5% Potash Super is applied to each paddock over the course the year. The first dressing goes on after the first cut, the second after the second cut and, depending on soil tests, the final dressing will go on in June.

At the end of June the established stands are also sprayed with either Atrazine or Paraquat to clean up any weeds.

The established lucerne stands are irrigated once or twice in the season by a Briggs RotoRainer which applies 50 mm of water in one pass.

David said "I don't want the plants to rely on irrigation" so he doesn't apply as much water to the first-year crops because he wants to encourage the plants to put down deep roots. He says being a deep-rooted plant the lucerne does deplete the deep soil moisture reserves so in irrigating he is simply topping up these reserves.

Based on his previous experience with lucerne, David is expecting the stands to last around eight years, but is managing the crop to the best of his ability to extend the life of each stand for as long as possible.

4.3 John Ridgen - Greendale

For Greendale farmer John Ridgen, lucerne is an important part of his farm system. John farms 700ha around the Greendale district of Central Canterbury, 300 ha of which is leased. As a specialist lamb finisher, lucerne enables him to keep lambs growing over January and February yet it is flexible in that it can be cut or sold standing in years where there is surplus feed.

Lucerne makes up 40% of the grazeable area of the farm the balance being sown in Italian ryegrass and kale. There are no traditional ryegrass based pastures grown, as without the benefit of irrigation, John has found these fail to maintain lamb growth rates over January and February.

John Ridgen finishes around 20 000 lambs a year and the lambs are growing at an average of 190 g/hd/day throughout their stay on the farm. This means the lambs can, at times, be growing at 450g/hd/d while at other times they will only be growing at 120 g/hd/d. He feels lucerne plays an important part in maintaining relatively consistent growth rates.

4.3.1 Establishment

Soils on John Ridgen's home farm include Templetons, heavier Mayfield soils and stoney Waimakariri soils while soils on the leased blocks include Lismores and Chertsey's. Lucerne is grown on the lighter soils, as arable crops are deemed to be a more economic use of the heavier quality soils on the farm. Only 30ha is irrigated by k-lines and side-roll irrigators, but this water is very unreliable.

John has, over the years, tried different varieties of lucerne and now has in the ground 'Kaituna', 'Torlesse' and 'Rhino'. He has found these varieties have a longer growing season and are more suited to grazing than the Pioneer varieties which had a shorter growing season and tended to be better suited for cutting and carrying. His lucerne stands last between five and eight years, and paddocks are renewed when weed populations have got high but before the plant populations have started to decline. John describes this as a pro-active approach as he would rather get in and renew a paddock before it loses production.

Old lucerne paddocks are put into kale or wheat while new lucerne stands are established into former kale (*B. oleracea* spp. *acephala*) or Italian ryegrass paddocks. The selected paddocks are soil tested to check pH and Olsen P levels, sprayed with glyphosate and minimum tilled. The paddock gets a pre-emergence spray of Treflan and is heavy rolled with the drilled into the crust left by the roller.

John likes the lucerne to be in the ground by October 1st, a time when there is still moisture the soil and soil temperatures are starting to rise. He allows 30% of the crop to flower before it is grazed for the first time and depending on rainfall, can get the first grazing off these paddocks before Christmas. In drier years the paddocks will not get their first grazing until the end of January.

4.3.2 Management

The lucerne paddocks are rotationally grazed. The lambs run onto the stands when they have the bulk of 1.5-2.5 t DM/ha and will graze the crop down to 0.8 t DM/ha. Lambs can spend up to a fortnight on one paddock but in order to prevent red gut, John has a strict policy of not grazing lambs on lucerne for more than five days consecutively. Rather, after five days on lucerne the lambs spend two days grazing Italian ryegrass before going back to the lucerne. John has found this strategy is enough to prevent stock losses.

Management is centred round the animals rather than the lucerne plant, but John believes the crop is not as difficult to manage as many people think. While he allows most lucerne paddocks to flower at some stage of the year, he does not always allow the paddocks to rest over autumn to replenish root reserves. He says he would rather be able to graze the paddocks and get lambs finished over late summer and early autumn, even if it is at the expensive of the longevity of the stand.

Typically John will finish grazing lucerne by the end of May and depending on the season, will start grazing it again on September 1st, or when the crop is 10-12 cm tall.
In years where feed is short, he has grazed lucerne in August, but usually this is the time of year when the Italian ryegrass paddocks are used.

Lucerne paddocks are sprayed for weeds two out of every three years with Paraquat and the paddocks get a dressing of boron annually and molybdenum every second year. Storksbill (*Erodium cicutarium*), shepherds purse (*Capsella bursa-pastoris*), dandelion (*Taraxacum officinale*) and horehound (*Marrubium vulgare*) are the predominate weeds in the lucerne stands on the lighter soils, while cropping weeds and grasses are the most problematic in the stands on the heavier soils.

In the 15 years John has been growing lucerne he has only ever had what he describes as two bad aphid years. He will spray for aphids if the crop is short, if it is long enough he will simply graze the paddocks as this is the cheapest form of aphid control.

Trading cattle are occasionally grazed on lucerne paddocks, but usually they are used to clean up stalk. Because of the risk of bloat, John says cattle are never allowed onto the crop when it is lush.

4.4 Silver Fern farms – Fairton

Lucerne is grown primarily as a cut and carry crop on Silver Fern Farm's 400 ha property at Fairton. A total of 62 ha of lucerne is grown on the irrigated part of the Fairton farm and Harrison says he expects to get four of five cuts off each stand annually. Farm manager Max Harrison says their lucerne paddocks are only ever lightly grazed in winter and this only to remove the bulk of the foliage before the crop is sprayed for weeds. "We regard it as a crop rather than a grazing proposition so winter grazing is just a bonus and used to get it [the lucerne] into the condition we want."

4.4.1 Establishment

Max Harrison says new stands of lucerne are sown in early November, usually following a winter forage crop although, against all the rules, he has tried direct drilling lucerne into some run-out lucerne stands with great success. He gets the first cut off the new paddocks in late January or early February and a second cut in March before they are spelled through autumn. Max has found the paddocks only really start to produce in their second year and he budgets on the stands lasting at least five years.

"With sensible management, especially careful winter grazing, we can make the stands more durable as we don't overgraze them.

This careful management is principally about protecting the crown of the plant which Max believes is the key to stand longevity. When a lucerne paddock does start to run out Max has had success direct-drilling grass into the paddock. The resulting lucerne/ grass mix is sought after for hay and he says he can get two or three years out of this mixed sward before the grass dominates.

4.4.2 Management

The varieties grown include 'Torlesse' and '54Q53' and the lucerne is used in three ways by Silver Fern Farms; in the feed mix for finishing veal on the processor's feedlot, made into silage and fed to cattle and thirdly, sold for $200/t to local feed company Winslow Feeds where it is turned into pelletised stock feed.

Max Harrison says he takes the first cuts off the established stands at the end of October and then takes subsequent cuts every six weeks from then on. When making the decision on when to cut the lucerne he looks for signs of tillering at the bottom of the plant as well as evidence that the plant is about to flower.

Over summer the lucerne crops are watered every 21-28 days by a border-dyke system. This water carries effluent from the processing plant and for this reason it needs to be managed very carefully. Due to the effluent, there is more than enough nitrogen in the soil and Harrison believes the lucerne plants are not fixing as much nitrogen as they would other situations. As well as the nitrogen loading from the effluent, Max says he has to be careful not to get the soil too wet as lucerne plants do not like getting their roots wet. Conversely, the lucerne is grown on Lismore soils which he says are quite light with a water holding capacity of just 75 mm (three inches). This means that in the heat of summer a 21 day irrigation return is barely enough to keep up with plant's water requirements.

On a dry matter basis, Max has found the best quality lucerne crops are those grown in late January/February when he expects to harvest 9-10 t/ha wet or 6-7 t/ha dry. This higher quality lucerne is sold to Winslow feeds. The lucerne paddocks are spelled in late summer and the crop allowed to flower. After flowering the lucerne is cut for hay.

Over winter the lucerne paddocks are lightly grazed by either lambs or calves (never adult stock). Harrison says the winter grazing is seen as a bonus and is primarily to prepare the crop for spraying. Docks (*Rumex obtusifolius*) and mallow (*Malva* spp.) are the most prolific weeds in the lucerne and Harrison uses a powerful brew of Atrazine and Gramoxone (a.i. 250 g/l paraquat dichloride) to help manage their populations.

Lime is applied every second year and while soil pH's, at around 6.4, are high he still sees a response to the lime because the effluent is so alkaline. The paddocks also receive dressings of Potash Super at 250 kg/ha as required, typically every second year.

5 Conclusions

- Lucerne has the potential to provide high quality fed for livestock production systems in New Zealand and has done so in the past.
- Lucerne is predominantly conserved as hay or silage for meeting animal demand in periods of low pasture growth in dryland farming of sheep, beef and deer in NZ.
- Direct feeding of animals on lucerne has significantly improved farm productivity for some dryland farms.
- Use of lucerne in New Zealand dairy systems is low and it is used predominantly as a supplement but direct feeding is possible.
- Research needs include:
    - Regional based information on lucerne productivity and agronomy,
    - Direct feeding systems for dairy grazing including the use of concentrates
    - Use of lucerne for nitrate capture, effluent disposal
    - Lucerne changes made on farm in relation to green house gas emissions

6

Glossary

Conditioning a process whereby the stems and leaves are squashed, cracked or kinked as an aid to drying.

Cultivar distinct line, selection or variety of plant species.

Green pick grazing a pasture or lucerne stand quickly as soon as it shows signs of growing after winter or drought.

Lodging the crop falling over as the stem becomes unable to support the combined stem/leaf weight.

ME metabolizable energy, energy available to animal (expressed as megajoules ME per kg of dry matter).

Red-gut a condition associated with sudden dietary change or unlimited access to lush green feed of high soluble protein and low fibre which can cause stock death. Autopsies show gut distension, reddening and twisting of the small and large intestines. Risk can be minimised by slow introduction of new feed source to “full” animals (to prevent gorging and allow the gut to adapt to change in feed quality) and access to additional fibre sources during acclimation period.

Senescence the yellowing or dying of plant leaves as they age.

Set-stocking continuous grazing of an area for long periods by same stock.

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