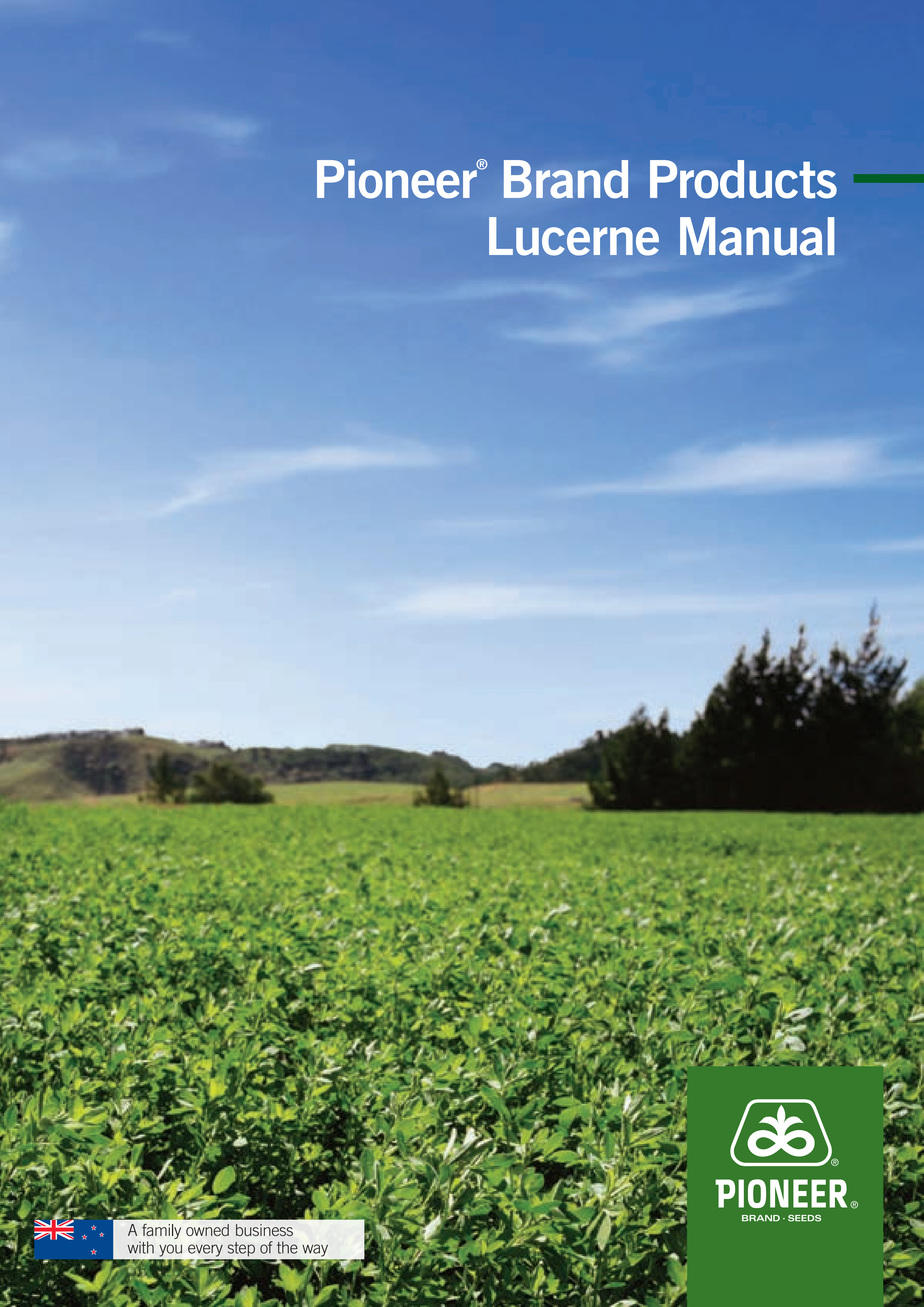
Pioneer® Brand Products Lucerne Manual



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Abbreviations

ADF = acid detergent fibre
BGA = blue green aphids
C = celcius
cm = centimetres
ha = hectare
kg = kilograms
kgDM = kilograms of drymatter
kg/ha = kilograms per hectare
kgMS = kilograms of milksolids
m = metres
ME = metabolisable energy
mm = millimetres
MS = milksolids
N = nitrogen
NDF = neutral detergent fibre
SAA = spotted alfalfa aphids
tDM/ha = tonnes of drymatter per hectare
ug/g = micrograms per gram
WUE = water use efficiency

INTRODUCTION

Lucerne is the major forage legume grown in approximately 45 million hectares worldwide. It is the oldest plant grown solely for forage with livestock feeding dating back to more than 3,300 years ago. Lucerne is a reliable, perennial deep-rooted legume that is well adapted to both irrigated and non-irrigated land in most climates. Environmentally friendly, lucerne improves soil health and allows sustainable animal production.

KEY STRENGTHS OF LUCERNE

- **Drought tolerant**. Lucerne has a deep rooting structure which allows it to access water and nutrients that have dropped out of the root zone of many other crops.
- **Soil builder.** As a legume, lucerne increases soil nitrogen (N) and organic matter enhancing soil structure and fertility. Approximately 100 kgN/ha/year is available for 3-4 years after its removal.
- **Versatile**. Can be used for on-farm grazing and forage conservation or for producing silage or hay for sale.
- **Perennial crop.** Lucerne produces greenfeed for much of the year. Productive stand life of 5-7 years.
- **Wide adaptability.** Lucerne grows well under a range of climatic and soil conditions.
- **High yielding.** Lucerne produces 12-20 tDM/ha/year.
- **Excellent feed quality.** Lucerne can be used to increase animal performance.
- **Strong global focus on lucerne breeding**. This means that new varieties with improved yield potential and greater disease resistance will be available into the future.

In New Zealand lucerne forms an integral part of many farm systems. Its production of high quality feed allows farmers to achieve high levels of animal production even under dry soil conditions. Lucerne is an excellent candidate for irrigation because it has a higher water use efficiency (WUE) than pasture as well as a deep rooting system that allows it to extract water that has dropped out of the root zone of pasture.

ESTABLISHMENT

Profitable lucerne production is based on a rapidly growing, dense stand. A profitable stand is the result of careful selection of well-drained paddocks, the addition of lime and required nutrients, good weed control, a proven variety and the use of good planting practises to ensure germination and establishment.

TIPS FOR GOOD STAND ESTABLISHMENT

- Choose a paddock that is well drained and spray out to eliminate all weeds (including grasses).
- Soil test to determine crop lime and nutrient requirements. Aim for a pH of 6.5-6.8.
- Cultivate to achieve a fine, even seedbed with no compaction layers.
- Plant high quality, certified seed. Certified lucerne varieties, although more expensive, provide better germination rates and establishment, better drymatter production, better aphid and disease resistance and are weed-free.
- Avoid sowing lucerne seed into dry soils. Sow early in dry areas to ensure that seedling plants have adequate moisture for successful establishment.
- Plant lucerne no deeper than 25 mm with the optimal soil depth ranging from 6-12 mm on clay and loam soils and 12-25 mm on sands.
- Plant coated seed and sow at 12-18 kg/ha.

Paddock selection

Lucerne requires a well-drained soil for maximum production. Waterlogged soils create conditions for Phytophthora Root Rot and other fungal diseases that may kill seedlings, reduce yields and kill established plants. Poor soil drainage also reduces oxygen movement to the roots reducing stand performance.

Weed control

Good weed control is critical for good stand establishment and subsequent yield and persistence.

If possible, perennial weeds should be controlled prior to planting since they can re-establish quickly and are difficult and expensive to remove from seedling crops. For better control, consider spraying-out perennial grasses such as couch in the autumn when they are actively growing. In cases where pressure from perennial weeds is severe, consider cropping the ground for 12 months prior to lucerne crop establishment.

When planting into paddocks containing yarrow or clover, consider adding tribenuron-methyl with the glyphosate when the area is sprayed out prior to cultivation. Please note tribenuron-methyl should not be applied within two months after lime application

Autotoxicity
Autotoxicity occurs when a plant species releases a chemical substance that inhibits germination and growth of the same plant species. Lucerne produces such a toxin. The older the lucerne stand, the higher the levels of toxin. For this reason any attempts to rejuvenate an old lucerne stand or to re-establish lucerne on a pre-existing stand that is more than one year old will usually be unsuccessful. Rotating to other crops for at least one year allows time for these toxic substances to degrade.

Sulfonylurea herbicides
Sulfonylurea herbicide residues can damage lucerne seedlings and reduce plant density. Ensure that the soil is free of sulfonylurea herbicides for at least two years prior to sowing lucerne.

Soil test pre planting
High soil fertility promotes early growth and increases stand tolerance to insect and disease pressures. It also increases crop yield and quality and improves stand persistence. A 150 mm soil sample should be collected in the autumn preceding spring planting. This sample should be tested for standard nutrients as well as sulphate-sulphur and micronutrients particularly copper, molybdenum and boron.

Once you have the soil test results contact your local Pioneer Area Manager, merchant or fertiliser company representative for a fertiliser recommendation. If possible, all of the micronutrients and a proportion of the base fertiliser (N, P, K, S, Mg) and calcium should be applied several months in advance to allow the micronutrients to become plant available and to raise the pH closer to the desired level.

Soil pH and liming
The optimum soil pH for lucerne is 6.5-6.8.

If soil pH is between 4.8 and 5.5, lucerne production may be reduced. Below pH 4.8, it will be difficult to get satisfactory establishment and lucerne growth will be markedly reduced.

Benefits of maintaining pH levels include:

- Increased stand establishment (Figure 1), early growth and crop vigour.
- Increased nitrogen fixation. Liming creates an environment conducive to *Rhizobia* bacteria survival, effective root nodulation and nitrogen fixation.
- Reduced potential for nutrient toxicities. Manganese, iron and aluminium become more available in toxic amounts to the lucerne plant at low soil pH.

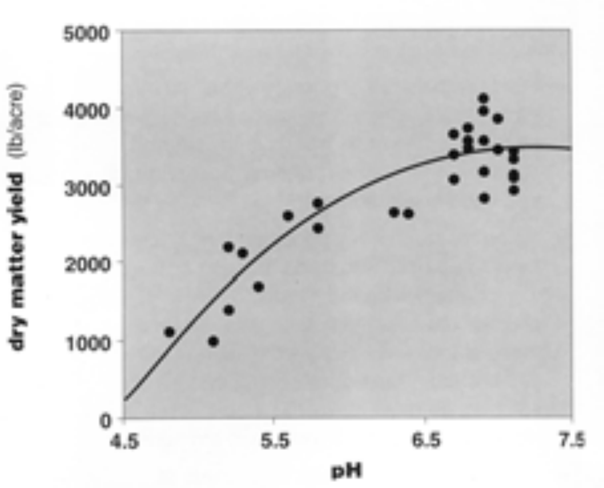
Increased availability of essential nutrients.
Phosphorus, potassium and molybdenum are made more available at neutral pH levels while the lime itself supplies calcium and/or magnesium (Figure 2).

The following signs might indicate that the soil is too acid for lucerne:

- Having trouble getting lucerne successfully established.
- Poor early growth.
- Poor persistence of recently sown lucerne.

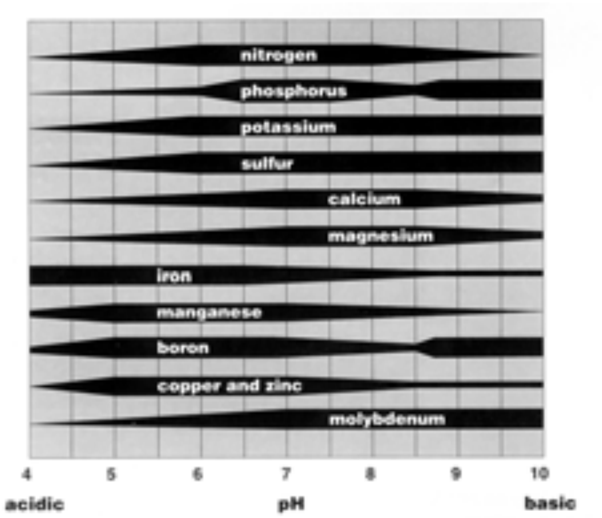
If the pH is very low and more than 3 tonnes of lime per hectare are required, consider applying 50% of the lime pre ploughing and the remainder post ploughing.

Figure 1: Lucerne first cut yield relative to soil pH



Source: Wollenhaupt and Undersander, University of Wisconsin, 1991

Figure 2: Available nutrients in relation to pH



Nutrient requirements during establishment

a. Nitrogen

The nitrogen needs of lucerne are met through a symbiotic relationship between the plant and nitrogen-fixing bacteria called *Rhizobia*. In this mutually beneficial relationship, the plant furnishes carbohydrates as an energy source for the bacteria and the bacteria convert atmospheric nitrogen into a form that the plant can use.

Research has shown that applying nitrogen to established lucerne greatly reduces nitrogen fixation by the *Rhizobia* bacteria and has no effect on forage yield or seedling vigour. Added nitrogen can stimulate weed growth, particularly of grasses.

The young lucerne seedling relies partially on soil nitrogen until the *Rhizobia* become established and active. In paddocks where soil nitrogen levels are low (e.g. poor or run-out pastures or continuously cropped paddocks) the addition of a small amount of nitrogen at planting (e.g. 20-40 kg/ha N) may improve early growth.

b. Phosphorus

Lucerne seedlings need relatively large quantities of phosphorus for rapid root growth and strong seedling development. Apply phosphorus in the base fertiliser application prior to seeding to build Olsen P levels. Under adverse growing conditions such as cool soils or drought where nutrient uptake is impaired, adequate phosphorus fertility helps ensure continued root development and plant survival.

c. Potassium

Potassium is a most important nutrient for lucerne production. Although the potassium requirement of lucerne is low in the seedling stages the demand increases rapidly with plant growth.

Potassium improves overall plant health by making plants less susceptible to diseases. It provides higher drymatter and total crude protein yields and enables the lucerne to better compete with weeds and grasses.

Lucerne is a surface feeder of nutrients and absorbs most of its potassium requirement from the top 150-200 mm of the soil.

d. Calcium, Magnesium and Sulphur

Both calcium and magnesium play important roles in plant nutrition. Sulphur is important in protein formation.

e. Micronutrients

Lucerne requires a number of micronutrients for growth (see Table 2, page 13).

Boron is an important element in cell division and other plant functions. Under drought stress conditions it is the micronutrient most likely to limit yields. Boron deficiency is more likely to appear on light sandy soils or silts during dry weather.
Molybdenum is needed for nitrogen fixation by *Rhizobium* bacteria on the plant roots and in the synthesis of protein.

Copper deficiency is more likely to appear on light, sandy soils. Symptoms include wilting and downwards curling of the youngest leaves, faded grey-green coloured foliage and short, bushy plants.

Select a proven variety

Several important factors must be considered when choosing a lucerne variety (Wiersma et al, 2000).

- High yield potential. Total yield has a huge impact on the profitability of lucerne production.
- Disease resistance. Multiple disease resistance is an important risk management strategy. Many diseases do not affect the health of the lucerne plant each year but having good disease resistance will prevent catastrophes and will likely show in large yield differences at least once during the life of a stand.
- Stand persistence. Healthy plants that persist throughout the productive life of the stand results in higher profitability. Persistence is often influenced by plant health, weed infestation, insect management, soil fertility and climatic conditions.
- Forage quality. When other yield, disease resistance and stand persistence criteria are met, growers may also want to consider forage quality.

Pioneer lucerne breeders have developed varieties with greater yield potential and resistance to many diseases and improved forage quality.

As illustrated in Table 1, yield has the largest effect on cost per kilogram of lucerne drymatter. A 5% increase in yield will substantially decrease drymatter cost. Greater persistence and cheap seed have a negligible impact on the cost of lucerne drymatter. In fact, using the example in Table 1, you can afford to pay $4/kg more for a lucerne variety that will give a yield advantage of just 50 kg/ha per year.

Table 1: Factors influencing the per kilogram of drymatter cost of lucerne

Factor	Cost per kgDM (cents/kgDM)
Standard yield (Year 1 – 9 tDM/ha/yr, Year 2+ -15 tDM/ha/yr, 6 years stand life, $21.70/kg seed cost)	23.0
Increased yield (5% per annum higher yield)	21.9
Better persistence Longer stand life (7 years vs. 6 years)	22.9
Lower seed price ($16.70/kg vs. $21.70/kg)	22.9

Lucerne varieties have a range of dormancies.

Winter actives are the least winter dormant group. They can produce up to 20% of their growth during the winter months. They generally have a short stand life (3-4 years). Winter actives have a higher crown making them more susceptible to disease and crown damage by machinery. They should not be grazed. Winter actives have more winter growth but once established all dormancies yield approximately the same amount of drymatter per year.

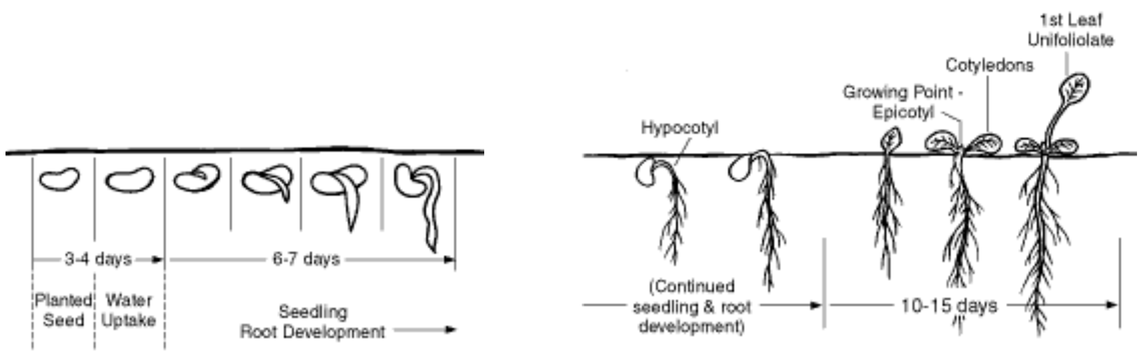
Semi-dormants produce up to 5-10% of their growth in the winter. Under good management, they have an economic stand life of 5-7 years or more.

Dormant varieties have little to no winter growth. They have the longest productive stand life and the crown is below the ground making these varieties more suitable for grazing. In terms of quality, dormant varieties have the highest leaf to stem ratio and therefore better forage quality.

Time of planting

Lucerne seeds begin to germinate after absorbing about 125% of their weight in water. Lucerne can germinate at temperatures greater than 2°C however the optimum germination temperature is higher. The rate of germination increases as soils warm because water movement into the seed, along with the rate of other metabolic activities associated with germination also increases.

Figure 3: Lucerne germination and emergence (Meyer, 1999)



Lucerne may be planted in either autumn or spring. Semi-dormant and dormant lucerne varieties do not reach full production levels until the second season. When planted in the autumn, these varieties have the winter to establish a good root system and tend to give higher first year yields compared to spring established crops. The downside is that the paddocks are virtually out of production over the first winter. In drier districts autumn sowing (once rainfall has become reliable) can give advantages in that it enables the seedling plant to become well established prior to the risk of summer moisture stress.

In cold districts crops generally require a minimum of 6 weeks growth after germination to survive the winter. The plant will usually survive if it forms a crown before a killing frost. The crown allows the plant to store root reserves for winter survival.

Spring sowing can begin in September-November. Remember that lucerne is a small seed, so time planting so that emergence is completed prior to the soil surface becoming too dry.

Crop planning
In the North Island in particular, lucerne production appears to be highest when lucerne is planted immediately after a crop rather than pasture. The full reason for this is unclear but improved soil fertility and weed control will have an influence. The ideal situation is to spray out pasture in the spring and plant a summer crop (e.g. maize silage, turnips etc). Once the crop is harvested in the autumn, weeds can be sprayed out, the area cultivated and the lucerne crop planted. Because lucerne requires high pH soils, some lime can be applied immediately after the pasture is sprayed out and then again after the crop but prior to lucerne establishment. Always refer to a soil test to determine exact lime requirements.

Lucerne is susceptible to infection from *Sclerotinia* (stem rot) fungus while in the establishment phase only. Care should be taken when planting lucerne in areas that have been planted in red clover, chicory, potatoes, onions and any other host crop. Contact your Pioneer Area Manager for further information.

Seedbed preparation
Establishing a uniform lucerne stand requires complete weed control in a firm, moist seedbed relatively free of surface trash. This promotes good seed to soil contact, uniform planting depth and aids in moisture availability to the seed. Pasture or winter crops should always be sprayed out with a herbicide such as glyphosate.

As well as beginning to prepare the soil for sowing the primary cultivation should aim to eliminate compaction layers which may impede lucerne growth. These most often occur in long term pasture hay or silage areas.

After the primary cultivation base fertiliser (or in the case of a split autumn/spring application the remaining fertiliser) can be applied. Cultivation should incorporate this fertiliser into the top 75-100 mm of soil and create a fine, even seedbed.

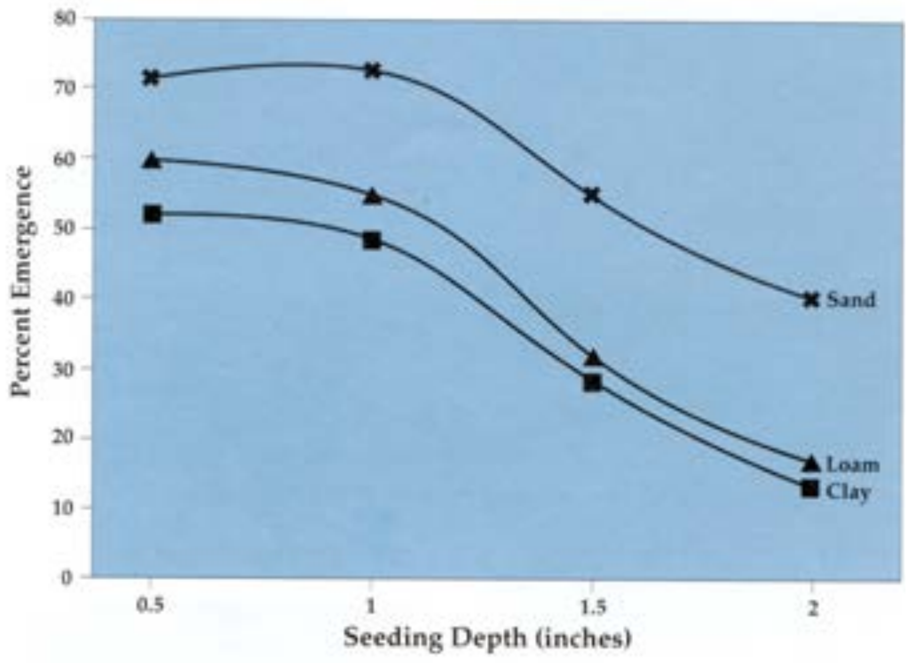
Prior to the final surface cultivation, a pre-plant grass and broadleaf herbicide should be applied (e.g. trifluralin). Please note that trifluralin is not effective on peat soils or soils over 9% organic matter.

Planting depth
Lucerne is a small seed with a limited supply of stored energy to support the developing seedling therefore correct seeding depth is very important. Placing seed in a moist soil at a uniform relatively shallow depth maximises germination and emergence.

Plant lucerne no deeper than 25 mm with the optimal soil depth ranging from 6-12 mm on clay and loam soils and 12-25 mm on sands. Seeding depths of greater than 25 mm make it difficult or impossible for the seed to germinate. Lucerne seedlings that do emerge from

deeper than 25 mm are weaker because of the energy expended during germination. Use the shallow depth for early spring seedlings when moisture is more abundant.
Roll-seed-roll is the most desirable planting method however care must be taken to ensure that the "V"'s from the front roller are no more than 25 mm. If the ground is soft and the "V"'s are deeper than this recommended depth, consider rolling prior to planting. An alternative recommended planting technique is to drill using a seed drill that has depth control on each individual coulter.

Figure 4: Effect of planting depth on germination percentage



Source: Sund et al., University of Wisconsin, 1966

Sowing rate
Order lucerne seed supplies ahead of planting and store seed in a cool, dry place.
The recommended seeding rate for lucerne ranges from 12-18 kg/ha for coated or untreated (bare) seed. The planting rate will vary depending on the condition of the seedbed, the soil type, method of planting and planting date. A typical planting rate is 15 kg/ha. The aim is to establish a plant stand of 60-90 plants per square metre in low rainfall areas and 110-130 plants per square metre in high rainfall or irrigated areas. Stems per hectare can also be used as a guide. Aim for 700-900 stems per square metre under good growing conditions and 400-600 stems per square metre under lower rainfall conditions. Lucerne is a self-thinning crop and it is more desirable to over-populate than to reduce the sowing rate resulting in a plant population too low for maximum production. High initial densities do not detrimentally affect long-term yields or persistence.

Seed inoculation
All lucerne seed should be inoculated with Group A *Rhizobium* inoculum. Once inoculated, lucerne can convert atmosphere nitrogen to a form available to the plant with the aid of *Rhizobium* bacteria. It is recommended that you use a seed coating that includes the *Rhizobium* inoculant as well as fungicides and some micronutrients.

Always plant seed that has been freshly inoculated or is within the guarantee period for the seed coating. Avoid planting seed which has been held over between seasons unless the seed has been tested and proven to have viable *Rhizobium* counts, or has been re-inoculated.

Nitragin* Plus lucerne seed treatment
Nitragin* Plus is a new lucerne treatment only available on Pioneer® brand lucerne seed. It contains:

- Superior strains of selected nitrogen-fixing bacteria (Rhizobium) resulting in high levels of nitrogen fixation for maximum crop yields.
- Apron XL®2 fungicide which is effective against fungal seedling diseases (including "damping off" disease.
- Lime for localised pH correction around the seed.

The benefits of Nitragin* Plus are:

- Superior seed adhesion with minimal dust making planting easier and more accurate.
- Patented seed drying process which assures customers of high Rhizobium levels on every seed.
- Excellent product stability – guaranteed Rhizobium shelf-life of two years from coating.
- 9% weight build-up in the coating process.

Nitragin* Plus is recommended for the establishment of all Pioneer® brand lucerne crops.

Post plant weed control
There are a range of herbicides that can be used to control weeds in lucerne. Contact your local seed supply merchant or herbicide company representative for paddock specific advice. Always follow the manufacturers' instructions for rate and timing of application and product mixing carefully.

* Nitragin is a registered trademark of EMD Crop BioScience and/or its affiliates

®2 Registered trademark of Syngenta

PRODUCTION

Once a good stand has been established, total drymatter yield and stand persistence depends on good management practices. Good management includes maintaining soil nutrients and controlling weeds (especially grasses) and insects. Monitor diseases to estimate stand life and to determine resistance needed in future plantings. Finally, production involves deciding when to plough down stands that are no longer profitable.

TIPS FOR MAXIMISING PRODUCTION

- Soil test (150mm test plug) annually to determine fertiliser and lime requirements.
- Apply fertiliser after the first cut and every second subsequent cut during the growing season.
- Control weeds to maximise the quantity and quality of lucerne harvested.
- Keep an eye out for insect pests and use appropriate control methods where necessary.
- Avoid sowing lucerne seed into dry soils. Sow in early spring or later in autumn in dry areas to ensure that seedling plants have adequate moisture for successful establishment.
- Lucerne responds well to irrigation. If you are able to apply water ensure that available soil moisture does not fall below

Annual fertiliser application

For the highest drymatter production the fertiliser rule of thumb is to top-dress after the first cutting in spring and again after every second cutting. The best time to apply is directly after harvest to avoid burning the regrowth. Avoid top-dress application of fertiliser to wet foliage. Nutrient removed per tonne of lucerne drymatter harvested is shown in Table 2.

Table 2: Nutrient removed per tonne of drymatter

Nutrient	Amount removed (kg/tonne drymatter)
Phosphorus (P)	2.8
Potassium (K)	22.1
Calcium (Ca)	13.8
Magnesium (Mg)	2.8
Sulphur (S)	2.8
Boron (B)	0.04
Manganese (Mn)	0.06
Iron (Fe)	0.15
Zinc (Zn)	0.02
Copper (Cu)	0.05
Molybdenum (Mo)	0.0009

Soil test

A soil test indicates whether the pH is suitable for maximum lucerne production and provides the information needed to make accurate economic decisions regarding fertiliser application. By testing annually, optimum fertiliser applications can be made to ensure desired fertility levels are maintained. In lucerne, soils can be sampled after any cutting. A 150 mm soil sampler should always be used.

Leaf analysis

Plant tissue analysis can determine the nutrient status of your crop before any visual symptoms appear. Used as a companion with soil tests, plant tissue analysis can assist in monitoring nutrient levels.

Begin sampling at or before first flower. Collect the upper 150 mm or one third of the plant. Make sure that all the plant tissue collected is at the same level of maturity or taken from the same relative position on the plant. Sample 25-40 stems avoiding plants damaged by insects, diseases or chemicals unless such damage is the objective of the analysis.

Proper handling of the samples is important for the analysis to be reliable. Make sure plant samples are clean by shaking or wiping with a damp cloth. Do not wash or rinse in water as soluble nutrients can be lost. **DO NOT** place samples in plastic bags or sealed containers as this promotes mould growth. Heavy paper or cardboard containers work best.

Table 3: Average nutrient levels in lucerne (top 150mm at a vegetative growth stage). Data supplied by Hill Laboratories.

Nutrient	Unit	Normal range
Nitrogen	%	4.5-5.0
Phosphorus	%	0.26-0.70
Potassium	%	2.5-3.8
Sulphur	%	0.26-0.50
Calcium	%	0.51-3.00
Magnesium	%	0.31-1.00
Sodium	%	0.00-0.05
Iron	ug/g	30-250
Manganese	ug/g	30-100
Zinc	ug/g	20-70
Copper	ug/g	10-30
Boron	ug/g	30-80
Molybdenum	ug/g	0.90-2.00

Nutrient deficiencies

Visual symptoms can be used to assess nutrient deficiencies although by the time visual symptoms appear on a crop, substantial yield penalties have probably already occurred.

Table 4: Nutrient deficiency symptoms in lucerne

Nutrient deficiency	Symptoms
Nitrogen	Yellowing especially in the older leaves which die and drop off. Spindly growth.
Phosphorus	Blue-green colour, stiff stunted and erect growth. Small dark green to purplish curled leaves.
Potassium	White spots in an even pattern around leaf margins. Yellowing and death of leaves in advanced cases.
Calcium	Stalks collapse on youngest fully developed leaves. Impaired root growth or rotting.
Magnesium	Yellowing of lower leaves, margins initially remain green.
Boron	Dwarfed plants with red-purple discolouration of lower leaves and yellow top foliage.
Iron	Yellowing of youngest leaves, bleached appearance.
Manganese	Yellowing of leaves and growth reduction.
Zinc	Reduced leaf size and upward curling of youngest leaves.
Copper	Youngest leaves are bent back with pale grey to white spots.
Molybdenum	Pale green stunted as with nitrogen deficiency.

Weed control

Herbicide selection should be based on weed species present so be constantly alert to changing weed problems and their densities in the field. The decision to use herbicides for weed control in established lucerne should be based on the amount and type of weeds present and the lucerne stand density. Mowing prevents weed seed production and causes perennial weeds to grow from roots. Repeated mowing can suppress some persistent weeds by gradually reducing their root reserves.

There is a range of herbicides available for weed control in lucerne. For a specific recommendation, contact your local Pioneer Area Manager, seed supply merchant or chemical company representative. Always follow the manufacturer's instructions for rate and timing of application and ensure that product is mixed carefully. Always thoroughly flush spray tanks pre and post herbicide application.

Insect management

a. Aphids

Aphids are the major insect pests in New Zealand lucerne. They cause yellowing of lucerne and growth suppression. Heavily infested plants wilt during the hottest parts of the day.

Cultural controls such as selection of aphid resistant varieties and reliance on beneficial insects (e.g. lacewings and ladybirds) or fungal disease (most common under moist warm conditions) should be employed before chemical control is implemented.

It is recognised that spraying pesticides is still necessary for yield protection when infestations are high. Damage thresholds vary greatly depending on the weather.

Control decisions should not be based solely on pest levels but also the rate of pest increase. Rapid pest population growth means greater damage potential. Gradual pest increase or plateauing (stable) levels may indicate good predator activity and delay or preclude the need to spray.

The standard sweep net sample consists of two swift 2.6 metre sweeps through the top 30 cm of a crop. The standard net is white nylon (1 mm) mesh 38 cm in diameter, 70 cm deep and the handle is 120 cm long. Ten to 20 samples are taken and the average number of insects per sample is then determined. Ideally the check should be carried out on a warm fine day when insect numbers are likely to be at their highest.

Blue green aphids: Adults are 3 mm long and have a waxy, bluish appearance. Their antennae are uniformly dark in colour. They are slightly smaller than pea aphids that are lime and glossy green. Blue green aphids (BGA) feed on the growing tip of the plant sucking sap. Damage is observed as reduced growth, shortened distances between the nodes of the stem, leaf puckering and the death of young seedlings. Beneficial insects can significantly decrease BGA levels. An early cut can often avert the need to spray although this is detrimental to the stand if done regularly. If BGA populations escalate, spray fresh regrowth at 100 per sweep and older growth at 300-400 per sweep sample. Spray seedling lucerne seedlings when 2-3 aphids are found per plant. Strategic use of a selective aphidicide (e.g. Pirimor 50) will often allow natural predators to control the population subsequently.

Figure 5: Blue green aphids (left picture) and Figure 6: Spotted Alfalfa Aphids (right picture)
(Department of Agriculture, Western Australia)

***Spotted alfalfa aphids*:** Adults are yellowish/olive and 2 mm in length. They are normally a pest from late spring until early autumn. Spotted Alfalfa Aphids (SAA) feed low on the plant and move upwards as they reproduce. They suck sap and inject a toxin into the plant causing yellowing of the leaves, premature water stress and flower and/or leaf drop. Copious quantities of honeydew are produced and this acts as a host for sooty mould. Spray when SAA populations reach 80 per sweep on fresh regrowth or 150-200 per sweep on more mature plants. Spray when one SAA is found per seedling.

There are a range of non selective insecticides that will control aphids in lucerne. They will also have some effect on the population of natural predators and therefore should be used with care. For a specific recommendation, contact your local Pioneer Area Manager, seed supply merchant or chemical company representative.

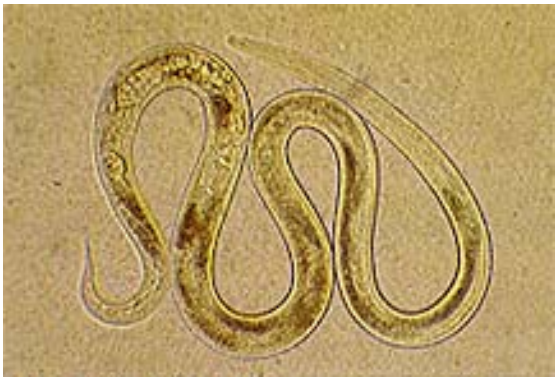
b. Stem Nematode

The stem nematode is an important pest especially in Canterbury and North Otago. Heavy infestations can severely reduce spring production and even kill susceptible lucerne cultivars. Stem nematode are microscopic roundworms 1-1.3 mm in length. The symptom of nematode damage is patches of stunted plants. These typically have swollen brittle stems and thickened nodes. Crowns of infected plants are swollen, discoloured, spongy and produce few stems. A very small percentage of affected plants may have one or more stems that are completely white.

Stem nematodes survive unfavourable periods in the crown of infected plants, infested hay and crop debris, seed and in soil (Pratt et al, 1998). The nematodes are spread to new areas by surface water run-off, wind-blown crop debris, soil and crop debris clinging to equipment, humans and livestock and with seed.

Chemical control of stem nematode is possible although the economics are questionable. Efforts should be made to prevent the spread of stem nematode into new areas by removing crop debris and soil from machinery before entering a new paddock. Rotation with cereal crops for 2-4 years will reduce stem nematode populations however low numbers of nematodes may survive the rotation period and begin to increase when lucerne is re-introduced. The most effective method of control is to plant a stem nematode resistant cultivar. Even the best varieties may become infected and develop symptoms during years with extended periods of wet, cool conditions (Pratt et al, 1998).

Figure 7: Microscopic view of a stem nematode. (Pratt et al, 1998)



c. Sitona Weevil

Adults are 44 mm long and fawn in colour. They have three cream stripes along the thorax (Figure 8). Eggs are cream and shiny when first laid but turn black within two days. Newly hatched larvae are 1 mm long and 0.2 mm wide. They grow to a length of 7 mm and a width of 2 mm. The body is milky-white and the legs are almost invisible. Sitona weevil larvae consume the roots and nodules of lucerne while adults eat the leaves.

Where there are a few weevils in a paddock, the only symptom of their presence is the occasional U-shaped notch in the edge of a leaf usually about 3 mm along the margin. Moderate infestations can be recognised when the leaves have many notches eaten out of them giving them a scalloped appearance. In heavy infestations the leaves are skeletonised.

Larvae damage the root nodules which leads to symptoms the same as for nitrogen deficiency (Wightman, 1998).

Figure 8: Adult Sitona Weevil (right picture) and Figure 9: Lucerne leaves showing Sitona Weevil damage (Department of Agriculture, Western Australia)

Sitona larvae are protected within the soil and cannot be killed. Adults can be controlled with insecticide but the economic returns on spraying are questionable unless insect levels are high.

d. Green Looper

The larvae are important pests of many solanaceous plants especially potato and tomato. Green looper can attack a range of plants including lucerne. Young caterpillars often make a series of small holes in the leaves and may leave the upper epidermis intact. This type of damage is termed windowing. Adults are 18-20 mm long and velvety brown in colour. Eggs are white, about 0.5 mm in diameter and usually laid singly or in small clusters on the underside of leaves.

The larva is a "semi looper" having three pairs of false legs instead of the normal five. It walks by "looping". All instars are pale green and later instars have thin white lines along the body. Large green droppings are a typical trademark of this caterpillar. There are at least four generations per year with the life cycle continuing at a faster rate during the summer months.

Crop residues that could harbour this pest should be disposed of. There are natural predators but spraying with a synthetic pyrethroid is usually necessary.

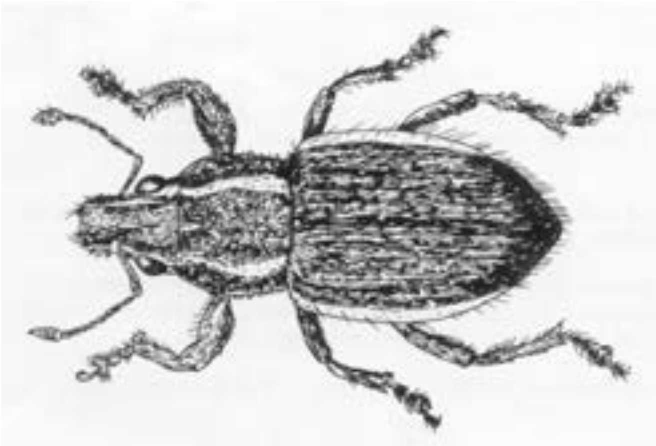
Figure 10: Green Looper larvae with droppings

e. White-fringed Weevil

Lucerne is one of the known host plants of the White-fringed Weevil. Weevils, sometimes called "snout beetles" have the head extended to a beak which carries the antennae and mouthparts. The adult is about 10 mm in length with a grey and white stripe pattern. Eggs are white, soft and somewhat shapeless. They are laid in ground litter in clusters of 20-60 which are cemented together with bubbly mucous which hardens into a protective film. The larvae hatch in about 3 weeks under favourable conditions or 1-2 days after the onset of rain if the eggs were laid in a dry period. They burrow into the soil where they feed throughout the winter. The mature larvae are about 15 mm long and cream in colour.

Since larvae feed on roots, the damage that they cause is only noticed when the plants begin to show signs of stress by becoming yellow or stunted and wilting. Seedlings and drought or graze-stressed crops are worst affected.

Figure 11: White-fringed Weevil adult



Insecticides may be used to control white-fringed weevil adults.

Disease management

a. Phytophthora Root Rot

Phytophthora Root Rot can kill both seedlings and established plants in wet or poorly drained soils. The disease can be devastating to seedling stands in cool wet conditions. As plants emerge they collapse and wither.

The disease can cause significant plant loss in established fields that are poorly drained or where water has ponded for up to three days. The infected plants wilt and the foliage, especially the lower leaves, turns yellow to reddish brown. Regrowth of affected plants is often slow after cutting.

Root lesions develop and in severe cases the tap-root may rot off at the depth of soil water saturation. This is often 100-200 mm below ground level. Plants may die within one week of infection or linger on with reduced root mass and growth rate. Often Phytophthora Root Rot is not discovered until the soil dries and apparently healthy plants begin wilting because their rotted tap-roots are unable to supply adequate water.

Soil and water management is the best control (where possible). Avoid poorly drained soils. Deep cultivation may break up compacted layers reducing the time that soil remains saturated. Monitoring the length of time water is applied helps alleviate the disease in irrigated areas. Resistant cultivars have been developed and combined with good management practises; these have been successful in controlling Phytophthora Root Rot.

b. Verticillium Wilt

Verticillium Wilt can reduce yields by up to 50% by the second harvest year and it severely shortens stand life. Early symptoms include V-shaped yellowing on leaflet tips, sometimes with leaflets rolling along their length. The disease progresses until all leaves are dead on a green stem. Initially, not all stems of a plant are affected. The disease slowly invades the crown and the plant dies over a period of months. The internal root tissue of infected plants is frequently brown. Root vascular tissues may or may not show internal browning. Resistant cultivars are the most effective means of coping with Verticillium Wilt.

c. Fusarium Wilt

Fusarium Wilt is a vascular disease that causes gradual stand thinning. Initially, plants wilt and appear to recover overnight. As the disease progresses, leaves turn yellow then become bleached, often with a reddish tint only on one side of a plant. After several months the entire plant dies. To diagnose Fusarium, cut a cross section of the root. The outer ring (stele) of the root is initially streaked a characteristic reddish brown or brick red colour. As the disease progresses the discolouration encircles the root and the plant dies. Because the pathogen that causes Fusarium Wilt persists in the soil for several years, the only practical control is the use of resistant cultivars.

d. Crown Rot

Crown Rot is widespread in New Zealand. It is caused by a range of fungi either acting alone or together. The range includes several genera, species and strains of fungi with bacteria and nematodes also being implicated.

Crown Rot is best identified in the field by cutting down the crown with a sharp knife. The rotten area is often in a V pattern from the crown down to the tap root of the plant. Crown Rot often causes plants to develop asymmetrically due to the death of buds on the affected portion of the crown. Crown Rot can be minimised by avoiding grazing or harvesting when soils are wet and maintaining adequate soil nutrient levels (especially potassium).

Irrigation

Lucerne is renowned for its drought tolerance, but at the same time is very responsive to water. In general terms lucerne requires 65-80 mm of water to produce one tonne of drymatter. In areas where summer rainfall is low, lucerne will benefit from one or two irrigations between cuts.

Around 90% of the water extracted from the soil comes from the top metre due to the high root concentration in this zone. When under moisture stress lucerne diverts its nutrients from the top to the crown and roots. Plant stress can occur when available soil moisture falls below 50%. Lost yield cannot be made up by irrigating more than necessary following the stress!

Following germination the young lucerne plant puts most of its emphasis into the production of a root system. Care must be taken not to over-irrigate the young lucerne stand. In mature crops, a general darkening in crop colour, tendency to wilt, cessation of growth and drying and cracking of the surface soil all indicate that it is time to irrigate.

Excessive watering, especially on poorly drained soils and where it causes localised ponding can increase root damage. Recently cut and well-grown plants are the most susceptible. Damage is slower when water logging occurs mid-way through the regrowth cycle (Lowe et al, 1994).

Lucerne yield potential

New Zealand lucerne yields are typically 15-22 tDM/ha in irrigated or higher rainfall areas (Table 5).

Table 5: Drymatter production of non-irrigated lucerne grown at Lincoln University (Moot, 2001)

Season	Lucerne yield (tDM/ha)
1997/1998	21.4
1998/1999	21.0
1999/2000	19.4
2000/2001	18.8

The yield potential under good management in drier non-irrigated regions is usually in the range 8-12 tDM/ha depending on rainfall levels.

Productive stand life

Determining when a lucerne stand has reached the end of its productive life can be a tough decision. To get the maximum value from your lucerne stand you need to be checking the health of stands that are 4 or more years old. Overseas research suggests that new crops should have at least 25-30 plants per square foot (275-325 plants per m^2) in the first year. Over time stands thin out and weeds may invade the crop.

Plant density is a poor estimator of yield potential because an individual plant may have few shoots and contribute little to yield. Recent research from the University of Wisconsin indicates that plant growers will get a more accurate assessment of the productive capacity of a stand if they count the number of stems per square area. This method works best if the stands have developed at least 15-20 cm of growth. Maximum yield can be expected if there are more than 55 stems per square foot (590 per m^2). When stem counts drop below 40 stems per square foot (430 per m^2) consider replacing the stand (Reese, 2001).

Effective lucerne removal

For herbicides to be effective in removing lucerne, the lucerne must be actively growing. Herbicide should be applied 4-6 weeks after grazing or cutting when the excess photosyntate is being moved down into the crown and taproot to replenish reserves.

SILAGE AND HAYMAKING

It is important to set goals for forage quality and use the appropriate harvest techniques to minimise field losses and maximise tonnage of high quality forage harvested.

TIPS FOR SUCCESSFUL SILAGE AND HAY MAKING

- Avoid damaging the crown buds during the harvesting process.
- Cut silage and hay early before the crop begins to flower. This will ensure that feed quality is maximised.
- When making lucerne silage, minimise the amount of time between cutting and baling or stacking. This can be achieved by cutting when wilting conditions are good and leaving the material in a wide windrow to dry. Use a high quality lucerne specific silage inoculants such as Pioneer® brand 11H50.
- For quality hay use a dormant or semi-dormant variety. Minimise leaf shattering from mechanical handling (e.g. raking and baling) when the hay is too dry.

Forage quality

Forage quality can be defined as the extent to which forage has the potential to produce the desired animal response. Factors that influence forage quality include (Ball et al, 2001):

- Palatability. *Will the animals eat the forage?* Palatability may be influenced by texture, leafiness, fertiliser, moisture content, pest infestation etc. High quality forages are usually highly palatable.
- Intake. *How much will they eat?* Animals must consume adequate quantities to perform well. Generally the higher the palatability and forage quality the better the intake.
- Digestibility. *How much of the forage will be digested*? Digestibility (how much of the feed is digested by the animal) varies greatly. Immature leafy lucerne may be 80-90% digestible while stalky, over mature material may be as low as 60%.
- Nutrient content. *Once digested will the forage provide an adequate level of nutrients?* Forages can be divided into two parts – cell walls (mainly fibre) and cell contents (proteins, sugar and starches).
- Animal performance is the ultimate test of forage quality. High quality forages will give high levels of animal performance.

Lucerne growth stages

Determining the growth stage of lucerne is important since it affects yield and quality. To determine the maturity of your stand follow the following three steps (Hall, 1996).

Step 1: Collect a random sample of approximately 40 stems.

Step 2: Separate the stems according to the criteria in Table 6 below.

Table 6: Definition of morphological stages of development of individual lucerne stems.

Stage number	Stage name	Stage definition
0	Early vegetative	Stem length no more than 15 cm, no buds flowers or seed pods.
1	Mid vegetative	Stem length 15-30 cm, no buds flowers or seed pods.
2	Late vegetative	Stem length greater than 30 cm, no buds flowers or seed pods.
3	Early flower bud	1-2 nodes with flower buds, no flowers or seed pods.
4	Late flower bud	3 or more nodes with flower buds, no flowers or seed pods.
5	Early flower	1 node with one open flower, no seed pods.
6	Late flower	2 or more nodes with open flowers, no seed pods.
7	Early seed pod	1-3 nodes with green seed pods.
8	Late seed pod	4 or more nodes with green seed pods.
9	Ripe seed pod	Nodes with mostly brown, mature seed pods.

Step 3: Determine maturity by multiplying the number of stems at each stage by the stage number and then dividing the result by the number of stems (Table 6).

Table 7: Example of determining mean growth stage

Stage	Number of stems	Mean growth stage
0	12	0
1	20	20
2	5	10
3	2	6
4	1	4
Total	40	40

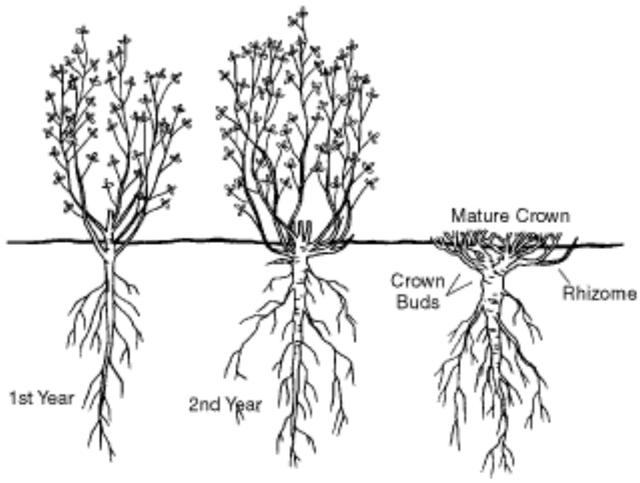
Mean Growth Stage = 40/40 = 1. Therefore the crop is on average in the mid-vegetative stage.

Lucerne growth and forage quality
Understanding how lucerne grows and its relationship to forage yield, forage quality and carbohydrate root reserves is critical to development of a good harvest program.

Lucerne is a perennial plant that stores carbohydrates (sugars and starches) in the crown and root. Carbohydrate reserves are used for regrowth both in the spring and also after each cutting. When lucerne is 150-200 mm tall, it begins replacing carbohydrates in the root. The cycle is repeated after each cutting. High levels of carbohydrate root reserves promote rapid regrowth and improve winter survival (especially in cool areas).

Regrowth comes from the crown of the plant. Usually the crown buds start growing prior to the harvest of the previous cut. Cutting too late can remove shoots for the next cutting and delay regrowth. If weather conditions mean that the cut is delayed, lift the cutter bar to ensure that the new shoots are not damaged.

Figure 11: Fully developed lucerne crown (Meyer, 1999)



Lucerne growth is most rapid from initial spring growth or right after each cutting until early flowering. During these vegetative stages the proportion of leaves is usually equal to or greater than that of the stems. By first flower or sometimes earlier the proportion of stems begins to exceed that of leaves.

Remember lucerne leaves contain 70% of the protein and 90% of the vitamin and minerals. Therefore lucerne quality is highest when harvest takes place at an early stage of development when leaf is a high percentage of the total drymatter yield.

The correct cutting time is a compromise between yield and quality as well as stand persistence (Figure 13).

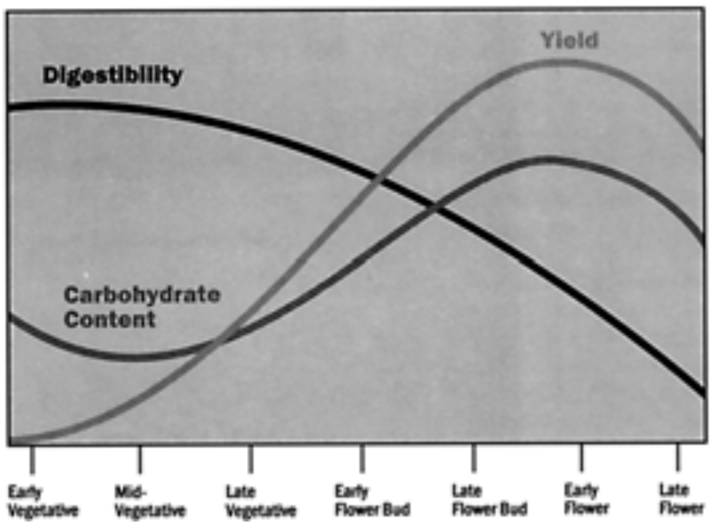
Lucerne quality is also influenced by the time of day lucerne is cut. Research has found leaf sugar and starch concentrates to be slightly greater from late morning to mid afternoon than any other time of the day.

Plant respiration during the night lowers the level of soluble sugars and starch within the plant but photosynthesis begins to replace these levels through the morning and afternoon hours.

Better quality product should result from harvesting lucerne when these highly digestible and fermentable carbohydrates are at maximum concentration. However, it is advisable to harvest based on weather and rain forecasts as plant and microbial respiration reduces carbohydrate levels during the wilting process.

In general, the afternoon is the best time to harvest lucerne that will be greenfed. For lucerne silage or hay, it is recommended that cutting takes place after the dew has lifted in the morning. This minimises the amount of wilting time.

Figure 12: Relative levels of carbohydrate content, forage digestibility and yield (Hall, 1996)



HARVEST MANAGEMENT

The first step in developing a harvesting schedule is to determine what your yield, quality and persistence goals are. Harvesting early will result in high quality lucerne but yields will be lower and stand life will be reduced.

Maximum persistence

If harvesting for maximum persistence, cut lucerne between first flower and 25% flower. This is approximately 35-40 days between cuttings. The system has a slightly wider harvest window and longer cutting interval when cutting for high quality because the emphasis is on high yield.

Maximising quality

When harvesting for high quality, the first cut should be taken early in the season when the plants are around 30 cm in height. Leave a 10 cm residual after cutting to promote tillering of the plant. The remainder of the cuts should be taken at mid bud generally 28-33 days early in the season and longer near the end of the season as temperatures drop. Cutting for high quality means that the lucerne must be harvested within a 3-4 day harvest window.

Optimum yield and quality

For harvest schedules to provide the optimum yield and quality, the first two cuts must be timely. During this time forage quality changes quickly and short delays can negatively impact quality. Take the first cut at bud stage or earlier. Take the second cut 28-33 days later or at mid bud (whichever is earliest).

Subsequent cuttings should be taken at around 10% bloom. An early first harvest followed by a short cutting yield gives high yield of quality forage. One half to full bloom cutting is recommended prior to autumn to allow the lucerne to build up its carbohydrate root reserves for winter and the subsequent spring production.

Autumn management in cooler regions

Autumn management of lucerne in cool regions (lower South Island and at altitude) involves balancing the need for extra feed against the risk of crop damage due to winter injury.

If you are in a region that has cold winters, select a variety with good winter hardiness and disease resistance. Ensure that soil fertility is good paying particular attention to potash levels since this nutrient is important in developing plants that have good winter survival (NAIS, 2003). Greater harvest frequency and stand age at harvest increases the potential for winter injury when autumn cuttings are taken. When the previous cutting interval has been 35 days or less, avoid harvesting before the first winter frost. This allows plants to enter the winter with higher carbohydrate root reserves. Leaving stem and leaf stubble insulates the crown of the plant and reduces the risk to the crop.

LUCERNE SILAGE

Cutting fresh lucerne at the optimal stage of maturity and feeding it directly to animals year round would supply the highest quality and most palatable feed possible. In addition, field and storage losses would be minimised. However, fluctuations in seasonal growth and plant maturity as well as changing animal feed requirements may make it necessary to harvest and store the lucerne crop to maximise both quality and quantity.

Silage compared with hay

Harvesting lucerne as silage has a number of benefits over hay, these include:

- Lower field losses when harvested as silage.
- Less leaf loss resulting in more nutrients for feeding.
- Consistent forage quality.
- Greater ability to harvest the crop at ideal maturity as less rain-free weather is required for silage.

Silage quality

As previously mentioned, as lucerne maturity increases yield also increases but quality decreases. This is because the proportion of leaves decreases and the stem increases in lignin and other fibrous constituents (cellulose and hemicellulose). The feed value of lucerne drops from bud to full bloom stage. Overseas studies have shown that each day of delay in harvesting results in the crop dropping 0.5% crude protein while increasing 0.7% in ADF and 0.9% in NDF.

Table 8: Analysis of lucerne cut at various stages of maturity

	Percentage drymatter basis				
Stage	Leaves % of total DM yield	Protein	ADF	NDF	ME
Bud	>40	>19	<30	<40	11.5
Early bloom	30-40	16-19	30-35	40-45	11.0
Mid bloom	20-29	13-15	36-40	46-50	10.5
Full bloom	<30	<13	>40	>50	10.0

Silage management

The principles for ensiling lucerne are the same as for any other crop. Lucerne is a high protein feed with low carbohydrate levels and a higher buffering capacity. This means that a lot of acid must be produced to drop the pH yet it is difficult for this to occur since carbohydrates (sugar substrate for the fermentation bacteria) are limited.

For lucerne, extra care must be taken to wilt, harvest, and store as quickly as possible. Using a quality silage inoculant will ensure that the limited amount of sugar available will be efficiently converted to acid.

Wilting

Freshly cut lucerne will normally have a drymatter content of 15-20%. It is essential to wilt plants before harvesting so that run-off is reduced and a desirable fermentation can be achieved. For precision cut lucerne silage harvest drymatter content should be 32-35%. For baled silage the drymatter content can be slightly higher (35-50%).

Table 9: Determining moisture content by the squeeze test

Condition of forage ball	Approximate DM content
Holds shape, considerable juice	Less than 25%
Holds shape, very little juice	25-30%
Falls apart slowly, no free juice	30-40%
Falls apart rapidly	Greater than 40%

The wilt time will depend on the wind, humidity, heat and sun but is normally between 12 and 24 hours.

When making lucerne silage, try to increase the drymatter percentage by 10-15% as soon as possible. The way to do this is to avoid putting the forage into a tight windrow. It is important that lucerne is not over-wilted, as the leaves as well as some of the nutrient value will be lost in the dust created by the harvesting equipment. In addition, high drymatter lucerne silage will be prone to excessive heating resulting in the formation of indigestible products which lower protein and energy values. Good quality lucerne silage should retain its greenish colour. A tobacco-brown colour and a caramelised odour indicate that some heating has occurred and this is undesirable.

Chop length

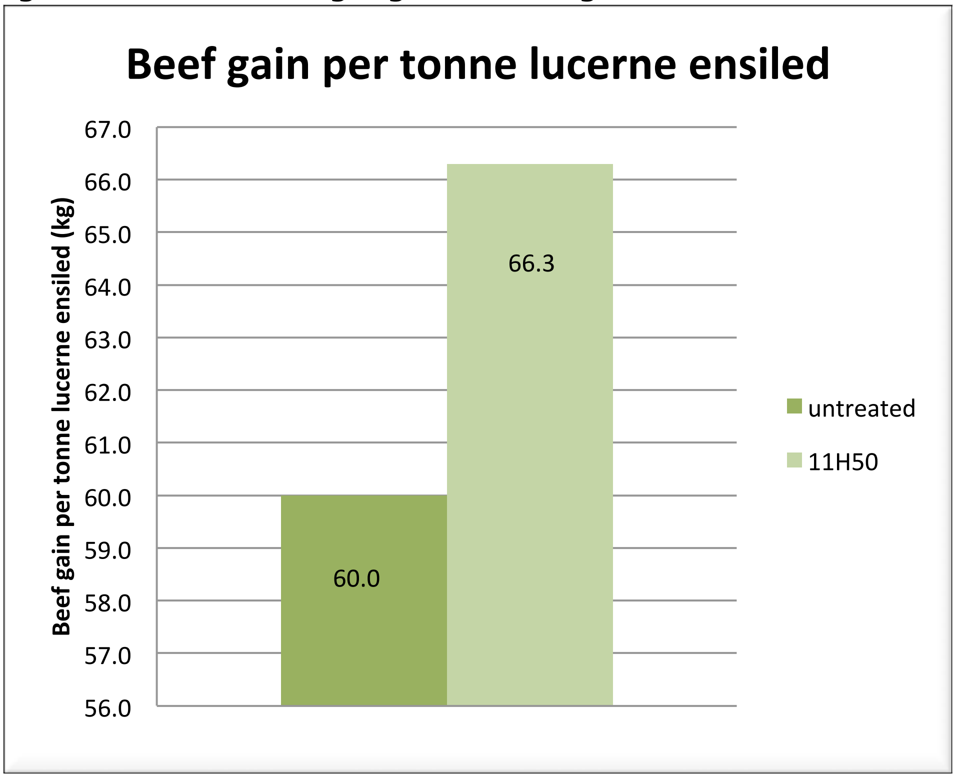
The chop length for lucerne should be set at 30-40 mm to assure an ideal fermentation and provide sufficient fibre for the rumen health of animals.

Pioneer® brand 11H50 lucerne silage inoculant
Pioneer® brand 11H50 lucerne specific silage inoculant contains bacteria specifically selected to best use available plant sugars maximising fermentation quality, silage digestibility and animal performance.

In a trial conducted at the Canadian Agriculture and Agri-Food Research Centre at Lethbridge, lucerne silage inoculated with 11H50 and fed to lambs had higher drymatter digestibility ($P \leq 0.05$) than untreated lucerne silage.

In a trial conducted at Kansas State University steers fed 11H50 inoculated lucerne silage had a 6.3 kg higher gain per tonne of silage ensiled ($P \leq 0.05$) when compared to an untreated control (Figure 14). The higher beef gain per tonne was a result of increases in both drymatter recovery and average daily gain.

Figure 14: Beef liveweight gain advantage to Pioneer® brand 11H50*



*Statistically significant beef gain per tonne advantage to Pioneer® brand 11H50 ($P<0.05$).

11H50 is available in water soluble or Appli-Pro® formulation. For more details on 11H50 please contact your local Pioneer Area Manager.

Lucerne silage analysis
The range of feed values and fermentation values for typical lucerne silage are shown in Table 10.

Table 10: Typical lucerne silage feed analysis

Feed test	Typical lucerne silage
Drymatter (%)	30-40
Metabolisable energy (MJME/kgDM)	10.0-11.5
Crude protein (%)	20-24
Ammonia N **(% of total N)**	<10-15
pH	<4.5
Lactic acid (%DM)	>2.0

LUCERNE HAY

As for lucerne silage, early cutting is essential in the production of high quality lucerne hay. All varieties decline in quality as they mature. Delaying of cutting after maturity results in leaf loss, thicker stems (which take longer to dry), and higher fibre content.

Lucerne hay quality

Good lucerne hay is green, leafy, soft to touch, sweet smelling and free from mould, dust, weeds and other foreign material. Lucerne hay quality will be reduced by the following (Stanley et al, 1994):

- Thin stands on paddocks in which grasses and weeds have intruded and where stems are coarse and hard.
- Weather damage leading to loss of green colour, leaf shattering from extra handling and mustiness and mould if baled or stacked wet.
- Over-mature at cutting resulting in hard and fibrous stems, loss of leaf and faded colour.
- Over-drying in the windrow causing severe leaf shattering, brittle stems and bleaching.
- Baling too wet causing heating from the fermentation process, mould and mustiness.
- Baling of over dry hay resulting in leaf shatter which gives coarse, stemmy hay with a low proportion of leaves.

Variety selection

Winter active varieties do not produce foliage that meets the criteria for good quality hay. They have smaller crowns with fewer basal shoots which tends to result in a less dense stand. They also have lower leaf densities. Dormants and semi-dormants on the other hand form much larger crowns with thicker, semi-prostrate foliage and they make much better hay.

Minimise haymaking losses

Haymaking techniques affect drymatter and nutrient losses. The amount of harvest and storage losses in making lucerne hay can range from 20-40%. The number one loss is from leaf shattering during mechanical handling such as raking and baling when the hay is too dry. Lucerne leaves dry down 3-5 times faster than the stems and as the plant drymatter content increases above 70%, the leaves become extremely brittle.

Nutrients leached by rain and plant respiration during storage are other contributing factors in hay making losses. The optimum drymatter content for baling hay is 82-85%.

Baling at higher moisture contents minimises mechanical leaf loss and reduces the risk of rain damage because of the shortened wilting and drying period. However, baling at moisture levels above 20% generally increases storage losses from excessive heating and moulding of the hay.

Cutting and raking

Lucerne should be cut 2-4 cm above the ground being careful not to damage the crowns. Cutting the lucerne when ground conditions are dry may increase the rate of drying. If faced with showery weather, cut when the weather conditions are best and let the hay lie on the ground until it reaches the same dryness as the ground. At this point, the hay will dry no further until it is turned.

Raking should be done while the crop is still wet and pliable in order to retain leaves. If possible, subsequent turning should be done in the late evening, early morning or at night when the dew reduces leaf shatter. Avoid deep dense windrows.

Baling

Estimating the correct moisture level for baling is important. Most hay makers have relied on the following stem test method. If free moisture is observed in the crank area or the skin peels readily when scratched with a thumbnail, the crop is too wet to bale. The simple microwave drymatter test is more accurate.

Besides drymatter and quality loss, other problems associated with slow hay removal from the field include:

- Wheel traffic damage to lucerne regrowth.
- Bleached hay.
- Damage to regrowth from shading plants.

The use of drying agents at the time of hay cutting hastens the drying time. Preservatives applied at baling do not shorten the drying time but prevent heating and mould growth at higher than recommended moisture levels. They are not commonly used in New Zealand.

GRAZING

Grazed lucerne can provide cost-effective high quality feed for a range of stock types and classes. Careful variety and paddock selection coupled with good grazing management will ensure that yield and persistence are maximised.

TIPS FOR SUCCESSFUL GRAZING

- Choose a dormant lucerne variety with a low crown and a free-draining paddock.
- Use a 35-40 day rotation and graze the animals for a maximum of 7-10 days to avoid damage to the new growth shoots.
- Where possible avoid grazing over the wet winter months.
- Allow new stands to flower before the first grazing.
- Watch for bloat in cattle grazing lucerne. Follow the recommended management practices (see below) and consider using anti-bloat products.

Grazing lucerne

More dormant lucerne varieties (such as Pioneer® brand 54V09) have lower crowns and are therefore better for grazing than semi-dormant or more winter active varieties.

The growing tip of the lucerne plant is located on the crown of the plant. The growing point can easily be damaged by overgrazing or grazing when the soil is wet. Regrowth comes from the crown of the plant. A rotational grazing system with 35-40 day "rest" periods is essential for productivity and longevity of lucerne. Graze the stand for 7-10 days to avoid animals eating the new growth shoots. If possible, lucerne should not be grazed during the wet winter months. Any growth over this period could be machine harvested and either fed as greenfeed or ensiled.

Most of the feed value is in the leaves of lucerne and these are always eaten first by stock. For this reason priority stock classes should be grazed at the front of the rotation.

Grazing new stands

New stands should be allowed to flower prior to the first grazing. This will enable the plant to build a strong root system and reduce the risk of animals pulling out plants. Ensure that the first grazings are light and for a short duration.

Bloat
There are few health dangers to animals grazing on lucerne. The most serious is bloat. Cattle are more susceptible than sheep and the risk of bloat is highest during winter and spring. The following precautions will greatly reduce the risk of bloat (Stanley, 1996):

- Avoid grazing lucerne when it is fresh and lush (particularly in the spring and autumn following a break) and when the stand is immature. Mature stands are much safer.
- Individual animals may be more prone to bloating. Keep these off the stand and, if grazing lucerne is an ongoing part of your management system cull these animals out of the breeding stock
- Avoid putting very hungry animals onto lucerne especially when it is wet with dew.
- Feed roughage (e.g. hay or maize silage) ahead of grazing lucerne and/or graze lucerne alternatively with pasture.
- Use anti-bloat agents (e.g. drenches or rumen bullets) where necessary.

Coumestan
Stock infertility on lucerne has been associated with high levels of coumestans in the leaves. The presence of leaf diseases, insect damage and severe moisture stress can all increase coumestan levels but disease is the major source. It is very rare that lucerne coumestrol levels would affect animal performance; however, diseased stands can reduce ovulation rates in ewes. Do not feed high risk stands in the 21 days prior to and during mating.

Red gut
Red gut is a relatively rare disease that can occur in weaned lambs grazing lush lucerne. It is characterised by sudden death. Affected animals show intense reddening of the intestines. Research conducted at Lincoln University in the 1970s (Jagusch et al, 1976) showed that the incidence of the disease was reduced when lambs were suckled or supplemented with good quality hay.

Enterotaxaemia (pulpy kidney)
Enterotaxaemia (pulpy kidney) may cause animal losses on lucerne as on many other high quality feeds. Ensure that sheep are vaccinated.

Sodium
Lucerne is low in sodium. Animals grazing on high lucerne diet may require salt licks.

FEEDING

Whether it is fresh cut or grazed or made into silage or hay, well managed lucerne has excellent energy and protein levels to sustain good levels of animal performance.

Lucerne for dairy cows

For many New Zealand dairy farms, protein is most likely to be production limiting during the summer months. Pasture protein levels of dry, stalky ryegrass pasture can be as low as 10-12%, which is considerably lower than the 14-16% requirement of late to mid lactation dairy cows.

Farmers who rely on large levels of low protein feedstuffs, such as maize silage, cereal silage or grains, to fill summer feed deficits or meet the early lactation requirements of autumn calving herds may also experience protein deficiencies and should consider feeding lucerne silage.

Research (Macdonald et al 1998) shows that including 0.7 kg of protein in a 50:50 diet of maize silage and summer/autumn pasture increased the protein content of the diet from 11.8-16.8%. Milksolids production increased by 115-165 gMS/cow/day for soybean and fishmeal respectively.

Lucerne for beef cattle

Lucerne will allow producers to achieve high animal growth rates and/or increase animal stocking rates. Its high energy and protein levels make it an excellent complement to lower quality summer pastures (Table 11).

Table 11: Effect of lucerne quality on rate and feed efficiency of 180-275 kg steers (University of Nebraska)

	Pre bud	Bud	Early bloom	Full bloom
Drymatter digestibility	73	69	62	55
Intake (kgDM/day)	3.5	3.0	2.5	2.0
Liveweight gain (kg/day)	1.00	0.86	0.55	0.36
Feed conversion ratio (kg feed per kg liveweight gain)	3.20	4.07	5.50	6.75

Lucerne for sheep

It is possible to achieve high lamb growth rates on lucerne. In an experiment conducted at Grasslands, Palmerston North, lamb growth rates were measured on pasture and a range of other forages including lucerne (Burke et al, 2002). Lambs grazing lucerne gained an average of 191 g per day compared to lambs grazing pasture which gained 105 g per day. Research conducted in Western Australia has shown growth rates of 1.0-1.75 kg per head per week (Devenish. 2003).

ECONOMICS

The cost of growing and harvesting lucerne varies greatly between districts. The costs in the table below are for stacked silage and are indicative only. For area-specific costings talk to your local contractor or seed supply merchant.

The costs of growing lucerne can be divided into first and subsequent years. Indicative first year costs are shown in Table 12.

Table 12: Indicative first year lucerne growing costs *

Activity	Product	Unit price	Rate/ha	Price per ha
spray out existing crop	-	-	-	$27.00
herbicide application cost	Roundup	$16.45	3	$49.35
base fertiliser aplication				$40.00
base fertiliser cost	-	-	-	$500.00
primary cultivation	-	-	-	$170.00
secondary cultivation	-	-	-	$120.00
pre emerge herbicide	Triflur 480	$13.20	2	$26.40
herbicide application cost	-	-	-	$27.00
treated lucerne seed	Pioneer® 54V09	$21.70	18	$390.60
planting costs	-	-	-	$110.00
post emergent herbicides	Spinnaker	$168.00	0.4	$67.20
	2,4-DB	$21.45	6	$128.70
herbicide application cost	-	-	-	$27.00
interest (6 months)	7.50%			$63.12
TOTAL - Establisment				**$1,746.37**

Harvesting costs	price per cut	number of cuts	Price/ha
mowing & raking	$91.00	4	$364.00
harvesting costs	$216.00		$864.00
TOTAL - Harvest			**$1,228.00**

TOTAL	**$2,974.37**

Fertiliser costs contribute a significant proportion of the second and subsequent year costs Table 13.

Table 13: Indicative second and subsequent year lucerne costs *

Activity	Product	Unit price	Rate/ha	Price per ha
base fertiliser application cost		$40.00	2	$80.00
base fertiliser cost	-	-	-	$1,000.00
herbicide	Metribuzin	$102.00	1	$102.00
	Centurion Plus	$115.90	1.5	$173.85
herbicide application cost	-	-	-	$27.00
interest (6 months)	7.50%			$51.86
TOTAL - crop production				**$1,434.71**

Harvesting costs	price per cut	number of cuts	Price/ha
mowing & raking	$91.00	6	$546.00
harvesting costs	$216.00		$1,296.00
TOTAL - Harvest			**$1,842.00**

Assuming an average stand life of 6 years, the cost of lucerne harvested as stacked silage is in the range 23-32 c/kgDM (Table 14). Note that drymatter cost is higher in the first season as the yield is lower while the stand is establishing. Stands that produce 11-15 tDM/ha in second and subsequent years would be expected to produce 6-10 tDM/ha in the first season.

Table 14: Indicative cost per kgDM across the life of the stand *

Stand life (years)	**6.0**						
Cost of production over the life of the stand							
Average annual yield (tDM/ha/year)	10.0	11.0	12.0	13.0	14.0	15.0	16.0
c/kgDM	32.3	29.3	26.9	24.8	23.0	21.5	20.2

Note that all costs and input listings are indicative only. For crop specific recommendations and input costings talk to your local contractor, merchant representative or Pioneer Area Manager.

*Cost are indicative only and are current as at 01 Oct 2010.

CALENDAR

Lucerne Plant & Harvest Calendar - AUTUMN PLANTING

ESTABLISHMENT SCHEDULE

ID	Task Name	February	March	April	May	June	July	August	September
1	Apply base (e.g. Lime, Phosphorous)								
2	Apply pre-emergent herbicide (e.g. Trifluarlin)								
3	Plant								
4	Monitor emergence								
5	Apply post-emergence herbicide (e.g. Spinnaker + 2, 4 D-B if required)								
6	Apply herbicide if necessary (herbicide will depend on weeds present)								
7	Soil test (150mm plug)								
8	Monitor for insects (e.g. Aphids)								

FIRST YEAR MANAGEMENT SCHEDULE (FOR SECOND & CONSECUTIVE YEARS MANAGEMENT SCHEDULE REFER OVERLEAF)

ID	Task Name	October	November	December	January	February	March	April	May
1	First cut (refer to harvest management section of the Pioneer® Lucerne Manual)								
2	Apply base fertiliser (60% of annual requirement per soil test)								
3	Second cut (+ 40 days)								
4	Leaf analysis								
5	Third cut (+ 35 days)								
6	Apply remaining base fertiliser (refer to leaf analysis & adjust if necessary)								
7	Fourth cut (+ 30 days)								
8	Fifth cut (+ 35 days)								
9	Final cut								
10	Apply herbicide (e.g. Spinnaker as a weed control over dormant phase)								

This calendar is a GUIDE ONLY. Planting dates, cutting schedules & number of cuts are all influenced by management & the environment. Generally speaking, cooler growing conditions slow down the growth of lucerne reducing the number of cuts for the season & ultimately final yields. Refer to the Pioneer® Lucerne Manual for details on herbicides labeled for use on lucerne in New Zealand & check product labels for timing & application. For further information on the successful growing, harvesting & incorporation of Pioneer® brand lucerne into New Zealand farm systems phone the Pioneer Advice Line toll-free on 0800 PIONEER (0800 746 633).

Lucerne Plant & Harvest Calendar - SPRING PLANTING

PIONEER® BRAND · SEEDS

ESTABLISHMENT SCHEDULE

ID	Task Name	September	October	November	December	January	February	March	April	May
1	Soil Test (150mm plug)									
2	Apply base fertiliser (60% of annual requirement per soil test)									
3	Apply pre-emergent herbicide (e.g. Trifluarlin)									
4	Plant									
5	Monitor emergence									
6	Apply herbicide if necessary (herbicide will depend on weeds present)									
7	First cut (refer to harvest management section of the Pioneer® Lucerne Manual)									
8	Second cut (+ 40 days)									
9	Apply base fertiliser (remaining amount)									
10	Third cut (+ 35 days)									
11	Final cut									
12	Apply herbicide (e.g. Spinnaker as a weed control over dormant phase)									

SECOND & CONSECUTIVE YEARS MANAGEMENT SCHEDULE

ID	Task Name	August	September	October	November	December	January	February	March	April	May
1	Soil Test (150mm plug)										
2	Monitor for insects (e.g. Aphids)										
3	First cut										
4	Apply base fertiliser (60% of annual requirement per soil test)										
5	Second cut (+ 40 days)										
6	Leaf analysis										
7	Third cut (+ 35 days)										
8	Apply remaining base fertiliser (refer to leaf analysis & adjust if necessary)										
9	Fourth cut (+ 30 days)										
10	Fifth cut (+ 35 days)										
11	Final cut										
12	Apply herbicide (e.g. Spinnaker as a weed control over dormant phase)										

This calendar is a GUIDE ONLY. Planting dates, cutting schedules & number of cuts are all influenced by management & the environment. Generally speaking, cooler growing conditions slow down the growth of lucerne reducing the number of cuts for the season & ultimately final yields. Refer to the Pioneer® Lucerne Manual for details on herbicides labeled for use on lucerne in New Zealand & check product labels for timing & application. For further information on the successful growing, harvesting & incorporation of Pioneer® brand lucerne into New Zealand farm systems phone the Pioneer Advice Line toll-free on 0800 PIONEER (0800 746 633).

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