Managing Pastures

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Acknowledgments

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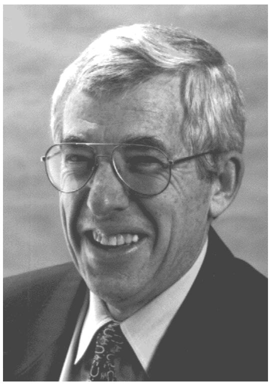
Foreword



John Craven, Program Manager, Farm Production, DRDC

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Dairying is one of the most progressive rural industries in NSW. This is evidenced by substantial changes in herd sizes and increases in production by cows and from farms.

An outcome of these increases is that management has become more complex, requiring greater knowledge and technical skills.

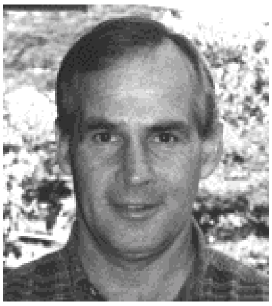
As farmers become more competitive through increases in both production and productivity, they will require even better technical information and management skills. Most important, they will need to know how to use the information in improving whole-farm performance and profits. This statement is supported by results of various Dairy Research and Development Corporation workshops and NSW Dairy Farmers' Association surveys, which have clearly indicated that farmers require technical packages that are current and relevant.

DairyLink is a series of integrated information packages that look at aspects of pasture, herd and feed management, and suggest practical ways of getting the best from your cows and pastures. The DairyLink series is a result of collaboration between NSW Agriculture officers, agribusiness and farmers.

The packages will be the basis of workshops and meetings for NSW dairy farmers.

DairyLink has much to offer the NSW dairy industry in helping improve farm productivity and profitability. We encourage farmers to attend and participate in the DairyLink workshops and meetings.

Preface



DairyLink is an innovative concept that introduces you to some important technical areas to help improve farm productivity and profits.

The modules in the series are of value to farmers, students, consultants and extension service providers.

DairyLink consists of the following information packages:

Establishing Pastures
Managing Pastures
Growing Heifers
Realistic Rations
Conserving Feed

The modules have been developed as technical manuals and farmer-friendly booklets, and are linked to the Tocal Dairy Home Study course.

I would like to take this opportunity to acknowledge and thank the various technical teams for doing an excellent job. I also appreciate the funding and support provided by DRDC.

Alex Ashwood
DairyLink Series Coordinator

Contents

Introduction

The objective of this manual is to help dairy farmers understand the principles behind good pasture management practice. The emphasis is on grazing management.

Pasture should be managed to balance maximum pasture growth against maximum animal production. To do this, you need a good understanding of how pasture grows.

Under a pasture-based system of farming, the key to profitability is high levels of utilisation of the pasture feed base, through the adoption of an effective grazing management system. The manual concentrates on the four most commonly grown pasture species: ryegrass, white clover, lucerne and kikuyu.

Bill Fulkerson

Pasture utilisation

The main goal of good pasture management practice is to achieve high quality pasture that is efficiently utilised by stock over the long term. The key words are therefore **production of top quality**, **utilisation** and **persistence** of pasture. (In this setting *utilisation* is used to mean the consumption of pasture by cows and its conversion into milk.)

In most grazing systems there is a massive amount of waste through forage decay; small changes in grazing intensity or frequency can dramatically improve pasture productivity. The potential for improvement varies with the region.

The cost of growing 1 ha of ryegrass–clover pasture is more than $500 a year (if grown under irrigation)—this is money wasted if some of the pasture is not utilised.

On the average dairy farm, 5–6 t dry matter (DM) per hectare per year of ryegrass or white clover pastures is utilised, but under good management up to 16tDM can be utilised. However , on the typical North Coast dairy farm, less than 3 t DM/ha/year is utilised (all pastures on the farm being considered; assuming 0.8 milkers/ha; each cow receiving 0.75 t of concentrates and producing 4400 L of milk per lactation). By contrast, on the South Coast, an average of 8–10tDM/ha/year is utilised.

Table 1 shows the potential production achievable on commercial dairy farms with present technology for the most common pasture types. (Obviously one of the greatest limitations is irrigation availability, particularly the further north you are.)

Table 1. Potential pasture production achievable on commercial dairy farms.

Pasture type	Yield (t DM/ha /year)	Notes
Perennial ryegrass + white clover	15	
Perennial ryegrass + nitrogen	16	At 200–250 kg N/ha/year
Annual ryegrass + nitrogen	14	On a kikuyu-based pasture but does not include the kikuyu
Kikuyu + white clover	18	If nematodes are not a problem
Kikuyu + nitrogen	9	Quality is the limiting factor
Lucerne	15	

Calculating pasture utilised

To be convinced of the benefits of adopting better grazing management, you need to be able to compare your present level of utilisation with the potential.

Accurate determination of pasture utilised is very time-consuming, but an acceptable estimate can be made from data readily found on-farm. For this estimate, assume 1kgDM gives 1L of milk. This estimate is based on the method developed in Victoria as part of the Target 10 extension project[(1)].

Step 1: Convert feed brought onto property during past 12 months into 'pasture DM' equivalence:

t hay* × 0.77	
t pasture silage (as fed) × 0.28	
t maize silage (as fed) × 0.26	
t grain or pellets × 1.1	
Total brought-in feed (tDM)	B:

* or tropical grass pasture; 40 square bales per tonne or 4.5 round bales (1.2 m) per tonne

Step 2: Calculate milk production from pasture:

Your annual milk prodn (L) ÷ 1000	A:
Brought-in feed (B from step 1)	B:
Total feed consumed on farm (A – B)	C:
Pasture utilised/ha (C ÷milking ha)	

= t DM consumed per ha

This estimate tends to lose its accuracy if milk production per cow is much above 6000L, as maintenance requirements decline relative to milk production.

You can now compare the value for tonnes DM utilised with previous years' production and with production on other farms. As a rough guide:

- < 2 t DM/ha consumed—read this manual
- 2–5tDM/ha consumed—average
- 5–8tDM/ha consumed—excellent
- > 8 t DM/ha consumed—we'll do a case study!

Limitations to pasture production

Pasture growth sets the potential for pasture utilisation, which has been shown many times to be related to profitability. This is because home-grown forage is still the cheapest source of feed. To increase pasture utilisation, you need to identify the aspects of your management that limit production.

The various components of pasture management that can limit the potential of pasture growth and influence utilisation are shown in Figure 1.

For example, a comprehensive irrigation system is useless if growth is restricted by poor fertility. Declining soil fertility, caused by removal of nutrients by a high yielding pasture, can suppress yield.

This manual concentrates on grazing management, and discusses other aspects of management, such as supplementation of stock and pests and diseases of pastures, which affect or are affected by grazing management. See the other DairyLink manuals on *Establishing Pastures* and *Conserving Fodder* for discussion of these topics.

Figure 1. Pasture management practices that influence growth potential and utilisation of pasture.

Management practice		
Soil fertility	↑	Increasingly sets pasture growth potential
Pest and disease control		
Pasture species		
Drainage		
Grazing management		
Fodder conservation	↓	Increasingly sets pasture utilisation

Grazing management—ryegrass

The ryegrass plant is actually a series of independent tillers clumped together. In the vegetative state (Figure 2), each tiller regrows after grazing until about 3 live green leaves have expanded. This number of leaves is then maintained by the emergence of new leaves matching the death of the oldest leaves.

The growing point of the vegetative tiller is near the soil surface; therefore it is hard to kill a ryegrass plant by hard grazing. In contrast, in its reproductive state (Figure 3), the tiller's growing point moves up the stem as the uppermost node. If the tiller is cut below this point, it will die.

The cue to begin reproductive growth is increasing daylength in spring, but a period of chilling is required before seed can set. This poses a problem for perennial ryegrass varieties (except the Kangaroo Valley types) on the NSW North Coast, as chilling is inadequate, and fewer than 10% of tillers produce a seed head. In contrast, 100% of annual ryegrass tillers set seed.

The poor seed set, and the fact that the few seeds that do set have little chance of surviving the harsh subtropical summer, means that swards need to be thickened up by oversowing. The continual decline in plant population from establishment is shown in Figure 4.

On the other hand, the lack of seed set reduces the need to 'top' perennial ryegrass pastures in spring to keep them leafy, as is common in temperate regions. Topping by slashing or grazing annual ryegrass hard after stem elongation begins, however, is still useful to let light in to the pasture to encourage new vegetative tillers.

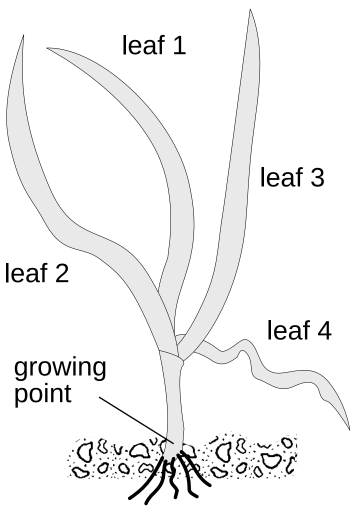


Figure 2. The vegetative ryegrass tiller.

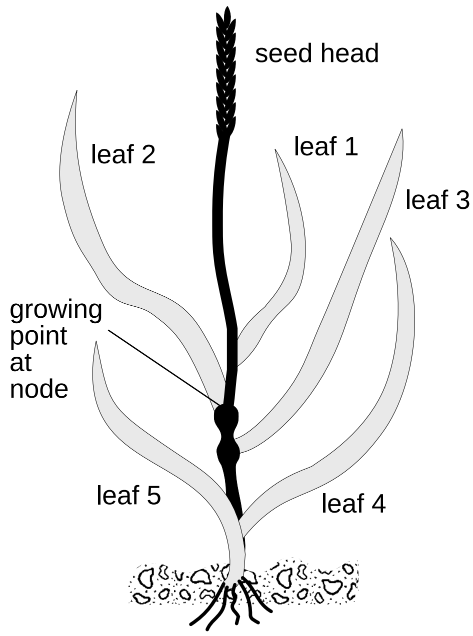
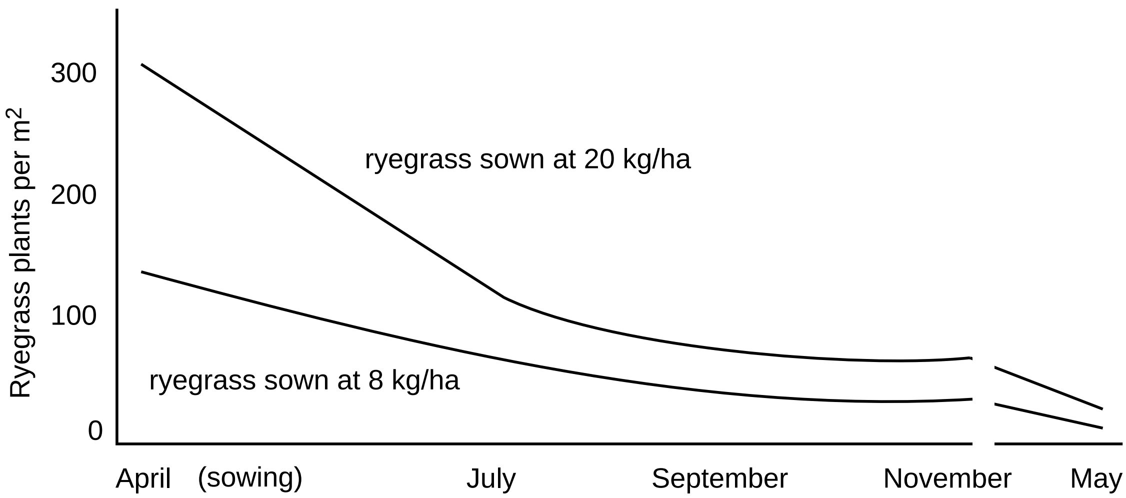


Figure 3. The reproductive ryegrass tiller.

Figure 4. Ryegrass plant density declines from sowing in April–May to the autumn of the second year.



Regrowth of the ryegrass plant

The drawings in Figure 5 show the regrowth of a tiller from grazing until 4 leaves have expanded.

In well grazed pasture, where most leaf is removed, the ryegrass tiller relies on carbohydrate reserves to initiate growth before the plant has sufficient leaf area to photosynthesise again and produce more carbohydrates. The changes in plant carbohydrate reserves during regrowth are shown in Figure 6.

The time taken for 1 leaf to expand is known as the **leaf appearance interval**. This is determined primarily by temperature. For example, leaf appearance interval of ryegrass is 20+ days in colder inland regions of NSW in winter, 12–14 days on the North Coast in winter, and as short as 6 days on the North Coast in spring.

Figure 5a. In well grazed pasture, most ryegrass leaves are removed and only the stubble remains. The roots stop growing after grazing.

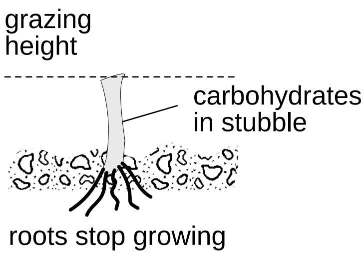


Figure 5b. The remnant of the youngest leaf expanding before grazing must extend quickly in order to catch the sunlight to produce its own carbohydrates, otherwise the tiller will die. It relies at first on carbohydrate reserves in the stubble.

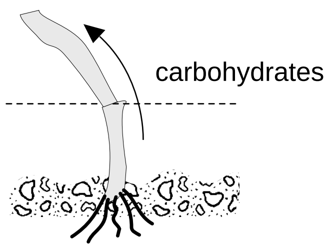


Figure 5c. When the ryegrass tiller has regrown about 3⁄4 of a new leaf, it starts to replenish its carbohydrate reserves, which were used up to expand the new leaf. The plant is most vulnerable to grazing at this stage because of the low reserves. The roots begin to regrow.

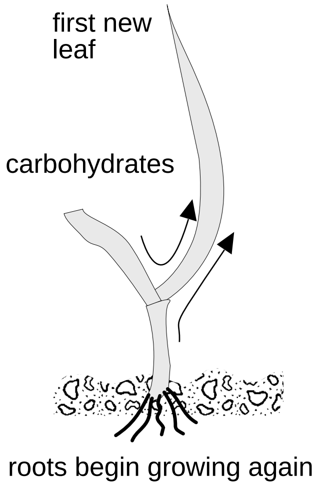


Figure 5d. When the tiller has regrown 2 new leaves, the carbohydrate reserves are adequately replenished, and the plant can again cope with grazing. Thus, the time it takes the plant to regrow 2 leaves is the minimum interval between grazings.

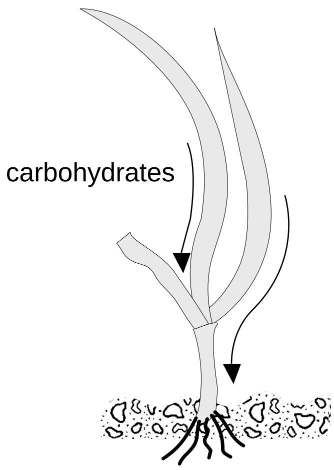


Figure 5e. At 3 leaves per tiller, carbohydrate reserves have increased further. Net growth is probably at a maximum.

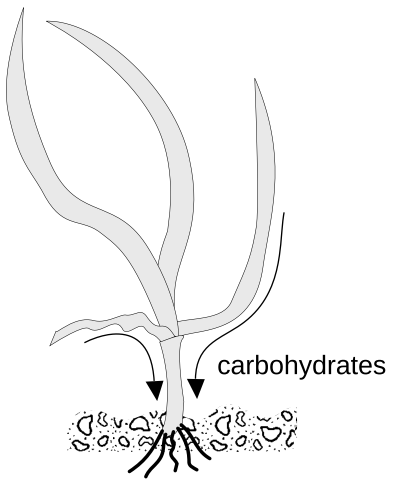


***Figure 5f. After 3 leaves per tiller have expanded, the oldest leaf starts to die as a new leaf appears. A total of 3 green leaves is thus usually present at any time. As a consequence, pasture quality begins to decline beyond this stage and pasture is wasted. The 3–3½-leaf stage is generally* the maximum grazing interval.**

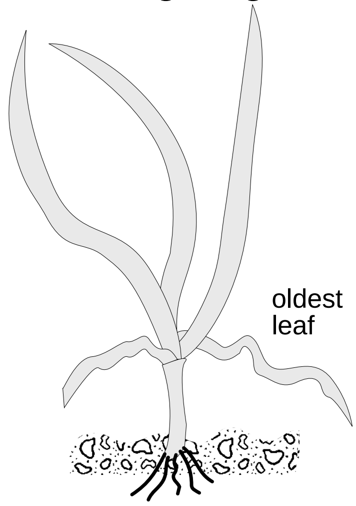
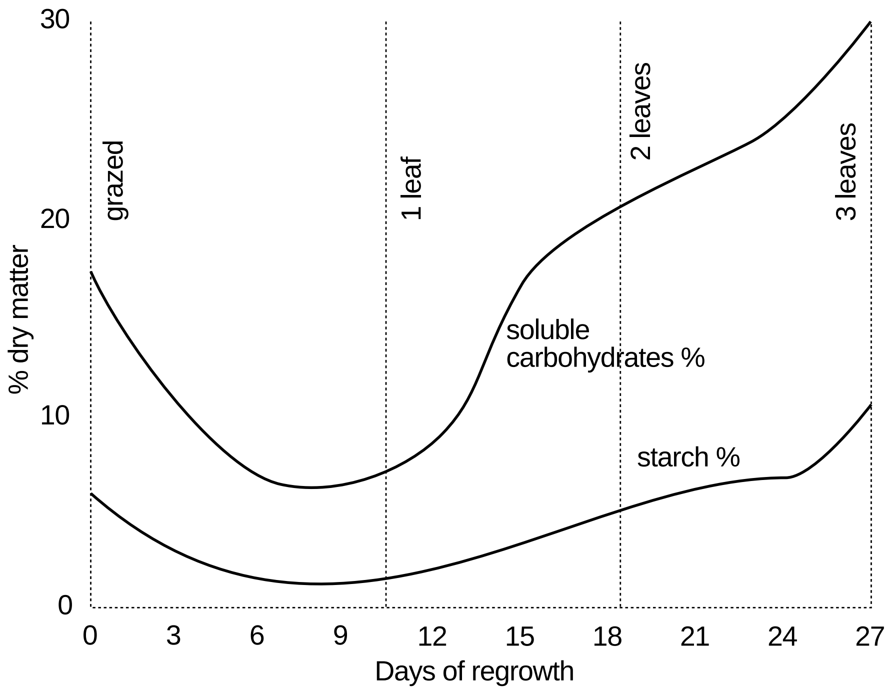


Figure 6. Soluble carbohydrates and starch in leaves decrease from grazing until regrowth of 1 leaf per tiller, and then increase to 3 leaves per tiller.



When to graze?

It is always best to use leaf appearance intervals to decide when to graze.

The best time for regrazing is from the **minimum grazing interval** (2 leaves) to the **maximum grazing interval** (3½ leaves). This stage often coincides with the attainment of the 2400kgDM of regrowth per hectare recommended by Target 10[1]. This amount is generally the maximum that stock can graze without unacceptable wastage.

Table 2 shows that cutting ryegrass at the 3-leaf stage gives a higher total yield than cutting it at a set interval of 2 or 4 weeks throughout the year. It also results in more tillers per plant, more roots per plant, greater plant survival during summer, and less invasion by summer grasses and weeds.

Pasture height is a better indicator of when to graze than set time intervals, but it is influenced by soil fertility and air temperature, and hence is not solely related to the plant's development.

In late autumn, the oldest leaf begins to die when the newest leaf is only about half grown, at the 2½-leaf stage, because new growth slows down. Therefore, exercise caution if you are going to delay grazing to save pasture for winter: if you wait until the 3½-leaf stage you will waste pasture and it will be unpalatable.

Table 2. Cutting ryegrass at the 3-leaf stage of regrowth gives a higher total yield than cutting it at regular intervals of 2 or 4 weeks.

Harvesting interval	Yield kg DM/ha (% increase)* Year 1	Year 2
2 weeks	9 260	3 084
4 weeks	10 927 (+18%)	4 384 (+41%)
3-leaf stage	12 223 (+32%)	4 904 (+59%)

* The bigger % increases in year 2 are because of greater increases in summer grasses and weeds in the more frequently cut pastures.

In late spring, as ryegrass turns reproductive, up to 6 live green leaves can be supported. This allows more bulk to be built up for hay or silage. However, this still promotes reproductive growth and a decline in pasture quality. If this bulk is subsequently grazed, there will be greater wastage as cows will trample it or simply not eat it.

If moisture stress becomes severe, new growth slows, leaf appearance interval increases, and death of older leaves begins before the 3-leaf stage. This is a survival mechanism designed to reduce the number of leaves exposed to evaporation. Therefore in this case grazing should begin earlier.

If shading of pasture limits growth (for example, plants lodge), also graze earlier. This could happen at the second or third grazing after establishment of short-term ryegrass, such as Concord, sown at high rates or fertilised with high rates of N.

If ryegrass becomes infected with leaf rust, you must graze more frequently or slash to remove badly infected leaves.

Grazing at the 3–3½-leaf stage has been shown to improve persistence of ryegrass. The plant appears to build up carbohydrate reserves to allow it to cope better with summer stress[2]. Most nutrients in pasture are also at the optimum for stock at this stage (see 'Which nutrients in pasture limit milk production?', later).

How hard to graze?

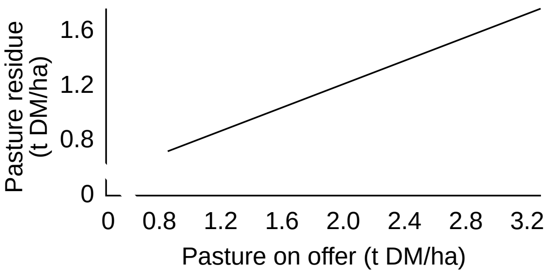
The harder you graze, the higher the utilisation at any one grazing. However, if pasture is grazed too hard (below 5cm stubble height), production per cow declines; and as more stubble is grazed, more of the plants' reserves are removed and less leaf remains to photosynthesise, and so regrowth declines. On the other hand, although leaving a few leaves speeds regrowth, it does not outweigh the consequent reduced utilisation, as these older leaves are photosynthetically inefficient.

Achieving a desirable residue of 5cm often conflicts with achieving a high production per cow. Figure 7 shows that residues increase as pasture on offer increases in an attempt by the dairy farmer to increase intake. Management practices can reduce this conflict:

- Train cows. Giving cows daily breaks or strips of adequate amounts of pasture trains them to graze harder at a given level of DM. The effect can be dramatic. Cows should be trained from calves to graze behind wires, as cows transferred from a herd grazing laxly to a herd under controlled grazing can take up to 3 months to adjust and may lose several condition scores.
- Providing new pasture at each milking is a common way of improving intake and reducing selection of pasture by cows. Some producers have taken this a step further and give a new strip of pasture 4–6 times a day to entice further increases in pasture intake.
- Sometimes pasture is cut before grazing and left to wilt 12–24 hours. After 4–5 days of adaptation, cows increase their intake, perhaps as a result of reduced water intake or the reduced energy required to graze. This practice is most common when the aim is to control bloat. The energy cost and time spent mowing should be considered.
- With a leader–follower system you can get high production per cow as well as high rates of pasture utilisation: the leaders (milkers) take the lower fibre, higher protein tops, and the followers (dry stock) take the higher fibre, lower protein stubble.

Although following milkers with dry cows has proved valuable, following higher with lower producing cows has not been shown to increase total milk produced.

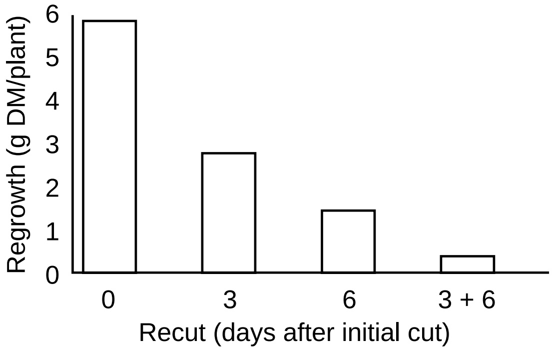
Figure 7. As pasture on offer increases, pasture residues also increase. (Cows grazing ryegrass – white clover pastures at Wollongbar.)



How long to graze?

After grazing, carbohydrate reserves in the stubble are moved to the youngest expanding leaf remaining. If this expanding leaf is regrazed there will be little carbohydrate reserve left to initiate regrowth. Figure 8 shows a dramatic fall in DM yield after a full regrowth cycle and an increase in plant death when plants

Figure 8. Glasshouse studies at Wollongbar showed a dramatic effect of reduction in regrowth by ryegrass plants recut at 3, 6, or 3 and 6 days after harvest[3]. More plants died too.



were recut at 3, 6, or 3 and 6 days after initial harvest. Studies in Tasmania[(4)] showed a 40% decline in DM regrowth of pastures grazed continuously for 6 days compared with pastures grazed for 1 or 3 days.

The greater the pasture growth rate, the shorter should be the duration of grazing (and the grazing interval). Generally, if regrown shoots are long enough to be regrazed by cows—say 8cm—duration is too long. Use a back fence to keep the cows off the regrowth.

Similarly, if followers are used or the area is mulched or slashed, it must be done within 3 days of the start of the first grazing or it will do more harm than good.

Managing ryegrass for persistence

Perennial ryegrass pastures are not very persistent on the east coast of NSW, but their rate of survival can be improved by appropriate management. The key to persistence is to maximise survival of ryegrass plants through the first summer, thus providing the least bare space for invasion by summer grasses (kikuyu, paspalum, couch and weeds). Management must focus on this goal.

Fortunately, grazing management practices that maximise forage quality and utilisation by stock also maximise persistence of pasture (see above), although other factors also affect it, including fertiliser and grazing in spring and summer.

Fertiliser requirements

Fertiliser requirements should be based on soil tests and the DM yields expected. For example, common soil test targets for highly productive dairy farms are >100ppm phosphorus (Colwell test) (perhaps lower on sands and loams) and >0.4meq of potassium per 100g of soil. Consult your local agronomist for local information.

A major cause of deterioration of perennial ryegrass pastures is often soil nutrient drain. Ryegrass contains about 3% potassium and 0.35% phosphorus. To minimise soil nutrient drain:

- grazing management **must** ensure that most dung and urine is returned to pasture—no night paddocks; use short grazing breaks (no cattle camps, etc.); reduce time on the laneway, yards and dairy
- nutrients lost in milk, calves sold, laneways and yards, and leached from or bound to soil **must** be replaced
- replacement rates of 400–600kg/ha/year of a 2:1 mix of superphosphate and muriate of potash must be considered.

Grazing in spring

Infrequent grazing in winter–spring allows the ryegrass plant to build up carbohydrate reserves to cope with the stress of summer. In trials at Casino[(2)], plants grazed in spring at the 3-leaf stage of regrowth had nearly twice as much soluble carbohydrates in early summer as plants grazed at the 1-leaf stage of regrowth. The carbohydrate levels also declined less after grazing; this left 3 times more carbohydrate per plant in February. The more frequently grazed plants also had a smaller root mass, which allowed 6 times as many plants to be lost through sod-pulling.

Any practice that reduces carbohydrate concentrations in plants seems to reduce the plants’ persistence. This includes grazing for too long and grazing too hard.

Grazing in summer

Trial results and farmer experience indicate that perennial ryegrass must be grazed hard but infrequently (every 4–6 weeks) in summer. A follow-up mulching or slashing is vital if there are any summer grass weeds present, or the less palatable weeds will smother the ryegrass.

The worst practice is continuous grazing. This punishes the more palatable ryegrass and gives the weeds an even greater advantage.

Rust in ryegrass and oats

Rust is a fungal disease commonly found on ryegrass and oats under humid conditions. The problem is greatest in late spring in the more subtropical dairy regions of Australia. Lack of moisture and nutrients (particularly N) predisposes plants to it. A typical symptom is yellow blotches on the leaves. The growth of infected plants can be severely reduced. Utilisation by cattle is also affected because of reduced palatability.

There is no commercially viable chemical control of rust. Fortunately, plant breeders are continually breeding for rust resistance in grasses. Appropriate management specifies removal of the infected leaves by grazing or cutting and removal of the moisture or nutrient stress if possible. Apart from minimising plant stress, it may be necessary to graze infected pastures earlier than normal, as the denser the canopy, the more severe the effect of the rust will be.

Grazing management—white clover

If white clover is the sole pasture species, the general recommendation is to graze it hard and infrequently. Graze when the oldest, lowest leaves in the canopy are starting to turn yellow. This could vary from 50 days in winter to 18 days in spring.

White clover ‘breaks up’ in summer. That is, the stolons (see Figure 9) break between the nodes and form new plants, which initiate roots from the nodes. The roots of these plantlets are much shallower than the taproot of the parent plant, and this makes the plants vulnerable to stress at this time and probably into the second year(2). We are still not certain of the best way to graze white clover in summer to improve its survival.

Ryegrass – white clover

White clover is more sensitive to low temperatures than ryegrass. As a result, growth in winter is slower, and thus plants are easily shaded by the more rapidly growing ryegrass. With its wide leaves, annual ryegrass is particularly quick to shade clover. Sow annual ryegrass at less than 10kg/ha to retain a worthwhile clover component in the pasture.

Within limits, the grazing intervals most appropriate for ryegrass also suit **large-leafed** white clover varieties such as Haifa, Osceolo and El Lucero.

Kikuyu – white clover

The incorporation of white clover into a kikuyu pasture in autumn by judicious management can be very productive. The pasture is more sustainable than ryegrass, there is less need for N fertiliser, and the pasture quality is excellent. Yields of more than 15tDM/ha/year (9 of white clover and 7 of kikuyu) can be achieved. However, the clover does not persist after the third year; the problem appears to be a severe build-up of root-knot nematodes. The system is not recommended until we can either select resistant varieties (not yet commercially available), or find a management practice that minimises the effect of nematodes. It should be tried only if adequate irrigation is available.

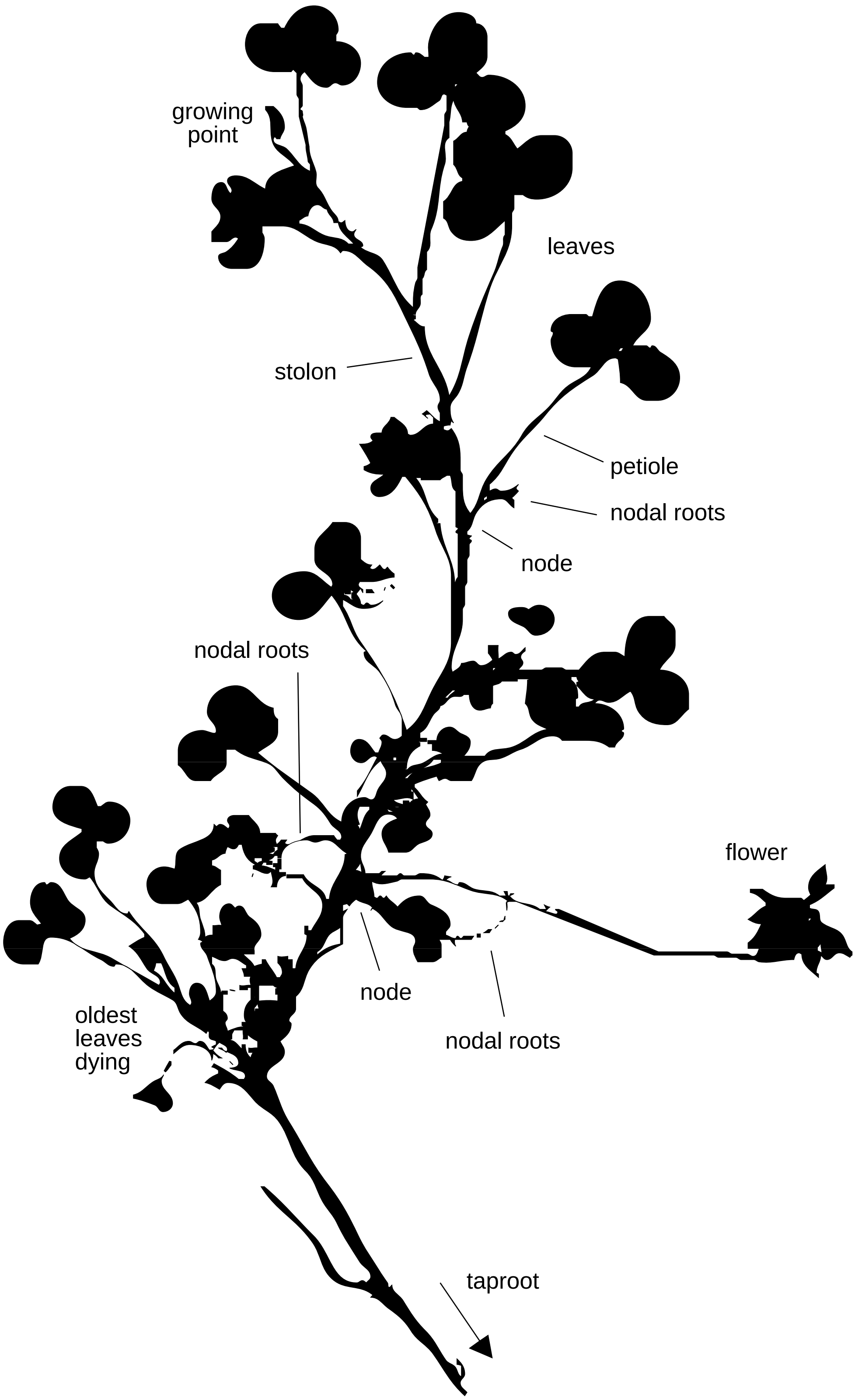


Figure 9. The growing point of the white clover plant is at its tip. The oldest leaves, furthest from the growing point, die if they are not grazed. The plant relies on carbohydrate reserves in its stolons to recover after grazing.

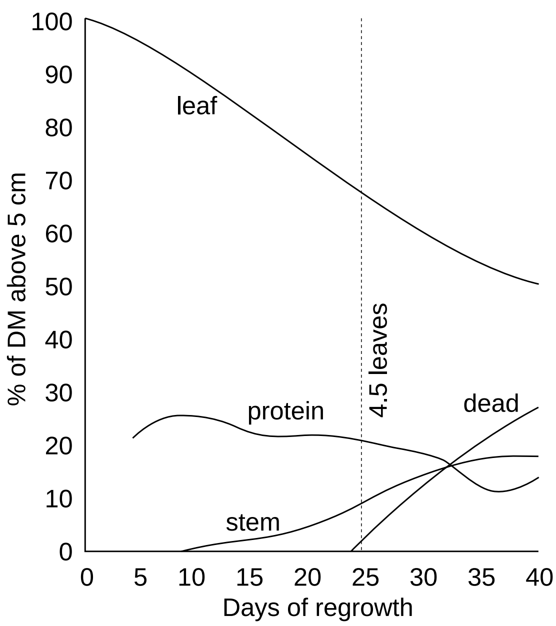
Grazing management—kikuyu

Management of kikuyu pastures should aim at getting the best forage quality and utilisation. To achieve this, as much leaf as possible should be presented to stock. This is because the leaf has much more protein and metabolisable energy (ME) than the stem. Unlike ryegrass, which develops a true stem only when it is reproductive, kikuyu has a stem in its vegetative state. Kikuyu is also less digestible than temperate grasses at the same stage of development.

Recent studies have led to the development of a system of management that achieves this aim:

1. After grazing, preferably mulch or slash back to 5cm of stubble **if moisture status is adequate** (less than 6 days since rain of at least 18mm) and if residues exceed about 15cm. Followers (dry or young stock) can also be used to reduce stubble if this is feasible. This operation removes the low quality kikuyu and allows light in to stimulate new growth. It is normally restricted to once in early summer to top weeds, perhaps 2 or 3 times at the peak of the season, and then once in later summer if the kikuyu is to be oversown with ryegrass or clover.
2. Apply N fertiliser after each grazing. A rate of 100kg of urea or 120kg of ammonium nitrate (nitram) per hectare (if rainfall or irrigation is not assured) seems ideal for productive and quality growth. Higher rates tend to cause a build-up of nitrates in kikuyu. This build-up could reduce digestibility in the rumen or, in extreme cases, cause nitrate poisoning. Higher rates of N also lead to lower efficiency of utilisation, resulting in higher costs per unit of growth and potential loss of N to the environment.
3. Graze at the appropriate interval. Studies at Wollongbar have shown that best quality coincides with the $4\frac{1}{2}$ **new** leaves per tiller stage of regrowth. After this the proportion of stem begins to increase and the number of dead leaves also increases markedly, resulting in a marked decline in quality (Figure 10). The mineral levels also change to be more in line with dairy cows' requirements. The time taken to reach $4\frac{1}{2}$ leaves depends on temperature, from as short as 12 days in mid summer to 35 days in autumn. The use of leaf number as an indicator of when to graze is relevant only in well-grazed or mulched pasture.
4. Provide a new strip of kikuyu pasture after each milking—this reduces selection and contamination of pasture by stock.

Figure 10. At the $4\frac{1}{2}$-leaf stage of regrowth, kikuyu protein content is still high. After this stage, the proportion of stem and dead leaves increases markedly.



Kikuyu yellows (*Verrucalvus flavofaciens*)

Kikuyu yellows is a fungal disease specific to kikuyu. It causes great concern to farmers north of Taree who rely on kikuyu for a major part of their pasture feed. The fungus spreads by waterborne spores, which is why infestations move from laneways and gateways and down gullies through movement of surface water or on cows' hooves.

Typical symptoms are circular patches of yellowing kikuyu swards. In advanced cases, weeds invade the centre of the circle as the kikuyu is progressively destroyed.

The yellowing, as such, is as much the result of stress caused by weakened roots lacking moisture and fertility. In fact, infected plants are reasonably productive under irrigation and high fertility.

At present there are no fungicides available to control kikuyu yellows, but work at Wollongbar is looking at using the antifungal agents in brassica species for control.

The fungus becomes inactive when minimum temperatures fall below 15°C. Benefit can be gained from applying N and other fertilisers once minimum daily autumn temperatures fall below 15°C so that the kikuyu plant can be repaired before next spring.

Spray small patches of kikuyu yellows with glyphosate to 50cm into the healthy kikuyu to starve the fungus and stop further spread—cows' hooves can spread it far and wide. These patches can be sown to ryegrass or rhodes grass until they are re-covered with healthy kikuyu. If entire paddocks are affected, a spell of 1–2 years without kikuyu may be sufficient to remove infection potential.

The kikuyu variety Noonan is slightly tolerant to yellows, but in view of its lower production (about 25% lower than Whittet), it is not commonly used. Breeders are currently selecting cultivars of kikuyu resistant to yellows.

Grazing management—lucerne

Lucerne is a perennial legume capable of producing feed throughout the year, but its main production period is from spring to autumn. It is a high-quality feed with no requirement for nitrogen fertiliser. Varieties fall into 4 growth types: highly winter-active, winter-active, semi-winter-dormant and winter-dormant (Figure 11 shows 2 of these).

Lucerne's biggest asset is its well developed taproot, which can extend to well over a metre in well drained, fertile soils. The taproot enables the plant to reach nutrients and soil moisture much deeper than most other pasture plants can reach, giving it a well deserved record of drought resistance.

Carbohydrate reserves are held in the main taproot. Lucerne is often quicker to recover after cutting or grazing than grasses because its taproot has more energy for regrowth and does not die after grazing or cutting, unlike many grass roots.

After the plant is grazed or cut, fresh shoots grow from either the remaining green stems or, most commonly, buds in the crown. The crown is the part of the taproot at or just above ground level. Heavy grazing can damage the new buds, but in most varieties these are rapidly replaced. Lucerne can live for 10 years or more, although the life of an average irrigated stand is closer to 4–5 years. As lucerne paddocks age, grazing damage, weed invasion, disease and insects take their toll, and the stand thins out.

Table 3 shows optimum plant densities for lucerne. Lucerne stands with lower plant densities than those will have reduced yield and will tend to be invaded by weeds; this will result in lower-quality feed. Direct drilling of other pasture species (for example, ryegrass and clover) into thinning lucerne stands can help maintain the productivity and quality of feed in the paddock.

Figure 11. Highly winter-active lucerne yields more in summer, autumn and winter than semi-dormant lucerne, but yields less in spring.

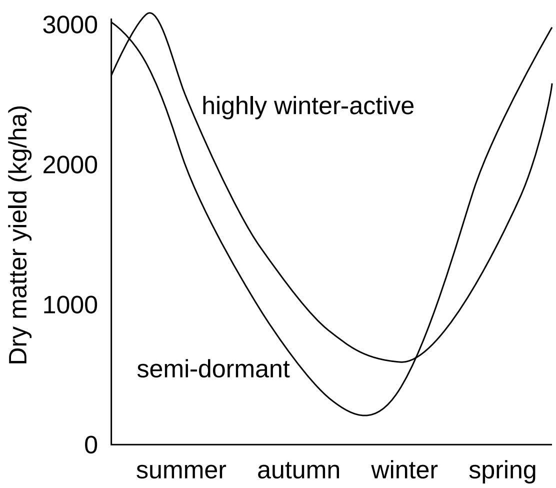


Table 3. Optimum plant density in lucerne stands for maximum yield.

Age of stand	Optimum plant density/m^2
Seeding year	>180
1 year	100
2 years	70
3 years and after	50

When to graze

The optimum grazing interval depends on the growing conditions in your area.

To promote good productivity and persistence of lucerne, root reserves have to be allowed to build up. Lucerne is well adapted to cutting or grazing, provided an adequate recovery period is given to allow essential root reserves to be replenished. Without these reserves, rapid regrowth after grazing is not possible, and survival,

Figure 12. When growth begins, root reserves are mobilised and are used by new shoot growth for about 15 days after defoliation. This process continues beyond the time when new leaves begin sending reserves back to the roots (about 5 days after defoliation). Root reserves reach a minimum at about 3 weeks after harvest and reach maximum at full flowering.

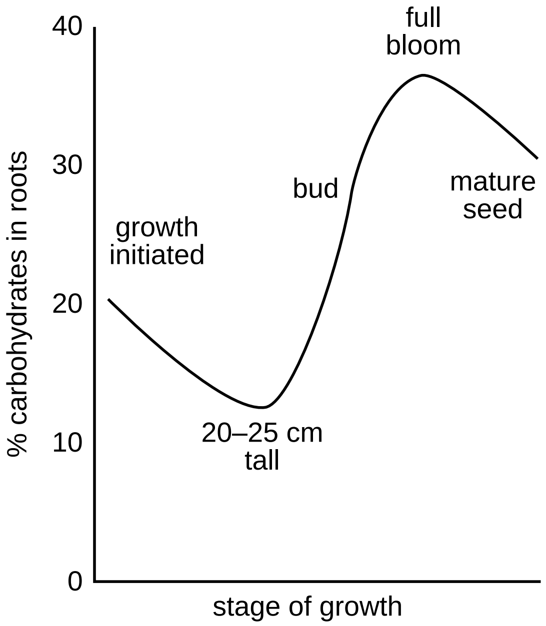
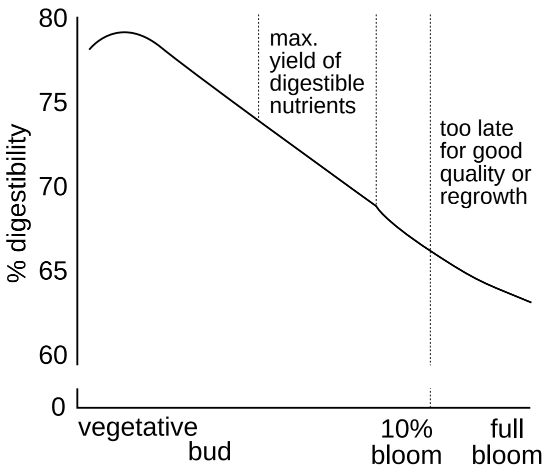


Figure 13. Digestibility of lucerne decreases as the plant matures.



particularly through stress periods, is threatened. Frequent removal of new shoots from lucerne plants depletes the essential carbohydrate reserves. Figure 12 shows the changes in carbohydrate root reserves in lucerne from harvest to full seed set.

By the time full flowering is reached, the stem is thick and the plant has already begun to drop leaves; this reduces both quality and yield. The maximum yield of digestible nutrients is obtained **before** full flowering (Figure 13). Cutting or grazing management is often based on the 10% flowering stage, which is considered an easily identifiable growth stage; this gives the best compromise for achieving high yields, adequate quality and persistence.

New varieties, including winter-active and highly winter-active lucerne, regrow faster after cutting and reach harvest maturity earlier than the more dormant types.

During winter in warmer climates, the more winter-active lucerne types can continue growth with very little or no flowering. Studies by K. Lowe at the DPI in Queensland showed that in spray-irrigated lucerne stands, the fixed cutting intervals shown in Table 4 achieved high yields, good quality and adequate root reserves. The same studies showed that cutting intervals were more important than cultivar type in determining yield. Grazing or cutting intervals more frequent than these substantially depleted root reserves.

Table 4. Fixed cutting intervals (in weeks) for lucerne types in spray-irrigated stands in Queensland to achieve the optimum balance of yield, quality and root reserves.

Season	Variety types			
	Winter-dormant	Semi-dormant	Winter-active	Highly winter-active
Summer	5	4	4	4
Winter	8	8	7	7

Longer intervals reduced forage and nutrient yield.

Root reserves are lowest in late summer. This reduces autumn – early winter production. Delaying cutting or grazing in late autumn allows lucerne to flower, which helps prevent run-down of root reserves.

Trampling and grazing damage crown shoots and allow disease entry. Therefore you should cut lucerne for hay or silage (not graze it) for as long as possible (particularly in the first 12 months) to maintain the plant population. Strip-grazing with back-fencing is necessary to prevent excessive crown damage. The narrower crowns and higher basal buds of the more winter-active lucerne varieties predispose them to greater crown damage.

Lucerne is more susceptible to pugging and trampling in wet weather than many other pastures. Grazing lucerne paddocks should be the **last option** in wet conditions.

Pest and disease incidence will influence grazing management. Early grazing can be justified to control both aphids and leaf diseases.

Cows grazing lucerne are susceptible to bloat. Lucerne can contain high amounts of plant oestrogens (which can cause animal reproductive disorders) if leaves are stressed by disease or insect damage.

Lucerne in a mixed pasture

Lucerne is sown mostly as a sole species, because of its use as a specialist hay crop and its specific grazing or cutting regimes, which do not suit other companion species. There are 2 alternatives: to favour the lucerne with long grazing intervals, which allows the companion species to grow past its best; or to graze the lucerne too frequently, causing a progressive run-down of root reserves and reducing its persistence. When lucerne stands of declining vigour are oversown with ryegrass, grazing management should aim to maximise utilisation and persistence of the ryegrass at the expense of the lucerne.

Yield

The maximum potential yield of well managed lucerne stands has been estimated at more than 25tDM/ha. Commercial yields are generally 12–18tDM/ha from 5–7 grazings between early October and late April.

What production per cow can we get from well managed pasture alone?

There is a remarkable divergence of opinion on how good pasture is for milk production—some people believe it is the perfect food, others believe only concentrates will give high production per cow. Both are probably right!

Ryegrass and white clover

Good ryegrass pasture should produce 20–22L of milk per cow per day. This assumes normal genetic merit and no live-weight change of stock and an acceptable level of pasture utilisation. Another 4–5L a day from body reserve loss brings total **peak** production to 26–28L a day (5500–6000L per cow per lactation).

Although most herds have a few cows producing 30–35L of milk a day on pasture, these cows 'strip' 11–12L of milk a day off their back. Such cows can lose 2 condition scores in 6 weeks. These cows end up in poor condition at mating and can therefore be difficult to get back into calf.

Production of up to 28L a day can also be achieved with energy-based concentrates, which are also fed to improve the protein to carbohydrate ratio of the total ration (see 'Which nutrients in pasture limit milk production?', below, and the DairyLink manual *Realistic Rations*). For example, on well managed dairy farms in Tasmania, an average of 20L of milk a day over the whole lactation is produced from pasture and pasture silage. In Western Australia, top herds produce 28–30L per cow per day, of which 18–20L is estimated to come from pasture and the rest from approximately 5kg of concentrates a day . Above this level of production the situation becomes more complex and the nutrient composition becomes critical. Higher production can be obtained from pure swards of clover, but work at Ellinbank in Victoria(5) has shown that this system is not stable.

Kikuyu

Even when best management practice has achieved the best quality pasture possible, kikuyu is still of lower quality than ryegrass. Daily yields of 15L of milk per cow (without bidyweight change) have been achieved with supplements of sodium (as salt), phosphorus and calcium. Although calcium levels seem reasonable, a high proportion may be bound to a chemical called oxalate and is not available. In addition, the level of sugars, a readily available energy source, is very low in kikuyu.

With well managed kikuyu as the feed base, delivering about 15Lof milk per cow per day, there is a useful role for energy supplements—barley fed at 3kg per cow per day lifts production to about 19L/day .

Higher milk production requires a protein supplement in addition to the energy concentrate. A trial at Wollongbar used canola meal that had been treated with formaldehyde to protect it from degradation in the rumen. Production of 21.5L/day was achieved by feeding 4.8kg barley and 1.2kg of treated canola meal. This supplement produced the largest response in milk produced per kg fed.

Which nutrients in pasture limit milk production?

Some dairy farmers want more production per cow than pasture alone can provide and must therefore supplement. The first step in deciding how much and what is to determine which nutrients in pasture limit milk production.

In all pasture species, phosphorus and magnesium are marginal and potassium is too high. In kikuyu, sodium and available calcium are also too low.

The nutrient levels in pastures depend on the pasture species, stage of growth, season and even time of day. The nutrient level desired depends on the level of milk production.

The commonly used nutrients and their abbreviations are listed here:

- ME (metabolisable energy) is the energy available to the animal for growth and production.
- ADF (acid detergent fibre) consists of cellulose, insoluble ash, indigestible protein and lignin. It is a good indicator of digestibility. Fibre is a precursor for milk fat synthesis and is important for rumen motility.
- NDF (neutral detergent fibre) is ADF + hemicellulose and is the plant cell wall.
- CP (crude protein) is estimated as total nitrogen % × 6.25.
- NPN (non-protein nitrogen) is the N level after the N in true protein has been subtracted.
- WSC (water-soluble carbohydrate) is the plant sugars. It is immediately soluble in the rumen and is readily available to rumen microflora as energy.
- Ca (calcium), Cu (copper), Zn (zinc), Mg (magnesium), K (potassium), P (phosphorus), Na (sodium), Fe (iron) and Mn (manganese).

Protein to carbohydrate ratio

One major limitation to production per cow is believed to be the high protein to carbohydrate ratio of most pastures. As a general rule, protein levels are too high, and energy levels, as readily fermentable carbohydrates, are too low for optimum digestion of feed by the microorganisms in the rumen.

If the protein to carbohydrate ratio is too high, the excess protein is converted to ammonium in the rumen, and the ammonium is detoxified to urea, which is secreted into the milk and urine. The excess protein is not only wasted, it costs energy to detoxify and excrete as urea. Cows often lose weight as they try to balance the high protein intake with energy from body reserves. Surprisingly, farmers still feed high protein pellets to cows on lush green pasture.

If the protein to carbohydrate ratio is too low (too much carbohydrate), for example from feeding silage low in protein (such as maize), protein deficiency limits growth of the rumen microorganisms, and carbohydrate is wasted. As a consequence, nutrients go to live weight rather than to milk.

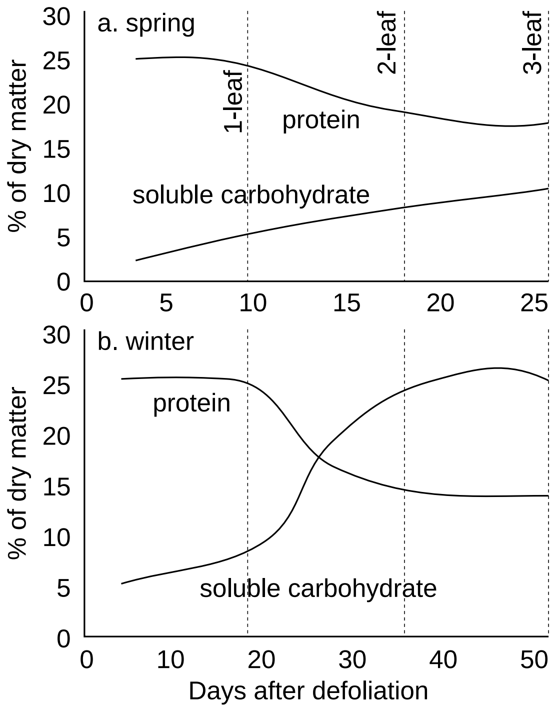
Stage of regrowth

In spring, at the 3–3½-leaf stage of regrowth, ryegrass has a protein to carbohydrate ratio (Figure 14) of 1.8:1. This is much better than the 4:1 ratio at the 1-leaf stage of regrowth. The changes in the ratio are even more dramatic in winter, going from 3:1 at the 1-leaf stage to 1:1.7 at the 3-leaf stage. This is because loss of carbohydrates is low during the cool nights, but clear skies during the day ensure ample accumulation. In spring, the carbohydrate levels are lower because the higher night temperatures allow higher respiration. In both ryegrass and kikuyu, magnesium and calcium levels increase and potassium levels decreases as the plant regrows (Figures 15 and 16). This is why older grass is better for stock than younger grass. The phosphorus levels, however, decrease.

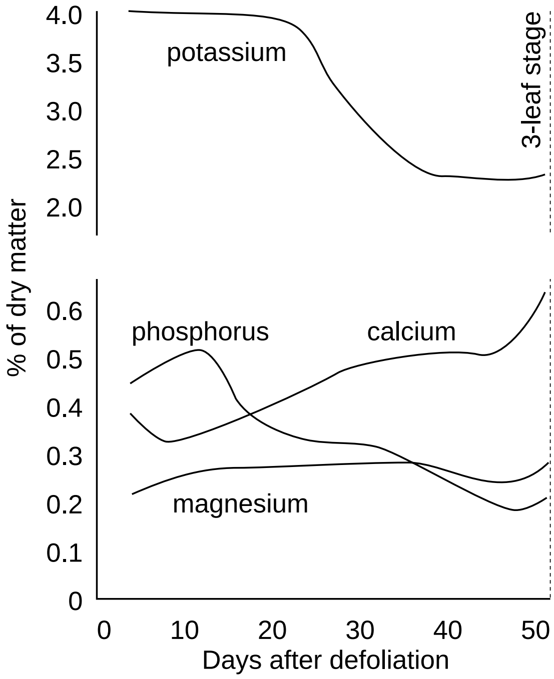
Time of day

In the plant, the immediate product of photosynthesis is sugar, a ready source of energy for plants (and animals). As a consequence, the carbohydrate content of the plant increases during the day (in the

Figure 14. Levels of carbohydrates increase and levels of protein decrease during regrowth in spring (a) and, more dramatically, in winter (b).



Figures 15 (left) and 16 (right). Calcium and magnesium levels increase and potassium and phosphorus levels decrease in ryegrass–clover pasture (left) and kikuyu pasture (right) during regrowth.



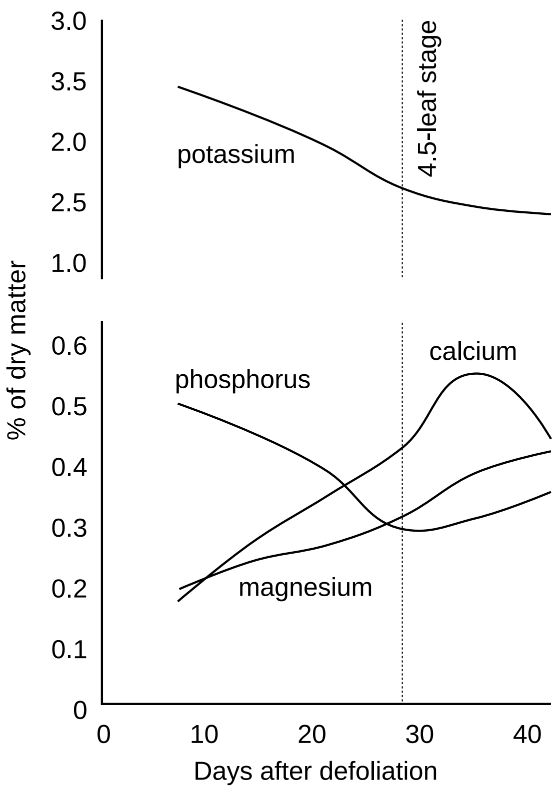
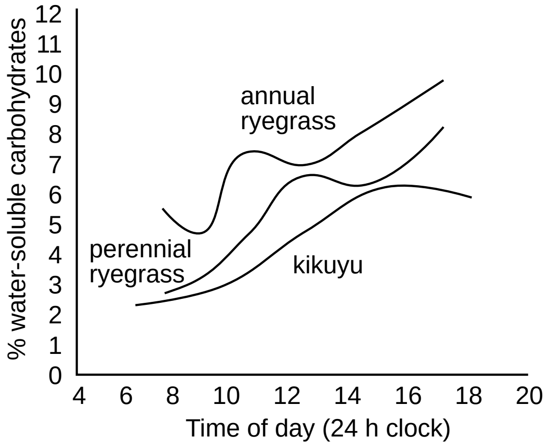


Figure 17. Changes in soluble carbohydrate from 6 a.m. to 6 p.m. for annual ryegrass, perennial ryegrass and kikuyu. The actual levels in ryegrass are from samples taken in early autumn and hence are low.



sun) and decreases at night (as the plant respires) (Figure 17).

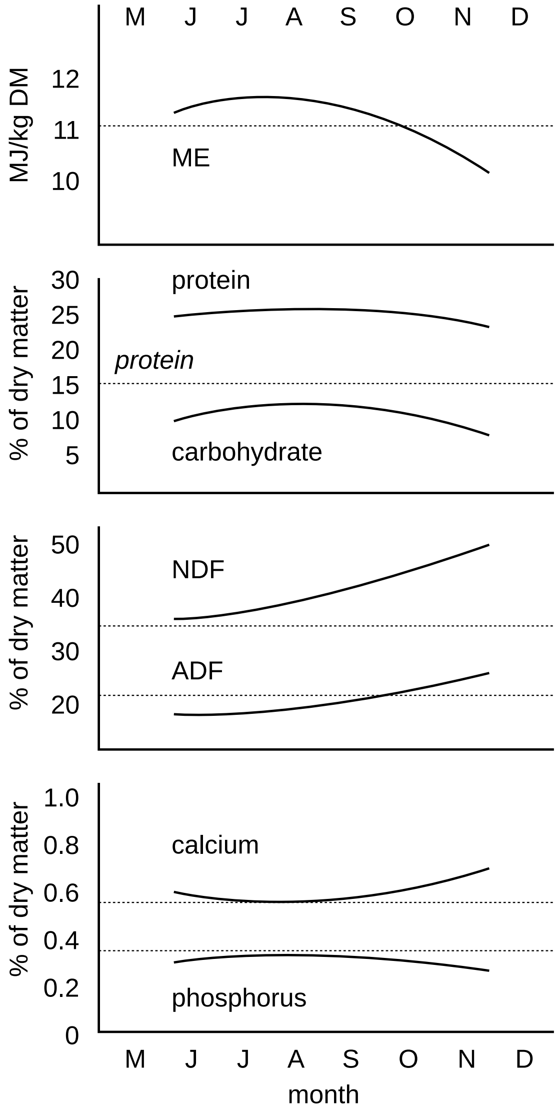
The level of carbohydrates increases at about 0.5% per hour from sunrise. Thus a cow eating, say, 15kgDM of pasture at 4 p.m. (13% sugars) would eat 0.75kg more carbohydrate than a cow grazing pasture at dawn (8% sugars). This is why some farmers cut silage late in the afternoon.

Perhaps it is worthwhile giving cows their largest pasture allocation after the afternoon milking, particularly with pastures low in carbohydrates, such as kikuyu. This proposition is being evaluated by NSW Agriculture at Wollongbar.

Seasonal variation in nutrients

Figures 18, 19 and 20 show the seasonal variation in nutrients in annual ryegrass pasture (Figure 18), perennial ryegrass – white clover pasture (Figure 19) and kikuyu pasture (Figure 20), and the minimum values required for cows producing 20L of milk a day[6]. Table 5 shows the average values of minerals with no seasonal variation for these 3 pastures.

Figure 18. Seasonal variation in nutrients in annual ryegrass pasture. The dotted lines are the minimum required for cows producing 20L of milk a day.



The ADF level is well below optimum from first grazing to the end of August. ADF is needed to keep the rumen functional and for fat synthesis. This period coincides with time of 'low fat' problems in many herds.

ME is adequate but declines rapidly from October. This coincides with stem elongation and seed set.

Protein, NDF and calcium are always adequate. Phosphorus is marginal.

Figure 19. Seasonal variation in nutrients in perennial ryegrass – white clover pasture. The dotted lines are the minimum required for cows producing 20L of milk a day.

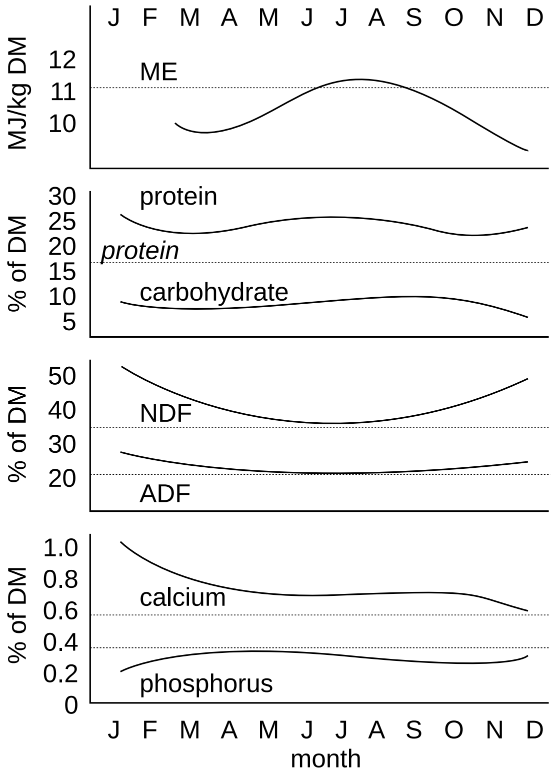
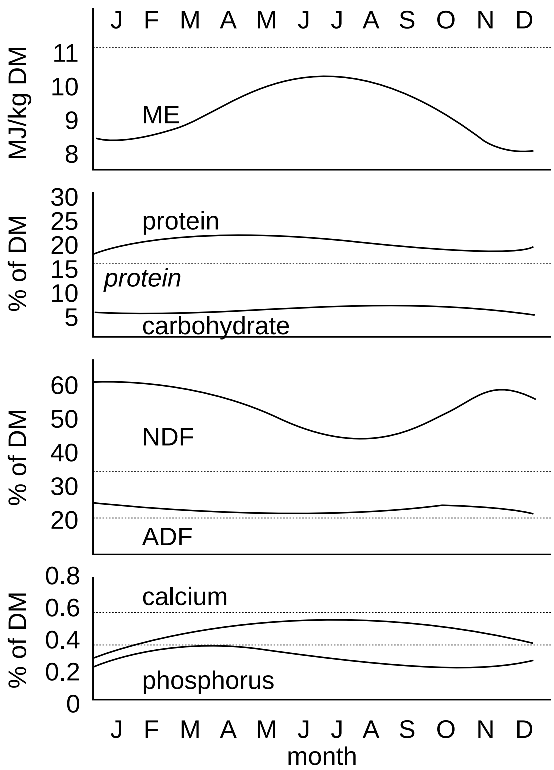


Figure 20. Seasonal variation in nutrients in kikuyu pasture. The dotted lines are the minimum required for cows producing 20L of milk a day.



ADF and NDF are adequate. ME is adequate except from late spring to early autumn.

Protein levels are always high. The protein to carbohydrate ratio is worst in autumn (4:1) and best in spring (3:1). This supports farmers' observations of quality differences between autumn and spring pasture.

Phosphorus levels are marginal, particularly in spring, but calcium is always adequate. This is probably due to the high levels of calcium in clover.

ADF is adequate, but NDF levels are far too high. This is believed to be the main reason why the daily DM intake of cows grazing kikuyu is only 12–13kg.

The ME values are always low, but highest in winter, when there are no high temperatures to increase fibre content. The problem with such a low ME is to find a sufficiently energy-dense supplement to raise the total ration ME to 11.5MJ/kg DM. This is difficult to achieve with grain at an ME of 12MJ/kgDM, and more energy-dense supplements based on oil may be needed.

Protein levels, surprisingly, are adequate, but carbohydrate levels are very low. Calcium and phosphorus levels are marginal to inadequate.

Table 5. Average values of nutrients with no seasonal variation. Most are adequate or more than adequate. Kikuyu is low in sodium and zinc.

Minerals	Minimum required for 20 L milk per cow per day[6]	Annual ryegrass	Perennial ryegrass – white clover	Kikuyu
Magnesium (%)	0.25	0.27	0.30	0.29
Sodium (%)	0.18	0.37	0.47	0.10
Potassium (%)	1	3.43	3.00	2.89
Copper (ppm)	10	11	14	14.5
Zinc (ppm)	40	38	37	29
Manganese (ppm)	40	112	119	88
Iron (ppm)	50	188	386	210

Efficient supplementation of cows on pasture

This section discusses the factors that determine response to supplementation.

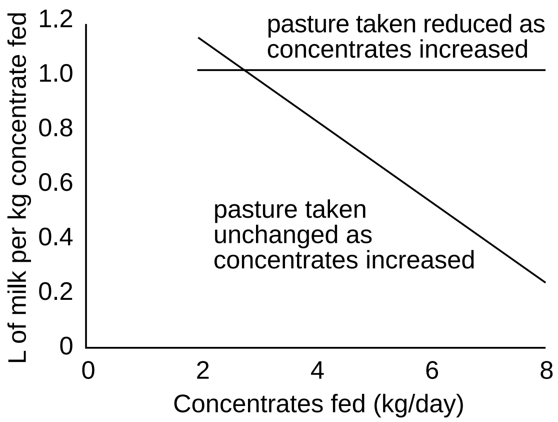
Concentrates can be given:

- to fill seasonal feed gaps
- to allow pasture growth and utilisation to be optimised
- to ensure that cows are on a rising plane of nutrition at mating.

The concentrate should be balanced for nutrients that limit production.

Concentrates are expensive, and when they are fed to cows also grazing pasture, the response is lower than under feedlot conditions. This is because cows invariably reduce their pasture intake as they are less hungry. This is called the **substitution effect**. Therefore, concentrates should be fed under conditions that minimise substitution.

Figure 21. If pasture availability is reduced as concentrates are increased, response to feeding should not change. On the other hand, if concentrates are increased but pasture availability stays the same and is high, response to concentrate fed decreases markedly[5].



The **potential** response to 1kg of concentrate is predictable—1kg of, say , barley contains 90% DM and has an ME value of about 13MJ/kg DM. To produce milk with 4.7MJ/L energy (at 3.6% milk fat), 1kg of barley should produce $13 \times 0.9 \div 4.7 = 2.5$L milk (if all other nutrients are adequate).

The **actual** response to an additional 1kg of concentrates varies from nil to 1.5L of milk, depending on the rate of substitution (of grass for concentrates) and on the effect of feeding concentrates on digestion of pasture in the rumen. In practice, very low responses can be expected from medium- to low-genetic-merit cows, in late lactation, on lush pasture, fed high amounts of concentrate. High responses can be expected from high-genetic-merit cows, in peak lactation, on poor quality pasture, and to the first few kg of concentrate a day.

Table 6 and Figure 21 show the effect of both genetic merit and level of concentrate feeding on production response.

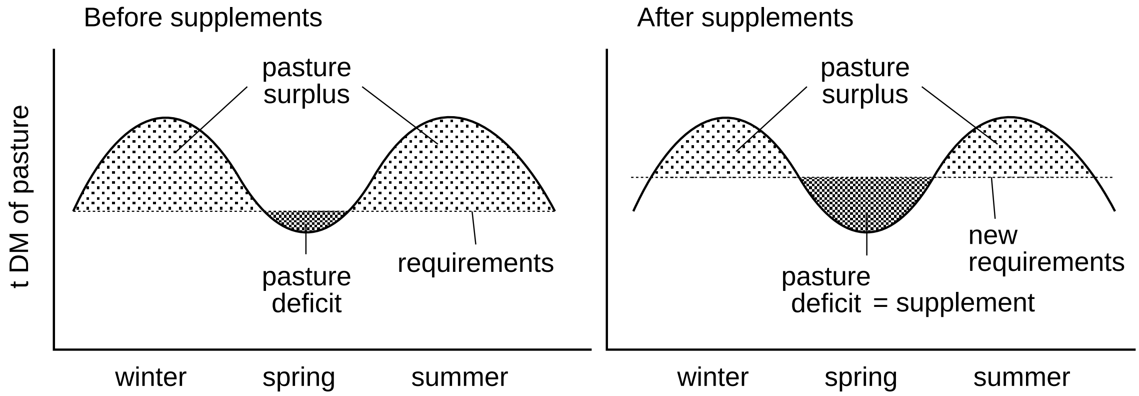
Table 6. The amount of milk produced per kg of concentrate fed decreases as more concentrate is given. High-genetic-merit cows do better than low-genetic-merit cows. The response in each case is relative to that of a group fed no concentrate.

Genetic merit	kg concentrate fed per cow per day	L of milk produced per kg DM fed	Total L produced on concentrate
Medium	2.9	1.24	3.6
	6.3	0.68	4.3
High	2.9	1.46	4.2
	6.3	0.97	6.1

On average, dairy farmers cannot expect more than 1L of milk per kg DM of concentrate fed. With the cost of 1kg of concentrate near that of 1L of manufacturing milk, concentrates must be fed cautiously. Feeding concentrates merely to increase production per cow, and constant feeding throughout the year, can only be wasteful as it must be associated with a high level of substitution for at least part of the year.

To gain a far greater benefit from feeding concentrates to cows on pasture, feed concentrates in order to achieve increased stocking rates and thereby to achieve greater utilisation when pastures are in surplus (Figure 22). In this situation, the direct benefits of feeding concentrates are minor but there is an overall increase in farm productivity. Thus the direct effect on milk response is not the dollar value of feeding concentrates but the dollars gained from higher stocking rate.

Figure 22. Surplus and deficit before and after suppplementation when this is associated with an increase in stocking rate to soak up the greater pasture surplus.



Setting up an effective grazing management system

These next sections discuss what is needed to put the grazing management options discusses previously into practice.

Setting up your farm for controlled grazing can be as sophisticated or as inexpensive as you wish. The principle is to be able to control grazing, and that takes only a few ‘hot’ wires.

Establish semi-permanent blocks small enough to allow no more than 2 days’ grazing in winter. Otherwise, use a back fence. These blocks can be further split into halves to give daily strips of pasture or into quarters to give a strip each milking. The fences need be only a single electric wire, which you can easily drop or roll up for cultivation, for example, or go under when shifting sprinklers.

The number of blocks depends on the optimum grazing interval, which is the time taken for ryegrass to reach 2½–3 leaves per tiller. For example, if it takes ryegrass 40 days to grow 3 new leaves per tiller, then you split your ryegrass area into 20 two-day blocks. Note: the area of each block is not an issue. If each block has insufficient pasture, either your stocking rate is too high or you need to give more supplements.

To estimate the time to reach the 3-leaf stage in the coldest month of the year (usually July), either look at a few leaves or use the average temperature for your district as follows:

$$3 \text{ leaf-appearance intervals} = 3 \times (20 - 0.55 \times (\text{max. temp.} + \text{min. temp.}) \div 2)$$
$$= 3 \times (20 - 0.55 \times \text{average temperature})$$

To achieve correct timing and intensity of grazing and provide adequate feed for your cows, you need to give supplements if pasture on offer is inadequate, or close up blocks for silage (or other stock) if pasture on offer is too much.

Even if you have good irrigation potential, you should store 3t of silage (1t DM) per cow per year . In a normal year only ⅔ of this will be used; the rest can be ‘rolled over’ to be used in a poorer year.

Feed planning

Feed planning is planning your feed supply to meet your target levels of milk production and the nutritional requirements of the herd.

The level of feeding and the continuity of feed supply account for the biggest differences in productivity and income between dairy farms. Feed planning can help you achieve maximum farm productivity and profits by balancing feed quality and quantity.

For most dairy farmers the cheapest way to feed dairy cows is with pastures, which comprise 60%–100% of the cows' feed intake. For profits on pasture-based dairy farms to be increased, it is vital that these pastures be well managed. Feed planning is essential to achieving this.

Feed for dairy cows accounts for 50%–80% of total variable costs. Feed planning allows you to reduce costs and increase profits by:

- reducing feed shortages and underfeeding of cows
- maximising the use of surplus feed
- examining management alternatives and options
- using farm equipment effectively
- optimising the use of pastures and supplements
- increasing pasture production
- increasing milk production
- optimising the use of fertilisers
- using irrigation more effectively
- optimising the use of supplements per cow
- maximising levels of profitable production for your farm.

Feed planing needs to take into account farm plans, feed budgets and grazing plans:

- **Farm plans** are long-term plans that set targets for pasture and milk production for the whole farm. They consider herd size, calving patterns, patterns of production and farm development.
- **Feed budgets** are medium-term plans that examine management alternatives to overcome feed imbalances and make the best use of pastures, supplements and conserved feed.
- **Grazing plans** are short-term plans that maximise pasture production and use through various pasture and grazing management strategies.

Allocating pasture and feed

Step 1. Measure pasture *on offer*

To calculate what quantity and quality of supplements to give, you need to measure the available pasture. Pasture DM can be estimated by eye, or more accurately with a rising plate meter (Figure 23). The meter measures the density of pasture by measuring how much the pasture holds up a standard plate (4kg/m ^{2}).

Total DM (on offer) per ha can be worked out from the **basic equation:**

kg DM/ha = (final reading – initial reading) ÷ no. readings ÷ 2 (to convert to cm) × pasture factor

Pasture factors:

- **Ryegrass or ryegrass – white clover:** 195 (not valid after stem elongation)
- **Oats:** 185 (not valid after stem elongation)
- **Kikuyu:** 200; for before grazing subtract 1200; for after grazing subtract 1400. (This equation gives DM considered to be available to the animal. It is valid only for hard-grazed pastures or for pastures mulched or slashed after grazing.)
- **Lucerne:** Estimating lucerne DM with the rising plate meter is too inaccurate because of lucerne's stalky nature. DM needs to be estimated from the actual crop height and density. Table 7 (over) shows DM estimates at different plant densities and actual heights for lucerne, and conversions of pasture meter heights to kgDM/ha for the other species discussed.

Available DM, which is always less than **total** DM ('on offer'), is calculated in step 2.

When using the pasture meter:

- take 60–80 readings per block so that the estimate is accurate
- take these readings at set intervals (2–3 paces) across the block
- place the plate of the meter horizontally on the pasture. Do not thump the plate or use it as a walking stick
- treat the meter carefully; bent rods give wrong readings. Use a wire brush every 2–3 weeks to clean the stem and rachet
- remember that the normal Ellinbank rising plate meter is graduated in $\frac{1}{2}$cm, not 1cm, graduations on the digital readout.

Figure 23. A rising plate meter in use.

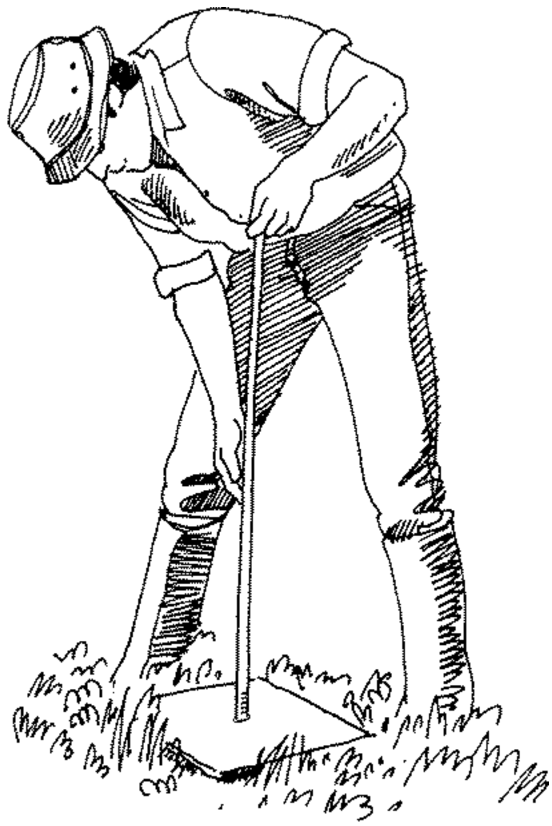


Table 7. Conversion between rising plate meter values (cm) for ryegrass, oats and kikuyu, or actual height (cm) for lucerne, and DM yields (kg/ha).

Pasture height (cm)	Ryegrass, or ryegrass–clover	Oats	Kikuyu		Lucerne	
			before grazing	after grazing	thin	dense
4	780	740	0	–	–	–
6	1170	1110	0	–	–	–
8	1560	1480	400	200	–	–
10	1950	1850	800	600	200	400
12	2340	2220	1200	1000	240	490
14	2730	2570	1600	1400	280	580
16	3120	2960	2000	1800	320	670
18	3510	3330	2400	2200	360	760
20	3900	3700	2800	2600	400	850
25	4875	4625	3800	3600	500	1150
30	5850	5550	4800	4600	650	1425
35	6825	6475	5800	–	800	1700
40	7800	7400	6800	–	1000	2000
45	–	–	–	–	1200	2400

Step 2. Calculate pasture *available* per cow per day

In step 1, we calculated pasture **on offer**; that is, the total offered to cows. For ryegrass, this is to ground level, but for kikuyu, it is to 5cm stubble height. (The mat below this is considered to be inedible.)

In this step, we now calculate pasture **available**; that is, pasture on offer minus residues left after grazing. Thus, **pasture available** depends on the residue, which in turn depends on stocking intensity, type of stock and actual amount on offer.

For ryegrass, aim to achieve 1000–1200kg DM/ha, or about 5cm, post-grazing residue. However, it is probably more relevant to determine pasture residues in your situation from the most recently grazed blocks with similar pasture on offer.

In well utilised kikuyu or kikuyu slashed or mulched after grazing, work on utilising $\frac{2}{3}$ of the DM **on offer** above 5cm stubble height. For example, if 800kg DM is **on offer** above 5cm stubble height, then $\frac{2}{3} \times 800\text{kg} = 533\text{kg}$ DM **available**. If there are 50 cows, this comes to $533 \div 50 = 10.6$kg DM per cow .

A prerequisite for allocating pasture in this manner is obviously a reasonable estimate of block or paddock size.

The table on the next page shows a worked example.

To calculate:	Example for ryegrass pasture
	meter reading on entering block = 15650; meter reading on leaving block = 16880; no. of readings = 56; residue of 1000 kg DM/ha after grazing; 1.8 ha, 180 cows
DM *on offer* per ha: take 60–80 readings before grazing and use the equations from step 1 to calculate pasture on offer	(16880 – 15650) ÷ 56 ÷ 2 × 195 = 2142 kg DM/ha *on offer*
DM *available* per ha: subtract the estimated post-grazing residue	2142 – 1000 = 1142 kg DM/ha *available*
total DM available: multiply by area of pasture grazed per day	1142 × 1.8 = 2056 kg DM available per day
DM available per cow per day: divide by the number of cows	2056 ÷ 180 = 11.4 kg DM available per cow per day

Step 3. Calculate DM supplements per cow per day

To calculate:	Example
Daily feed requirements: maintenance: 5.5 kg DM per cow per day for average Friesians (use 6.5 for large); milk production = 2 L milk/kg DM. Assume daily production = 20 L milk per cow	
feed intake per cow per day: use values for maintenance and milk production	5.5 + 20 ÷ 2 = 15.5 kg DM per cow per day
supplements required: subtract available DM from requirements	15.5 – 11.4 = 4.1 kg DM per cow per day

Note that the supplement required is calculated on a dry-matter basis. This will have to be corrected to ‘as-fed’ before feeding stock. For example, you need 4.1kg DM supplements but grain is 91% DM. Therefore you actually need 4.1 ÷ 0.91 = 4.5kg.

Thus cows can be fed to the appropriate level by first determining pasture available.

Many farmers end up simply using the pasture meter periodically to ‘get their eye in’ (that is, to check their estimates), and then estimate DM/ha by eye.

Budgeting and monitoring pasture

We should aim to budget pasture (and other feeds), just as we budget our cash flow. The success of pasture budgeting depends on obtaining accurate pasture growth rates for your property and having a means of monitoring actual pasture cover relative to previous years, which you can compare with budgeted cover. A fortnightly farm walk, during which you estimate pasture cover, satisfies both these needs.

On your walk, assess feed on offer on each block with the pasture meter. This should not be a chore but an opportunity to assess the health of your farm. The data will give you:

- growth rates for various pasture types at fortnightly intervals throughout the year
- post-grazing residues: Are cows grazing too hard? Hard grazing will reduce regrowth and is an indication that cows are being underfed (approx. 1000kg DM/ha is ideal for ryegrass and 300kg DM/ha is ideal for kikuyu)
- pre-grazing DM on offer: Is it too high? Cows tend to waste pasture above 2400kg DM/ha.

Compare feed on offer on the farm this year with last year and calculate surplus or deficit.

Table 8 shows how the results can be recorded. Figure 24 shows how they can be represented. If you have a computer and a spreadsheet program you can automate calculations (one, called PASTURE ASSESSMENT, is available from NSW Agriculture).

Block 3 has obviously been grazed since the last farm walk and so its results are discarded.

Figure 24 clearly indicates a 60t DM deficit compared with last year. Some ways to remedy this might be:

- to remove heifers from the milking area:

  agisting 50 heifers (average age 15 months) × 8kg DM per heifer per day × 90 days saves 36t DM
- to buy 60t hay
- to dry off 20 cows @ 15 L of milk per cow per day (1 month early):

  feed saved = 20 × 13kg per cow per day × 30 days = 7.8t DM
- to apply 50 kg N to 20 ha at an expected response of 24kg DM/kg N; this should give 24t DM
- to increase concentrate feeding by 4 kg per cow per day for the 180 cow herd:

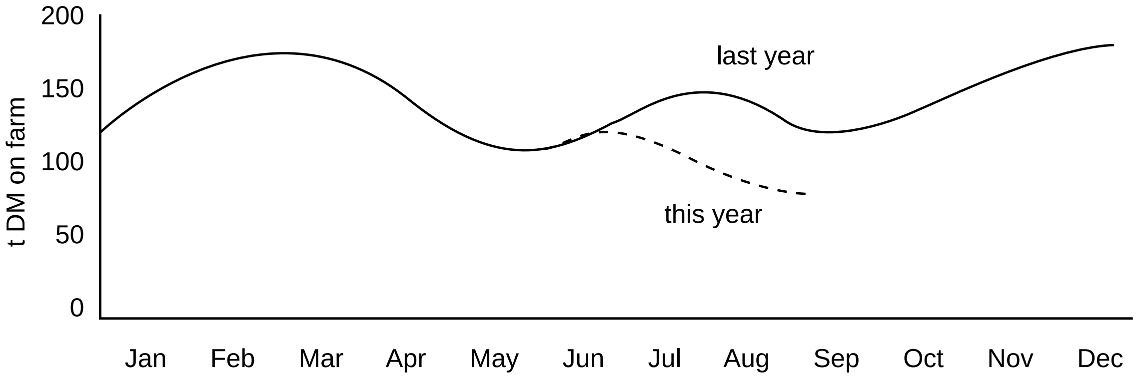
  4kg × 180 cows × 30 days provides 21.6t DM.

Table 8. Sample fortnightly record of pasture growth.

Block	Area (ha)	Pasture type	1 July				15 July				Growth rate kg DM/day
			Meter readings			on offer kg DM/ha	Meter readings			on offer kg DM/ha	
			in	out	no.		in	out	no.		
1	0.6	Ryegrass	15600	15980	50	741	780	1490	50	1385	46
2	1.4	Ryegrass	15980	16940	60	1560	1490	2410	55	1631	5.1
3	0.8	Kikuyu*	16940	18420	70	814	2480	3300	80	–275	–

* When working out average pasture cover for kikuyu, use kg DM/ha = 200 × meter reading (cm) – 1300.

Figure 24. Feed* on offer *on the farm last year and this year estimated from fortnightly farm walks with the rising plate meter.



Thus, accurate estimates of growth rates can give reliable budgets, and monitoring pasture can flag the need to take action early.

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Questions

Grazing kikuyu at the 4–41⁄2-leaf stage optimises quality. What is the penalty in quantity by not letting it grow longer?

If there is a high residue of ryegrass after grazing (well in excess of 5cm) for whatever reason, is it better to regraze or to wait for a full regrowth cycle?

Many ryegrass plants are lost through sod-pulling. What can be done to reduce this?

Is there any benefit in using nitrogen fertiliser on white clover to increase dry matter yields and take advantage of the high-quality herbage?

Is there any advantage in harrowing pastures to prevent dung pads, especially when short grazing rotations are being used?

When feed is in short supply, what value does concentrate have relative to silage?