Kikuyu grass

(Pennisetum clandestinum)

by Bill Fulkerson

KIKUYU FOR DAIRY COWS

Kikuyu requires high soil fertility for good growth. It is suited to the subtropics and is endemic on the east coast of Australia, north of Sydney and under irrigation in south west of Western Australia.

If managed correctly, kikuyu can provide nutritional feed for dairy cows during summer and autumn, its period of predominant growth.

Like most C_4 grasses, kikuyu has a high fibre content but can be managed to keep the metabolisable energy (ME) content of the leaf above 9MJ/kg DM.

Kikuyu is deficient in sodium and calcium so these minerals need to be provided as supplements to dairy cows grazing kikuyu pastures.

Cows grazing well-managed kikuyu pasture can derive about 14-15L milk/day from this grass (compared with about 20-22L milk/day from well-managed ryegrass).

Cows grazing kikuyu respond well to grain supplements (about 1.5 – 1.6L milk/kg grain fed for the first 2-5kg/cow/day).

Grazing and fertiliser management are the keys to achieving the best value from kikuyu for dairy cows.

The water use efficiency of kikuyu is similar to maize. Kikuyu is twice as water efficient as high as perennial ryegrass in summer, even when the latter is adequately watered.

Kikuyu is a C_4 tropical grass which originated from the kikuyu region of Kenya. It has become endemic along most of the east coast of Australia and in irrigated pastures in the south west of Western Australia.
It is probably the second most important pasture species for dairy production in Australia after ryegrass.

When appropriately managed and cows are supplemented to address mineral deficiencies, cows grazing kikuyu can produce up to 14-15L milk/cow/day (compared to 20-22L milk/day/cow for ryegrass). To achieve higher milk yields, high response rates to energy dense supplements such as cereal grains are common.

The results in Table 1 show production from Holstein-Friesian cows in mid lactation (all feed converted to milk) grazing pure kikuyu pastures and supplemented with various levels of rolled barley grain.

Table 1. *Milk production and milk composition of cows in mid lactation.*

Barley Fed kg/cow/day	Milk Yield (L/cow/day)	Milk Fat (%)	Milk Protein (%)
0[a]	14.2	3.8	3.1
3[b]	18.3	3.5	3.2

[a] Provided with a mineral lick containing calcium, sodium and phosphorus
[b] Balanced for calcium, sodium and phosphorous

ESTABLISHMENT

The originally-introduced cultivar, now called 'common' kikuyu does not set much seed so was propagated from stolons. The commercially-available seed of Whittet kikuyu is now sown almost exclusively, as it seeds prolifically.

Sowing: Sow at up to 3kg/ha, drilled to about 1cm depth or broadcast then roll. Sow in **early autumn**, when soil is still warm enough to germinate the seed (minimum temperature >15°C). Kikuyu is usually sown with a cover crop of oats or ryegrass at about half the normal sowing rate (15kg/ha for ryegrass or 60kg/ha for oats). Then in late spring, when it is warm enough for kikuyu to grow, graze or slash the resident sward (oats/ryegrass) frequently to prevent young kikuyu seedlings being shaded. As a rule of thumb, expect to graze every 10-14 days from November onwards.

Kikuyu can be established quickly, by sowing in mid-spring, but this requires a very clean seed bed and regular slashing (14-21 days) otherwise the kikuyu seedlings will be overtaken by other summer grasses.

GRAZING MANAGEMENT

In contrast to ryegrass, the aim of managing kikuyu is to maximise **quality** (Table 2). Metabolisable energy is the first limiting nutrient for dairy cows in a pasture-based system, so the aim is to maximise energy density.

Table 2. *Metabolisable energy (ME) and crude protein content of kikuyu leaf, stem and dead material.*

Kikuyu component	**Metabolisable energy** (MJ/kg DM)	**Crude protein (%)**
Leaf	9.2	21
Stem	7.4	17
Dead	6	9

To maximise metabolisable energy and protein content, kikuyu needs to be managed to maximise leaf availability to the cow. This involves grazing milking cows to remove the leaf, followed by removing the residual stem either mechanically (slasher/mulcher) or grazing with animals with lower requirements, such as dry cows. In most years this can be achieved by mulching two to three times, usually after substantial rain.

Leaf regrowth and quality

The optimum time to graze is when the maximum amount of good quality leaf is available. This can be determined by referring to the numbers of leaves regrown.

After grazing, each kikuyu tiller grows up to four new leaves before the oldest leaf begins to die and stem growth increases substantially. Thus, once four leaves are present, the proportion of green leaf available to the animal decreases (See Figure 1a) and forage quality falls dramatically in terms of digestibility (metabolisable energy) and protein content (See Figure 1b).

Leaf stages

The number of leaves on a tiller are like the hands on a biological clock in the paddock. They reflect previous growth conditions for the plant (primarily temperature) and indicate if the pasture is ready to graze. This makes leaf stage a useful tool for determining grazing interval.

To use leaf stage effectively the following points need to be considered.

- The ***'remnant'*** leaf is the new shoot first appearing after grazing, it was only partly extended before grazing and continues to extend after grazing and can be identified by the tipped end (See Figure 2).

Figure 1. *Changes in (i) the proportion of leaf, sheaf, stem and dead components of total dry matter above 5cm stubble and (ii) crude protein (CP) and organic matter (OM) digestibility with age of regrowth.*

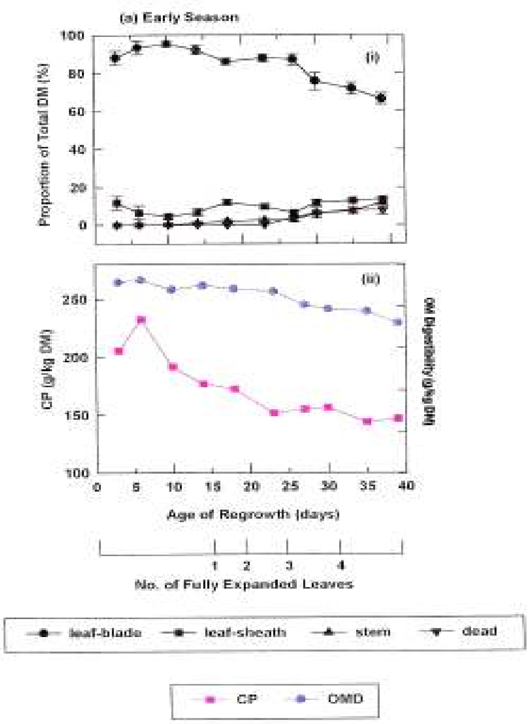
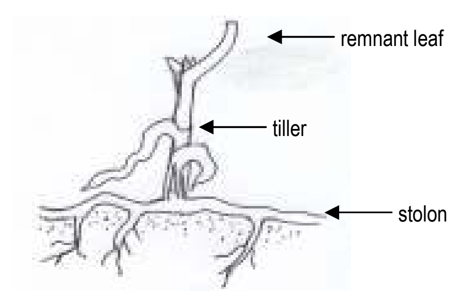


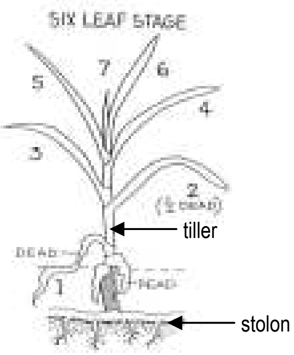
***Figure 2**: A kikuyu tiller immediately after grazing showing the youngest 'remnant' shoot extending.*



- If the remnant leaf grows to half the size of a normal leaf or more, it is counted as the first new leaf. The subsequent leaves will emerge from the sheath before each previous leaf has fully extended. Therefore, at the 4-leaf stage, the fifth leaf will just be emerging out of the sheath (See Figure 3).

***Figure 3**: Kikuyu tiller with six leaves extended, the seventh*

leaf just emerging, and the oldest (leaf 1) leaf is starting to die.



- There are far more lateral tillers than apical ones. Apical tillers at the end of a stolon usually have a higher rate of leaf appearance so that there will be more leaves at a given time. Look at 8-10 tillers at random to get an accurate estimate of leaf stage.

Determining grazing interval

As the rate of emergence of leaves depends primarily on temperature, the 'leaf appearance interval' for kikuyu might be as short as three days giving a 12-day (4 leaves x 3 days/leaf) grazing interval in summer. Where moisture stress becomes severe, the time taken for each leaf to emerge will increase. This is a survival mechanism to reduce water loss from the plant from fewer leaves.

Kikuyu can be grazed before the 4-leaf stage with little detriment to plant growth, but there are two concerns.

First, having less pasture on offer means cows need to cover more area and expend more energy to get a set intake. The advisability of this will depend on growth rate, ie how much is on offer, which depends on moisture, soil fertility and temperature.

Second, kikuyu is notoriously low in sodium, magnesium, phosphorus and calcium. The content is lowest in young regrowth. Potassium is far too high for grazing ruminants and is particularly high in kikuyu during early regrowth but falls with leaf maturity. Low levels of magnesium can cause metabolic problems however magnesium levels rise with leaf maturity. Thus, apart from phosphorous, the mineral status of the kikuyu leaves improve substantially with maturity.

Grazing Intensity

Milking cows tend to eat 1,100-1,300kg DM/ha from a kikuyu pasture, irrespective of the amount on offer. This is probably because this volume represents the 4-5 youngest green leaves with the rest being stem and dying material.

Even when grazing at the optimal grazing interval, cows should only be forced to graze about two thirds of the pasture above 5cm stubble height. Under these conditions stubble builds up after a few grazings and then needs to be slashed back to 5cm stubble. If stubble is left to grow too tall before slashing, regrowth will be slow. This is because the growing point has grown above the cutting height so many of the growing points will be removed in the slashing process

FERTILISER MANAGEMENT

Kikuyu requires highly fertile soil. Apply the equivalent of 50kg N/ha after every second grazing, reflecting growth and the need for nitrogen.

WATER EFFICIENCY

In summer, kikuyu is one of the most water-efficient species to grow (see Table 3) just behind maize and more than double the efficiency of perennial ryegrass. With its deep root system, kikuyu can grow well with relatively infrequent irrigation but grows best at high humidity.

NUTRIENT CONTENT

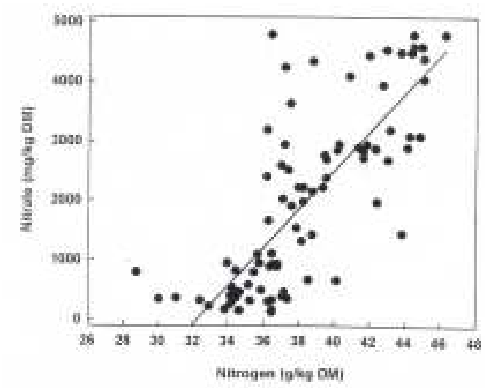
Cows grazing kikuyu pastures need to be supplemented with calcium, phosphorus (usually dicalcium phosphate) and sodium (as salt).

These mineral deficiencies are usually corrected by feeding additives with concentrates. Alternatively a lick can be provided in the paddock.

When managed correctly, the metabolisable energy value of kikuyu can be reasonable (Table 3) especially in the cooler climates south of Sydney (metabolisable energy up to 9.0MJ/kgDM and over 10 in late Autumn).

Protein is also adequate if appropriately fertilised with nitrogen. However, once protein content gets above about 23% (≈ 3.4% nitrogen) nitrates start to accumulate (see Figure 4). Nitrate is converted to nitrite in the rumen, which is toxic to some cellulytic micro-organisms, thus reducing digestibility of roughage, including kikuyu. This can cause rejection of kikuyu pasture by stock and a reduction in rumen efficiency. At very high levels, nitrate can be toxic and in some cases fatal.

Figure 4: *The relationship between nitrogen (g/kg DM) and nitrate (mg/kg DM) content of kikuyu pasture above the 5cm stubble height with fitted regression line (Reeves 1998).*



The intake of kikuyu is limited by its relatively high fibre content (>50%Neutral detergent fibre, see Table 3). The response to high energy dense/ low fibre supplements, such as cereal grain, is high and under good management can be 1.5 – 1.6L milk/kg grain fed.

YIELDS

Figure 5 shows growth rates of kikuyu oversown with short rotation ryegrass at Camden in NSW. Under appropriate management (grazing, fertiliser, irrigation) nearly 18t DM/ha has been achieved in the FutureDairy's Forage study in a paddock scale comparison. This should be achievable on commercial farm situation.

Figure 5: *Average monthly pasture growth rates (net herbage utilisation, kg DM/ha/day for kikuyu oversown with ryegrass in autumn at Camde, NSW). Data averaged over 2 years.*

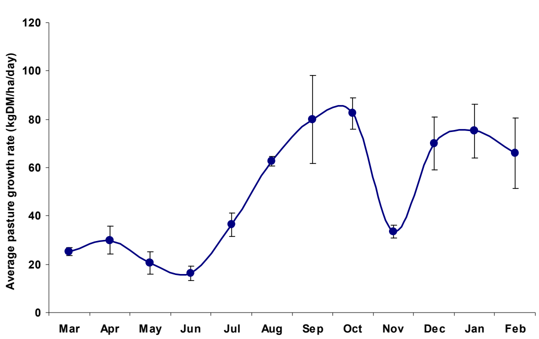


Table 3: *Nutrient content (%, unless otherwise indicated) of kikuyu, perennial ryegrass and requirements for a 600kg Holstein-Friesian cow producing 20L/day.*

Nutrient/WUE	Perennial Ryegrass[b]	Kikuyu[b]	Paspalum[b]	Cow requirements[b]
Metabolisable energy (MJ/kg DM)	11.4	9.6	8.1	10.3
Nitrogen	3.9	3.9	3.5	2.4
Non-protein N	0.9	1.1		
Nitrate N	1.10	0.52		0.14[d]
Crude protein	24.3	24.2	22.0	15
Acid detergent fibre	23	26		18
Neutral detergent fibre	49	64	70	45
Water soluble carbohydrate	7.8	2.8	3.1	
Calcium	0.53	0.42	0.3	0.51
Phosphorus	0.32	0.28	0.4	0.33
Potassium	2.2	2.9	2.6	0.9
Magnesium	0.28	0.3	0.2	0.2
Sodium	0.1	0.14	0.04	0.18
Sulphur	0.43	1.31	0.3	0.2
ERDP:FME (g/MJ) [a]	17	20	19	10
Bypass protein (% total protein)	42	40	25	
Water use efficiency (MJ ME/mm water) [c]				
Winter	360			
Summer	160	410	350	

a – Ratio of effective rumen degradable protein (ERDP) to fermentable metabolisable energy (FME)
b – For kikuyu and paspalum in summer and for perennial ryegrass in winter
c – Includes all water – irrigation, rain and use of soil moisture
d – Maximum content

KIKUYU FOR DRY COWS

Kikuyu is suitable for dry cows if it is grazed properly and cows are appropriately supplemented. There is no difference between kikuyu and ryegrass except that the magnesium content may be a bit lower in kikuyu.

Rotationally graze kikuyu so cows graze leaf and stem at a mature leaf stage. Supplement with magnesium – the potassium content is much lower in mature leaves than young shoots. The low calcium content of kikuyu is good for dry cow forage.

Do not set stock dry cows on a large area of kikuyu. Cows will only have young shoots to eat which are high in potassium and low in magnesium. This predisposes calving cows to milk fever and other metabolic disorders. Giving any cows access to a large area of any pasture (including kikuyu) that has new shoots due to a recent rainfall event can cause metabolic disorders and nitrate poisoning as shoots are very high in nitrates.

Oversowing kikuyu pasture for winter feed

WHITE CLOVER

A kikuyu/white clover pasture has great productive potential. Under commercial dairy farm conditions these pastures can produce more than 12t DM/ha of white clover and 8t DM/ha of good quality kikuyu. However, the system can fail from nematode infestation of clover (see later).

Each species complements the other. White clover re-establishes during April/May as the growth rate and quality of kikuyu falls. Kikuyu comes into its own in December after white clover sets seed and its growth declines. In this context it is a sustainable system. A kikuyu base prevents weeds from establishing during summer, which is a problem when attempting to grow a monoculture of white clover.

Establishment

The establishment of white clover in autumn requires an understanding of growth characteristics of both kikuyu and white clover. The time to sow white clover is about six weeks before the first expected frost, eg when the minimum air temperature has fallen to below 15^{0}C.

For example, on flood plain regions of northern NSW, clover should be established in early April. This will allow the establishment of the clover plants while it is still warm. The onset of cold weather will restrict competition from kikuyu grass. It may be more difficult to establish white clover in coastal regions where kikuyu continues to grow further into winter.

Seasonal management for a kikuyu/white clover pasture is shown in Figure 6.

Suppressing kikuyu growth during white clover establishment

The options are:

- Removing the kikuyu mat by hard grazing;
- Spraying with a herbicide; or
- Grazing, mulching, fertilising and closing the kikuyu pasture a month before harvesting for silage and then sowing.

Removing the kikuyu mat by hard grazing will require the equivalent of 150-200 cows/ha/day. Usually there are insufficient dry cows for this. In this case mulch to 5cm stubble height, preferably after the previous grazing to allow the mulch to settle before sowing time, and then graze hard again at sowing.

This technique should be used after the end of March, otherwise competition from kikuyu is too great.

Spraying with herbicides can produce variable results but is the only option for sowing before the end of March.

Although it is common to use low rates of glyphosate (Roundup®) (½ and ¾L/ha) to suppress kikuyu, the result can vary from complete kill of kikuyu to no effect at all. In addition, the continual use of glyphosate over many years is believed to be responsible for the loss of kikuyu pastures.

A better method is to use a desiccant such as gramoxone at 3L/ha. Under most conditions this stops kikuyu growth for 2-3 weeks so that sowing can be brought forward to mid-March.

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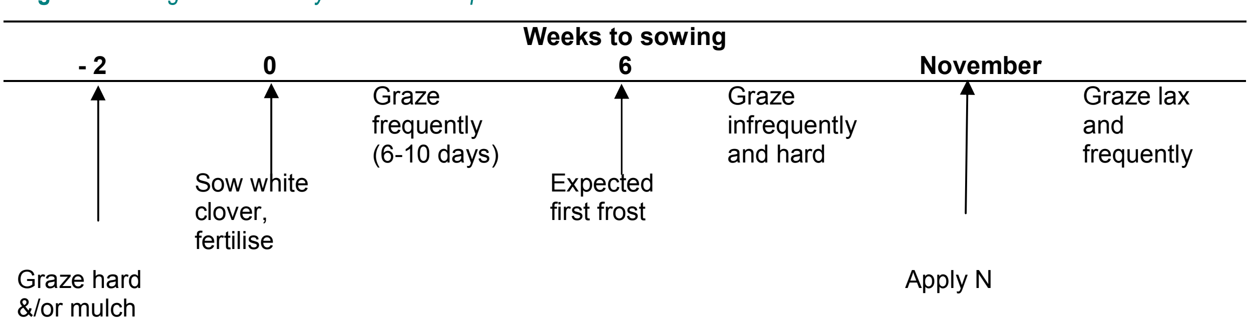
Figure 6 *Management of kikuyu/white clover pastures*



The silage option is becoming increasingly popular. After silage kikuyu is slow to recover because many of the growing points on the extending stems have been removed. This reduces competition while the clover establishes. Thus silage is a valuable pasture management tool that also provides a feed of moderate quality (63% digestibility; 8MJ/kg DM metabolisable energy and 15% protein).

Ground preparation

A light disc harrowing before sowing and rolling after sowing can be beneficial, particularly if no irrigation is available. Alternatively, or in addition to rolling, soil around the seed can be compacted by leaving several dry cows in each block for a couple of days after sowing.

Sowing

White clover seed is broadcast at 4kg/ha. The white clover variety, Haifa, seems ideal as its vigorous winter growth complements that of kikuyu, with growth slowing after seed set in November.

Fertiliser

White clover needs adequate phosphorus (superphosphate) and potassium (muriate of potash). It also needs molybdenum for nodulation which can be applied either as standard molybdenum superphosphate (200kg/ha) or sprayed onto pasture as sodium molybdate. Coating the seed with molybdenum can satisfy requirements in the immediate post-establishment period. Molybdenum needs to be applied about every 3-5 years. Check pH; if it is below 5 ($CaCl_2$) then sowing white clover is not recommended.

Irrigation

On the north coast of NSW, do not grow white clover unless irrigation is available in late spring. White clover is more sensitive to cold than ryegrass but tolerates heat better. Hence its major growth is in spring and early summer. The advantages of white clover over ryegrass will not be realised without adequate moisture, as it is highly sensitive to moisture stress.

Grazing during establishment

Shading will kill young clover seedlings. Therefore, after germination, graze every time the new kikuyu shoot exceeds 8cm. This could be as frequently as every 7-8 days. This practice:

- Prevents kikuyu shading clover. The shading will kill a lot more plants than treading by stock.
- Sets back growth of kikuyu (in autumn).
- Provides very palatable feed enabling stock to 'clean up' the pasture quickly.

The young shoots are very high in potassium and nitrate and can cause metabolic problems. Only allow cows to graze it as a small portion of their diet.

This frequent grazing should last for 5-7 weeks until clover dominates. Then graze hard and infrequently (every 30-40 days during winter and spring). In late spring (late November) allow kikuyu to take over. This can be done by frequent, light grazing to remove clover leaf and favour kikuyu growth. Hard grazing at longer intervals, favours clover growth.

Re-establishing white clover

If appropriately managed, white clover should last for at least three years without the need to resow. As kikuyu growth increases in December, the white clover 'disappears' to remain dormant during the summer. White clover is then reinitiated in autumn from dormant existing plants and as seedlings from seed set in the previous spring when kikuyu competition declines due to lower temperature. Another benefit of the Haifa cultivar is that it is a prolific seeder.

Appropriate management in early autumn (mid March onward) is needed o suppress kikuyu growth. Conditions can be manipulated to favour clover by ceasing to apply nitrogen (N) fertiliser, grazing hard and watering frequently. This means suppressing kikuyu growth in late March and April to allow white clover to re-establish.

Caution: nematodes

Although the kikuyu/white clover system has been shown to be extremely productive, dense swards of white clover can attract plant root nematodes in some situations. As a result of nematode infection, plant population and pasture vigour will decline after the third year. There are no white clover varieties resistant to nematode attack. The only remedy is to quarantine the area by growing kikuyu alone or oversown with ryegrass for three years.

KIKUYU/SHORT ROTATION RYEGRASS

It is very common to oversow kikuyu with short rotation ryegrass. Short season varieties are best as they decline in growth in late spring when kikuyu growth commences. The management for establishment is the same as for white clover. The seed rate varies from 15 to 30kg/ha with the higher rate providing more early feed.

KIKUYU/BRASSICA RAPE PASTURES

Brassica rape can also be oversown into a kikuyu pasture as early as mid-March and earlier than ryegrass provided a desiccant is used to set back the growth of kikuyu. Management is similar to clover with a seed rate of about 5kg/ha of superstrike-treaded seed. The Brassica is vigorous and will appear in four days of sowing under ideal conditions. Brassica also seems to be less sensitive to moisture stress and therefore can be sown earlier than ryegrass.

Brassica provides autumn feed (5-6 weeks from sowing) of very high energy value (see Technote on Brassica).

KIKUYU/PERENNIAL RYEGRASS PASTURES

In higher latitudes than Sydney, perennial ryegrass just cannot survive in a kikuyu-based pasture. However, south of Sydney and in the south west of Western Australia, perennial ryegrass is regularly resown and coexists with kikuyu for 3-4 years before it completely dominates and has to be sprayed out and perennial ryegrass resown.

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About FutureDairy

FutureDairy aims to help Australia's dairy farmers manage the challenges they are likely to face during the next 20 years. The challenges are expected to be related to the availability and cost of land, water and labour; and the associated lifestyle issues.

Our activities are structured around three priority areas – **Forages, Feeding and Innovations**. These are the areas where there are opportunities to address the challenges related to water, land and labour resources.

FutureDairy's approach is unique in that our work considers Science, Systems and People issues. In addition to conducting trials on research farms (**Science**), we explore how our findings work under commercial conditions on Partner Farms (**Systems**). We also use social research to help understand the social issues (eg labour, lifestyle and practical implications) involved in taking on new practices and technologies (**People**).

Our **Forages** work is all about producing more home grown feed from the same area of land. We are investigating the potential to concentrate resources (water, fertiliser and management). Our target is to produce more than 40t DM/ha/yr in a sustainable way. To achieve this we are trialling a 'complementary forage rotation' based on growing three crops a year:

- a bulk crop (eg maize);
- a legume for nitrogen fixation (eg clover); and
- a forage to provide a pest/disease break and to improve soil aeration (eg a brassica).

Our **Feeding** work is researching if it is more profitable to use extra bought-in feed to feed more cows (ie increase stock numbers) or to increase production per cow.

FutureDairy is investigating a number of **Innovations** that could improve farm efficiency, labour management and lifestyle. We have a major study on automatic milking systems (AMS), the obvious labour saving innovation. We are adapting automatic systems to be profitable and suitable for Australia's pasture-based, large herd situation.

We are also studying innovations that allow precision farming without increasing labour needs. Some examples include remote sensing of animal function and pasture status, and the use of video cameras to monitor paddock activities (eg calving) remotely via a computer.

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