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Milk Production from Kikuyu Grass-based Pastures

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Bill Fulkerson, Dairy Farm Consultant, Wollongbar; Peter Beale, Senior Land Service Officer LLS, Taree; Blake Cheer, Dairy Development Officer NSW DPI, Port Macquarie; Nathan Jennings, Senior Land Services Officer LLS, North Coast.

Introduction

Kikuyu (*Cenchrus clandestinum)* is a tropical grass introduced into Australia in the 1920's from stolons brought from the Belgian Congo. In 1969, "Whittet", a seeded kikuyu cultivar, was released. Kikuyu has since been naturalised along most of the east coast of Australia and was the dominant summer pasture on coastal dairy farms. A survey in 1994 found that 30% of dairy pastures were kikuyu grass-based and in summer 70% of milk came from kikuyu pastures.

To provide winter-spring forage, kikuyu is commonly over sown each autumn with short rotation ryegrass (*Lolium multiflorum*) or less commonly, with oats (*Avena sativa*), brassica (*Brassica spp*), chicory (*Chicorium intybus*), white clover (*Trifolium repens*) or red clover (*Trifolium pretence*). A smooth transition from the summer kikuyu phase to the winter forage phase is essential.

Once established, kikuyu pastures can last 30 to 40 years. Kikuyu provides strong competition against invasive weeds, provided fertility and ground cover is maintained. It tolerates less well drained soils and will recover from drought. This explains why kikuyu has adapted to a wide range of coastal conditions.

However, the area of kikuyu pastures on dairy farms has waned due to:

1. The use of high rates of glyphosate to retard kikuyu growth in early autumn in order to establish short rotation ryegrass by over sowing.
2. The loss of kikuyu pastures from infection by the fungal disease, kikuyu yellows *(Verrucalus flavofaciens*).
3. A rise in the use of lucerne, white clover, chicory and Italian ryegrass pastures on more permeable soils.

Kikuyu for Milk Production

Kikuyu is capable of high summer growth, but milk production can be limited by its relatively low quality. Thus, to maximise production per cow and per hectare, the priority for management is to maximise pasture quality.

Cows can produce up to 14 L milk/day grazing kikuyu compared to 20-22 L milk/day from ryegrass, provided the kikuyu is well-managed and dairy cows grazing the kikuyu pasture are supplemented with minerals to address deficiencies inherent in kikuyu

This level of production from kikuyu pastures is based on a daily intake of 13 kg Dry Matter (DM)/cow after which intake is limited by neutral detergent fibre (NDF) to 1.5% of body weight.

Cereal-based concentrates are commonly fed to achieve higher milk production and the response to the first 3-4 kg/cow per day is excellent, as shown in Table 1. The rate of response to higher levels of cereal concentrates above 3-4 kg/cow per day declines.

Table 1: Milk production and composition from cows in mid lactation, grazing well managed kikuyu grass pastures *(Reeves 1998)*

Barley (kg/day)	Milk (L/day)	Milk Fat (%)	Milk Protein (%)
0	14.2	3.8	3.1
3	18.2	3.5	3.2

Diet is balanced for calcium, sodium, and phosphorus with mineral supplements. All milk is presumed to have come from feed, not body reserves in mid-lactation.

The mean annual consumption from dryland kikuyu/ryegrass pastures on the north coast of NSW is about 7.0 t DM/ha per annum on a farm wide basis. However, kikuyu is able to achieve high summer growth rates of 80 to 150 kg DM/ha per day or 6 to 11 t DM/ha per annum of kikuyu consumed. When over-sown with ryegrass in the autumn for winter feed, a further 6-8 t DM /ha per annum can be consumed, giving a total pasture utilised of 12 to 18 t DM/ha per annum. These higher levels of production are achieved on highly productive dairy farms, where high soil fertility, irrigation or favourable rainfall is combined with good pasture, particularly grazing management. To consume the higher growth potential of kikuyu higher stocking rates are required over the summer period *(See under 'Pasture intake and Stocking rate' on page 9)*. This can pose a high risk in dryland conditions and may not suit market requirements for stable year-round milk production.

Photo 1: Jersey cows grazing kikuyu pasture

Grazing Management

In contrast to ryegrass, the aim of managing kikuyu is to maximise quality with metabolisable energy being the first limiting factor for milk production on a pasture-based system.
In this regard, Table 2 illustrates the difference in metabolisable energy of leaf, stem and dead kikuyu.

Table 2: Metabolisable energy (MJ/kg DM) and crude protein (%) content of kikuyu leaf, stem and dead material (Reeves et al 1998)

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

This shows that to maximise metabolisable energy and protein, grazing management needs to maximise ***leaf available to the cow*** and minimise development of stem. This is achieved by maintaining adequate nutrition and an optimum "grazing interval" that is based on plant maturity, as indicated by the number of leaves on each tiller (see next section).

Grazing Interval

After grazing, each kikuyu tiller grows up to 4 ½ new leaves/tiller and then stem growth increases substantially and, as a result, the proportion of green leaf available to the animal decreases. This is associated with a decline in overall digestibility and protein content of kikuyu as shown in *Figure 1.*

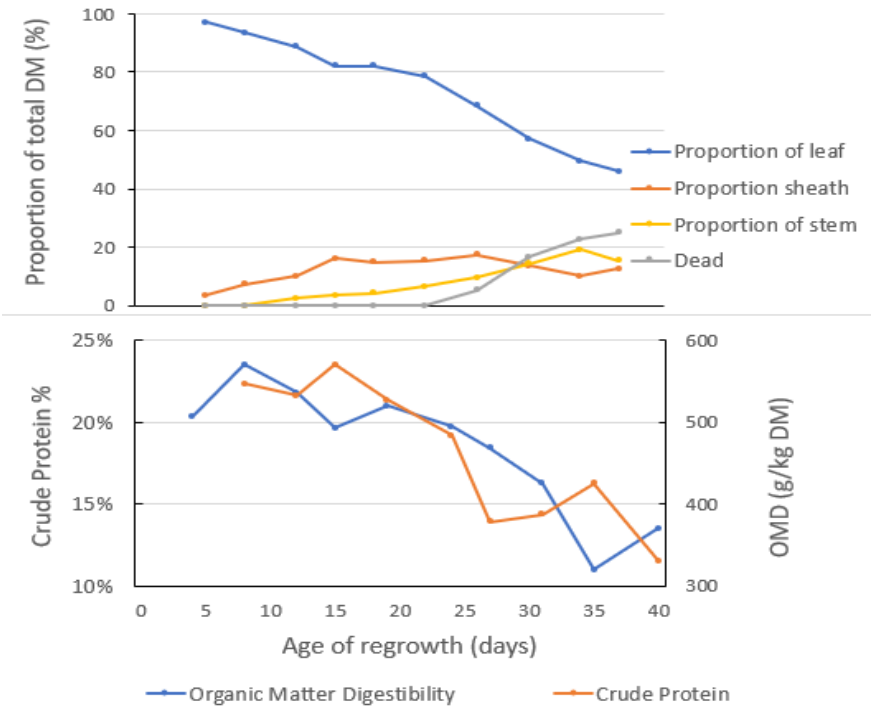


Figure 1: The proportion kikuyu leaf, stem and dead components of total DM above 5 cm stubble (a) and changes in crude protein (%) (CP) and organic matter digestibility (%) (OMD) with age of regrowth for kikuyu in mid season *(Reeves 1998)*

Therefore, grazing at the 4 – 4 ½ leaf stage provides the highest proportion of leaf and the highest quality grass.
Table 3 shows the effect of cutting kikuyu at an interval of 2, 4 or 6 leaves/tiller in summer, equivalent to grazing at 6, 12 and 18 days. Cutting at a 2 leaves/tiller interval produces the most leaf in summer, but over the whole year the yield is less than when cut at 4 leaves.

Table 3: The yield of kikuyu leaf and stem in summer and yield of leaf, % leaf and average metabolisable energy (ME) annually when kikuyu is cut at 2, 4 or 6 leaves/tiller on the far north coast of NSW *(Fulkerson et al. 1998)*

Defoliation Interval (leaves/ tiller)	Summer		All Year		
	Leaf	Stem	Leaf	Leaf	ME
	(kg DM/ha)		(kg DM /ha)	%	(MJ/kg DM)
2 (6 days)	4240	340	8,707	91	9.1
4 (12 days)	3530	470	10,399	87	8.8
6 (18 days)	2500	1440	9,336	79	8.6

If cut at 6 leaves/tiller, the leaf yield in summer is lowest and stem growth is substantially higher than when cut earlier at 2 or 4 leaves/tiller.

To maintain the quality of pasture consumed by cows, it is important not to force them to graze into the stems/stolons or more than about 70% of the pasture.
Even when kikuyu is grazed at the 4 ½ leaf stage, stem/stolon material will build up after a few grazings and will need to be removed mechanically by mulching/topping. Alternatively, animals with lower herbage quality requirements (e.g. dry cows or heifers) that can graze harder into the stems, can be used.

Also, where the stems are left to grow too tall, regrowth after mulching will be slow as many of the growing points are on the stems and will have been removed.
Kikuyu can be grazed **before** the 4 ½ leaf stage without too much detriment to plant growth, but there are several other concerns:

- Lower pasture *on offer* means cows need to cover more area and expend more energy for a given intake.
- The content of magnesium and available calcium is low in regrowth as shown in Figure 2 but rises with maturity. Potassium is too high in early regrowth and improves with maturity. Thus, as can be seen in Figure 2, apart from phosphorus, the mineral status of kikuyu improves substantially up to the 4 ½ leaf stage of growth.

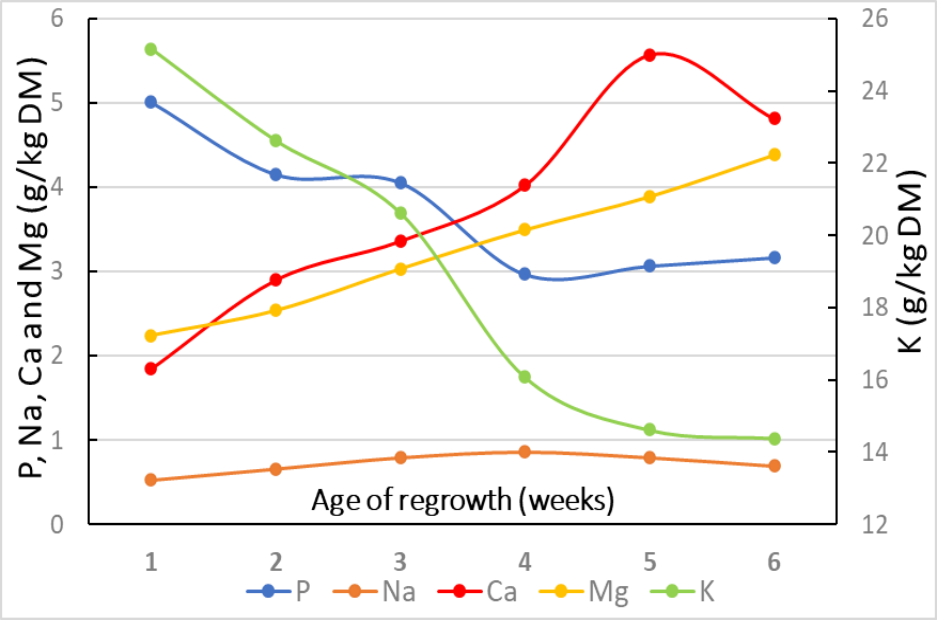


Figure 2: Content (g/kg DM) of Potassium (K), Phosphorous (P), Calcium (Ca), Sodium (Na) and Magnesium (Mg) in the leaves of kikuyu *(adapted from Reeves et al. 1998). In this example the 4 leaves/tiller stage is at about 4½ weeks.*

Identifying Leaf Stage of Regrowth

The number of leaves per tiller is like the hands on a biological clock in the paddock. It indicates when the pasture is ready to graze. In order to use leaf stage effectively, the following points need to be considered:

1. The '**remnant**' leaf is the new shoot first appearing after grazing, it was only partly extended before grazing and continues to extend after grazing.
   It can be identified by the tipped end that was removed when grazed (see *Diagram 1*)**.** Nitrate content can/is also be too high in early regrowth to levels which are toxic to some micro-organisms in the rumen, thus reducing digestibility of roughage.

   If the remnant has grown to half normal length or more, it is counted as the first leaf. The subsequent leaves will emerge from the sheath before each previous one has fully extended. Therefore, at the 4 leaf stage, the fifth leaf will just be emerging out of the sheath (see Diagram 2).

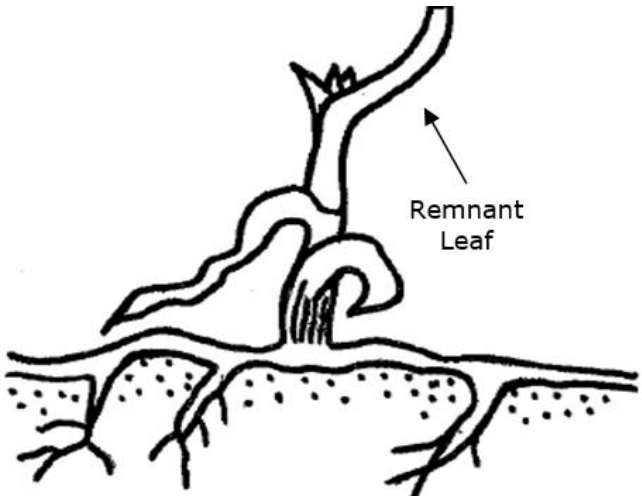


Diagram 1: A kikuyu tiller immediately after grazing showing the 'remnant' leaf extending

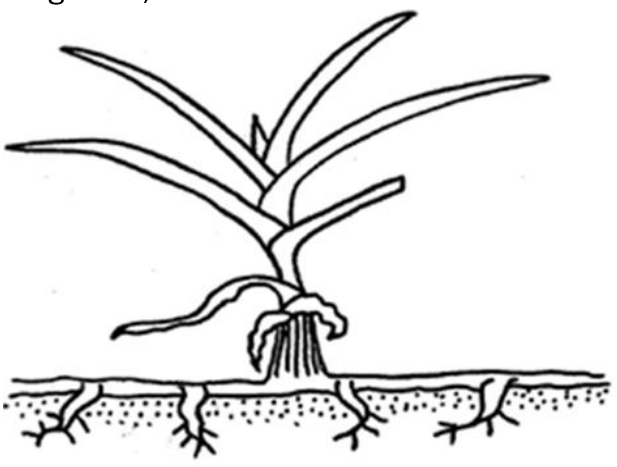
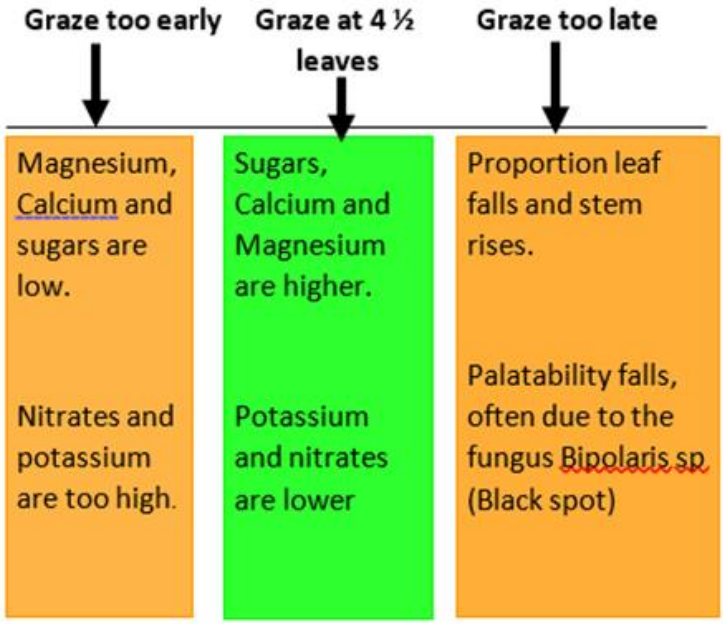


Diagram 2: A kikuyu tiller with 4.5 leaves, the 5th is extended, the sixth leaf just emerging, and the remnant oldest leaf is senescing.

Below summarises the reasons why we need to graze at 4 to 4 ½ leaves/tiller:



2. There are more lateral tillers (tillers that come off a horizontal stolon) than apical tillers (tillers that are at the end of a stolon, see Photo 2). The apical tillers usually have a higher rate of leaf appearance so that there will be more leaves at a given time. Thus, look at 8 – 10 tillers at random to get an accurate measurement of leaf stage.

   The rate of emergence of leaves depends primarily on temperature. From December to March, the 'leaf appearance interval' for kikuyu might be as low as 3 days, giving a 12 day (4 leaves x 3 days/leaf) grazing interval and, in fact a 12-14 day grazing interval, at this time of the year, is recommended. In April and November, the grazing interval should be extended to around 20 days.

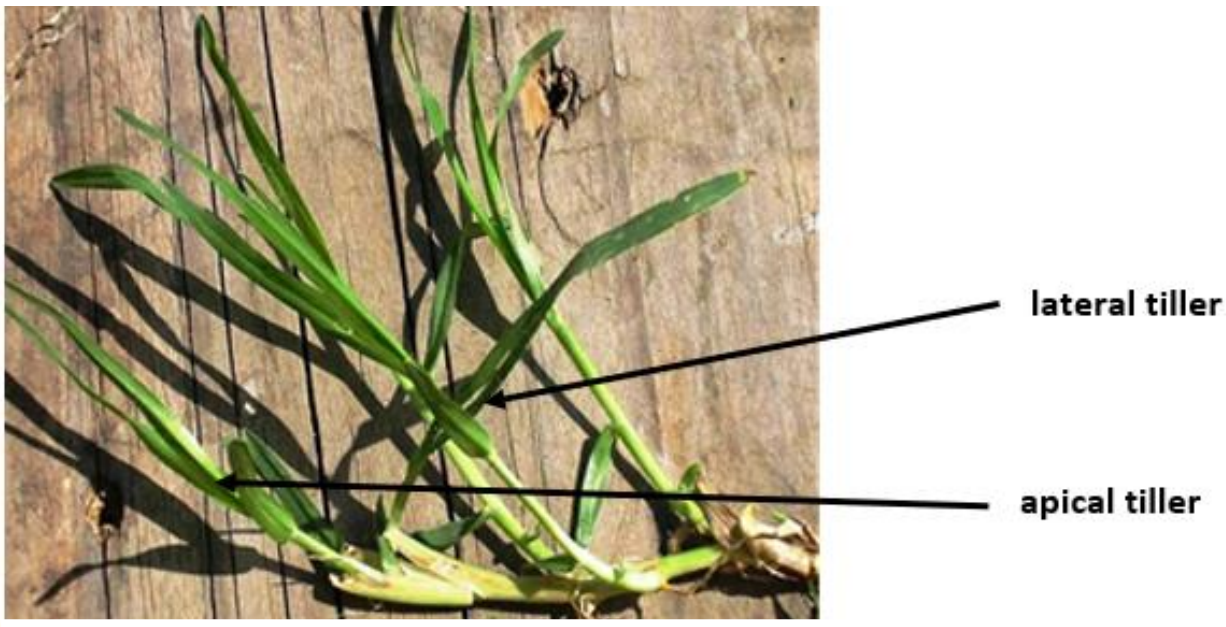


Photo 2: A stolon of kikuyu grass with three lateral tillers and one apical tiller.

Variation in Sugar Content of Kikuyu through the Day

Sugar or water-soluble carbohydrate content in the leaves of kikuyu, and other grasses, accumulates during the day, in full sunshine, as the supply of sugar from photosynthesis exceeds the plant's needs for respiration and growth.

The sugar levels then decline during the night when there is no photosynthesis, but respiration and growth is ongoing (see Figure 3).

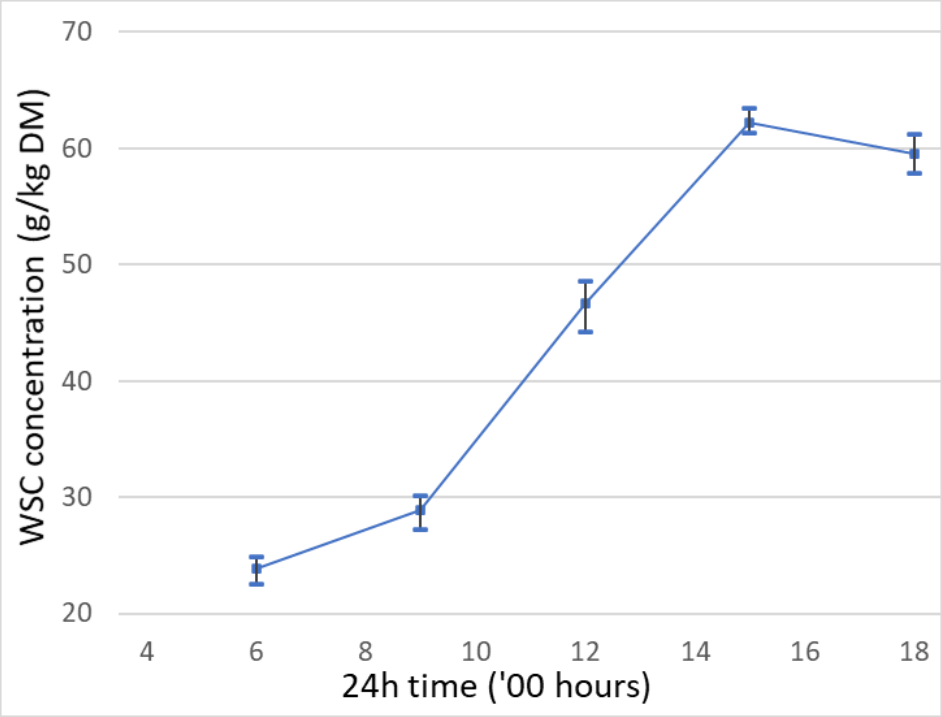


Figure 3: The change in WSC (water soluble carbohydrates) or sugar concentration of kikuyu from 6 AM to 6 PM

In this regard, there can be a milk response by feeding kikuyu in the afternoon, to capture the maximum sugars in the plant before it is respired away during the night. This may be useful when there is insufficient kikuyu to feed twice-a-day with the other part of the daily ration (perhaps hay or silage) fed in the morning.

Palatability of Kikuyu Grass

In a study on 14 pasture species used as dairy pastures, kikuyu was the second most preferred pasture species by dairy cows, after prairie grass (Horadagoda *et al* 2009). This high palatability remains after kikuyu is conserved as silage if it is well made.

Supplements Fed when Cows Graze Kikuyu Grass

Since kikuyu is low in sodium, phosphorus and ***available*** calcium, cows grazing kikuyu pastures are usually supplemented with dicalcium phosphate, and salt. Sodium bicarbonate is added to the ration to buffer the change in pH in the rumen brought about by feeding grain-based supplements.

When kikuyu is optimally managed, metabolisable energy values of up to 10.0 MJ/kg DM can be achieved, particularly on the south coast of NSW where the climate is cooler.

The intake of kikuyu is limited by the relatively high fibre content (>50% neutral detergent fibre, see Table 4). The response to high energy, low fibre supplements, such as cereal grain, can be 1.5 – 1.6 L milk/kg grain when fed under good pasture management conditions.

Protein is normally adequate for milking cows when kikuyu is fertilised with nitrogen. However, once 'protein' content gets above about 20% (≈ 3.2% nitrogen), nitrates start to accumulate, and this could cause rejection by stock and a reduction in rumen efficiency.

Comparison of the Herbage Quality of Kikuyu and Ryegrass

The overall nutrient quality of kikuyu is compared to perennial ryegrass and to cow requirement in Table 4.

Table 4: The nutrient content (% unless otherwise specified) of kikuyu in comparison to perennial ryegrass (vegetative state), taken from sampling on the far north coast of NSW, and the requirements for a 600 kg Holstein-Friesian cow giving 20 litres of milk/day (Reeves 1998)

Nutrient	Perennial Ryegrass (May -Oct)	Kikuyu (Nov-May)	Cow Needs
ME (MJ/kg DM)	11.7	8.9	10.3
Nitrogen	4	3.4	2.4
Non-protein N	0.9	0.7	
Nitrate N	0.05	0.03	0.014
Crude Protein	25	21	16
ADF *	18	23	18
NDF *	40	60	<45
WSC *	9	2	7
Available Calcium	0.53	0.12	0.51
Phosphorus	0.33	0.31	0.33
Potassium	3.4	3.1	0.9
Magnesium	0.24	0.22	0.2
Sodium	0.4	0.02	0.18
Sulphur	0.43	1.31	0.2
ERDP:FME *	17	20	10
BP *	42	40	

ADF=Acid Detergent Fibre, NDF= Neutral Detergent Fibre, WSC= Water Soluble Carbohydrate (sugar), BP=Bypass Protein as % of total protein, ERDP: FME = *Ratio of effective rumen degradable protein (ERDP) to fermentable Metabolisable energy (FME)* (g/MJ).

The metabolisable energy values tend to increase with latitude such that higher values are common on the south coast of NSW. The quality of ryegrass over late spring/early summer is only marginally better than kikuyu, and growth rates of kikuyu are 2 ½ times higher.

Pasture Intake and Stocking Rate

Milking cows tend to eat no more than 1,000 to 1,200 kg DM/ha from a kikuyu pasture at any one grazing, irrespective of the amount *on offer*. This is the new growth of the last 4 to 5 youngest green leaves. The remaining material is made up of the stem and senescent material.

Under good growing conditions kikuyu can produce up to 1,200 kg DM/ha every 14 days, or around 80 kg DM/ha per day and this is sufficient to carry 7 to 8 cows/ ha. This assumes each cow consumes 10 kg DM kikuyu pasture/day.

Although this growth rate is possible under irrigation, under dryland conditions it is achieved for only a few months, so lower stocking rates of 2-4 cows/ha are more common. This means that at a 'typical' stocking rate for most dairy farms, the milking herd cannot consume the kikuyu pasture in the peak growth period. This can lead to excess kikuyu of low forage quality. To preserve quality pasture a number of practices can be employed to minimise this excess pasture and retain quality, as follows:

1. Mulching/topping to 5 cm after grazing for the first 7 to 10 days after heavy rain when growth is maximised. This will reduce growth rate but provides the opportunity to improve subsequent quality.
2. Locking up some paddocks for silage to reduce grazing rotation length
3. Using dry or replacement stock to follow the milkers.
4. Reduce the rate of nitrogen application or skip an application.

Using these strategies to reduce the amount of post grazing residue will also assist to prepare seedbed conditions for over sowing ryegrass in early autumn.

Kikuyu Grass for Dry Cows

As kikuyu grass contains a low level of available calcium, it can be a suitable feed for dry cows, if appropriately grazed. Young kikuyu leaves contain very high levels of potassium which blocks the uptake of magnesium by the cow. This can cause milk fever and other metabolic disorders. Therefore, kikuyu should be rotationally grazed so dry cows are forced to graze all the leaf at the right stage. If dry cows are set stocked on large areas of kikuyu, they can selectively graze the newer shoots increasing potassium intake to dangerous levels.

Water Efficiency of Kikuyu

The water use efficiency of kikuyu is very high in summer at 410 MJ ME/mm of water* and is more than twice as high as perennial ryegrass at 160 MJ ME/mm of water, even when the latter is adequately watered**. For ryegrass there is also a decline in forage quality as maximum temperatures exceed 30 °C in summer-the metabolisable energy of perennial ryegrass declines from 11.0 MJ ME/kg DM in July to 10 MJ ME/kg DM in February and NDF increases from 35% to 47%, respectively.

*Includes irrigation, rain and soil moisture
** *Source: Neal et al (2019)*

Fertiliser Management

Kikuyu requires high soil fertility to achieve its potential production. Small differences in latitude, altitude and distance from the coast can have large impacts on the timing, reliability and amount of summer rainfall (500 to 900 mm/year). The availability of irrigation adds further complexity to the

growth potential of kikuyu in any given situation. Fertiliser inputs need to assess potential of each situation and fertilise to meet plant demand.

Phosphorus

Soil phosphorous (P) should be maintained at greater than 60 ppm Colwell P on clay and clay loam soils on which dairying is commonly located on the north coast of NSW. The Phosphorus Buffering Index (PBI) is used to refine the optimum Colwell levels for other soil types.

Between 25 to 30 kg of phosphorus/ha per annum is required to replace nutrients removed by milking cows under a normal grazing situation. This is often applied when sowing short rotation ryegrass in autumn, sometimes followed by topdressing 10 to 20 kg of phosphorus/ha as single superphosphate or in a blend with potassium in early spring.

Nitrogen

To achieve maximum yield of kikuyu grass (under irrigation or in highly favourable environments), a total nitrogen requirement of 150 to 200 kg N/ha should be applied during the kikuyu growth phase (November to March). In these circumstances apply 45kg N/ha every 30 days or every second grazing. Cease applying nitrogen to kikuyu pasture 4-5 weeks or two grazings prior to over sowing ryegrass to partially supress kikuyu growth after sowing ryegrass.

Lower nitrogen rates are required for the kikuyu phase in dryland conditions. Many farmers cease nitrogen application over the kikuyu phase because soil moisture deficit peaks in October and rainfall from October to January is often below evapotranspiration and as a consequence, nitrogen responses are low. The kikuyu phase does benefit from residual nitrogen that was applied to ryegrass, and from nitrogen fixed by clovers. These residual nitrogen “reserves” wane over the summer growing season.

Nitrogen application is often not required in February/March due to high rainfall, rapid soil mineralisation of nitrogen and rapid kikuyu growth that is difficult to consume anyway. However, where rainfall is delayed until late February to March, application can be beneficial.

In the ryegrass phase, apply about 45 kg nitrogen/ha per month or after every grazing. Ryegrass may require higher rates during establishment to account for the decline in soil nitrogen where the kikuyu was not fertilised over the summer, and after extended wet periods that are common in February/ March.

Potassium

Soil potassium levels should be maintained above 0.45 cmol/kg. In many cases, nutrient imports from grain and silage will maintain an adequate soil potassium status. Where soil test levels are below ideal, fertilise with a split application of 30 kg potassium/ha (60 kg/ha of muriate of potash) in autumn and again in early spring. Alternately, apply Greentop K or Malanda (NKS ratio is 33:21:5) instead of Urea.

Establishing Kikuyu Grass

Kikuyu is slow to establish from seed, for this reason, only sow a small proportion of the farm (10-15%) in any one year because the pasture yield, in the establishment year, will only be near half of normal. Once established, kikuyu should persist for many years. Therefore, it is worthwhile spending time and money on getting the establishment right. The major threat to establishment success is weed competition from annual summer grass weeds, particularly crows foot (*Eleucine indica*) (see Photo 3 right).

Persistent perennial grass weeds, such as couch grass, can also be a problem.

Photo 3: Crows foot grass, also known as Crab grass and wire grass is an annual C4 tropical grass. Seeds spread by wind and water.

Precaution: Do not allow ryegrass to set and shed seed in the spring before subsequent autumn sowing of kikuyu. In a normal wet humid summer, the ryegrass seeds do not survive but after a dry summer they do and can swamp kikuyu seedling sown in the subsequent autumn with minimal survival.

Selection of Kikuyu Variety

There are now 3 commercially available kikuyu varieties that are used as dairy pastures-Whittet, Acacia and Fulkerson (registered in 2023).

The kikuyu variety, Fulkerson, is resistant to kikuyu yellows infection, in most, but not all situations because there are 3 strains of kikuyu yellows. The varieties Whittet and Acacia are not resistant. Fulkerson is also resistant to a second fungal disease, black spot, Acacia is slightly resistant, but Whittet is not resistant.

The yield of Fulkerson was shown to be 24% higher than Whittet and 12 % higher than Acacia. Both Fulkerson and Acacia are more winter-active than Whittet. The herbage quality for the 3 varieties is similar.

Thus, on the subtropical north coast of NSW, where the 2 fungal diseases are prevalent, the variety Fulkerson is recommended whereas there is little difference between Fulkerson and Acacia if these fungal diseases are not present, for example, in the warm temperate climate of the south coast of NSW or inland where humidity is lower.

Time of Sowing

The best time to establish kikuyu grass is in mid spring (early October on the subtropical east coast of Australia). This coincides with ideal temperatures for germination and early growth. **However**, coastal rainfall is variable at this time of year and, more importantly, competition from annual summer grass weeds is a significant problem.

Where the seedbed has no summer grass weeds in the seed bank and irrigation is available, sowing in early spring is an option. However, since this situation is very rare, and therefore, **establishment *in early autumn*, (late-March) *is very strongly recommended.***

Figure 4 shows the minimum temperature for Lismore, on the far north coast of NSW, with the green and red lines at about 15°C.

This minimum temperature of 15°C marks the critical time when the 'hard' tropical grass weeds (particularly Crows foot, see Photo 3) stops growing in autumn and starts growing again, in spring. The actual date when the minimum temperature reaches 15°C is about the 1st April and mid-November on the far north coast of NSW.

Both periods are critical in the successful establishment of kikuyu as follows:

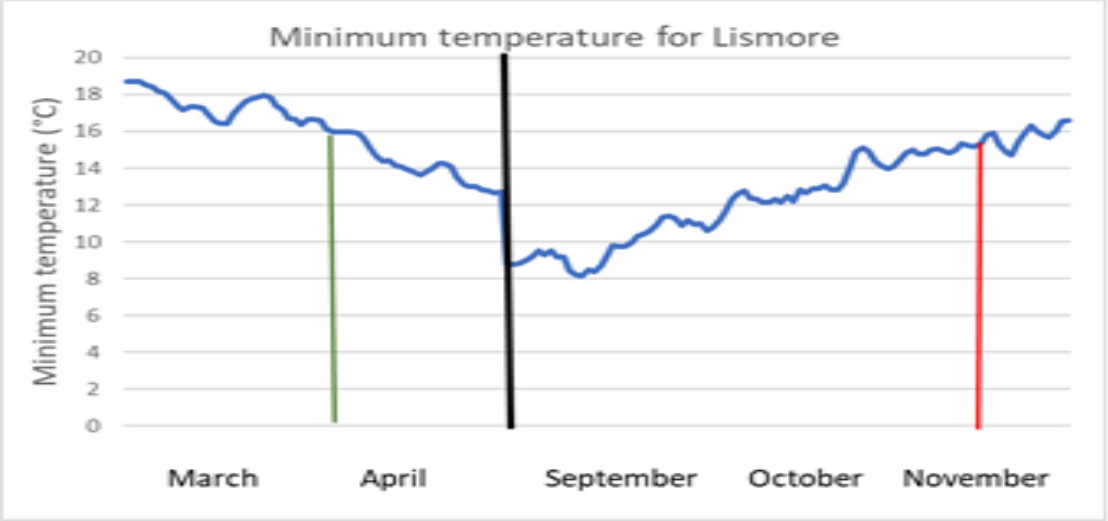


Figure 4: The minimum temperature of 15°C for Lismore is on about the 1st of April (green line) after which establishing kikuyu is safer because summer grass weed competition is minimal. This temperature is also critical in September to November (November 15th for Lismore, red line) by which time the young kikuyu plants need to have established a good ground cover to compete/block out germination of annual summer grass weeds. This is especially true in the first spring but also applies to established kikuyu pastures (the middle of each respective month's name is in the middle of the month).

There are two options for sowing kikuyu grass, depending on the level of kikuyu yellows present and the annual summer grass weed burden.

Option 1 – Where there are no existing kikuyu plants

Spray out the existing vegetation with glyphosate when the minimum temperature falls below 15°C in autumn (about 25 March on the far north coast of NSW). Sow 1 week later at 4-5 kg kikuyu seed/ha to a depth of about 1 ½ cm, preferably with a disc drill to minimise soil disturbance and hence grass weed germination. Broadcasting kikuyu seed is not recommended as seedling survival is low unless subsequent conditions are perfect in terms of moisture. At 6 weeks after sowing kikuyu, broadcast 10 kg short rotation ryegrass/ha immediately before the cows graze. The low rate of ryegrass will protect the kikuyu seedlings from frost without shading it too much.

Option 2- Where most of the kikuyu in the paddock is affected by kikuyu yellows

The resident pasture is sprayed out with glyphosate in autumn and then winter and summer break crops are grown over a period of at least 1 year.
If a broadleaf species such as chicory is grown as a break crop, this period will allow the use of grass selective herbicide to be used to reduce annual summer grass weeds such as Crows foot (*Eleusine indica*) (see Photo 3). The 12 months 'break' also allows time to eliminate kikuyu yellows spores and, or live kikuyu yellows contaminated kikuyu stolons. After the break period the sowing procedure is the same as in Option 1.

On-farm trials have shown that a very effective 'break' crop sequence is as follows:

1. Spray out with glyphosate (rate as recommended on the label, in early autumn (end of March)), sow 6 kg chicory and 10 kg short season ryegrass/ha.
2. Spray out at the end of the ryegrass season using a product that contains Flumetsulam under guidance of an agronomist or advisor, up until Christmas if needed (some products can have long plant-back periods of about 3 months, check the label). These herbicides will not harm the chicory which should grow through summer.
3. In early autumn, spray with glyphosate and sow kikuyu grass seed a week or so later, preferably after some rain and when the minimum temperature is still above 12°C.
4. If available, use lime-coated seed as the coating will protect seed from a "false start"- the seed will not germinate until there is adequate moisture to dissolve the lime coating, giving the seedling a better chance of survival.
5. Drill 4kg kikuyu/ha (or 6 kg/ha of lime coated seed) to about 1-1 ½ cm soil depth, followed by a heavy rolling. If possible, use a disc drill to minimise soil disturbance and hence weed germination.
6. Broadcast 10 kg short rotation ryegrass/ha immediately before the first grazing of kikuyu grass, at about 6 weeks after sowing. If correctly managed (graze relatively frequently), the cover crop of ryegrass should not compete with the kikuyu seedlings in winter/early spring and the ryegrass will provide some protection against winter cold and frost and provide a reasonable yield.

Spring Management

Appropriate management of kikuyu in the first spring is just as important as at establishment in the previous autumn.
From mid-September, or whenever the minimum temperature reaches 8-9°C (see Figure 6), or when the kikuyu stolons start 'running', there is a 2 month period, from mid-September to mid-November, to ensure that the young kikuyu plants have optimal conditions for growth to develop an impenetrable mat to supress 'hard' annual tropical grass weeds which germinate and start to grow when the minimum temperature reaches 15 to 16°C. To achieve this, graze relatively frequently- at no more than 14 day intervals or when canopy cover occurs, topping post grazing, providing ample N fertiliser (100kg urea/ha per month) and irrigation if needed and available.
Topping after grazing ensures that uneaten patches of ryegrass around dung pats and urine patches do not shade out the kikuyu.

Over Sowing Kikuyu Pastures in Autumn with Ryegrass for Winter Feed

For successful establishment of short rotation ryegrass into a kikuyu pasture, an understanding of the growth characteristics and needs of both kikuyu and ryegrass is required.

Time of Sowing

The recommended time to start sowing ryegrass into a kikuyu pasture is when the minimum air temperature has fallen below 15°C. At this time, the soil is still warm enough for good establishment and growth of ryegrass but close enough to the onset of colder weather to restrict competition from kikuyu. This will be in late March on the far north coast of NSW, mid-March in the central coast, below Taree, and early March on the south coast of NSW, below Nowra.
Sowing time may need to be delayed further in frost-free situations, within a few kilometres of the coast, where kikuyu continues to grow further into the winter.
Sowing prior to this can produce more early winter feed, but it requires more aggressive management strategies to suppress the growth of kikuyu and also increases the risk of army worm damage.

Sowing Methods

Disc drilling is the preferred method of establishment for early sowings. The seed should be sown at 1 - 1 ½ cm soil depth to provide less opportunity for the ryegrass seedlings to dry out in the warm conditions. However, the discs or tynes of the drill do cut the kikuyu stolons, retarding kikuyu growth slightly in the following spring. Broadcasting is more reliable with later sowings and in wet conditions and is much quicker.
A light cultivation with disc harrows or aerators before sowing, and then rolling after sowing may improve seed to soil contact. However, cultivation can promote weeds to germinate and so it is not normally recommended.

Management Before and At Sowing Ryegrass

When ryegrass is sown into an actively growing kikuyu sward, two factors need to be managed:

1. **The kikuyu thatch, consisting of uneaten stems, stolons and dead material can interfere with sowing equipment and prevent broadcast seed from reaching the ground or cover sown seed with too much material.**

In normal conditions, regular grazings at 4.5 leaves keeps the underlying thatch to a manageable post-grazing stubble height of 5 to 8 cm. However, the underlying thatch can still build up over the summer, especially where good rains produce more kikuyu than the herd can consume, or the kikuyu has remained ungrazed for weeks e.g. after wet conditions. This may require strategies to ensure sowing is unimpeded such as:

- Mulching to 5 cm after the previous 2 grazings from mid-February to sowing ryegrass. This will ensure the thatch has time to decompose so that the levels are manageable by sowing in late March.
- Follow the milkers with dry cows or heifers to eat further into the sward.
- Cease nitrogen fertiliser application 5-6 weeks prior to sowing.

Table 5: Schedule of events pre sowing for establishing short rotation ryegrass in kikuyu pasture on the far north coast of NSW:

Early Feb	14 days later	26 days later	40 days later
Last N	**Graze, Mulch Hard**	**Graze**	**Sow, graze then mulch**

2. Kikuyu leaf growth can recover quickly, smothering the seedling ryegrass.

The removal of the entire thatch to ground level prior to, or just after sowing, removes the growing point of the kikuyu, delaying regrowth. By removing the thatch, left after grazing, the kikuyu stems do not shade the emerging ryegrass and the new kikuyu leaves are regrowing from the same height as the ryegrass.

These following sowing options achieve the goal of kikuyu suppression:

1. Broadcast the ryegrass seed immediately before grazing to allow the seeds to be pressed into the soil by the grazing cows, then followed by a "hard" mulch. Hard mulching means a residue height of **less than 2 cm** with some soil exposed (see Photo 7).
2. Application of desiccants post grazing, but before mulching. Gramoxone at 1.6 to 2.4 L/ha of (250 g /l) usually sets back kikuyu growth for 2-3 weeks. Glyphosate at 75 – 100 g a.i./ha (e.g. 165 to ml/ha of 450 g/l) can also be used effectively to set back kikuyu growth for about a week.

Photo 4: Regrowth of kikuyu leaf 15 day after mowing and spraying with 75 g/ai glyphosate (right) vs not spayed (left). Kikuyu is not killed with low rates but stunted for several weeks allowing faster ryegrass establishment but less kikuyu in the first grazing. Ryegrass emerging in sprayed plots receive more sunlight and emerges earlier than unsprayed plots.

3. Make kikuyu silage, - hard mulch, after grazing, then lock up the kikuyu for 3 – 4 weeks before taking a silage cut. The silage cut will set back kikuyu growth for 2-3 weeks because the stems grow upward, in an attempt to find light, and the silage harvest then removes the elevated growing points on the stem. Sow ryegrass as soon as possible after the silage is removed.

Management After Sowing

The emerging seedling has limited energy reserves (sugars) that can be rapidly depleted during the process of emergence. Therefore, it is essential that light reaches the young seedlings within 6 -7 days of emergence to allow photosynthesis to start in the first leaf, otherwise the seedling will die. Loss of seedlings can occur, if the seed is sown too deep, (greater than 2 cm), and/or if the first leaf is shaded by a thick mat of kikuyu leaves and/or kikuyu residue.

The pasture may need to be grazed lightly every 7-10 days after sowing if the seedlings are being shaded by kikuyu. This is particularly important in early sowings and under warm and wet autumn conditions when growth rate of kikuyu can remain high. Grazing may kill 10-20% of ryegrass seedlings from cow treading, but shading will kill many more seedlings.

Photo 5: Early sown ryegrass faces severe competition from kikuyu (foreground). Where kikuyu has been suppressed the ryegrass seedlings establish free of competition for light and nutrients (background)

Seed Rates and Treatment

Short rotation ryegrass should be sown at a rate of 30 to 40 kg/ha. Tetraploid ryegrasses can establish better, as the seed is larger and the seedlings are more vigorous and so compete better with the kikuyu.
A ryegrass seed dressing that contains both imidacloprid and clothianidin (e.g. Poncho Plus®) can improve establishment in early sowings. However, withholding periods can be restrictive.
Avoid high rates of fertiliser sown with the seed in drill rows. Mixing seed and fertiliser before broadcasting is safer but the period between mixing and sowing should be minimised (less than 1 hour)

Photo 6: Drill sowing ryegrass into mulched kikuyu

Photo 7: Drill sown ryegrass emergence with white clover in mulched kikuyu

Management in Spring

Strong growth of ryegrass in August to September will require short grazing intervals to prevent the ryegrass shading the kikuyu. This problem is more pronounced in November- December with later maturing ryegrass varieties. This can cause the kikuyu to lose vigour and thin out, reducing production over the early summer and allowing weed invasion.
Apart from staying with a short grazing interval to minimise shading of kikuyu by the ryegrass, several other options are available as follows:

- limit nitrogen inputs.
- take silage harvests in early (before mid-September), rather than late, spring. It is also wise to avoid using the same field for making silage every year.

Over Sowing Kikuyu with Brassicas (Forage Rape/Leafy Turnip)

Brassica seedlings are less sensitive to heat and moisture stress than ryegrass, enabling them to be over-sown into a base kikuyu pasture earlier than ryegrass (early March, about the same time as oats). When sown at this time, brassicas have higher growth rates than ryegrass until early May (see Figure 5), providing a good option for early autumn feed.

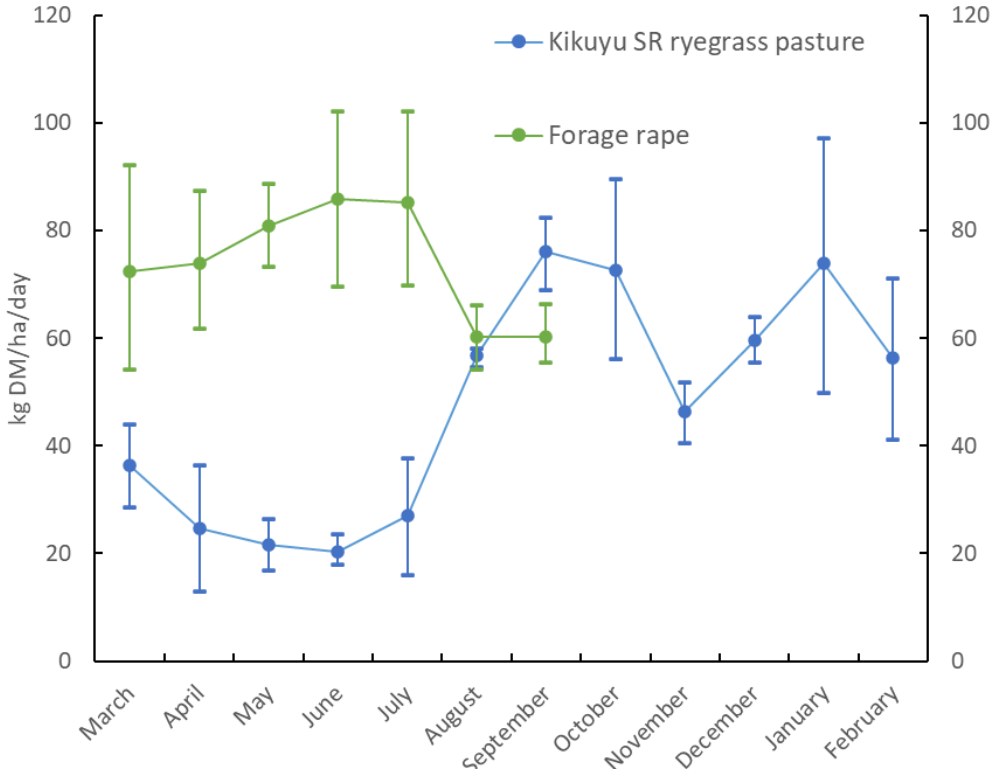


Figure 5. The average growth rate (kg DM/ha) of forage rape over 3 years and over sown at the beginning of March compared to short rotation ryegrass over sown into a kikuyu pasture at the end of March on the far north coast of NSW

The brassica seed is very vigorous and under ideal conditions will emerge after 4 days. Brassica seedlings will compete well with kikuyu once they are established.

Brassica can be first grazed when 6 leaves have grown or at about 6 weeks after emergence. Management before and at sowing is similar to over-sowing kikuyu with white clover or ryegrass.

Brassica should be sown at a seed rate of about 4 kg/ha of insecticide-treated seed. Brassicas can be sown with ryegrass into a kikuyu pasture but will need to be later to get successful ryegrass establishment. However, if sown early, it will not allow the pasture to be grazed for 6 weeks, and the kikuyu may then 'swamp' the ryegrass.

Over Sowing Kikuyu Pasture with White Clover

The kikuyu/white clover system has been shown to be extremely productive with up to 12 t DM/ha per annum of white clover and 8 t DM/ha per annum from kikuyu in plots sited on a dairy farm and into well-established kikuyu pastures over a 3-year period (Fulkerson *and Reeves 1996*).

However, white clover pastures do require management for bloat but nearly all dairy farmers provide Monensin in the dairy feed which minimises bloat. More importantly, the common white clover variety, Haifa, is infected by the root knot nematode, *Meloidogyne trifoliophila,* which multiplies rapidly resulting in a severe decline in clover population and vigour in the third year after establishment. A survey in northern NSW and southeast Queensland by Zahid *et al in* 2001, found that root knot nematodes were present on white clover roots at all 12 sites, and at 9 sites the effect on seedling growth was severe (seedling growth of less than 25% normal). There has been no white clover variety that was resistant to root knot nematode so this potentially productive system had not been further developed.

Recently, a white clover variety, Ocoee, was selected and evaluated in the subtropical environment of Florida in the US, for resistance to root knot nematode *Meloidogyne trifoliophila,* the same strain that we have here and the seed is now commercially available.

Ocoee appears to grow further into summer than the naturalised variety, Haifa, previously sown. More knowledge needs to be gained on the growth pattern and management requirements of Ocoee under our conditions before it can be widely recommended.

Kikuyu Persistence

Productivity of kikuyu-ryegrass pasture relies on a delicate balance between the persistence and vigour of kikuyu and the productivity of the ryegrass. Where kikuyu vigour is reduced, by stress or a run of shorter growing seasons, the persistence declines and less desirable summer grasses establish that are hardier but lower in quality and less productive. These can be perennial grasses such as couch, and annual summer grasses such as Crows foot (crab grass), annual setaria and other summer grasses.

Two of the most common factors that reduce kikuyu persistence are those that occur during the transition of the kikuyu to ryegrass (the use of high rates of glyphosate to prevent the shading of the ryegrass seedlings by kikuyu) and then the transition back to kikuyu (shading of the kikuyu by the peak growth of ryegrass, this can be exacerbated by the extended growth of late maturity ryegrass varieties).

Dry or very wet conditions and the infestation of kikuyu yellows (see later) can also either limit the length of the growing season of kikuyu or impose a stress that dramatically reduces the vigour of kikuyu.

Adhering to the management of a kikuyu/ryegrass pasture in both autumn and spring, as discussed earlier is essential. When two or more of these stress events occur in the same year, or over several years in a row the impact can be multiplied.

Making Kikuyu Silage

Making kikuyu silage in early autumn is a useful management tool to remove excess growth and reduce subsequent competition by kikuyu on the newly sown ryegrass seedlings. A metabolisable energy value of over 8.5 MJ /kg DM ME and protein of over 16% is achievable.
Maintaining feed quality during the silage making process can be achieved by taking the following steps.

1. Graze hard before lock-up and apply 50 kg Nitrogen/ha. Ensure that all the new growth to be harvested is new leaf i.e. no more than 5 ½ leaves/tiller. In early autumn this should take about 20-22 days.
2. For pit or bunker stored silage, allow the cut material to wilt to greater than 30 % dry matter. At this moisture content, no moisture is left on the hand when a sheaf of kikuyu silage is squeezed. A moisture content of 40 to 50% is ideal for baled silage.
3. If wilting takes more than 48 hours, the feed quality of the kikuyu will drop dramatically.
4. Wilting, placement in the stack and the start of cold fermentation must occur as quickly as possible to retain sugars and maximise energy value.
5. The use of an inoculant is strongly recommended to assist the fermentation process. Molasses can also be added to aid fermentation if a quick wilt is not possible
6. Cover the pit with plastic and seal well. Ensure good drainage around the pit.

Disorders of Kikuyu

Black Spot

Black spot (*Bipolaris* sp) is a fungal disease which infests kikuyu. Effects are more pronounced if the kikuyu is nitrogen or moisture deficient. Typically, the ends of the more mature leaves turn yellow and black spots can be seen on the leaf which is the fungus. (see Photo 8).

Photo 8: Black spot lesions on kikuyu

Infection will not reduce growth, but leaves become unpalatable. There is no long-term effect of this disease on kikuyu persistence.

Controls:

There are several options that can be used to reduce the impact of Black spot.

1. Reduce grazing interval so the canopy is less dense in order to reduce humidity and the leaves are younger and hence more palatable when grazed.
2. If possible, remove the stress factors such as the lack of nitrogen and moisture.
3. Allow cows to select the non-infected grass by lax grazing and then mulch or slash the residue after grazing. The subsequent regrowth should then be free of fungal infection if humidity is lower and the stresses have been removed

Kikuyu Yellows

Kikuyu Yellows is a fungus that is unique to kikuyu, infecting the roots of the plant. As a consequence, plants can be easily pulled from the soil due to stunted root systems. Visual symptoms are yellowing and stunting of the leaves, short internode length and gradual death of the plant. As the plant dies, the kikuyu yellows fungus moves out from the initial contamination spot (see Photo 9) The bare area is then replaced by other grasses such as couch and paspalum and weeds such as thistles (see Photo 10).

The disease is spread by water-borne spores and, as a consequence, the areas of contamination tend to move down slopes but can be spread on the hooves of cattle. The fungus becomes inactive in early autumn when minimum daily temperatures fall below 15 °C.

Photo 9: Actively spreading kikuyu yellows in January soon moving down the slope

Photo 10: Dead areas formed by kikuyu yellows, now dormant in May, broadleaf weeds filling the bare ground.

Kikuyu yellows remains dormant in winter, reappearing in late November on the NSW north coast when the minimum temperature exceeds 15°C. As with Black spot, kikuyu plants are most susceptible to kikuyu yellows when nitrogen is deficient or under moisture stress.

Prevention:

Providing adequate nitrogen and moisture will minimise the adverse impact and spread of kikuyu yellows. For example, kikuyu pastures grown on fertile soil and under irrigation will show minor adverse effect on growth, even though kikuyu yellows is present.

Control:

Where there are only isolated patches of kikuyu yellows, spray out the patch with glyphosate and the 0.5 m to 1 m of the healthy kikuyu around the contamination patch to starve the fungi.

Where the kikuyu yellows infestation is widespread, spray out the kikuyu, then grow other species such as setaria, ryegrass, maize or brassicas before resowing to kikuyu in 1 or 2 years. There is anecdotal evidence that a break period from kikuyu of 1-2 years kills the kikuyu yellows spores.

Resowing with a kikuyu yellows-resistant kikuyu variety:

A new kikuyu variety, Fulkerson, is resistant to kikuyu yellows in most but not all cases and was registered in 2023.The seed is commercially available. Neither Whitett nor Acacia are resistant to kikuyu yellows

Kikuyu Poisoning

Kikuyu pastures have been implicated in the deaths of dairy cows since the 1950's. In the past thirty years, significant incidents have been recorded in NSW coastal areas in 1983, 1987, 2003, 2006, and 2010. The condition is relatively rare and tends to be sporadic, but it can result in fatalities for a large percentage (10 to 30%) of the herd within 24 to 48 hours.

Poisoning typically occurs in nitrogen-fertilised pastures in autumn when there has been rapid regrowth of the pasture after an extended dry period. Although this coincides with an increase in nitrate levels, symptoms are not consistent with nitrate poisoning. Poisoning has also been reported to be associated with recent army worm infestation, however, this, again, is not always the case.

Thus, the cause of kikuyu poisoning is unknown, although mycotoxins derived from a fungal association on the leaves have been suggested as the most likely cause. The disease causes salivation, dehydration, depression, abdominal pain and death. Cows may exhibit sham drinking where they are standing at the drinking trough but not drinking.

Control:

After the break of prolonged dry conditions ensure roughage continues to be fed until the dry matter content of the pasture increases.
Ensure kikuyu is not the only forage source when introducing cows onto suspect pastures.

Insect Pests of Kikuyu Grass

In general, insect pests do not cause economic damage to kikuyu grass as production losses are low and infrequent. However, kikuyu can harbour insect pests that affect subsequent crops and pastures.

Armyworm

The Common Armyworm (*Mythimna convecta*) and Lawn Armyworm (*Spodoptera mauritia*) and more recently Fall Armyworm (*Spodoptera frugiperda*) are common pests of kikuyu pasture on the north coast of NSW, in early autumn. The moths migrate throughout northern NSW during summer and autumn, laying eggs that hatch from January to March. The larvae (see Photos 11 and 12) feed on kikuyu leaves and stems reducing pasture growth. The infestation of army worm is one reason not to sow kikuyu with ryegrass too early.

Photo 11: Lawn armyworm larvae *(Photos L. Turton)*

Photo 12: Common armyworm larvae *(Photos L. Turton)*

Emerging ryegrass seedlings in over-sown kikuyu pastures can be severely damaged by an existing armyworm infestation. This may require resowing, delaying first autumn grazing by as much as 4 to 5 weeks. There is a range of insecticides available that can be applied prior to sowing ryegrass, to reduce the armyworm population and so protect the emerging seedlings

Photo 13: Common Armyworm moth *(Photos L. Turton)*

Photo 14: Lawn army worm moth

African Black Beetles

African Black beetles (*Heteronychus arator Fabricius*) (see Photo 16) have both adults and larvae that live under the soil feeding on roots and organic matter. The adults that survive the winter begin mating and egg laying in August and continue to December.

Larvae populations peak at this time coinciding with maize planting. Damage to seedling maize sown into kikuyu swards can be severe if seed is not treated. The larval populations decline over summer depending on moisture conditions but may still be a significant threat for early March sown ryegrass. Current controls are seed treatment of maize and ryegrass with imidacloprid.

Damage to kikuyu is infrequent but can occur when populations build up under warmer spring – summer conditions but the kikuyu does recover.

Photo 15: African black beetle larvae *(Photos L. Turton)*

Photo 16: African black beetle adult beetle *(Photos L. Turton)*

Field Crickets

The Black Field Crickets (*Teleogryllus commodus*) (see Photo 17) can grow over summer in kikuyu pasture allowing large numbers of immature crickets to feed on over-sown ryegrass.
Field crickets attack both broadcast and drill sown seed. Surface application of insecticides before ryegrass sowing can reduce the threat.

Photo 17: Adult black field cricket *(Photos: NSW DPI)*

Photo 18: Black field cricket *(Photo: Andrew Weeks, Cesar Australia)*

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Further Reading

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PASTURE IMPROVEMENT CAUTIONS

Pasture improvement may be associated with an increase in the incidence of certain livestock health disorders. Livestock and production losses from some disorders are possible. Management may need to be modified to minimise risk. Consult your veterinarian or adviser when planning pasture improvement

The *Native Vegetation Act 2003* restricts some pasture improvement practices where existing pasture contains native species. Inquire through your office of the Department of Natural Resources for further details