



Managing Pastures - Readers' Note

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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 % \times 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

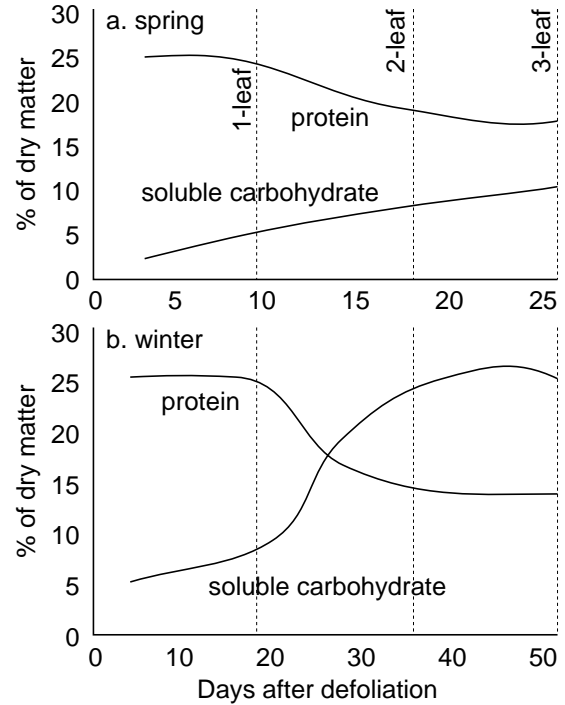
In spring, at the 3–3½-leaf stage of regrowth, ryegrass has a protein to carbohydrate ratio (Figure 14) of 1.8:1. This is much better than the 4:1 ratio at the 1-leaf stage of regrowth. The changes in the ratio are even more dramatic in

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.

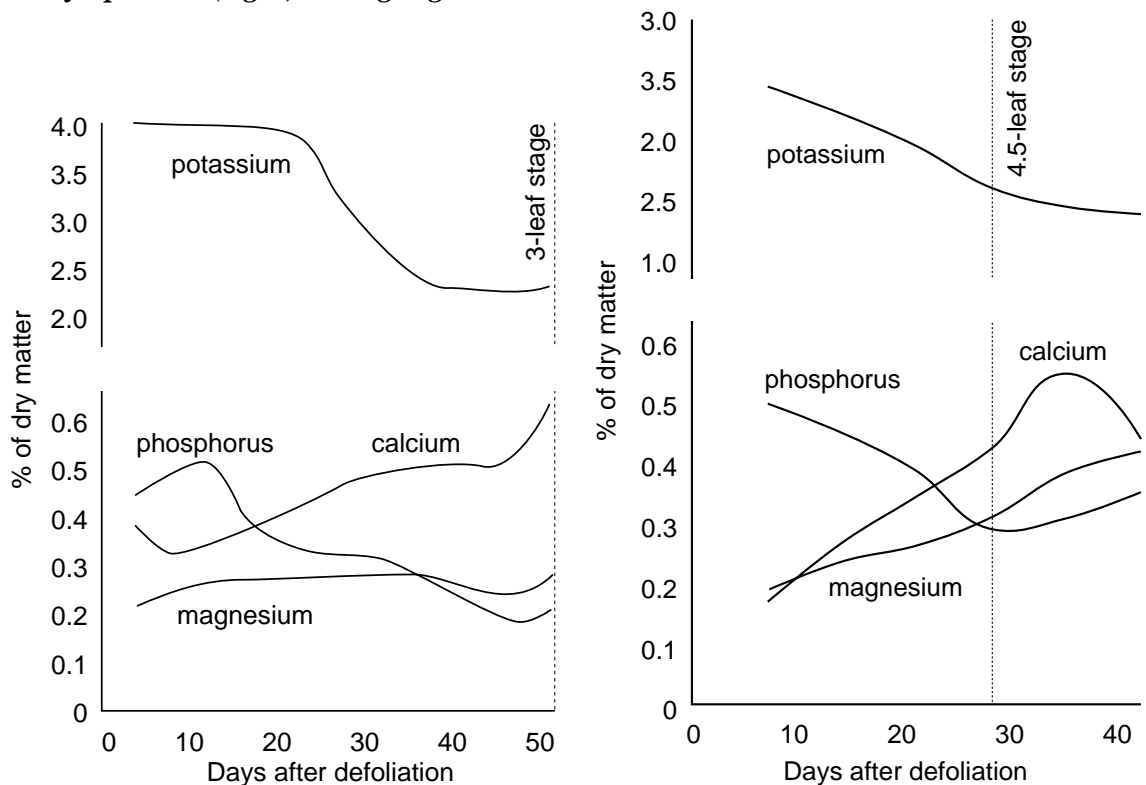
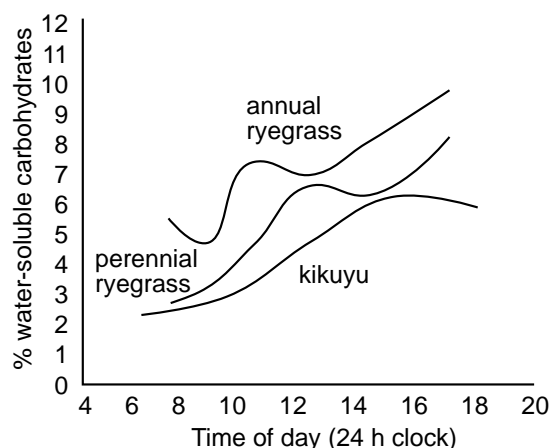


Figure 17. Changes in soluble carbohydrate from 6 a.m. to 6 p.m. for annual ryegrass, perennial ryegrass and kikuyu. The actual levels in ryegrass are from samples taken in early autumn and hence are low.



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

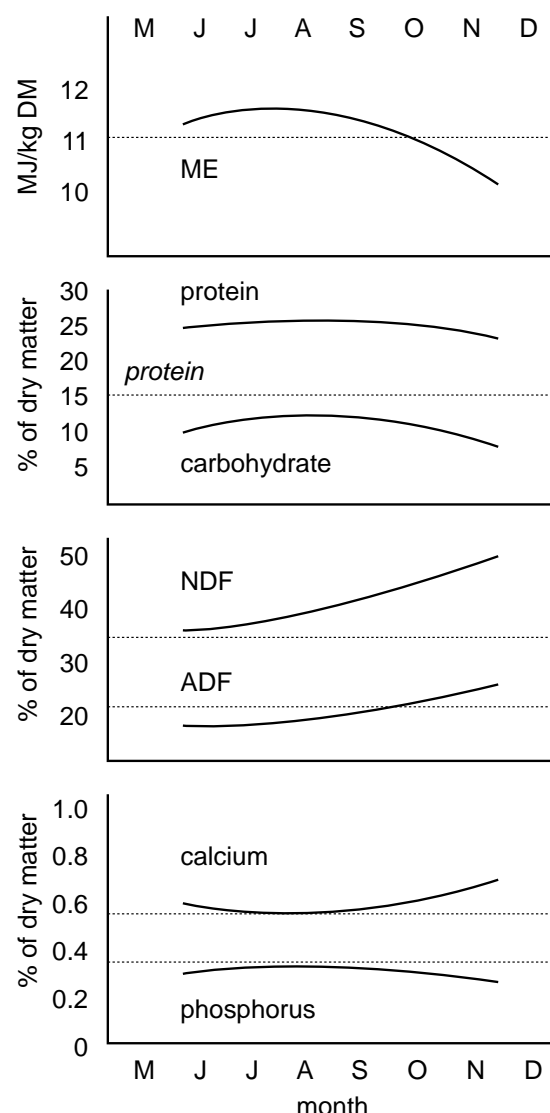
The level of carbohydrates increases at about 0.5% per hour from sunrise. Thus a cow eating, say, 15kgDM of pasture at 4 p.m. (13% sugars) would eat 0.75kg more carbohydrate than a cow grazing pasture at dawn (8% sugars). This is why some farmers cut silage late in the afternoon.

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

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.

shows the average values of minerals with no seasonal variation for these 3 pastures.

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.

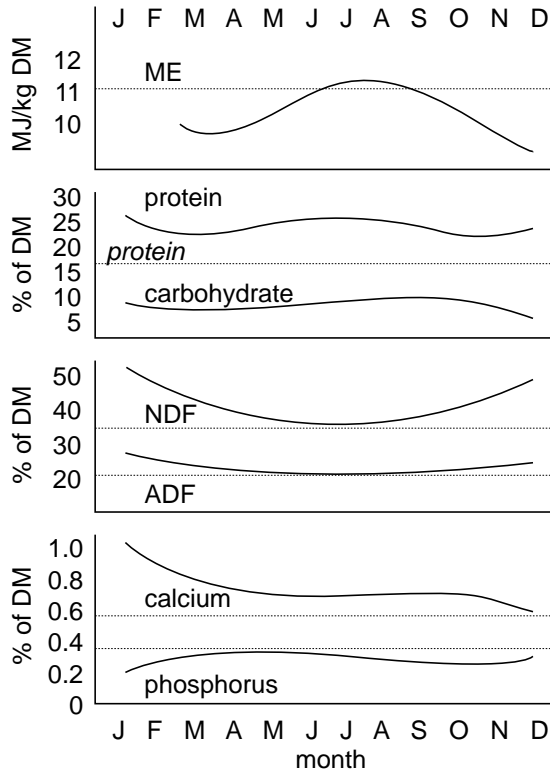
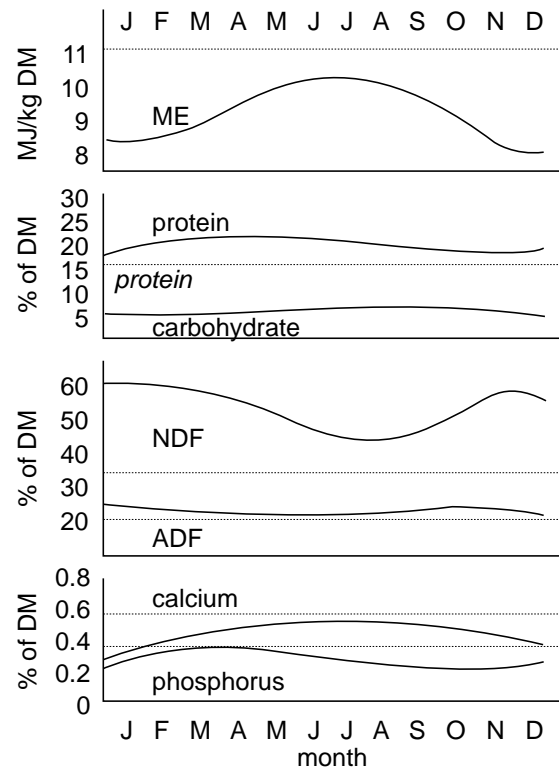


Figure 20. Seasonal variation in nutrients in kikuyu pasture. The dotted lines are the minimum required for cows producing 20L of milk a day.



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