Feed requirements and forage quality

The northern dairy industry falls broadly into two groupings based on rainfall. Higher rainfall coastal farms are tropical pasture-based (mainly grass and tropical legumes), while further inland as rainfall diminishes and periods of low temperature in winter are longer and colder, there is increasing reliance on forage cropping such as oats.

As you move further south or to fertile upland areas there is a change to subtropical grasses such as kikuyu and perennial temperate species such as white clover. Prairie grass, fescue or ryegrasses become more viable as short-term perennial pastures. Irrigation may be used to provide high quality forage for the milking herd, (lucerne, annual ryegrass, clover mixtures) but as a limited resource is not generally used for feeding heifers. Heifers and dry stock may graze any surpluses, but more usually they are reared on rain grown pastures - often unimproved, or with minimal fertiliser inputs.

Energy from forages and grain

A well-fertilised, actively growing tropical grass pasture can provide 9 MJ ME/kg (mega joules of metabolisable energy per kg) of dry matter (DM) and 14 to 19% crude protein (CP) (Table 1). Such pastures contain 30 - 45% green leaf. In contrast, mature pasture or unfertilised grass with a low leaf content may offer as low as 7 MJ ME/kg DM and 6-10% CP.

Some forage cropping (sorghum, forage legumes) may be used both for grazing and as conserved feed for winter, but generally the quality of pasture, forage and hay used is low. Concentrates, grain and/or protein supplements (Table 1) are required if dairy replacement heifers are to achieve adequate growth.

Low quality pasture and forage limits heifer growth, delaying sexual maturity, conception and calving or increases the need for supplementation to achieve desired growth targets. Average age at calving is around 30 months and heifers may be lighter than optimum, resulting in lost milking potential as the heifer continues to grow. Improving the quality of forage provided to heifers will increase their growth and productivity.

Growth of tropical pastures is determined by rainfall, temperature and fertiliser inputs. Tropical grass pastures should be fertilised with at least 200 kg nitrogen (N) per hectare over the growing season, with phosphorus (P) and potash (K) applied according to soil requirements. Bicarbonate extractable soil phosphorus (Colwell) levels above 25 mg/kg and potassium above 0.4 meq/100 g are adequate for tropical pastures. At lower fertility levels consider fertiliser inputs up to 11 kg P and 60 kg K per hectare per annum.

Table 1. Nutritive value of various forages or grain

Forage or grain type	Metabolisable energy MJ/kg DM	CP %	NDF %	ADF %
Fertilised tropical grass- green leaf	9	15	62	35
- stem	7	8	70	40
Forage sorghum	8-9.5	14	68	40
Unimproved pasture	7-8	<10-12	70	40
Maize silage	9.5-10	7-8	40-50	25-30
Oats	9.5	17	55	30
Lucerne hay	9.5	20	45	31
Irrigated ryegrass, clover	10	25	30	25
Cereal grain (barley, sorghum, maize)	13	10	18	9
Molasses	11.5	6 (NPN*)	-	-
Whole oil seed (white cottonseed etc.)	12-16	20-23	44	34
Oil extracted protein meal (cottonseed meal, sunflower, soybean, canola, copra, PKE**)	12	35-45	28	20

*NPN - non protein nitrogen **PKE - palm kernel extract

Yields increase rapidly from October to January, but with a reduction in leaf percentage as the season progresses and the grass matures. High yields of stem are maintained into autumn but the green leaf begins to decline from March (Figure 1). All measures of pasture quality are much higher for leaf than stem (Figure 1, Table 1) and quality of pastures decline with advancing maturity and senescence. Changes in digestibility (in-vitro dry matter digestibility - IVDMD) are associated with increasing NDF (fibre) content of the pasture.

NDF or neutral detergent fibre is a measure of the amount of structural carbohydrate in the plant and includes both digestible (hemicellulose), less digestible (cellulose) and indigestible (lignin) components. ADF - acid detergent fibre is the amount of indigestible carbohydrate. In tropical grasses the ratio of ADF:NDF (the indigestible component) in leaf and stem is consistently high at 55-59% respectively throughout the growing season. Protein (CP) content and digestibility (IVDMD) are highest in spring - early summer in young, leafy pasture, and decline as stem content of the pasture increases with maturity, seeding and senescence in late summer - autumn. Nitrogen fertiliser increases yield, leaf and crude protein content of grasses.

Dairy farms in northern Australia supply a whole-milk market requiring consistent supply and as a consequence, farmers calve cows year round and are not able to make best use of the summer pasture flush. Feed requirements for growing heifers are defined in relation to their size or age, as farms will always have small groups of animals of varying ages requiring differential feeding, depending on their specific needs and the quality of pasture available. Understanding the nutrient levels and variation in pasture and forage available will allow concentrate supplements to be used which best meet deficiencies of the base forage. Factors other than feed quality can impact on gains by heifers. Climate factors such as hot humid weather or cold and wet conditions reduce feed intake, increase stress on the animal and increase its susceptibility to parasitism and disease. Higher levels of supplementation at such times can be beneficial to maintain nutrient intake. Control measures may be necessary to minimise the economic effects of parasites.

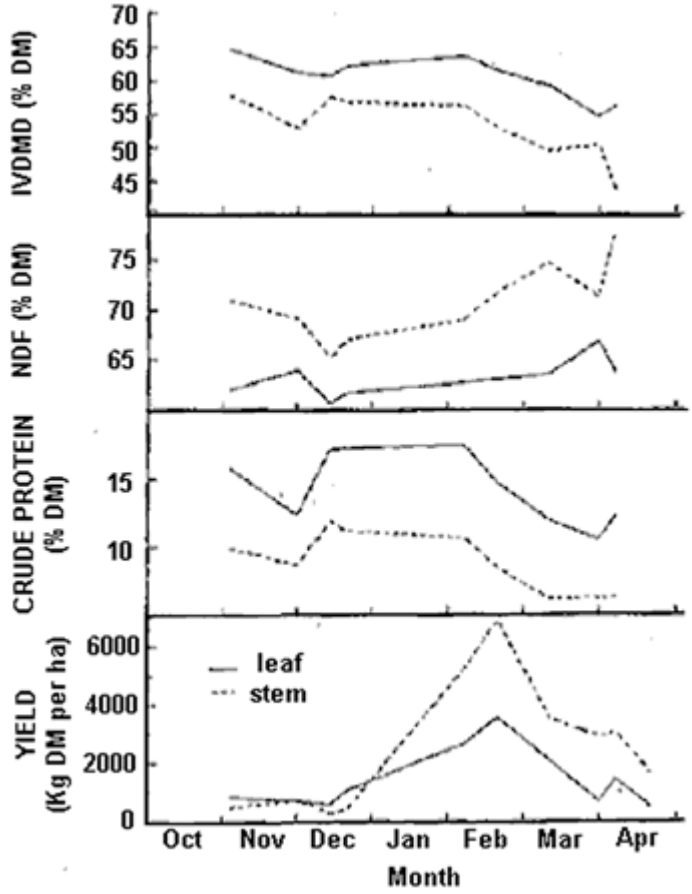

Figure 1. Changes in green dry matter (DM) yield on offer, and crude protein (CP%), fibre (NDF) and digestibility (IVDMD) content of green DM for a fertilised rain-grown Rhodes grass pasture during spring, summer and autumn.

Nutrient requirements

Nutrient requirements of the growing heifer vary according to her stage of physiological development. Initially the pre-ruminant calf can digest only milk. As her ruminant digestive system develops she is able to absorb and utilise volatile fatty acids (VFA) from microbial breakdown of starch, sugar, protein and fibre in the rumen, together with bacterial protein re-synthesised by microbial fermentation and feed escaping degradation that can be digested in the hind stomach (abomasum).

The early weaned heifer (2 months) requires a high dietary nutrient content (Figure 2) with 16% crude protein (CP), a digestible energy content of 11 MJ ME/kg DM plus minerals, particularly calcium (Ca) and phosphorus (P) for muscle and skeletal growth. She can however only eat about 2.5% of her live weight of a high fibre diet such as tropical grass (Moss and Goodchild 1992). Tropical grass pastures have a low leaf to stem ratio, commonly 25 - 35% green leaf. Nutrient levels in stem are lower than for leaf (Figure 1), but even if she were to consume only green leaf, the young heifer would not be able to meet her energy needs to sustain a live weight gain of 0.6 to 0.8 kg/day.

By understanding nutrient needs relative to pasture quality and physiological development we can formulate an effective feeding program for growing heifers.

Figure 2 illustrates the respective intakes of energy or protein needed for dairy heifers at various stages of development to gain 0.6, 0.7 or 0.8 kg/day, and the intakes achievable from tropical grass pasture. Capacity of grain or concentrate supplementation to satisfy animal requirements is demonstrated. Good quality, fertilised tropical grass alone will not support live weight gains >0.6 kg/day until heifers reach about 250 kg live weight (Figure 2a). Leafy pastures theoretically contain adequate protein for weaner calves, but it is insufficient to supply the protein required to balance high energy-low protein supplements (grain) until animals reach about 200 kg (Figure 2b).

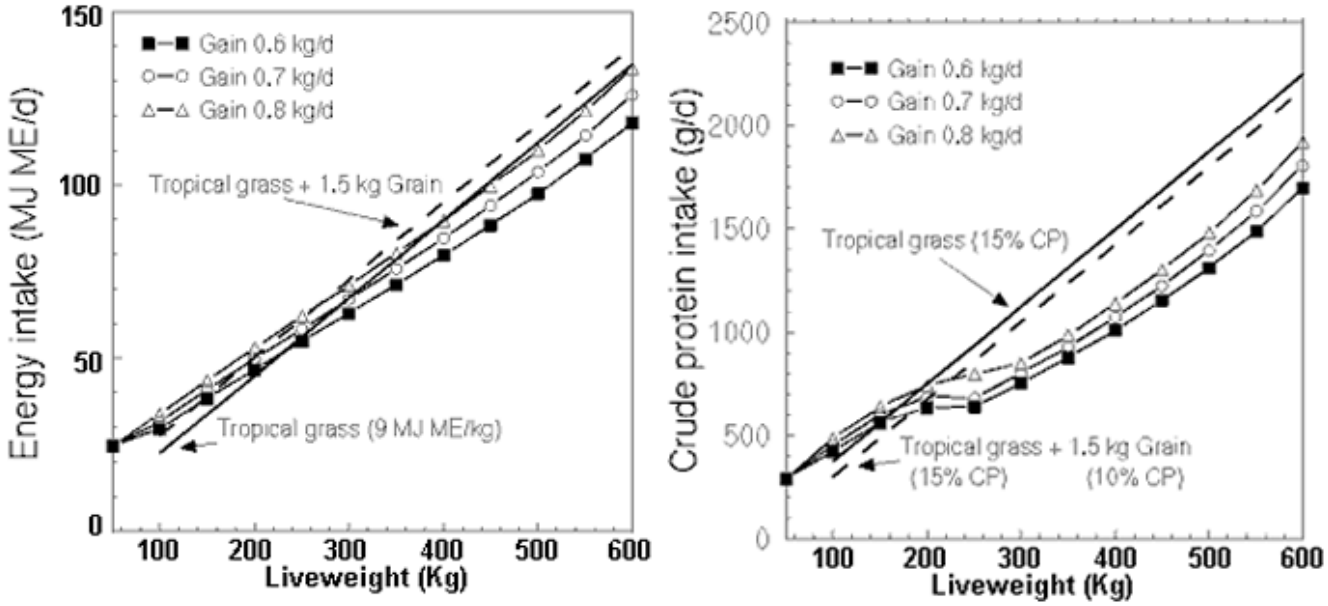

Figure 2. (a) Dietary energy (MJ ME/day) and (b) crude protein (g/day) requirements of dairy heifers at various rates of gain (NRC 1989) and the ability of tropical grass pastures to satisfy these requirements. Assumed voluntary intake of pasture - 2.5% live weight (Moss & Goodchild 1992).

Progressive stages of heifer development

For better management of dairy replacement heifers, we should consider four progressive stages of development (Table 2), with differing intensity of management and nutritional inputs necessary at each stage to achieve our growth targets.

In stage 1, the newborn calf is a monogastric requiring milk to survive and grow. In this period, health and survival are our major concerns. Nutritionally however we must provide the type of feeds that will be used by the calf to develop her rumen, so that she can be weaned at an early age onto solid feeds - pasture and concentrate.

Stage 2 is a period of consolidation after weaning, again requiring a high level of management and correct nutrition to maintain growth, prevent a post weaning growth check and prevent losses or poor growth due to parasite burdens.

By about 8 months of age (Stage 3), the heifer is more robust and is able to obtain a large proportion of her nutrient needs from pasture or forage. This however is the period when heifers often slip below target, as fertilised tropical pastures alone cannot support growth necessary for heifers to calve at 2 years of age. On unimproved pasture, gains will be much lower. Failure to maintain gains above 0.6 kg/day will extend the time of sexual maturity and first mating.

The final stage (Stage 4) is the period from mating to calving. Heifers of this age are fed to maintain growth, provide for the needs of the developing calf and set her up for her forthcoming lactation. Most of the heifer's requirements can be supplied by good quality fertilised pastures. Unfortunately these heifers are often run with mature dry cows on the worst pasture on the farm - but unlike mature cows, the heifer must also continue to grow. If the heifer is checked at this point her capacity to milk will suffer and she may be more difficult to get back into calf.

Live weight targets for replacement heifers can be related to herd productivity. An optimum live weight is around 85% of the mature weight pre-calving for cows in their herd, or 90% of mature cow lactating weight (Moss, Miller and Buchanan 1996). A live weight of 500-520 kg at 2 years (Holstein-Friesian) is acceptable for herds producing 5000 L of milk per cow, but higher production farms should feed for heavier heifers with a mating weight of 350 kg by 15 months to calve at 550 kg at 24 months. To achieve this Holstein-Friesian heifers need to maintain an average growth rate of 0.7 kg/day. Recommended progressive live weight targets for Holstein-Friesian (0.7 kg/day) and Jersey (0.5 kg/day) heifers are given below (Table 2). Suitable heifers for farms at moderate production can be raised using tropical pasture plus concentrates but gains of 0.7 kg/day for heifers to calve at 2 years are not easily achieved using tropical pastures. Higher quality forages such as lucerne, oats maize silage or temperate pasture will allow this growth target to be maintained. With tropical grass high inputs of concentrates are necessary, increasing rearing costs.

Table 2. Development stages and age - live weight targets for calving at 2 years

Stage	Age target (months)	Live weight target (kg)	
		Holstein-Friesian	Jersey
1. Birth to weaning	2	70	55
2. Weaning to eight months	8	200	145
3 Eight months to mating	15	350	260
4. Mating to calving	24	550	

Minerals

Calcium and phosphorus are needed for bone and muscle growth. The young weaner heifer requires about 20 g of calcium and 11 g phosphorus a day. Much of this can be supplied by pasture, but addition of mineral supplements such as di-calcium phosphate (DCP) at around 20 g a head per day or proprietary mineral mixes will satisfy animal requirements. Minerals can be added to concentrate supplements or fed separately free access mixed with salt.

Depending on local pasture/soil deficiencies and water quality, salt and other minor minerals (such as magnesium, cobalt, copper) may be necessary. Trace elements such as selenium may be deficient in some sandy coastal areas. However as it can be toxic at relatively low levels of excess and remain in the environment, selenium should not be added to rations unless a deficiency is known or has been identified by soil or blood analysis.

Vitamin additives may be beneficial with conserved feeds (silage, hay) but are not necessary with green pastures. In drought periods there will be a greater reliance on conserved forage and balanced supplements will be more important.

In summary

- The growing season of unimproved pastures is too short and their leaf content too low to provide an adequate forage base for the growing dairy replacement heifer.
- If the age of heifers at calving is to be reduced and their live weight increased improved pastures and forages adequately fertilised must be used.
- Tropical pastures alone will not support necessary growth rates by pre-pubertal heifers.
- Concentrate supplements correctly formulated to balance pasture availability and the heifer's nutrient requirements relative to her stage of growth will ensure she meets her growth target.
- Forages of higher digestibility and/or increased supplementation are necessary to sustain live weight gains of 0.7 kg/day.
- Expenditure on fertiliser to improve pasture growth and quality will reduce the need for more expensive purchased feeds such as grain and protein concentrates or hay.

Further information

Moss, R.J. and Goodchild, I.K. (1992). Rearing dairy calves on irrigated tropical pastures. 2. Effects of levels of maize and cottonseed meal on growth of weaner calves. Australian Journal of Experimental Agriculture 32: 581-585

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Source: Queensland Department of Agriculture, Fisheries and Forestry; 2009