

# WINTERING DAIRY COWS ON FODDER BEET

Jim Gibbs  
Animal Science, Lincoln University.

## Introduction

Winter feeding is a pivotal in the seasonal dairy calendar, carrying cows through late pregnancy and setting up body condition for the lactation to come. Crop feeding is routine in large herds here in the South Island because pasturing is unavailable or expensive, and feedpad alternatives bring both effluent and ration formulation issues. Kale (*Brassica oleracea*) has been the most common crop, being viewed with the benefit of years of experience as a dependable, low cost and low care approach to winter feeding. In the last five years, the use of fodder beet (FB; *Beta vulgaris*) has bolted to approximately 6000 ha in NZ. As an alternative winter crop, the recent popularity has been driven by a few key ideas: it will yield 30 t/ha, it will provide metabolisable energy (ME) of over 13 MJ/ kg DM at less than 10 cents / kg DM. These ideas have folded together in the folklore of the industry to promise what seems to be a dream ME/ \$ value above alternative winter crops.

However, in practice neither of those ideas are automatically achieved, and as with most new developments, there have been unseen challenges and teething troubles. As NZ is almost the only country to graze FB as a sole feed, there are no information sources anywhere else internationally to get solid feeding, health or production values from, and as an industry we have been required to make it up as we travelled along. In response to the growing use of FB and the lack of knowledge around the use of FB as a winter crop, in 2010 DairyNZ commissioned a specific research project to establish the genuine feed values and health risks associated with 'Kiwi' FB wintering, and this paper is a summary of the key results.

## Dry matter and feed value of fodder beet

It has been well established that there are considerable differences between FB cultivars in the bulb dry matter (DM), with a range of approximately 10-20% observed in NZ. However, in most FB crops there is also substantial variation in the size of the plants across and between paddocks, and in the amount of leaf present. There had not been any research to establish if bulb DM changed with bulb size or across the season. Because these questions have obvious impact for determining both the crop yield and the daily allocation, this project sampled nine South Island FB crops repeatedly across the winter for large, medium and small bulbs of the various cultivars, assessing the DM and quality.

The results demonstrated that even within cultivars there were sometimes large differences (eg. > 50%) in bulb DM between large and small bulb sizes and also between bulbs

of similar size, at different times in the winter. Clearly, this has the potential to hinder appropriate allocation of the crop, at two levels. First, this means there is a requirement with FB crop yield estimation to assess paddocks very carefully: there are commonly areas of different bulb size, particularly after dry autumns; precision drilling means rows may not have similar plant density if the drill 'skips' in places; and the leaf yield changes with the season. Second, the shifting DM means that a late May crop yield estimate may not accurately represent the crop in late June or July.

A practical solution to this is to use a different and more accurate FB crop yield estimation method. Best practice is to use the row width (mid row to mid row) and then at least 4 m of the row for the area sampled for crop weight, and to do this at three sites in the paddock, and to do this twice in the season. For example, a 50 cm row width by 4 m gives 2 m<sup>2</sup> sampled at each site. Compared with the traditional 'square metre' ring throw, this is a better method for FB to get around both bulb size difference and bulb density variation in rows, and also the bulb DM and leaf yield differences. To get the DM, sample smaller and larger plants: the entire plant leaf material should be used, and a full length (crown to tip) 'wedge' of each bulb sampled – don't assume that a top or bottom slice works for the entire bulb.

## **Feed value**

Fodder beet has been used as a stock feed in Europe for more than a century. However, it is typically harvested and the leaf removed before consumption in that system, while here in NZ it is grazed in the paddock. With feed testing of this crop for cow ME value, there are automatically several problems that are worth fleshing out.

The ME value of a feed is the amount of energy from the diet (total or gross energy), minus that proportion of the feed that is never digested (eg. 15-20% of the DM for ryegrass), and minus another amount of energy that is lost to the cow after digestion by methane gas or compounds in the urine (typically 8-15%). So to determine the ME of a feed, you need a digestibility value. The only way to genuinely measure digestibility is to feed 4 - 8 ruminants for 7 - 10 days and weigh all the feed in, and weigh all the faeces out – the difference in DM weight is approximately what the animal digested. Of course, that never happens except in

---

Notes:

research settings, so when feed is usually tested for the ME value, the small sample sent is used to estimate the digestibility of it, then that estimate is used with some methane equations (commonly drawn from pasture feeding, rather than supplement feeding, trials) to estimate the ME. The various methods of estimating digestibility all require some form of comparison of the sample with a larger pool of samples that do have known ruminant digestibility. This is important to understand, because it means that when you have a feed sample assessed for ME value, the estimate returned is about as strong as the collection of background samples. There is an alternative method of ME estimation where the contribution of each feed component – carbohydrate, protein, fat etc – to the total ME is calculated from book values (from previous digestibility trials overseas) and the total is the ME estimate for that feed.

For ryegrass pastures, ME estimation is a relatively accurate process here in NZ because there are now a credible number and range of background samples, but for most other feeds, dedicated feeding trials and reference samples are scarce. For FB, prior to this project they were non-existent, and the last direct FB work of any kind done in NZ was in 1971 (Williams and Coup, 1971), and this was not a feeding trial! So in NZ, when FB has been tested it has often been estimated to be highly digestible, and high estimates of ME have been then produced from that. It is important to note that because there were no FB reference feed samples from feeding trials, it was difficult to 'correct' ME estimates to a practical feeding value in the cow.

To establish the feeding value of FB and develop reference standards it was necessary to measure the digestibility in ruminant trials. To do this, the project used groups of dry cattle and groups of sheep fed fresh FB and a fibre supplement for 21 days each time, with total faecal and urine collections to determine the digestibility. In total, this was repeated three times for each of the sheep and cattle groups, once each with Rivage, Munro and Brigadier cultivars. In addition, a large amount was dried and set aside for use as a future reference store for better feed testing. The resulting digestibility values demonstrated that the FB cultivars, as fed in the industry with typical bulb: leaf ratios, were of a broadly similar digestibility bracket to top end ryegrass. This suggests the ME values of the crop as fed here in NZ will typically be 12 – 13 MJ/ kg DM.

## **Supplements for fodder beet**

As FB is a high ME crop with most of that energy stored as a rapidly fermentable sugar, rumen acidosis is typically considered the major feeding risk, and the use of high fibre supplements is routine to manage this. In NZ, the use of supplements with FB has rapidly evolved in a few years. Supplements were first used with FB in a manner similar to kale: that is, straw at about 20% of the total ration. This has shifted, with some current advice promoting 50% of the ration as supplement, and the use of silage or baleage rather than straw. While this

has worked well, it makes winter feeding more expensive as supplements are typically the more costly component of the diet.

To establish what level of supplement was required for good cow health and rumen function, various FB cultivars were investigated out in the paddock using LUDF fistulated cows wintering on them, and also with pen feeding of dry stock. These fistulated cattle were fitted with rumen pH probes and dataloggers to map the rumen pH across the feed cycle, and they were also directly sampled around the clock for rumen acids and nitrogen. The results of these many trials clearly demonstrate that FB is a crop that requires strict attention to feeding to minimise the risk of acidosis – FB is a ‘careful’ feed. The results show clearly that FB has a rapid and strong effect on the rumen environment, consistently and significantly reducing rumen pH after morning feeding, and thereafter pH rose steadily back to above 6.0 in about eight hours. However, when the fibre supplement was maintained above about 35% of the diet, this effect on rumen pH was capably managed by cattle, and appeared to have no impact on either health or intake. When supplements were reduced under 35%, clinical rumen acidosis was observed. It is notable that of all the many diets of the South Island herd I have assessed for rumen impact over some years, FB is the only one to have produced clinical rumen acidosis.

In addition, several years of winter crop work with rumen sampling has demonstrated that once daily feeding of low crude protein (CP) crops produces a rumen environment where protein nutrition is marginal for good rumen function. This was certainly true with FB, where the CP % of the crop can sometimes be below 10%. The serial sampling of farms across the season demonstrated the CP content of FB cultivars appears broadly stable across the season, with considerable differences between leaf and bulb that have been well documented previously by the industry (eg. DairyNZ FB Fact Sheet 2011). In general, however, FB is a low CP crop, and this is particularly so when there is little leaf material remaining. For a wintering cow, a minimum CP content of approximately 12% DM is required, and for some FB crops (eg. a Brigadier crop with very low leaf mass), total diet CP will be below this unless the supplement used is a good CP source (eg. grass silage). This low protein status means the supplement used with FB becomes important not only for the fibre it supplies, but also for the CP it supplies. FB

---

Notes:

is different to other winter crops in this regard, which is significant for the true cost of feeding FB.

## Mineral nutrition

The mineral analyses of FB in NZ available previously has been from relatively few samples and only a few sites. To improve the understanding of winter crop mineral nutrition, this project analysed the mineral content of leaf and bulb of the common cultivars across different South Island regions and across the season. Of the minerals important to cow nutrition, it is only in phosphorus (P) and calcium (Ca) content that FB is notably different to kale or swedes, as in broad terms the trace element content of FB is similar to other winter crops.

The P content of FB leaf ranges from approximately 0.2 - 0.3% DM, and the bulb is particularly low, ranging from 0.1 - 0.2% DM. A value of below 0.24% DM for P is considered deficient, and total intakes of P below 10 - 14 g/ d have been reported to reduce production in beef and dairy cows (Ternouth et. al 1996; Wu et. al 2000). Calcium deficient diets are typically below 0.27% DM, and FB leaf ranges from 0.8 - 1.3% DM, and bulb from 0.1 - 0.2% DM. For a typical FB crop of 20% leaf, fed at 8 kg DM/ d with 5 kg DM straw (P = 0.06% DM, Ca = 0.35% DM), this is a *maximum* P intake of:  $(6.4*2) + (1.6*3) + (5*0.6) = 20.6$  g/ d. The feeding standards (ARC, 1980) recommend for the dairy cow (late gestation) a minimum P intake of 20 g/ d, so it can be seen that FB is marginal in providing this. Generally, Ca should be approximately 1.5:1 with P, giving a desired minimum Ca intake of 30 g/ d, and following the same nutrient accounting, maximum Ca intake on the above FB diet is 51g – which can be seen as adequate.

What this means is that with the typical diet and P content ranges above, P will be marginal or deficient, and Ca will be adequate, and such diets are not common in ruminant systems. However, as the leaf contains 7 - 10 times the Ca of the bulb, if the crop is grazed with very low leaf, Ca intakes may also be closer to the minimum recommended content. Although there is limited research data on this subject at present, it would appear that P deficiency is a potential issue with grazing FB, particularly when cereal straw is used as a supplement as it also has a low P content. This is also complicated by the known relationship of P and Ca, as Ca is the dominant driver of the physiological systems to retrieve stored P and Ca in the bone tissue, and the question of how the endocrinological processes that release the stored P and Ca in the cow are impacted when P is deficient and Ca is adequate in the diet are not entirely clear at present. However, there are a number of reports of farms with a high prevalence of unusual or severe cases of apparent milk fever in early lactation after wintering on FB, which respond poorly to standard Ca treatment. There are reports of broadly similar cow health events in high production systems overseas (Gerloff and Swenson 1996). In addition, there are also reports

farms with years of experience using FB that have successfully used dicalcium phosphate supplementation (50 g / cow / d) to prevent these early season cases, having previously had significant trouble. It may be that with some FB feeding rations the relative scarcity of P and the co-relationship between P and Ca nutrition is disrupting early lactation regulation of these important minerals. This area is the subject of further research this season.

## **Cow health issues**

### ***Oxalates***

The leaf of many beet crops is well known to contain oxalic acid, and high levels of this compound have been documented as toxic to ruminants (Duncan et. al 1997). The usual clinical signs of toxicity are direct rumen damage, nervous signs and renal collapse (Panciera et. al 1990). It might be expected that this is a challenge for cows grazing FB, and in Europe the convention is not to feed the leaf to stock. However, crop grazing of FB in NZ has not been associated with widespread signs of oxalate toxicity. Assessment of leaf oxalates from South Island farms this year at winter grazing in this project and in others had measured values below 2% DM, which is less than the content reported for ruminant toxicity internationally, for example with plants such as *Halogeton* or *Rumex spp.* (James and Butcher 1972; Panciera et. al 1990).

Although oxalates are present, there are several reasons why in most circumstances this compound does not appear to be a significant issue for cows grazing FB in the NZ manner. The oxalate content in other beet leaf is known to vary with growing stage, being higher in the early growth phases, so grazing FB after 120-150 growing days may be inherently less risky. Second, the actual leaf mass is often substantially reduced by the time of grazing in June and July, compared with earlier in the season. Third, rumen metabolism to degrade oxalates is known to increase rapidly with exposure in the diet (Duncan et. al 1997). It is unlikely that oxalates are a significant cause of morbidity or mortality in NZ cows grazing FB crops in winter.

---

Notes:

## **Cow deaths**

There is no evidence to suggest cow deaths on FB are significantly higher than on other winter crops, and in general losses appear to be low. While mismanagement can result in cow deaths at any time when grazing FB (or other winter crops), there does appear to be two distinct 'windows' where most cow deaths associated with FB are generally observed. The first is 7 – 10 days on the crop, and the second is in early lactation. As outlined above, the rumen impact of FB must be carefully managed, and the end of the first week on the crop is a vulnerable time. Typically at this transition time supplements or pasture bouts are being reduced from the high early levels, FB allocation is increasing to maximum levels, and cow intakes of FB are steadily increasing. In addition, rumen adaption to both the diet and the timing of feeding is improving. However, crop utilisation is not uncommonly poor in the first few days, and this leaves more left over bulb available for 'back grazing' in addition to the increasing crop allocation, and the rising intakes of some cows will take advantage of this. The deaths in this first period are usually associated with rumen acidosis due to these practical difficulties around transition.

There is little documented evidence on deaths in early lactation after wintering on FB, but the available anecdotal reports usually suggest they are not as common as in the first 'window' and often have some association with unusually severe or unresponsive hypocalcaemia cases. There is a need for further research here, but the P and Ca nutrition of FB grazing outlined above may be a factor in these.

## **Best practice fodder beet feeding**

The results of this project and the accumulated experience of farmer using the crop for some years enable some guidelines on safe and productive FB wintering to be put forward.

The crop yield should be robustly assessed close to use to enable accurate allocation, which is vital for cow health and production when using FB. The cows should be transitioned onto the crop carefully over at least 7 days, and short interval break out fencing is more important with FB than with other winter crops. The early FB allocation should start at 2 kg DM/ d, rising about 1 kg DM/ d for the first week to 7 kg DM. The rest of the ration can be either walk on / walk off pasture or grass silage, fed before the FB access. The cows should be monitored closely for those that refuse FB or show signs of acidosis (off feed, scouring, tucked up). The full FB allocation should not be more than 8 kg DM, with 4 – 5 kg DM supplement fed first each day. The lower CP content cultivars (eg. Brigadier) or crops with low leaf yield benefit from using grass silage instead of straw, as the CP content of the total ration should be above 12%. The use of 50 g/ cow/ day of dicalcium phosphate or an equivalent may be warranted, particularly when straw is being used. Transition off the crop should be onto equivalent ME intake of pasture and silage/straw.

## Summary and conclusions

Fodder beet is a 'careful' winter feed. A well grown and managed FB crop can deliver high yields and be successfully and cost effectively used for dairy cow wintering, but it takes more attention to detail than other winter crops to get best results. Crop allocation is crucial to obtaining desired body condition and for preventing cow health disasters, and there are challenges getting accurate feed value and yield assessments with FB, so the methods used are important. Because FB is a high energy and low CP feed, both the amount and the type of supplement used become more important. Transitioning on and off the crop is more challenging with FB than other winter crops, and is an area that rewards very careful attention. The principal cow health issues are rumen acidosis and mineral nutrition, particularly P supply, and oxalate content does not appear to be significant issue in the NZ FB grazing system.

## References

- Agricultural Research Council. 1980. The Nutrient Requirements of Ruminant Livestock. Commonwealth Agricultural Bureaux, Farnham Royal.
- Duncan A J, Frutos P and Young S A. 1997. Rates of oxalic acid degradation in the rumen of sheep and goats in response to different levels of oxalic acid administration. *Animal Science* Vol 65(3): 451-455.
- Gerloff B J and Swensen E P. 1996. Acute recumbency and marginal phosphorus deficiency in dairy cattle. *Journal of the American Veterinary Medical Association*. Vol 208(5): 716-719.
- James L and Butcher J E. 1972. Halogeton poisoning of sheep: effect of high level of oxalate intake. *Journal of Animal Science*. Vol 35: 1233-1238.
- Pancieria R J, Martin T, Burrows G E, Taylor D S, Rice L E. 1990. Acute oxalate poisoning attributable to ingestion of curly dock (*Rumex crispus*) in sheep. *Journal of the American Veterinary Medical Association*. Vol 196(12): 1981-1984.

---

Notes:

- Ternouth J H, Bortolussi G, Coates D B, Hendriksen R E and McLean R W. 1996. The phosphorus requirements of growing cattle consuming forages. *The Journal of Agricultural Science*. Volume 126: 503-510.
- Wu W, Satter L D and Sojo R. 2000. Milk Production, Reproductive Performance, and Fecal Excretion of Phosphorus by Dairy Cows Fed Three Amounts of Phosphorus *Journal of Dairy Science* Volume 83, Issue 5: 1028-1041.