Fodder Beet in the New Zealand Dairy Industry

Jim Gibbs, Lincoln University

Introduction

The use of fodder beet as a forage crop for winter and shoulder feeding has been pioneered by the New Zealand dairy industry, and it has rapidly increased in hectares sown over the past ten years. This has included use as both a grazed crop and as harvested bulb. This paper outlines my experience of the recent developments in the use of fodder beet in the New Zealand dairy industry, including both the current and developing approaches to winter and shoulder feeding, from direct nutrition research and on-farm consultancy in winter and shoulder feeding the crop.

Winter feeding

The principal use of FB in the dairy industry in 2014 remains as a winter feed, and there has been continuing increase in the hectares sown to this purpose. The best guess from collating seed sales on total hectares of FB in 2014 is around 15 000 ha, a steep increase from the 100 ha estimated in 2006, and most of this will be dairy winter crop. Beyond the growing industry familiarity with the crop, two factors have driven this expansion of winter fed FB; the advances in agronomy, and advances in cost effective systems for feeding.

Over the past five years there have been steady improvements in agronomy, with the result of increasing, and more consistent, crop yields. The key factors in achieving more consistent high yields in recent years have been greater attention to fertiliser inputs and timing, and focused, early weed control strategies. Attention to the role of significant potassium and sodium inputs in growing big crops is a current feature of leading best practice FB growers. Current minimum target yields for dryland crops are 20t DM/ ha, and for irrigated crops 25t DM/ ha, with the largest yields recorded this year again above 35t DM/ ha. Given total establishment costs to grazing are the same despite the yield (typically $1900-2200/ ha in 2014), greater yields directly reduce the cost of winter grazing feed (5-10c/ kg DM in 2014), and increase stocking rates on crop which reduces the land required for wintering. Therefore, improving agronomy has been a key driver for the continuing expansion of the crop into the dairy industry.

The other driver of the winter crop expansion has been the advances in feeding the crop. The supplement inputs into winter feed systems are the largest cost besides the crop itself. Earlier research (Gibbs 2011) into the level of supplement required for stable rumen function with grazed FB were focused on the early winter period, and higher supplement inputs are needed in this period. Further research in this project with extended (100 day) FB grazing systems progressively demonstrated that reduced supplement inputs (<20% of the total ration) after appropriate transition procedures did not impact FB intake, rumen function or animal health.

At the same time, greater daily intakes of FB were being investigated. Traditional use of winter crops has been by restricted intakes behind a hot wire, and unrestricted intakes have not been a feature of brassica crop use in New Zealand due to the low utilisation rates that result.

However, the typically high utilisation of grazed FB (>90%) enables increasing intakes to be achieved without progressively greater crop wastage.

In addition, the traditional animal health caution with unrestricted intakes of high energy feeds has been the risk of rumen acidosis. However, the continuing research using rumen fistulate cows in commercial wintering systems on FB crop demonstrated that there were no significant differences in rumen function between *ad libitum* and restricted (eg. 8kg DM) feeding approaches to FB grazing after appropriate transition, even with lower supplement ratios in the diet. This appears to be due to different intake pattern apparent with *ad libitum* feeding, where cattle cease rapid intakes at the opening of the break and move to a slower, daylength intake pattern. As a general guide, large frame Holstein Friesian cows were observed to eat a maximum of 12kg DM FB, and Kiwi cross frames about 10-11kg DM FB, with another 2-3 kg of supplement.

The combination of *ad libitum* FB intakes and reduced supplement inputs increases the daily winter feeding ME intakes possible, and significantly reduces total feed costs. For example, if the post transition winter ration is moved from 40% grass silage and 60% FB for a 14kg DM total (approximately 6kg silage: 8kg FB), to 20% silage (approximately 3kg silage: 11kg FB) then at 2014 prices for silage (35c/ kg DM) and grazed FB (8c/ kg DM) the saving is *c*. 30% in winter feed costs, or *c.*$40 000 every 1000 cows wintered. Given the ME of FB is 12 MJ/ kg DM, and a silage value of 10 MJ/ kg DM, the shift also increases the daily ME intake from 154 to 161 MJ. This high daily ME intake is substantially above industry standard of even a few years ago, and enables body condition score gains of >0.5, up to 1.0 in some cases, in a typical 50 day winter period.

The use of this feeding strategy on farms for several years has demonstrated the practical value and safety of the approach, and the uptake has contributed to the rapid expansion of FB.

Transition Procedures For Winter Grazing of Fodder Beet

The DairyNZ fodder beet project at Lincoln University (Gibbs 2011), along with continuing work in the area, established reference values for composition and energy content of FB on NZ farms by large scale sampling across regions, seasons and cultivars. The typical crop plant will be 20-25% DM of leaf and 75-80% DM of bulb, an ME of 12 MJ/ kg DM, <10% crude protein (CP) bulb and >15% CP leaf, and 25-30% neutral detergent fibre (NDF). The bulb has low CP and NDF (<15%), and is 40-60% sugar, so is palatable and rapidly fermented in the rumen. As a consequence, the transition to the FB crop by cows must be carefully managed to avoid rumen acidosis.

Transition is the most important period of FB feeding, as the consequences of rumen acidosis are stock losses, enduring rumen damage in affected cows, and a powerful 'training' of even mildly affected cows ***not*** to eat FB, which can significantly impact herd intake patterns and subsequent body condition score (BCS). The first 14 days of transition set up the success of the winter feeding, and the value of sensible planning and attention to this cannot be overemphasised. All FB feeding problems are entirely preventable with standard management using the knowledge of the crop gained here in NZ in the past five years.

The transition programme developed here at Lincoln University through the DairyNZ FB project has been in widespread use across NZ for several years, and has proved successful and practical. The cows start with 1-2kg DM FB allocated behind a wire on day 1, then increase 1kg DM every second day for 14 days – about 9-10kg DM. The supplement inputs are 8kg DM on day 1, dropping to 4kg by day 14, then 2-3kg at day 21 and thereafter. From day 21, the break line is then moved a little each day until the cows leave FB behind to achieve *ad libitum* intake. That programme is the same for R2 heifers, who typically eat a maximum of 8-9kg DM FB. The R1 calves can be readily fed on FB, the only change from adult stock being the protein content of the supplement is required to be higher than that of the crop, so grass silage is usual, and the allocation. The calves start on 1kg DM FB to start and then 0.5kg DM FB increases every second or third day for 14 days, then after 21 days *ad libitum* feeding, which is often 4-5kg DM FB.

There are various NZ opinions insisting on a requirement for high (40%) supplement inputs to FB crop use, after transition. It is worth noting that these views are not drawn from research with FB, here or overseas, and do not represent the current industry approach for experienced FB operators. The principal effect of increasing supplement use to that level is an immediate increase in winter feed costs, with a reduced ME intake. It is simply not required, and not to be recommended.

The supplements are fed in transition at least 3h before the FB is grazed, which ensures it is eaten and the cows begin the break fully fed – supplement in the morning and FB after midday is common. Short intervals between supplement and opening the break, as is common with brassica crops, can cause problems as some cows will not eat the supplement before starting on the FB. After transition, the timing of supplements is not important. As the supplement does not function to supply energy or protein, only fibre, it is typically bought on lowest cost available, which is usually straw or meadow hay (20-25c/kg DM). Because in the early days of transition larger amounts of supplement are consumed, pasture or silage is usually then included in the ration if straw or hay are being fed to ensure it is eaten. It is possible to use pasture, grass silage and whole crop silages as the entire supplement supply, and this is common in the southern provinces, but in most cases this is not cost effective against straw or hay. In addition, caution is required with whole crop silage if there is a generous amount of grain in it, as it may contribute to rumen overload of fermentable carbohydrates.

Practical Transition Procedures

The high yields of FB combined with the requirement to limit cow intakes in transition lead to the need for a different approach to paddock design and use when winter feeding. A 30t DM/ha crop has 3kg DM every square metre, which is the day 1 allocation for three cows. This means that the line does not move far each day, unlike the lower yielding brassica crops, so the cows are not making ‘space’ for themselves on the crop. Traditionally, winter crops are planted to the four points of the paddock to maximise use, and the cows used to clear (eat and trample) a headland on initiation – with FB, the cows must not do that, and this lack of space then creates pressure on the line, soil damage due to very high stocking rates, and the temptation for farmers to open up the crop more quickly than they should.

To avoid these issues, when planting the paddock, a headland of 6m should be left, usually planted with Italian annuals. For a usual face length of 1m per cow, this 6m is ample space for the mob, even when mobs of 450 are used. It is possible to instead plant all the paddock then harvest the FB to make a headland before use, but in my experience this is just another job in a busy time, and wet weather or distractions mean it doesn't always happen, so wherever possible I plant it out with grass. As FB is close to the ground, in sustained driving rain cattle will not eat into the wind, complicating transition intakes, so in the South Island wherever possible the drill rows and paddock set up are designed to graze north.

Another feature of high yielding FB crops is the need to accurately allocate on transition. If the yield is properly measured – at the transition face (Gibbs 2011), not hectares away in the paddock – then square metres can work well. However, in early transition it is usual to move the line a metre or less a day, and as this is usually paced out not measured, problems can arise. If instead the crop is grazed across the planting rows, which are typically 0.5m, then it is easy for staff to allocate a number of rows. Also, the linear metres of a row can easily be calculated for the FB DM amounts – for example, a 30t DM/ ha crop has 3kg DM each square metre, and across the rows there will be two rows in that metre, or 1.5kg DM each metre.

If the crop is to be fed at restricted FB intakes after transition, then a valid yield assessment is required. If the crop is being fed to appetite after transition, then I use a practical method instead. A 'transition' yield can be estimated in 5t DM/ ha increments by experienced agronomists, rounding up and never down. For example, a 22t/ ha crop is set at 25t/ ha for all the transition allocations, and as after transition the crop is then fed to appetite the deliberate under allocation does not matter, and the actual ME intake difference between 'real' and 'estimated' yields is not important for those 14-21 days, and it builds a safety factor into transition allocation. For many crops in NZ today, that practically means setting a transition yield of 25t or 30t, and 35t for the really large crops.

Mature cows will readily take to eating FB, and it is unusual to have cows refuse it. However, all cattle take at least seven days to achieve full intake capacity, even if they have experience with the crop. Rising two year old (R2) heifers and rising one year old calves (R1) will be slower to take to eating the bulbs, and will sometimes benefit from splitting bulbs (eg. tractor wheel) to get them onto the crop.

Troubleshooting Transition Problems

There is effectively only one problem with grazing FB - **inadequate transition** – but it presents in several different ways. The single genuine cow health risk with FB is rumen acidosis, a result of over consumption of FB ***before the rumen is adapted to FB***. Note that it is not overconsumption alone, as once cattle are properly transitioned to full intakes of FB they can eat to appetite without restriction, with no risk of acidosis, and this commonly practiced on farms across the country, and is used in the current beef applications in calves and mature stock to drive profit.

The rumen ferments carbohydrates to energy rich acids for use. There are numerous processes involved in regulating the rumen environment to keep it stable so the microbes and gut lining can continue to survive and function, and all of these change with shifts in feed. The processes continue to change for approximately three months in cattle after feed changes, but the important changes with sugar rich diets – absorbing the acids and learning to regulate the intake – are very well advanced at 14 days. This series of changes is in many important features similar to introducing cattle to cereal grains in feedlots, but in the case of FB the diet is also very low DM, which also requires a period of adaptation.

The most common problem with transition is rumen acidosis from day 7-14, as by then cow intakes are ready for lots of FB, while the rumen is still not ready for high intakes, and as a farmer once pointed out to me, operator patience with the process is dwindling about then. Sometimes the over allocation will be just too large a break too soon, sometimes it will be because a days of over allocation has left 'banked' FB under their feet, and as their intakes rise at day 7, they go back and eat it. Where a mob has been affected at most 5% will be obviously affected, either down or off feed. However, there is also another group that will have been affected, are not obvious, and typically will not take to normal FB intakes after. They will typically be slow to eat supplement or FB for a few days after, and can sometimes be identified by this with close observation.

In rare cases acidosis can occur after transition in restricted feeding systems. Where restricted FB feeding is in place, for example 8kg FB, and a breakout enables cows to eat full FB intake (eg. 12kg DM), the difference between 8 and 12kg is too much for the rumen for some cows. In general, avoiding increases of more than 2kg DM FB a day prevents this. If cows have been transitioned to full intakes, then subsequently reduced in intake, this problem is not seen, highlighting the value of cow intake 'training' through transition. If transition is completed to *ad libitum* intakes, breakouts are no longer a cow health risk.

Sometimes the supply of supplement is the cause of acidosis problems in transition. In transition there is a clear requirement for supplement before the cows eat FB, so under supply (wet, muddy weather), inadequate access by all cows (eg. bale feeders), poor timing, or sudden changes in supplement type have all been an issue on NZ farms. In general the recommendation is not to make any feed shifts of more than 2kg DM a day – so if feeding 4kg pasture and 4kg hay day 1-7, and then hay alone after that, don't abruptly remove all the pasture on one day, but over a few days, as it is likely a group will have been eating mainly pasture, and they are suddenly moved to a low or zero supplement intake by the shift.

If there is a management breakdown in transition, and rumen acidosis is then observed, the affected cows should be removed to pasture for treatment. However, the herd should not be removed from the crop, as even in severe breakdowns only a small proportion (5%) are affected, and the majority will be completely normal. Because it typically happens in transition, removing the herd from the FB unnecessarily prolongs and complicates this for no gain. Instead, the line should be reset to three quarters of the current scheduled allocation for several days, and the supplement increased during this time, then the FB increased once again.

Transition problems are sometimes said to be the result of oxalates in FB inducing hypocalcaemia. However, extensive sampling of various FB cultivars across regions, seasons and years in the NZ research to date has demonstrated that oxalates are not present at concentrations that cause harm (Gibbs 2011). In addition, hypocalcaemia is a routine finding in early rumen acidosis, which may sometimes confuse the issue. It should also be noted that FB grazing is not associated with nitrate toxicity, bloat or goitre in stock.

Phosphorus in Fodder Beet Feeding

Fodder beet, like most bulb crops, is relatively low in both calcium and phosphorus. The samples obtained in the DairyNZ FB project (Gibbs 2011), along with others collected from allied projects, have demonstrated that the typical FB plant in NZ wintering will have a phosphorus content below that considered adequate for pregnant cows (<0.24% DM), and in most cases, a calcium content that is approximately adequate (>0.4%). In most wintering applications, this is of no consequence, and on most farms it is not addressed. But for reasons that are not clear, some regions appear to produce FB with very low phosphorus content (<0.1%), and some FB wintered herds in these regions can have relatively high milk fever incidences in early lactation (up to 10%), along with specific cases of identifiable phosphorus deficiency, seen as 'creeper cows'. These appear as milk fever cases, but the cows are typically alert though down, can respond quickly to calcium injections but relapse promptly, and often struggle to recover. This constellation of clinical signs is associated with inadequate phosphorus supply (<*c*.9g/ day) across winter. It is rare where grass silage is used as the supplement, as this commonly has a moderate phosphorus content, and typically hay or straw will have been used.

A very effective prevention strategy in these herds is the use of 50g of dicalcium phosphate (DCP) per cow daily throughout winter feeding, fed right through to calving. This supplies 9g phosphorus daily, and is usually applied by mixing a slurry and pouring over the supplement. In 2014 DCP costs approximately $800/ t, so costs about 4c/ cow/ day. It should also be noted that the use of DCP before calving does not influence adversely the incidence of milk fever by supplying calcium, as the 18g contained in the DCP dose is an insignificantly low dose to induce that effect.

Springer Management After Wintering on Fodder Beet

There are no specific requirements in terms of rumen adjustments for return to pasture after wintering on FB, and cows can be, and routinely are, put onto pasture immediately without adverse effect. However, as wintering of cows in the South Island has become more focused on delivering higher BCS at calving than was traditional even a few years ago, metabolic diseases in early lactation have required more management. Higher BCS cows, independent of their winter diet type, have greater risk of both milk fever and ketosis, and one critical management tool to prevent this is springer nutrition.

As FB is the highest energy diet available for winter crops, the use of high intake strategies has meant that many FB herds now have high BCS and need to manage springers more carefully. The approach I take is to have the springers maintained for the 10-14 days before calving on an ME intake (100-110 MJ/ d) at maintenance or slightly below. This encourages mild lipolysis and all the physiological processes soon to be required in early lactation around the use of body stores to begin, without putting pressure on the cow or altering BCS. In contrast, high ME intakes in springer management of high BCS cows after FB wintering have been associated with higher incidences of metabolic disease in my experience.

Fodder Beet in Lactation

Fodder beet is now used extensively as a supplement in lactation, in both spring and autumn. The principal driver for this was the advantage offered by autumn feeding in aiding subsequent transition, but the low cost of FB as a high energy supplement is also an advantage. Lactation use of FB is limited to approximately 5kg DM, as lactation requirements for CP, NDF, calcium and phosphorus are often greater than can be supplied by pasture and more than 5kg DM FB, and difficulties with mineral nutrition, acidosis, and cell counts have been reported. The approach to transition to FB on the platform is similar to that described above – 1 kg DM to start, then no more than 1kg DM increase every second day.

Fodder beet can be used in lactation as a grazed crop or as harvested bulb. Spring sown FB bulbs (the leaf is flailed off) can be harvested either in autumn or in spring, and current harvesting costs are approximately 5c/ kg DM. For harvest and storage, higher DM beets are preferred to increase storage times and reduce transport costs. Sugar beets are the highest DM cultivars (25-30%), and they also yield the highest bulb as they are sown at greater seed densities, so they have been the preferred option for harvesting to date.

The bulbs are stored in windrows 2.5m high and 6m wide, and have been successfully used for 4-5 months after harvesting without any requirement for covering. The effect of rain and frosts in NZ is insignificant for use as a stock feed, and typically no change in palatability occurs because of this. In addition, while in Europe washing and chopping of bulbs is customary, there is no requirement for this in terms of cow preference, intake or cow health (eg. choke); it will confer no advantage and will add unnecessary cost. To date there have been more than a thousand tonnes fed out across the South Island from windrows without covers, washing or chopping, and it has been very successful.

It is also possible to harvest the upright FB cultivars (eg. Brigadier) with the leaf intact using a tractor bucket or grapple to scrape them to a pile. These can also be used through a silage wagon, but the leaf degrades over time so typically they are not stored for more than a week.

Grazed FB in lactation requires FB to be sown on platform, and as it is sown in spring this effectively takes out paddocks for a year. However, because FB responds to high soil potassium and sodium, recent use has been to ‘mine’ paddocks where effluent applications have been intensive. As 5kg DM takes less than two hours to consume, use of grazed FB effectively redistributes the higher nutrient loading of such paddocks across the farm as the cows then return to pasture. Given the very large amounts of these salts FB can use, there is a future possibility that certain paddocks could be preferentially ‘banked’ with effluent applications prior to subsequent FB sowing. Bulbs harvested from the platform and used on pasture will have the same redistribution effect.

There is also a growing understanding of the role that low CP supplements have in autumn use on pastures, given that current ideas of nitrate leaching favour reduced autumn excretion of nitrogen from cows. Both maize and FB are low in CP, and harvested bulb is particularly low (6-8% DM). Harvested bulb (ME 12 MJ/ kg DM) can be used through standard silage wagons to be fed out on pasture as silages are, with the added advantage over maize of higher ME value and excellent utilisation (>90%), even in wet weather. With standard 2014 costs (6-8c/ kg DM to grow; 5c/ kg DM to harvest), harvested bulb represents a comparably cheap energy supply.

The Future for Fodder Beet in New Zealand?

The rapid expansion of FB into the dairy industry has demonstrated to me that farmers see unusual value in the crop, both as a winter feed and as a lactation supplement. New Zealand pastoral industries have never had an equivalent of the cheap feed energy source that grains are for other countries like Australia and the US, but I am now persuaded that FB may well fulfil this role. In a short time, NZ has adapted and developed agronomic expertise in FB that has enabled it to be profitably grown in most regions, and each season there are new and effective applications of feeding the crop that make use of the high energy value and potential for augmenting seasonal pasture deficits.

The clear advantages of FB over traditional winter crops in lower costs, longer windows of use, reduced land requirement, reduced nitrogen excretion rates and greater BCS gains possible on the back of the higher ME are likely to drive a continued expansion of FB as the winter crop of choice. That trend is accelerating already. But I believe that the faster growth area will be the use of FB on platform as a low CP shoulder feed, partially replacing the more expensive silages, and integrating into pasture renewal programmes and leveraging novel approaches to targeted effluent use. With that, as such use becomes more common, the commercial production of bulb by specialist cropping units is also likely to expand, and that is already happening in a few regions (eg. Ashburton). The increasing number of harvesting units imported will aid this expansion.

In conclusion, it is worth noting again that the development of FB for the dairy toolbox is a uniquely NZ initiative. These are Kiwi innovations, there is no other nation that developed grazing FB or has engaged with the crop in these new applications. The growth is being driven by farmer recognition of the value and utility of the crop, as there are no other international sources to provide experience of the crop, and NZ dairy is now exporting expertise to other pastoral industries and other nations.

Further Reading

Gibbs, SJ (2011) Fodder Beet. South Island Dairy Event Conference Proceedings, Lincoln University.