

Feeding fodder beet in New Zealand beef and sheep production

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Introduction

The New Zealand cattle and sheep systems achieve profitability from the inexpensive supply of quality grass. The durability and continuing success of these sectors amply demonstrate the value of this approach, but the reliance on seasonal pasture supply is not without limitations. Broadly, pasture growth is strong in spring and early summer, moderate in autumn, and low in summer and winter (Li *et al.* 2011). The use of seasonal calving and lambing to best use this variable supply improves production, but for beef cattle the lack of a continuous energy supply through all seasons means that age of slaughter in NZ is typically 26-36 months, with at least one and often two winter periods that require bought feed. This results in reduced carcass quality (age and poorer nutritional periods) and profit (via expensive non-pasture feeds). For both beef and sheep there is a requirement for winter feed beyond pasture if stocking rates are set to fully utilise spring pasture growth.

Traditional mitigation of seasonal feed supply deficits has been the use of conserved feeds and winter forage cropping, and to a lesser extent, cereal grains (Clark and Woodward 2007). However, the cost difference between pasture and either hay or silages is always significant, and in recent years is being exaggerated by the burgeoning dairy sector as it drives land prices and feed costs. Regardless of the conserved feed used, in 2014 it will be above 20c/kg dry matter (DM), and in most beef and sheep operations this will be approximately twice the comparable cost of pasture in practical terms (Anon. 2013). In addition, the energy supply of conserved feeds is moderate rather than high, with few conserved forages above a metabolisable energy (ME) of 11 megajoules (MJ) per kgDM, and most well below this. As a consequence, liveweight (LWT) gains are correspondingly low when these are used as a primary diet, a fact that has been understood for many years (Binnie *et al.* 1975).

Winter crops have been used extensively for many years across NZ, particularly the South Island. Traditionally brassicas have been dominant, with swedes and kale overwhelmingly accounting for the majority of hectares planted in winter crop (De Ruiter 2009). Summer crops of other brassicas like turnips and rape have also been popular farm strategies. The brassicas are easy to grow, well understood by the pastoral industries for best use, and at 2014 prices typically provide a feed of 10.5-11 MJME/kgDM for 10-15c/kgDM. The limitations of brassica use are the short window of effective grazing possible, particularly in winter, the relatively low yields per hectare (4-12tDM/ha), and insufficiently high energy intakes achieved. This means that as a tool to drive consistent LWT gains across the year they have not been found to deliver the energy supply required, and no significant finishing industry has been forged from use of these. In addition, they can have a range of anti-nutritional compounds, such as high nitrate levels, goitrogens, SMCO's, and animal health issues such as bloat, that require some management to best use the crops (Gibbs and Hughes 2009).

The final alternative feed to maintain year round energy supply is cereal grains. They are high ME (11-12.5MJ/kgDM), easy to transport and supply, and have been used for many years internationally to finish cattle and sheep to slaughter weights in accelerated programmes, so there is a large body of study around their use. However, grains in NZ are inherently limited in stock feed applications by competition for use in human food and the lack of suitable arable land for their cultivation, so the high price of such land given the demand requires a formidable

pricing for all cereal grains produced here. This is accentuated by the steady international trend toward higher grain prices. Typically, 2014 NZ grain prices are above 40c/kgDM, and spot prices for wheat and corn grain have been above 50c/kgDM in the past few years. Where grains have been inexpensive (USA, Australia), systems of finishing stock on them have prospered, but on a rolling mean these prices are approximately one quarter of NZ prices, and even in these systems in recent years the profit margins have been declining. It is difficult to envisage a profitable system of LWT gain for cattle or sheep on the grain prices of NZ over the past five years, or on the prices projected for the next five years (Anon. 2011). This would appear to be borne out in practice - there are very few significant grain finishing operations in NZ.

The use of fodder beet (FB) as a finishing and wintering diet for cattle and sheep is, then, best explained on the basis of the general points outlined in the introduction above: it meets the requirements of low cost, high yields, high ME, and continuity of supply across the seasons by the possibility of supplying grazing feed in autumn, winter, and spring, and summer feed if harvested and stored. This paper will outline the use of FB as a finishing feed for NZ livestock, the practical feeding use, and the approach to troubleshooting problems with stock on FB.

Fodder beet in New Zealand

Fodder beet has been in use as a stock feed in Europe since the Middle Ages, and was introduced to NZ in the late nineteenth century. However the European use of the crop was restricted by the idea that the plant was inherently toxic to livestock, so typical use (for centuries) was after removing the leaf material and storage, and in quantities below 3kgDM. This approach was followed in NZ until very recent times, and Williams and Coup (1959) in the NZVJ affirmed with a small sheep study the 'toxicity' of the plant, with the recommendation that any amount above 3kgDM was a 'killing dose' for cattle. Unsurprisingly, these ideas strictly limited use of the crop here in NZ, and in the early-mid 2000's the total hectares sown in NZ was below 500, and in all likelihood below 100.

A Christchurch seed company, Seed Force, reintroduced the crop commercially to NZ in the mid 2000's, using an established European variety ('Brigadier'), but began publicising the possible benefits of the crop as a grazed feed. About that time, a number of South Island dairy and deer farmers in Southland and Canterbury had begun trialling the crop for winter grazing, as a kale and swede replacement, convinced that the crop offered a far greater yield and cost return opportunity. One notable feature of this use of FB was grazing the standing crop (albeit behind a hot wire) as the primary diet, which had never been done elsewhere except NZ. It took the Kiwi farmers a few short years to work out this sensible application, after the Europeans had fed the crop without this for hundreds of years!

From that time FB steadily increased in use in the dairy industry, and DairyNZ then funded Lincoln University in primary research on the use of FB in winter and shoulder feeding. The work included a combination of fundamental rumen function studies and on-farm crop and animal assessments.

From this body of work there were a number of novel developments: the demonstration of the lack of any anti-nutritional compounds of practical significance in NZ FB; the high yields (25-30tDM/ha) and low feed cost (6-10c/kgDM) achieved on commercial farms and the actual ME value (12MJ/kgDM); the critical role of transitioning cattle to FB; the use of *ad libitum* feeding of FB; and the use of minimal supplement systems to maximise FB intakes and minimise costs. This work was then extended to the broader dairy industry by the use of multiple best practice farms for several years.

The success of the *ad libitum* feeding system with reduced supplement in significantly reducing costs and maintaining unusually high intakes – approximately 12kgDM FB maximum and 2-3kgDM supplement for larger frame dairy cows - amply demonstrated the potential for use as a specialist tool for finishing in the red meat industries. The crop had been in limited use as a grazed winter feed in the NZ beef and sheep sectors since re-introduction in the mid 2000's, but was not used for finishing stock.

On the back of these developments, five key Canterbury beef producers, centred around the Fisher family at Silverstream Charolais, were approached to work with Lincoln University to begin a project using FB to finish beef steers before 18 months of age. The work used the twin ideas developed from the dairy work of driving maximum intakes by restricting supplement, and using *ad libitum* intakes for long periods of time, up to 180

days. The work was subsequently joined by Silver Fern Farms, who were developing carcass assessment systems for elite quality beef, and saw the possibilities enabled by accelerated finishing with the use of energy dense forages across the winter season. The key system developments from this work are outlined below.

Early weaning calves and fodder beet – the ‘Fisher System’

The advantages in early weaning calves are well understood internationally (Myers *et al.* 1999). The key profit drivers are earlier finishing, and the reduced drain on cow LWT that allows for reductions in winter feed costs, improved body condition, and increased stocking rates. The structural reality on many farms, however, is a lack of quality feed for weaned calves in early autumn, and for the reasons outlined above alternative supplement provision is most often unaffordable in terms of a LWT return.

In this system, fodder beet is used in calves from 200-250kg LWT (*c.*120 days) as the primary feed, using 1kgDM supplement, with total intakes of approximately 2.5% of LWT. This intake rate against LWT can be maintained on the FB crop from early autumn to mid spring, when pasture growth typically begins to match consumption. The calves can then utilise spring pasture, having typically achieved mean daily LWT gains around 1kg for the preceding autumn and winter, which enables them to use the high spring LWT gains typically achieved (>1.5kg/d) to finish at 14-18 months.

In many beef operations, dryland pastures have strong growth and quality for October, November and December, and are severely limited thereafter until later autumn. That spring pasture mass can be used to calculate the cattle required to use it, and from that a hectare of FB crop to hold that number of cattle across autumn and winter. In this system, that pasture can be effectively used in full, with cattle achieving at least 270kg carcass weight (CWT) by the end of December, representing approximately 2000kg CWT/ha/year.

Practical feeding and transition

Calves going into this system at 200-300kg LWT when freshly weaned get at least 21 days on good quality pasture at unrestricted intakes, to develop the capacity of the rumen for higher energy uptake. Clostridial disease is an important concern on the high sugar diet, so a two vaccination course is mandatory prior to beginning on crop. The calves require about 5kgDM/d of feed at initiation, and the transition approach to FB feeding is starting Day one on 0.5kgDM of FB, with 4+kg of pasture or palatable supplement fed before. Every second day for 14 days the FB is increased by 0.5kgDM, and the supplement reduced, until at 14 days the ration is 4kgDM FB and 1kgDM supplement. After Day 21, the break line is then moved to appetite each day, promoting maximal *ad libitum* intakes, and the supplement is not increased as the cattle grow into larger FB intakes.

The supplement used in rising one year old (R1) cattle should be of a protein content above that of the FB crop (*c.*13%), and nearly all grass and lucerne silages will be of appropriate quality in terms of supplying that protein requirement and a fibre contribution, and additional protein supplementation is not used. It is important to note that the supplement is the principal feeding cost on the crop, and feeding even a few kilograms more supplement increases dramatically the average per kgDM feed cost, reduces the average ME content of the diet, and significantly reduces the FB intake. Feeding supplements to appetite for beef steers on FB will typically result in a 30% increase in feed costs with a 30% decrease in LWT gain, and no change in animal health. Driving the ME intake by maximising FB intakes is the principal driver to post transition feeding success and profit.

Rumen acidosis is the primary feeding risk to these R1 cattle, but only for the transition period, and only if the FB allocation is excess or the supplement input either too close to the FB intake or insufficient (see below). After transition the cattle are encouraged to eat as much as they can every day, so there is no risk of breaking over the wire, and there is no risk of rumen upsets with the amounts or timing of supplements.

In R1 cattle, the risk of acidosis at transition is much reduced compared with older cattle or dairy cows. They are typically slower to adapt to the new feed, and will often require a few days of the beat bulb being physically opened to begin eating adequately, which extends the transition period. As a consequence, it is not common to get rumen acidosis in R1 cattle at transition. There are no issues with feeding FB and teeth eruptions, and typically there are very few cattle who refuse to eat FB.

Finishing older cattle

Rising two year old (R2) cattle are cheap to purchase in autumn, typically at 400-450kg LWT, and often have been undernourished in the preceding summer and early autumn. Due to their larger frame and typically lower body condition, these cattle can be quickly increased in LWT with an appropriately energy dense diet. The current approach with fodder beet finishing is to transition these cattle and then finish them to slaughter weights (>550kg LWT) within 70-80d for the premium schedule in August and September.

The transition approach is to start with a total diet 8-10kgDM on Day 1, with 1kgDM FB. This is important because fully fed cattle have a slower intake rate when eating the crop (which reduces rumen loading of dietary sugar from the FB), and generally put less pressure on break fences, and it is often neglected by operators. Older cattle typically tend to take to eating bulbs faster than younger cattle, so are at more risk of rumen acidosis in transition when poorly managed – though beef steers and heifers are far less at risk than dairy cows. The fodder beet is increased 1kgDM FB every second day for 14 days, while the supplement is decreased from 8-9kg at Day 1 to 6kg at Day 7 and 4kg at Day 14. From Day 21, the FB is fed to appetite for unrestricted intake, with 2.5kg of supplement is fed daily. Sometimes it is necessary to lower the supplement input around the Day 7 mark to encourage appropriate FB intake, but this should not be below 4kgDM, and should be done over several days.

The supplement used in R2 systems does not contribute to feed energy or protein, only to the fibre content of the diet. As there is no requirement for energy or protein from this supplement it is usually bought on price alone, with meadow hay or cereal straw the cheapest form available (20-25c kgDM), but older pasture can also be effectively used.

It is also possible to use harvested FB bulb rather than grazed FB. The process of harvesting removes the leaves and the bulbs are stored in windrows 2.5m high x 6m wide, uncovered, where they will last for 3-5 months. Contrary to opinions in the popular press, neither rain nor frost damage is significant, nor lessens the feeding value to stock. When feeding the bulb, the lack of leaf matter means the protein content and mineral content of the fodder beet ration is very different, with reduced protein (<10% DM), calcium (<0.4% DM) and phosphorus (<0.2% DM). As a consequence, the supplement used is required to have a higher protein content than meadow hay or straw, and will typically be either grass silage or pasture. One effective method, is to use harvested bulb through a silage wagon dispersed out on pasture, with 10kgDM of harvested bulb and 2-3kgDM of pasture after transition. The LWT gains achieved to date using harvested bulb on pasture have been the highest recorded for beef in the trial work to date, above 2kg LWT/d.

Troubleshooting cattle feeding of fodder beet

As outlined above, and again contrary to popular reports, NZ FB has never been demonstrated to contain any practically significant levels of anti-nutritional compounds. Oxalic acid is present in the leaf and the bulb, as with all *Beta* genus plants, but is found at insignificant concentrations in all growing phases of FB in NZ, except for the first 60 days of growth - when it is never grazed anyway as the plant is then very small and the yield unaffordably low to use. It should be also noted that bloat, nitrate toxicity, and goitre are not associated with the feeding of FB.

The only animal health issue typically encountered with FB feeding in beef systems is rumen acidosis. My approach to problem solving in FB is now very straightforward after years of direct consultancy experience with winter crops. If any cattle are refusing feed or down on the FB crop, it will almost always be rumen acidosis – not oxalate or nitrate toxicity - and that will be a result of over allocation of FB or sudden under allocation of supplements, almost always inside the transition window. Therefore the first assessment is the crop yield, the transition face length, the depth of the break, and the number of cattle in the mob. In most cases, those can be done on the spot, and done for the past three days by visual assessment of the crop face. The intake of yesterday should be compared to the intake of the previous two days – routinely, within the last 48 hours there will have been an increase of more than 2kgDM in one day, even if that allocation was inadvertent by including the “banked” FB uneaten until that point, under their feet.

As FB is a high yielding crop, operators unfamiliar with these yield densities, and who often have not adequately measured the crop, can often inadvertently but wildly over allocate.

As an example, a 30t DM/ha FB crop will have 3kgDM per square metre. Therefore a single square metre allocated per head can be a threefold over allocation on Day 1 of transition. It cannot be overemphasized that over allocation in transition is the routine cause of rumen acidosis. After appropriate transition to *ad libitum* feeding of FB, the work to date here at Lincoln University has demonstrated there is no possible over allocation, and even abrupt removal of supplement does not induce acidosis, as the cattle will reduce FB intakes to mitigate this.

It should be noted that all stock, even older stock, it takes a period of approximately seven days to master full fodder beet intakes, regardless of their previous experience with it. However, rumen adaptation to higher FB intakes takes 14 days, so the most common practical problem is an increase in allocation at or around Day 7, often because before that time beet bulb has been accumulating under their feet as daily allocation has outstripped daily intake. When full intakes can be achieved by the cattle this accumulated beet will be eaten and acidosis usually occurs at this point in transition for that reason.

Acidosis almost always occurs in transition, but in some rare circumstances in restricted FB feeding (e.g. 6-8kgDM) this can occur after transition as they are intake 'trained' and now able to consume full intakes (e.g. 10-12kgDM) of FB, but the rumen has not been adapted to the higher intakes of FB. In broad terms, an increase of above 2kgDM a day is associated with some risk of this when intakes are at 8kgDM FB or below. This risk is removed with a transition policy to *ad libitum* feeding, even if subsequently the cattle are then eased back to lower levels of FB intake.

In a few rare circumstances, an abrupt change in supplement type or amount offered during transition can precipitate acidosis, as the supplement supply is a key factor in preventing this during transition. One example of this is in systems where both pasture or silage are fed with hay or straw; it is common to have the former dropped out at Day 7-14, as supplement amounts drop and for reasons of economy and logistics of grazing. A proportion of cattle will not have been eating the lower quality supplements, only pasture, and so are abruptly moved to low or absent supplement intakes at a key risk period, and acidosis sometimes results. The recommendation is therefore that supplements are changed over a few days. Sometimes, the problem is not strictly under allocation of supplement, but of insufficient time between supplement feeding and opening the FB break. Usually, 3-4 hours is required, as a small proportion of cattle (5%) will refuse the supplement if habituated to a short period between supplement and FB feeding, as they will prefer the FB. For this reason, the standard recommendation through transition is supplement feeding at 8am, with enough linear space for all to consume the required amount, and FB feeding after midday.

In cases where acidosis has occurred in a herd, the affected stock will typically number, at worst, 5% of the mob, and often 1%. These should be removed, as the rumen epithelial burn is usually severe, and recovery to normal production unlikely. However, the other stock *should not* be moved off the crop, but correct the break to a three quarter reduced allocation for two days with increased supplement, then resume increasing the FB as before. Removing the herd is unnecessary as the overwhelming majority are not affected, and as it will almost always be in transition, the setback to the programme is costly in supplement use and in time lost to full production.

Choke is not a feature of FB grazing or consumption of harvested bulbs. In feeding FB to more than 50,000 cattle over some years in structured supervision, R1, R2, bulls and cows, and sheep, goats and deer, I have recorded a single death by choke. Cattle eat whole FB with their incisors, while chopped FB is more typically masticated with the molars, in the manner they eat kale, and it would appear anecdotally that faster rate of intake is typical with chipped bulb. This is not desirable during transition, and is of no benefit after transition.

The adherent soil on harvested FB bulb or on FB grazed as a crop is not an animal health or nutrition issue. Some years of intense rumen fistulate use, in pen feeding and commercial farm scenarios, has amply demonstrated that no adverse soil accumulation occurs in FB feed cattle comparable to any other NZ winter feeding systems, including pasture grazing and kale feeding. It is routine in winter feeding to have soil present in the ventral sac of the rumen in all systems, and the amount of soil consumed by cattle in winter is typically underestimated. By summer, this soil will have largely disappeared from the rumen. Given this, it is very hard to make a case for concern around soil iron and interference with copper uptake, as on a herd level in South Island cattle issues with maintaining copper status across winter with standard management are not a demonstrated feature. In addition, in my experience there is no evidence for rumen epithelial damage as a consequence of soil intake, either

grossly or by histological assessment, for any winter feeding system.

Fodder beet for Sheep

Both adult and growing stock can be successfully grazed on FB, and in southern Otago and Southland large numbers now do so each year. There are, however, very different management systems for sheep compared to cattle. Sheep are not prone to rumen acidosis when grazing FB, similar to deer, so the transition to the crop is far easier. However, the crop is not used for finishing growing lambs, as there is a higher crude protein requirement for high LWT gains than can be typically achieved with FB, and the provision of additional protein in the form of either silages or meals is typically not cost effective. It is possible to combine quality pasture and FB as a finishing diet, at approximately equal measures, but logistically this is difficult as it requires twice daily mob shifts, and both pasture and FB allocation for effective use are challenging.

As a result, routine use with lambs is as a 'holding' crop, wherein LWT gains of 100g/d are achieved but at very high stocking rates – for example, a 25t DM/ha crop holds >300 lambs/ha at FB intakes of 900g for 90d. Lambs are then drafted off to finish on pasture as required, effectively raising the stocking rate of the farm. Daily shifts can maximize LWT gains, but twice weekly shifts are more common. Supplement inputs are low, typically 50-100g/d, and either pasture or silage is used, but not hay or straw.

Hoggets and ewes can be wintered effectively on FB, in a manner similar to the use described for lambs, but at stocking rates of approximately 200/ha for fully fed stock for 90d. The supplement use is similarly low, but the timing of the breaks and the FB grazing management becomes important with wintering ewes. If breaks of greater than three days are used, the ewes will be grazing for several days on bulbs alone after quickly eating all the leaf material, and as the protein content is low, this will inevitably restrict their intakes. Shorter breaks allow effective protein recycling, so ME intakes are maintained and pregnancy toxemia avoided. There is a similar problem caused by failure to force ewes to utilize the bulbs, by moving on too soon. At some point the operator will then fence the ewes in on large breaks of bulbs remaining, and without any leaf material for protein, the ewes will reduce intakes and metabolic disease can result.

The principal sheep health issue on FB grazing is sudden death from clostridial disease, and all classes of sheep can die in appreciable numbers if not vaccinated recently, from the high sugar load to the intestine. The standard recommendation is for lambs to have a two vaccination course before entry to crop, and for ewes to be re-vaccinated several weeks prior.

It is very rare to see rumen acidosis in sheep on FB, and the typical transition policy used is run on and off a few hours for several days after pasture grazing first, then remain on the crop with supplement available, usually in three day breaks.

Summary

Fodder beet use in NZ beef and sheep production is growing rapidly, on the back of an internationally unique 'Kiwi' approach to grazing it profitably. The crop offers significant novel advances in large yields of high ME feed at very low cost, in seasons where traditionally energy supply through pasture has been lacking. Recent NZ advances in both FB crop agronomy and specialist finishing feeding systems have opened up new opportunities for cost effective use in both beef and sheep sectors, and improved extension of the body of knowledge now available for feeding FB will likely fuel the uptake of these systems to the broader pastoral community. An important component of that extension will be the emphasis on sound nutritional strategies required, particularly careful management of transition feeding, to best leverage the economic returns of the crop with positive animal health and production.

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