FEEDING FODDER BEAT IN LACTATION AND TO REPLACEMENT HEIFERS

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Introduction

Fodder beet (Beta vulgaris) is a high yielding, temperate bulb crop that has been developed in the past ten years for use in a winter feed system that is now widespread across the South Island of NZ. This use of FB is an innovation for Kiwi pride– NZ is the only country in the world to graze the crop, and all the research and development was done here in NZ. It has been a livestock feed in Europe for five hundred years, but misconceptions about an assumed toxicity kept its use to a minimum, so it was typically used after harvesting strictly as a minor supplement, and this pattern was repeated in New Zealand since it was first introduced here in the late nineteenth century (Coop 1959). In 2006, it was estimated there was 60 000 hectares of FB sown globally (Henry 2010), and in NZ there was less than 500 hectares sown at that time.

In the last decade specific research commissioned by Dairy NZ and conducted by Lincoln University demonstrated that fodder beet did not contain any toxins of significance, and that ruminant health issues associated with FB diets resulted from insufficient adaptation of the rumen to the sugar rich content of the bulb, causing simple rumen acidosis, which was easily managed by simple and practical transition strategies (Gibbs 2011, Gibbs and Saldias 2014b). As a result, the crop could be easily fed to wintering cows, and there was rapid farmer uptake of FB as a higher energy alternative to the brassica crops that were historically grown (De Ruiter *et al* 2009). In addition, the research demonstrated that FB could be fed to wintering cows *ad libitum* as a primary diet with a minimal roughage inclusion rate, which significantly reduced feed costs and simplified management, both of which also spurred increased farmer uptake (Gibbs and Saldias 2014a), with an estimated 40 000 hectares sown in NZ in 2014.

The use of FB in NZ dairying has more recently expanded beyond winter feeding, and lactation feeding and youngstock rearing on FB have both been successfully pioneered in the

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past few years. This paper will discuss the nutritional basis and practical applications of lactation feeding and youngstock rearing on FB currently used in NZ.

Lactation feeding

Feed quality and cost

In most of NZ, FB is a spring sown crop that is used from autumn forward, and will go to seed late in the next spring. Proximate analysis of FB grown across NZ in the past decade has demonstrated that compared with pasture the plant has a high sugar content, a relatively low protein and fibre content, a typically low phosphorus content and a moderate calcium content broadly adequate for dry stock, but unsatisfactory for lactating cows (Table 1). The metabolisable energy of FB was also established in NZ research through specific digestibility and methane chamber trials as 12MJ/ kg DM (Gibbs 2011).

Table 1. The Neutral Detergent Fibre, Crude Protein, Calcium and Phosphorus Content of New Zealand Fodder Beet Leaf and Bulb on Commercial Farms in 2011. All values are displayed as % of dry matter, range and mean.

	NDF	**CP**	**Calcium**	**Phosphorus**
Leaf	12.4-46.9 (29.9)	11.4-25.9 (17.0)	0.39-3.9 (1.6)	(0.06-0.4) (0.26)
Bulb	7.8-14.9 (10.6)	5.1-13.4 (8.1)	0.01-0.05 (0.02)	0.08-0.38 (0.18)

The cost of growing FB to a mature (>200 day) crop is best assessed in those regions where FB has been grown in the greatest hectares and for the longest time, as the industry develops capacity and experience in agronomy with increased exposure over time, and this approach gives a realistic display of what is most likely to become standard in other regions in the future. In both mid Canterbury and North Otago, the most experienced commercial agronomy providers have individually some thousands of hectares annually sown to FB, and the typical cost for these best practice operators is between $1900 and $2400 per hectare in 2015. Given the corresponding yields under this care are broadly 24-28 t DM per hectare, many farms are consistently growing FB for 7-10c/ kg DM. However, even doubling that price the crop is still competitive ranked against 2015 season contracts for palm kernel expeller (20-30c), maize silage (32-35c), grass silage (30-40c) and grains (40c+).

Viewing both FB feed quality and cost together, it can be seen that the crop offers an alternative to PKE, silages and grains for shoulder feeding during feed pinches in pasture based systems. It can be used efficiently in lactation to provide energy at a price lower than most alternatives, but when used in lactation it also has specific limitations that are not a consideration in winter feeding FB. For example, the usual autumn or spring plant will have an

overall protein content (leaf + bulb) of 11-13%, a fibre content (neutral detergent fibre) of <15%, a phosphorus content below 0.2%, and a calcium content of 0.4-0.5%. In each of these components, a lactating cow will require more, so in contrast to a wintering cow there is an inherent upper limit to the inclusion of FB to a pasture based, lactating cow diet without additional protein, fibre, phosphorus and calcium supplemented. In most cases, that limit will be 5-7 kg DM of FB grazed (leaf and bulb), or 4-5 kg of FB bulb.

Used at this level in pasture based diets, which are typically 15-20 kg DM daily intake at the shoulders, there is a positive effect in providing ME, while the reduced protein content of FB matches well the surplus protein of pasture, and the phosphorus and calcium provided by the pasture is adequate. Used above this level, which has been done previously in autumn in certain regions, the low protein begins to reduce milk yield, and animal health issues related to fibre (poor rumen function), and phosphorus and calcium (eg. production losses, cell counts, down cows) can occur. It is possible to remedy these deficiencies, but it requires a mixed ration approach that is not common in NZ systems.

The twin advantages of FB as a shoulder supplement centre around the low cost of the ME it provides significantly reducing the cost of production, and the relative ease of fitting FB use into both standard feeding systems on pasture and the pasture renewal programme on platform. In times of reduced payout, the opportunity to reduce the cost of production by lowering supplement costs is increasingly attractive. In particular, the cost of grass silage in recent years has increased to the point where the traditional use has been reviewed on many farms. Given silage is almost always used in lactation simply as an energy source, the use of cheap, high ME FB grazed on platform across autumn and spring is a viable alternative. Following from that, at 15% pasture renewal on platform, FB can be used in conjunction with sophisticated effluent ‘loading’ of paddocks destined for FB sowing later that season. When cows graze this FB, this effectively ‘mines’ this effluent nutrient and redistributes it across the farm by urinary and faecal excretion during subsequent pasture grazing that day, while reducing fertiliser costs for growing the FB initially.

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Practical considerations of lactation use of fodder beet

As FB is a spring sown crop, with mature yields the following winter and dying off the following spring, the use of grazed FB in a seasonal lactation involves decisions on methods of use. In autumn, when energy supplements are used to extend the round and improve body condition, the crop will be below mature yields, and this is a genuine cost of use of FB in autumn. In the following spring this is not a factor, but excess crop will be lost if it is not eaten before going to seed, and the paddock has been out for at least 12 months before regrazing pasture on it.

Grazing is always the most cost effective method of crop use in lactation, but one consideration of this use is the increase in walking distance that can result from having a daily period in one crop paddock on farm. Unless this paddock is adjacent to the milking shed, having this fixed point to walk to each day while still maintaining the pasture round will increase walking distance at times when lameness is often increasing. This increased walking is exaggerated in larger herds due to more hectares in the platform, and in general terms herds above 500 cows should be cautious in positioning FB paddocks for lactation grazing.

The alternative to grazing FB on platform is harvested FB. This can be done by commercial harvest of the bulb, where the leaf is flailed off and the bulb is stored for later use. It can also be done by daily or weekly harvest of bulb with leaf by use of a 'beet bucket' that simply pushes the plant out. Both harvest approaches then feed out via a conventional feed wagon, typically on pasture. The advantages of commercial harvesting is that the crop is stored for easy use, and without the leaf the bulbs last up to six months when stored without cover, and three months everywhere in NZ. If the crop is harvested in autumn, the paddock can also be regrassed for use in spring, reducing the time out. However, it will also be reduced in potential yield by up to 10 t DM/ ha, which must be factored in. The disadvantage of commercial harvesting is simply the additional costs of forgoing the leaf and 5c / kg DM harvest cost.

Note that not every FB cultivar is suitable for lifting and storing. In general the higher dry matter varieties (>20%) suit this as they are deeper in the ground, allowing a uniform height for flailing the leaf off, and store longer the higher the dry matter is. The best option for lifting and storage are the sugar beet types, and currently in NZ the only commercially available cultivar is 'Suga'. The mid dry matter varieties, of which there are currently seventeen, can be lifted and stored but do not last as long (eg. 3 – 4 months) before decomposition.

Bucket harvesting of FB conserves the protein and mineral rich leaf material, often about 20% of total DM yield at 200 days. But because the leaf degrades fast and then composts the FB can't be stored for more than a week or so, leaving a regular task to be done that is subject to poor weather access difficulties and the like. However, it is less expensive at approximately 1c

/kg DM. It can be done effectively even in herds of 1000 cows – a number of South Island farms supply 5 kg DM daily to herds of this size with bucket harvest.

Transitioning onto fodder beet in lactation

There is no important difference in principle between transition to FB for winter feeding or for lactation. The high sugar content of FB provokes rapid rumen acidosis if cows are given too much, too soon. This essential requirement to transition cows to FB is as important in lactation feeding as in winter feeding, and the same guidelines apply. These are described in detail in a previous SIDE proceeding (Gibbs and Saldias 2014a), but the most important factor is the strict allocation of FB by dry matter weight over at least 14 days – start at 1kg FB DM then increase no more than 1 kg DM every second day, and in most cases, it takes about 14 days to get to 5 kg DM FB in lactation.

There are, however, important practical differences in how to achieve good transition between winter and lactation FB feeding. In wintering mobs, you have greater control of the diet as there is only a single objective – get all cows eating FB together and increasing this over 14 days. The total daily intake is also lower than lactation diets, and FB will be a greater proportion, which enables the use of mild restriction of the supplements if needed to get the cows on to FB to start. With lactation feeding, the cows have ample feed beyond the FB, and the imperative of milk production typically prevents the use of feed restriction. Therefore, the primary management challenge in lactation transition is a twin fork: to get the mob switched on to FB without leaving some cows behind, and also without some cows getting far enough ahead to eat themselves into acidosis.

The strategy to achieve this is to provide adequate space and time, in that order. All ruminant stock classes are actually slow to get ‘on’ to FB, contrary to popular ideas about this. As a herd, it is about seven days for cows to achieve full intake potential after starting FB, even cows who have been on FB in winter for several years. The confusion arises because a few cows will take to it immediately – but not the whole mob. Also, with lactation diets, starting at 1 kg DM means that FB is effectively a discretionary feed for cows in that mob, so put the two together and it means that 30-40% of a mob can ignore FB fed out on pasture as a lactation diet

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supplement in the beginning. That also means the other 60% can over eat FB. So when starting FB in lactation, best results are achieved by making sure all cows have equal access – at least a metre of face width on crop, and the same for FB spread out in a paddock through a wagon – and ample time to try it (one hour access minimum). When the access face is too small, on crop or in the paddock, then younger and shy feeders get bullied off, regardless of the actual allocation, and that leaves FB for greedy cows to over eat. That is the most common transition problem in lactation today, and the solution is simply more space and time.

At the start in lactation, unlike in winter feeding, it is often a good idea to put them onto the FB before they are fully fed with the rest of the diet. Start them on 1 kg DM FB with the tractor wheel across it to break it up, and then do not increase the allocation until the entire mob is steadily eating it. It is better to work out that some aren't eating it when you are allocating 1 kg, not when you are up to 5 kg. A common mistake is to watch the first few minutes and assume all are eating it because they all walked over to it.

Troubleshooting lactation feeding

1. The most common problem is mild acidosis in a few cows within two weeks of starting the FB. It is rare today to have genuine over allocation at the beginning, and almost always it is simply a few cows overeating because a proportion of the mob is not eating much, thereby freeing it up for the greedy cows. The problem is prevented by good transition protocol (as above), but once it appears the solution is to correct the space and time limitations while reducing the FB back to 2-3kg DM until all cows are eating it. There are two things to note about this problem. First, that feeding FB to 5 kg DM in a pasture based system never requires the feeding of a buffer – eg MgO, Na bicarbonate – and the use of any of these will never stop the issues that arise with poor transition, no matter how much is used. There are a few information sources still advocating this, and it should be taken as a sign of their complete inexperience with FB feeding, and roundly ignored. Second, the problem is never a lack of fibre when the diet is 5-7 kg FB or less in a pasture based system. There is no requirement to feed additional fibre (eg straw) when on pasture, as grass has plenty of fibre fit for purpose. As an example of this, in beef FB systems, the ration of highest liveweight gains can be <1 kg DM grass and unlimited FB. It is a common myth that lactation feeding FB to cows needs extra fibre. In addition, when there is a management breakdown, cows will die on 3-4 kg DM FB with a rumen full of hay or straw – the over allocation of FB is never corrected by more fibre, another common and dangerous myth.
2. Too much FB in a lactation diet. In a standard pasture based system, feeding above 5-7 kg DM FB will typically require additional inputs to the ration – calcium, phosphorus, protein, and fibre, in that order. The mineral imbalances typically do not show as metabolic diseases

(eg milk fever), but production losses, and sometimes cell count issues. As FB is a high energy and low protein feed, over use without additional protein will begin to dry cows off, another production loss, and a contributor to cell count issues. In extreme cases – 10 kg DM FB allocation in a 14-15 kg DM lactation ration – there will also usually be a few obvious cases of clinical acidosis as well, as select cows in the mob will be eating almost all FB at that level, and transition will also have been done badly in most of these cases. The solution is to reduce the FB to 5-7 kg DM, and if it is desired to include it above that, get advice from a reputable nutritionist experienced in FB feeding first.

Feeding fodder beet to youngstock

There is common agreement that in general heifer rearing to first calving is not done as well as it should be in NZ, despite the industry knowing well the benefits of doing so (McNaughton and Lopbell 2012). In particular, it is the first year after weaning that presents the greatest challenge in liveweight gain, and in recent years there has been a growing awareness that better nutritional strategies are required. In the South Island there has been a move to address this by multi-farm groups using a single, 'purpose built' youngstock farm to rear their own heifers. This gives control over nutrition, and therefore liveweight targets, but parasite control has been very difficult when high stocking rates of weaners on grass and no adult stock meant pasture burdens of larvae get dangerously high. This, and frequent drenching programmes, all contribute to parasite breakdown issues (McAnulty and Gibbs 2010).

Crop use can fit this type of system because it enables increased stocking rates, good winter feed, and breaks the parasite life cycle. The early attempts were with brassica, particularly kale, but in general liveweight gains on kale in rising one year olds are poor and the window of use is restricted to late autumn to winter (Gibbs and Saldias 2014b). As a result, FB was used since 2007 as a dairy heifer rearing tool to fulfil the above described purposes, and the 'integrated heifer management system' has been developed using FB for this purpose.

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'Integrated Heifer Management System'

Spring born dairy heifers weaned at 100 kg liveweight typically then get a summer off platform grazing, and in many cases such dryland environments are poorer quality energy and protein nutrition. In this system they can be grazed on FB from February forward, typically at 25-35/ ha, and stay on crop until the grass reappears in spring. Growth rates across this period can be above 900g/d, and even in casually operated scenarios will be above 500g. Spring grass quality and quantity in all areas of NZ lead to three months of good liveweight gains, typically above 1kg/d, through first mating and then slow through summer. The heifers can be put back onto FB in early autumn, and kept there until removed for calving. In this system there is little difficulty in achieving target growth rates, and there is room to reduce growth rates across the summers if required.

The FB is fed *ad libitum* (after careful transition) with very low supplement inputs – in the first year, 1kg DM daily, in the second year 2 kg DM – and on /off pasture grazing is used as the only supplement until wet winter weather stops this, typically mid June, then grass silage (not straw for youngstock) so the feed costs are low. For example, even with FB costed at 10c/ kg DM and pasture at 20c kg DM, an average first year FB diet is 5-6 kg FB + 1 kg grass, or $0.80/ day, and similarly for the second year 8-9 kg FB + 2 kg grass is $1.30/d. Including grass silage at 35c for part of the period increases the average cost to about $0.90/ and $1.40/d respectively. Given the very high stocking rates and maximum ME intakes it provides, this makes it cost effective for both owners or contract graziers.

The use of FB ensures high energy intakes across the seasons – autumn and winter – where traditionally heifers have struggled. Protein nutrition is positive in this system, as the FB will typically have an increased proportion of leaf material when grazed at sub-mature yields in early autumn, above 30% of total DM on average but 50% in some cases, and the leaf is the protein rich component of the plant. At these times, the total protein content of the FB is typically above the 13% figure used as the upper limit for mature crops. The use of pasture, usually well above this protein content, and then grass silage is also designed to maintain this level.

There are no mineral nutrition issues associated with this system, and conventional trace element supplementation programmes for youngstock are used.

The advantages of this system are: total control of nutrition of heifers; liveweight targets achieved in simple systems of low cost; pasture released in autumn/ spring for other uses due to high DM yields and stocking rates on limited land areas; excellent parasite control and slower drench resistance issues; and healthy, well socialised heifers due to frequent human contact with daily breaks moved.

A case can even be made for using platform land for heifer rearing on FB in some cases. At a payout of $4.20, assuming $0.50 net per kg milksolids and 1500 kg milksolids /ha, the lost income is $750 if the land is used for drystock. Current heifer grazing costs are $7.00/ week May to May, then $11.00/ week May to calving. At above 20/ ha stocking rate on FB, it can be seen the saving from either rising one year olds or rising two year olds is significant.

Practical youngstock feeding

Transition to FB is just as important in weaners as in adult cows, however, they are not typically as prone to rumen acidosis as they have different intake patterns. The challenge is usually to get them eating the FB, which they are much slower to get onto than cows are.

The transition programme for weaners in general has been described thoroughly in Gibbs and Saldias (2014b), and starts at 0.5 kg DM FB on day one, rising no more than 0.5 kg DM every second day for 14 days. In week one they get at least 3 kg DM daily of a palatable supplement or pasture, then 2 kg in week two, then 1 kg thereafter. They should not have straw, but grass or quality silage. Straw is not required for fibre at any time, and will immediately suppress intake if fed to youngstock on FB. Transition as rising two year olds is the same as adult cows, described in Gibbs and Saldias (2014a).

At the beginning, it is common to break up the FB bulbs for them for a few days, and generally they will take at least 3-4 days to begin eating the FB, so the allocation is not increased for this period. Unlike older stock, they can be coaxed onto the FB initially by restricting the other diet component before opening the FB, as fully fed weaners will rarely take to FB immediately. The space given to each heifer is a critical ingredient for successful introduction to FB – even the weaners need 1 metre of face each, and if this is reduced, shy feeders are quickly excluded from the FB. Mob size does not matter – we routinely use mobs of 200 or above – but face access is most important.

However, note that it is rare to have a tail end of any mob that genuinely do not eat FB after the introduction period, and if by 7 days this is occurring then something is wrong with the design, approach or the cultivar used. Youngstock, unlike cows, are intake sensitive to the FB cultivar used, and in general mid DM varieties will have far more difficulty than the upright,

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low DM mangel types such as ‘Brigadier’. In our experience cultivar selection is very important in this youngstock system, uniquely among FB use applications, and Brigadier is routinely and preferentially used in weaners. In addition to ease of introduction, some cultivars also drive higher intakes in youngstock, while certain mid DM varieties have been associated with poor intakes.

The heifers should be transitioned up to *ad libitum* intakes of FB, which will be approximately 3-4 kg FB as weaners, and 9 kg FB prior to calving. In the same manner as adult stock, after transition to unrestricted FB intakes, there are no possible management risks with rumen acidosis after breakouts etc. There are no other animal health issues associated with this FB system except that clostridial deaths are common if stock have not been vaccinated with a full course of 5 in 1, which is an essential requirement before going on the crop. There are no bloat, nitrate, glucosinolate, goitrogen, or SMCO (redwater) issues with FB grazing, unlike brassica crops. Choke due to oesophageal obstruction is a rare event in youngstock, but is occasionally seen in the higher DM variety cultivars.

Troubleshooting youngstock feeding

Poor liveweight gains (400g/ day) is the most common problem. This is always an intake problem, but the causes differ. Most commonly, the situation will involve a mid DM cultivar fed out with a cramped face, and lots of silage and straw fed behind it. The latter two can be easily remedied, as even with odd shaped paddocks additional face length can be gained by blazing out strips with a bucket, and supplement can be reduced in amount and straw removed. The cultivar is harder to work with, and in some cases can’t be overcome, and low intakes will have to be accepted for that year.

However, in a few cases the poor intakes are a result of a sub-standard transition period. Youngstock are resistant to clinical rumen acidosis, but if the mob is ‘crashed’ by sloppy management, mild acidosis will quickly ‘teach’ young cattle ***not*** to eat lots of FB – and this learned feed aversion is not quickly lost, with poor intakes and liveweight gain the result for the season.

Finally, in a very few cases confined to certain regions, phosphorus deficiency also results in poor intakes. This is very rare. Note, it does not show as skeletal development issues, simply as reduced intakes and low liveweight gains. It can be very effectively remedied with the use of dicalcium phosphate at 30g/ heifer a day fed with the supplement, but as it is rarely required, talk to an experienced fodder beet nutritionist before doing so.

Conclusions

The high yields and high energy content of FB drive a low cost ME supply suitable for widespread use in the NZ dairy industry, and two new applications are lactation and youngstock feeding. The current higher costs of alternative supplements in NZ have pulled FB use into lactation feeding systems from the original winter feeding use, and increasingly sophisticated systems of co-ordinated effluent use and pasture renewal programmes on platform have been developed here. The primary use in lactation is, and is likely to remain, as a shoulder feed supplement to replace silages, and in this FB is an easy fit with NZ pasture based systems, and is rapidly growing across the industry.

An integrated heifer management system using FB to provide long periods of high quality feed at very low cost, and using restricted land areas at high stocking rates, is a novel development in NZ FB use. The development is timely as there is increasing interest in heifer rearing to meet liveweight targets, and reducing overall cost of production is a major strategy of many farms in times of lower payout. The system offers a controlled approach to each phase of heifer rearing, weaners to calving heifers, and can be practically and simply managed for positive benefits in liveweight and animal health on typical NZ dairy farms.

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