

A survey of fodder beet use and feeding practices on dairy farms in Canterbury, Otago and Southland

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Abstract

High yields, consistent quality and emerging environmental benefits make fodder beet (FB) an important feed in South Island dairy systems. However, these benefits may be negated by animal-health issues associated with some FB-feeding regimes. To quantify the range and prevalence of feeding regimes, a telephone survey focussing on practices in 2018 was conducted in Canterbury, Otago and Southland. Of the farmers surveyed, 69% fed FB, 24% had never fed FB and 8% of farmers had stopped feeding FB. The most frequently cited reasons for having stopped feeding FB were animal-health issues, cost and management challenges. Most (82%) respondents feeding FB determined allocation by yield and break area. Almost all farmers (98%) transitioned cattle on to FB, over an average of three weeks. Of those that fed FB to non-lactating cows in winter, the mean allocation was 10.3 kg DM/cow/day (66% of the diet), and 12% fed FB *ad libitum*. A greater proportion of herds fed FB (41% of herds) reported metabolic issues (>5% of the herd affected) compared with herds not fed FB (23%). This survey is valuable to inform future research and reinforces the need to continue investigating animal-health issues associated with FB-feeding, with an emphasis on metabolic issues.

Keywords: fodder beet; winter crop; animal health

Introduction

Forage crops such as brassicas and fodder beet (FB) are important features of farming in the southern regions of New Zealand, especially during the cool winter months when pasture growth is slow (Dalley & Geddes 2012). Fodder beet is a low nitrogen (N) feed which can be grazed *in situ* or lifted and fed out or stored (DairyNZ 2013). It has a high yield potential with typical target yields of 20 t DM/ha for dryland crops and 25 t DM/ha for irrigated crops (Gibbs 2014). The consistent quality (Gibbs 2011) and high utilisation of FB (Edwards et al. 2014) mean that high energy intakes can be achieved. Feeding FB in the period before calving can help to meet body-condition score targets at calving (Gibbs 2014) of 5 to 5.5 (Roche et al. 2009).

Recent studies have shown that FB may have environmental benefits due to the smaller area of land required for cropping (due to high yields), and lower N leaching losses measured from simulated grazed FB in comparison to other forage crops (Malcolm et al. 2016). Other studies have shown that increasing amounts of FB in the diet reduced urine-N concentration (Dalley et al. 2020, Waghorn et al. 2019) and a lower N intake resulted in lower urine-N excretion (Waghorn et al. 2019). Lower urine-N concentration and N excretion are likely to result in lower N leaching losses due to the relationship between urine-N loading rates and subsequent leaching (Di & Cameron 2007).

The benefits of feeding FB may be negated by increased animal-health and welfare risks associated with some FB-feeding regimes, for example poor yield estimation leading to over allocation and potentially rumen acidosis. A recent study showed that feeding 85% of the diet as FB (with barley straw as the sole fibre source) to non-lactating cattle was unsuitable due to inadequate nutrition, a high

incidence of acidosis (Waghorn et al. 2018) and negative effects of FB on rumen function (Pacheco et al. 2020). Similarly, Waghorn et al. (2019) concluded that the risks associated with feeding lactating cows high proportions of FB for extended periods were likely to outweigh benefits associated with reducing N excretion, unless appropriate mineral supplementation is adopted.

The integration of FB into dairy-farm systems saw exponential growth from 2005 until 2018, however the area planted has declined for the last two years. Early research focused on understanding digestive changes during the introduction of livestock to the crop and developing a robust set of transitioning guidelines for farmers to follow to minimise the risk of acidosis and other animal-health issues (Dalley 2016, Gibbs 2011, 2014, Gibbs et al. 2015). More recent studies have investigated dairy-cow-wintering practices in Canterbury (Edwards et al. 2017) where it was shown that a high proportion of cows were wintered on-paddock, off the milking platform, with dairy farmer-owned or -leased support blocks being the most common location. The current study sought to better understand the range of FB use and feeding practices within South Island dairy systems. Information can be used to identify the prevalence of 'high-risk' practices and results will help focus the direction of future research as well as where development and extension efforts should be focussed.

Materials and methods

A telephone survey of 508 dairy farmers was completed between 4 December 2018 and 15 February 2019, when farmers were asked about their FB-feeding practices in winter 2018.

Survey questions

The survey had three sections. The introductory section collected information about the respondent's

role on farm, the size and type of farm and what time of year they calve (questions related to spring-calving herds only). The second section asked specific questions about any animal-health or performance issues occurring in the previous 12 months across all animal classes on farm, and the percentage of the group affected. In the third section, farmers were asked questions about their FB-feeding practices (farmers not feeding FB did not complete this section). Questions included whether FB was grazed or lifted, details around feed transitioning, feed allocation, and what supplements or other feeds were offered (and amounts), including mineral supplements. Note that all survey data collected from farmers were self-reported.

Selection criteria

A random sample of dairy farmers from the Canterbury, Otago and Southland regions, with contact details, was sourced from DairyNZ's customer relationships management database. Telephone interviews were conducted by independent interviewers contracted by Cuthbert and Associates in two phases. In the first phase 583 calls were made and 207 farmers who fed FB and 95 farmers who did not feed FB in 2018 completed the survey. A second phase of 401 calls was made to increase responses from farmers who did not feed FB in 2018. An additional 58 farmers who did not feed FB in 2018 completed the survey. The 148 additional farmers contacted who fed FB in 2018 were recorded for the purposes of establishing a population estimate of FB use, but as the required sample number had been met, they were not asked to complete the full survey. Only 2% of a total of 984 farmers called refused to take part, and with 508 interviews completed, the overall response rate was 52%; the remainder had not answered after three attempts, had disconnected numbers or had left dairy farming.

Data analysis

Due to question filtering, number of responses and over-sampling of non-FB users, three distinct segments were represented. Sample sizes, and the associated margins of error at the 95% confidence interval were as follows: 1) the sample size for the FB use/non-use is $n=508$, which gives a maximum margin of error of $\pm 4\%$, 2) the sample size for the animal-health section is $n=359$, which gives a maximum margin of error of $\pm 6.5\%$ for FB users and $\pm 7\%$ for non-FB users, and 3) the sample size for FB feeding practices section is $n=207$, which gives a maximum margin of error of $\pm 6.5\%$.

The number of responses (n) can vary slightly between questions where the base n of a sub-group would appear to be the same. This is due to omitting extremes or cleansing of data, e.g., deleting obvious typographical errors from the dataset. The n numbers stated in the results refer to the number of responses to a particular question, not the number that responded with a particular answer. Outliers have not been excluded in most central tendency analyses, with the exception of averages, which are displayed as trimmed means. Except for population estimates of FB use,

no weighting has been applied to these data as FB users and non-FB users have been reported separately.

Survey data have been summarised using percentages. Note that not all percentages add up to 100% due to either rounding or respondents having the option of selecting multiple responses for some questions.

Results

Population and demographic

The sample of farmers surveyed represented the population of dairy farmers and farms in Canterbury, Otago and Southland (Table 1) (LIC & DairyNZ 2019). Of the 508 farmers who completed the survey, 69% fed FB in 2018 (5% were feeding FB for the first time), 24% had never fed FB, and 8% of farmers surveyed had stopped feeding FB. The most frequently cited reasons for stopping feeding FB were animal-health issues (34%), not getting value for money (22%) and management challenges (18%). Farmers who fed FB in 2018 ($n=207$) operated on average 2.3 farms, with 53% operating more than one farm, whereas, farmers who did not feed FB ($n=153$), operated on average 1.8 farms, and 41% operated more than one farm. They also milked more cows (767 cows; $n=196$) compared with farmers who did not feed FB (645 cows; $n=144$). Of the farmers who fed FB in 2018, 19% had been feeding it for 1-2 years, 59% for 3-5 years, 19% for 6-10 years, and 4% had been feeding FB for more than 10 years.

Fodder beet-feeding practices

Of the farmers who fed FB in 2018, many used a combination of sources of FB and feeding practices. The majority (90%) grew FB on farm (milking platform and/or support block), while some purchased it standing (13%) or lifted (6%), or FB was fed by a grazer (5%). Of those farmers who grew or purchased FB standing, 96% said they left FB in the ground and 32% said they lifted some FB (i.e., many used a combination of both of these practices) (Table 2). The majority of farmers feeding lifted FB said they fed it in the paddock, and 13% said they fed it off paddock, for example, on a feed pad (Table 2).

On average, FB was grown on 5% of the milking platform area and 29% of the support block, which equates to 9.5% of the total area associated with a dairy farm. Caution is advised regarding the reliability of the support-block data due to multiple farms sharing a support block

Table 1 Summary statistics of survey respondents (located in Canterbury, Otago and Southland) and comparative population statistics.

| | Survey | Population ¹ |
|----------------------------|---------|-------------------------|
| Total herds | 343 | 2,630 |
| Total cows | 243,435 | 1,820,411 |
| Total effective hectares | 79,172 | 591,513 |
| Average herd size | 715 | 692 |
| Average effective hectares | 225 | 225 |
| Average cows per hectare | 3.2 | 3.1 |

¹New Zealand Dairy Statistics 2018-19 (LIC & DairyNZ 2019)

Table 2 Prevalence of fodder beet (FB) feeding methods from a 2018 survey of farmers in Canterbury, Otago and Southland.

| Method of feeding out | % of FB feeders (n=197) ¹ | % of sub-group ¹ | % of sub-group |
|---------------------------------------|--------------------------------------|-----------------------------|----------------|
| Left in the ground and grazed | 96 | | |
| <i>Quantity to feed estimated by:</i> | | | |
| Yield and paddock length | | 82 | |
| Counting rows | | 23 | |
| Time in paddock | | 13 | |
| Other | | 4 | |
| Lifted then fed to stock | 32 | | |
| <i>Quantity to feed estimated by:</i> | | | |
| Weighing on feed wagon | | 75 | |
| Amount that fits in a bucket or wagon | | 29 | |
| Don't know | | 1 | |
| <i>Where Lifted FB is fed:</i> | | | |
| In paddock | | 94 | |
| Off-paddock | | 13 | |
| <i>Component fed:</i> | | | |
| Bulb & leaf | | 52 | |
| <i>Length of time stored:</i> | | | |
| Within one week ² | | | 44 |
| Within one month | | | 30 |
| Longer than one month | | | 25 |
| Don't know | | | 1 |
| Bulb only | | 48 | |
| <i>Length of time stored:</i> | | | |
| Within one week ² | | | 18 |
| Within one month | | | 42 |
| Longer than one month | | | 39 |
| Don't know | | | 0 |

¹Adds to more than 100% due to some farmers using multiple methods

²Including lifted and fed immediately

and data may be overestimated. Of the farmers who grew FB in 2018 (n=207), more grew FB on the milking platform (83%) than on support blocks (78%), indicating that some farmers might be using FB purely for autumn feed. Many farmers (45%) surveyed did not know their FB cultivar (n=186). For those who answered, the most popular cultivar was Brigadier (Seed Force™ Ltd, Christchurch, New Zealand) followed by Jamon (Agricom Ltd, Christchurch, New Zealand). Fodder beet was followed by permanent pasture in rotation in 45% of responses, with the next frequent being forage crop (23%), then cereal (20%), and short-term pasture (11%) (n=238).

Estimating yield and dry matter (DM)

Seventy-one percent of respondents used a commercial company to assess their FB yield, with an equal percentage using an independent company or the company which supplied the FB seed. Another 21% of farmers cut and weighed FB themselves (81% of these weighing leaf and bulb separately), 8% estimated yield by visual assessment, and 2% did not estimate yield. Of the farmers who grew

FB or purchased it standing 84% had dry matter analysed and 12% used a literature value for dry matter (n=180). The mean FB yield achieved was 24 t DM/ha; 7% of respondents did not know their yield (n=196).

Feed allocation

Farmers used a combination of methods to determine how much FB to feed. When FB was grazed *in situ*, 82% of farmers said they used the estimated yield and break-feed face length to determine break width, 23% said they allocated FB by counting rows, and 13% of farmers allocated FB based on time in the paddock (Table 2). Of the 32% of farmers lifting FB, 75% said they weighed the FB to determine allocation before feeding, and 29% said they estimated the amount based on what fitted in a tractor bucket or a wagon. Around half of the farmers feeding lifted FB were feeding both leaf and bulb (52%), while the rest were feeding bulb only and stored them longer (39% longer than a month, compared with 25% for leaf and bulb).

Almost all farmers (98%; n=199) transitioned their cows onto FB, on average taking three weeks to reach maximum allocation.

Fodder beet use by animal class

The use of FB by age class and time of the season are presented in Table 3 with the age class most commonly fed FB being non-lactating cows over winter. Significantly (P=0.01) more farmers fed FB to rising two-year-old heifers (R2) (52% of farmers) and to cows during mid to late lactation (65% of farmers) in Southland and South Otago than in Canterbury and North Otago (32% and 45% of farmers, respectively). However, a significantly (P=0.05) greater proportion of farmers in Canterbury and North Otago wintered non-lactating cows on FB (91%) than in Southland and South Otago (82%). More farmers managed their R2 heifers differently to their non-lactating mixed-age cows (51%) than managed them the same (40%). The average number of weeks each age class was fed FB is presented in Table 3. Young stock tended to be fed FB for longer than mixed-age cows.

Mean maximum allocations of FB fed to cows of different age classes and at different times of the season as well as total allocation of other feeds are presented in Table 3. On average, 12% of FB fed to non-lactating cows during winter was *ad libitum*, otherwise the mean maximum allocation of FB was 10.3 kg DM/cow/day, 66% of the offered diet. Rising two-year-old heifers were fed mean maximum allocations of 9.8 kg DM/cow/day. *Ad libitum* feeding of FB to rising one-year-old heifers (R1) was more common than for other age classes with 23% of farmers saying that they let the R1 heifers eat as much as they want. Greater amounts of other feeds were fed to lactating cows than non-lactating cows (Table 3).

The most common feed offered with FB was pasture silage or baleage, for mixed-age non-lactating cows during winter. This was followed by straw, and maize silage, cereal silage or baleage. Many farmers may have fed a combination of feeds. Cows fed FB during lactation were

Table 3 Percentage of surveyed farmers feeding fodder beet (FB) in Canterbury, Otago and Southland regions in 2018, the average length of time, and the average amount allocated for age classes and seasons.

| Total Sample ¹ | Non-lactating cows (winter) | Non-lactating pre-calving cows (spring) | Cows in early lactation (spring) | Cows in mid-late lactation (autumn) | Rising 1-year-olds (winter) | Rising 2-year-olds (winter) |
|--|-----------------------------|---|----------------------------------|-------------------------------------|-----------------------------|-----------------------------|
| Fed FB in 2018 (%) | 57 | 13 | 24 | 35 | 17 | 27 |
| Sub Sample ² | | | | | | |
| Fed FB in 2018 (%) | 87 | 20 | 36 | 53 | 26 | 40 |
| Weeks fed FB | 8.9 | 4.3 | 5.7 | 5.6 | 10.9 | 9 |
| Maximum amount of FB | | | | | | |
| Allocation (kg/cow/day) | 10.3 | 5.8 | 3.4 | 4.9 | 5.8 | 9.8 |
| Eat as much as they want (%) | 12 | 8 | 3 | 2 | 23 | 13 |
| Other feed | | | | | | |
| Allocation (kg/cow/day) | 4.9 | 9.7 | 12.8 | 12.5 | 3.6 | 5 |
| Eat as much as they want (%) | 11 | 5 | 18 | 12 | 25 | 11 |
| None, i.e., solely FB (%) ³ | 1 | 0 | 8 | 11 | 23 | 0 |
| Total diet | | | | | | |
| Allocation (kg/cow/day) | 16 | 15 | 15 | 16 | 9 | 15 |
| Proportion of FB (%) | 66 | 36 | 33 | 40 | 74 | 66 |

¹All farms, i.e. including those that did not feed FB (n=302)

²Only those that fed FB in 2018 (n=198)

³It is likely that farmers may have misinterpreted this question and not been thinking of pasture as an “other feed”

Table 4 Percentage of farmers surveyed in Canterbury, Otago and Southland regions who experienced animal-health issues in >5% of their herd in 2018, split between those that fed fodder beet (to any stock class) and those that did not feed fodder beet.

| | Fodder beet (%) (n=207) | Non-fodder beet (%) (n=153) | |
|-----------------------------|----------------------------|--------------------------------|----|
| Metabolic issues/milk fever | 41 | 23 | ** |
| Mastitis | 42 | 54 | * |
| Rumen acidosis | 1 | 1 | |
| Broken bones | 0 | 0 | |
| Abortions | 0 | 1 | |

*Significant difference based on two-sided tests assuming equal variances with a confidence level 0.05

**Significant difference based on two-sided tests assuming equal variances with a confidence level 0.01

most likely to be fed the balance of their diet as pasture, followed by pasture silage, and straw.

Use of minerals

The responses indicate that many farmers fed more than one mineral with FB. Dicalcium phosphate (DCP), magnesium oxide, magnesium chloride, or a mix customised for their farm, were the most-common mineral supplements fed to mixed-age non-lactating cows during winter, which was similar for cows in early lactation, except that more farmers also fed lime flour in early lactation. Sixteen percent of farmers who fed FB to non-lactating cows said they did not feed any mineral supplements: this was 10% for non-lactating cows pre-calving, 6% for cows in early lactation, and 8% for cows in mid-late lactation.

Sixty percent of farmers who fed FB to non-lactating cows over winter knew the allocation of phosphate

supplement they were feeding. This averaged 71 g of phosphate supplement/cow/day such as DCP, MagPhos, monosodium phosphate, monocalcium phosphate, or soluble phosphate. The most common method of offering phosphate supplements to non-lactating cows during winter was to mix it with silage using a mixer wagon (40%), followed by applying a slurry on supplement or baleage once in the paddock (18%), loose lick or lick block (18%), in-line water dispenser (15%), and 10% said they dusted it onto paddocks (n=53).

Attitude towards fodder beet

Attitude towards FB was generally positive. Of farmers who fed FB in 2018 (n=188), 44% rated FB 8 to 10 out of 10 as a stock feed, 29% rated it 5 to 7, 15% rated it less than 5, and 12% didn't know; where 0 meant “very dissatisfied” and 10 meant “very satisfied”.

Animal-health issues

Of the herds fed FB in 2018, a significantly greater proportion (41%) were affected by metabolic issues (>5% of the herd affected), compared with 23% for herds not fed FB (P=0.01; Table 4). In contrast, a greater proportion of non-FB herds were affected by mastitis (54%) compared with those fed FB (42%) (P=0.05; Table 4). On farms where FB was fed, the greatest incidence of both metabolic issues and mastitis occurred when FB had been fed for 3-5 years, the majority reported as occurring when cows were lactating in spring. Around 12% and 20% of mastitis was reported as occurring in non-lactating cows for FB feeders and non-FB feeders, respectively. For metabolic issues the occurrence in non-lactating cows for FB feeders and non-FB feeders was 6% and 3%, respectively. Other performance issues which farmers were concerned about included poor reproductive performance, poor body-condition score, excessive body-condition score and poor

production. However, the proportions of farmers concerned with these were similar for those that had fed FB in the last 12 months and those that had not.

Discussion

The 57% of farms feeding FB during the non-lactation winter period (Table 3) aligns with data collected as part of the 2018-19 DairyNZ Animal Husbandry Survey. From the annual DairyNZ Animal Husbandry consults (n=500 nationally) the number of cows fed FB had declined from 87% in 2016-17 to 69% in 2018-19 for Canterbury/North Otago, and from 63% to 46% for Southland/South Otago, respectively. This is represented by the 8% of farmers in the current survey who had previously fed FB but did not feed FB in 2018. The proportion of farms feeding FB on the milking platform (57%) in the current survey was similar to that reported by Edwards et al. (2017) in Canterbury (64%). The current survey delved deeper specifically into FB-feeding practices, age classes of stock, animal-health issues and mineral supplementation than these previous studies.

On average FB made up 66% of the diet of non-lactating cows over winter in this study (Table 3) which is more than the maximum of 60% FB recommended when fed with pasture silage (Pacheco et al. 2020). A study by Waghorn et al. (2018) demonstrated that a diet comprising 85% FB with barley straw was not suitable for non-lactating dairy cows due to the risk of inadequate nutrition and a high incidence of acidosis; lower dry matter intake, poor rumen function and a negative N balance resulted. A diet of 65% FB and 35% pasture silage provided adequate nutrition, however, there was still some risk of acidosis. The high average proportion of FB in the diet of non-lactating cows during winter (of those surveyed), combined with the 16% of farmers not feeding mineral supplements to these animals, should be a focus of future research and extension to ensure diets containing FB supply sufficient minerals to reduce the risk of animal-health issues.

The use of FB in New Zealand has expanded beyond winter feeding to non-lactating cows, with lactation feeding and youngstock rearing on FB proving successful (Gibbs et al. 2015). In the current study, R1 heifers were fed diets of 74% FB on average (n=23), and R2 heifers 66% FB diets (n=55; Table 3). This is similar to the 65% FB diet fed to R2 heifers by Atkins et al. (2018) where this was shown to be a viable alternative to winter housing in high-input total-mixed-ration systems. An integrated heifer-management system using FB fed *ad libitum* from early autumn (after careful transition) has been developed by Gibbs et al. (2015) with suggested intakes of 3-4 kg FB for weaned heifer calves and 9 kg FB for heifers prior to calving. The mean maximum allocations of FB to R1 and R2 animals in the survey were higher than those suggested by Gibbs et al. (2015) at 5.8 and 9.8 kg DM/cow/day, respectively (Table 3). Young stock are not as prone to rumen acidosis as adult cows, as they have different intake patterns (Gibbs et al. 2015), however, they have a higher requirement for protein and minerals to support growth. This indicates

that youngstock diets for many of the respondents may be inadequate. Many respondents did not know how their youngstock were being managed with 20% of FB feeders and 27% of non-FB feeders reporting that they did not know what percentage of their youngstock were affected by animal-health issues. This is likely due to youngstock typically being managed separately off farm. A similar observation around uncertainty of management by graziers was made by Edwards et al. (2017) where few farmers answered a question relating to supplement fed to cows by the grazer.

The proportion of FB in the diet fed to cows in early lactation and mid-late lactation of 33% and 40%, respectively (Table 3) is within the maximum amount of FB in the diet of lactating cows recommended by previous studies (Waghorn et al. 2019). A diet comprising 40% FB with pasture resulted in lower milk production than a 25% FB or 25% maize diet; this may have been a result of subclinical acidosis caused by the high sugar content of FB (Dalley et al. 2020). Similarly, Waghorn et al. (2019) reported that a diet of 60% FB was detrimental to lactating cow health due to the occurrence of acidosis. While a diet with 23% FB increased dry matter digestibility, 45% FB reduced N and neutral detergent fibre (aNDF) digestibility, suggesting an alteration in rumen function. The authors warned that care should be taken to ensure diets contain sufficient N, phosphorus and sulphur as FB bulbs are inadequate in these minerals for lactating cows if fed for extended periods.

The survey indicated that farmers generally use recommended yield-estimation practices. Most farmers surveyed were relatively experienced in feeding FB with only 19% having fed FB for less than two years. High-risk practices of feed estimation, such as only visually assessing crop yield or not assessing it at all, not weighing FB bulb and leaf separately, and using a literature value to estimate dry matter, were few within the survey group. These practices lead to poor accuracy of FB allocation. Feeding FB in the paddock using a time-based approach to allocate FB has a higher risk of acidosis if strict guidelines on herd feeding management are not followed, since cows can consume up to 1 kg FB DM/20 minutes.

Conclusion

The survey results demonstrate how widely FB is used and that, despite animal-health challenges, relatively few farmers have stopped feeding FB. However, declining area sown may indicate farmers are reducing the amount they use. In general, farmers are using recommended yield-estimation practices with a low incidence of high-risk practices relating to feeding. The high proportions of FB in the diets of non-lactating cattle and replacement heifers is of concern if sufficient protein and minerals are not supplied to overcome deficiencies and potential animal-health risks. This survey has helped identify gaps for future research priorities and extension: reinforcing the need to continue investigating opportunities for FB diets that meet protein

and mineral-requirement targets to minimise animal-health issues associated with FB-feeding.

Acknowledgements

This project was funded by the Sustainable Farming Fund (405512) administered by the Ministry for Primary Industries, Wellington, New Zealand; DairyNZ and PGG Wrightson Seeds. We would like to acknowledge Susan Cuthbert (surveyor) of Cuthbert and Associates for facilitating the survey and the wider project team for their input into survey questions.

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