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Ministry for Primary Industries
Manatū Ahu Matua

AGRONOMIC SOLUTIONS FOR FODDER BEET
Defining good management practices

Fodder beet *(Beta vulgaris* L.*)* has a strong place in New Zealand feeding systems aiming to deliver a high yielding, high quality forage that satisfies nutritional (energy, fibre and mineral) requirements, can fit in production systems with minimal environmental issues, and yet is profitable for both cropping and animal producers. The fodder beet industry appears to have reached peak production with farmers questioning the merits and disadvantages of the crop from agronomic, animal performance and environmental perspectives.

A key aim of the SFF project 404915 was to consolidate the fragmented information on fodder beet crop management particularly the crop requirements for nutrients and validate agronomic recommendations for a range of farm types.

Research questions

Yields have increasingly been below expectations based on agronomic, genetic and climatic drivers resulting in reduced profitability for the crop. Poor fertiliser management and crop establishment issues have been identified as sources of yield variation. With good management, consistent yields of 28-30 tonnes DM/hectare are possible.

Research on fertiliser practices and the variable response to amounts applied in regions with differing climate and soils across New Zealand has confirmed some common management rules. Regional trials under the SFF project focused on the most important nutrients (N, K and B) with an assessment of treatments required to stabilise productivity and profitability.

The key for successful fodder beet cropping is to follow Good Agronomic Practices (GAP) for growing and utilising the crop, followed by good post-grazing management resulting in less impacts on the environment.

Measurements of DM yield, partitioning of DM among plant fractions (green leaf, petiole, dead leaf and bulbs), canopy cover development (scaled normalised difference vegetation index [NDVIsc]), green leaf area index [GLAI]), crop nutrient composition and the soil nutrient status contribute to a better understanding of yield variation.

Key messages

1 Soil test to 15 cm prior to cultivation to refine N inputs.
- If anaerobically mineralisable nitrogen (AMN) is greater than 80 µg/g then only 50 kg N/ha is required.
- If AMN <80 µg/g, then apply 100 kg N/ha.

2 There is no yield response above 100 kg/ha of total N applied in fertiliser.

3 Timing of N application is important – 50% at sowing and 50% before canopy closure.
- Late N (after canopy closure) will grow more leaf but not yield. It will not raise protein sufficiently for animal maintenance, nor is it economic.
- Late N does not protect canopy from disease but does increase the leaf to bulb ratio.

4 Complete a soil test to confirm soil K levels. There is no specific yield response to K fertiliser if Quick Test K (QT K) level is >5.
- If QT K less than 3 apply 100 kg K/ha.
- If QT K 3–5 apply 50 kg K/ha.

5 Boron rate and timing of application has no effect on yield or incidence of B deficiency symptoms.
- Apply 1.5 kg B/ha when soil test for B is less than 1 ppm.

6 Maintain a healthy canopy through monitoring and control of foliar diseases to maximise yield. Prevent carry-over of disease by not sowing successive crops of fodder beet in the same paddock.

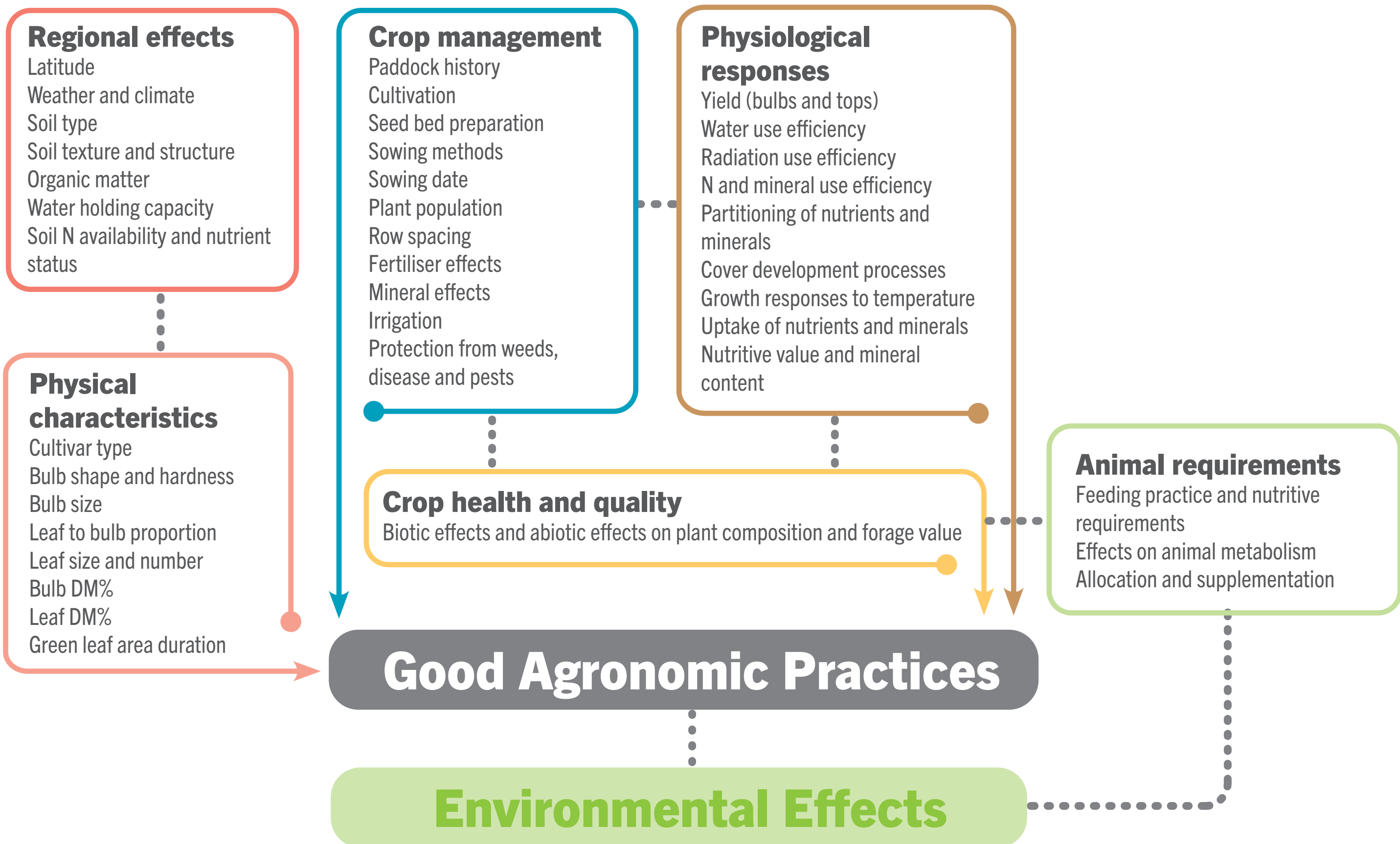
Production and mineral content

Approximately 60,000 hectares (2018-19) of fodder beet is sown in New Zealand, primarily for dairy wintering. Other uses include feed for autumn dairy milk production, spring dairy milk production, rising one- and two-year-old dairy animal feeding, finishing beef, and winter feeding in the sheep and deer sectors.

Range of trial yield (N trials)	13.8 – 27.9 t DM/ha (no N fertiliser)	14.8–34.6 t DM/ha (300 kg N fertiliser/ha)
Range of trial yield (K trials)	11.3–32.0 t DM/ha (no K fertiliser)	14.1–31.2 t DM/ha (150 kg K fertiliser/ha)
Range of trial N% content	0.77–1.69 % N (no N fertiliser)	1.49–2.31 % N (300 kg N fertiliser/ha)
Range of trial N uptake	117–452 kg N/ha (no N fertiliser)	317–531 kg N/ha (300 kg N fertiliser/ha)
Range of trial K% content	0.55–3.43 %K (no K fertiliser)	1.35–3.80 % K (150 kg K fertiliser/ha)
Range of trial K uptake	91–895 kg K/ha (no K fertiliser)	235–916 kg K/ha (150 kg K fertiliser/ha)

Regional fodder beet trial setup and demonstrations for growers.

Figure 1: Direct (arrows) and indirect (dotted lines) factors contributing to good agronomic practices and crop performance



Protocols for Good Agronomic Practices

Consult industry professionals for detailed advice on fodder beet cultivars, chemical options for weed, pest and disease control measures and other agronomic effects on crop performance.

Fertiliser management

Nitrogen

- In most soil types, there is no yield increase with N applications over 100 kg/ha unless the potentially available nitrogen (PAN) in the soil is low (<120 kg/ha) (Table 1).
- Apply N early to support canopy growth preferably without later side dressing.
- Nitrogen applied at or around canopy closure does increase the amount of N in the crop at maturity, but has no effect on yield. Any late N applied is not sufficient to supply the animal protein requirement.
- The amount of N taken up by the plant and the N (protein) concentration is affected by N fertiliser rate. However, it is not economic to use N fertiliser for enhancing crude protein content of fodder beet.

N response trial: paddock (left) and trial (right).

K fertiliser trial: there is no response to K fertiliser rate. The colour effects are due to a N fertiliser response.

Figure 2: Mean yield response (over sites) to N fertiliser applied in split applications at sowing, canopy closure and mid-February. Means were for seven sites in Season 1 (2016–17) and four sites in Season 2 (2017–18)

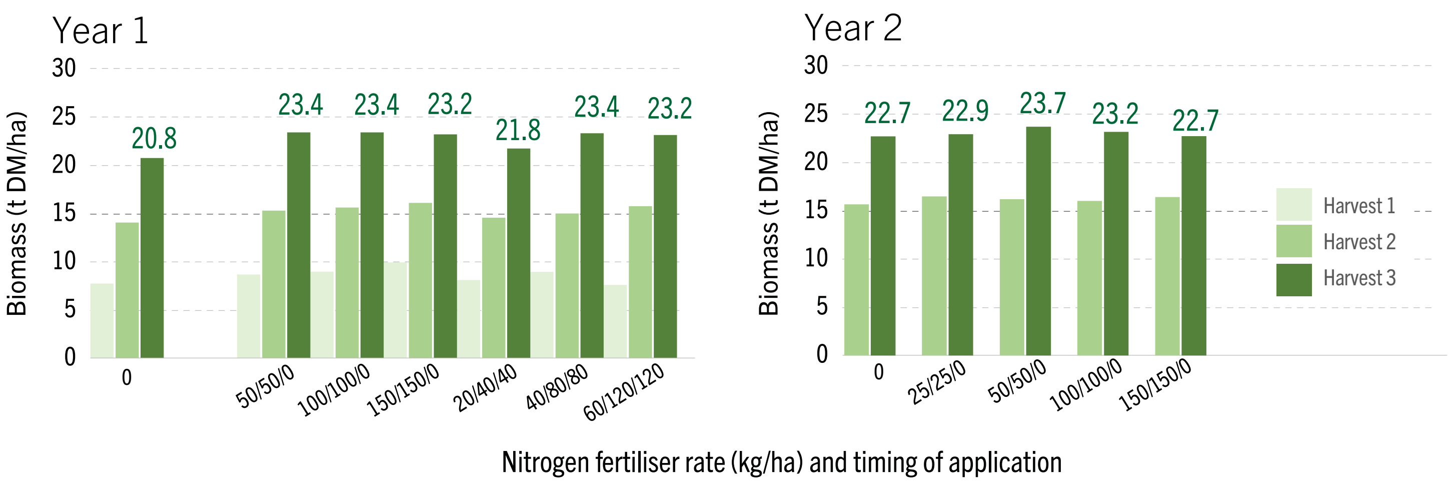
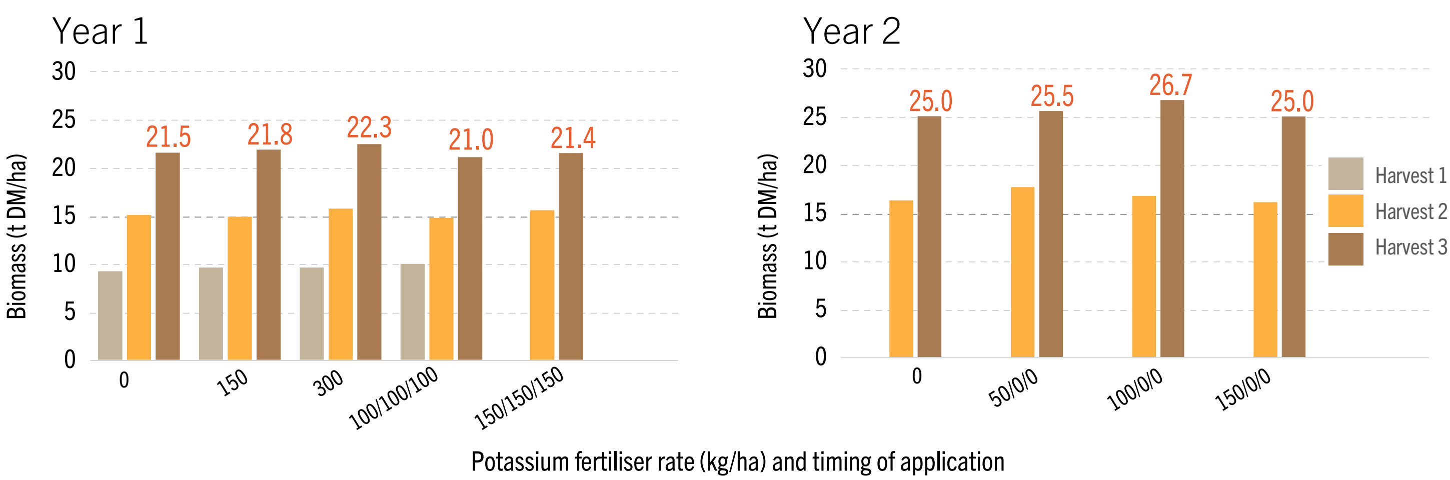


Figure 3: Effect of potassium (K) fertiliser rate and timing on crop yield in two seasons (seven locations in Season 1, and five locations in Season 2). K fertiliser was applied either at sowing or in three split-timings (sowing, canopy closure or mid-February). Harvests were at canopy closure, mid-February and maturity (mid to late May).



Potassium

- The application of K fertiliser does not typically result in a yield response in fodder beet, despite high uptake by the plant. The exception is some volcanic soils with QT K <5 and TBK <1.0.
- Most sedimentary soils in NZ have high reserve K (TBK), more than supplying the requirement for K. High yielding crops (25–30 t DM/ha) can take up more than 500 kg K/ha.
- High removal rates of K from the soil could result in the need to replenish soil K levels for subsequent crops (especially if the crop is lifted rather than grazed in situ). Therefore, consider K nutrition and K fertiliser applications within the context of cropping rotation to maintain the K balance.

Weed and insect management

Fodder beet is sown at 80,000–100,000 plants/ha but seedlings are slow to establish, and susceptible to weed competition and insect attack. Also, in the early stages, fodder beet plants are prone to agri-chemical damage.

- The first weed spray is the pre-emergence/post planting spray. Apply as soon after planting as possible. An insecticide should be included in the spray.
- Up to two post-emergence sprays are required for the target weed spectrum; followed by a pre-canopy closure spray for selected weeds only (if required).
- Aphids are the main vector for transmitting viral diseases in fodder beet.

Disease management

- There are a range of viral and fungal diseases that appear at specific plant development stages and/or environmental conditions that favour specific modes of infection and spore dispersal and disease progression. These have a strong impact on productivity and profitability.
- A limited number of chemicals and application exposures are available in New Zealand to reduce incidence of fungal diseases (*Cercospora*, leaf rust, powdery mildew). There are currently no registered chemicals for controlling *Agrobacterium, Rhizoctnia, Alternaria, Fusarium,* Downy Mildew or bacterial leaf spot. Often secondary infection with *Fusarium* occurs after a primary *Rhizoctnia* infection.
- Viral diseases include beet mosaic virus, beet western yellows virus, and beet mild yellowing virus.
- Little can be done to prevent development of viral disease aside from maintaining hygienic crop practices and reducing aphid populations.

Irrigation

- Under restricted water availability fodder beet shows visible signs of stress (e.g. daytime wilting).
- On light soils, fodder beet yield is directly related to the amount of irrigation applied.
- The crop has a capacity to extract water from deep in the soil profile and therefore there may be opportunities to limit the amount of irrigation on heavier soils without compromising yield.

More information

Additional guidelines for management of fodder beet are available on the DairyNZ website:
www.dairynz.co.nz/feed/crops/fodder-beet

Table 1: Nitrogen fertiliser recommendations for fodder beet based on sampling to 15 cm soil depth and for given ranges for N availability in a pre-cultivation soil sample

Soil N test method[a]	Typical test range	Recommendation	
		Soil test	N fertiliser (kg N/ha)
1. Anaerobically mineralisable N (AMN; µg/g)	20–150 µg/g (high range >80)	<80 µg/g >80 µg/g	100 [d] 50 [e]
2. Potentially available N[b] (PAN; kg N/ha)	30–225 kg N/ha (high range >120)	<120 kg N/ha >120 kg N/ha	100 [d] 50 [e]
3. Mineral N[c] (ammonium and nitrate; kg N/ha)	10–150 kg N/ha (high ranges; >30 for NH_4^+ and >100 for NO_3^-)	<50 kg N/ha 50–75 kg N/ha >75 kg N/ha	50 [f] 25 [f] Nil

a Assuming a soil bulk density of 1.0; all values given for 0–15 cm depth. Use the AMN values as primary test for fertiliser N rate to apply. If the mineral N test[c] is available, use this to add to the total N fertiliser recommended by the AMN test.
b PAN (potentially available nitrogen) is calculated as AMN (µg/g) x depth (cm) x 0.1 x bulk density (w/v). PAN is usually determined close to sowing time and before cultivation.
c High amounts of ammonium are indicative of freshly decomposed organic matter, high rates of soil N mineralisation, or recent application of urea. Values of ammonium >30 are indicative of high mineralisation activity. Nitrates build up in soil with active microbial conversion from NH_4^+.
d 50 kg N/ha at sowing and 50 kg N/ha pre canopy closure.
e 50 kg N/ha at sowing only.
f Recommended additional N on the basis of mineral N test range. Apply additional N before canopy closure. Do not exceed a total N application of 100 kg N/ha.

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Table 2: Nutrient recommendations for fodder beet for soils sampled over 0–15 cm soil depth and within the given soil test ranges

Soil Test	Typical test range in fodder beet paddocks	Measured soil test range	Nutrient recommendation (starter fertiliser)
Phosphorus [a] (Olsen P)	8–30 + µg/ml	Olsen P < 15 Olsen P > 15	50 kg P/ha 20 kg P/ha
Potassium (K)	2–10 QT	QT K <3 QT K 3–5 QT K >5	100 kg K/ha 50 kg K/ha No K
TBK (reserve K)	0.5–3.0 me/100 g	TBK <1 TBK 1.0–1.5 TBK >1.5	100 kg K/ha 50 kg K/ha No K
Calcium (Ca)	2–15 QT	QT Ca <4 QT Ca >4	Apply lime No Ca
Magnesium [b] (Mg)	4–20 QT	QT Mg <8 QT Mg >8	25–30 kg Mg/ha No Mg
Sodium (Na)	1–10+ QT	QT Na <5 QT Na >5	150 kg/ha of AgSalt No Na
Sulphur [c] ($S0_4$-S)	2–10+ QT	QT S <5 QT S >5	Apply S in basal fertiliser No S
Boron [d] (B)	0–4 ppm	<1.0 ppm >1.0 ppm	1.5 kg B/ha No B

a Generally, P is not required in large quantities for crop growth, with optimum range of 25–30 µg/g Olsen P.
b Very few soils have low Mg. Some yield reductions may occur with soil tests less than QT Mg 8.
c Sulphur is not required in large quantities for fodder beet production.
d Boron rate and timing of application has no effect on yield or incidence of B deficiency symptoms.