Monitor Farm Innovation Funded Project on Fodder Beet 2019 – Report

Project team - Kirsten Williams, SAC Consulting and Dr Robin Walker, SRUC

Introduction

The project developed as a way of providing sufficient technical information about fodder beet grown across Scotland, from which sound business decisions can be made. Although there is an extensive research community in Scotland, farmer led applied research does not feature heavily as a means of developing and disseminating an evidence base for certain crops of interest to farmers.

Prior to this project, there was a distinct lack of up to date or relevant data to assist farmers on how to successfully grow fodder beet in Scotland. Information on which were the key factors to consider e.g. yield, frost susceptibility, dry matter, agronomy, establishment techniques, etc were limited. This restricted pool of information and lack of basic knowledge specific to fodder beet crops grown in Scotland was a challenge for Scottish livestock farmers who are growing the crop. Interest in the crop stems from the fact that fodder beet has the potential to provide many benefits to livestock producers in Scotland - the largest being the yield potential, which is larger than any other forage crop grown in the UK. The high yield has potential to make fodder beet one of the cheapest forage per kg of dry matter, as well as one of the cheapest forage per mega joule of energy due to its nutritional characteristics. Achieving high yields in a cost effective manner in Scotland is one aspect of maximising the potential of the crop.

The consideration of these challenges led to the collaborative innovation project between 4 monitor farms and their associated community groups which is reported here. The project aims were:

- Test and evaluate a system for farmer led trial design, as a means to collect an evidence base that peers can use to implement business decisions on farm that lead to enhanced business performance.
- Develop a much-needed knowledge repository on growing fodder beet, covering all of the growing stages, that can be used by farmers from across Scotland who are looking to grow the winter forage crop.

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The potential impact on Scottish livestock systems from growing fodder beet is massive and this innovative project has been key in helping to collate and synthesise relevant agronomic and crop utilisation information through the Monitor Farm network and beyond. To achieve this a series of trial fodder beet plots were hosted on farms throughout Scotland as a source of data captured under Scottish growing conditions. The project also benefitted from knowledge provided by a number of fodder beet experts from around the world.

The farmers were supported initially by the Dr Robin Walker, who was in dialogue with them when they were setting up the fodder beet crops to be monitored, the types of treatments they were interested in and the most appropriate way of laying out the trials to make best use of the data gathered from the plots. Compromises were required due to logistical and technical issues. Data collection templates were created and basic protocols provided to help support the farmers with data collection. This data has now been analysed and this report provides a synthesis of the key findings based on the information received.

Throughout the growing season, a series of virtual meetings were hosted, and these allowed the trial farmers to discuss issues that occurred in their fodder beet crops, and to generally share experiences. Given the geographical spread of the farm-based trials, this virtual peer-to-peer discussion, along with the use of an active WhatsApp group was key to the success of the project. These agronomy sessions and the WhatsApp group were facilitated by Kirsten Williams of SAC Consulting.

Some of the farmers hosting the trials were also supported by members of the trade, who are providing support in kind in the form of, for example, seed and foliar fertilisers.

Facilitation and Technical Group

- Kirsten Williams, SAC Senior Beef & Sheep Consultant
- Robin Walker, SRUC Researcher
- Derek Hanton, Shetland Monitor Farm Facilitator

The approximate location of the seven farms involved in trialling fodder beet in 2019 as part of this project are indicated in Fig 1 and highlight the broad geographical range covered, ranging from Shetland in the far north, down to Galashiels in the Borders. There was also a mix of coastal and inland farm locations within the group. The farms are numbered from 1 to 7, with Farm 1 being the furthest North and farm 7 the furthest South. Farm names have been anonymised and will be referred to by their allocated farm number throughout the report as financial information will be discussed in later sections.

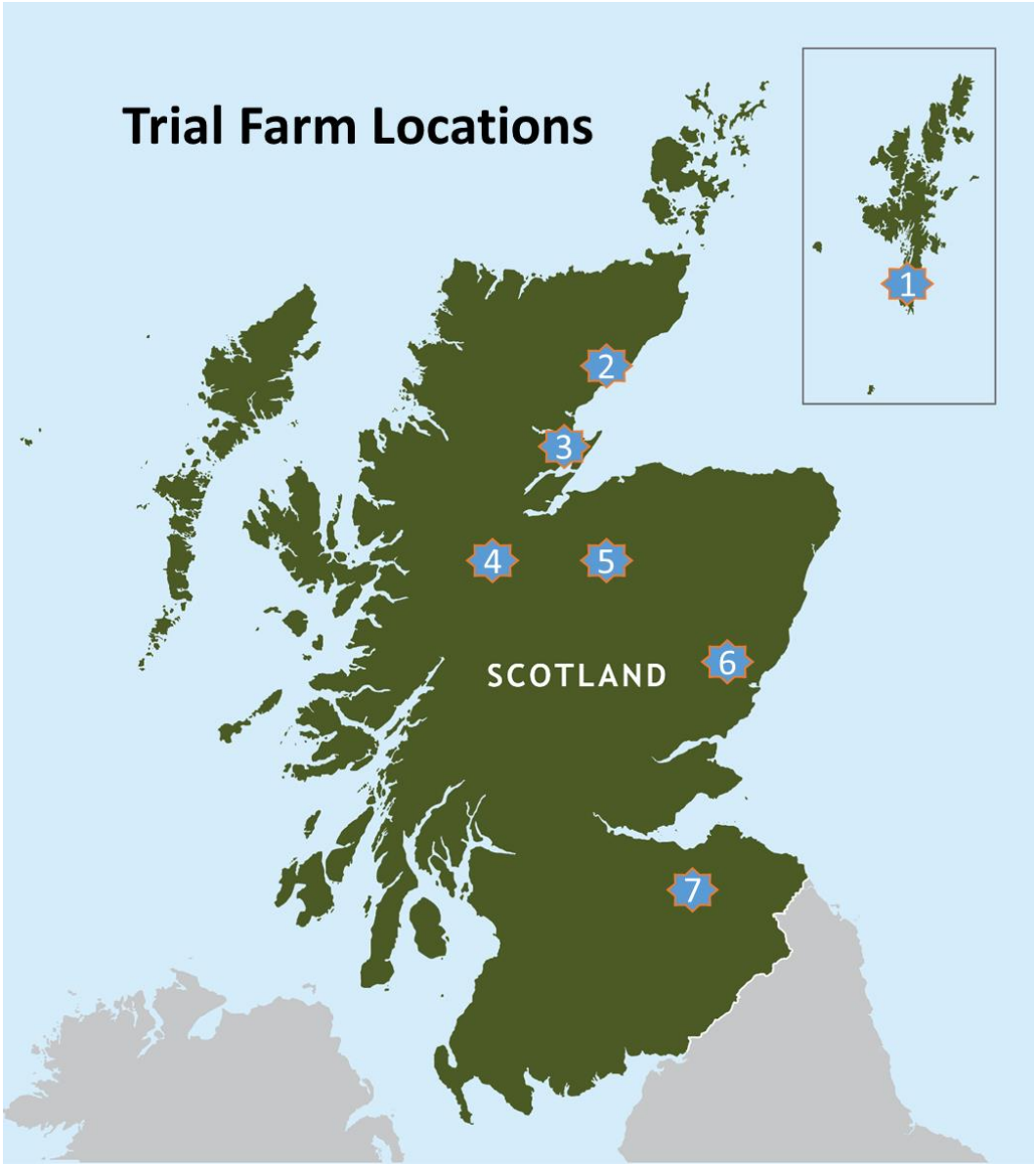

Figure 1: Approximate location of the demonstration trial farms which grew fodder beet as part of this project in 2019.

Initiative supported by:
The Scottish Government
The European Agricultural Fund for Rural Development: Europe investing in rural areas
SRDP Scottish Rural Development Programme
AHDB
QMS
SAC CONSULTING

Background information for each farm demonstration trial

Where it has been made available, basic information is presented for each farm in terms of which treatments were planned for comparison in their fodder beet demonstrations, as well as associated background information relating to the agronomy used.

Farm 1

This farm was the furthest North and was located in Shetland. Two demonstration trials were established at this farm. The first trial investigated three varieties (Geronimo, Enermax and Bangor) and the second trial investigated three different seed rates (100k, 90k and 80k ha^{-1}) of the same variety (Geronimo). Both were established using a direct drill on 24th April 2019. A basal fertiliser was applied at sowing, with a follow up treatment a little later in the season. Herbicide was applied on 3 occasions during the season. There is no information relating to slug pellets or fungicide applications, so will assume these were not made. More details are given in the following table.

	Demonstration Trial 1	**Demonstration Trial 2**
Variety	Geronimo, Enermax & Bangor	Geronimo
Sowing Date	25/4/2019	25/4/2019
Seed Treatment	Force 10 on Geronimo	Force 10
Primed Seed	Yes (only Geronimo)	Yes
Seed Treatment (fungicide/pesticide)	On Geronimo only (Force 10)	Force 10
Primary Cultivation	None	None
Secondary Cultivation	None	None
Sowing Methods	Direct drill with Moore unidrill	Direct drill with Moore unidrill
Seed Rate (ha^{-1})	100k	100k, 90k and 80k
Depth	3cm	3cm
Row Spacing	40cm	40cm
Altitude	No info	No info
Field ID	Ramsa	East Lea
Area	2ha	2ha
Previous crops	Barley, grass	Barley, grass
Salt Applied	200kg	200kg
Primary Fertiliser	14-8-23 400kg/ha	14-8-23 400kg/ha
Secondary Fertiliser	24-0-13 200kg/ha	24-0-13 200kg/ha

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Initial Herbicide	25/4/2019 Bettix Flo 3L/ha	25/4/2019 Bettix Flo 3L/ha
2 Herbicide	19/6/2019 @ 1 litre Bettix flo + 2 litres Betasana trio	19/6/2019 @ 1 litre Bettix flo + 2 litres Betasana trio
3 Herbicide	3/7/2019 @ 1 litre Bettix flo + 2.5 litres Betasana trio	3/7/2019 @ 1 litre Bettix flo + 2.5 litres Betasana trio
Fungicide	No info	No info
Slug Pellets	No info	No info

Farm 2

This farm was the second furthest North and was located near the east coast at Brora. A wide range of demonstration treatments were involved ranging from differing cultivation treatments, variety comparisons at different seed rates as well as primed seed on one treatment and additional Nitrogen on another treatment. More details are given in the following table.

Variety	Fortimo, Geronimo, Goldimo, Betimo, Lactimo
Sowing Date	7/5/2019
Seed Treatment	See below (primed seed)
Primed Seed	Active Boost on one Geronimo treatment
Seed Treatment (fungicide/pesticide)	None
Primary Cultivation	Plough
Secondary Cultivation	Disc
Sowing Method	Precision sown
Seed Rate (ha^{-1})	80k, 95k, 110k
Depth	Details not provided (probably around 2cm)
Row Spacing	45cm
Altitude	A few m above sea level
Field ID	Lower Lochy
Area	4ha
Previous crops	2016/17 grass; 2018 swedes
Salt Applied	No
Primary Fertiliser	Lime @ 635kg/ha at cultivation; MOP 0-0-60 1800 kg; DAP 18-46-0-0.2 B 600 kg; 24-0-0 + 30 SO3 1200 kg

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Secondary Fertiliser	One treatment of Lactimo @ 110k seeds ha^{-1} was given 200kg N
Initial Herbicide	12/5/2019 Bettix flo + Betasana trio (no rate info)
2 Herbicide	25/5/2019 Bettix flo (no rate info)
3 Herbicide	15/6/2019 Bettix flo + Betasana trio + Dowshield (no rate info)
Fungicide	No info
Slug Pellets	None

Farm 3

This farm was the third furthest North and was located near the east coast at Tain. The demonstration treatments were based around the comparison of 4 different varieties grown at different seed rates. There was an event held at this farm that was attended by many of the project group when Jim Gibbs (fodder beet expert from New Zealand) was in the UK. His knowledge and input to the group discussion was extremely valuable. More details are given in the following table.

Variety	Robbos, Jamon, Geronimo, Brigadier
Sowing Date	24/4/2019
Seed Treatment	Not indicated (apart from priming)
Primed Seed	Yes
Seed Treatment (fungicide/pesticide)	Not indicated
Primary Cultivation	Plough
Secondary Cultivation	Cultivate and use of paddle rollers for level and firmness
Sowing Method	Vaderstad Temp 6R (sown across plough, cultivation and fertiliser direction)
Seed Rate (ha^{-1})	80k, 90k, 100k, 110k
Depth	2cm
Row Spacing	45cm
Altitude	15-25m above sea level
Field ID	Rhynie March
Area	6ha of fodder beet (total field area 17.5ha)
Previous crops	2016/17/18 grass
Salt Applied	400kg / ha agricultural salt

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Primary Fertiliser	0-0-53 @ 560kg/ha (Broadcast @ sowing); 23-22-0 @ 295kg/ha with seed (all on 24/4/2019)
Secondary Fertiliser	27-0-0 @ 466kg/ha (broadcast on 24/6/2019)
Initial Herbicide	25/4/2019 Bettix flo @ 1.75L/ha
2 Herbicide	4/6/2019 Bettix flo @ 1L/ha Betasana Trio SC @ 2L/ha
3 Herbicide	7/7/2019 Bettix Flo @ 1.5 L/ha + Betasana Trio SC @ 2L/ha
Fungicide	None
Slug Pellets	None

Farm 4

This farm was the third furthest West of the demonstration farms in this project and was located in the highlands near Drumnadrochit. The demonstration treatments were based around slightly different Nitrogen fertiliser and herbicide treatments, although these were on two different fields, so direct comparisons require some caution.

	Demonstration Trial 1	**Demonstration Trial 1**
Variety	Geronimo, Robbos	Geronimo, Robbos
Sowing Date	10/5/2019	10/5/2019
Seed Treatment	See below	See below
Primed Seed	No	No
Seed Treatment (fungicide/pesticide)	Vibrance + Tachigaren (fungicide) Force (insecticide)	Vibrance + Tachigaren (fungicide) Force (insecticide)
Primary Cultivation	Chisel Plough	Chisel Plough
Secondary Cultivation	Leveller & Heavy rolled	Leveller & Heavy rolled
Sowing Method	Precision seeder	Precision seeder
Seed Rate (ha^{-1})	100k	100k
Depth	Not detailed	Not detailed
Row Spacing	50cm	50cm
Altitude	170m	160m
Field ID	Tulloch	Park Cottage
Area	4ha	4ha
Previous crops	Swedes 2018, Grass <2017	Long-term grass

Salt Applied	150kg/ha sylvinite basal at sowing (8/5/2019); 50kg/ha 12/7/2019	150kg/ha sylvinite basal at sowing (8/5/2019); 50kg/ha 12/7/2019
Primary Fertiliser	16-16-16 + SO3 250kg/ha (with seed on 10/5/2019)	16-16-16 + SO3 250kg/ha (with seed on 10/5/2019)
Secondary Fertiliser	Polysulphate 150kg/ha 8/5/2019; 50kg N/ha 29/6/2019; Boron foliar 1.5L/ha	Polysulphate 150kg/ha 8/5/2019; 100kg N/ha 29/6/2019; Boron foliar 1.5L/ha
Initial Herbicide	12/5/2019 Goltix 1L/ha + Effect 1L/ha	12/5/2019 Goltix 1L/ha + Effect 1L/ha
2 Herbicide	6/6/2019 @ 1.25L/ha Betanal Maxx Pro	6/6/2019 @ 1.25L/ha Betanal Maxx Pro
3 Herbicide	1/7/2019 @ 1.5L/ha Betanal Maxx Pro	N/A
Fungicide	None	None
Slug Pellets	No info	No info

Farm 5

This farm was the most centrally located demonstration farm from within the group and was located in the Highlands near Boat of Garten. Information in relation to this farm and its demonstration treatments have been slow to materialise, but two varieties were known to have been sown. Details, where available, are given in the following table.

Variety	Robbos, Geronimo
Sowing Date	7/5/2019

Farm 6

This farm was the second furthest South of the demonstration farms in this project and was located near Brechin in Angus. Information in relation to this farm and its demonstration treatments have been slow to materialise. Details, where available, are given in the following table.

Variety	Feldherr

Farm 7

This farm was the furthest South and was located near Galashiels in the Borders. The demonstration treatments were based around four varieties. More details are given in the following table.

Variety	Jamon, Robbos, Geronio and Fortimo
Sowing Date	7/5/2019
Seed Treatment	See fungicide / pesticide below
Primed Seed	No
Seed Treatment (fungicide/pesticide)	Vibrance + Tachigaren (fungicide); Force (insecticide)
Primary Cultivation	Plough
Secondary Cultivation	Power Harrow
Sowing Method	Precision seeder
Seed Rate (ha^{-1})	100k
Depth	5cm
Row Spacing	50cm
Altitude	355-375m
Field ID	Hogg Hill
Area	3 ha
Previous crops	Long-term grass
Salt Applied	No
Primary Fertiliser	260kg/ha 0-20-30 + 200kg/ha 27-0-0-8 on 5/5/19
Secondary Fertiliser	200kg/ha 27-0-0-8 on 27/6/19
Initial Herbicide	Bettix Flo SC 3L/ha + Remix 0.333L/ha on 12/5/2019
2 Herbicide	Betasana Trio SC 2.22 L/ha; Bettix Flo SC 1.11 L/ha 10/06/2019
3 Herbicide	N/A
Fungicide	None
Slug Pellets	None

A comparison summary of the varieties grown at each of the demonstration farms, as well as information on the sowing and emergence dates where this has been provided by the respective farm is included in Table 1.

Table 1: Summary of the varieties grown, as well as sowing and emergence dates on each of the seven demonstration farms where information has been provided.

Variety	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7
Robbos			x	x	x		x
Jamon			x				x
Geronimo	x	x	x	x	x		x
Fortimo		x					x
Brigadier			x				
Bangor	x						
Enermax	x						
Feldherr						x	
Lactimo		x					
Betimo		x					
Goldimo		x					
Sown	24/4/2019	7/5/2019	25/4/2019	7/5/2019	10/5/2019		7/5/2019
Emerged	9/5/2019						17/5/2019

Farms 5 and 6 only managed to provide limited data on the crop after establishment.

Results & Discussion

Establishment

Many of the farms had problems with establishment, primarily due to the poor weather which particularly hampered seed bed formation and early growth, and herbicide spraying operations. As a result, some of the intended fodder beet plant numbers per m^2 were reduced, in some cases around 50% or even less of intended plant numbers, but once established, the crops generally grew away quite well, compensating for the poor growth of some plants by filling these gaps in the rows and competing better with any weeds in tandem with any applied herbicides that were showing reasonable efficacy. One farm (Farm 1) resorted to cross drilling over the original crop around 5 weeks later at a half seed rate to try and boost plant numbers due to poor initial establishment. There were some weed issues like docks on one farm, making for some patchy field plots initially, but a pest damaged the docks knocking them back and the fodder beet grew away. The crop receiving "active boost" on Farm 2 seemed to have greater vigour than the same variety (Geronimo) drilled at the same seed rate that hadn't received this additional treatment in the same field.

Leaf tissue nutrient concentrations

Tissue samples of the fodder beet leaves were made from randomly collected leaf material on several of the farms over the late summer/early autumn period and tested for a range of nutrient concentrations to establish if they fell within the generally expected ranges of healthy fodder beet plants (Table 2). Of the leaves that were tested, the majority of the nutrient contents were broadly within the expected range of values. These can change over the season, with concentrations of P, K, Cu, Fe and S generally expected to decline over the season, with Mg expected to rise in concentration over the course of the season, whilst the remaining nutrients tested would be expected to remain relatively constant over the season.

Table 2: Nutrient contents of randomly collected leaf samples taken from selected farms.

	Farm 1	Farm 2	Farm 3		
Date received at lab	7/8/2019	14/8/2019	13/9/2019	**Typical Average Range**	
Dry Matter (g/kg)	78.28	95.57	109.06		
Phosphorus (% by Wt DM)	0.767	0.418	0.331	0.4-0.6	
Potassium (% by Wt DM)	3.86	2.87	2.23	0.03-4	Young plants
				2.5-3	Mature plants
Magnesium (% by Wt DM)	0.305	1.2	1.05	0.1-0.3	
Calcium (% by Wt DM)	0.311	0.863	1.12	0.4-0.8	
Sodium (% by Wt DM)	1.04	0.759	1.44	0.05-0.4	
Copper (mg/kg DM)	9.85	13.3	6.63	0.03-15	
Zinc (mg/kg DM)	104	64.9	41.1	15-60	
Boron (mg/kg DM)	28.8	36.5	26.5	0.02-8	
Iron (mg/kg DM)	148	101	84	100-200	
Sulphur (% by Wt DM)	0.371	0.327	0.266	0.2-0.5	
Manganese(mg/kg DM)	80.2	235	218	30-300	

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Yields

Total yields were estimated based on measured values of both bulb and leaf yields sampled in the fields. Some farms provided more detailed data than others with respect to yield from the various plots they had been established.

A key message from Jim Gibbs (NZ based fodder beet specialist) is that yield and DM are important, but maintaining green leaf for as long as possible into the season and utilisation of both leaf and bulb are really the key drivers of profit, with this linked to how effectively the livestock are managed in terms of access to the face of the crops and the amount and the ease at which they can eat the bulb which can depend on how much of the bulb is available to the animal above the ground. A technical leaflet for further advice on how best to manage crop utilisation has been produced following this meeting.

It must be made clear that these results are from one season, and most of the demonstration trials had no physical replication, so a note of caution should be taken when making comparisons between treatments.

Farm 1: Yield

Total yields for the variety Geronimo ranged from 16.3 to 21.4 t/ha DM. This was based on an average bulb yield of approximately 13 t/ha DM and an average leaf yield of approximately 8 t/ha DM. Lower seed rates (80,000 seeds / ha) generally produced the least yield. The other field with 3 varieties (Geronimo, Enermax & Bangor) all drilled at 100,000 seeds / ha, produced lower yields overall, between 11.7 and 13.4 t/ha DM for the bulbs and 4.6 and 7.7 t/ha DM for the leaf yield. Geronimo performed well within this group.

Farm 2: Yield

Yields for the crops grown in this demonstration trial showed some interesting trends (Table 3). The standard seed rate was 110,000 seeds / ha, and in this instance, Geronimo only performed well when it had “active boost” applied, without it, the DM yields were very poor compared to other varieties sown at the same seed rate, particularly in relation to relative leaf yield. Of the varieties grown at 110,000 seeds / ha without any other additions, the variety Betimo appeared to be quite productive, with good DM yields for bulbs as well as leaves. The variety Lactimo was drilled at several seed rates, and in this instance, the 95,000 seeds / ha appeared to work well, with an apparent dip at the standard seed rate of 110,000 seeds / ha. Discing during establishment of the crop helped to improve yield at this higher seed rate slightly, and the addition of 200kg N/ha did appear to provide the biggest yield improvement overall, but clearly these require additional costs. Without greater replication or comparison data, these trends can only provide an indication of likely performance in terms of yield (green leaf retention and utilisation by livestock will have a big impact on overall economic performance). The farm noted that Lactimo performed well in terms of DM yield, but also sat out of the ground more than others making utilisation easier for sheep in particular.

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Table 3: Fodder beet yield (DM / ha) for each treatment tested on Farm 2 (* x1000 seeds / ha).

Variety / Treatment	Leaf Dry Matter Yield (kg DM/Ha)	Root Yield (kg DM/Ha)	Root & Leaf Yield (t DM/Ha)
GERONIMO 110*	3666.7	8917.3	12.6
GERONIMO 110* ACTIVE BOOST	7700.0	13918.0	21.6
GOLDIMO 110*	6600.0	13181.8	19.8
FORTIMO 110*	6783.3	13640.0	20.4
BETIMO 110*	8616.7	14105.3	22.7
LACTIMO 80*	7150.0	12789.5	19.9
LACTIMO 95*	7700.0	12822.6	20.5
LACTIMO 110*	7700.0	10714.3	18.4
LACTIMO 110* 200 kg N/ha	8433.3	17395.0	25.8
LACTIMO 110* DISCED	7333.3	11953.1	19.3

Farm 3: Yield

Yields for the crops grown in this demonstration trial showed some interesting trends (Table 4). The standard seed rate was 90,000 seeds / ha, at which seed rate Jamon performed best in terms of DM yield, with Geronimo and Robbos close behind. Brigadier did not perform particularly well in terms of DM yield production. The seed rate data from Jamon indicated that in this instance, 90,000 seeds / ha was appropriate as it provided the best DM yields at this time in this row spacing.

If row spacing can be reduced to nearer 35cm, Jim Gibbs (NZ based fodder beet specialist) suggests that higher seed rates, perhaps as high as 130,000 seeds / ha might be appropriate. However, the trial on this farm, and on the other farms in the project were currently on more typical 45-50cm row spacing's. Without greater replication or comparison data, these trends can only provide an indication of likely performance in terms of yield (green leaf retention and utilisation by livestock will have a big impact on overall economic performance). It was noted that Robbos had better leaf retention later in the season than Geronimo, a key factor in variety choice, along with traits that impact on utilisation of the crop by stock.

Table 4: Fodder beet yield (t DM / ha) for each treatment tested on Farm 3.

Variety	Seed Rate	Yield		
		Leaf - t DM/ha	Bulb - t DM/ha	Total t DM /ha
JAMON	**80**	8.9	15.2	24.0
	90	9.6	18.4	28.0
	100	9.6	12.4	22.0
	110	9.0	11.4	20.5
Averages		9.3	14.4	23.6
GERONIMO	**80**	0.0	0.0	0.0
	90	11.4	14.9	26.4
	100	0.0	0.0	0.0
	110	0.0	0.0	0.0
Averages		N/A	N/A	N/A

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BRIGADIER	**80**	0.0	0.0	0.0
	90	6.0	11.8	17.8
	100	0.0	0.0	0.0
	110	0.0	0.0	0.0
Averages		N/A	N/A	N/A
ROBBOS	**80**	0.0	0.0	0.0
	90	7.5	17.6	25.2
	100	0.0	0.0	0.0
	110	0.0	0.0	0.0
Averages		N/A	N/A	N/A

Farm 4: Yield

Yields for the fodder beet crops grown in this demonstration trial were around 10.35 t DM / ha for the bulbs and around 4.6 t DM / ha for the leaves, giving a total of 14.95 t DM / ha in total. This figure is quite low compared to many of the other farms in this project, but this low yield can probably be explained by the fact that out of approximately 10 plants / m2 that were sown, only around 50% of these plants survived to grow on to produce any leaf or bulb biomass. It was noted that Robbos had better leaf retention later in the season than Geronimo, a key factor in variety choice, along with traits that impact on utilisation of the crop by stock.

Farm 7: Yield

Yields for the fodder beet crops grown in this demonstration trial are provided in Table 5. The data indicate that in this situation, Geronimo performed better than the other two varieties on test, with Jamon perhaps marginally better performing in terms of DM yield than Robbos, although this is one trial in one season, so the results should be used with caution.

Table 5: Fodder beet yield (t DM / ha) for each variety tested on Farm 7.

Variety / Treatment	Leaf Dry Matter Yield (t DM/Ha)	Root Yield (t DM/Ha)	Root & Leaf Yield (t DM/Ha)
GERONIMO	7.7	16.4	24.1
JAMON	6.7	12.4	19.1
ROBBOS	6.6	10.5	17.1

Feed Quality

Summarised data of feed quality based on dry matter (DM), metabolised energy (ME) and protein contents of leaf and bulbs of fodder beet from a range of treatments from several of the project farms are provided in tables 6.1 to 6.5 and Fig 2. Average value is estimated based on bulb yield being approximately 2/3 of total yield and leaf yield being approximately 1/3 of total yield. DM ranged from 14.0% on Farm 3 to as high as 15.6% on Farm 4, although most DMs were in the 14.6 to 15.1% range. ME ranged from 10.6 MJ/kg DM on Farm 4 to as high as 12.1 MJ/kg DM on Farm 1, with the majority around 11 MJ/kg DM or just over. Protein taken as a combination of leaf (1/3) and bulb (2/3) as described above ranged from 9% on Farm 4 to as much as 17.2 on Farm 7, with most being in the 12-16 % crude protein range.

Table 6.1: Fodder beet quality of Geronimo tested on Farm 1.

Farm 1	Geronimo		
	Leaf	Bulb	AVERAGE
Dry Matter %	13.5	15.3	14.7
ME MJ/kg DM	10.6	12.9	12.1
Protein %	31.1	8.7	16.2

Table 6.2: Fodder beet quality of unknown treatment tested on Farm 2.

Farm 2			
	Leaf	Bulb	AVERAGE
Dry Matter %	7.5	18.1	14.6
ME MJ/kg DM	9.9	11.4	10.9
Protein %	17.7	9.4	12.2

Table 6.3: Fodder beet quality of 4 varieties tested on Farm 3.

Farm 3	Brigadier		Geronimo		Jamon		Robbos		AVERAGE
	Leaf	Bulb	Leaf	Bulb	Leaf	Bulb	Leaf	Bulb	
Dry Matter %	9.7	10.5	16.7	16.0	12.9	11.7	14.1	19.3	14.0
ME MJ/kg DM	9.9	12.4	11.2	12.3	10.9	12.7	10.7	12.9	11.9
Protein %	28.7	8.8	25.9	8.6	30.9	14.8	24.1	7.1	15.7

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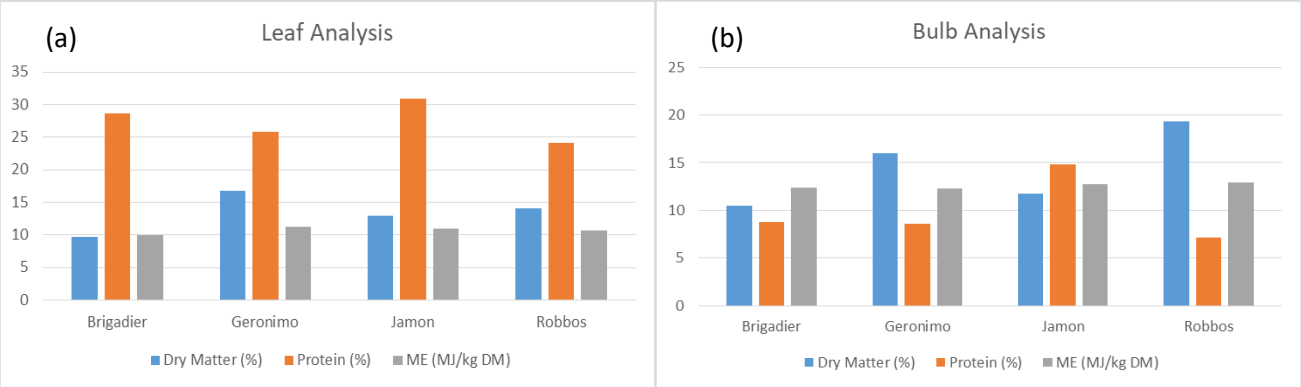

Figure 2: Comparison of the average leaf (a) and bulb (b) analysis for DM (%), ME (MJ/kg DM) and Protein (%) for the 4 fodder beet varieties (Brigadier, Geronimo, Jamon and Robbos) tested on Farm 3.

Table 6.4: Fodder beet quality of Robbos and Geronimo varieties tested on Farm 4.

Farm 4	Robbos		Geronimo		
	Leaf	Bulb	Leaf	Bulb	AVERAGE
Dry Matter %	10.0	16.8	9.7	18.5	15.6
ME MJ/kg DM			8.4	11.7	10.6
Protein %			17.1	5	9.0

Table 6.5: Fodder beet quality of 4 varieties tested on Farm 7.

Farm 7	Geronimo		Jamon		Robbos	Fortimo	AVERAGE
	Leaf	Bulb	Leaf	Bulb	Bulb	Bulb	
Dry Matter %	11.2	18.0	11.1	16.1	17.2	16.6	15.1
ME MJ/kg DM	-	-					
Protein %	29.1	6.9	40.7	9.9	5.1	9.9	17.2

Financial outputs

Based on the data provided by the farmers that was available at the time of writing this report. A range of comparisons have been made for five of the farms involved in this project in terms of their costs to produce 1 MJ ME and 1 kg of protein from their fodder beet crops (Table 7).

These can be compared with similar feed value / cost criteria from typical grass-clover and barley crops and current indicative prices as outlined below:

Feed	£/MJ ME	£/kg CP
Grass	£0.005	£0.273
Barley	£0.013	£1.557
Fodder Beet average	£0.004	£0.402

Based on the fodder beet demonstration trials undertaken in this project and the actual (or in some cases estimated) production costs, cost per MJ ME are in the order of £0.003 to £0.005 which is comparable to that of grass and three times lower than that of barley.

The cost of crude protein from the fodder beet is between £0.19 to £0.72 per kg, with an average of £0.40/kg. When compared with grass, there is £0.129 of a difference, with grass being the least cost option. When comparing with barley, fodder beet is almost four times as lower to produce/kg of protein.

When comparing fodder beet to grass, we are assuming grass at 12 MJ ME/kg DM and 220g CP/kg DM, this level of nutrition would not be sustained throughout the winter months when fodder beet would be utilised.

Table 7: Estimated costs for the production of 1 MJ ME and 1 kg of protein from the fodder beet crops grown by five out of the seven farms involved in this project.

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 7
Fixed Costs	**£**	**£**	**£**	**£**	**£**
Plough		£75.00	£60.54		£45.70
Level			£54.36		£36.56
Disc/Cultivate		£35.00	£37.07		
Spread lime		£10.00			
Sow	£50.00	£75.00	£61.78		£52.83
Roll			£9.64		£12.00
Spray x2/3	£72.00	£60.00	£34.80		£44.46
Fert x2/3	£40.00	£20.00	£23.47		£5.50
Total Fixed Cost	**£162.00**	**£275.00**	**£281.65**		**£197.05**
Cultivation (different to above)				£190.00	
Variable Costs					
Lime		£82.00			£55.60
Seed	£217.50	£107.00	£139.37	£194.00	£181.00
Salt			£42.00	£0.00	
Fertiliser	£265.25	£314.00	£372.06	£267.65	£186.39
Sprays	£262.13	£242.00	£163.78	£62.35	£185.43
Total Variable Costs	**£744.88**	**£745.00**	**£717.21**	**£524.00**	**£608.42**
Total Growing Cost	**£906.88**	**£1,020.00**	**£998.86**	**£714.00**	**£805.47**
Yield (t/DM/ha)	18.7	20	22.87	14.9	20.09
Cost/t DM	£48.50	£51.00	£43.68	£47.92	£40.09
Cost/kg DM	£0.05	£0.05	£0.04	£0.05	£0.04
ME (MJ/kg DM) allowing 2/3 bulb, 1/3leaf	12.1	10.9	11.95	10.6	n/a
MJ/ha	226270	218000	237327	157940	n/a
£/MJ ME	**£0.004**	**£0.005**	**£0.003**	**£0.005**	**n/a**
Protein (g/kg DM) allowing 2/3 bulb, 1/3leaf	161.73	69.1	156.8	90	172.3
g/ha	3024351	1382000	3114048	1341000	3461507
£/gram Protein	**£0.0003**	**£0.0007**	**£0.0003**	**£0.0005**	**£0.0002**
£/kg Protein	**£0.31**	**£0.72**	**£0.28**	**£0.56**	**£0.23**

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Virtual Meetings

01 Virtual Agronomy (Webinar) – 5th June 2019

An hour long webinar was hosted by AHDB and facilitated by Kirsten Williams, SAC Consulting. The action research project was explained to participants. The guest speaker was Dr. Alex Sinclair, SAC Consulting, Senior Consultant and soil and nutrient specialist, who discussed the nutrient requirements of the growing crop, including nitrogen requirements, salt reactions in the soil and timings for applying trace elements. There were numerous questions asked by the virtual participants and excellent feedback was received from this output, which was made available afterwards on the monitor farms hub.

02 Virtual Agronomy (Podcast) - 19th July 2019

Growing conditions started to become a real challenge as the summer progressed for the trial farmers. The temperature was cold, and there was a lack of sun for the crop. Plants had stopped growing and many of the trial farmers were becoming concerned about their crops, lack of growth. In response to this, Jamie Cattell, agronomist with Gardiner ICM and grower of sugar beet was contacted and asked to do a podcast with Kirsten Williams. The aim of the podcast was to address the issues that were being found on farm, and to give tips on what the sugar beet growers have done in the past. This podcast was circulated to the trial farmers, as well as being made public on the monitor farms hub. The advice given in this podcast put the trial farmers mind at rest and allowed for the swift application of trace elements to aid the stressed plants.

03 Virtual Agronomy (Skype Call) – 19th August 2019

Through social media, we learned that a New Zealand seed company (Agricom) were preforming field days to show results of their trials on seed and row spacing. We organised a skype call with Sam Robinson, Agricom and the trial farmers, to hear about the crop in New Zealand and the trial work that was happening. This was a very interactive meeting, with all farmers asking questions throughout Sam's presentation.

This had more focus on the agronomy and growing of the crop. Key aspects of the call included sowing rates, monogerm vs multigerm, and leaf retention and ground preparations.

04 Face to Face Meeting (On Farm) – 11th November 2019

We invited Jim Gibbs, who is a fodder beet specialist, ruminant nutritionist and vet who works for Lincoln University, New Zealand to visit one of the trial farmers and speak to the participating farmers. This was a closed meeting for the trial farmers, to ensure they could all ask questions and get the most value from Jim. This was a phenomenal meeting, with a huge amount of knowledge exchanged in the room. A report summarising the discussions made during the meeting was drawn up and circulated.

This meeting changed the direction of the project, where the focus had largely been about growing the fodder beet crop and looking at varieties. Jim's focus was heavily on the actual potential that the crop has, increasing the level of green leaf retention, the transition of the crop, the class of stock grazing the crop and the best way to maximise utilisation of the fodder beet crop. This allowed for a complete change in mind set for the trial farmers and really sparked an interest of where else this crop could be used.

WhatsApp Chat

This has been a huge asset to the project, letting all the farmers and facilitators connect, share photos and experiences and learn from each other. The project group was also lucky enough for Jim Gibbs to join the chat and impart lots of highly relevant information to the group from his huge amount of knowledge on the subject of growing and utilising fodder beet crops.

Utilisation

This information is primarily derived from the workshop in which Jim Gibbs (NZ based fodder beet expert) was a keynote speaker.

Transition

Transition, especially in cattle is very important to reduce the risk of losses. The best solution was found to involve transitioning over an approximately 2-3 week period. Starting at 1kg DM per animal per day then moving up 2kg DM every two days (or 1kg per day) until they start to leave it. Cattle transition is rigid and inflexible. If cattle are put on to fodder beet too quickly, instead of teaching them to eat the beet more slowly, you can put them off eating the beet. If cattle eat fodder beet too quickly they may feel a bit ill, through a mild dose of acidosis, this makes them associate eating beet with feeling unwell, so tend to avoid it.

Cattle need a period of time to learn to eat beet on an annual basis, so if dry cows are grazed every winter, they will need a period of time to re-train eating the crop the following year. They will take about a week to learn how to eat the beet compared to grass.

Top tips for transition:

1. Have a headland of 6-10 metres of grass or green stubble, to allow the cattle to transition in their own time and not have to rely on a ring feeder for additional forage which can result in some animals not getting forage when they want it. Ring feeders are not ideal due to access issues.
2. Allow 1 metre of fence per animal – access to the fodder beet is as important as allocation
    a. This way the cattle can all access the beet at the same time and choose their plant and eat it
    b. Cattle have a strong preference in the way they eat the beet bulb. They knock the bulb over, eat the middle out, then eat the bottom and leave the crown. They often go and forage or ruminate before coming back to the crown.
3. Assume a 20t DM crop and therefore every m^2 = 2kg of DM. This is an easy way to estimate the crop. If you use rows to transition you will know the width of the rows making it much simpler and more reliable to make the right amount of beet available to the livestock, rather than relying on various members of staffs “metre” steps which can vary hugely. So an average 50cm row x 1 metre length = 1kg DM (for a 20t DM /ha crop).

Set the estimated yield in 5- 10 tonne lots. For example if the crop is estimated to be 28t DM / ha allocate on a 30t /ha DM basis (if 23 tonne assume a 25 tonne crop, etc.). An overestimate of the crop allows for a slightly reduced intake, and limits the risk of over feeding and potentially death of the animal until the transition process is complete.

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In the first few days of allocation, allow for 1kg DM per animal per day, which means the supplement (forage) will be higher e.g. 8kg DM per day. During the second week the level of beet will be increasing so the level of supplement can decrease e.g. 4kg DM per day, thereafter the supplement can be as low as 2kg DM per day.

As the animals transition, they will tend to eat what is easy to forage. So if grass is available, they will choose the grass first, and will gradually introduce themselves to beet. If the supplement offered is silage at the start, ensure this stays as silage and the animals are not offered something else with different nutritional profile, e.g. straw. This staged approach increases the likelihood that the livestock will maximise their intake on the fodder beet rather than other available forage / fodder.

Feeding fodder beet to growing cattle

To maximise intakes and therefor growth rates in growing cattle, you should set up your grazing so that you can see evidence of residues three days behind you. For the current day (Day 0) would be 100% allocation, but you will have left behind 25% of the previous day's beet (1 plant in 4), 10% of the day before that and 5% of the day before that.

Fodder Beet Face

Current Day Fence (Day 0)	100% of beet
Day prior (Day-1)	25% of beet
Day prior to that (Day-2)	10% of beet
Day prior to that (Day-3)	5% of beet

The cattle will move away from the current face and mop up the residual beet left in the area behind from the previous 3 days feeding – this is the most efficient method of utilisation and one of the most difficult concepts to get farmers to undertake in practice. As it is often felt that all of the beet tidied up and grazed behind the fence is a sign of excellent utilisation.

Variety Choice

The higher the dry matter content, the more of the bulb tends to be in the ground. Aged cattle knock beet over and eat it, but young stock won't, so a high dry matter variety for young stock will tend to lead to high wastage as they can't access the buried part of the bulb so easily.

A low dry matter content cultivar usually has less DM yield but it also usually has a higher utilisation rate than a high dry matter cultivar. It is important to realise that the bigger the DM yield doesn't necessarily lead to an improved financial model, but the better the utilisation of the bulb (of even a lower yielding, lower dry matter content variety) and also the high yields of retained leaf will drive profit.

Some cultivars can be unpalatable to stock, if this is the case then the crop loses its advantage. The stock will not eat the bulb and it will leave a lot of wasted crop. However, sometimes factors such as weather and other management can play a role in making a cultivar unpalatable, and this isn't always consistent between seasons.

Key attributes to look for in variety selection – do they keep good leaf long into the season and do the ones that tend to be buried deeper in the ground (generally high dry matter varieties) graze well.

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Sheep

Sheep eat fodder beet in a different way from cattle in that they do not knock the beet over, they eat them as the fodder beet stand in the ground. If the sheep do not like the bulb, they leave it in the ground, however, if they find the beet palatable, they eat will eat the bulb down to the ground, and cone out the bulb inside to below ground level. Sheep are more likely to be selective over palatability of beet over cattle. If sheep find the bulbs to be unpalatable they will just eat the leaf which is wasteful.

A trial was carried out in New Zealand with ewes grazing fodder beet, where their intake was assumed to be 2% of their live weight, although after investigating the figures more closely, they were actually eating 3.1% of their live weight. With a crop with good leaf retention, there should be no need for an additional supplement (forage). If there is no leaf then it is hard to replace, as the supplement will likely be high in fibre and lower in protein which will decrease the intake. The best supplement is grazed grass if it is available.

A high water diet such as fodder beet, increases the efficiency of the rumen. The sheep will urinate approximately one quarter of their body weight e.g. 25litres from a 100kg ewe.

Sheep transition is not as important as cattle transition. They will self-regulate themselves as intake increases, ideally this should be done over a week, with regular switches made between a few hours on and then off the fodder beet. For maintenance feeding e.g. ewes, add supplement feeding. Sheep, like cattle, require space and ideally a large headland to run off the beet. Allow 0.3m face length per sheep. A two day shift is ideal for sheep, to allow for a balance of bulb and leaf availability.

Leafy crops have a high level of protein, so transition with care if tupping on the beet. The main benefit for sheep on a fodder beet system is the ability to raise the stocking rate on the farm by grazing early.

Conclusion

This project allowed for a one year trial, in a very challenging growing year, this has made it very difficult to make firm conclusions. To have more robust data and sufficient information, the trials would need to be repeated over a number of years and under different growing conditions.

The key points that have been taken from this project and that will maximise the potential of fodder beet in Scotland are:

1. Variety choice, especially that of understanding the difference between a monogerm and a multigerm. Where the monogerm will have lower losses due to the seeds being bred as hybrids with one seed per pod. The multigerm variety has higher establishment losses, due to the seeds being bred in clusters, which require mechanical scarifying, to break open the pods to get one seed, this process can damage seeds and germination can be poor.

   Variety choice - the importance of a variety that has leaf retention through the winter and yields dry matter, but is utilisable by the class of stock. E.g. a white high dry matter variety will yield high dry matter but under 50% will be utilised if being fed to sheep.

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2. Having a 6-10 metre headland to ease transition onto the crop. It is absolutely essential to gradually transition animals on to the crop and allow for at least 1m width of feed face for cattle and 0.3m for sheep. Transition in cattle must start at 1kg DM/animal/day. This should not be increased until all bulbs are being cleaned up. Then move up 1kg DM every two days until they start to leave the beet.

3. The crop is extremely high yielding and a very cheap solution to rationing animals throughout the winter per unit of energy or protein. It is a crop that requires attention to detail and a skilled agronomist is essential.

4. Fodder beet is not a brassica crop and should not be treated like one. It requires careful transition management (21 day period for cattle and 7 days for sheep), follow the steps on our guide "grazing – where to start?". Don't be scared by the crop, think of the potential in performance of the livestock and the nutrition that it will deliver.

5. Retaining green leaf in the crop, throughout the winter, maximises the protein content of the crop. This reduces the requirement of offering supplementary feeds such as silage and allows for growing stock to be managed on the crop.

The project farmers key outputs.

I thoroughly enjoyed the last year looking at fodder beet with the group. I think the drip feed of info with a chat group makes the amount of info you receive seem less. The sharing of little and big ideas all year has been invaluable.

The Jim Gibbs meeting has been the highlight, in terms of project outcomes it has given us more questions and things to look into for the future.

Key message – do everything you can, advice from growers especially, to grow the crop well, then figure out how you're going to feed it.

Jamie Leslie

Being connected to other likeminded people. Its good for our business and our mental health.

Jason and Victoria Ballantyne

We have got so much from the group, most valuable part was Dr Jim Gibbs visit. How to transition young cattle onto beet has been a game changer for us. 1kg DM/head/day of silage, the rest of the diet is beet. And leaving 25% day 1, 10% day 2 and 5% day 3. Next year we will look at optimum row spacing.

Key message - ask other growers questions everyone has theory's and ideas but its amazing what you'll learn from a group.

Fearn Farm

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