Northern Crop Research Site

Research Summary 2015

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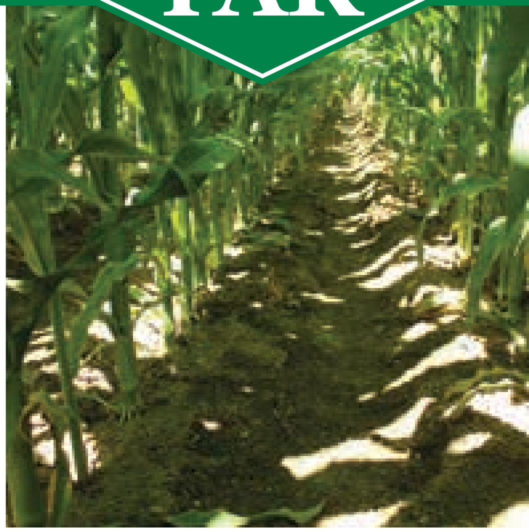

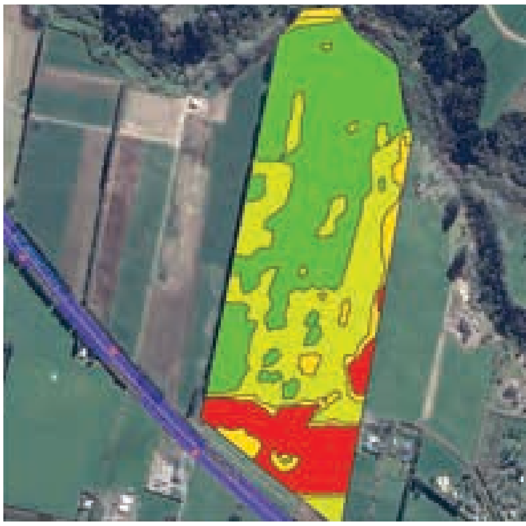

Northern Crop Research Site 2014/15

This publication provides a summary of trials undertaken at Northern Crop Research Site over the 2104/15 season, and their results. Key take home messages are provided for each trial.

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2014/15 summary

FAR's Northern Crop Research Site is located at 82 Oaklea Lane, Tamahere, near Hamilton.

At the Northern Crop Research Site FAR runs research trials and demonstration plots in order to provide quality research and extension activities for New Zealand, and particularly North Island, cropping farmers.

Staff

Allister Holmes joined Mike Parker in the Waikato during 2014, and in January 2015 FAR established an office at Ruakura. Being sited at the Ruakura science hub alongside research providers such as AgResearch, Plant & Food Research, Landcare Research and Lincoln Agritech, allows regular interaction on existing and new research projects.

Sam McDougall was employed to help with the 2015 harvest and has since been employed full time to help manage the Northern Crop Research Site and to plan and undertake trials. Mike and Sam manage and maintain the site, and organise the multiplicity of different crops, sowing dates and treatments.

Field days

Over the year, FAR hosted hundreds of growers and industry personnel at Northern Crop Research Site field days. The first, in November, looked at a number of trials while the maize crop was still below waist height (V7-8) including: cropping systems, row spacing, and legumes for nitrogen supply to maize and weed control trials. December saw a visit from FAR's Northern North Island Arable Research Group (ARG) to view all the trials. A further field-walk was held in January to visit the Maize Performance Trial (MPT) and to revisit the weed control trials when the crop was at full height. In March a group of growers, organised by PGG Wrightson, visited the Maize Hybrid Performance Trials (MPT).

Site changes

The main change at the site has resulted from the continuing development of the State Highway 1 expressway. Unfortunately this development has cost us a 20 metre strip along the roadside, which contained some of our Long Term Cultivation Trial plots.

We also removed two large trees stumps from the paddock to the left of the entrance, and levelled out this area, which will ultimately provide a much better area for growing crops. For the 2015/16 season we will undertake a cover crop and weed control trial in this block, but will avoid the areas where the stumps have been buried until the soil consolidates in future years.

New FAR office at Ruakura.

The 2014/15 season saw the total trial area expanded by three hectares. Trial areas were also divided by grass laneways into areas of similar soil textural classes and water holding capacity. This was a result of the previous year showing up areas of the site more prone to drought stress. By separating these into separate blocks we maintain greater uniformity within trials, and allow better access to the individual trials.

Weather

The weather leading up to spring 2014 was warm and dry, however, in late September and October temperatures were cooler and wetter than usual, and the growth of many very early planted maize crops in the Waikato was interrupted. Maize development was slower due to lower than average temperatures and from January onwards conditions turned hot and dry leading to drought stress across the region. We believe this resulted in a lower than usual level of disease pressure. Table 1 summarises the rainfall received over the growing season.

Table 1. 2014/15 rainfall at Northern Crop Research Site.

	Oct	Nov	Dec	Jan	Feb	Mar	Six Month Total
2014/15 (mm)	101.4	82.2	78.2	25.2	46.6	73.2	406.8
% of 1981-2010 Mean	101%	92%	74%	31%	63%	87%	57%

Long term cultivation trial

Take home messages

- Full cultivation, strip-till and direct planting had no significant effect on mean maize yield over seven seasons.
- Soil moisture level trial results were inconclusive – it will take a few seasons for cultivation practice to change soil characteristics.

The aim of the long term cultivation trial (LTC) is to compare the effect of conventional tillage, strip tillage and direct planting of maize on crop performance each year, and also their long term effects on soil conditions. The LTC trial has been established for seven years, with each treatment being repeated on the same plots each year.

Unfortunately, due to the SH1 expressway development, we have lost two of the replicated plots in the trial, however we will continue to run the trial and gather valuable data.

We have also established a new trial, similar to the original, on another block on the site. The new trial has three treatments: no-till, strip-till and full cultivation, with four replicates of each. Plots are 94 m long by a minimum of eight rows wide.

In conjunction with Karen Muller at Plant & Food Research we have measured baseline data around soil bulk density, water infiltration, and water holding capacities as well as the usual plant populations and yields. The crop was planted into soil at near field capacity moisture.

Soil moisture levels in the new long-term cultivation trial were regularly assessed through the growing season and produced some surprising results. We expected the direct drill and strip till treatments to have greater water availability than conventional tillage, however direct drill results showed slightly less soil moisture overall, with strip tillage tending to have the greatest water availability. The soil moisture content lines for all three treatments showed the same trend over the season, which suggests the crops are growing at a similar rate, which is in line with the harvest results. Soil moistures were recorded from 0 - 120 cm deep, with the 40 – 50 cm (Figure 1). The explanation for these results might be that the new trial site is in its first year after ten years of cultivation and needs more time for the treatment effects to establish.

This trial was harvested for grain by combine, and weighed by weigh wagon, as opposed to many of our trials which are hand harvested. The yield of all treatments (Table 2) did not differ significantly.

Soil bulk densities were recorded in the new trial a couple of weeks before harvest (Table 3). Higher readings indicate more compacted soil conditions, although all readings at the site are relatively low. It is difficult to pull out early trends, but we should have a better idea of effects and trends in the future.

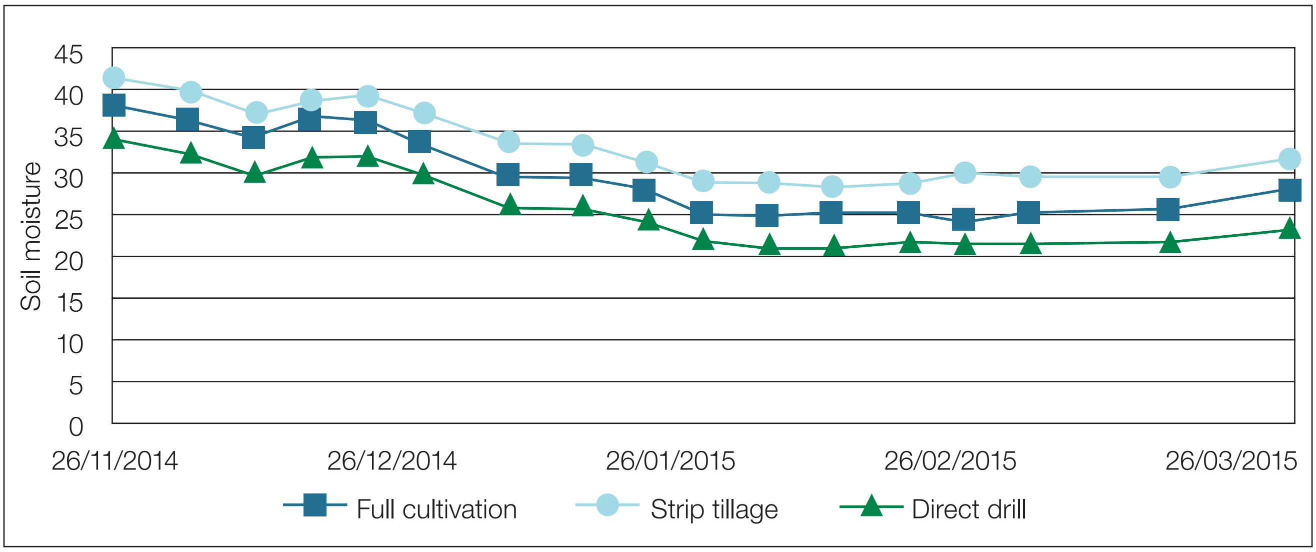

Figure 1. Soil moisture data for layer 40 – 50 cm for three tillage methods, 2014/15.

Table 2. Mean grain yields, old and new long term cultivation trials 2014/15 (t/ha).

	Old cultivation trial	New cultivation trial	Mean of both trials	2008-2015 mean for old LTC
Full cultivation	12.71	10.47	11.22	11.8
Strip till	10.95	10.34	10.54	11.3
Direct drill	11.82	9.41	10.44	11.9

Table 3. New long term cultivation trial soil bulk densities recorded (kg/l).

	0-10 cm depth	10-30 cm depth
Full cultivation	1.0275	0.9379
Strip till	1.0166	1.1690
Direct drill	1.0658	1.0993

Figure 2. No-till maize planted directly into stubble from previous maize grain crop.

Maize herbicide trial

Take home messages

- Annual summer grass weeds were late to establish due to the cold spring.
- Pre-emergent acetachlor (Roustabout®) followed by post emergent topramezone (Arietta®) provided the best overall weed control, but was also the most expensive treatment.

Background

The aim of the herbicide trial was to evaluate the efficacy of commercially available herbicide treatments on weed cover in maize plots. This trial always receives great interest from growers at fieldays.

FAR commissioned AgResearch to undertake this work. The trial was planted on 13 October 2014 and regular rainfall occurred until the end of November, with the pre-emergence herbicide only treatments (treatments 2-4, Table 4) providing a good level of weed control for the entire season (80% or higher). This level of weed control may be adequate depending on the species of weeds present and the stage of maize growth.

Annual summer grasses were late establishing due to the cold spring, with the main flush emerging around mid-December. The post-emergence herbicide treatments were targeted mainly at grass weeds, and were applied on 13 December 2014. Broadleaf weeds were at different stages of growth at this time of spraying, with some large plants (up to 7 leaves) present, particularly in the plots treated with Ace™ 840 pre-emergence (Treatments 10 and 11).

The main broadleaf weeds at the site were fathen, prostrate amaranth, pink shamrock, twin cress and broad-leaved dock. Weed species present in low numbers included chickweed, redroot, black nightshade, willow weed, purslane, Apple of Peru and shepherd's purse. The grass weeds present included summer grass, barnyard grass, smooth witch grass, Indian doab and some yellow bristle grass.

Of the pre and post-emergence spray programmes evaluated, pre-emergent Roustabout® followed by post-emergent Arietta® (Treatments 5 and 6) provided the best overall weed control (99 %+). Roustabout® followed by Arietta® was also the most expensive combination with the chemical cost of $180/ha. Ace™ 840 (acetachlor) followed by the a Callisto® mix (Treatment 11) that included the wetting agent Megawet™ and used only half the volume of water (100 L/ha) was the most cost effective at around $110/ha and provided 97% weed control overall. It also gave much better control of a persistent oxalis population compared to the standard Ace™ 840/Callisto® mix (Treatment 10). Treatment 11 is worth investigating further.

Other pre + post-emergence treatments that provided very good weed control were acetochlor + atrazine followed by nicosulfuron (Treatments 7 – 9) which would cost between $150 - $170/ha. These results are outlined in Table 4.

Figure 3. Herbicide treatment 1. Photo taken 13/01/2015.

Figure 4. Herbicide treatment 5. Photo taken 13/01/2015.

Table 4. Herbicide application rates, weed control effectiveness and application costs of herbicide treatments.

	Pre-emergence				Post-emergence				Grand Total	Cover (%)	Control (%)
Trt no	Product	Chemical Group	Rate (Product/ha)	Cost* ($/ha)	Product	Chemical Group	Rate (Product/ha)	Cost* ($/ha)	Cost* ($/ha)	13.01.15	13.01.15
1	Untreated	-	--	$0.00		-	-	$0.00	$0.00	98	0
2	Roustabout®	K	3000 mL	$59.85		-	-	$0.00	$59.85	7	80
3	Roustabout® Gesaprim®	K C	3000 mL 3000 mL	$59.85 $29.94				$0.00	$89.79	5	87
4	Roustabout® Sharpen®	K G	3000 mL 150 g	$59.85 $95.41					$155.26	2	95
5	Roustabout®	K	3000 mL	$59.85	Arietta® Gesaprim® Hasten™	F C -	200mL 1000 mL 0.5%v/v	$103.68 $9.98 $10.26	$183.77	<1	99
6	Roustabout®	K	3000 mL	$59.85	Arietta® Gesaprim® Hasten™	F C -	200mL 1000 mL 0.5%v/v	$103.68 $9.98 $10.26	$183.77	<1	100
7	Roustabout® Gesaprim®	K C	3000 mL 3000 mL	$59.85 $29.94	Astound® Ultra	B	1500 mL	$103.68 $9.98 $10.26	$154.95	2	97
8	Roustabout® Gesaprim®	K C	3000 mL 3000 mL	$59.85 $29.94	Latro® 750 WG Bonza®	B	80 g 0.5%v/v	$68.00 $12.61	$170.40	3	95
9	Roustabout® Gesaprim®	K C	3000 mL 3000 mL	$59.85 $29.94	Neeko™ Oleo	F	1000 mL	$61.86	$151.65	2	96
10	Ace™ 840	K	3000 mL	$47.35	Callisto® Atraflow™ Synoil™	F C -	200 mL 1000 mL 1%v/v (200 L/ha water rate)	$47.23 $5.58 $18.14	$118.30	6	92
11	Ace™ 840	K	3000 mL	$47.35	Callisto® Atraflow™ Megawet™ Megawet	F C -	200 mL 1000 mL 1%v/v 0.1%v/v (100 L/ha water rate)	$47.23 $5.58 $9.07 $3.20	$112.43	2	97
12	Dual Gold®	K	2000 mL	$79.80	Cadet® Gesaprim® Actiwett	F C -	40 mL 3000 mL 0.075%v/v	n/a $29.94 $4.65	$114.39 + Cadet	4	90
13					Callisto® Gesaprim® Synoil™	F C -	200 mL 1000 mL 1%v/v	$47.23 $9.98 $18.14	$75.35	10	90
14					Callisto® Gesaprim® Synoil™	F C -	200 mL 1000 mL 1%v/v 1500 mL	$47.23 $9.98 $18.14 $65.16	$140.51	1	98

Reduce nitrogen input to maize by growing winter active legumes

Take home messages

- Growing a winter clover crop followed by maize, with no added N fertiliser, may be more profitable than growing maize with N fertiliser.
- The yield of maize grown with no additional applied nitrogen fertiliser following a winter clover crop was the same as maize grown with full N fertiliser applied.
- Growing a winter legume crop, followed by maize with no N inputs may be a viable cropping system.
- More research is being undertaken in 2015/16 season.

Background

Maize is often grown in rotation with winter grass or oats which may be grazed. An alternative approach is to grow a winter legume crop that is either incorporated into the soil in spring or inter-cropped during summer. The potential N benefit to the maize crop depends on factors that influence the amount of N fixed by the legume and subsequent release characteristics. Understanding these dynamics can help farmers decide on the value proposition of incorporating legumes into their rotation (instead of grass) and optimise the subsequent fertiliser N management of the maize crop.

The aim of this work was to quantify how much and how quickly N is supplied from a selection of different winter legumes, in order to be able to calculate the optimal supply of N fertiliser to a subsequent maize crop for maximum silage yield and minimal residual soil N.

Methods

In autumn 2014 four winter crops were sown at FAR's Northern Crop Research Site, following cultivation of a previous maize silage cropped area. These were three winter-active clovers and a Tama ryegrass control. Each treatment was replicated four times. The clovers were Sensation red clover, Prima Gland clover and Balansa clover. In spring, two different cultivation practices (strip tillage to check growth and allow inter-cropping, or full incorporation, to terminate winter crop growth) were imposed on top of the winter crops. Summer maize was then planted on 13 October (P0021 @ 90,000 seeds per hectare). No fertiliser N was applied, so the amount of N returned to maize by the various winter crop types could be calculated throughout the summer season.

Key measurements included:

- Initial soil characteristics. Basic soil nutrients, soil organic profile, mineral N background fertility.
- Final winter crop biomass productivity and soil N indicators immediately before cultivation in spring. Above-ground total biomass provided crop performance data for the clovers and grass. Crop N removal and soil mineral N provided information on the estimated interim N balance under each treatment. Root biomass was not measured due to practical limitations; instead, the subsequent maize crop was a useful indicator of the amount of N that was present in the roots. Regular measurements of the total above-ground biomass provided an estimate of the rate and amount of N released from each of the winter covers. Soil mineral N was not measured on these occasions.
- Final biomass productivity and soil characteristics at silage maturity provided crop performance data for the maize. Crop N removal and soil mineral N provided information on the estimated final N balance.

Performance of the winter crops

Winter crop biomass yields in September, when the strip-tilling/intercropping and cultivation/non intercropping treatments were imposed, were low. Ryegrass and gland clover yielded 3.1 t/ha while the other clovers averaged 0.8 t/ha. N removal was also generally low, the Italian ryegrass control removed 30 kg N/ha and the clovers 24 to 90 kg N/ha.

The red clover was the only species to survive the strip-tillage, and its total yield, including winter production and inter-row production totalled 10.7 t/ha.

Clover biomass yields and N concentrations increased rapidly in the intercropping treatments when the clover was left to grow longer. However, the only treatment to survive strip-till cultivation was the red clover which yielded an additional 10.0 t DM/ha after strip tillage as undertaken, with N removal of 237 kg/ha. The red clover competed significantly with the subsequent

maize crop for moisture and the maize only yielded 9.9 tDM/ha. This competition may be less significant in a season with more rainfall.

Despite low productivity over the winter growth period, N balance values within the clover were all positive (up to 91 kgN/ha) which implied a net increase in N availability over the winter growth period compared to the ryegrass control.

Performance of the summer maize

There was strong evidence of increased maize yields in the balansa and gland clover treatments, with the maize yields from these plots averaging 17 and 23.7 t/ha respectively, with N removal of 78 and 122 kgN/ha. These yields were significantly greater than the ryegrass control which averaged 7.9 tDM/ ha with N removal of 46 kgN/ha. The fully fertilised border treatments yielded 22.4 tDM /ha by way of comparison.

Discussion

Different clover species vary in their ability to grow over winter, with gland clover being the most productive at this time. Gland clover has two benefits: first it produces additional dry matter over the winter, and second it improves the performance of the subsequent maize crop. Using gland clover over winter before a maize crop gives an overall benefit of around $1,000/ha, depending on the cultivation method used. Further work is needed to see if these system can be used over several seasons without a reduction in maize crop performance.

Figure 5. Foreground is Prima gland clover, then Balansa, Tama ryegrass, sensation red clover. (9 Sept).

Figure 6. This picture illustrates the comparison between the Italian ryegrass control (foreground), followed by the red clover and Prima gland clover cultivated/non intercropped plots. The ryegrass used available nitrogen to grow, and then microbes used the N to break down organic matter once the ryegrass was killed off.

Table 5. Biomass yield and N removal in four different winter crops and subsequent maize crops.

		Balansa clover	Gland clover	Red clover	Ryegrass cv. Tama
Winter crop	**Yield (t DM/ha)**	0.9	3.1	0.7	3.1
	Yield from strip-till to maize harvest (t DM/ha)	0	0	10.7	0
	Nitrogen removal (kg N/ha)	24	90	26	30
Maize crop biomass yield (t DM/ha)	**Strip till**	19.4	22.1	9.9	7.8
	Cultivated	17.0	23.7	20.0	7.9
Maize crop nitrogen removal (kg N/ha)	**Strip till**	89	97	57	45
	Cultivated	78	122	113	46
TOTAL yield (t DM/ha)	**Strip till**	20.3	25.2	20.6	10.9
	Cultivated	17.9	26.8	20.7	11.0

Table 6. Financial effect of four different winter crops in subsequent maize crops.

		Balansa clover	Gland clover	Red clover	Ryegrass cv. Tama	No winter crop[1]
TOTAL yield (t DM/ha)	Strip till	20.3	25.2	20.6	10.9	-
	Value of dry matter[2] ($/ha)	$5,075	$6,300	$5,150	$2,725	-
	Cultivated	17.9	26.8	20.7	11.0	22.4
	Value of dry matter ($/ha)	$4,475	$6,700	$5,175	$2,750	$5,600
	Cost of fertiliser ($/ha)	$0	$0	$0	$0	$175[3]
Gross margin benefit above standard[4]	Strip till	-$350	+$875	-$275	-$2,700	-
	Cultivated	-$950	+$1,275	-$250	-$2,675	$0

[1] 'No winter crop' results taken from border adjacent to trial
[2] Value of dry matter assumed to be 25c/kg DM
[3] 200 kg/ha DAP (17.6 % N, $875 /tonne ex. GST)
[4] Calculated from value of dry matter less cost of fertiliser

This work is part of a Ministry of Primary Industries Sustainable Farming Fund Project, Reducing the Environmental Footprint of Arable Crops. This project is led by FAR with support from Environment Canterbury, DairyNZ and the Hawkes Bay Regional Council.

Clover sown under maize

Take home messages

- It is difficult to establish clover under established maize just by broadcasting seed.
- More research being undertaken 2015/16 season.

As a follow-on from the legume trial, it was decided to try and establish red clover under established maize once the maize crop reached about knee high. We believed that if we could do this, the red clover would not grow much while the maize had total canopy cover, but would be established and ready to grow in the autumn once the maize was harvested, providing a significant head start to the crop in comparison to post-harvest sowing. Seed was applied to the surface of the soil by broadcasting on either 12 December 2014, or 17 February 2015.

Prior to harvest a visual assessment was made of the level of clover establishment in the plots, and it was found to be very poor. This was attributed to the dry summer, and the fact that the seed was not covered at sowing. However, after grain harvest the stubble was spread, and after autumn rains some clover plants were found to be present.

There is great interest in the possibility of planting legumes under established maize, or before maize, and in winter 2015 we have established various winter cover crops to investigate the relationship between cover crops, herbicides and weed control in following maize crops.

Fungicide trial

Take home messages

- The incidence of disease, as expressed by leaf symptoms, did not differ between fungicide treated and untreated plots.
- Significant increase in yield of fungicide treated plots over untreated plots, despite low levels of fungal diseases present.

Background

Most maize crops in New Zealand do not have any foliar fungicide applied in the growing season. The aim of this trial was to evaluate whether fungicides applied to maize ultimately increased the yield of the crop.

A demonstration trial was run to assess the effect of applying fungicides to maize crops. Strips of six different hybrids with a range of fungal disease resistance ratings were grown. Half of these strips had no fungicide applied, and the other half had two applications of a combination of Opus® (active ingredient epoxiconazole from the triazole family) and Comet® (pyraclostrobin from the strobilurin family). Planting was carried out late in the season (27 November 2014) in order to increase the chances of common rust pressure from neighbouring earlier plantings. One fungicide application was made at the V7 stage (waist height) and one just before silk and tassel emergence. Sprinkler irrigation was applied weekly to moisten leaves in an attempt to increase fungal disease pressure.

Grain harvest results returned a considerable difference between the treated and untreated plots, with fungicide treated plots having a mean of 10.8 t/ha and untreated plots 7.4 t/ha. The result was found to be statistically significant at the 90% confidence level.

We were somewhat surprised by this result and we wondered what caused the difference in yield if it was not related to leaf tissue damage. Some fungicides are known to delay senescence and prolong green leaf retention. We also know that moisture is critical at pollination, and at the time of flowering this past season the plants in this trial were under considerable moisture stress, although leaves did not visually appear stressed. Therefore a fungicide application helping to maintain green leaf retention would likely result in increased yields.

We carried out a field scale, replicated trial in late planted maize at an irrigated site in the Hawkes Bay and no significant differences in disease symptoms or yield were recorded.

International research has found that strobilurin fungicides can increase yield even in the absence of disease. For example, benefits such as improved stalk strength, and water and nitrogen use efficiency may result from fungicide use in corn, and these claims are appealing to producers looking to retain standability of corn at harvest. As a result, many fungicide applications across the U.S. Corn Belt are made in anticipation of these perceived benefits, rather than being made in response to disease or a disease threat. Further work in 2015/16 will continue to investigate the role of fungicides in increasing maize yields under a range of environmental conditions in 2015/16.

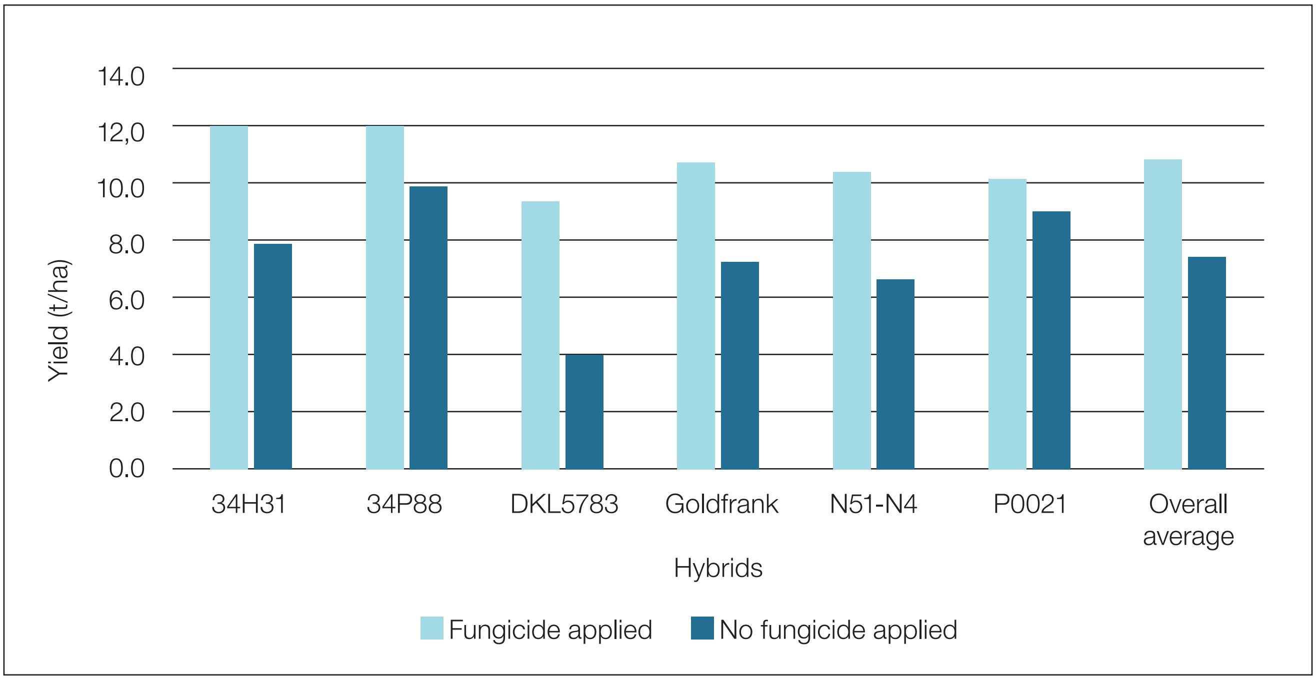

Figure 7. Northern Crop Research Site fungicide trials 2014/15, grain yields, adjusted to 14% moisture.

Figure 8. The photos above show the difference in cob pollination between fungicide treated (left) and untreated (right) crops.

Maize population and spacing trial

Take home messages

- Increasing seeding rates do not necessarily lead to increased yield.
- Trial results were inconclusive, but highlighted the effect of different levels of hybrid flex on yields.

Background

The aim of this work was to investigate the effect of population and row spacing on maize crops. Almost all maize in New Zealand is planted at 76 cm row spacings, however some maize planters can plant at row spacings varying from 38 cm to 76 cm, or plant two rows close together, with the centres at 76 cm. Growers have expressed interest in FAR undertaking maize population and spacing research. We used two hybrids with differing abilities to adapt to low population densities, with Genetic Technologies Ltd rating 34H31 as 4 out of 9 for low population adaptability, and 34P88 a 9 out of 9.

Each treatment was replicated four times. Plots were either eight rows at 76 cm spacing (30 inches), single row; or 16 rows at 38 cm spacing (15 inches), double row. The single row spaced plots had three population densities 75,200, 84,600 or 94,000 seeds per ha, while double row spacings had densities of 76,000, 86,000 and 94,000 seeds per hectare.

The double rows were established using a conventional planter returning between the rows using the GPS. This resulted in variability in seed emergence, possibly due to variable soil compaction caused by the planter wheels. The seeds were planted at fixed rates, but plant populations at harvest varied. Table 7 illustrates this variability.

Grain harvest results varied (Table 8). There is reduced yield from the 34H31 hybrid at the lower plant populations in 76 cm row spacings. Overall the effects of seeding density on yield were not statistically significantly different.

Figure 9 shows that as population increases at conventional row spacing (76 cm), yield increases, but at the narrow row spacings yield decreased as population increased for both hybrids. It is likely that the effect of row spacing and plant population is affected by the particular site, season and hybrid planted.

For the 2015/16 planting season we will undertake more plant population work, looking at populations from 75,000-120,000 seeds per hectare at 76 cm row spacing on the yield and feed quality of maize silage.

We hypothesise that narrow row spacings will allow reduced plant population per hectare, and we intend to carry out more research in the future. However, the availability of suitable planters for row spacing work is a challenge we need to overcome.

Table 7. Mean calculated plant populations as counted at harvest (plants/ha).

Seeding rate/ha	75200	76000	84600	86000	94000	94000
Row spacing	Single (76cm)	Double (38cm)	Single (76cm)	Double (38cm)	Single (76cm)	Double (38cm)
34H31	76772	80052	87927	87270	93832	95801
34P88	65617	75459	75459	70866	81365	79396
Combined	71194	77756	81693	79068	87599	87599

Table 8. Mean calculated grain yields (t/ha).

Seeding rate/ha	75200	76000	84600	86000	94000	94000
Row spacing	Single (76cm)	Double (38cm)	Single (76cm)	Double (38cm)	Single (76cm)	Double (38cm)
34H31	9.73	11.11	10.74	11.66	10.72	10.75
34P88	11.02	11.61	12.13	11.62	12.02	11.10
Combined	10.38	11.36	11.44	11.64	11.37	10.92

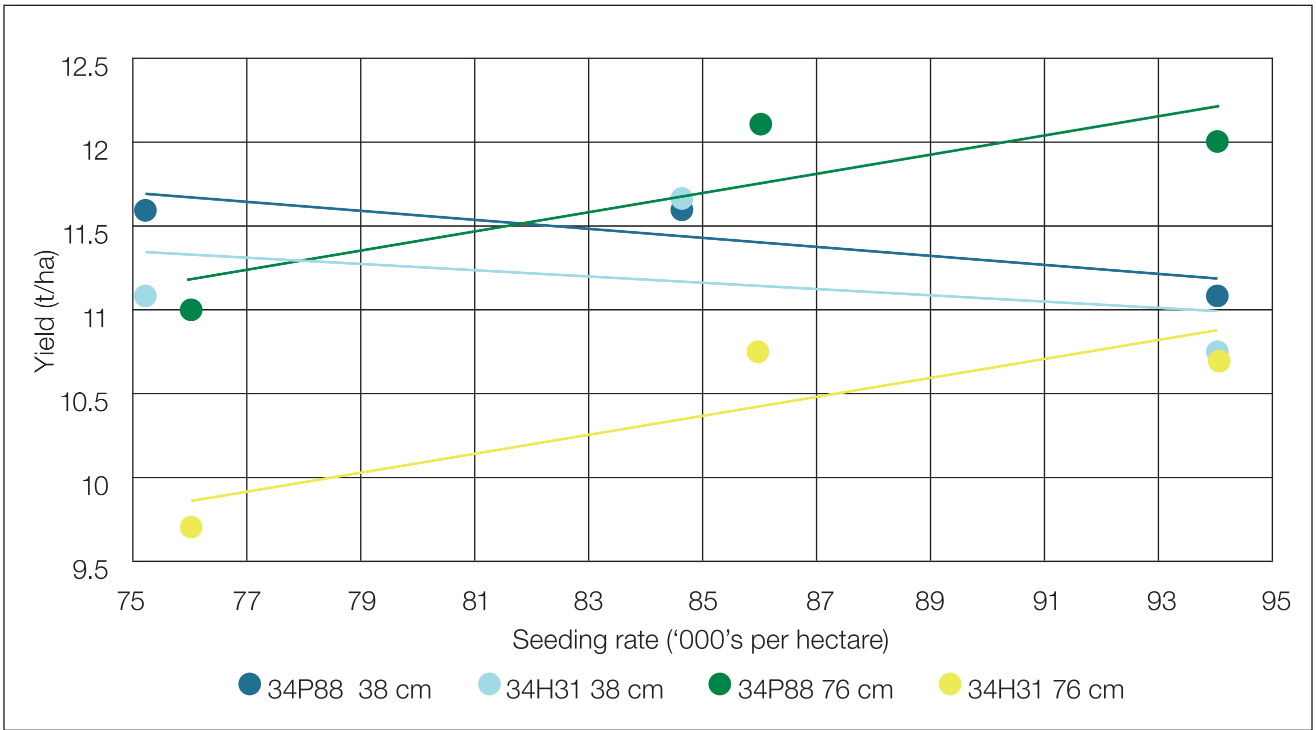

Figure 9. Yield versus seed rate for different row spacings.

Maize Hybrid Performance Trial (MPT)

Take home messages

- The first year of this programme has gone well, and its value will increase over the coming years.
- No significant yield differences were identified between leading hybrids.

Background

For a number of years maize growers have been asking for an independent maize hybrid testing scheme which would provide objective measurements of the agronomic and quality performance of commercial maize hybrids available to the New Zealand arable industry across appropriate production regions. In 2014 an industry based Maize Technical Committee developed operating procedures for a Maize Hybrid Performance Trial Programme (MPT) and the protocol for the inaugural year of the scheme was broadly identified.

It was agreed that:

- The purpose is to foster industry adoption of proven hybrids to maximise industry efficiency and profitability.
- A pilot testing programme for maize grain and silage hybrids was to be established at four trial sites in spring 2014. These were in Waikato (2 sites), Bay of Plenty and Canterbury. The trial design was a fully replicated, small plot design which included agreed standard hybrids for comparison.
- Additional New Zealand maize grain and silage growing regions will be brought into the scheme as experience is gained with the trialling procedures.
- Any seed company may enter a hybrid into the scheme. It is expected that their hybrids will be backed up with their own trial data, and that seed will be either available commercially or be very close to (within 1 year) commercialisation. There will be a cost to entering hybrids into the scheme.
- Analyses of the trial results will be carried out by an independent statistician. The development of an independent maize hybrid testing programme is a considerable investment for the industry collectively, but a well operated scheme should reduce individual company investment, and as a consequence grower investment, in developing hybrids. Seed companies will pay to have their hybrids included in the scheme. Maize levy money will be invested in the governance of the programme, analysis of the results and reporting.

We deliberately started at a pilot scale in order to allow the industry to evaluate the scheme's purpose and value. Results given in the Maize Hybrid Performance Evaluation booklet are from a single year's trials at three sites. The results provide an independent and objective evaluation of the performance of the hybrids in the trials, but one year's data may not reliably indicate the performance of a hybrid due. In order to make good use of the results of these and other trials please consider the following:

1. Use multi-year data. These trials are from the first year of the MPT trial programme.
2. Use multi-location average data. Consider single location results with caution.
3. Evaluate consistency of performance of the hybrids you are interested in over years, across locations in other zones. Look for hybrids that are consistently in the top group, and beware of hybrids that have widely varying performance across various sites and seasons.
4. Look at other reliable, unbiased, replicated independent trial results focusing on consistency.
5. Test new hybrids on your farm before planting large areas.

One of the three MPT sites in the 2014/15 season was established at Northern Crop Research Site, and the results from this site are outlined in Tables 9 and 10.

In the 2015/16 season further sites will be established in Manawatu and Rangitikei, and on peat soil in the Waikato. A full copy of the MPT results booklet can be found on the FAR website **far.org.nz**.

Table 9. Silage harvest results from MPT trial at Northern Crop Research Site 2014/15.

HYBRID	Days to 50% Silk Emergence		Plants per Hectare		Days to Harvest		Harvest Dry Matter (%)		Yield (t DM/ha)	
C29-A1	88	i	84598	g	143	b	39.3	a	26.3	a
33M54	96	a	96799	ab	147	a	33.0	efgh	25.8	ab
PAC 456	93	d	88430	fg	147	a	35.3	bcde	24.9	abc
C78-S8	95	b	92800	bcde	147	a	30.3	hi	24.2	abcd
Z71-F1	94	c	91957	cdef	143	b	31.2	ghi	24.2	abcd
PAC 343	94	c	93758	bcde	143	c	34.6	cdef	23.9	abcde
G49-T9	91	f	92853	bcde	143	b	37.2	abc	23.6	abcdef
PAC 432	95	b	90250	ef	143	b	36.1	bcd	23.5	bcdef
C56-C4	92	e	98935	a	141	d	35.7	bcde	23.4	bcdef
N39-Q1	90	g	97030	ab	143	b	37.7	ab	23.2	bcdef
PAC 230	91	f	92374	cdef	143	b	37.5	abc	22.4	cdef
P0021	91	f	95858	abc	140	e	32.2	fghi	22.4	cdef
P0791	93	d	94728	abcd	141	d	29.8	i	21.6	def
Goldfrank	93	d	94474	bcde	143	b	35.6	bcde	21.3	ef
34P88	93	d	91129	def	147	a	34.6	cdef	21.2	ef
37Y12	89	h	95225	abcd	140	e	35.5	bcde	21.0	f
Mean	92.1		92165.7		143.1		34.6		23.2	
LSD @ 10%	0.5		4320.2		0.3		0.8		2.9	
CV%	0.40		4.00		0.20		6.00		10.40	

Note: Hybrids with the same letter beside them are not significantly different for the characteristic listed.

Table 10. Grain harvest results from MPT trials at Northern Crop Research Site 2014/15.

HYBRID	Days to 50% silk emergence		Plants per hectare		Harvest moisture (%)		Test weight (kg/hl)		Yield (t/ha @ 14% moisture)	
C29-A1	88	i	84598	g	21.6	ef	72.9	ab	14.6	a
PAC 432	95	b	90250	ef	24.7	b	69.5	de	13.4	abc
PAC 230	91	f	92374	cdef	21.4	f	72.3	bc	13.2	abc
P0021	91	f	95858	abc	23.3	cd	72.1	bc	13.2	abc
N51-N4	93	d	92166	cdef	24.3	bc	71.0	cd	13.2	abc
PAC 343	94	c	93758	bcde	23.8	bcd	72.4	bc	13.0	abc
37Y12	89	h	95225	abcd	21.7	ef	74.2	a	12.6	bcd
Goldfrank	93	d	94474	bcde	23.4	cd	69.8	de	12.3	cd
34P88	93	d	91129	def	27.8	a	68.4	e	11.8	cd
C56-C4	92	e	98935	a	22.8	de	73.2	ab	11.8	cd
N39-Q1	90	g	97030	ab	21.8	ef	69.5	de	11.3	d
Mean	92.1		92166		23.2		71.6		12.9	
LSD @ 10%	0.5		4320.2		1.3		1.7		1.7	
CV%	0.40		4.00		4.60		2.00		11.00	

Forages for Reduced Nitrate Leaching

Small plot trials to test crop management strategies for feeds with reduced N loading

Take home messages

- Potassium had no effect on fodder beet yield.
- Nitrogen had little effect on rape and sorghum yields.
- Fodder beet, forage rape and sorghum all compensate well for low plant populations.

Background

The Forages for Reduced Nitrate Leaching project aims to identify good management practices for producing feed of high nutritional value and low N content suitable for grazing or conservation. This research will consider how the crops are going to be used and what percentage of the diet will be composed of the supplement.

In Waikato grazing systems, crops are required primarily for summer and autumn supplementation of pasture for dairy cows. Feed quality needs to be high to support production up to 1.1 to 1.2 kg milk solids/cow/day and to maintain cow condition. Protein requirements for lactation are 15-16% in the whole diet. We propose to identify crop and management combinations to meet these requirements while improve environmental outcomes. In the 2013-14 and 2014-15 seasons at the FAR Northern Crop Research Site, the range of crops tested in small plot trials included rape, sunflowers, soya beans, linseed, fodder beet, sorghum, oats, chicory and maize.

In the 2014-15 season, we tested the effects of nitrogen and potassium fertiliser on yield and forage quality of fodder beet (cv. Jamon), and also plant population and nitrogen interactions in forage rape (cv. Goliath) and forage sorghum (cv. BMR Revolution, a brown mid-rib, low lignin cultivar). Potassium at nil vs 350 kg KCl/ha had no effect on the final yield of fodder beet. Similarly, nitrogen fertiliser had little effect on the final yield of rape and sorghum.

Yield differences due to nitrogen rate (0 vs 100 kg N/ha) were apparent in some intermediate harvests in fodder beet and rape, but were not significant at maturity. The yield results showed that fodder beet, forage rape and sorghum all compensated well for variable population, and that the soil provided sufficient N and K to maintain near optimum uptake. There were visual differences in biomass between the control and N fertiliser plots, and differences may appear in herbage quality once data analysis is complete.

Forages for Reduced Nitrate Leaching is a DairyNZ-led programme researching the possibilities of diverse pasture species and forage crops to reduce nitrate leaching while maintaining or enhancing profitability of farming enterprises. The programme is directed to dairy, arable and sheep and beef farms. The collaborating research organisations are DairyNZ, AgResearch, Plant and Food Research, Lincoln University, FAR and Landcare Research. The main funder is the Ministry of Business, Innovation and Employment; all partners co-fund the programme.

Figure 10. Fodder beet crop showing difference between two different nutrient treatments.

Figure 11. Forage rape in centre, chicory to left, sorghum to right.

Forage sequence trial

Take home messages

- A combination of autumn and spring sown crops can provide an alternative, and equally high yielding, source of dry matter production to the traditional maize-annual ryegrass rotation.
- A high yielding autumn crop can compensate for yield lost with a delayed maize sowing.

Background

The aim of this trial is to maximise dry matter production and fulfil forage quality requirements by testing alternative cropping rotations for dairy runoff and support blocks. Waikato maize crops can produce very high yields, however, their management often leads to preceding or following crops being harvested early or established late, thus compromising the yields of these other crops. This trial is part of a project investigating crop sequences to maximise total dry matter production over three years or more. The sequences that were planted were:

Standard:
ryegrass – maize – ryegrass – maize

Mixed crop and animal:
triticale – forage sorghum – barley – maize –

Cropping:
faba bean/clover – maize – clover – fodder beet –

Quadrats were cut to assess dry matter production, and samples were analysed for feed quality. The results are outlined in Table 11.

After one full year of the rotation the three crop sequences have achieved similar yields. Figure 12 shows the relative dry matter production of each crop, ranging from the majority of the yield contributed by the spring crop (maize) in the traditional rotation to a higher yield from the autumn crop (triticale) in an alternative rotation. This also illustrates that a similar annual forage yield can be obtained by delaying the sowing date of maize by a month to maximise yield of an autumn sown crop. Two high yielding forage crops in a year can spread risk and cash flow, and fill more feed gaps in pasture-based operations. The various crops grown in the trial cover a range of feed qualities, and crops can be selected to fill nutritional needs at certain times of the year. Additional potential benefits from including alternative crops in the rotation, such as nitrogen fixation from legumes and breaking disease and pest cycles are expected, but have not yet been quantified.

To date no total gross margin analysis has been undertaken, but it is expected there will be large differences in cost associated with growing different crops.

Table 11. Forage sequence performance at the Northern Crop Research Site in 2014/15 season.

Crop	Total DM yield t/ha	Days	Production Kg/ha/day	Harvest date	CP %DM	ADF %DM	NDF %DM	Soluble sugars %DM	ME
Annual ryegrass	8.7	166	52.4	11/09/14 24/10/14	13.9	24.7	41.6	17.6	11.9
Early maize	26.4	173	152.6	01/04/15	6.7	24.4	41.1	3.3	10.2
TOTAL	35.1	339	103.5						
Triticale	21.1	218	96.8	15/12/14	6.2	33.2	52.3	10.7	8.1
Forage Sorghum	14.3	122	117.2	08/01/15 16/02/15 15/04/15	16	29	55	7.8	10.3
TOTAL	35.4	340	104.8						
Faba beans + clover	17.6	218	80.7	15/12/14	15.7	31.5	42.3	12.1	10
Late maize	16.1	137	117.5	01/05/15	6.2	20.3	35.8	4.65	11
TOTAL	33.7	355	94.9						

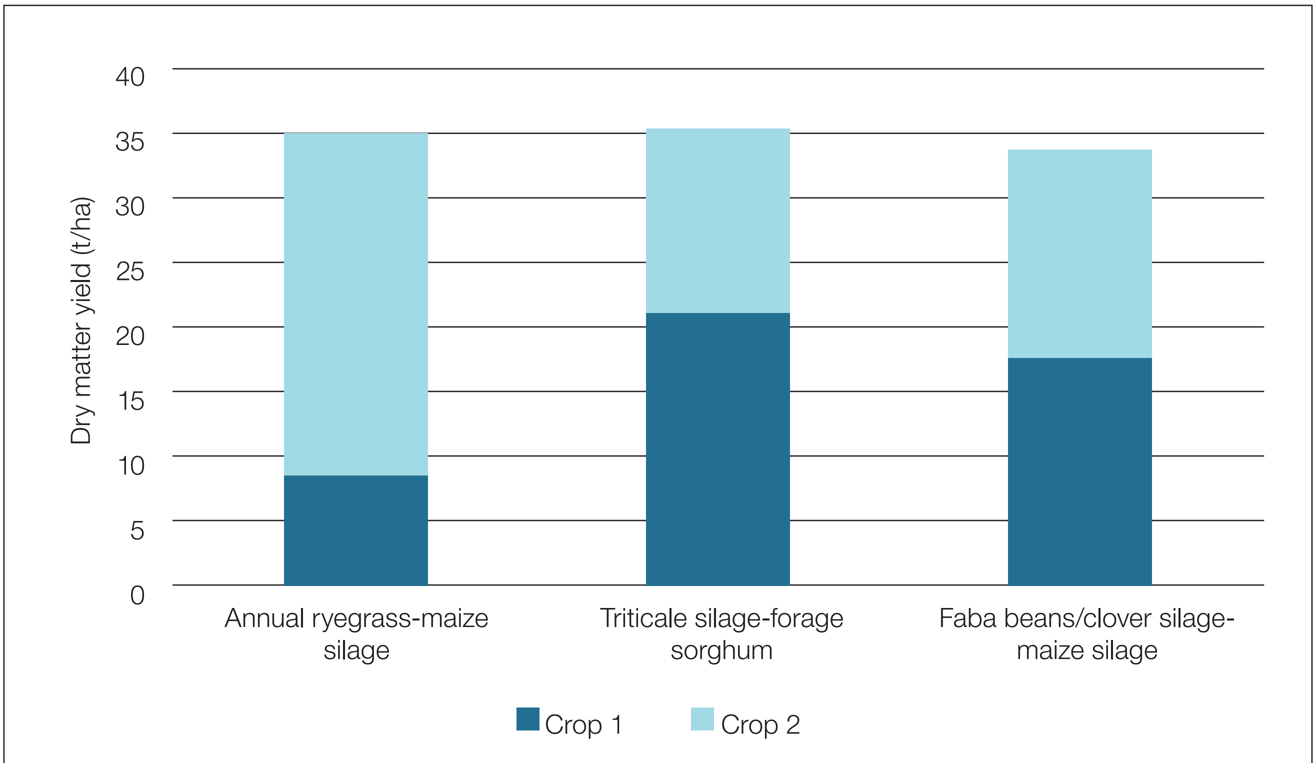

Figure 12. Total dry matter yield from each rotation after two crops.

Fence line herbicide trials – avoiding glyphosate resistance

Take home messages

- Metsulfuron added to glyphosate is an effective and economic alternative to glyphosate alone.
- To avoid risk of weeds developing glyphosate resistance add metsulfuron to the glyphosate spray mixture once every 4-5 applications.
- If more persistence is needed, add terbuthylazine to the glyphosate mix.

Background

The aim of this trial was to investigate alternative herbicide options for long term weed control along fence lines, driveways and buildings which will help to avoid development of resistance to glyphosate. The main weed species present included:

- Milkweed (*Euphorbia peplus*)
- Chickweed (*Stellaria media*)
- Hedge woundwort (*Stachys silvatica*)
- Stone parsley (*Sison amomum*)
- Cleavers (*Galium aperine*)
- Sow thistle (*Sonchus oleraceus*)
- Hedge mustard (*Sisymbrium officinale*)
- Black nightshade (*Solanum nigrum*)
- Velvety nightshade (*Solanum chenopodioides*)
- Nipplewort (*Lapsana communis*)
- Henbit (*Lamium amplexicaule*)
- Fathen (*Chenopodium album*)
- Broad-leaved dock (*Rumex obtusifolius*)
- Blackberry (*Rubus fruticosus*)
- Cocksfoot (*Dactylis glomerata*)
- Perennial ryegrass (*Lolium perenne*)
- Prairie grass (*Bromus willdenowii*)
- Indian doab (*Cynodon dactylon*).

Applications of different herbicides were applied to sections of a fence line at the Northern Crop Research Site and at the FAR research site at Chertsey, Canterbury.

At the first assessment one month after spray application, glyphosate alone (Treatment 1) received an average score of only 75%, due to poor control of blackberry and docks. New weed seedlings also appeared in these plots in large numbers. Combinations of glyphosate with metsulfuron or oxyfluorfen (Treatments 2 and 3) provided the best results, with very few new seedlings appearing in these treatments. The addition of oxadiazon (Treatment 4) did not improve efficacy over glyphosate alone, but its residual activity stopped new weed growth. Amitrole (Treatment 5) had the lowest efficacy (73%) and new seedlings also appeared in this treatment. Treatments 6 and 7 had lower efficacy on blackberry but provided good control of all other weeds and showed good residual activity.

The mixture of glyphosate with metsulfuron was the most cost-effective treatment for controlling weeds along fence lines. It provided excellent initial activity on weeds in both trials, and also had the second longest residual activity. Its cost is considerably lower than other treatments and only slightly higher than glyphosate alone.

TAG™ G2, a mixture of four herbicides, all from different herbicide mode of action groups, was another good treatment with excellent efficacy and residual activity. It is expensive, but as it did not require repeat spraying for the duration of either trial, it could be an acceptable alternative for rotating herbicides to avoid development of glyphosate resistance.

This work was part of a Ministry of Primary Industries Sustainable Farming Fund Project, Avoiding Glyphosate Resistance. This project was led by FAR with support from the Vegetable Research and Innovation Board, the Road Controlling Authority NZ, Dairy NZ, BASF and Nufarm and assistance from Waikato and Horizons Regional Councils.

Table 12. Treatments and costs in the fence line trials.

Tmt no.	Herbicide name (active ingredient)	Chemical group	Product Name	Product (Litres/ha)	Cost/ha ($)	Applications per year	Cost/ha/yr
1	Glyphosate	M	Weedmaster® TS 540	2.7	29.70	3	89.10
2	Glyphosate + metsulfuron	M B	Weedmaster® TS 540 + Escort®	2.7 + 0.05	36.20	1	36.20
3	Glyphosate + oxyfluorfen	M G	Weedmaster® TS 540 + Oxy™ 250 SC	2.7 + 6	320.10	2	640.20
4	Glyphosate + oxadiazon	M G	Weedmaster® TS 540 + Oracle®	2.7 + 4	385.70	2	771.40
5	Amitrole	Q	Activated amitrole + surfactant	6.0	193.20	2	386.40
6	Glufosinate + oxyfluorfen	N G	Vixen™	6.0	298.80	2	597.60
7	Glyphosate + amitrole + terbuthylazine + oxyfluorfen	M Q C G	TAG™ G2	20.0	592.00	1	592
	Untreated		N/A	-	0.00	-	-

Miscanthus

Take home messages

- Miscanthus grows rapidly and could be a useful shelter plant.
- Feed quality is low.

Background

Miscanthus is a rapidly growing gross feeder that is highly efficient at up taking applied nutrients. If a block of Miscanthus was grown on dairy farms, and effluent was applied, it is possible that the Miscanthus could uptake much of the applied nutrients, thereby minimising the risk of nutrient leaching and loss, and capturing the nutrient. Miscanthus is a perennial C4 grass, and can be used for stock bedding, feed, biofuel or other uses. The aim of this demonstration plot is to observe the establishment and growth of Miscanthus.

The Miscanthus was planted in late September 2014, and weed control was undertaken using atrazine and alachlor applications in common with the adjacent maize block.

In May 2015 we took a sample of Miscanthus for feed analysis (Table 13).

These results would indicate limited use for animal feed. However, in spring 2015 the Miscanthus was mulched to about 200 mm above ground level, allowing fresh growth which will also undergo feed analysis. We will measure dry matter production and feed analyses over multiple cuts.

Table 13. Feed analysis of Miscanthus harvested May 2015.

Analysis	Value
DM%	37.1%
CP %DM	7.9%
ADF %DM	42.6%
NDF %DM	67.8%
OM %DM	92.5%
Soluble Sugars %DM	7.9%
Starch %DM	1.8%
Crude Fat %DM	2.0%
DOMD %	35.8%
ME	5.7
Non-structural carbohydrate	14.7%
OMD in vivo	38.7%

Figure 13. Miscanthus, November 2014, two months after planting.

Figure 14. Miscanthus, November 2015.

Large scale crop rotation trial

Take home messages

- The forage pea cultivar used in this trial matured very rapidly, making harvest timing difficult.
- Spring sown faba beans are prone to high disease pressure.

Background

In the United States the classic cropping system includes a rotation of maize for grain one year, followed by soybeans for grain the following year. In New Zealand we are yet to discover a profitable legume crop to include in the maize crop rotation. The aim of this large scale crop rotation trial was to evaluate various legumes as possible rotation crops with maize. Approximately 2000 m^2 each of Enrich Clover, AP2 Peas, and Ben faba beans were planted on 25 September 2014, and maize was planted alongside on 10 October 2014.

Harvest was carried out in January 2015. The faba beans developed two distinct areas within the crop, one of which had dried down much more quickly than the other (70.4% DM). The peas dried off very quickly, and by harvest the foliage was very dry, however this was not reflected in the harvest dry matter result. The Enrich clover suffered severe lodging and rots were appearing in the lower stems. The Enrich clover regrew after this harvest, but by September 2015 there was very little dry matter production.

Because the forage pea crop rapidly progressed from immature to over-mature we believe it has limited value as a forage crop in the Waikato. Also, the spring sown faba beans developed a high incidence of Chocolate Spot (*Botrytis* sp.), and ultimately developed poorly, and wilted severely. We have had much better results with autumn sown faba beans.

After harvest of these crops, barley cv. Bumpa was established on the faba bean and pea plots, the clover was left to regrow, and annual ryegrass cv. Tama was planted on the maize stubble.

In the 2015/16 season a trial has been planted into this site to assess the value of the legume on the following maize crop. It is likely that there will be significant reserves of nitrogen in the soil fixed by the legumes.

Figure 15. Clover cv. Enrich, Faba bean cv. Ben to left, maize to right (23/01/2015).

Table 14. Harvest results from large scale crop rotation trial, Northern Crop Research Site 2014/15.

Crop	Harvest date	Days to harvest	Dry matter (%)	Dry matter (t/Ha)	Protein (%)	Dry matter production (kg/Ha/day)
Peas cv. AP2	06/01/2015	103	24.4%	11.8	-	114.6
Faba bean cv. Ben	29/01/2015	126	45.3%	11.1	14.8	88.1
Clover cv. Enrich	29/01/2015	126	17.4%	8.0	14.5	63.5
Maize	05/03/2015	143	35.5%	23.2	5.6	162.2

Soil mapping and precision agriculture

Take home messages

- Assess variability of paddocks.
- Determine if there is value in managing variability to improve profitability.
- FAR managing SFF Project *Transforming Variability to Profitability*.

Background

In late 2014 FAR used a Veris MSP3 machine to carry out on-the-go soil testing at Northern Crop Research Site. The aim of this was to identify areas of soil quality variation on the site by measuring soil pH, organic matter and electrical conductivity. Figure 16 shows Northern Crop Research Site from the air in February 2014. This was during a period of drought, and the areas of variation can be seen clearly in the image.

Results from the Veris MSP3 machine showed variation similar to the patterns in the image above. Figure 17 shows the patterns of electrical conductivity, with higher readings in green, and lower readings in red. Lower readings are indicative of coarse soil texture, and therefore lower moisture holding capacity. This sort of information has been used by some growers in the South Island to develop Variable Rate Irrigation scheduling with the aim of maximising water use efficiency and crop response to the water, thereby improving profitability.

While irrigation is not common on cropping land in the Northern North Island, it may be possible to use this information to inform decision making for other inputs. For example, areas of different soil textures and characteristics could receive different sowing populations, fertiliser and lime applications etc.

Figure 18 shows the zones of different pH readings at Northern Crop Research Site. pH affects crop uptake of nutrients, and by understanding variation of pH in crop paddocks, it will be possible to apply lime at different rates according to the need of the area, rather than based on the average of the whole field.

It is vital that the information gained from this sort of soil mapping technology can be used to improve profitability, either by increasing income or decreasing costs. To this end FAR has begun a MPI Sustainable Farming Fund project, *Transforming variability to profitability*, which aims to increase the uptake of precision agriculture technology through the development of easy-to-use systems for transmitting and interpreting data. The project will include a stocktake of precision agriculture technologies available in New Zealand. It will also use available PA tools to carry out geo-spatial analysis of soil characteristics and to measure yield and quality of barley, maize and potatoes from those soils.

The aim of this project is to identify soil and crop characteristics associated with profitability, and the creation of a simple system to allow the development of site-specific crop management plans using geospatial soil and crop sensing data. It is hoped that these outputs will, in turn, encourage the adoption of precision agriculture and increase the efficiency of inputs such as water, agrichemicals and nutrients.

This work is part of a Ministry of Primary Industries Sustainable Farming Fund Project, Transforming Variability to Profitability. This project is led by FAR with support from the Landcare Research, NZ Centre for Precision Agriculture, John Austin Limited, AS Wilcox & Sons, Potatoes NZ and Smart Ag Solutions.

Figure 16. Northern Crop Research Site from the air showing variability (Trevor James, 25/02/2014). Measurements from the marked area can be seen in Figures 17 and 18 below.

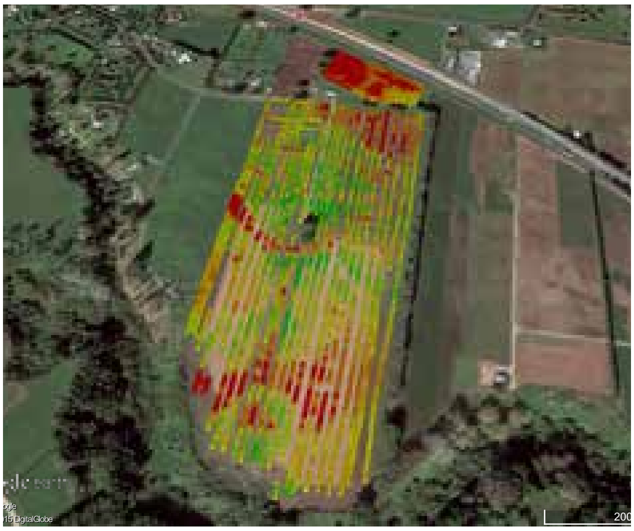

Figure 17. Results from the Veris MSP3 machine testing at Northern Crop Research Site late in 2014. Green indicates higher levels of electrical conductivity, with lower readings in red.

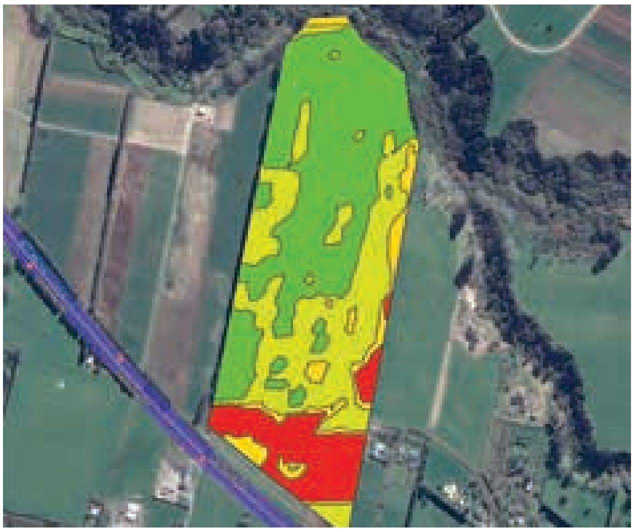

Figure 18. Zones of different pH readings at Northern Crop Research Site.

Endnote

This is the first time FAR has produced an annual summary of trials undertaken at Northern Crop Research Site. We hope that the results presented are of value to you. If you have any comments or observations about the work reported on here, or have suggestions to make about further work you would like to see done, please contact us:

Allister Holmes
Research & Extension Team Leader
allister.holmes@far.org.nz
027 833 1155

Mike Parker
Research Manager – Agrichemicals
mike.parker@far.org.nz
021 960 078

Sam McDougall
Field Research Officer
sam.mcdougall@far.org.nz
0274 688 8803

Nick Pyke
CEO
nick.pyke@far.org.nz
021 374 083

Alan Henderson
Board Member
Northern North Island
07 871 9934

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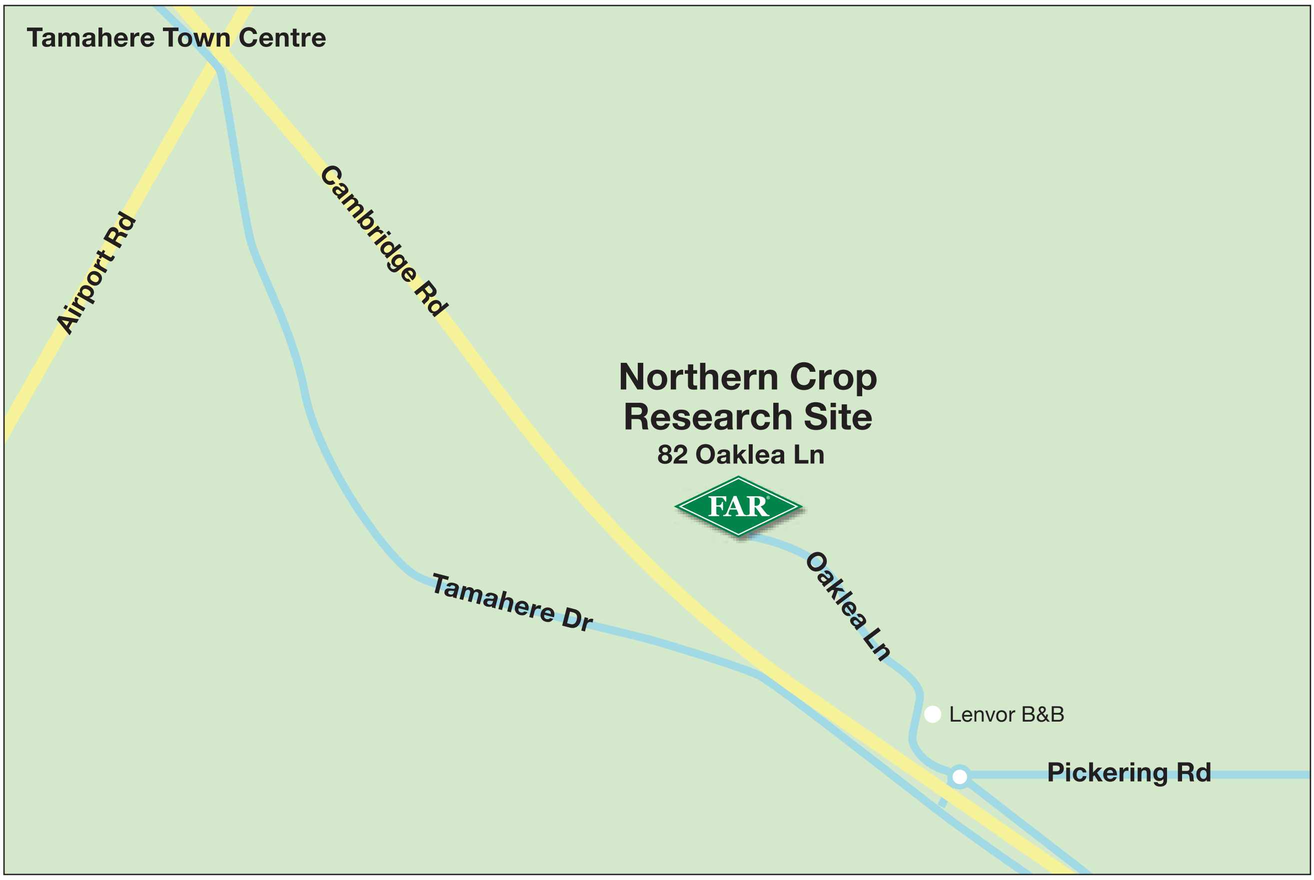

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Foundation for Arable Research

PO Box 23133, Templeton, Christchurch 8445, New Zealand
Phone: +64 3 345 5783 • Fax: +64 3 341 7061 • Email: far@far.org.nz • Web: www.far.org.nz