Northern Crop Research Site Field Day

Northern Crop Research Site
Oaklea Lane, Tamahere

Thursday 14 December, 2017

On behalf of the Foundation for Arable Research, welcome to this year's Northern Crop Research Site field day.

We hope that you make the most of this opportunity to view a range of FAR trials and hear up-to-date research findings from New Zealand and overseas experts.

We have worked hard to create a programme covering a range of crop management issues, and encourage you to participate fully in all discussions and deliberations. The aim of this day is to provide you with information and ideas that will help you to solve problems and create new opportunities in your cropping business. Presentation titles and speakers are outlined over the page, and summaries can be found further on in the booklet.

What's on?

The programme and map over the page outline the times and locations of all of today's presentations. Each speaker will give their presentation twice - once in the morning, and again in the afternoon. Each talk is around 20 minutes long and will be followed by time for questions and discussions. There will also be the chance to talk to speakers at lunch time and at the end of the day.

Lunch and end of day barbecue

Lunch will be available after the morning presentations finish at 12.30pm. A barbecue and refreshments will be served immediately after final presentations at 3.00pm.

Questions?

Should you require any assistance throughout the day, please don't hesitate to contact a member of the FAR team who will be more than happy to help.

We are confident that you will leave the event with new information to assist you in making critical farm management decisions and to improve the economic and environmental performance of your crop production system.

Enjoy your day

The FAR Team

Northern Crop Research Site Field Day 2017

Thursday 14 December 2017

Topics and Speakers

1. Cover crop interactions with herbicides for weed control.
Mike Trolove and Trevor James, AgResearch

2. Inter row-sowing.
Sam McDougall, FAR

3. Variable rate seeding for maize.
Allister Holmes, FAR

4. Nutrient management for maize – a New Zealand update.
Matt Norris, Plant & Food Research and Diana Mathers, FAR

5. Nutrient management for maize – a US perspective.
Jim Camberato, Purdue University

6. Benefits of no-till maize establishment.
Allister Holmes, FAR

7. Agrichemical application and Work Safe NZ – are you compliant?
Mike Parker, FAR and Murray Beare, Educhem

8. Preserving the quality of forages with good silage management and the role of silage inoculants.
Jakob Kleinmans, NutriAssist

9. Crop resilience to climatic variability – can we grow good maize consistently?
Bob Nielsen, Purdue University

Timetable

<table>
<tr><th>10.30 am</th><th>11.00 am</th><th>11.30 am</th><th>12.00 pm</th><th>12.30 pm</th><th>1.30 pm</th><th>2.00 pm</th><th>2.30 pm</th><th>3.00 pm</th></tr>
<tr><td rowspan="9">Welcome</td><td>2</td><td></td><td></td><td rowspan="9">Lunch in marquee</td><td>2</td><td></td><td></td><td rowspan="9">Refreshments & barbecue</td></tr>
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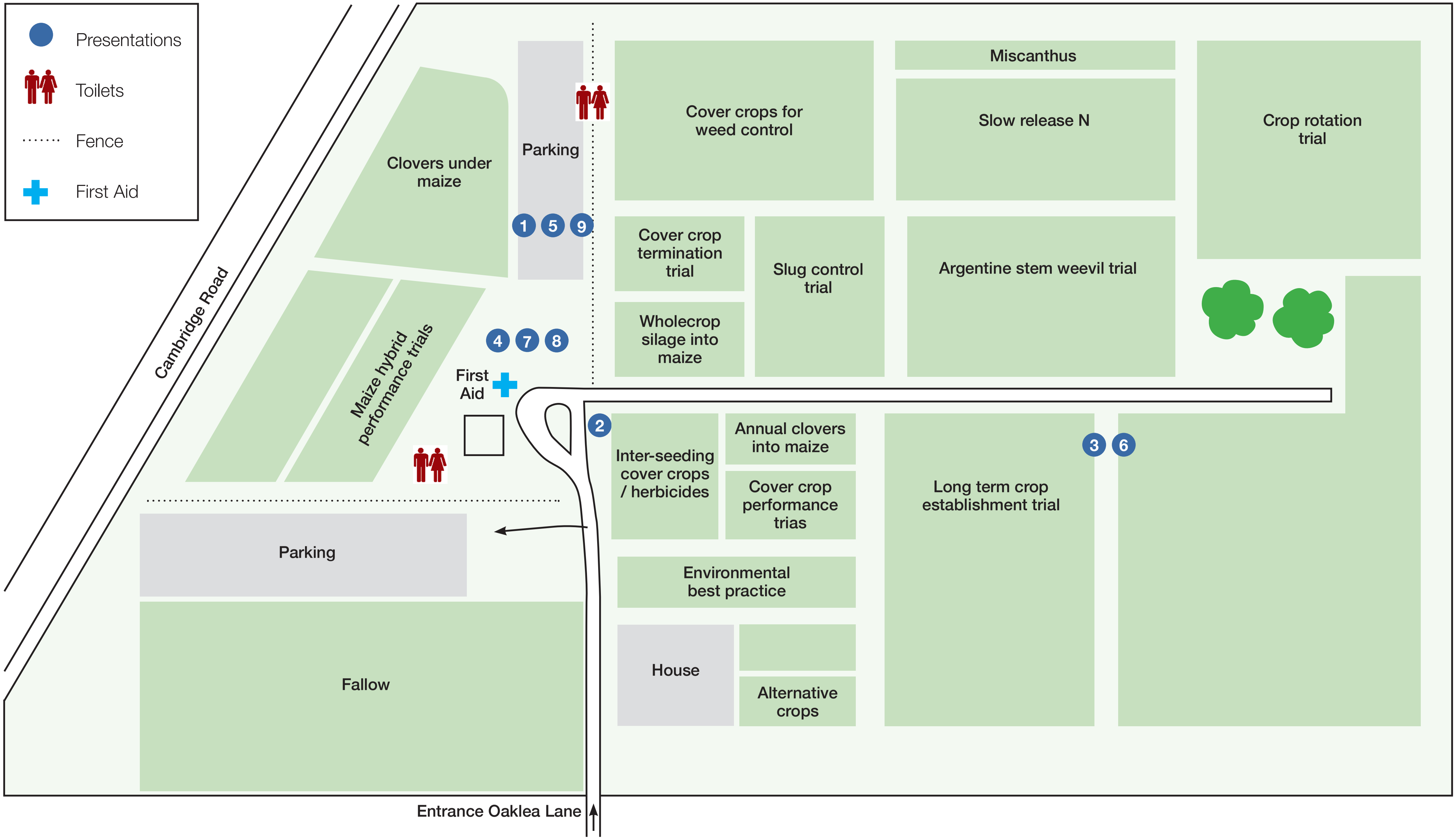
Northern Crop Research Site Map

82 Oaklea Lane, Tamahere, Hamilton



Winter cover crops to reduce herbicide inputs in maize crops (Year 2 - 2016/17)

Mike Trolove and Trevor James, AgResearch

Background

- Four winter cover crops were planted 2 June 2016: faba bean (cv. Ben), gland clover (cv. Prima), oats (cv. Milton) and annual ryegrass (cv. Tama). A strip was left fallow for comparison.
- Three days prior to maize planting these cover crops were pushed over and sprayed with herbicide and then left on the surface.
- Maize (cv. Pioneer 9911) was no-till planted on 27 October 2016.
- Parameters studied included winter cover crop persistence, the emergence and growth of weeds, herbicide inputs, maize silage and grain yield.

Key results

Cover crop residues:

- Oat and ryegrass residues provided a good physical barrier to weed incursion. Residue breakdown was slow with >70% cover remaining on the soil surface at maize canopy closure (10 weeks after emergence).
- Clover residues broke down rapidly within the first two weeks with only 6% remaining at maize canopy closure. They also provided good weed suppression.

Weed cover:

- Pre and/or post-emergence herbicide regimes all provided good weed control.
- Without any herbicide (untreated plots) weed ground cover in ryegrass, oats or gland clover plots was 81-85% less than the winter fallow plots (Figure 1).

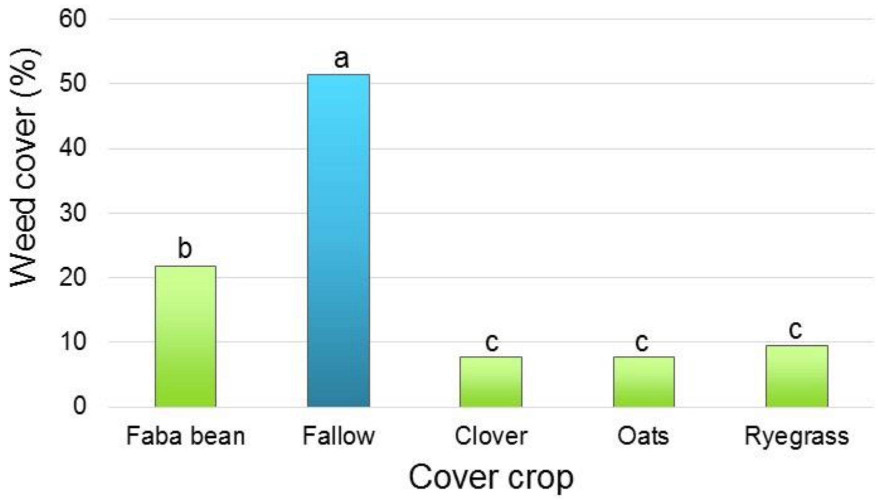


Figure 1. Weed cover (%) at maize canopy closure (10 weeks after emergence) of the four winter cover crops and fallow treatment.

Maize silage yield:

- Maize silage yields were significantly higher in plots with residues of gland clover and faba bean compared to oats and ryegrass. Fallow plots were intermediate (Figure 2).
- There was no difference in silage yield between different herbicide treatments, including the untreated plots, due to low weed pressure and adequate summer rainfall. Herbicides gave no increase in yield.

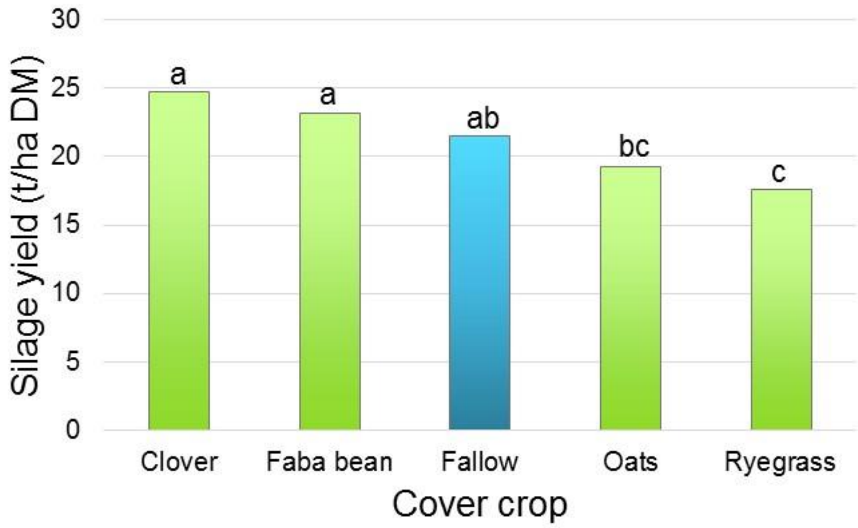


Figure 2. Maize silage yield (15 Mar 2017), pooled according to cover crop.

Maize grain yield:

- As with silage yields, maize grain yields from the gland clover and faba bean plots were significantly higher than from the oat and ryegrass plots (Figure 3).
- There was no difference in grain yield between different herbicide treatments, including the untreated plots.

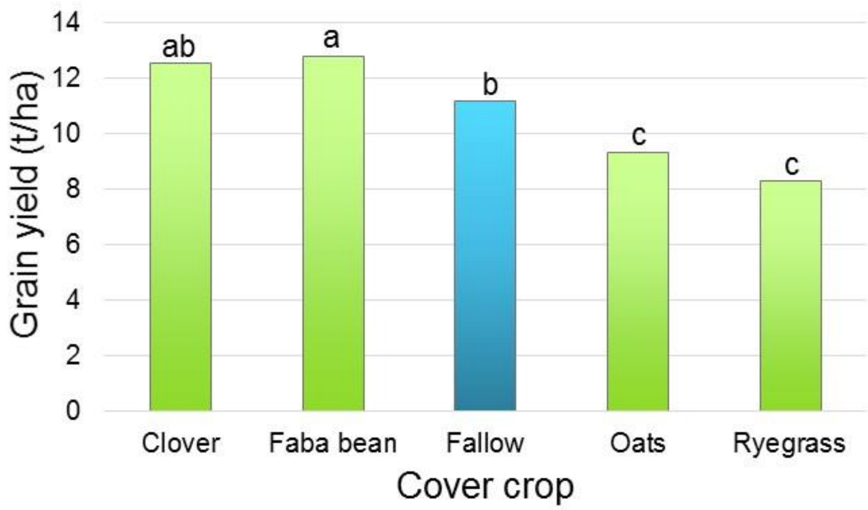


Figure 3. Maize grain yield (2 May 2017), pooled according to cover crop.

Looking ahead to Year 3 (2017/18 season)

- The trial and cover crops were repeated in the exact same place. The aim is to evaluate the use of this cover crop system over successive years.
- A wetter than average autumn and winter meant winter crops were planted late (11 June 2017), with establishment and yield less than 2016/17 season, especially gland clover.

Table 1. Yield of winter cover crops for 2017 (harvested 2 November 2017).

Crop	DM (kg/ha)	Yield compared to 2016
Gland clover	316	70% less
Faba bean	3330	16% less
Oats	4929	26% less
Ryegrass	2323	50% less

Inter-row seeding of cover crops within maize – current work update

Sam McDougall, FAR

Key points

- A range of perennial/biannual plant types inter-seeded at V5 produce considerable quantities of dry matter by the following spring.
- Over the last two years hand sown cover crop seed established well approximately 40 days after saflufenacil and acetochlor herbicide application at maize stage V5.

Background

Establishing a winter cover crop following maize grain or after late harvested silage crops can be difficult, especially if paddocks are wet. This often leads to maize ground being left fallow over the winter, which has associated environmental costs. Thus, identifying a method of establishing winter cover crops post-harvest in wet seasons, could provide significant environmental benefits, as well as economic returns from the crops.

Since 2015, FAR has been working on developing methods for inter-row seeding cover crops into established maize as an approach to minimising winter fallow and developing valuable forage.

Strengths of inter-seeding

- Avoids complications of getting onto sodden ground after late harvested maize to sow cover crops.
- Potential to capture solar energy during autumn period when maize is dying down and utilise this for production.

Weaknesses of inter-seeding

- Annual species such as cereals, annual ryegrass, faba beans and annual clovers are likely to establish more easily and may be more productive than slower growing inter-seeded perennial/biannual species when sown after earlier harvested maize silage crops.
- Inter-seeding is new to most growers and management is different to other crops. As such, a good understanding of new crop management techniques is required.

Inter-seeding research at NCRS

General findings from 2015/16 inter-seeding cover crops in maize trial

The 2015/16 trial received a pre-emergence herbicide application of saflufenacil (Sharpen^{TM}) and acetochlor (Roustabout^{TM}) only.

- The perennial/biannual cover crops (red clover and chicory) sown at the V5 stage established better and had a better survival rate under the maize canopy than crops sown at the V8 stage.
- Annual cover crop species (faba beans, lupin, Persian clover and annual ryegrass) sown at V5 and V8 struggled to survive the season under the maize canopy.

- Annual cover crops performed well when seeded in March as the maize dried down. This approach has a lot of potential but requires greater outlay from growers to get over mature crops (e.g. highboy seeders or aircraft contractors).
- The herbicides used appeared to have little effect on the establishment of buried seed, but some effect on seed broadcast at V5.
- Presence of cover crops did not affect maize yields.

Overview of 2016/17 inter-seeding cover crops small plot trial

The 2016/17 trial received a pre-emergence herbicide application of saflufenacil (Sharpen™) and acetochlor (Roustabout™) only. Maize sown 27 October, herbicide applied 28 October, cover crops sown 7 December 2016 and trial harvested for maize grain 3 June 2017.

- Focus on perennial/biannual species sown at maize growth stage V5.
- Test a range of cover crop types, including clovers, broadleaves, brassicas and grasses.
- Assessing performance of cover crops planted in mixes.

2016/17 trial results

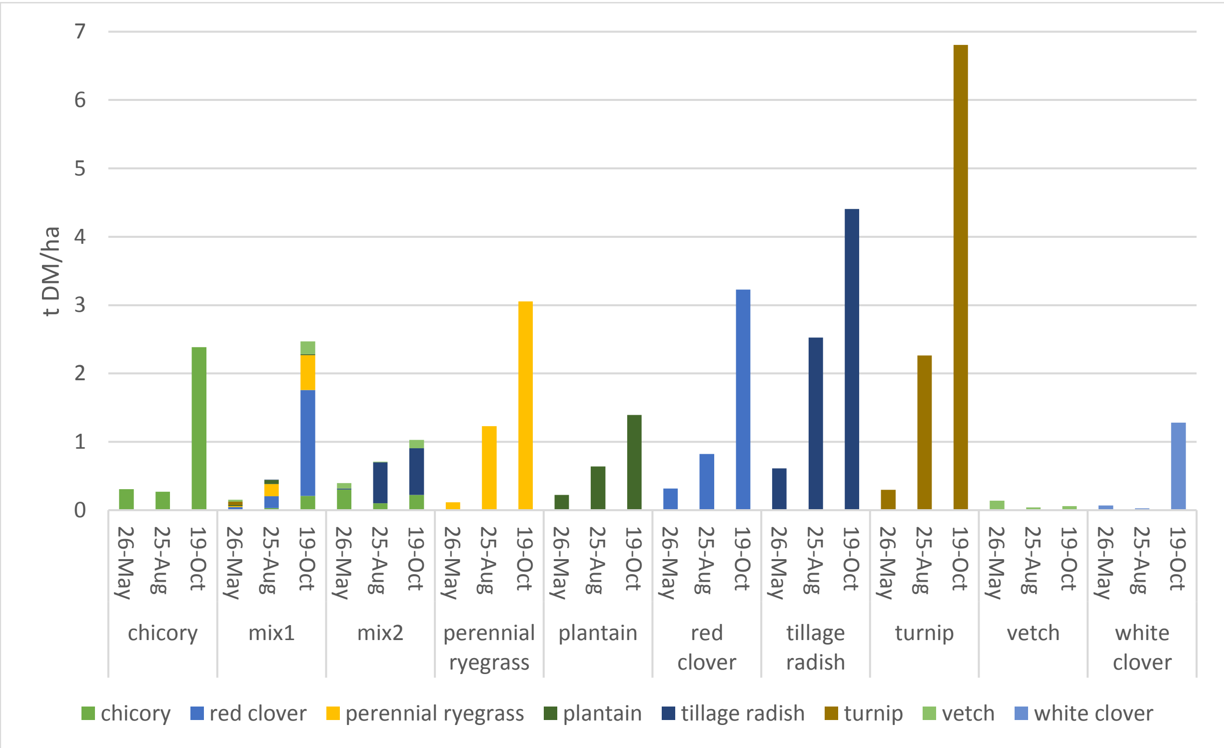


Figure 1. Cover crop dry matter yields in the 2016/17 inter-seeding species trial at NCRS. Dry matter cuts taken at 3 dates over the cool season. Mix 1 species include red clover, chicory, plantain, perennial ryegrass, vetch and tillage radish; Mix 2 included chicory, tillage radish and vetch. Harvest 1 (26 May) LSD 0.37 t/ha, harvest 2 (25 August) LSD 1.46 t/ha, and harvest 3 (19 October) LSD 2.85 t/ha.

Table 1. Maize grain yields in 2016/17 inter-seeding cover crops trial at NCRS. Grain harvests were made on 28 April in cover crop treatments with the greatest biomass. *Differences between treatment grain yields were not significant (NS).

	Chicory	Mix 1	Perennial ryegrass	Red clover	Tillage radish	Turnip	Vetch	Control	LSD	
Maize grain yield t/ha	8.33	8.94	9.38	9.21	8.65	9.02	9.34	8.73	1.36	NS*

A) Mix 1: 30 May 2017

B) Mix 1: 17 October 2017

Figure 2. Mix 1, species include red clover, chicory, plantain, perennial ryegrass, vetch and tillage radish. Photos taken A: 30 May 2017 and B: 17 October 2017.

Looking forward

- Further work is required to understand cover crop interactions with further herbicides. This year a small plot trial was set up looking into 5 pre-emergence and 7 post-emergence herbicides.
- Develop a greater understanding of cover crop species and their potential economic and environmental value.

Variable rate seeding in maize

Allister Holmes, FAR

Key points

- Precision agriculture tools can tailor crop inputs to different management zones.
- Variable rate seeding can decrease seed costs without reducing crop yield.

Trial objective

For the 2016/17 maize season, a seed rate trial was established in a paddock at FAR's NCRS research site, to investigate the effect of different planting populations in the different management zones (MZ) of the paddock. Four replicated strips of 75, 90 and 105 thousand seeds per hectare were planted across the three zones established in the paddock. These areas all received the same rates of starter fertiliser at planting, and side-dressed nitrogen.

To determine these zones, combine harvester yield data files were obtained from previous harvests and analysed for spatial trends across the paddock, and temporal (time) variability over the different years. From this data, we developed a Management Zone map, and then a proposed variable rate seeding (VRS) prescription map (Figure 1). This prescription was then used to establish a trial comparing VRS with fixed rate planting as shown in Figure 2.

Figure 1. Variable Rate Seeding prescription for planting 2016.

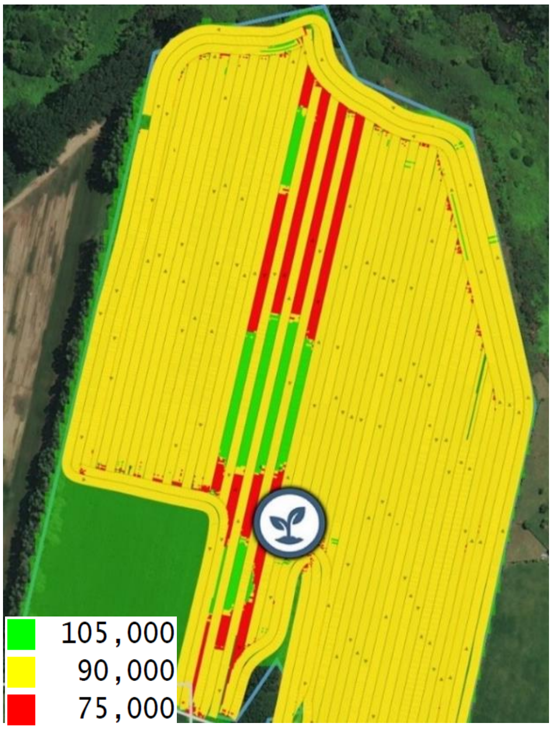


Figure 2. Planter seeding rates (seeds/hectare).

Maize harvest results

The maize grain crop was harvested on 4 June 2017 using a John Deere combine harvester with yield monitor and GPS, and the data recorded and analysed for each of the different management zones and seed planting rates (Figure 3).

From this data, we calculated geospatial Gross Margin (GM), (Figure 4). Gross Margin was calculated using a grain price of $350/tonne, and value for the land was included. The average GM for the paddock was $344/ha). Using the management zone map, we could calculate what the yield and gross margin (GM) would have been for the different management zones, if we had planted using Variable Rate Seeding. Results (Table 1) show no significant difference between yield and gross margin from the standard and VRS.

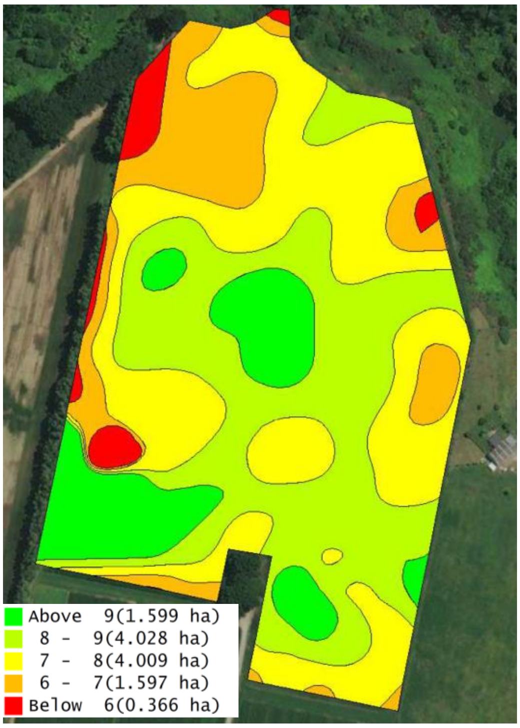


Figure 3. Average maize grain yield from NCRS paddock 2017 (t/ha @ 14% moisture).

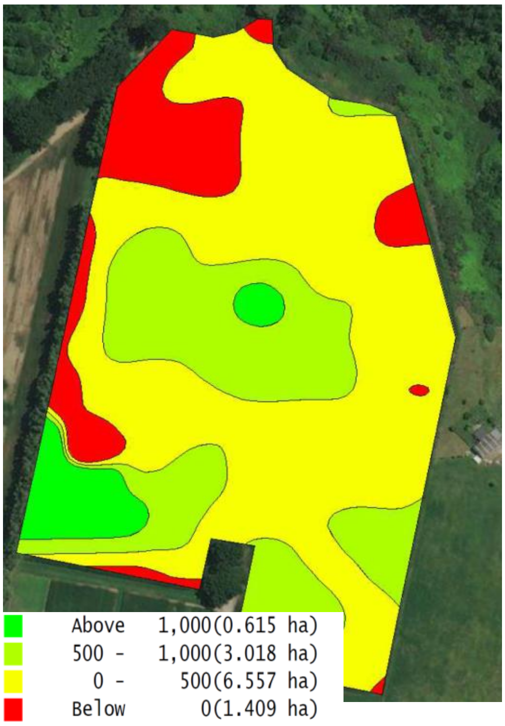


Figure 4. Calculated Gross Margin for maize grain crop at NCRS, 2017 ($/ha)

Table 1. Seeding rate, yield and Gross Margin calculated from VRS and standard seed rates

	Average seed rate (thousands/hectare)	Yield (t/ha @ 14% moisture)	Gross Margin ($/hectare)
Fixed seed rate	100.1	8.1	$417
Variable seed rate	96.0	8.1	$453
LSD 5%	1.6	1.2	$382

Discussion

If the entire paddock were planted at 90,000 seeds per hectare, the total 11.6 ha paddock gross margin would be $4,837. If planted using Variable Rate Seeding, the paddock gross margin would be $5,255, an increase of $36 per hectare over the constant seed rate.

Nitrogen Management for New Zealand Maize Growers

Matt Norris, Plant & Food Research and Diana Mathers, FAR

Key points

- Regional rules are pushing farmers to demonstrate that they are farming with good management practices. In Waikato it is likely that farmers will need to develop individual N reference points and have farm environment plans to demonstrate they are farming with good management practices.
- A nutrient mass balance is a useful way of calculating fertiliser requirements. It enables fertiliser applications to be better matched to the crop's requirements. The mass balance equation is:
- **N Fert = Crop N Demand – Soil Min N – Soil Org N.**
- Nitrate Quick Test strips can be used to estimate mineral N levels in the soil at any time during the crop's growth. They are easy to use.
- Using a Nitrate Quick Test strip just prior to side dressing enabled N to be applied more efficiently to our trial maize crops. At site 1, rechecking the mass balance recommendation with the Quick N test results just prior to side-dressing confirmed the grower's fertiliser plan was correct. At site 2, rechecking prior to side-dressing showed that no additional fertiliser was required. 42% less N was applied with no yield penalty.

Why test for soil N?

Regional Council land and water plans are pushing farmers to adopt industry agreed good management practices (GMPs). Managing the N supply to the crop has become increasingly important, yield potential must be maintained and the risk of environmental losses reduced.

The industry agreed GMP for nutrient management is to balance the crop's demand for nutrients, first with the supply from the soil and supplementing the balance with fertiliser.

An N mass balance budget is an efficient way to determine how much N fertiliser should be applied to the crop to achieve its potential yield. However, for the budget to be developed, estimates are required for how much N the crop will need and how much N will be supplied by the soil.

Measuring the soil N supply depends on soil testing; mineral N tests give an estimate of how much N is immediately available and AMN tests estimate the potential for N to become available in the future as organic N is mineralised.

It is useful to have quick, cheap methods for estimating soil N levels throughout the season are useful. Previous work in New Zealand has shown that nitrate quick test strips can be used successfully as a cost effective and reliable substitute for the mineral N test.

Station 4: 11.30am & 2.00pm

Quick Test N Strips - how do they work?

The Quick N Test strips are similar to the litmus strips used for soil pH testing but are coated with a chemical which is sensitive to nitrate.

1. The testing process starts with a set of in-field soil samples, collected in the usual way.
2. These are mixed together and a 10ml subsample is taken for testing.
3. The subsample is sieved, then mixed with 30ml of calcium chloride solution to extract the nitrate from the soil.
4. After 30 minutes a Quick N Test strip is dipped into the soil solution and left for one minute for the colour to develop.
5. The colour is compared a to a nitrate concentration scale and gives a measure of NO3 in mg/L in the soil solution.
6. A correction factor that takes into account bulk density, soil texture and moisture is used to convert the volumetric value (mg/L) to a gravimetric value (mg/kg), relating the result to the NO_3 level in the soil.

Conversion factors which consider soil moisture, bulk density and texture are used to convert the Quick N Test nitrate values from a volumetric to a gravimetric basis, enabling a $kgNO_3/ha$ measure are being developed for a range of New Zealand soils.

Nitrogen – Measure it and Manage it – Year 1 Results for Maize Growers

Nitrogen-Measure it and Manage it is a 3year project focussing on nutrient management decisions for a range of crops, including maize. In year one the focus of the experimental work was on side-dressing decisions. Two maize trial sites were established.

Site 1 was near Cambridge on a Horotiu sandy loam and Site 2 was near Morrinsville on a Morrinsville clay loam. Maize had been grown for at least 5 years prior to the trial being established at both these sites

Two treatments were used;
Treatment 1 was the grower's planned amount of N, to be applied at side-dressing
Treatment 2 was a quick test mass balance (QTMB) treatment, where the side-dressing N application was based on a mass balance budget calculation using Quick test strips to estimate the soil N supply just prior to side-dressing.

The mass balance equation is:
N Fert = Crop N Demand based on the potential crop yield – Soil Min N – Soil Org N.
(The potential Crop N demand for the maize was estimated to be 210 kg N/ha.

Results: Nitrogen applied and yield.

Site	Crop	Trt	Nitrogen applied KgN/ha)				Yield (DM/ha) Above ground biomass And P value Kg DM/ha	Plant N Uptake
			Base	Planting	Side dressing	Total		
1	Maize (grain)	Grower	46	18	83	147	21	134
		QTMB	46	18	106	170	20.3	143
							P = 0.39	P = 0.38
2	Maize (silage)	Grower	124	35	115	274	21.8	213
		QTMB	124	35	0	159	22.5	236
							P = 0.73	P = 0.30

Site 1 Maize Grain

At site 1, the QTMB treatment recommended that an additional 23 kg N/ha of side-dressing N fertiliser was required to meet crop N demand. At harvest there was no difference between the yields from the two treatments, the grower yield was 21.0 t DM/ha and QTMB yield was 20.3 t DM/ha.

Site 2 Maize Silage

The QTMB treatment correctly recommended that the potential yield could be reached without any side-dressing N. At harvest the yields were comparable between the treatments despite the QTMB treatment receiving 42% less fertiliser N. The grower treatment yielded 21.8 t DM/ha and the QTMB treatment yielded 22.5 t DM/ha.

Additional nitrogen management practices to consider

- Use slow release products. These are a less risky option for farmers who prefer to complete all their fertiliser management at planting.
- Nutrients can be applied, little and often via the irrigation system.
- Chose shorter season maize grain hybrids to enable a winter cover crop to be established. Legume winter cover crops can provide “free nitrogen” for the next maize crop.
- Be aware of the mineralisation potential of your soils. Soils coming out of long-term pasture or after dairy effluent applications can supply sufficient N for the crop without any fertiliser applications.
- Soil testing is the key to savings.

Nutrient Management for Maize – A US perspective

Dr. Jim Camberato, Agronomy Department,Purdue University, West Lafayette, Indiana, USA
jcambera@purdue.edu www.soilfertility.info

Importance of nitrogen to maize production and nitrogen rate recommendations

Nitrogen (N) fertilizer is important to maize production in most of the US. Few soils in the US provide enough N from mineralization of soil organic matter to produce maximum yield. Nitrogen is relatively expensive comprising about 25% of the variable cost of maize production. Optimum fertilization rates vary across the Corn Belt from less than 140 kg N/ha in the central and northern Corn Belt (for example Iowa and Minnesota) to more than 250 kg N/ha in some areas of the eastern Corn Belt (Indiana and Ohio). In most Corn Belt states (representing about 65% of the US maize crop) recommended N fertilization rates are empirically-based on results of numerous recent N trials, the cost of N, and the anticipated value of grain[1]. Maize grown after maize requires 35 to 55 kg N/ha more than maize following soybean. Increasing N rate results in diminishing returns up to a point where yield plateaus with additional N. Grain and total plant protein is increased with N rates above those resulting in optimum yield. Although N recommendations previously were made based on anticipated yield, N recommendations in most of the Corn Belt are no longer made using this approach[2,3]. Losses of N to the environment reduce N availability to the crop as well as harm the environment.

Pathways of nitrogen loss and environmental impact

Nitrogen from soil and fertilizer leaves the field via leaching below the rootzone, lateral flow, and runoff. In brackish and saline waters, excessive N stimulates algal growth, resulting in low oxygen and death of marine life. Loss of N from agricultural fields, mostly in the nitrate (NO3-) form, contributes to water quality declines in the Gulf of Mexico[4] and Chesapeake Bay[5], important fisheries and recreational water bodies. More than half of the N reaching the Gulf of Mexico via the Mississippi River is attributed to N loss from agricultural fields in the Corn Belt. States in the Mississippi River Drainage Basin have voluntarily adopted plans to reduce N loss from fields. Nutrient applications are regulated by laws in areas draining to the Chesapeake Bay. Nitrate contamination of ground and surface drinking water resources is also a major concern in several areas of the US.

Gaseous losses of N from soil and fertilizer are also environmentally important. Ammonia forms fine particulates that cause respiratory problems. Several gaseous losses of N arise from NO3-. Nitric oxide (NO) depletes the ozone layer. Nitrous oxide (N2O), garnering the most attention lately, is a 'greenhouse gas' and contributes to global warming. Seventy-five percent of US N2O emissions arise from agricultural soil management[6] which includes N application. Other than an awareness of the effects of acid rain, a consequence of NO*x* and sulfur emissions, on pristine lakes and forests the impacts of atmospherically deposited reactive N on natural ecosystems has received little attention in the US.

Conversion of soil and fertilizer N from NH4+ to NO3- (the process of nitrification) primarily determines the pathway and quantity of N loss from the field to the environment. Ammonium being positively attracted to the soil is relatively immobile in soil and not subject to loss unless on the soil surface and in a high pH environment. Negatively-charged NO3- on the other hand is repelled by the soil's negative charge and can leach below the rootzone. Nitrate is also subject to denitrification, a microbially-mediated process that occurs with low oxygen, resulting in gaseous losses as NO, N2O, and N2 as mentioned above. Specific inhibitors of nitrification are commercially available. The efficacy of these materials depends on soil properties affecting the activity, persistence, and movement of the active ingredient and the occurrence of soil and weather conditions conducive to N loss.

Nitrogen fertilizer source, application timing and placement

Nitrogen fertilizers, timing of N application, and N placement vary considerable across the US. Choice of a fertilizer program – source, timing, and placement is determined by fertilizer availability, cost, application logistics, tradition, safety, soil properties, potential for N loss, and other factors. In the western and northern Corn Belt, anhydrous ammonia (AA) is the predominant fertilizer. Generally AA is the least expensive per kg N and least likely to result in N loss when applied in advance of planting, but it requires the most specialized application equipment and is by far the most dangerous to human health. Anhydrous a liquid under pressure, is typically injected with a knife 15 to 18 cm deep on 76-cm centers. Ammonia (NH3) reacts immediately with soil water upon application to form ammonium (NH4+). Where soils freeze for several months and winter and spring precipitation is low AA is frequently applied at the onset of winter, months before maize planting. In warmer climates, AA is applied in spring or side-dressed after planting, up to about the V6 stage when the height of the corn limits application.

Liquid urea ammonium nitrate (UAN, 28-32% N) is used more frequently than AA as the primary N source in the warmer and wetter eastern Corn Belt. UAN-N is about 50% urea-N, 25% NH4-N, and 25% NO3-N. UAN can be broadcast, surface banded, or injected (10-15 cm deep) into the soil. UAN is typically applied shortly before or during the growing season. Nitrification is rapid when broadcast, but slows when banded. Within several days after application urea is hydrolyzed by urease enzymes that occur in soil and plant residues. If this occurs on the soil surface N may be lost to the air as NH3[7].

Granular urea is infrequently the primary source of N for maize, despite being less costly per kg N than UAN. The primary concern with urea is NH3 volatilization from urea remaining on the soil surface, especially with abundant plant residues and on soils with low buffer capacity7. Most NH3 loss occurs in the first several days after application and losses can be 30% or more of the urea-N content.

Ammonia loss to the atmosphere from urea is more likely and greater in magnitude in no-till cropping systems and when temperatures are warm. Incorporation of urea fertilizers into the soil reduces N loss to negligible levels. Rainfall of 1.25 cm or more shortly after application will 'incorporate' the urea into the soil. If surface applications must be made, banding rather than broadcasting the fertilizer increases movement into the soil and reduces urea hydrolysis, thereby reducing NH3 loss. A chemical urease inhibitor with surface applications of urea fertilizers also reduces NH3 loss. Preplant applications of urea fertilizers well in advance of planting are avoided unless a nitrification inhibitor is used to slow the formation of NO3-N which is subject to leaching and denitrification.

[1]http://cnrc.agron.iastate.edu
[2]https://www.extension.purdue.edu/extmedia/AY/AY-335-W.pdf
[3]https://ag.purdue.edu/agry/extension/SiteAssets/soilfertilityassets/PM2015.pdf
[4]https://www.epa.gov/ms-htf
[5]https://www.chesapeakebay.net/issues/agriculture
[6]https://www.epa.gov/ghgemissions/overview-greenhouse-gases
[7]https://ag.purdue.edu/agry/extension/Documents/Soil%20Fertility/Urea%20June%202017.pdf

Benefits of no-till maize establishment

Allister Holmes, FAR

Key points

- Data from the crop establishment trial shows no significant difference between maize grain yields from no-till, strip-till and full cultivation treatments.
- No-till & strip-till crop establishment techniques result in increased profit.
- Soil organic matter is critical for various soil functions.
- Long term cultivation techniques lead to decrease in soil organic matter.

Introduction

Cultivation serves a number of purposes in maize production including residue management, seed bed preparation (soil aggregation, aeration and warming) and weed control. However, costs associated with cultivation can be substantial and excessive cultivation can damage soil structure.

Reducing cultivation intensity has a number of benefits including preserving soil structure, soil organic matter and soil moisture, reducing the risk of wind or water erosion, reducing the rate of N mineralisation (important in paddocks coming out of long term pasture), and reducing cost. However, while these benefits are generally well accepted, such approaches have had limited uptake by maize farmers in New Zealand.

From 2008 until 2015, there was a long-term cultivation trial established at NCRS to support the development and adoption of reduced cultivation and establishment practices for successful maize production. Three cultivation practices were included: full conventional cultivation (FC); strip till (ST) and direct drill (DD). Each year incremental improvements have been made to the technologies associated with ST and DD and key agronomic issues have been resolved. Unfortunately part of this trial was lost to the State Highway 1 development in 2014.

In 2014 we established a new crop establishment trial at NCRS, with four replicates each of FC, ST and DD established crops.

Objective

The aim of the long term crop establishment trial is to compare the effect of conventional tillage, strip tillage and direct drilling on the establishment and subsequent crop performance and profitability of maize each year, and also their long term effects on soil conditions.

2017 Results

Table 1. Results from different crop establishment treatments

	2017 Yield (t/ha @ 14% DM)	Cost of cultivation and planting ($/ha)	Gross Margin ($/ha)
Full cultivation	9.3	$519	$733
Strip till	10.7	$359	$1,146
Direct drill	10.2	$314[1]	$1,195

[1] includes two applications of slug bait

LSD 5% = 1.76 t/ha; CV = 10.1%

Long term cultivation trial 2017

The current LTC trial was planted on 17 October 2017. It can be seen in Figure 1 below that the maize established using no-till planting develops more slowly than the maize established into cultivated soil. These effects are significant at the V5 stage, and we will continue to track them through the maize crops development.

Figure 1. Strip till 8 rows on left; full cultivation 8 rows in middle; no-till 8 rows on right.

Soil quality indicator categories

Physical indicators provide information about soil hydrologic characteristics, such as water infiltration and retention, which influences availability to plants. Some indicators are related to nutrient availability by their influence on rooting volume and aeration status. Other measures tells us about erosional status. Indicators include measures of:

- **Soil aggregate stability** is greater under no tillage than conventional tillage. Accelerated mineralisation of organic matter under conventional tillage reduces soil organic matter which plays an important role in stabilising soil structure.
- **Available water capacity -** Soils under no-till systems have greater presence of macropores and organic matter, and therefore a greater ability to store water.
- **Bulk density** Surface soil bulk density measurements were taken at the surface of each treatment (Table 2). The cultivated treatments had the lowest bulk density at the surface compared to the strip till and direct drilled treatments.

Table 2. Soil physical properties measured from old crop establishment trial after eight seasons in each treatment. Measurements taken at surface (0 – 15cm).

	Bulk density (kg/l)	Carbon (kg/m^2)
Full cultivation	0.81	4.38
Strip till	0.88	5.53
Direct drill	0.90	5.89
Adjacent pasture	0.77	6.41

- **Soil crusts and infiltration** Ability for rain to enter the soil. Especially important in heavy rain events.
- **Slaking** The breakdown of large soil aggregates into smaller ones following sudden immersion in water. Slaking occurs when aggregates are not strong enough to withstand internal stresses caused by rapid water uptake.
- **Soil structure and macropores** Macropores are large soil pores (generally greater than 0.08mm in diameter). Macropores drain freely by gravity and allow easy movement of water and air.

A good way to assess the effect of cultivation on soils physical properties is to compare the soil under an adjacent fence line to that in the middle of the cropping paddock. Another way is using Visual Soil Assessments, which can be downloaded from: http://www.landcareresearch.co.nz/publications/books/visual-soil-assessment-field-guide/download-field-guide

"The best thing you can put on your farm is your feet."

Agrichemical applicator and Work Safe NZ – are you compliant?

Mike Parker, FAR and Murray Beare, Educhem

Effective application of agrichemicals not only requires a knowledge of pest and disease lifecycles and hence timing of applications, but also an understanding of application equipment. Nozzle type, pressure, water rate, speed and correct calibration are all integral to effective application and operator safety is also very important. As of 1 December 2017 Work Safe NZ has been responsible for enforcing Hazardous Substances legislation in the work place.

Today we will discuss what you need to do to be you need to be compliant, while also looking at agrichemical sprayer application and safety.

Compliance requires:

- An inventory of all agrichemicals stored, including the UN numbers. UN numbers are issued by the United Nations and relate to Transport of Dangerous Goods. They can be found at the top of the product Haznote sheet (Figure 1).
- Copies of Safety Data Sheets or Haznotes or similar for all agrichemicals stored on your premises. Your chemical supplier should provide sheets for each product you purchase. Alternatively, they Haznote sheets are available on-line. Just search the name of the chemical and look for the link to the Haznote (Figure 1).
- While Approved Handler certificates will be phased out you will require to be a certified Handler for 6.1As and 6.1Bs i.e. acutely toxic chemicals such as paraquat, chlorothalonil (e.g. Bravo formulation) and methamidphos.
- New role of the PCBU (person in charge of business unit). See over page.

Dow AgroSciences **HAZNOTE™**

Dow AgroSciences (NZ) Ltd
89 Paritutu Road, New Plymouth
Tel: 0800 803 939

EMERGENCY INFORMATION AND STORAGE GUIDE / DANGEROUS GOODS DECLARATION

Tordon™ Brushkiller XT Herbicide

Substance: Liquid herbicide containing Triclopyr butoxyethyl ester (CAS No.64700-56-7), Picloram as the hexyloxypropylamine salt (CAS No. 1918-02-1) and Aminopyralid as the hexyloxypropylamine salt (CAS No. 150114-71-9).
Proper shipping name: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S (Triclopyr butoxyethyl ester, Picloram)

UN No.:	DG Class:	Subsidiary Risk Class:	Packing Group:	Flash Point (°C):	HAZCHEM:	Marine Pollutant:	Land Transport Schedule[1] Exemption Quantity:
3082	9	None	III	82 °c	•2X	Yes	250 L

HSNO Classifications: [Approval No: HSR007630]	Tracking Required:	Approved Handler:	IER Guide No:
3.1D, 6.1D, 6.3B, 6.4A, 6.5B, 6.9B, 9.1A, 9.2A, 9.3C	Yes	Required when being used	47

EMERGENCY PROCEDURES — **24 HOUR ADVICE IN AN EMERGENCY ONLY: 0800 844 455**

IF THIS HAPPENS	DO THIS
Tanker/Vehicle Accident	Switch off engine and electrical equipment. Keep people away, warn other traffic. Check for spills, leaks. **Call the emergency services: Dial 111**

Figure 1. Example portion of a Haznote™ sheet.

Health and Safety at Work (Hazardous Substances) Regulations 2016 Commencement dates:
Most of the new Hazardous Substances Regulations come into effect on the 1st of December, however there are some sections within the Regulation that come into effect on later dates, for these see below.

Commencement date: 01/09/2017

Reg	Section
1	Armed Forces etc
3	General duties relating to Risk Management
4	Certified Handlers, supervision & training of workers
6	Compliance Certification (Certifiers)
12	Class 5 Substances
15.1	Gases under pressure (Interpretation)
15.2	Gases under pressure, application of this part to certain pressure equipment

Commencement date: 01/06/2018

Reg	Section
4.5	Competency requirements for certified handlers
13.26	Storage of certain class 6 & 8 substances not located at a hazardous substances location
13.27	Requirement applicable to farms > 4 hectares

Commencement date: 01/06/2019

Reg	Section
1.4	Hazardous Waste
13.34	Duty of PCBU to establish hazardous substance location class 6 & 8 substances • **6.1A, 6.1B, 6.1C, 8.2A & 8.2B**
13.37	Requirement for indoor storage cabinets for class 8 substances

Commencement date: 01/12/2019

Reg	Section
13.38	Compliance Certificate for Hazardous Substances Location for the following: • **6.1A Qtys > 50kg/l** • **6.1B Qtys > 250kg/l** • **6.1C Qtys > 1000kg/l** • **8.2A Qtys > 50kg/l** • **8.2B Qtys > 250kg/l** **For farms >4 hectares** • **6.1A Qtys > 100kg/ℓ** • **6.1B Qtys > 500kg/ℓ** • **6.1C Qtys > 3500kg/ℓ** • **8.2A Qtys > 500kg/ℓ** • **8.2B Qty's >3500kg/ℓ**

The balance of the new HSWA Regulations will come into effect on the 1st December 2017. Tracking will be required for classes: 6.1A & 6.1B & some other classes.

Please see below a list of Agrichemicals that trigger HSNO Classes **6.1A & 6.1B** and will require a compliance certificate by the 1/12/17 unless you have a current Approved Handler Test Certificate endorsed Agrichemicals.

Table 1 Agrichemicals that trigger HSNO Classification 6.1A

Trade Name	Trade Name
AGPRO Paraquat 200	Parable 250
Counter 20G	Para-Ken 250
Crop Care Phorate	Paraquat 200SL
Disect	Peropal
Divap	PQ200
Flash 250AC	Preeglone
Gramoxone 250	Speedy 250
Nufarm Phorate	Thimet 20G
Parable	Uniquat

Table 2 Agrichemicals that trigger HSNO Classification 6.1B

Trade Name	Trade Name	Trade Name
Agpro Canyon	Climax	Metafort 60SL
AGPRO Chlorothalonil 720	Cobra	Metafort SC
AGPRO Lambda-Cyhalothrin	Cotnion 200 SC	Metaphos
AGPRO Metamitron	Duplosan KV	Meteor
Aquathol K	Fenafos 400	Mighty 700SC
Balear 720 SC	Ficam W	Mitron 70WG
Barrachlor 720	FIL Formalin	Monitor
Barrack Betterstick	Flavylan 350EC	Nando
Bendi 800	Furakote EW	Nemacur
Blizzard 720SC	Goltix	Nematak 400EC
Bravo 720 SC	Goltix FLO	Nuvos
Bravo Weather Stick	Harvestcide Granules Biocide	Solvigo
Cannon	Instrata	Tameron
Cavalry 720SC	Kentron	Taratek 5F
Chlorcarrb 720 SC	Max CL	Thalonil
Chlorocarb	Mesurol	Thicarb 500FS
Chlorotek	Mesurol SC	Vydate L
Chlorothalonil 720	Metafol SC	YM-Nylate

A person conducting a business or undertaking or **PCBU**

- means a person conducting a business or undertaking managing all risks.
- whether the person conducts a business or undertaking alone or with others; and
- whether or not the business or undertaking is conducted for profit or gain.

The PCBU must manage all risks associated with the workplace including workplace controls of Hazards including Hazardous Substances, manage workplace fixtures, fitting and plant.
The PCBU needs to ensure they and have evidence for the following to all workers and people who are on site:

Instruction

Information

Training

Meaning of reasonably practicable
Reasonably practicable, in relation to a duty of a PCBU means that which is, or was, at a particular time, reasonably able to be done in relation to ensuring health and safety, taking into account and weighing up all relevant matters, including—

(a) the likelihood of the hazard or the risk concerned occurring; and
(b) the degree of harm that might result from the hazard or risk; and
(c) what the person concerned knows, or **ought reasonably to know**, about—
(i) the hazard or risk; and
(ii) ways of **eliminating** or **minimising** the risk; and
(d) the availability and suitability of ways to eliminate or minimise the risk; and
(e) after assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.
.

Ref No: 5.8.3
Subject: Boom Spray Diary Template
Date: 14.11.2017

Client Name:

Address of application:	**Applicators Name & address:**	**Date:**	**Total Time Taken:** **Area Sprayed:**
Name of Agrichemicals Used:	**HSNO Approval Number:** **HSR** **HSR** **HSR** **HSR**	**Amount of Agrichemical Used:**	**Application Rate/ha:**
Additives Used:	**Amount of Additive Used:**	**Rate/Ha:**	**Rate/100 Litres of Water:**
Weather Conditions: **(write in relevant details)**	Wind speed, wind direction, Rain likely, Relative Humidity,		
Protective Clothing Used: **(please circle)**	Boots, Cotton Overalls, Nitrile Gloves, eye protection, ½ face respirator, Full face Respirator, Apron		
With Holding Period:	**List the Sensitive Areas:**		
Restricted Entry Interval **Hours**	**Re-entry period:**		
Container Triple Rinsed:	**What did you do with the rinsate?**	**Disposal Method: (please circle)** **Agrecovery, Returned to supplier, Plasback or Left with client**	

Preserving the quality of forages with good silage management and the role of silage inoculants

Jakob Kleinmans, Nutriassist Ltd

Key points

- Good silage management reduces waste and contributes to profitable supplement use.
- Harvesting management (crop moisture, sugar, adequate compaction) and stack management (complete seal and face management) determine silage quality and losses.
- Silage inoculants can be very profitable. Informed decision about product use and choice is recommended.

Introduction

Agronomic practices to produce feed for livestock aim to produce high yields and high quality. Some crops are not grazed, but instead need to be conserved for later use as silage. Silage management has a significant impact on feed profitability because it affects wastage, and therefore how much of the grown feed is converted into milk. Feed wastage in silage storage can range from below 10% up to 40%. Typical sources of wastage are storage losses in the closed stack or at feed-out after opening. These avoidable losses represent a lost opportunity to produce milk and are reflected below in the price of feed; feed price increases according to wastage from 33 to 50c/kg DM (3.0 to 4.5 c/MJME) which often amounts to a difference that determines whether a feed is used profitably or not.

Table 1. Silage wastage % in storage

Feed	Excellent	Average	Poor
Grass silage	5	10-15	20-40
Maize & cereal silage	6	10-15	20-40

Source: DairyNZ Facts & Figures (2017).

Table 2. Wastage affects the price of feeds*

Wastage %	10%	20%	30%	40%
Feed price (c/kgDM)	33	38	43	50
Feed price (c/MJME)	3.0	3.4	3.9	4.5

*Assumptions: original feed at 30c/kgDM and 11 MJME/kgDM

Factors affecting silage losses

Silage fermentation is the process of microorganisms converting sugars into acids - preferably lactic acid because it is the most efficient acid to lower the pH quickly and to reduce the potential effect of undesired microorganism that compete with lactic acid bacteria for the substrate (food) sugar. If the pH does not drop rapidly, undesirable fermentations from microorganisms such as enterobacteria and clostridia can dominate. Clostridia are a particular risk factor in grass and lucerne silages at lower dry matter, and cause significant quality losses.

The ability to ferment differs between forage types. Maize and cereals are easily fermentable crops because they provide high levels of sugar and a low buffering capacity, i.e. enough substrate (food) to allow high levels of lactic acid production and little "resistance" from the "buffering capacity" of the crop, which is the ability of the forage to resist a drop in pH. However, they are also prone to heating and moulding at the silage face and at feed out. Lucerne and grass silages are the reverse of maize and cereal silage. Up front fermentation is harder and slower, but they are less susceptible to heating at the silage face and at feed out.

1. Harvest management

Wilting crops efficiently without losing too much sugar is critical for forages like grasses, clover and lucerne. This is because they are cut at a low dry matter level and wilting increases the dry matter before ensiling, which increases their ability to ferment well. However, crops such as maize and cereal silage can be directly harvested without wilting when the whole crop reaches an ideal dry matter content (generally 32-40% DM). Crops that are too wet when they go in the stack may not ferment well because the water dilutes the sugar and increases the risk of Clostridia fermentation, resulting in high losses and low quality. Ensiling crops below 28% dry matter releases liquid (effluent). While effluent represents a loss of nutrients in the silage, the risk it poses for water pollution is probably of greater concern. Harvesting crops when they are too dry tends to make ensiling difficult because the crop becomes too springy to compact, leaving air in the stack which can hinder fermentation and lead to increased aerobic losses after stack opening.

2. Stack management

Fermentation takes place in the absence of air, so creating a well compacted stack with a good oxygen barrier seal is essential. Preventing air from entering the silage once the stack is open can be difficult but is key to preserving dry matter and quality of the feed. Even with good fermentation, dry matter losses are inevitable, but minimising damage at the face of the stack helps to reduce air penetration into the stack. In extreme conditions dry matter losses can reach 30% over a 10 day period (Honig & Woolford, 1980). When feeding out, remove at least 20 cm each day from the stack face to ensure fresh unspoiled silage is fed every day.

Figure 1. Face of well compacted stack

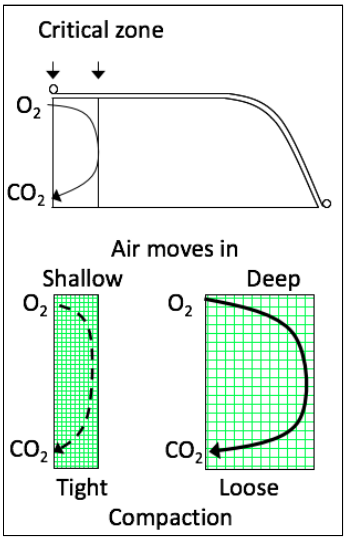


Figure 2. Silage compaction and air penetration into stack.

3. *Silage inoculants*

A better understanding of silage microbiology in the 1980s has led to the development of silage inoculants and a widespread use worldwide. Generally, bacteria in inoculants act in one of two ways, improving either fermentation efficiency or aerobic stability (keep silage cool). Specifically selected strains of lactic acid bacteria can convert plant sugars more efficiently and are more competitive than bacteria and yeasts already present on the plant. These are homofermentative strains, often from the species *Lactobacillus plantarum*. They form the basis of silage inoculants that can improve fermentation efficiency.

In the 1990s the use of heterofermentative strains of *Lactobacillus buchneri* was found to produce less heating of silage once it was exposed to air after opening. These strains are used in silage inoculants, and produce lactic acid, as well as other acids, such as acetic or propionic acid, and can improve aerobic stability (keep silage cool).

Depending on their effects, the use of silage inoculants can be very profitable. Combination effects i.e. improved silage quality plus animal performance will bring the highest return. Things to consider when selecting silage inoculants:

- **Research:** An effective silage inoculant will have independent and statistically analysed published data supporting its use for the purpose planned.
- **Type of bacteria and targeted effects:** improve fermentation and/or aerobic stability.
- **Application rate:** The international industry standard is a minimum of 100,000 viable colony forming units per gram of forage. A good inoculant product will have its guaranteed bacteria number printed on the label.
- **Service:** The inoculant should be supplied by a company with competent service that will support customers to make the right decisions selecting a product and provide on-going support and advice as required.
- **Price:** Price alone should not be the driving factor for choosing an inoculant.

Factors influencing silage inoculant effectiveness

Silage inoculants do not always work, and there are many different possible reasons why.

1. Active ingredients: Some products fail to provide information about active ingredients.
2. Product handling and quality control: Silage inoculants are live organisms, and production quality control and proper product storage handling are fundamental steps in supplying and maintaining a product that supplies the guaranteed number of bacteria on the label to the forage harvested.
3. Product form and application: products applied wet generally have an edge over dry ones. Two potential issues may affect the viability of inoculant bacteria when mixed with water: *Chlorine:* if the water source is chlorinated and contains more than 1ppm chlorine, look for an inoculant that has compounds which react with the chlorine so it doesn't kill the live bacteria. *Temperature:* inoculant viability is best below 40° C.

Crop Resilience to Climatic Variability…Can we grow good maize consistently?

Dr. RL (Bob) Nielsen, Agronomy Department, Purdue University, West Lafayette, Indiana, USA

One of the consequences of climatic variability for agriculture is the greater frequency of severe or extreme weather patterns. New Zealand has an inherently favorable climate for achieving high maize yields. However, increasingly frequent, yet unpredictable, extreme weather events represent a serious agronomic challenge to growing "good" crops consistently year in and year out.

The negative effects of extreme weather on crop growth are amplified by the presence of other yield limiting factors (YLFs). For example, the effects of excessive rainfall on crop growth are magnified in fields with poor soil drainage and soil compaction. Mitigation of either or both of these YLFs will increase crop resiliency toward the effects of excessive rainfall.

Consequently, one strategy for improving crop resilience to climatic variability is to identify and mitigate manageable field-specific YLFs. This involves spending quality time in the field looking for YLFs, diagnosing the causes of YLFs, and identifying strategies or solutions for reducing or eliminating YLFs.

Spatial maps of historical grain or forage yield data can help identify the locations and extent of crop problems in fields, as can aerial imagery during the current growing season (satellite, commercial aircraft, small Unmanned Aerial Vehicles). In season aerial imagery can be particularly useful because it can identify the existence of crop problems earlier, which translates to a higher likelihood of successfully identifying the causes of the problems AND the allows for the possibility of taking steps to mitigate the problems during the current growing season.

Until the art/science of weather forecasting improves to the point that we can accurately predict next season's extreme weather events, maize growers must rely on sound, fundamental agronomic decision-making that will, hopefully, result in a crop that is more "stress proof" and better able to tolerate a range of unforeseen severe stresses.

Here's a short list of agronomic decisions that maize growers can focus on to improve the stress tolerance of their crops. One useful resource to consider for other agronomic information is my website: www.kingcorn.org/cafe.

Soil water management
Tile drainage or surface drainage systems can increase a field's capacity to handle excessive rainfall events and minimize the negative effects on crop growth. On soils prone to drought stress, improved irrigation scheduling and management can increase a field's capacity to withstand the negative effects of severe drought on crops.

Hybrid selection

Strive to identify hybrids that not only have excellent genetic yield potential, but also documented tolerance for a wide range of unforeseen stresses. Look for hybrids that perform well across multiple locations of private or independent variety trials. The combination of excellent genetic yield potential plus tolerance to unforeseen stress is crucial to achieving good yields consistently "in the real world."

Soil health, quality and tilth

No matter what fancy word you use to describe it, good soil characteristics are important for encouraging effective rooting of the crop that will enable it to tolerate stress later. Reduce opportunities for compacting soil with field equipment. Improve the drainage on poorly drained soils. Reduce opportunities for soil erosion by implementing cover crops and/or reduced tillage practices.

Soil fertility / plant nutrition

Pull soil samples regularly and take steps to improve overall soil fertility levels, including soil pH. Spatial variability patterns for soil nutrients and pH are most accurately estimated with spatially intense soil sample strategies (0.5-hectare grid patterns or smaller). Starter fertilizer applied to the side and below the seed (5-cm x 5-cm) at robust rates (18 to 36 kg actual N per ha) will help a crop endure challenging early season growing conditions. Adopt nitrogen fertilizer management practices that minimize the risk of N loss by leaching, denitrification, or volatilization. One of the simplest ways to minimize the risk of N loss is to either split-apply your N fertilizer (some pre-plant, some sidedress) or apply the majority of N as a sidedress.

Weed control

With all of today's fancy herbicide chemistries, we still struggle to control weeds in our fields. Weeds compete with crops for light, water, and nutrients. Make sure you know the weed species you are dealing with. Make sure you understand which herbicides are most effective against your weed species. Make sure you aim to control weeds when they are young and vulnerable.

Disease control.

Be alert for the development or risk of diseases, especially foliar diseases like common rust (*Puccinia sorghi*). Select maize hybrids with excellent genetic resistance to this disease. Be prepared to apply foliar fungicides if necessary. Generally, QoI strobilurins (Group 11) fungicides are more effective on common rust than are DMI triazoles (Group 3) fungicides.

In addition to making sound agronomic decisions, another secret to growing good maize consistently is to thoroughly understand what is going on within your fields. That means you, or someone you trust, simply has to spend a lot of time walking and scouting fields throughout the growing season.

For further information please contact: rnielsen@purdue.edu or www.kingcorn.org/cafe

Notes

Health and safety

We trust that you will enjoy your day with us at NCRS; to assist us in ensuring your health and safety whilst on the property we ask that you both read and follow this information notice.

For your safety, please:

- Follow instructions from FAR staff, or other event manager, at all times.
- Stay within the areas specified by FAR/event staff.
- Stay out of trial plots unless invited by FAR/event staff.
- Report any hazards noted directly to a member of FAR/event staff.

Specific hazards to be aware of:

- ***Vehicles:*** Take care when moving across or through the car parking, entry and exit areas.
- ***Trips and falls:*** Watch out for uneven ground.
- ***Weather:*** Sun block is available on site.
- ***Electric fences:***

First aid and emergencies

We have a number of First Aiders on site. Should you require any assistance, please ask a member of FAR staff. First aid kits are in the main marquee.

In case of emergency call 111 and notify a FAR staff member.

The address for the site is: 82 Oaklea Lane, Tamahere

- All visitors are requested to follow instructions from FAR staff at all times.
- All visitors to the site are requested to stay within the public areas and not to cross into any roped off area.

Rubbish

Rubbish bins are available for your use; we ask that you dispose of all rubbish considerately.

Smoking

No smoking permitted inside any marquee.

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