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Evaluation of reduced tillage maize trial data supplied by FAR

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Executive summary

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Between 2005 and 2020, the Foundation for Arable Research (FAR) conducted a wide range of research studies (38 in total) that included investigations into different tillage establishment methods for maize production. A lot of the research involved conducting discrete studies, analysed at the individual site/trial level. The purpose of this current project was to conduct an analysis (i.e. a mini 'meta-analysis') of all data gathered during these previous studies to investigate whether the aggregated data from multiple studies were able to provide any new insights.

The project scope was to investigate effects of crop establishment methods on established plant populations, maize yields, and associated gross margins (for the latter, where available). Further topics of interest included relationships between nitrogen application rate, seeding rate and planting date on crop establishment outcomes. All data included in the meta-analysis were provided to Plant & Food Research (PFR) by FAR.

Following statistical analysis of the dataset, the main findings included:

- A yield advantage to using full cultivation establishment practices was observed. Median grain yield was approximately 5% higher, or 0.5 t/ha for full cultivation (FC) compared to the no tillage (NT) treatment, while 25 % of the trials had a FC yield advantage >10%. It is, however, not possible to comment upon whether best practice tillage was conducted in these trials.
- When a subset of the data was used to include only sites with a seeding rate of 88–90 thousand seeds per hectare, the established plant population was consistently lower for the NT tillage (median 85 000 seeds/ha) than strip tillage (ST) and FC treatments (medians 90 and 88 000 seeds/ha). Established plant population is often considered to be more variable under NT than FC, but we did not observe it to be more variable, just lower overall.
- While there are insufficient data to compare results robustly, there is no indication of yield advantage or penalty associated with nitrogen (N) fertiliser rate, or of an N interaction with tillage treatment. We observed for two silage trials where zero fertiliser N was applied, yields of ~18 and 27 t DM/ha were recorded. As no soil mineral N information was available, we cannot comment on whether this trend is observed due to ample soil and fertiliser N in the growing system, resulting in yields being limited by factors other than N or otherwise.
- Using a slightly modified overall dataset to investigate financial aspects, we found that the economic advantage tended to favour NT. This was largely assumed to be associated with taking into account the cost of additional cultivation passes for FC and was noted despite our previous observation of a small yield advantage to FC.

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1 Introduction

Over the last 15 years (2005–2020), the Foundation for Arable Research (FAR) has conducted a wide range of research studies (38 in total) that have included investigations into different tillage establishment methods for maize production. Much of this work involved conducting discrete studies analysed at the individual site/trial level. The purpose of this project was to conduct an analysis (i.e. a mini 'meta-analysis') of all of the data gathered during the previous studies to investigate if the aggregated data from multiple studies were able to provide us with new insights.

Project scope was to investigate effects of crop establishment methods on established plant populations, maize yields, and associate gross margins (the latter, where available). Further topics of interest included relationships between nitrogen application rate, seeding rate and planting date on crop establishment outcomes.

The data included in the mini meta-analysis were provided to Plant & Food Research by FAR.

2 Methods

2.1 Raw data provided by FAR

The raw datasets were compiled by Allister Holmes (before he departed from FAR). The following points are important to note:

- There were 386 rows or observations in the main sheet of data.
- The data came from 38 trials at 15 sites in five regions of New Zealand.
- The trials took place between 2005 and 2020.
- The trials mostly involved replication. However, for the purposes of this meta-analysis, some of the data have some pseudo-replication that needed to be taken into consideration (see statistical methods, section 2.5 for detail).
- For each observation, PFR was provided with Harvest.year, Region, Site, Treatment, FAR.Code and Grain.yield or Silage.yield (depending on type of trial).
- There were missing GPS coordinates for three sites and missing soil type for three sites.
- The maize hybrid, seeding rate, established plant population and amount of N applied data were all somewhat limited due to missing data.
- There were data giving the specific full cultivation method. No trial used more than one full cultivation method.
- In addition to grain yield, we have incomplete moisture percentage and test weight data.
- With the silage yield there were data for dry matter (DM) percentage but this was also incomplete.
- An additional sheet was supplied that showed financial information, but the extent of what has been included to derive this information was not clear or defined.

2.2 Data preparation for analysis

There were several places where adjustments to the provided data were necessary, so that further statistical analyses could be carried out. These actions were as follows:

- There was one observation that did not make sense. In the 2008 Site 6 trial, one of the 18 observations had a different hybrid, seeding rate and nitrogen application rate. This observation was removed as it was too hard to tell if there were errors in the other variables.
- The year part of the harvest date was entered incorrectly for trial 13 at the NCRS Old site and trial 31 at Site 4. These have both been amended.
- Some of the silage dry matter data were recorded differently from the rest. It was a decimal rather than as a percentage, for example we have 0.3266 instead of 32.66%. The grain moisture data was also like this in places. They were each amended so that data were consistent.

- Trial number 44 at Site 9 in 2007 has 10 observations. It appeared that there are four reps for two treatments with data for plant population for each of the replicates, but only treatment means for the grain yield and moisture. To correct this we removed the extra two rows and added in the grain yield and moisture means to the replicates (since we mostly worked with summarised data, or means, this was acceptable).
- Trial number 18 at the NCRS Old site in 2013 has four Rep 1s for each treatment. This is because for this trial there were two Hybrids and two Planting Dates in the trial design. When the means are taken, we averaged over these effects, but when we looked at the Hybrids we had to treat the data points for this trial separately.
- The Trial.number is site specific. For example, we have Trial.number 26 for NCRS New and Site 12. For this reason we append the Site to the Trial.number. There are 38 observations without a Trial.number, but the Site is known. For these we replaced the NA with Harvest.Year.

2.3 Tillage categories

The table below shows the number of observations for each of the tillage treatments.

Treatment	Frequency
FC	144
FC & ST	1
NT	124
ST	32
ST1	12
ST2	70

We asked Allister Holmes for an explanation about this and gleaned the following information:

- FC = full cultivation
- NT = no tillage
- ST = strip till
- ST1 is 1 ST pass
- ST2 is 2 ST passes
- Combining ST1, ST2 and ST into a single category makes good sense.

We re-coded the data to reflect the information above and the single line of data with FC & ST was removed. The revised data counts then became:

Treatment	Frequency
NT	124
ST	114
FC	144

2.4 Supplementing the FAR data

2.4.1 Cultivation methods

Where the FC treatment was used we have 129 observations of 14 different types of cultivation method.

Allister Holmes was consulted about interpreting and consolidating these categories. He suggested the following groupings.

Three categories based on primary working:

PLOUGH:	
"PL PH"	plough / power harrow
"PL D"	plough / disc
"PL D RT2"	plough / disc / rototill / rototill
"PL PH"	plough / power harrow
"PL Roll"	plough / roll
"PL RT RT"	plough / rototill /rototill
RIP:	
"R PH"	rip / power harrow
"R PH2"	rip / power harrow / power harrow
"R RT2"	rip / rototill / rototill
"RH SX"	rip / Simba X-Press (top down)
OTHER:	
"D PH"	disc / power harrow
"DR DR RT"	disc&roll / disc&roll / rototill
"DR PH"	disc&roll / power harrow
"SX2"	Simba X-Press / Simba X-Press

Two categories based on whether or not a power harrow was used:

POWER HARROW USED:	
"PL PH"	plough / power harrow
"PL PH"	plough / power harrow
"R PH"	rip / power harrow
"R PH2"	rip / power harrow / power harrow
"D PH"	disc / power harrow
"DR PH"	disc&roll / power harrow
POWER HARROW NOT USED:	
"PL D"	plough / disc
"PL D RT2"	plough / disc / rototill / rototill
"PL Roll"	plough / roll
"PL RT RT"	plough / rototill /rototill
"R RT2"	rip / rototill / rototill
"RH SX"	rip / Simba X-Press (top down)
"DR DR RT"	disc&roll / disc&roll / rototill
"SX2"	Simba X-Press / Simba X-Press

Table of counts for primary working categories:

Cult.Prim.Working	Frequency
Plough	8
Rip	7
Other	15

Table of counts for power harrow usage:

Power.Harrow	Frequency
Used	19
Not.Used	11

2.4.2 Soil data

The trial data information included a soil texture classification (Soil.FAR in Table 2) for 11 out of 15 sites. The GPS coordinates were missing for three of the four sites without this texture classification. As the trials there involved PFR personnel, we enlisted the help of our colleagues Paul Johnstone and Nathan Arnold and were able to obtain approximate trial location coordinates (from topographic maps).

Using the coordinates for all sites, we compiled more detailed soil data, i.e. New Zealand soil classification 'Order', and estimates of sand, silt and clay percentages. This was completed using SMAP (Manaaki Whenua Landcare Research, 2021) where possible, and in the case of the Moore site, from the NSD (National Soils Database, Manaaki Whenua Landcare Research) (Table 2) and was added to the dataset. The soil.FAR variable was largely consistent with the texture classification obtained from SMap.

Given the wide range of soil Orders present in the data, we created a category 'GroupOrd' to provide two soil levels of soil Order information, where *AOP* is Allophanic, Organic and Pumice soils, and *Sediment* (Sedimentary) is Brown, Gley and Recent soils.

Table 2. Compiled soil information for the 15 trial sites.

Site	Region	Soil.FAR	Order	Group Order	Texture[a]	Clay %	Sand %	Silt %
Site 11	Sth Head	-	Brown	Sediment	sand	13.50	72.5	14.00
Site 12	Sth Head	-	Brown	Sediment	sand	13.50	72.5	14.00
Site 4	Sth Head	-	Brown	Sediment	sand	13.50	72.5	14.00
Site 8	B of P	Loam	Brown	Sediment	loam	24.00	35.0	41.00
NCRS New	Waikato	Silt loam	Allophanic	AOP	l.over.s	15.00	30.0	55.00
NCRS Old	Waikato	Silt loam	Allophanic	AOP	l.over.s	15.00	30.0	55.00
Site 5	Waikato	Loam	Allophanic	AOP	l.over.s	22.50	27.5	50.00
Site 13	Waikato	Peat	Organic	AOP	peat	43.75	12.5	43.75
Site 10	Waikato	Silt loam	Brown	Sediment	clay	32.50	15.0	52.50
Site 7	Gisborne	Loam	Pumice	AOP	-	-	-	-
Site 3	Gisborne	Silt loam	Gley	Sediment	s.over.c	30.00	10.0	60.00
Site 9	Gisborne	Clay	Gley	Sediment	clay	50.00	5.0	45.00
Site 2	Gisborne	Clay	Recent	Sediment	clay	47.50	7.5	45.00
Site 6	HB	Sandy loam	Brown	Sediment	silt	16.50	35.0	48.50
Site 1	HB	Silt loam	Recent	Sediment	loam	15.00	65.0	20.00

[a] This was obtained from SMAP (or NSD). *l.over.s* = loam over sand, *s.over.c* = silt over clay,

In Table 2, the soil classification data provided by FAR is called Soil.FAR. GroupOrd is *grouped order* where *AOP* is Allophanic, Organic and Pumice, and *Sediment* (Sedimentary) is Brown, Gley and Recent.

2.4.3 Hybrid data

To look at the effect of the hybrids, we need to be able to classify them. David Densley (FAR) was able to provide CRM numbers for all but one of the hybrids.

These numbers are used to create the variable *Maturity*. It has three levels *early* ($\mathrm{CRM} < 99$), *medium* ($99 \leq \mathrm{CRM} < 106$) and *late* ($\mathrm{CRM} \geq 106$).

When we take the means over the trials, we need to allow for the two hybrids that were part of trial number 18 at ‘NCRS Old’ in 2013. There were also two Hybrids with trial number 17 at NCRS Old in 2012. The planting dates also differed for the two hybrids for both of these trials. This means we have an extra six observations when examining the hybrids. It then appears as though those two trials are treated as four trials. We do this because we are very short on data for the hybrids.

2.4.4 Standardised tillage variables

The data as they stand were hard to interpret because yields can vary depending on the season/year due to influences like the weather. To compare the different cultivation methods, we normalised the data.

We created new *standardised* variables so we could consider the treatment effect on the yield for the trials. There was a lot of missing data since not all trials tested all three tillage treatments.

The standardised yield variable for ‘NT.minus.ST’ was calculated for each trial as appropriate. It is the difference between the NT yield and ST yield normalised by the mean yield for that trial:

$$\text{NT. minus. ST} \leftrightarrow \frac{\text{NT yield} - \text{ST yield}}{\text{Trial mean yield}}$$

The standardised yields for, ‘NT.minus.FC’ and ‘ST.minus.FC’, were calculated similarly.

This method of standardising is similarly used for grain moisture and grain test weight data.

2.5 Statistical analysis

The statistical analyses in this report were carried out using R version 3.6.3 (2020-02-29). The meta-analysis focused on looking for insights rather than carrying out formal modelling and obtaining p-values. The data investigated here do not come from a controlled experiment, and as such there could be many unreported influences on the outcomes (for example, as trials are conducted over a 15 year time span, and climate has not been considered here as a variable/factor, neither are soil quality or soil structure etc).

The dataset contained 382 observations. However, as the individual trials involved their own replication, all of the observations are not independent, the within-trial replication effectively acting as pseudo-replication. Pseudo replication would be misleading for our meta-analysis because the within-trial dependence is hard to visualise. Assuming that most of the time replicates within a trial are more similar to each other than to the results from other trials, we could not justify giving a trial with eight reps twice as much representation in meta-analysis plots compared to a trial with four replicate observations. For this reason, we calculated the mean result for each trial and tillage treatment, and used this for our analyses. The same approach was applied to established plant population. Nitrogen application rates and seeding rates were consistent within each trial, so there was no requirement to calculate a mean.

To enhance the visual display of results, a small amount of horizontal jitter (and in the case of seeding rate, vertical jitter) has been added to many of the plots to decrease points being plotted over the top of each other and therefore appearing absent.

3 Results and discussion

3.1 Overview of the trial sites

Trial locations extended from South Head Auckland in the north, to Hawke's Bay in the south of the North Island (Figure 1). The data made available to PFR varied in the number of tillage treatments tested at each site, and whether seeding rate, plant population or N fertiliser treatment data were available (Table 1). In addition, the sites varied in soil characteristics (Table 2).

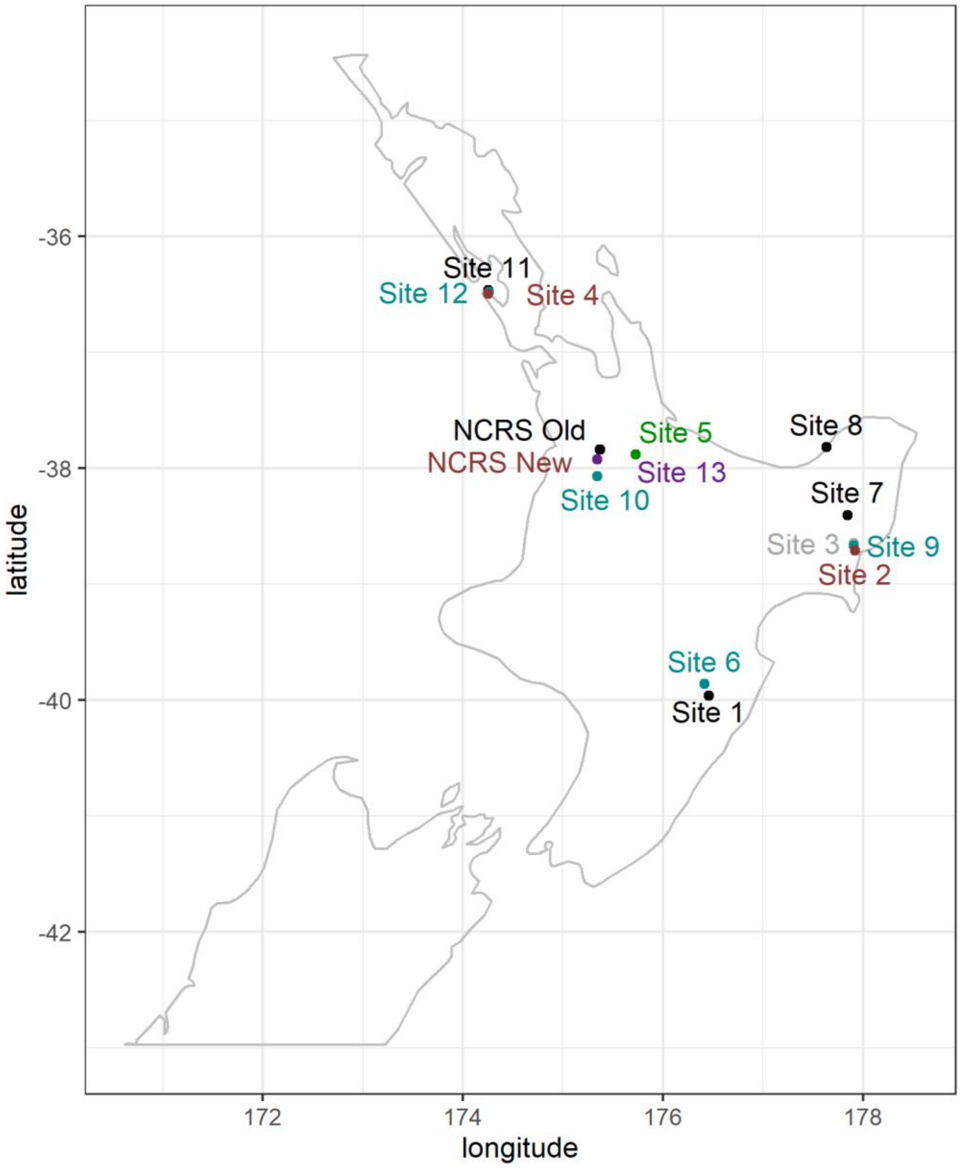

Figure 1. The dataset comprised data from 15 trial locations (38 trials) in the North Island.

In the following table we show details about the trials – where they were, when they took place, which tillage treatments were studied, whether they were grain or silage, and whether we have data for the nitrogen application rate, seeding rate and established plant population.

Table 3. Summary of the data and trial sites made available to PFR.

FAR Number	Site	Harvest Year	Treatments	Grain	Silage	N applied	Seeding Rate	Plant Population
21	NCRS New	2015	NT, ST, FC	Y	-	Y	Y	Y
22	NCRS New	2016	NT, ST, FC	Y	-	Y	Y	-
23	NCRS New	2017	NT, ST, FC	Y	-	Y	Y	-
24	NCRS New	2018	NT, ST, FC	Y	-	Y	Y	-
25	NCRS New	2019	NT, ST, FC	Y	-	Y	Y	-
26	NCRS New	2020	NT, ST, FC	-	Y	Y	Y	-
13	NCRS Old	2008	NT, ST, FC	Y	-	Y	Y	-
14	NCRS Old	2009	NT, ST, FC	Y	-	Y	Y	Y
15	NCRS Old	2010	NT, ST, FC	Y	-	Y	Y	Y
16	NCRS Old	2011	NT, ST, FC	Y	-	Y	Y	Y
17	NCRS Old	2012	NT, ST, FC	Y	-	Y	Y	Y
18	NCRS Old	2013	NT, ST, FC	Y	-	Y	Y	-
20	NCRS Old	2015	NT, ST, FC	Y	-	Y	Y	-
-	Site 1	2008	ST, FC	-	Y	Y	Y	Y
34	Site 2	2018	NT, ST, FC	Y	-	-	-	-
43	Site 3	2019	ST, FC	Y	-	Y	Y	-
27	Site 4	2017	NT, FC	Y	-	-	-	-
31	Site 4	2018	NT, FC	Y	-	-	Y	-
37	Site 4	2019	NT, FC	Y	-	-	-	Y
35	Site 5	2019	NT, ST, FC	Y	-	Y	Y	-
41	Site 5	2020	NT, ST, FC	-	Y	Y	Y	-
-	Site 6	2008	ST, FC	-	Y	Y	Y	Y
-	Site 6	2009	ST, FC	-	Y	Y	Y	Y
33	Site 7	2018	NT, FC	Y	-	Y	-	-
28	Site 8	2017	NT, FC	Y	-	Y	-	Y
32	Site 8	2018	NT, FC	Y	-	Y	Y	-
12	Site 9	2005	NT, ST, FC	Y	-	-	-	-
44	Site 9	2007	NT, ST	Y	-	-	-	Y
43	Site 10	2009	ST, FC	-	Y	Y	Y	Y
45	Site 10	2011	ST, FC	-	Y	Y	-	Y
30	Site 11	2018	NT, FC	Y	-	Y	Y	-
38	Site 11	2019	NT, FC	Y	-	-	Y	Y
40	Site 11	2020	NT, FC	Y	-	Y	Y	Y
26	Site 12	2017	NT, FC	Y	-	Y	-	Y
29	Site 12	2018	NT, FC	Y	-	-	Y	-
36	Site 12	2019	NT, FC	Y	-	-	Y	Y
39	Site 13	2019	NT, ST	-	Y	Y	Y	Y
42	Site 13	2020	NT, ST	-	Y	Y	Y	Y

3.2 Does tillage affect harvest yield?

Across all of the trials, the data provided no clear evidence of a yield trend over the date range studied (i.e. yields were not consistently increasing or decreasing with consecutive harvest year; Figure 2). Further, tillage treatment did not appear to alter the general range of yields observed, which were ~6–15 t/ha for grain and ~15–27 t/ha for silage systems irrespective of tillage treatment (Figure 3).

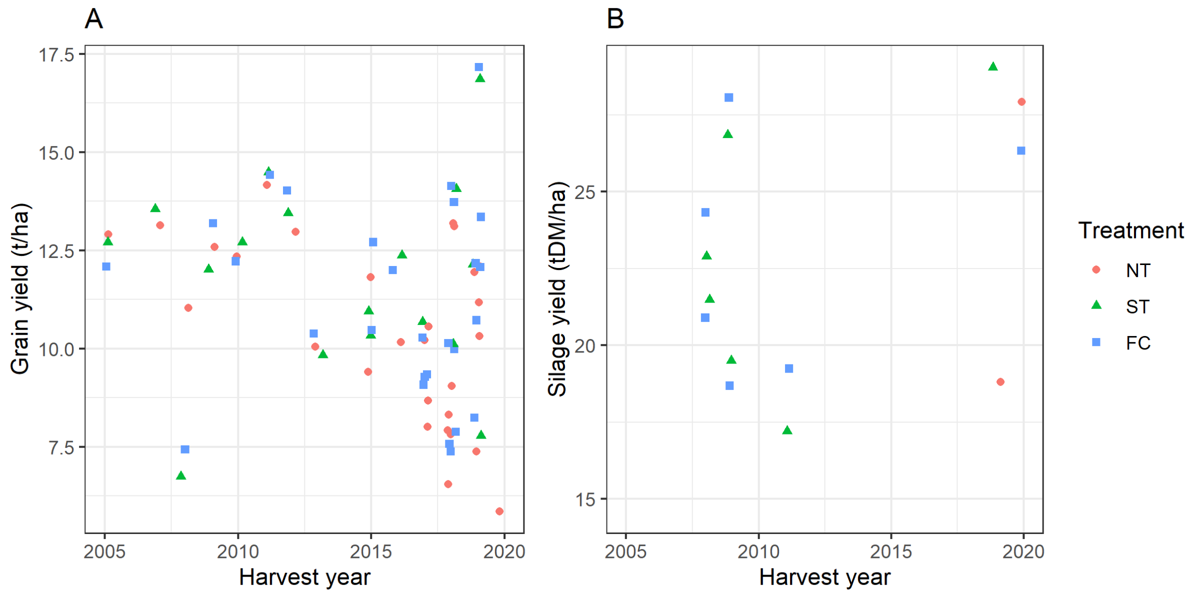

Figure 2. Maize yields by harvest year, for (A) grain and (B) silage crops.

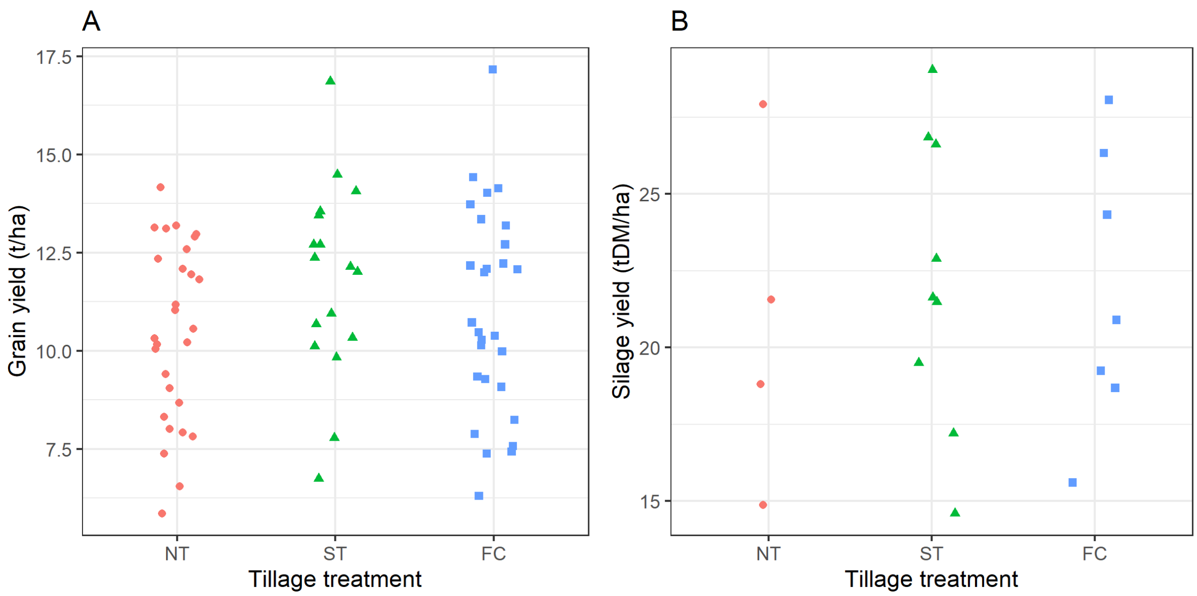

Figure 3. Grain (A) and silage (B) yields for each of the tillage treatments, where NT refers to no-tillage, ST to strip tillage, and FC to full cultivation.

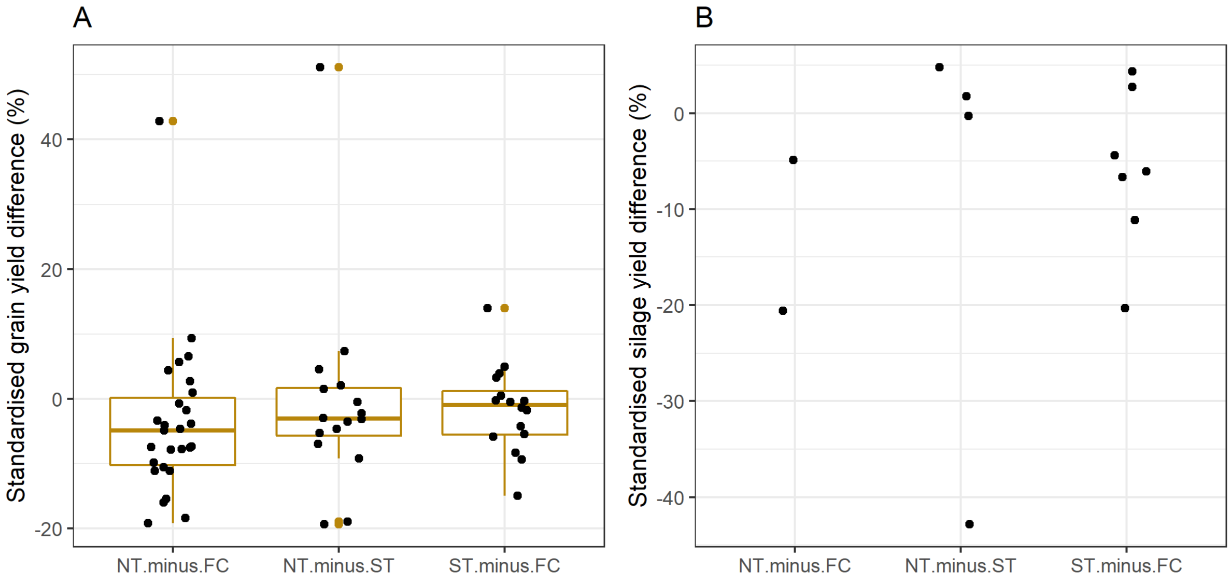

Figure 4. Pairwise comparison of tillage treatments for maize grain (A) and silage (B) trials. Boxes represent data from the 25–75 percentile, while the line within the box is the median.

However, when yield was standardised within each trial, we observed on average a small yield advantage to using full cultivation establishment practices. Median grain yield was approximately 5% higher for FC compared to the NT treatment (i.e. the median for NT.minus.FC is negative), while 25% of the trials had a greater than 10% yield advantage (Figure 4A). It is not known whether best practice NT was conducted in these trials. In real terms, the 5% yield advantage equates to 0.5 t/Ha more grain harvested from FC than NT treatments. The median yield advantage for ST compared to NT is also ~5%, however the data are skewed with a tail towards lower yield advantage than this median. There are insufficient data to draw any conclusions regarding yield advantages between tillage treatments for maize silage trials.

3.3 Is there any evidence that yield observations correlate to different seeding rates, established plant populations or yield components?

We investigated whether the observed yield trends (Figure 4) could be attributed to different seeding rates, established plant populations or components of yield (e.g. grain moisture content at harvest).

3.3.1 Seeding rates and established plant population

The trials conducted included eight different seeding rates (expressed as 1000s/ha): 76, 88, 89, 90, 100, 105, 108 and 120 (Figure 5). We were interested to see whether there was an interaction between seeding rate and established plant population for the tillage treatments. While the dataset is small, it shows that higher seeding rates typically result in higher plant populations for both the grain and silage trials (R^2 = 0.70 and 0.85 respectively; Figure 6). It is unlikely that this relationship is linear; and as growers target different plant populations for maize grain or silage, it is not helpful to investigate this further from the available dataset. Moreover, it is important to note that as *not all three tillage treatments were included in every trial, the dataset is further confounded.*

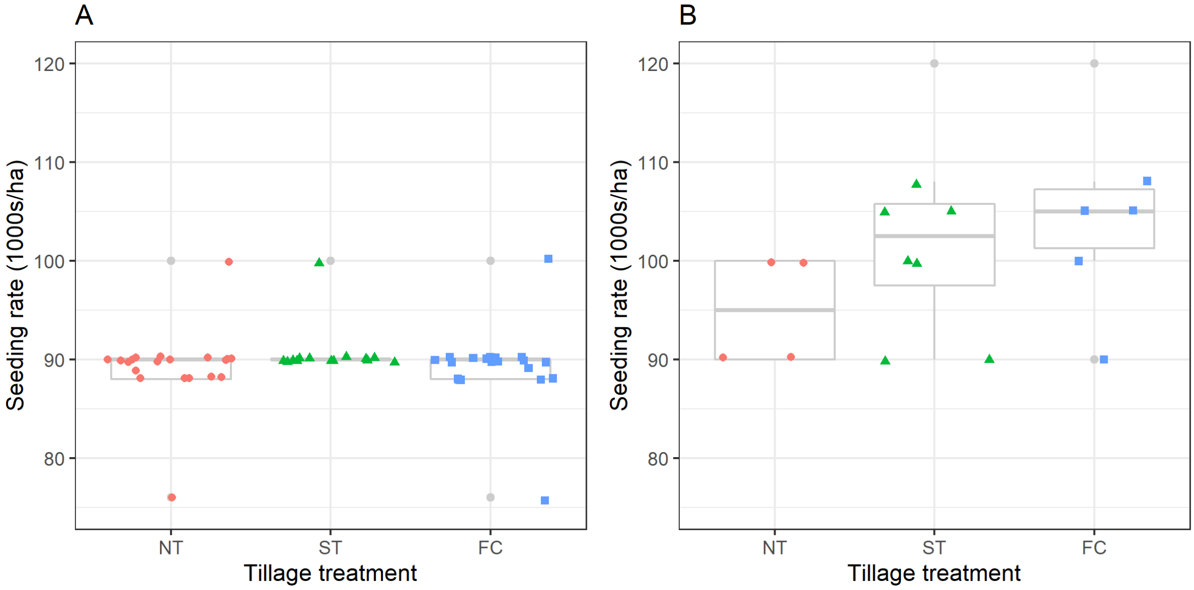

Figure 5. Seeding rates versus tillage treatments for (A) grain and (B) silage.

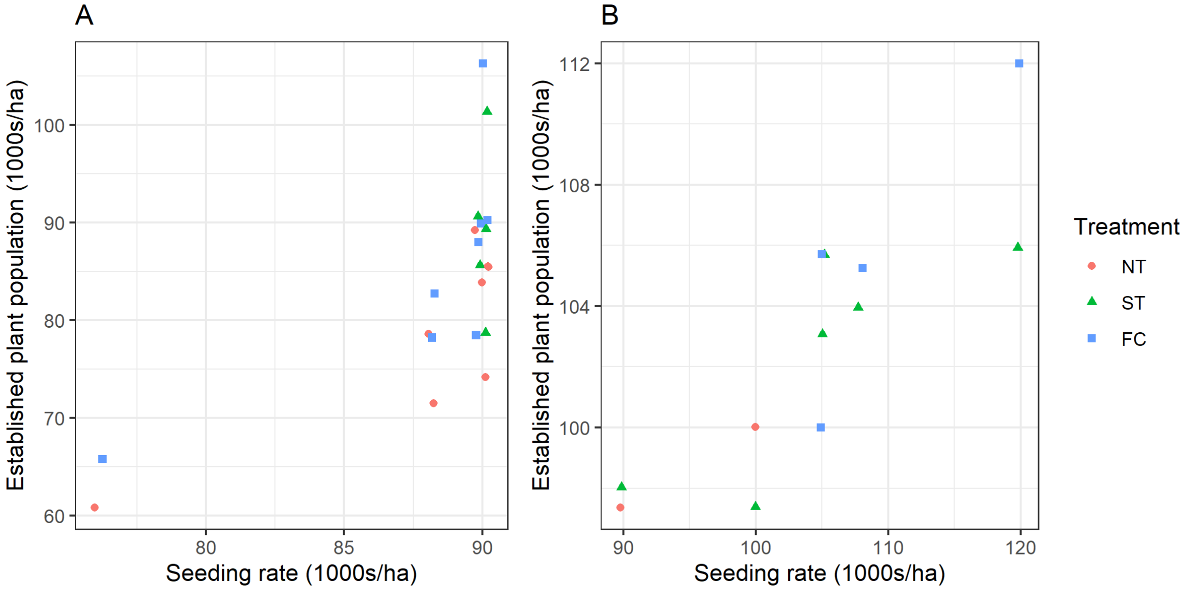

Figure 6. Established plant population versus seeding rate with tillage treatments for (A) grain and (B) silage.

3.3.2 Data subset: Seeding rate 88–90 000/ha

Seeding rates of 88–90 (1000 seeds per hectare) were reasonably well represented in the data (eight trials, five sites), and thus we identified this subset of the data to investigate further. The majority of these observations were from grain enterprises. Established plant population on a trial basis is depicted in Figure 7, as only one trial with a seeding rate of 88–90 (000's seeds/ha) was conducted in each calendar year, with the exception of 2019 when two trials took place. In order to distinguish between these two trials, the points from one trial are displayed more faintly than for the other. For this controlled seeding rate, established plant population was consistently lower for the NT tillage treatment compared to ST and FC. While the NT population was on average lower than that for ST and FC, the range of populations appeared similar (e.g. 72–97 for NT and 78–106 for FC), Figure 8.

For transparency, using this subset of data, the yield penalty of the lower plant population for NT compared to FC is quantified as 7% (Figure 9), with tillage treatment trends consistent to those seen across all trials, all-be-it more pronounced for this subset.

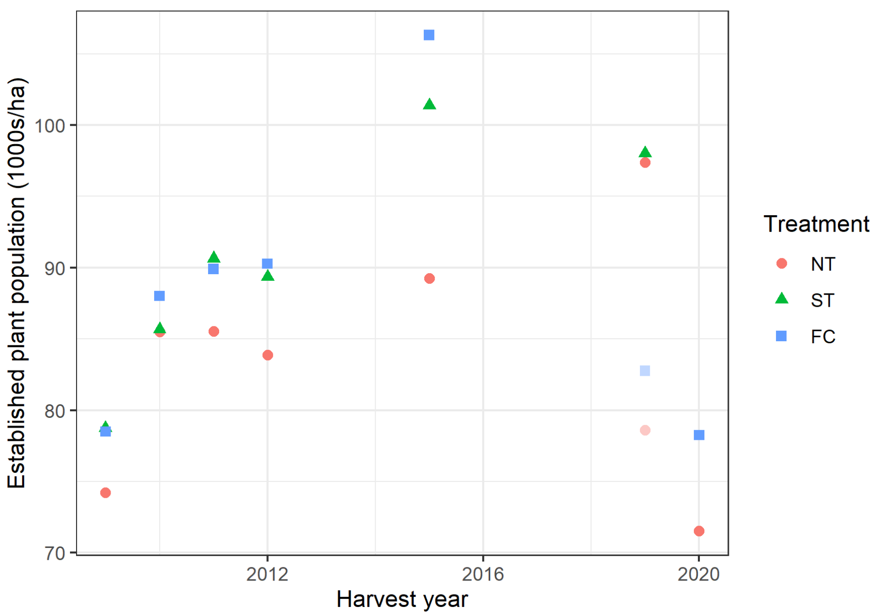

Figure 7. Established plant population versus harvest year with tillage treatment, using only the data with seeding rates of 88–90. Note that in 2019 there were two trials and the data for one are intentionally faint so that it is clear which is which.

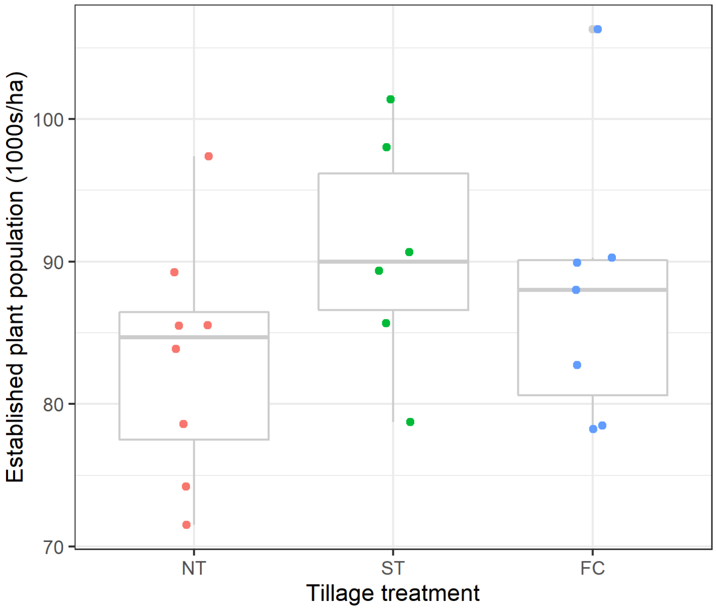

Figure 8. Established plant population versus tillage treatment, using only the data with seeding rates of 88–90.

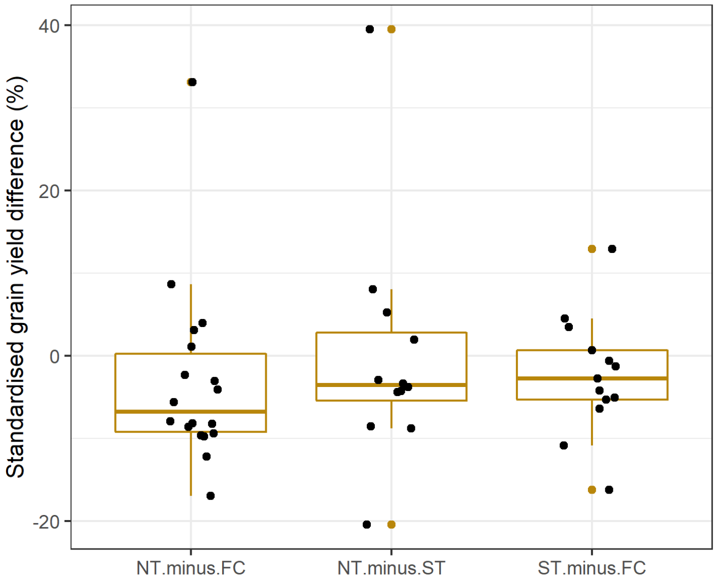

Figure 9. Grain yield treatment differences for the data with a seeding rate of 88–90 (1000s/ha).

3.3.3 Yield components

PFR was also provided with moisture (28 trials) and test weight data (22 trials) for grain trials. Initial observations (Figure 10), suggested NT grain moisture may have been higher than for the other tillage treatments, however when differences were standardised between treatments, this observation was not supported by the data, i.e. we could not detect any tillage treatment effects on grain moisture or grain test weights (Figure 11). PFR did not have visibility of how each of the trials were managed, i.e. were all tillage treatments sown and harvested on the same day, and if so, whether the treatments reached maturity at different points in time.

(We observed grain moisture and test weight data were not consistently recorded for all three tillage treatments, with data missing for the ST treatment approximately half of the time).

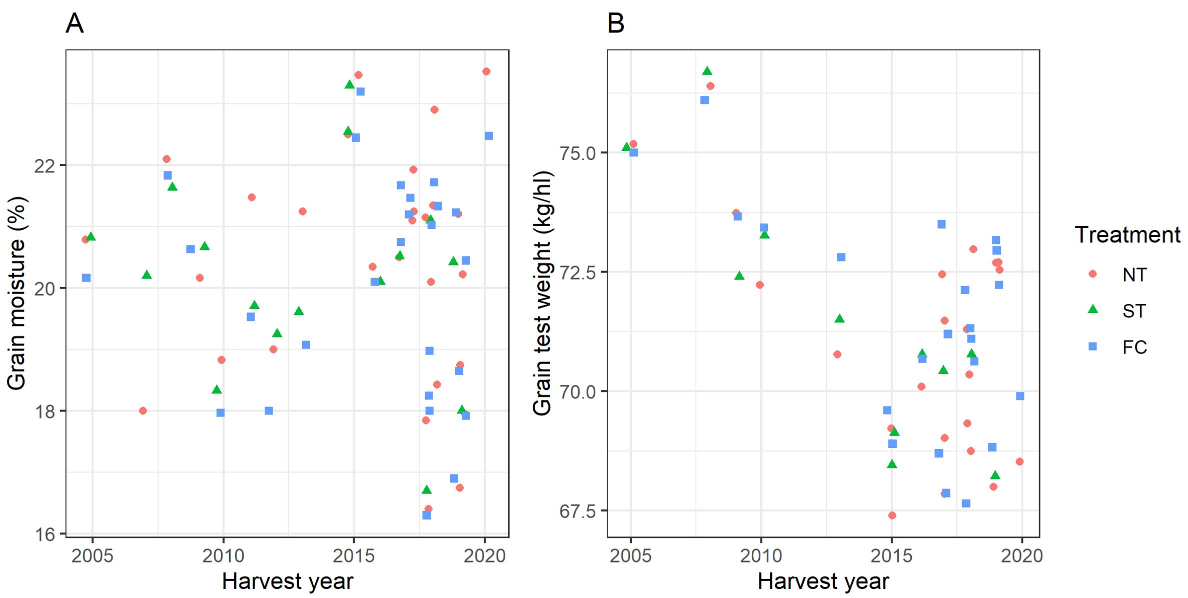

Figure 10. Grain moisture (A) and test weight (B) versus harvest year with tillage treatments.

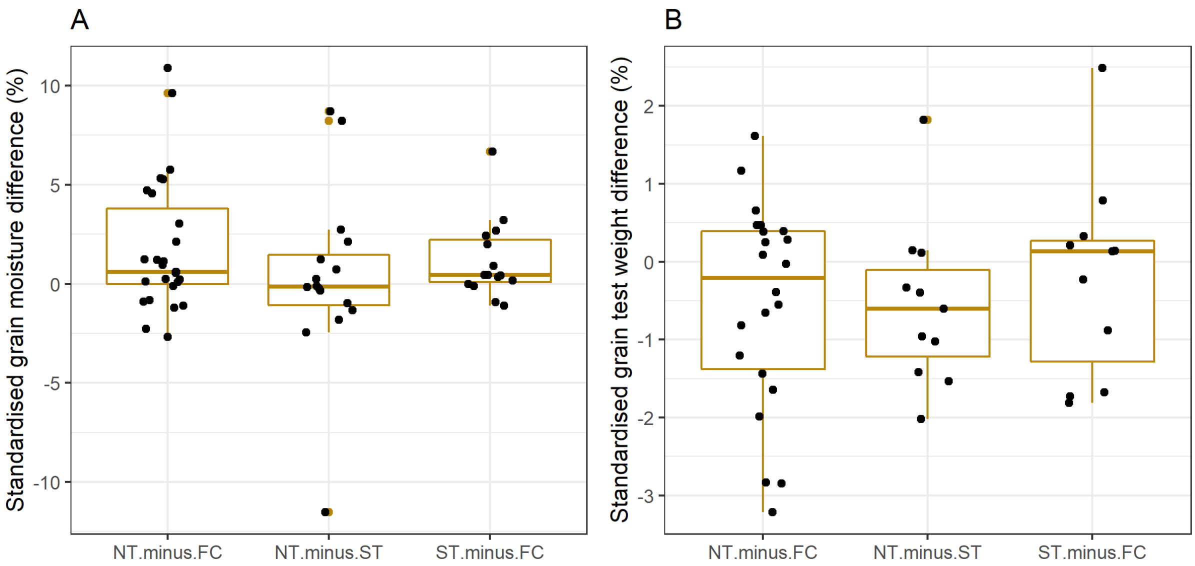

Figure 11. Grain moisture (A) and test weight (B) versus harvest year with tillage treatments.

For the silage trials, there were insufficient dry matter percentage data to investigate further.

3.4 Nitrogen application in space and time

The dataset contained N application rates of between 0 and 289 kg N/ha, and no obvious trend in N application rate with time was observed (Figure 12). The dataset contained two trials with a recorded nitrogen application rate of 0 (zero), where Maize silage was grown with ST and FC establishment treatments. At the time of compiling this report, we believed these to be true zero applications and not missing data. While there are insufficient data to compare results robustly, there appears to be no indication of yield advantage or penalty associated with N fertiliser rate, or compared with an N interaction with tillage treatment (Figure 13). The two trials which received no fertiliser N had maize silage harvests of ~18 and 27 t DM/ha. We were not supplied with soil mineral N information, or length of time since the site was in pasture, and therefore cannot comment on whether this trend was observed due to a surplus of soil and fertiliser N in the growing system.

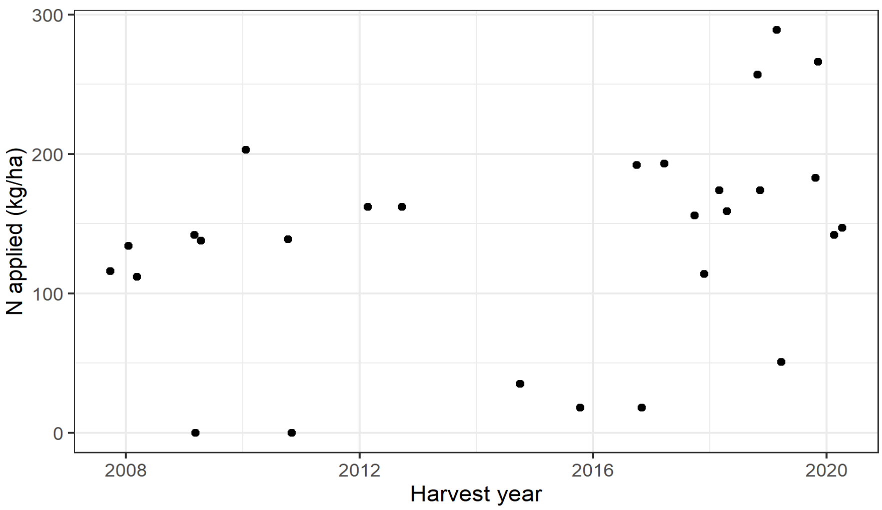

Figure 12. Fertiliser N application rate versus harvest year.

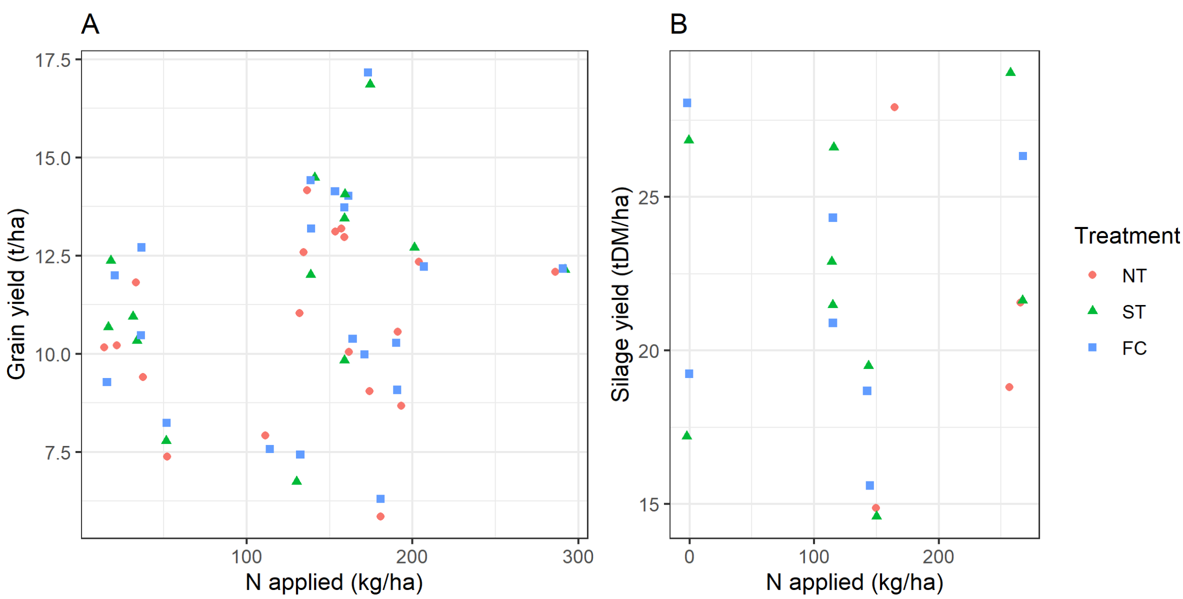

Figure 13. Grain yield (A) and silage yield (B) versus N applied with tillage treatments.

3.5 Hybrids and planting date

In the plots below, colours are used to distinguish between the hybrid maturities. The sowing time of year and the harvest time of year do not appear to make sense as they do not correspond with their respective maturity classifications. We would expect to find the early maturity points mostly sitting towards the left of the graph and the late ones to be towards the right. However, this is not the case, so it indicates that pursuing this classification is unlikely to be meaningful.

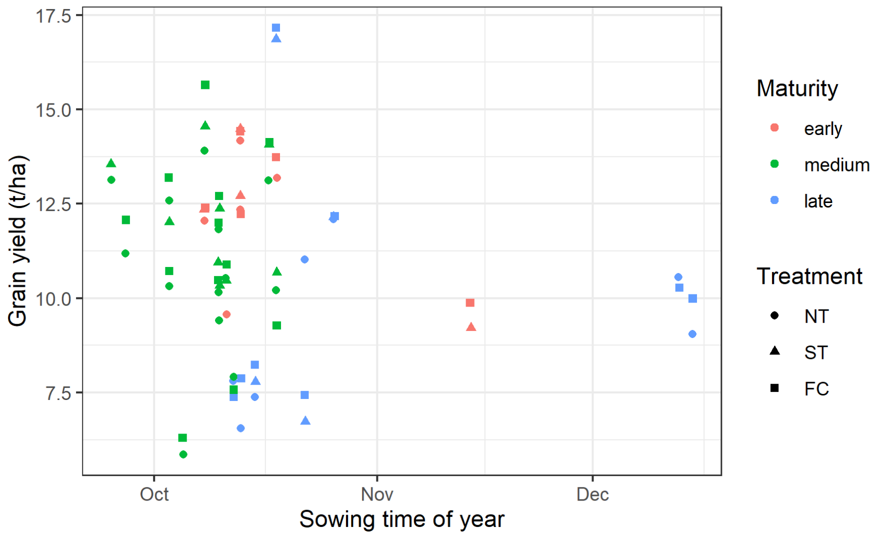

Figure 15. Grain yield versus planting time.

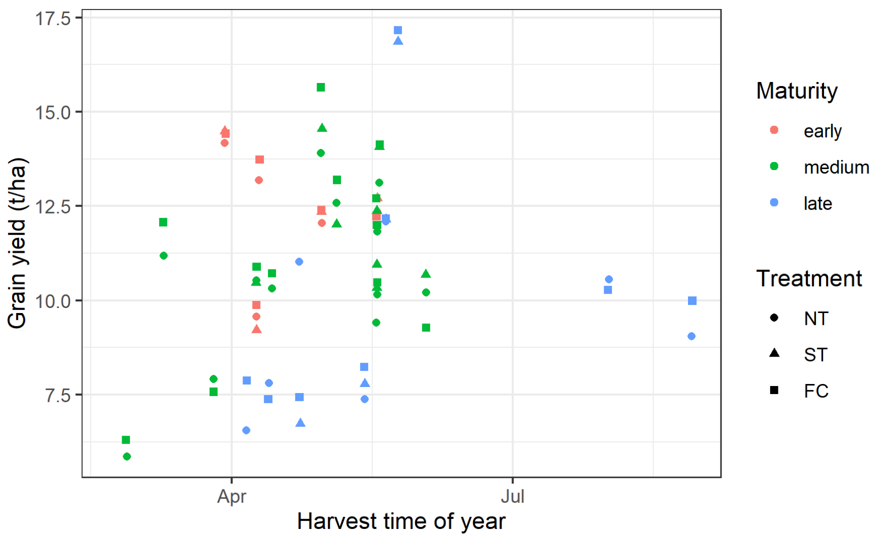

Figure 16. Grain yield versus harvest time.

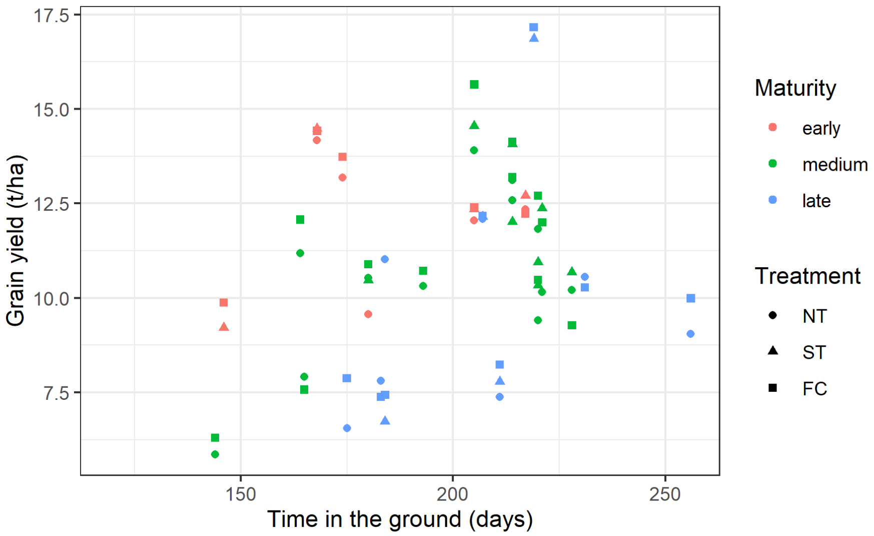

Figure 17. Grain yield versus time in the ground.

3.6 Soils

Trials were conducted on a wide range of soil types, representing a wide range of soil Orders. To give some indication of whether soil is likely to influence the outcome of tillage treatment trials we grouped more similar soil Orders together to create a tillage category as discussed in Section 2. Soil groups were *AOP*= Allophanic, Organic and Pumice soils, and *Sediment* (Sedimentary) = Brown, Gley and Recent soils. Given the high variability within and between trials, soil Order grouping did not appear to influence tillage treatment effects on grain yield (Figure 18). Further, nitrogen fertiliser application rates appeared independent of soil Order grouping (Figure 19), although replication is low.

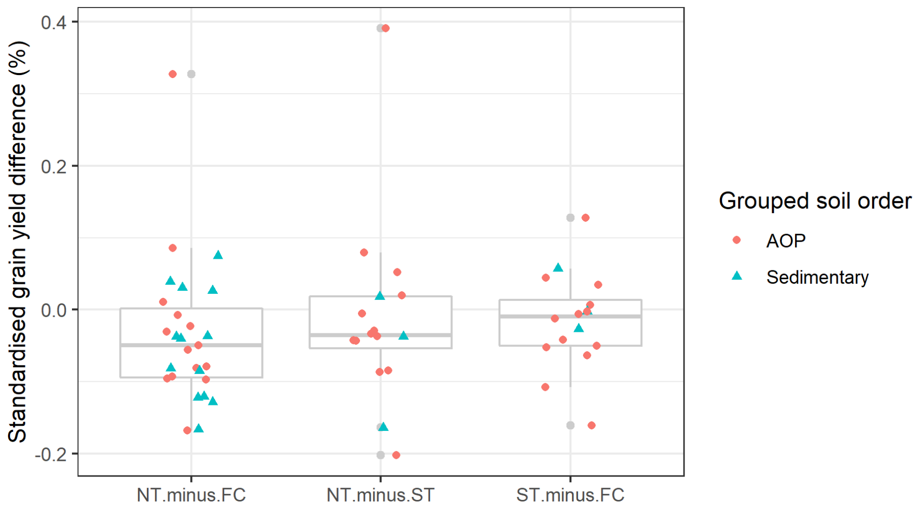

Figure 18: Grain yield tillage treatment differences with the grouped soil order.

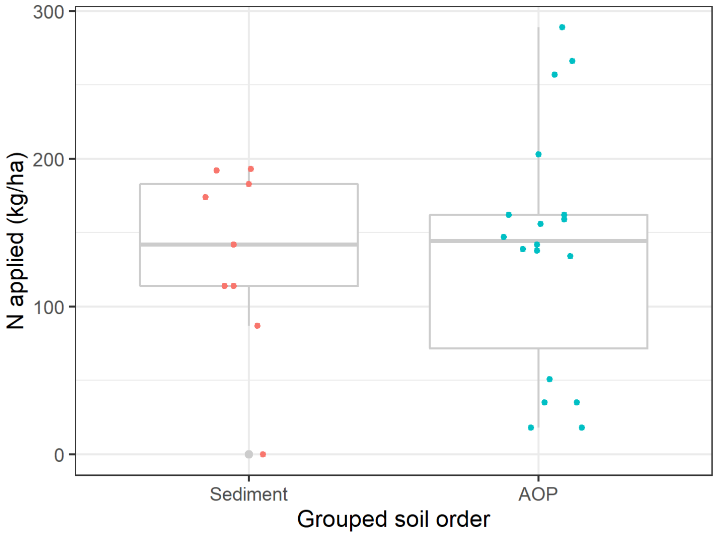

Figure 19. Fertiliser N application rate versus grouped soil order.

3.7 Gross margin

The full set of data provided to us for this section does not appear to be from exactly the same set of trials as described in the rest of this report. However, in an attempt to more closely align them with the other the data in the current investigation, we have excluded the small number (five) of records that were included for trials conducted before 2005.

We have assumed that FAR personnel have allowed for and included all the required costs in the calculated data that were provided (column Y in a separate sheet in the dataset) to PFR. It was not possible for us to match up these financial data with the results that were described above and so the data may include a mixture of both grain and silage trials.

In Figure 20, we show the economic advantage of NT compared to FC. Data above the dashed red line represents a monetary advantage to no-till, while points below the red line indicate a disadvantage. There are more points above the dashed line than below it, thus indicating more often than not a profit advantage to NT. Although we earlier observed a small *yield* advantage to FC, when we take account of the cost of additional cultivation passes, we note when other factors are taken into account that the *economic* advantage tends to favour NT.

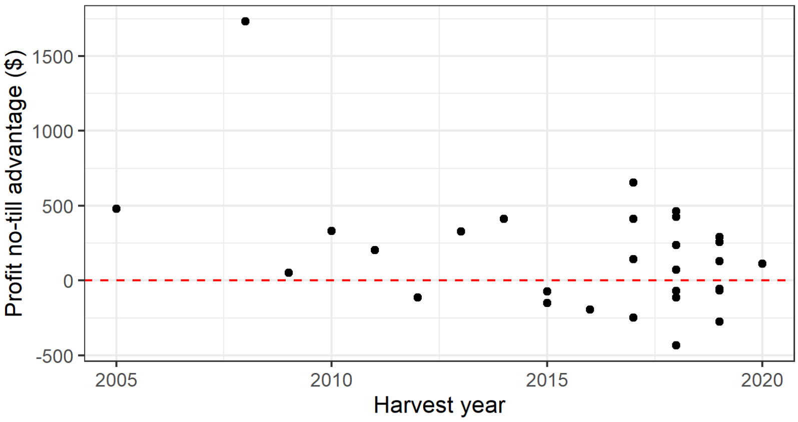

Figure 20. Profit no-till advantage over time.

4 Conclusions

The main findings from the mini meta-analysis were:

- An apparent yield advantage to using full cultivation establishment practices was noted. Median grain yield was approximately 5% higher, or 0.5 t/ha for full cultivation (FC) compared to the no tillage (NT) treatment, while 25% of the trials had a FC yield advantage >10%.
- Established plant population is often considered to be more variable under NT than FC, but we did not observe it to be more variable, just lower overall. When a subset of the data was used to include only sites with a seeding rate of 88,000 to 90,000 seeds per hectare, the established plant population was consistently lower for the NT tillage (median 85,000 seeds/ha) than strip tillage (ST) and FC treatments (medians 90,000 and 88,000 seeds/ha). It is possible this lower established plant population contributed to the slightly lower yield trend.
- There is no indication of either yield advantage or penalty associated with nitrogen (N) fertiliser rate, or of an N interaction with tillage treatment. There are, however, insufficient data to compare results robustly. For two silage trials where zero fertiliser N was applied, yields of ~18 and 27 t DM/ha were recorded. As no further soil N information was available, we cannot comment on whether this trend is observed due to ample soil and fertiliser N in the growing system, resulting in yields being limited by factors other than N or otherwise.
- When the cost of additional cultivation passes is taken into account, the economic advantage tends to favour NT rather than FC.

5 Acknowledgements

We would like to acknowledge Allister Holmes & David Densley for compiling data and sourcing additional information when requested.

6 References

Manaaki Whenua Landcare Research, 2021. SMAP, Version 3.1.224@2021. Retrieved 20 May 2021.

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