MAIZE SILAGE RESEARCH 2024

PIONEER®
BRAND · PRODUCTS

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INTRODUCTION

Welcome to the Pioneer Maize Silage Research update for 2024.

For many years we've produced Maize Silage Hybrid Performance Information which provides comprehensive hybrid yield data enabling growers to make informed decisions on which hybrid to plant. However, our research programme covers so much more than just hybrid evaluation. Each year we aim to deliver more value to growers by conducting a range of agronomic, farm system and environmental research. In this publication, we've summarised some of our latest plant population and nitrogen research. We also summarise a recently produced report on reducing the reliance of NZ livestock systems on internationally produced feed.

An IMPACT™ small plot planter at Gordonton, Waikato. IMPACT is the acronym for "Intensively Managed Product Advancement and Characterisation Training" trials.

Long term breeding delivers higher yields

The annual rate of maize silage yield gain in New Zealand is estimated to have been over 300 kgDM/ha/year over almost 60 years (Figure 1). Crop management and genetic improvement have both made significant contributions to yield increases.

A newly introduced Pioneer hybrid will usually have considerable yield advantage over older hybrids. To maximise returns, silage growers should look to introduce suitable new hybrids regularly. Desired harvest timing, soil type, cultivation methods and agronomic traits such as early growth, drought tolerance, stalk and root strength, disease resistances and silage quality are all important considerations to include in the hybrid selection process.

The most reliable way to select superior hybrids is to consider trial yield data gathered over several seasons from a wide range of locations within a growing region. An individual on-farm trial result should not be used to select a hybrid because in isolation, it is not a reliable predictor of future hybrid performance. Hybrids should be planted and harvested at the same time. Trial data should be statistically analysed to determine if there is a real yield difference between the hybrids.

This publication provides a summary of the investment made to evaluate the silage yield performance of Pioneer® and other brands of maize silage hybrids in five defined growing regions;

1) Northland and north Auckland **2)** Waikato **3)** Bay of Plenty, Gisborne and northern Hawke's Bay **4)** Lower North Island and Taranaki **5)** South Island.

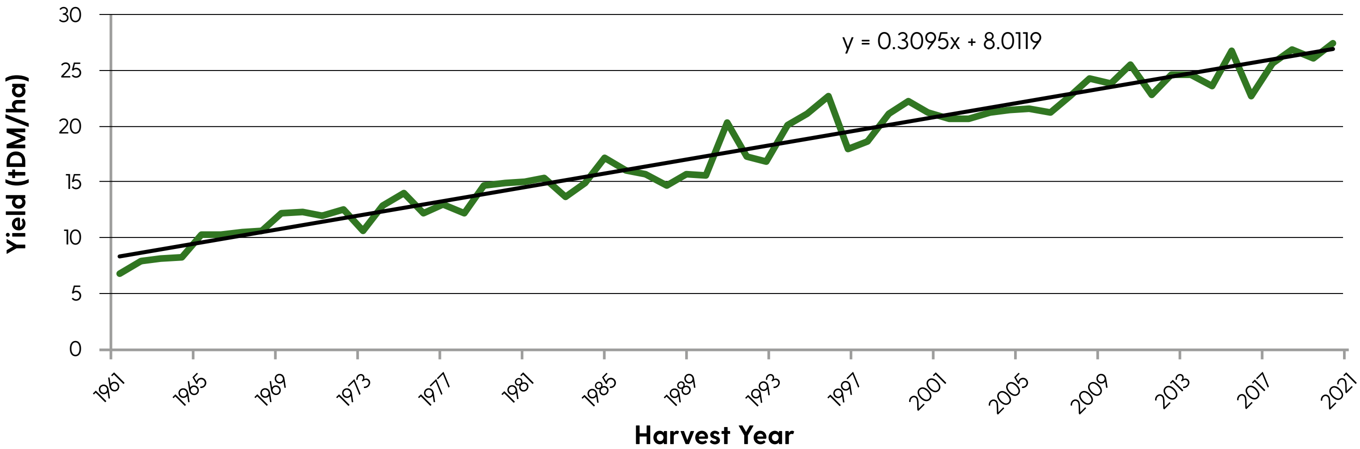
Summarised hybrid comparison data published in this book has been collected from field trials conducted over one or more growing seasons up to and including the 2023 harvest. The most recent regional Hybrid Performance Information (HPI) can be found at pioneer.nz.

Sometimes we publish comparisons between hybrids which were not trialled during the most recent growing season. There are two main reasons why this happens. Firstly, where two commercial hybrids have been extensively trialled and a statistically significant difference has been established, there is no need to continue trialling these hybrids. Secondly, not all competitor hybrids have trial seed available every season. Because trial results are published prior to the spring sales season, we occasionally publish comparisons which include recently retired competitor hybrids.

It is impossible to publish every possible hybrid comparison. When determining which competitor hybrid comparisons to publish we:

- **only publish comparisons where the P value is <0.10 which means there is a greater than 90% probability the yield difference is real and not just due to chance. This includes trials where the result is commercially acceptable (CA) (see opposite page). Consequently, comparisons involving new hybrids may take several seasons to generate sufficient data to publish.**
- **don't compare hybrids based on Comparative Relative Maturity (CRM) ratings because there is no industry standard. This means hybrids from different companies can have the same CRM rating but take varying amounts of time to reach silage harvest maturity.**
- **only include comparisons where the harvest drymatter difference is +/- 4%. This is an objective measure and a more robust way to compare products. We also always publish the actual drymatter difference so growers can consider hybrid maturity as well as yield in their hybrid decision.**

Figure 1: New Zealand maize silage yield trend



Source: New Zealand Year Book (1961 to 1996) and Pioneer® brand products New Zealand Research Programme (1997 to 2021).

Interpreting the hybrid comparison t-test

The table below presents a summary of the possible t-test outcomes.

P value	Confidence level	Scientific designation	Level of significance	Yield advantage	Interpretation
<0.001	>99.9%	★★★	Very highly significant	YES	**Hybrid superiority for yield <u>can be claimed</u>.** Can confidently plant the winning hybrid providing no key agronomic traits are limiting. Check the trait ratings for any considerations.
<0.01	>99.0%	★★	Highly significant	YES	
<0.05	>95.0%	★	Significant	YES	
<0.10	>90.0%	CA	Commercially acceptable	YES	May be regarded as a commercially acceptable basis for a decision.
>0.10	<90.0%	NS	Not significant	NO	**Hybrid superiority for yield <u>cannot be claimed</u>.** Ignore the yield comparison and refer primarily to important trait ratings to select between the hybrids.

The more stars (★) present for the comparison, the more confident we can be that the measured average yield difference is due to an actual genetic yield difference between the two hybrids rather than just chance.

Where a result is commercially acceptable (**CA**), the P value is <0.10 indicating the result is suitable for making a hybrid decision based on yield. Key agronomic traits must always be considered.

Where a result is not significant **(NS)**, we cannot conclude there is a yield difference between the hybrids. There are two principle explanations;

1. Where the yields are very similar and the comparison has been made over a large number of locations, no significance may indicate there is little measurable difference between the two hybrids or;
2. Where there appears to be a large yield difference, no significance likely indicates there are too few trial locations, or there have been inconsistent or fluctuating results. It is therefore not possible to indicate that the difference is real.

In both instances above, growers should use regionally important hybrid trait ratings to select which hybrid to plant.

In other comparisons, yield differences may appear to be relatively small but still achieve significance – this happens in cases where yield data quality is high, and the number of trial locations is large.

A t-test analysis of statistical significance is carried out on all Pioneer hybrid comparisons and we take great care to base our product yield statements and recommendations on the outcome.

NEW

PIONEER BRAND P7179

QUICKEST OPTION FOR THE COOLEST GROWING REGIONS.

CRM 71

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P7179 (kgDM/ha)[2]	Statistical significance[3]
National					
P7179	P7124	26	5.75	-1,659	★★
P7179	P7364	26	2.93	-2,657	★★★
P7179	P7524	25	6.83	-1,713	★
South Island					
P7179	P7124	12	4.16	-1,608	CA
P7179	P7364	12	2.90	-3,198	★★★
P7179	P7524	11	4.83	-2,057	CA
Lower North Island					
P7179	P7124	14	7.12	-1,703	★
P7179	P7364	14	2.96	-2,193	★★★
P7179	P7524	14	8.40	-1,444	CA

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	110
Medium yield environments	120
High yield environments	130

NEW

PIONEER BRAND P7364

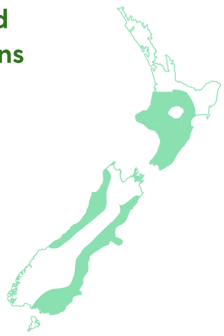
THE NEW STANDARD FOR YIELD & EARLINESS.

CRM 73

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P7364 (kgDM/ha)[2]	Statistical significance[3]
National					
P7364	P7124	45	2.88	1,092	★★★
P7364	P7179	26	-2.93	2,657	★★★
P7364	P7524	43	3.91	625	NS
P7364	P7647	26	1.22	-341	NS
South Island					
P7364	P7124	22	1.29	1,555	★★
P7364	P7179	12	-2.90	3,198	★★★
P7364	P7524	19	0.96	977	NS
P7364	P7647	12	0.60	45	NS
Lower North Island & Taranaki					
P7364	P7124	23	4.39	648	NS
P7364	P7179	14	-2.96	2,193	★★★
P7364	P7524	24	6.25	346	NS
P7364	P7647	14	1.75	-673	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	110
Medium yield environments	120
High yield environments	130

NEW

PIONEER® BRAND P7647

DELIVERS SUPERIOR YIELDS OF TOP-QUALITY SILAGE.

CRM 76

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P7647 (kgDM/ha)[2]	Statistical significance[3]
National					
P7647	P7364	26	-1.22	341	NS
P7647	P7524	25	2.49	1,507	★
P7647	P8000	20	3.42	213	NS
P7647	P8086	18	3.65	-1,738	★★
South Island					
P7647	P7364	12	-0.60	-45	NS
P7647	P7524	11	0.97	1,616	NS
P7647	P8000	10	2.78	172	NS
P7647	P8086	8	3.05	-1,692	CA
Lower North Island & Taranaki					
P7647	P7364	14	-1.75	673	NS
P7647	P7524	14	3.69	1,422	★
P7647	P8000	10	4.06	255	NS
P7647	P8086	10	4.13	-1,775	★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	105
Medium yield environments	110
High yield environments	115

NEW

PIONEER® BRAND

P8086

RELIABLE EARLY HYBRID WITH EXCELLENT FEED VALUE

CRM 80

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P8086 (kgDM/ha)[2]	Statistical significance[3]
South Island					
P8086	P7647	8	-3.05	1,692	CA
P8086	P8000	13	-0.29	1,259	CA
P8086	P8240	11	2.03	-320	NS
P8086	P8333	12	1.12	-1,238	CA
Lower North Island & Taranaki					
P8086	P7647	10	-4.13	1,775	★
P8086	P8000	13	-1.65	1,755	★
P8086	P8240	13	0.45	-1,401	NS
P8086	P8333	13	-1.79	-468	NS
National					
P8086	P7647	18	-3.65	1,738	★★
P8086	P8000	26	-0.97	1,507	★★
P8086	P8240	24	1.17	-906	NS
P8086	P8333	25	-0.39	-838	CA
P8086	Titus	15	0.19	5,282	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	105
Medium yield environments	115
High yield environments	125

NEW

P8240

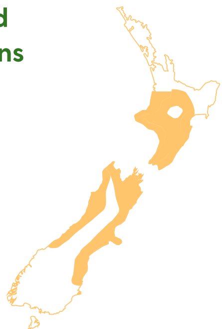
BULK AND ENERGY TO FILL THE VAT.

CRM 82

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P8240 (kgDM/ha)[2]	Statistical significance[3]
National					
P8240	PAC007 (Booster)	15	0.66	3,405	★★★
P8240	P8000	50	-3.43	2,601	★★★
P8240	P8086	24	-1.17	906	NS
P8240	P8333	68	-1.13	414	NS
P8240	P8532	31	2.63	-2,545	★★★
P8240	P8666	78	0.32	-323	NS
P8240	Titus	26	-1.71	6,388	★★★
South Island					
P8240	P8000	19	-2.01	1,452	★
P8240	P8086	11	-2.03	320	NS
P8240	P8333	28	-0.42	-335	NS
P8240	P8532	10	1.85	-2,649	★
P8240	P8666	32	0.39	-749	CA
P8240	Titus	11	-2.86	6,370	★★★
Lower North Island & Taranaki					
P8240	P8000	31	-4.30	3,304	★★★
P8240	P8086	13	-0.45	1,401	NS
P8240	P8333	26	-1.84	1,038	★
P8240	P8532	13	1.72	-1,764	★
P8240	P8666	31	-0.16	20	NS
P8240	Titus	15	-0.86	6,400	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	105
Medium yield environments	115
High yield environments	120

HIGHLY PRODUCTIVE MID-MATURITY OPTION.

CRM 83

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P8333 (kgDM/ha)[2]	Statistical significance[3]
National					
P8333	PAC007 (Booster)	25	1.30	1,543	★★
P8333	P8000	110	-2.21	1,929	★★★
P8333	P8086	25	0.39	838	CA
P8333	P8240	68	1.13	-414	NS
P8333	P8532	32	3.60	-2,967	★★★
P8333	P8666	119	1.41	-774	★★★
P8333	P8711	38	4.48	-1,244	★★
P8333	Titus	39	-0.34	5,396	★★★
South Island					
P8333	P8000	49	-1.51	1,912	★★★
P8333	P8086	12	-1.12	1,238	CA
P8333	P8240	28	0.42	335	NS
P8333	P8532	11	1.21	-2,412	★
P8333	P8666	43	0.96	-436	NS
P8333	P8711	11	2.84	-80	NS
P8333	Titus	18	-1.73	5,611	★★★
Lower North Island & Taranaki					
P8333	P8000	59	-2.77	2,080	★★★
P8333	P8086	13	1.79	468	NS
P8333	P8240	26	1.84	-1,038	★
P8333	P8500	13	3.95	-2,697	★★
P8333	P8666	50	1.55	-836	★
P8333	P8086	11	4.42	-691	NS
P8333	Titus	21	0.85	5,213	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	110
High yield environments	115

NEW

PIONEER® BRAND

P8532

BALANCED ALL-ROUND PLANT DESTINED TO "TIP THE SCALES".

CRM 85

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P8532 (kgDM/ha)[2]	Statistical significance[3]
National					
P8532	P8240	31	-2.63	2,545	★★★
P8532	P8333	32	-3.60	2,967	★★★
P8532	P8500	28	-2.83	3,182	★★★
P8532	P8666	30	-0.72	2,661	★★★
P8532	P8711	18	0.49	2,122	★★★
P8532	P8805	7	-2.25	4,930	★★★
P8532	PAC007 (Booster)	17	-0.44	1,305	★★
P8532	Titus	8	-1.74	8,554	★★★
Waikato					
P8532	P8240	8	-5.11	3,684	★★
P8532	P8333	8	-6.34	4,171	★★★
P8532	P8666	8	-2.13	3,055	★★★
P8532	P8711	8	1.42	2,475	★★
Lower North Island & Taranaki					
P8532	P8240	13	-1.72	1,764	★
P8532	P8333	13	-3.95	2,697	★★
P8532	P8500	11	-2.83	2,647	★★★
P8532	P8666	12	0.37	2,983	★★
P8532	PAC007 (Booster)	10	0.28	1,640	★
South Island					
P8532	P8240	10	-1.85	2,649	★
P8532	P8333	11	-1.21	2,412	★
P8532	P8500	9	-1.66	3,181	★★
P8532	P8666	10	-0.91	1,959	CA
P8532	P8711	8	-0.68	1,445	CA

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	110
High yield environments	115

GROWS WELL, YIELDS VERY WELL AND FEEDS EVEN BETTER.

PIONEER® BRAND P8666

CRM 86

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P8666 (kgDM/ha)[2]	Statistical significance[3]
National					
P8666	P8333	119	-1.41	774	★★★
P8666	P8500	181	-0.92	350	CA
P8666	P8532	30	0.72	-2,661	★★★
P8666	P8711	80	2.26	166	NS
P8666	P8805	71	-0.59	2,196	★★★
P8666	PAC007 (Booster)	50	0.19	1,314	★★
P8666	Titus	30	-2.00	6,377	★★★
Waikato					
P8666	P8333	25	-2.03	1,200	★★
P8666	P8532	8	2.13	-3,055	★★★
P8666	P8711	23	3.10	-1,088	★
P8666	PAC007 (Booster)	15	1.87	2,719	★★
Lower North Island & Taranaki					
P8666	P8240	31	0.16	-20	NS
P8666	P8333	50	-1.55	836	★
P8666	P8500	79	-1.53	44	NS
P8666	P8532	12	-0.37	-2,983	★★
P8666	P8711	38	2.49	763	CA
P8666	Titus	15	-1.29	6,026	★★★
South Island					
P8666	P8240	32	-0.39	749	CA
P8666	P8333	43	-0.96	436	NS
P8666	P8532	10	0.91	-1,959	CA
P8666	P8711	18	0.70	640	NS
P8666	Titus	15	-2.72	6,728	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	110
High yield environments	115

NEW

PIONEER® BRAND

P8711

NEW LEVEL OF PERFORMANCE FOR NORTHERN REGIONS.

CRM 87

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P8711 (kgDM/ha)[2]	Statistical significance[3]
Waikato					
P8711	P8532	8	-1.42	-2,475	★★
P8711	P8666	23	-3.10	1,088	★
P8711	P9127	23	-0.30	126	NS
Lower North Island & Taranaki					
P8711	P8333	11	-4.42	691	NS
P8711	P8500	25	-5.13	-1,146	★
P8711	P8666	38	-2.49	-763	CA
P8711	P9127	25	0.41	-144	NS
South Island					
P8711	P8333	11	-2.84	80	NS
P8711	P8532	8	0.68	-1,445	CA
P8711	P8666	18	-0.70	-640	NS
P8711	P8805	15	-2.72	2,886	★★★
P8711	P9127	17	-0.13	196	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	110
High yield environments	115

NEW

PIONEER BRAND P92575

SOLID, BALANCED HYBRID, WITH TOP-OF-THE-LINE FOLIAR HEALTH.

CRM 92

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P92575 (kgDM/ha)[2]	Statistical significance[3]
National					
P92575	P9127	51	-2.81	158	NS
P92575	P9400	57	-1.74	487	★
P92575	P9650	15	-1.22	153	NS
Waikato					
P92575	P9127	25	-3.53	787	NS
P92575	P9400	30	-2.20	797	★
P92575	P9650	8	-1.13	-218	NS
Lower North Island & Taranaki					
P92575	P9127	23	-2.14	-410	NS
P92575	P9400	23	-1.05	74	NS
P92575	P9650	7	-1.33	577	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	110
High yield environments	120

STANDS TALL – DELIVERS BIG TIME.

CRM 94

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P9400 (kgDM/ha)[2]	Statistical significance[3]
National					
P9400	P9127	186	-0.03	-409	★
P9400	P92575	57	1.74	-487	★
P9400	P9650	22	0.81	-743	NS
P9400	P9721	238	2.13	7	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	108
High yield environments	115

NEW

PIONEER® BRAND P9650

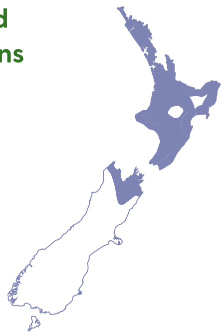
SECURITY WITH PERFORMANCE.

CRM 96

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P9650 (kgDM/ha)[2]	Statistical significance[3]
National					
P9650	P92575	15	1.22	-153	NS
P9650	P9400	22	-0.81	743	NS
P9650	P9911	18	2.12	-419	NS
P9650	P9978	22	2.91	-1,169	★★
P9650	PAC249	15	-0.28	3,173	★★★
Waikato					
P9650	P92575	8	1.13	218	NS
P9650	P9400	11	-0.88	1,110	CA
P9650	P9911	10	0.85	1,135	NS
P9650	P9978	11	2.26	-525	NS
Lower North Island & Taranaki					
P9650	P92575	7	1.33	-577	NS
P9650	P9400	11	-0.74	376	NS
P9650	P9911	8	3.71	-2,363	★
P9650	P9978	11	3.55	-1,813	★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	110
High yield environments	120

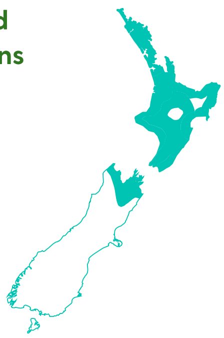
TOP YIELDING, DROUGHT BUSTER.

CRM 99

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P9911 (kgDM/ha)[2]	Statistical significance[3]
National					
P9911	P0021	253	-1.76	1,178	★★★
P9911	P0362	120	0.98	177	NS
P9911	P9650	18	-2.12	419	NS
P9911	P9721	247	-1.85	1,321	★★★
P9911	P9978	93	-1.07	-516	★
P9911	PAC249	81	-1.79	3,428	★★★
P9911	PAC295 (N39-Q1)	86	-2.62	1,727	★★★
P9911	PAC314	46	1.00	1,118	★★
Waikato					
P9911	P0362	64	1.28	317	NS
P9911	P9650	10	-0.85	-1,135	NS
P9911	P9978	43	-0.77	-457	CA
P9911	PAC249	37	-2.11	3,866	★★★
P9911	PAC295 (N39-Q1)	55	-2.20	2,030	★★★
Lower North Island & Taranaki					
P9911	P9650	8	-3.71	2,363	★
P9911	P9721	125	-2.36	1,324	★★★
P9911	P9978	40	-1.03	-400	NS
P9911	PAC249	41	-1.75	3,271	★★★
P9911	PAC295 (N39-Q1)	27	-3.84	1,024	CA
P9911	PAC314	21	0.22	1,910	★★
P9911	PAC344	9	1.79	1,946	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	108
High yield environments	115

VERY DEFENSIVE. VERY STABLE. VERY PRODUCTIVE.

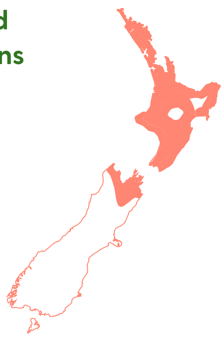
PIONEER BRAND P9978

CRM 99

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P9978 (kgDM/ha)[2]	Statistical significance[3]
National					
P9978	P0362	54	2.72	-77	NS
P9978	P9650	22	-2.91	1,169	★★
P9978	P9721	42	-0.54	1,622	★★★
P9978	P9911	93	1.07	516	★
P9978	PAC249	49	-1.24	2,954	★★★
P9978	PAC314	44	1.50	1,579	★★★
P9978	PAC344	22	3.84	987	★
Northland					
P9978	P9911	10	2.52	1,233	★
Waikato					
P9978	P0362	26	2.91	-470	NS
P9978	P9650	11	-2.26	525	NS
P9978	P9911	43	0.77	457	CA
P9978	PAC249	22	-2.43	3,495	★★★
P9978	PAC314	23	1.81	874	★
Lower North Island & Taranaki					
P9978	P9650	11	-3.55	1,813	★
P9978	P9721	21	-0.86	2,751	★★★
P9978	P9911	40	1.03	400	NS
P9978	PAC249	24	-0.72	2,645	★★★
P9978	PAC314	20	1.07	2,389	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	110
High yield environments	120

ROBUST HYBRID DELIVERING YIELD AND ENERGY.

CRM 103

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P0362 (kgDM/ha)[2]	Statistical significance[3]
National					
P0362	Brutus	14	1.54	1,839	★★
P0362	Maximus	13	-0.03	1,977	★★★
P0362	P0021	72	-2.41	1,340	★★★
P0362	P0640	53	1.05	-914	★★
P0362	P9911	120	-0.98	-177	NS
P0362	P9978	54	-2.72	77	NS
P0362	PAC314	37	-1.89	2,264	★★★
P0362	PAC344	17	1.32	1,534	★
P0362	PAC355 (G49-T9)	51	-2.20	2,211	★★★
Waikato					
P0362	Brutus	14	1.54	1,839	★★
P0362	Maximus	12	-0.13	1,844	★★
P0362	P0021	44	-2.29	1,333	★★★
P0362	P0640	40	0.89	-1,308	★★★
P0362	P9911	64	-1.28	-317	NS
P0362	P9978	26	-2.91	470	NS
P0362	PAC314	24	-2.17	2,103	★★
P0362	PAC344	15	1.61	1,560	CA
P0362	PAC355 (G49-T9)	45	-2.34	2,129	★★★
Lower North Island & Taranaki					
P0362	P0021	26	-2.69	1,188	★
P0362	P9911	44	-0.63	-138	NS
P0362	P9978	23	-2.12	-280	NS
P0362	PAC314	13	-1.37	2,562	★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	105
High yield environments	115

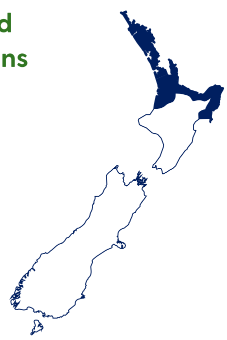
LEAF DISEASE CHAMPION DELIVERING SILAGE YIELD STABILITY.

CRM 106

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P0640 (kgDM/ha)[2]	Statistical significance[3]
National					
P0640	Brutus	17	0.25	3,502	★★★
P0640	Maximus	27	-1.09	2,328	★★★
P0640	P0362	53	-1.05	914	★★
P0640	P0891	143	-1.45	-6	NS
P0640	P0900	61	0.44	505	NS
P0640	P0937	67	1.44	827	★★
P0640	P1315	14	1.42	-843	NS
P0640	PAC344	9	0.36	1,032	CA
P0640	PAC355 (G49-T9)	72	-2.75	2,923	★★★
Northland & South Auckland					
P0640	P0891	28	-2.76	-262	NS
P0640	P0900	10	-0.77	-28	NS
P0640	P0937	10	0.10	557	NS
Waikato					
P0640	Brutus	17	0.25	3,502	★★★
P0640	Maximus	24	-0.96	2,320	★★★
P0640	P0362	40	-0.89	1,308	★★★
P0640	P0891	106	-1.12	217	NS
P0640	P0900	44	0.92	843	★
P0640	P0937	54	1.65	951	★★
P0640	P1315	9	2.34	-1,209	CA
P0640	PAC355 (G49-T9)	62	-2.75	3,226	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	105
High yield environments	110

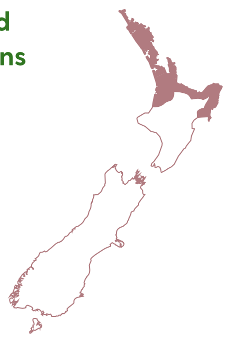
RELIABLE VETERAN.

CRM 107

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P0891 (kgDM/ha)[2]	Statistical significance[3]
National					
P0891	Brutus	19	0.76	2,135	★★★
P0891	Maximus	85	1.17	2,137	★★★
P0891	P0640	143	1.45	6	NS
P0891	P0900	82	1.62	-451	NS
P0891	P0937	113	3.12	-25	NS
P0891	P1315	27	2.55	-2,245	★★★
P0891	PAC355 (G49-T9)	94	-1.56	2,390	★★★
Northland					
P0891	P0640	29	2.76	262	NS
P0891	P0900	13	1.65	539	NS
P0891	P0937	19	3.14	1,481	★★★
P0891	P1636	17	3.81	-501	NS
Waikato					
P0891	Brutus	17	0.80	2,150	★★★
P0891	Maximus	68	1.14	2,263	★★★
P0891	P0640	106	1.12	-217	NS
P0891	P0900	59	1.47	-784	★
P0891	P0937	80	2.73	-554	★
P0891	P1315	27	2.55	-2,245	★★★
P0891	PAC355 (G49-T9)	74	-1.65	2,370	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	105
High yield environments	110

PIONEER® BRAND P0900

HARD TO FAULT, STABLE, ALL-ROUND HYBRID.

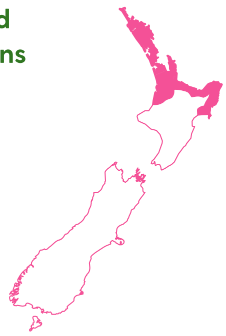
CRM 109

Optimum® AQUAmax®

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P0900 (kgDM/ha)[2]	Statistical significance[3]
National					
P0900	P0937	92	1.10	159	NS
P0900	P1315	29	0.47	-520	NS
P0900	P1636	28	2.34	-1,052	CA
Northland					
P0900	P0640	10	0.77	28	NS
P0900	P0937	14	0.97	-29	NS
Waikato					
P0900	P0937	67	0.84	312	NS
P0900	P1315	28	0.46	-570	NS
P0900	P1636	26	2.39	-1,250	★
Bay of Plenty					
P0900	P0937	11	2.85	-537	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	85
Medium yield environments	95
High yield environments	115

SOLID HYBRID WITH GREAT STANDABILITY AND FOLIAR HEALTH.

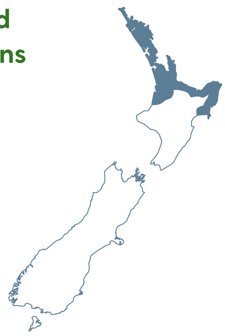
PIONEER BRAND P0937

CRM 109

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P0937 (kgDM/ha)[2]	Statistical significance[3]
National					
P0937	Brutus	16	-2.19	3,359	★★★
P0937	P0640	67	-1.44	-827	★★
P0937	P0900	92	-1.10	-159	NS
P0937	P1315	33	-0.47	-1,528	★★
P0937	P1636	44	0.89	-1,410	★★
Northland					
P0937	P0640	10	-0.10	-557	NS
P0937	P0891	19	-3.14	-1,481	★★
P0937	P0900	14	-0.97	29	NS
Waikato					
P0937	Brutus	16	-2.19	3,359	★★★
P0937	P0640	54	-1.65	-951	★★
P0937	P0900	67	-0.84	-312	NS
P0937	P1315	30	-0.34	-1,078	★
P0937	P1636	35	1.22	-1,251	★
Bay of Plenty, Gisborne & Hawke's Bay					
P0937	P0900	11	-2.85	537	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	90
Medium yield environments	100
High yield environments	115

NEW

PIONEER BRAND

P1315

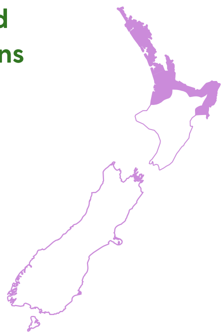
DEFENSIVE FROM NORTHLAND TO HAWKE'S BAY

CRM 110

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P1315 (kgDM/ha)[2]	Statistical significance[3]
National					
P1315	Goliath	8	-1.40	2,575	CA
P1315	P0900	29	-0.47	520	NS
P1315	P0937	33	0.47	1,528	★★
P1315	P1477W	85	2.61	-456	NS
P1315	P1636	81	1.82	-200	NS
Northland					
P1315	P1613	14	1.77	716	NS
P1315	P1636	18	1.92	179	NS
Waikato					
P1315	P0900	28	-0.46	570	★
P1315	P0937	30	0.34	1,078	★★
P1315	P1636	38	1.77	-171	NS
P1315	PAC430	15	-0.08	1,855	NS
P1315	PAC500 (Z71-F1)	23	0.98	1,045	★
Bay of Plenty					
P1315	P1477W	25	2.51	-785	NS
P1315	P1636	25	1.81	-519	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	80
Medium yield environments	90
High yield environments	100

ENJOY THE AGRONOMICS OF THIS TOP YIELDING HYBRID.

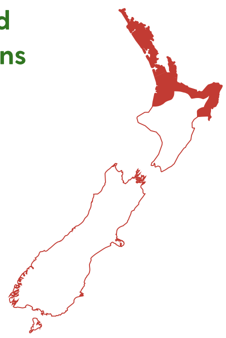
PIONEER BRAND P1636

CRM 112

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P1636 (kgDM/ha)[2]	Statistical significance[3]
National					
P1636	P0900	28	-2.34	1,052	CA
P1636	P0937	44	-0.89	1,410	★★
P1636	P1315	81	-1.82	200	NS
P1636	P1477W	140	1.09	-535	★
P1636	P1837	37	1.57	377	NS
P1636	PAC500 (Z71-F1)	92	-0.04	1,551	★★★
P1636	PAC624	73	3.24	1,357	★★
Northland & South Auckland					
P1636	P1315	18	-1.92	-179	NS
P1636	P1837	6	0.26	-115	NS
Waikato					
P1636	Goliath	8	-2.26	4,186	★
P1636	P0900	26	-2.39	1,250	★
P1636	P0937	35	-1.22	1,251	★
P1636	P1315	38	-1.77	171	NS
P1636	P1477W	66	1.76	-188	NS
P1636	P1837	21	2.33	484	NS
P1636	PAC430	14	-0.68	2,338	★
P1636	PAC500 (Z71-F1)	68	0.32	1,818	★★★
P1636	PAC564	20	1.13	1,791	★★
P1636	PAC624	53	3.76	1,452	★
Bay of Plenty, Gisborne & Hawke's Bay					
P1636	P1315	25	-2.31	519	NS
P1636	P1477W	39	-1.92	-725	NS
P1636	P1837	10	0.91	446	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	105
High yield environments	110

NEW

PIONEER BRAND P1837

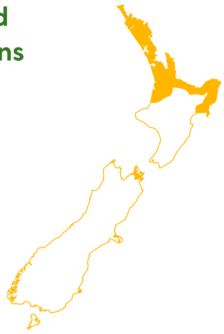
DEFENSIVE FULL-SEASON GIANT.

CRM 115

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage to P1837 (kgDM/ha)[2]	Statistical significance[3]
National					
P1837	P1477W	39	-0.14	-1,176	★
P1837	P1636	37	-1.57	-377	NS
Waikato					
P1837	P1636	21	-2.33	-484	NS
P1837	PAC500 (Z71-F1)	15	-2.74	1,343	★
P1837	PAC624	14	1.38	1,498	CA
Bay of Plenty, Gisborne & Hawke's Bay					
P1837	P1477W	10	0.70	-1,987	★
P1837	P1636	10	-0.73	-446	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 3.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	70
Medium yield environments	80
High yield environments	90

THE EFFECT OF PLANT POPULATION ON MAIZE PLANT SIZE AND SILAGE YIELDS

Introduction

Despite year-to-year maize yield variability, New Zealand maize silage yields have been increasing. Yield gains can be largely attributed to improvements in genetic yield potential and stress tolerance. Previous research conducted in the USA indicated that when planted at very low densities, modern maize hybrids are not any better yielding than older genetics. Yield gains in modern hybrids are only realised when planted at an optimum population that results in maximum light interception. These hybrids have a greater ability to withstand stress attributed to high plant density. Modern hybrids show much reduced barrenness and lodging at high plant densities than older hybrids. The ability to tolerate higher planting density, accompanied by a steady increase in planting rates can hence be considered as the main reason behind the per hectare maize silage yield increases over the years. Other factors may include better agronomic management, improved disease and lodging resistance, and better staygreen.

General relationships between hybrid maturity, crop environment and planting density

Typically, the response of maize yield to increasing plant density is linear at low plant densities, followed by a curvilinear response as densities increase. At some point, often between 100,000 and 120,000 plants/ha depending on the environment and hybrid, yield passes its economic optimum and begins to decline as density continues to increase. This is largely due to plant competition for moisture, light and/or nutrients, increased incidence of plants with no ears (barrenness) and a greater degree of lodging as the plants become increasingly crowded. The optimum density will vary by hybrid, environment, season, moisture availability, soil fertility and other management conditions.

Increased plant densities tend to have the greatest yield responses in high yielding situations and the optimum density for a hybrid is highest under unstressed conditions. Thus, in dry conditions or where soil fertility is low (e.g., light sandy soils) or where weeds are poorly controlled, optimum densities are usually lower. The optimum density of early maturing hybrids (e.g. CRM 90 or less) are usually about 10% higher than that of later maturing hybrids (e.g. 100 CRM or more), reflecting the bigger size and leaf area of later maturing hybrids.

Due to spatial and temporal variability, it is almost impossible to estimate with a high degree of accuracy, the impact of plant populations on yield for a given season. The most credible method of estimating yield response to plant population is to trial and quantify yield responses of hybrids of variable genetics and maturity classes at various densities over a number of years and locations.

Maize leaf area index

Maize leaves can be considered as the plant factory that converts sunlight to yield through a process called photosynthesis, which is the primary determinant of crop yield. In fact, approximately 90% of the total maize biomass yield is thought to be produced by the leaves. Maize yield potential is directly correlated to its leaf area index (LAI), which can be defined as the total area of leaves per unit ground area. The LAI of a maize crop can be maximised by increasing plant population or by increasing leaf area on a per plant basis. Ideally, a LAI value closer to 6.0 is required to maximise maize yields. Below this value, less sunlight is captured, allowing light to penetrate further to the soil surface which can be considered wasteful (see picture below).

Figure 1: Maize plants planted at 70,000 plants per ha, showing inefficient use of sunlight (left) vs. maize plants planted at 110,000 plants per ha, showing optimum light interception (right)

Pioneer® brand seeds conducts plant population studies every year to ascertain yield response to density of newly commercialised hybrids under a range of environments. A very wide plant population range (10,000-150,000 plants/ha) is tested to establish a robust curve of yield response to population density. Figure 2 below illustrates the impact of plant population on LAI. Our research indicates that for every 6,500 plants/ha increase in plant population, the value of LAI increases by 0.1. The same research also showed that at lower plant densities, maize silage yields increased by 580 kg DM/ha for a 0.1 unit increase in LAI (Figure 3). Closer to the optimum LAI levels, the rate of silage yield increase with LAI decreases, consistent with the law of "diminishing returns." Significantly higher LAI values could result in intra-canopy shading which reduces photosynthetic efficiency as well as a reduction in plant tolerance to stress and disease susceptibility.

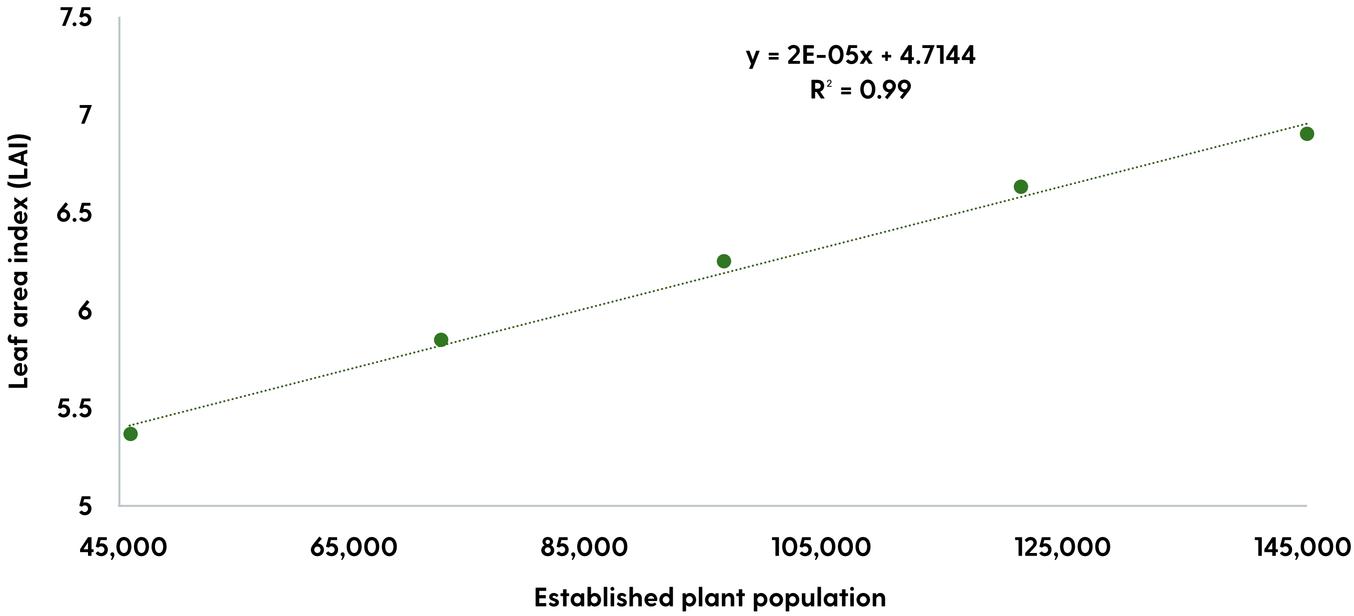


Figure 2: The relationship between maize population and leaf area index for a range of Pioneer hybrids planted between 45,000 and 150,000 plants/ha at a range of sites between 2019-20 and 2022-23 seasons.

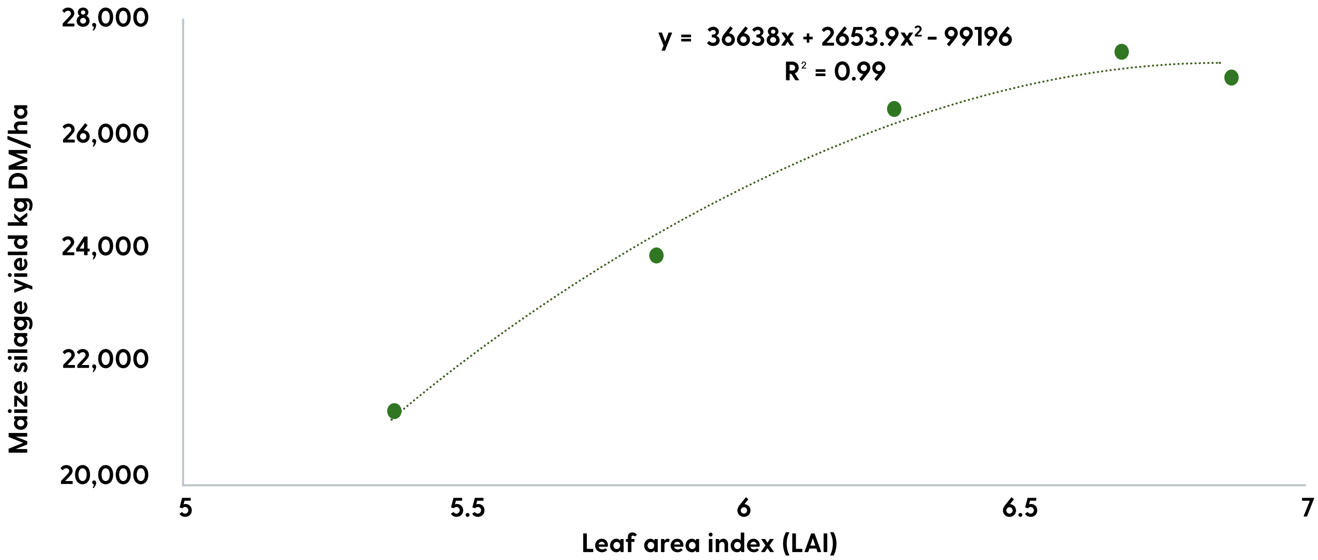


Figure 3: The relationship between maize silage yields and leaf area index for a range of Pioneer hybrids planted between 45,000 and 150,000 plants/ha at a range of sites between 2019-20 and 2022-23 seasons.

Smaller statured hybrids, require higher planting densities to achieve sufficient canopy cover required to optimise radiation interception particularly if planted in cooler environments. The long and relatively cool growing season experienced in New Zealand is hence the main reason why optimum densities for maize are similar to those of North-Central Europe but 10-20% higher than those in the USA.

Impact of population density on individual plant size and maize silage yield

As plant density decreases, plant size will increase due to plants becoming less crowded (Figure 3, page 27). The maize plant has an intrinsic ability to compensate, to some extent, for a reduction in density by capturing additional sunlight, water and nutrients per plant when densities are low. Leaf area and size also increase. This plasticity or flex is usually not sufficient to compensate fully for loss of plant stand, resulting in a yield reduction on a per unit area basis (Figure 4). The lower yields from low planting densities are largely due to inefficiencies in sunlight interception as a result of bigger gaps in the plant stand.

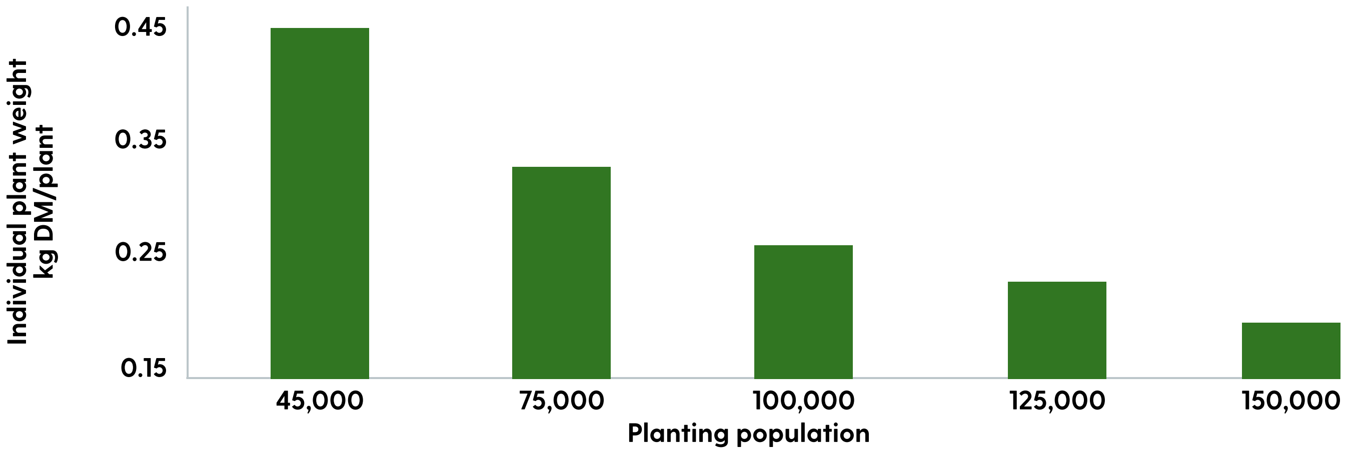


Figure 4: Effect of plant population on mean per-plant silage yields of Pioneer maize hybrids representing five CRM ratings at seven sites across New Zealand between 2018-19 and 2022-23 seasons.

Figures 4 and 5 show that when plant population was decreased from 100,000 to 75,000 plants/ha (a 25% reduction), individual plant size increased by 20% while the per hectare silage yields decreased by 5%. This equates to a yield reduction of 1.25 t DM/ha if we assume a 25 t DM/ha yield potential. The increased plant size was not sufficient to compensate for the decrease in plant population. These results are consistent with previous Pioneer population studies conducted from 2012-2018 which showed a 4% maize silage yield reduction when plant stand was reduced by 20%.

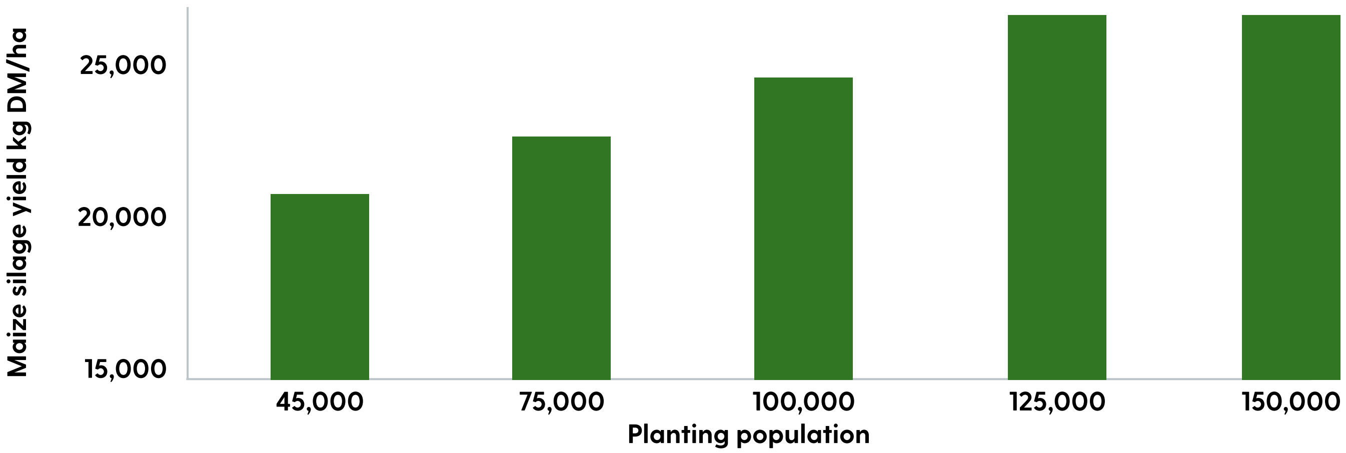


Figure 5: Effect of plant population on mean per hectare silage yields of Pioneer maize hybrids representing five CRM ratings at seven sites across New Zealand between 2018-19 and 2022-23 seasons.

Most maize hybrids usually have a quadratic or curvilinear yield response to planting density, whereby the yields initially increase linearly until it reaches the hybrid's optimum population for the environment before eventually decreasing. Figure 6 is a plant population x yield response curve of Pioneer hybrids representing five comparative relative maturity (CRM) groups tested in seven environments across New Zealand between 2018-19 and 2022-23 seasons.

Other than one hybrid (73 CRM), optimum agronomic yields were achieved between 100,000 and 120,000 plants/ha. The different response of the short season hybrid (73 CRM) can be attributed to its smaller stature and the cooler environment where the hybrid was planted.

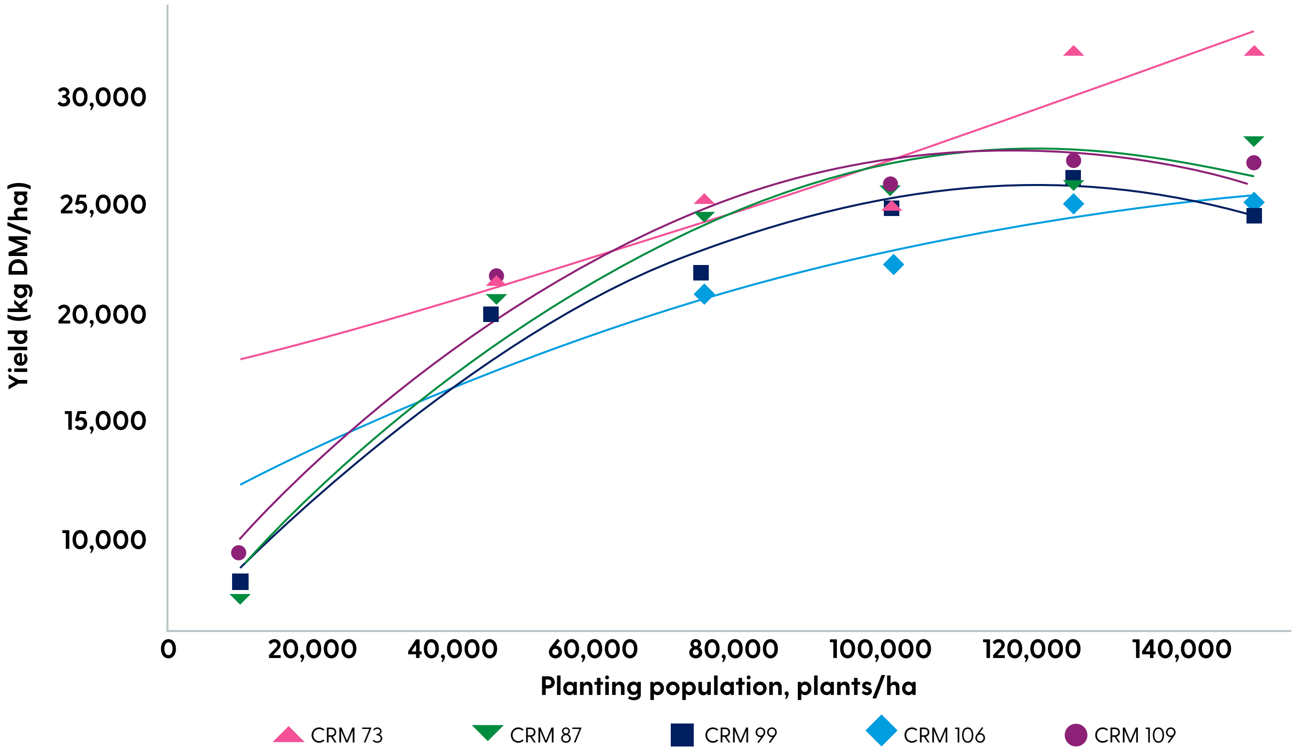


Figure 6: The relationship between plant population and maize silage yields of hybrids representing five CRM ratings at seven sites across New Zealand between 2018-19 and 2022-23 seasons.

Impact of plant population on cob size and maize grain yield

Larger cob sizes can typically be achieved by lowering populations. However, research shows increased cob size is usually not sufficient to compensate for the yield loss due to the reduced population. Below is a visual representation of various populations and the resulting cob size. Based on the population data, the average cob size at 70,000 plants per ha was 208g per cob compared with 185g per cob at 90,000 plants per. The resulting maize grain yield at 70,000 plants/ha was 12.5 t/ha vs 15.0 t/ha at 90,000 plants/ha.

Summary

Lower maize plant density results in bigger individual plant sizes as well as reduced seed costs. These benefits are usually far outweighed by the economic cost of reduced maize silage yields. Optimum population required to maximise yields without compromising on plant health will vary by hybrid and environment. Because they usually have a smaller size, short season hybrids should be planted at higher planting densities to allow them to achieve the optimum LAI values required to maximise yield. When deciding on the best planting density for a particular environment it is important to use data encompassing a range of seasons because yield response to population is dependent on the environment and season. The best conditions favour high populations and a high optimum plant density for yield. For a customised recommendation on optimum plant populations for your area please consult you Pioneer Area Manager or merchant representative.

Figure 7: Dr Rowland Tsimba presenting cobs from the plant population trial at the Pioneer Rukuhia Research Station Open Day

REDUCING THE RELIANCE OF NZ LIVESTOCK SYSTEMS ON INTERNATIONALLY PRODUCED FEED

New Zealand is a net importer of grain and feed of which 75% is consumed by the dairy industry. A recent Our Land and Water report[1] investigated global grain and feed price and supply and identified opportunities for NZ to reduce its reliance on IPF. This included modelling the economic and environmental implications of New Zealand dairy farms reducing stocking rates and growing more home-grown feed.

Internationally produced feed (IPF)

New Zealand is a net importer of grain and concentrates with imports rising to a record level of 3.7 million tonnes in 2022 (Figure 1). The dairy industry is the largest consumer of IPF consuming 75% of all feed imports of which palm kernel expeller (PKE), sourced from Malaysia and Indonesia, is the highest volume feed supplement. In 2022 New Zealand imported 1.97 million tonnes of PKE (1.78 tDM) representing around 54% of total grain and feed imports.

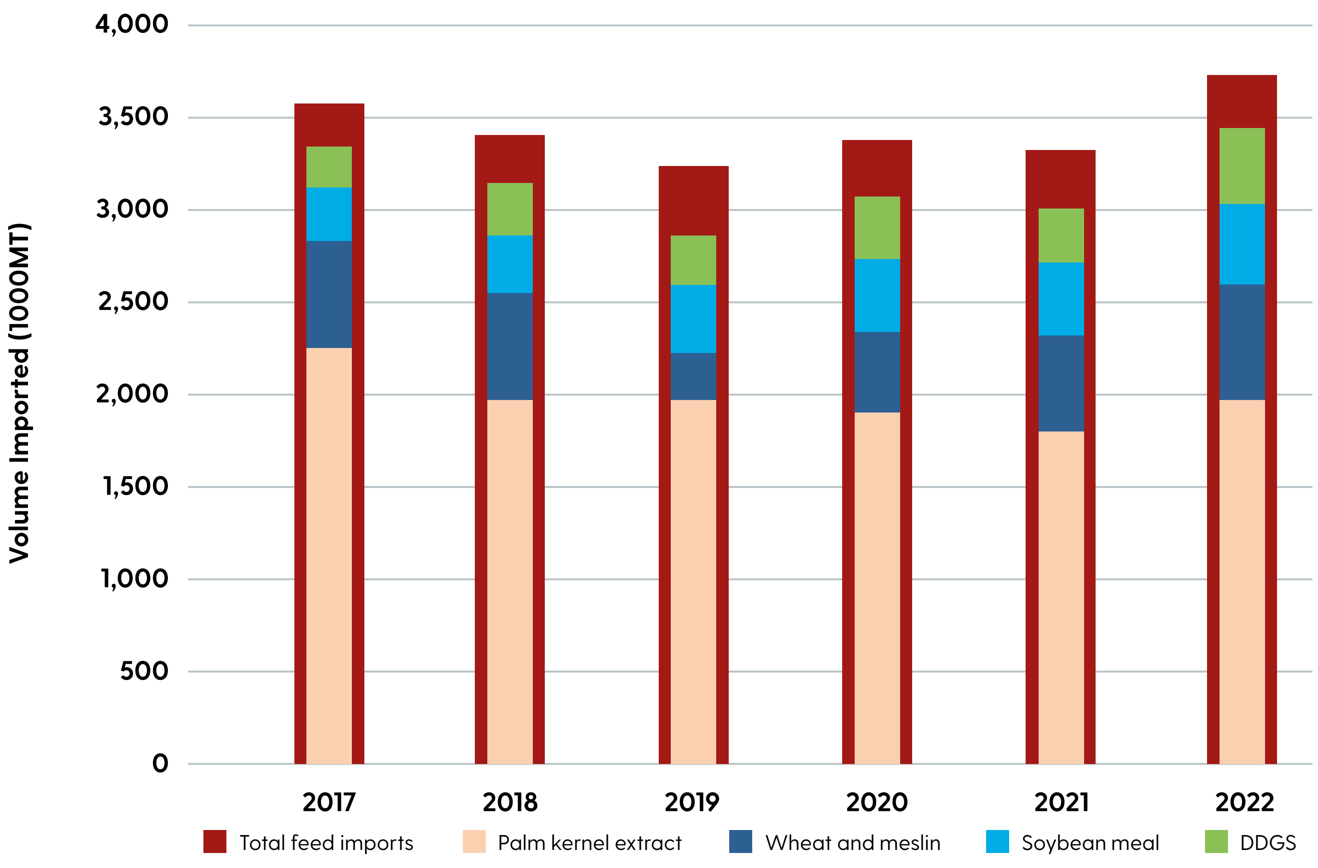


Figure 1: New Zealand feed imports (USDA, 2023)

How likely is a shortage of PKE?

Malaysia and Indonesia produce more than 80% of the worlds palm oil and they export 93% of palm nut or kernel oil residues (including PKE). While the oil palm is a uniquely productive crop there is growing Western consumer resistance to palm oil use due to health, environmental and socio-economic concerns. Changes in consumer preferences away from palm oil could slowly reduce the supply of PKE. Extreme weather events, pests and diseases, labour shortages, geopolitical instability or conflict and variations in government policy could have a larger and more rapid impact on New Zealand's ability to source PKE.

Currently New Zealand imports enough PKE to meet the total feed requirement of around 8% of the nation's dairy cows. A shortage could have major impacts on the dairy industry.

How can NZ dairy farms be less reliant on IPF?

Dairy cow numbers increased from around 2.4 million in 1992-93 to a peak of 5.0 million cows in 2017-18. During this time more than 730,000 additional hectares were converted to dairying. Over approximately the same period, average per cow production has lifted from around 259 kilograms of milk solids (kgMS)/cow to 397 kgMS/cow (53%) and stocking rates have risen 18% from 2.43 to 2.86 cows/ha (Figure 2)

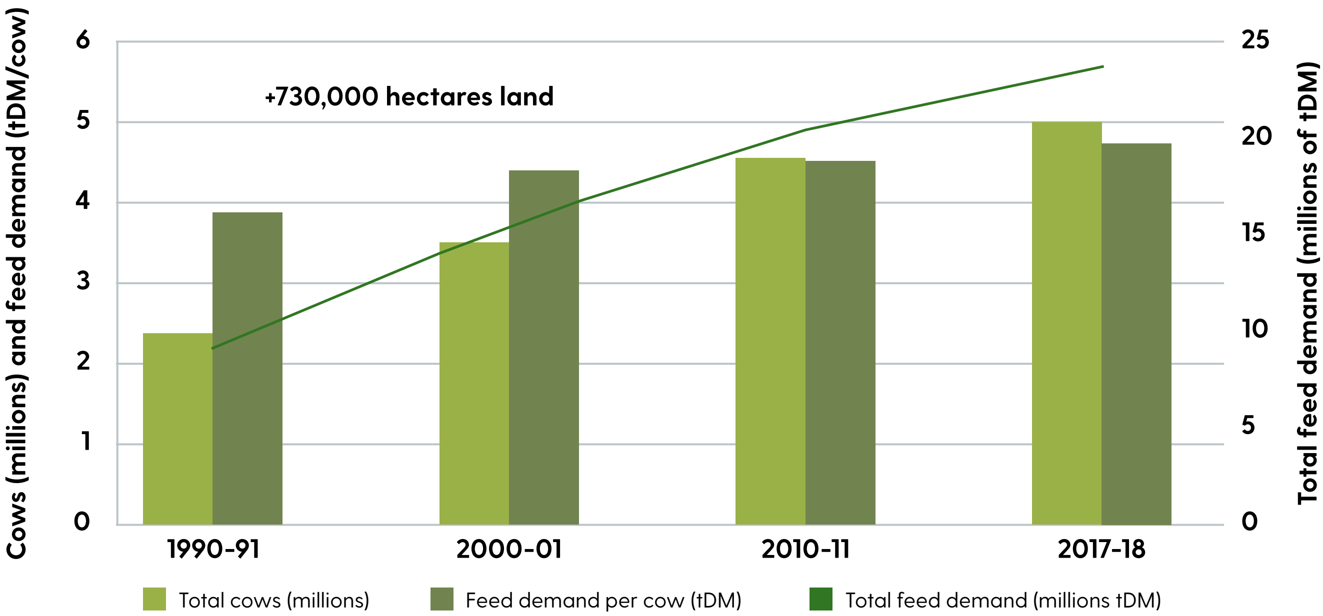
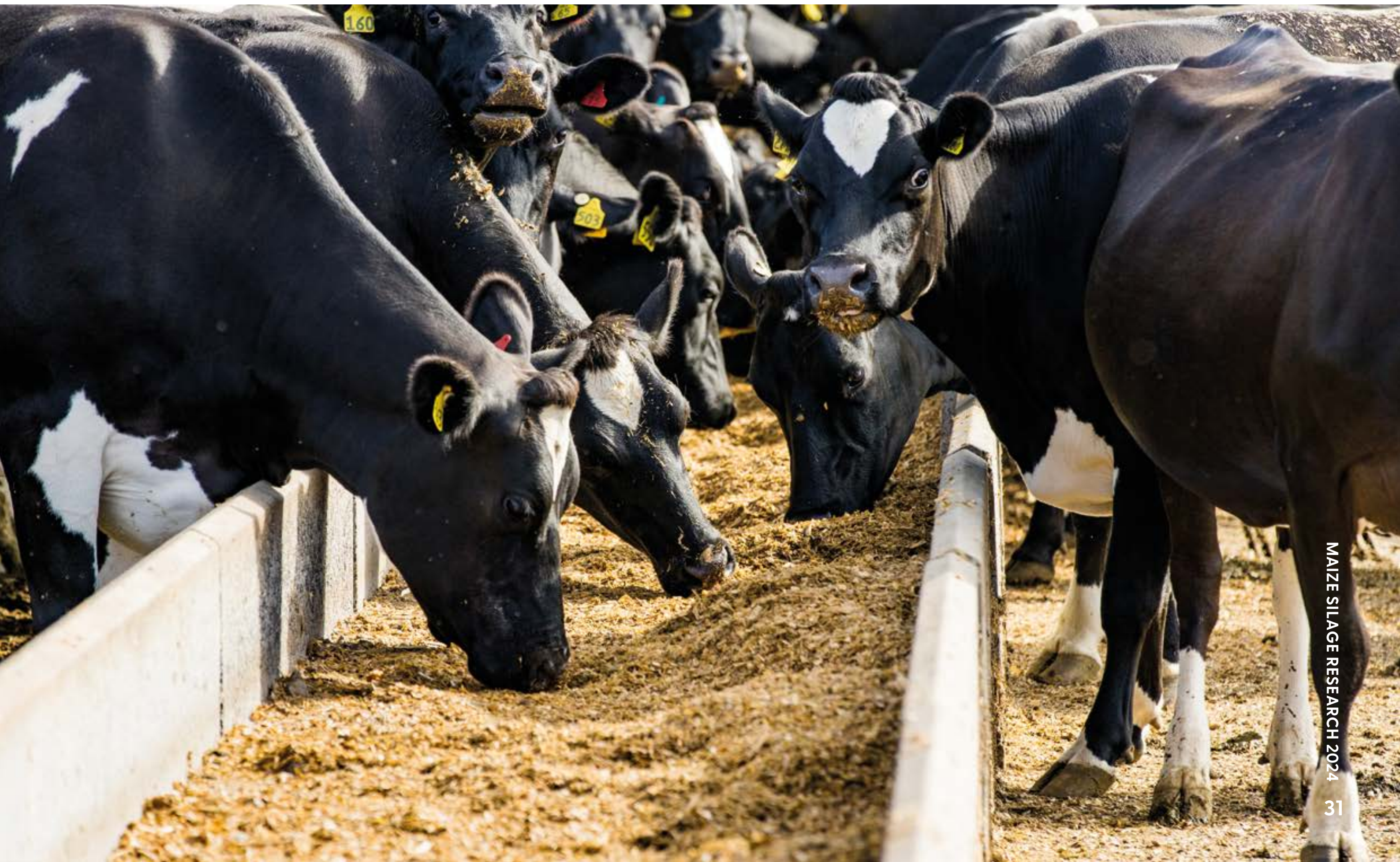


Figure 2: Changes in dairy cow numbers and feed demand from 1990-91 to 2017-18

The dairy industry's demand for more feed has been met by more land and more homegrown and imported (including IPF) supplements. The compound annual growth rates for supplements have been 5.6% for harvested supplements (e.g maize silage and barley), 5.6% for fed in situ crops (e.g. beet, kale, swedes) and 9% for imported feeds including PKE.



Dairy farm modelling

A potential way for dairy farmers to decrease their demand for IPF is to reduce stocking rates and grow more on-farm crops. To model the impact of varying supplementary feed management strategies, five base whole farm models were created using Farmax and OverseerFM. The models represented an 'average farm' of flat to rolling contour in Northland, Waikato/Bay of Plenty, Taranaki, Canterbury, or Southland. A number of DairyNZ reports were used to determine typical supplementary feed use and this varied between regions and included a mix of home grown and brought in feeds.

To establish the economic and environmental differences, two additional scenarios were modelled for each region. These were:

Scenario 1 (all imported feed) modelled removing all home-grown crops (excluding home grown pasture silage) and replacing them with imported feed. Cow numbers (stocking rate) did not change. Northland and Taranaki had summer crop turnips replaced with imported maize silage and PKE. Waikato/BOP had home grown maize silage replaced with imported maize silage and PKE. Canterbury had home grown fodder beet replaced with imported maize and pasture silage. The Southland base model had no home-grown crops; however, the whole herd was wintered off for 9 weeks. In Scenario 1 for Southland, the whole herd was wintered on farm and additional pasture silage, hay, barley grain, and PKE imported.

Scenario 2 (all homegrown feed) modelled removing all imported feed and replacing it with home grown feed/crops. Cow numbers (stocking rate) were reduced to ensure opening and closing BCS of the herd and pasture covers were the same as the base models and BCS and pasture trends (month ends) throughout the season were as similar as possible to the base models. For Northland, summer crop turnips and maize silage was grown, and total cropping area was increased from the initial base models, whilst the number of cows wintered off was reduced. For Waikato/BOP, and Taranaki, summer crop turnips and maize silage was grown, and total cropping area was increased from the initial base models. In Canterbury, an increased area of fodder beet was grown, and an additional crop of maize silage grown from the base model. The same number of cows were wintered off as the base model. For Southland, the whole herd was wintered off for 9 weeks as in the base model. This was due to the base model not growing winter crops and the Intensive Winter Grazing (IWG) regulations which cap the area of winter grazed crops at current levels. A summer crop of oats was grown for cereal silage.

For the purposes of the model, it was assumed no capital investment in infrastructure was made. Maize and pasture silage were fed out in the paddock (no feedpad) with an assumed utilisation of 80%.

	Northland Base	Waikato/ BOP Base	Taranaki Base	Canterbury Base	Southland Base
Effective area (ha)	140	120	107	233	222
Stocking rate (cows/ha)	2.3	2.8	2.7	3.4	2.6
Potential pasture growth (tDM/ha)	10	13.6	12.4	16	12.4
Nitrogen use per total ha (excl. crops) (kg N/ha)	112	128	145	167	159
Replacement rate (% peak cows milked)	21	23	22	22	22

Table 1: Physical parameters for each region in the base Farmax model

Financial parameters used in the FARMAX models included a milk price of $7/kgMS and a urea price of $1,300/tonne. The costs for homegrown supplements were pasture silage ($200/tDM), maize silage ($4,000/ha stacked), bulb turnips ($1,800/ha) and fodder beet ($3,150/ha). Imported feed costs included concentrates ($500/tDM), maize silage ($450/tDM) and pasture silage ($400/tDM)

When compared to the base model, reducing stocking rate and growing all feed on farm resulted in substantially lower feed costs and 5-14% lower milk production. Farm profit was higher in the three North Island regions, the same in Canterbury and lower in Southland (Figure 3).

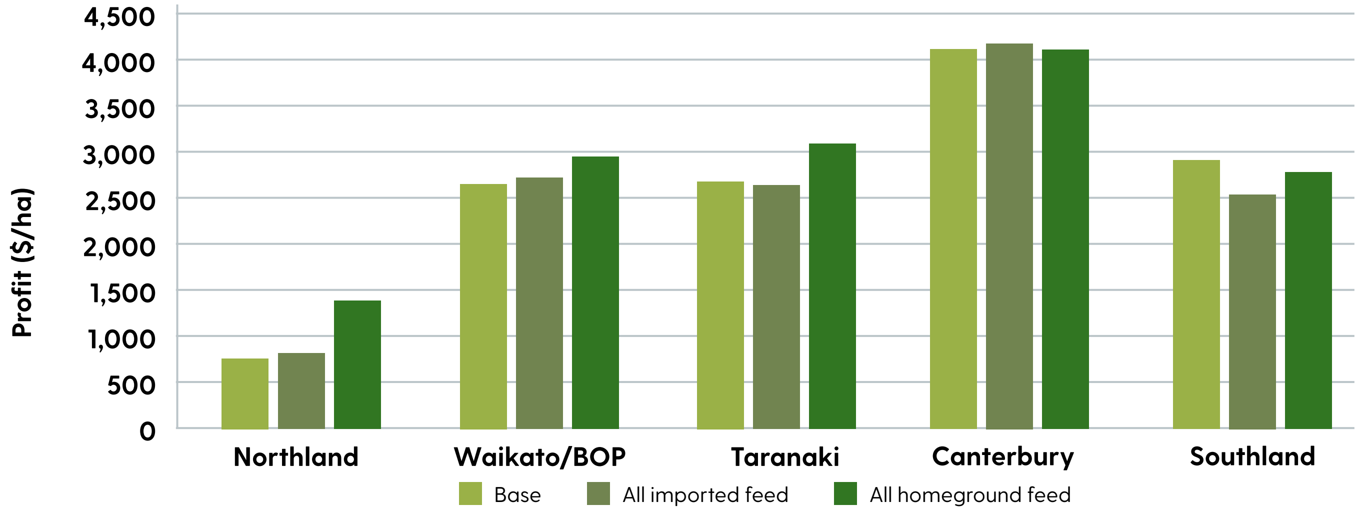


Figure 3: Profitability for base FARMAX model vs all imported and all homegrown feed.

A sensitivity analysis was conducted for the Waikato and Canterbury using concentrate prices of $400 to $600/tDM and milk solids prices from $6.00 to $8.00/kgMS. It highlighted regional differences in the profitability of growing all feed (Scenario 2) versus buying in all feed (Scenario 1).

In the Waikato, growing all feed on farm was more profitable than buying it in except when the milk price was above $8.00/kgMS and the supplement price was below $500/tDM delivered. For most farmers this equates to a price of close to $400/tonne for concentrate ex-works.

In Canterbury it was more profitable to grow all feed on farm when the milk price was $6.00, and the concentrate was $450/tDM or higher. At higher milk prices, it was marginally (0 to 5%) more profitable to have a higher stocking rate and buy in feed.

When compared to the regional base scenarios, Scenario 2 (all homegrown feed) decreased N loss to water slightly in three regions but increased it slightly in two regions.

Across all five regions, the base scenarios had an average biological GHG emission of 10.57 tonnes of carbon dioxide equivalents per hectare (tCO_2e/ha) of which 80% was methane and 20% nitrous oxide. Using all homegrown feed reduced the average biological GHG emission to 9.46 tonnes of carbon dioxide equivalents per hectare (tCO_2e/ha) of which 79% was methane and 21% nitrous oxide. The reduction in biological GHG was lowest in Canterbury (6%) and highest in Southland and Taranaki (13%). The reduction in GHG emissions from using a lower stocking rate and homegrown feed will have a positive impact on profitability once farmers have to pay for their emissions.

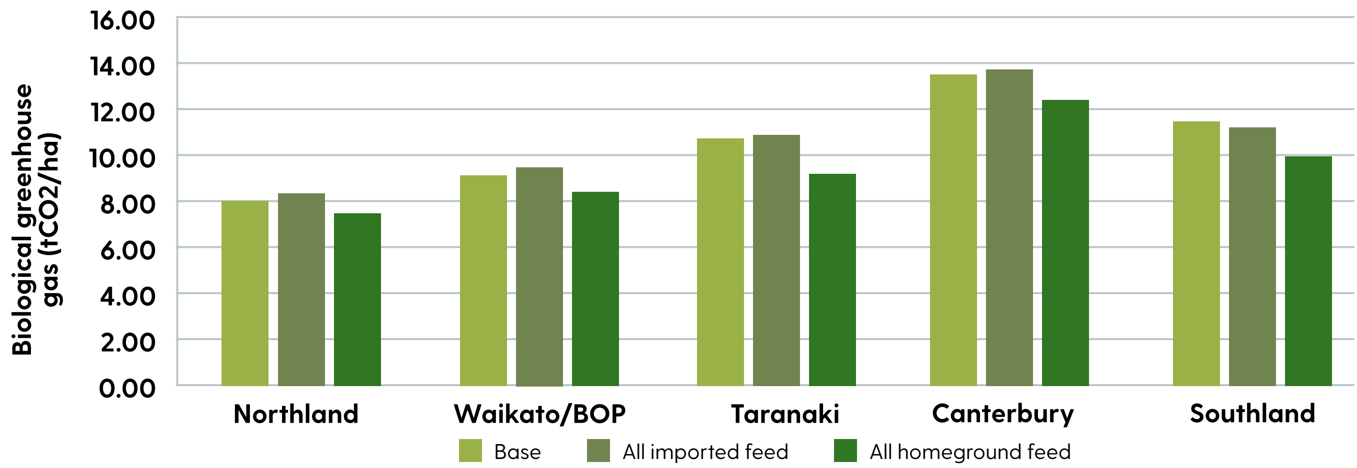


Figure 4: Biological greenhouse gas emissions for base FARMAX model vs all imported and all homegrown feed.

Fonterra have already recognised destocking and on-farm cropping as a means of reducing on-farm GHG emissions and this modelling work supports their strategy while at the same time decreasing dairy farm demand for IPF.

On summary, New Zealand dairy systems are reliant on internationally produced feed. This represents a risk especially to the profitability and sustainability of the dairy industry. Transitioning to dairy farm systems which utilise more home-grown feed could reduce our reliance in IPF.

[1]Densley, R.; Hunt, J.; Reti Kaukau, J.; McEldowney, L.; Journeaux, P. 2023. Implications of global price and supply of supplementary feeds on the New Zealand agricultural sector. Report prepared by AgFirst Waikato for Our Land and Water Contestable Fund. June 2023.

For the full report see: https://ourlandandwater.nz/outputs/implications-global-price-supply-supplementary-feeds-on-nz

OPTIMISING NITROGEN APPLICATION FOR MAIZE SILAGE PRODUCTION

Introduction

An ideal fertiliser management strategy should optimise profit while reducing the environmental impact of maize cropping. Excessive and inefficient nitrogen (N) fertiliser use can damage the environment and reduce profitability whereas applying less fertiliser than crop demand reduces crop production and potentially depletes soil organic matter (OM) levels over time.

To maximise efficiency of N fertiliser application, crop nutrient demand and uptake, as well as the amount of N supplied by the soil should be considered before deciding on the amount and timing of N fertiliser application. Accurately predicting the right amount of N to meet crop demand and achieving synchrony between N supply and crop demand are prerequisites to optimising production and protecting the environment. Even though most New Zealand soils generally have high OM levels which allows them to mineralise a significant amount of N, it is often difficult to accurately predict when this N will become available to the crop. The unpredictability of weather makes the decision-making process even more complicated.

Nitrogen management studies

An ongoing N management study was initiated in the spring of 2021 at the Pioneer Rukuhia Research Station (Waikato) on a long-term cropped allophanic soil. The objective of the research was to help us understand how different rates of N fertiliser influences maize silage yield, soil fertility and N losses. A range of N fertiliser treatments - nil fertiliser (0 kgN/ha) , low (160 kg N/ha), standard (250 kg N/ha) and high (320 kg N/ha) - were applied to different maize plots at the V5 stage of maize growth, resulting in soil N levels ranging from about 90-400 kg N/ha. The measured N reported in this article refers to soil N that was in the mineral form and ready for plant uptake, rather than potentially available N as reported in standard soil tests.

Maize yields and soil N balance

During the first two years of the study, initial N measurements conducted just prior to fertiliser N application (V4 maize stage) averaged about 90 kg N/ha. These rates do not include any potential soil-N supply (mineralisation) after V4.

Based on the estimated N content of maize silage, without additional soil-N supply, the 0 kg N/ha N fertiliser plots would be expected to yield approximately 8 t DM/ha. However, mean yields for maize that received no N fertiliser averaged almost 18 t DM/ha during the first two years of the study (Figure 1).

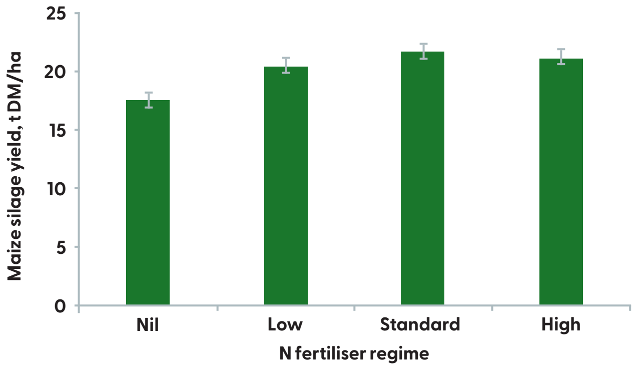


Figure 1: Mean maize DM silage yields on a Waikato ash soil during the 2021-22 and 2022-23 maize seasons.

These yields were slightly lower than the 21-22 t DM/ha obtained when fertiliser N was applied. Despite the 3 t DM/ha yield reduction in the nil N fertiliser plots, 87 kg N/ha was measured in the soil immediately after maize harvest (Table 1). This suggests that there was sufficient soil-N supply to achieve the paddock yield potential and that the lower yield was likely due to poor synchronisation between maize crop N demand and soil-N supply.

N treatment	Total N (fertiliser + soil N)	Soil N after maize	Estimated soil-N supply (mineralisation)
		kg N/ha	
Nil	90	87	177
Low	250	128	66
Standard	330	162	42
High	410	229	24
*SE**	*5.72*	*26.0*	*31.1*

Table 1: Soil N dynamics on a Waikato ash soil during the 2021-22 and 2022-23 maize growing seasons. *SE refers to the standard error of the mean.

The key observation in the first two years of this study was that in N deficient situations, the soil mineralised significantly more N than normal. The mean estimated soil-N supply was 177 kg N/ha compared to only 42 kg N/ha for the standard N rates. These results are consistent with previous studies that concluded that N fertilisation decreased OM decomposition and under low soil N levels, microbes meet their N demand by decomposing OM. The question this study intends to answer eventually is how this “N mining” will influence soil OM in the long term.

During the 2023-24 growing season, the average soil N at V4 averaged 100 kg N/ha. The "nil" fertiliser treatment achieved significantly lower yields than the previous two seasons (Figure 2). Nitrogen stress was observed as early as silking time (Figure 3). Maize silage yields for the low fertiliser were significantly lower than for the standard fertiliser N rates.

This illustrates the importance of customising N management for conditions. In high OM soils or those coming out of long term pasture, fertiliser N can be reduced or omitted depending on fertility levels whereas to avoid OM degradation in continuous cropping situations, growers should not skimp on fertiliser N.

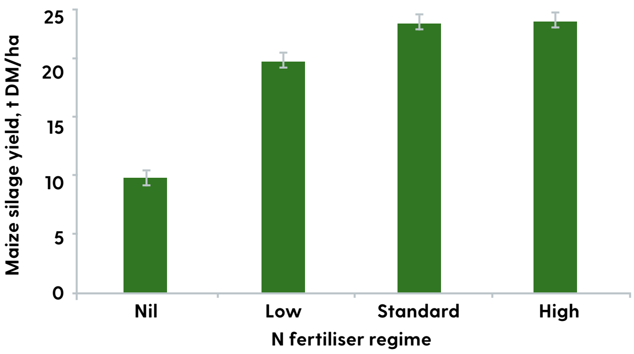


Figure 2: Mean maize DM silage yields on a Waikato ash soil during the 2023-24 maize season.

Figure 3: Maize plants from an ash soil with an initial soil mineral N level of 100 kg N/ha at V4, followed by nil (left) or 160 kg N/ha (right) sidedressing fertiliser N during the 2023-24 season.

Figure 3 shows maize plants (right) that received 160 kg N/ha as fertiliser N during early grain fill. Unlike previous seasons, the plants showed some mild N stress, suggesting possible temporary N deficiency. In the previous two seasons yields were similar to the standard N rate, but in the 2023-24 season these plots yielded 21 t DM/ha, 15% less than the standard fertiliser treatment.

The high N plots did not yield any greater than the standard fertiliser treatment, further emphasising the importance of prudent N use to minimise the environmental impact of maize cropping. Even though soil N fertilisation could potentially conserve soil organic matter in low OM situations, applying excessive N could result in an increased environmental impact through leaching especially in higher OM paddocks. Fertiliser N rates should hence be consistent with plant demand and soil organic matter status.

Nitrogen management

Maize uses less than 10% of its total N requirement between emergence and the V6 growth stage. The amount supplied through starter fertiliser is usually sufficient to meet crop requirements to this stage. Nitrogen leaching risk is usually greatest prior to V6. At this stage roots are shallow and soils are usually wetter, increasing the potential for leaching following heavy rainfall events. Pioneer research conducted on a Waikato soil and Canterbury stony loam soil indicated that leaching losses after late spring, which coincides with commencement of the rapid vegetative growth phase of maize (V6 stage), were marginal, contributing less than 10% of the total annual N leaching losses from maize-based systems.

Summary

This study suggests that to achieve optimum yields, it is best to apply the appropriate amount of fertiliser N, which is consistent with yield potential, accounting for paddock history and soil fertility. While applying less than the recommended N fertiliser and relying on soil supplied N may appear economical, our research indicates there could be a long-term yield and environmental penalty.

Mineralisation is influenced by a range of factors such as moisture and rainfall, making it difficult to get the synchronisation between soil N release and plant N demand. This can result in nutrient deficiencies due to timing even when there is theoretically enough N available.

It is almost impossible to predict soil N supply in time and space and yet either skimping or excessive fertiliser N use in maize cropping is not an option. Our recommendation is to:

- Measure soil N supply by collecting representative soil samples.
- Use your knowledge of the paddock and hybrid yield potential to calculate crop N demand using a realistic potential yield.
- Where nitrogen is required, apply standard levels of starter fertiliser (around 30 kgN/ha) and sidedress the remainder of the crops requirements around V5 - V6 after the highest risk of leaching is lower.
- Establish a cover crop immediately after maize harvest. Any potential excess soil N can be "mopped up" by the catch crop during the winter period, minimising potential leaching losses.

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