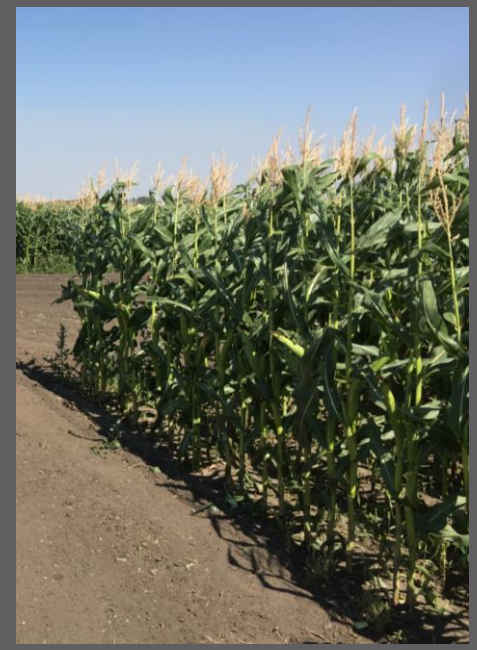
PAMI
Innovative Solutions for Agriculture and Beyond

March 5, 2019
Soils and Crops Workshop

Defining Agronomic Practices for Forage Corn Production in Saskatchewan



Prairie Agricultural Machinery Institute (PAMI)

Charley Sprenger, Paul Jefferson, Joy Agnew, Zach Kendel

Government of Saskatchewan
VÄDERSTAD
SCA Saskatchewan Cattlemen's Association
Growing Forward 2

Overview

Introduction

- Research Objectives

Methods

- Experimental Design
- Data Collection

Results & Discussion

- Emergence
- CHU & Precipitation
- Biomass Yield
- Forage Quality

Conclusions

- Economics

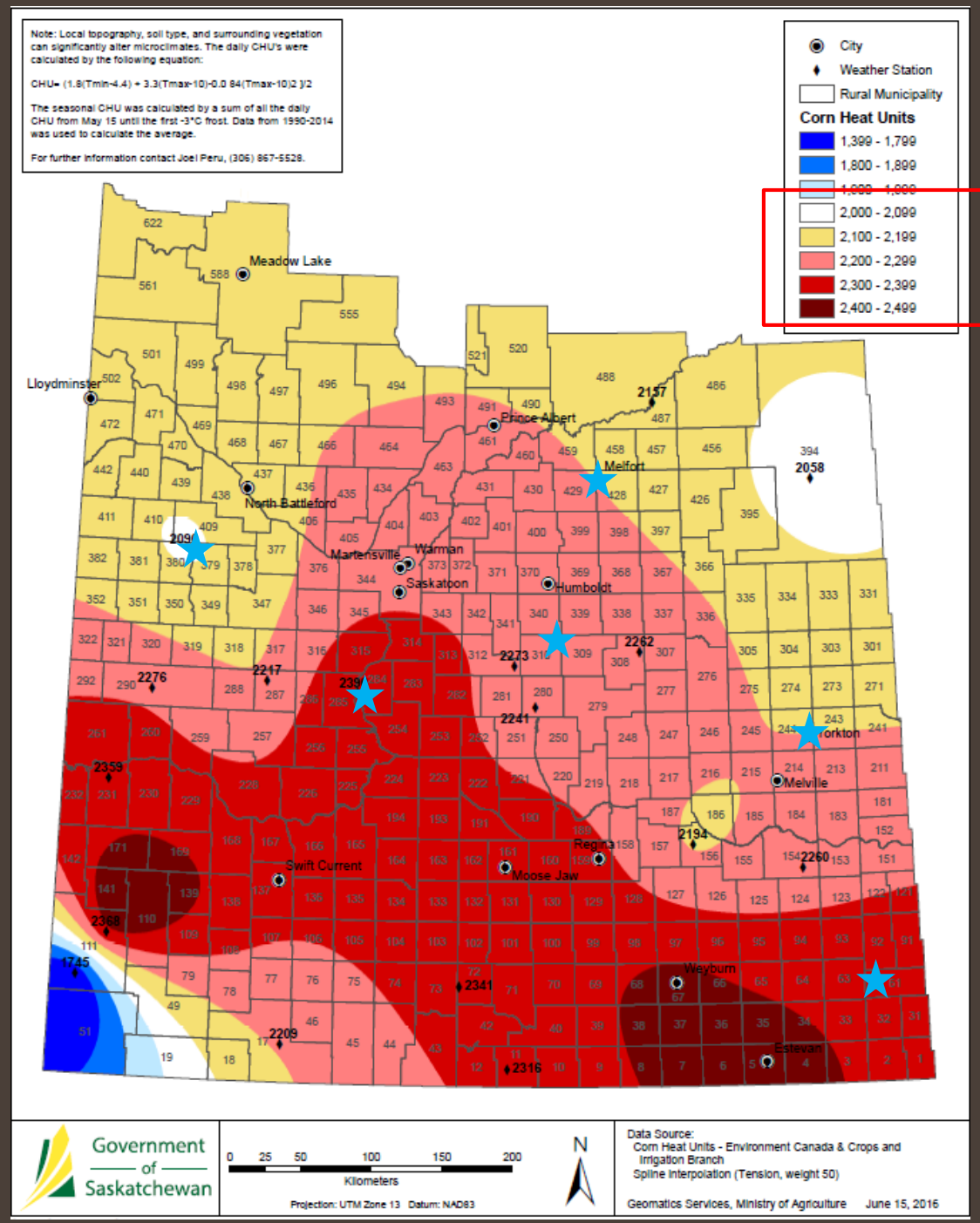
Introduction

- Corn is gaining popularity as a forage alternative for beef cattle
- Current corn forage agronomic recommendations are for seed varieties

Research Objectives:

1. Develop and refine seeding and fertility recommendations for corn silage production.
2. Evaluate the cost of production and feed quality of corn silage grown in Western Canada.

Saskatchewan Average Accumulated Corn Heat Units (CHU)



Experimental Design

- Site (n=6)
  - Short season (Melfort, Lanigan, Scott)
  - Long season (Redvers, Outlook, Yorkton)
- Nitrogen Application Rate (n=3)
  - High (200 lb N/acre)
  - Mid (150 lb N/acre)
  - Low (100 lb N/acre)
- Seeding Rate (n=3)
  - High (125,000 plants/ha)
  - Mid (100,000 plants/ha)
  - Low (75,000 plants/ha)
- Seed Brand (n=2)
  - Hybrids selected based on site CHU rating

3 repetitions
- 54 plots per site
- 324 plots per year
- 972 plots over 3 years

Site Preparation and Planting

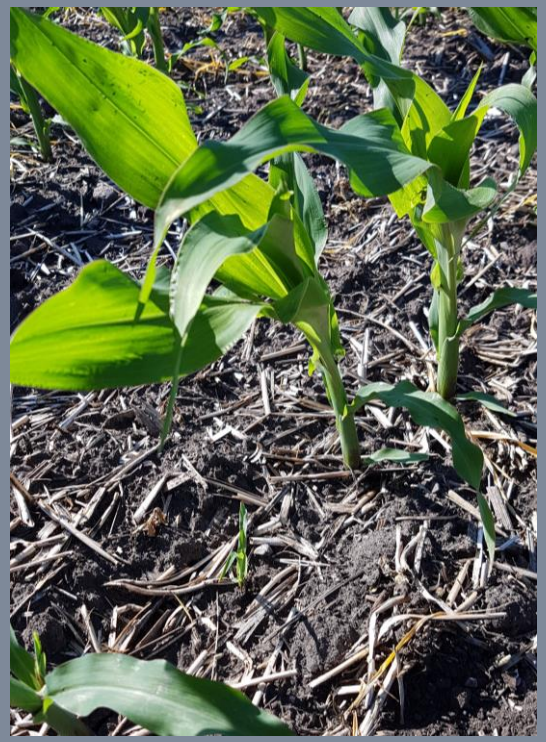
- Soil samples (30 cm) analyzed at each site
  - P, K, and S added to reach 50, 125, and 15 kg/acre if deficient
- Urea (N) added based on residual soil NO_3-N and required application treatment (<2 days before planting)
- Modified, 4-row Vaderstad planter used at all sites (30" spacing)

Trial Site	Seed Date 2018
Redvers	May-14
Yorkton	May-15
Outlook	May-16
Melfort	May-30
Scott	May-22
Lanigan	May-29

Harvest

- Corn is ready for silage harvest when kernels reach the ½ milk line
  - Harvested sites once mid-N rate, mid seeding rate plots reached maturity (N application may effect maturity)
- Wet biomass yield (kg):
  - 10ft harvested from the center two rows
  - 5 to 7.5" stubble height
- Plant heights and visible fusarium or bird damage recorded
- Subsamples collected for dry matter and forage quality analysis

Emergence



Summary of Actual Plant Populations by Seeding Rate in 2018

	High Seed Rate	Mid Seed Rate	Low Seed Rate
Avg Actual plants/ha	109,262	88,876	69,758
Target plants/ha	125,00	100,000	75,000
Difference	12.6 %	11.1 %	7.0 %

- Less competition appears to indicate a higher germination/ emergence rate at the lower seeding rate

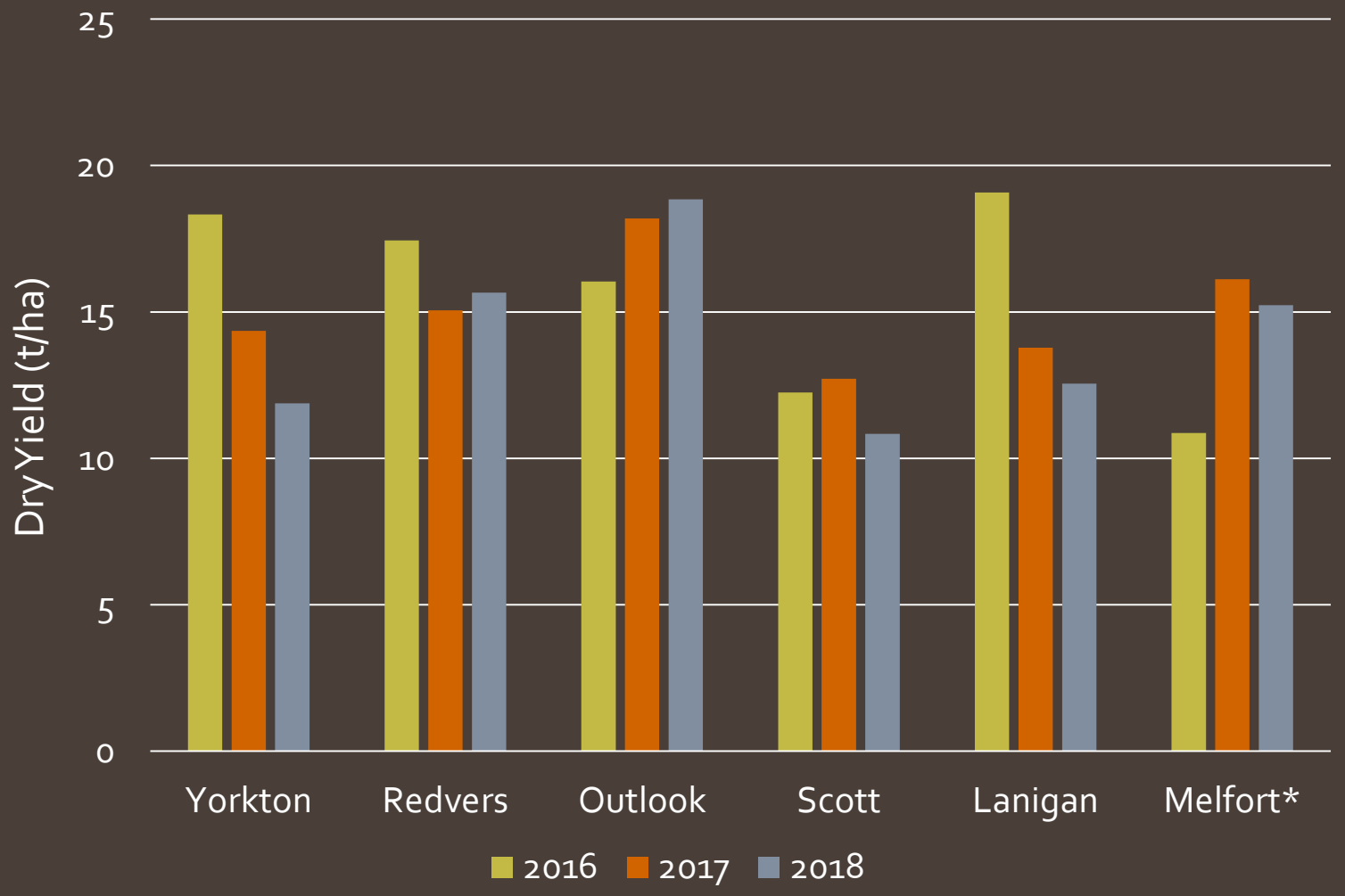
CHU & Precipitation

- Cumulative corn heat units (CHU) calculated from planting until harvest or a -2°C frost
- Silage corn requires 200 fewer CHU on average than site ratings

Site	Season Length	CHU Rating	Seed Date 2018	End date 2018	2018 CHU	2017 CHU	2016 CHU	2018 Rain	2017 Rain	2016 Rain
Redvers	Short	2450	May-14	Sep-12	2332	2149	2209	11.1	5.7	15.0
Yorkton	Short	2250	May-15	Sep-12	2287	2291	2372	9.1	6.6	11.7
Outlook	Short	2300	May-16	Sep-18	2288	2091	2271	3.9	4.4	13.6
Melfort	Long	2175	May-30	Sep-21	1876	2181	2263	3.9	4.8	13.3
Scott	Long	2100	May-22	Sep-19	1976	1983	2002	7.8	5.0	9.4
Lanigan	Long	2150	May-29	Sep-5	1826	2025	2104	5.8	3.2	12.4

- 2018 precipitation amounts were between that of 2016 and 2017
  - Except Melfort & Outlook (very dry)

Biomass Yield by Site

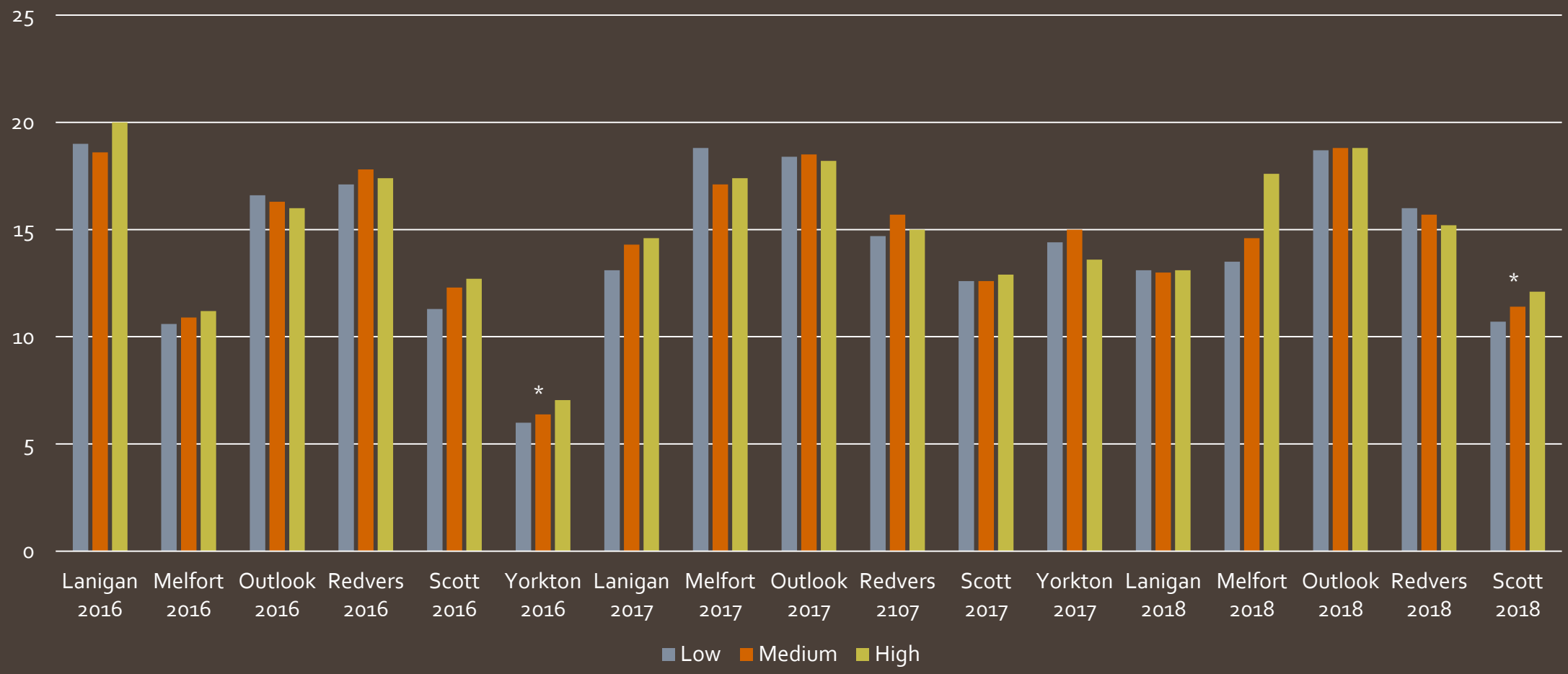


ANOVA results across 16 site-years*

Moisture content (%) and dry matter forage yield

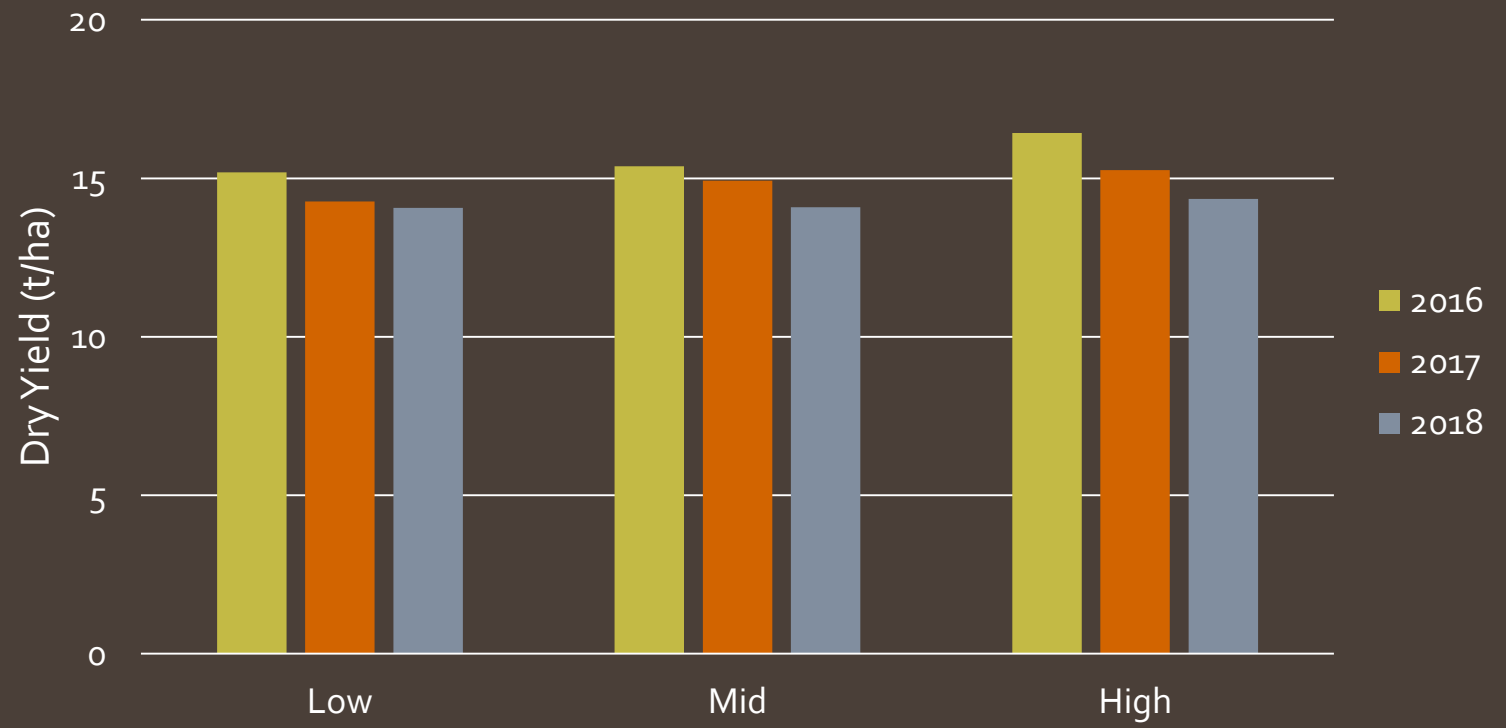
Source	df	Moisture Prob>F	DM yield Prob>F
Site-Year (SY)	16	<0.001	<0.001
Brand (B)	1	0.013	0.139
SY*B	16	<0.001	<0.001
N rate (NR)	2	0.046	0.016
SY*NR	32	0.093	0.002
B*NR	2	0.171	0.828
SY*B*NR	32	0.548	0.212
Seed Rate (SR)	2	0.366	<0.001
SY*SR	32	0.005	0.281
B*SR	2	0.445	0.876
SY*B*SR	32	0.850	0.996
NR*SR	4	0.967	0.246
SY*NR*SR	64	0.940	0.974
B*NR*SR	4	0.923	0.595
SY*B*NR*SR	64	0.986	0.953
C.V. (%)		5.1	14.7

Effect of Nitrogen Application Rate on Dry Matter Yield (t/ha)



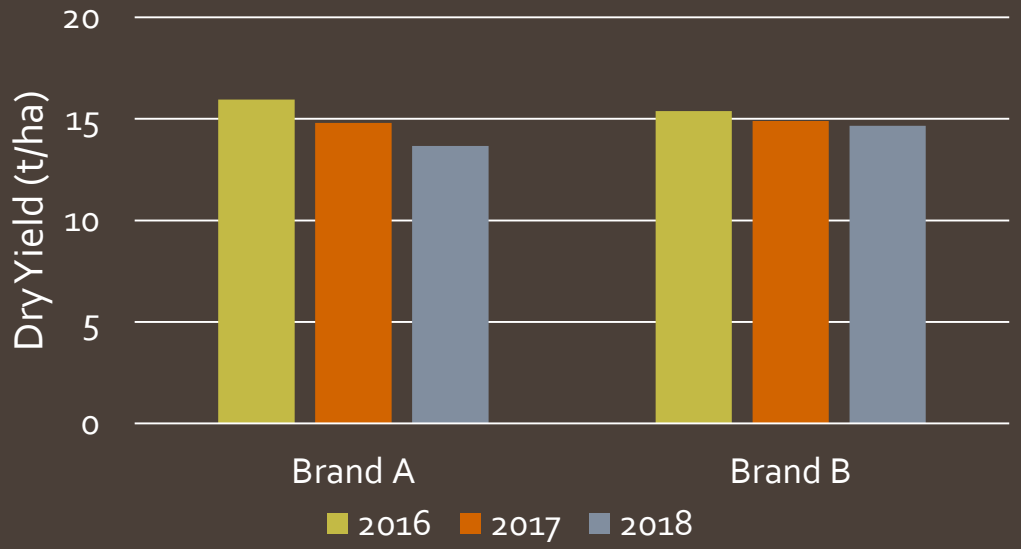
- No effect of N fertilizer for 14 of the site-years

Effect of Seeding Rate on Dry Matter Yield

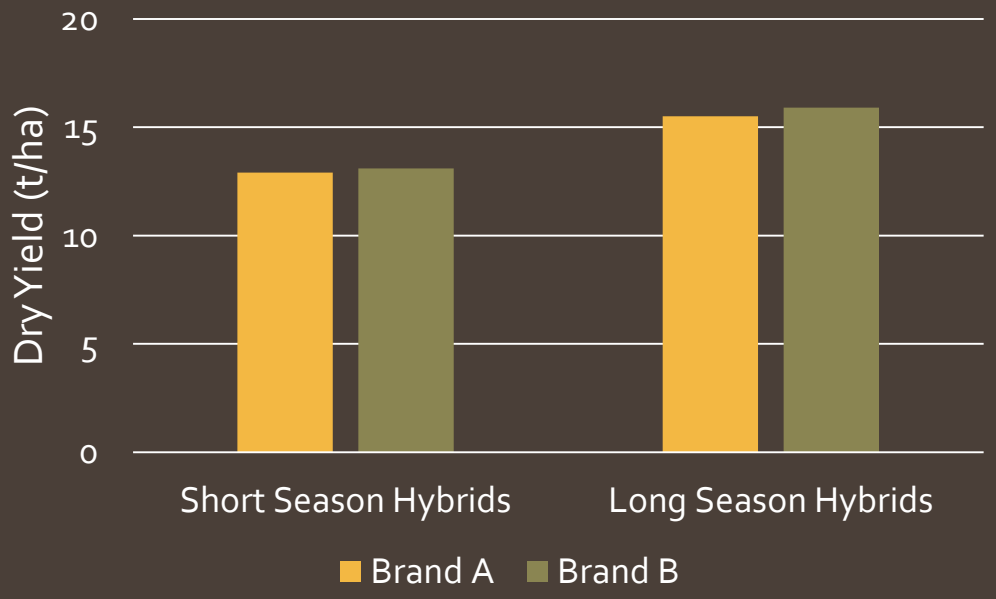


- Higher seeding rate treatments resulted in a significantly higher yield in 2 of the 3 trial years (2016 & 2017)

Dry Matter Yield by Brand and Season Length



- Overall, there was no difference between hybrids for dry matter yield



- Hybrids are rated appropriately for the CHU zones

Forage Quality

- NIR analysis completed by Cargill Central Lab Services
  - crude protein
  - soluble protein
  - fat
  - ash
  - cADF
  - cNDF
  - lignin
  - calcium
  - phosphorous
  - magnesium
  - potassium
  - sodium
  - chloride
  - sulfur
  - total sugar
  - starch

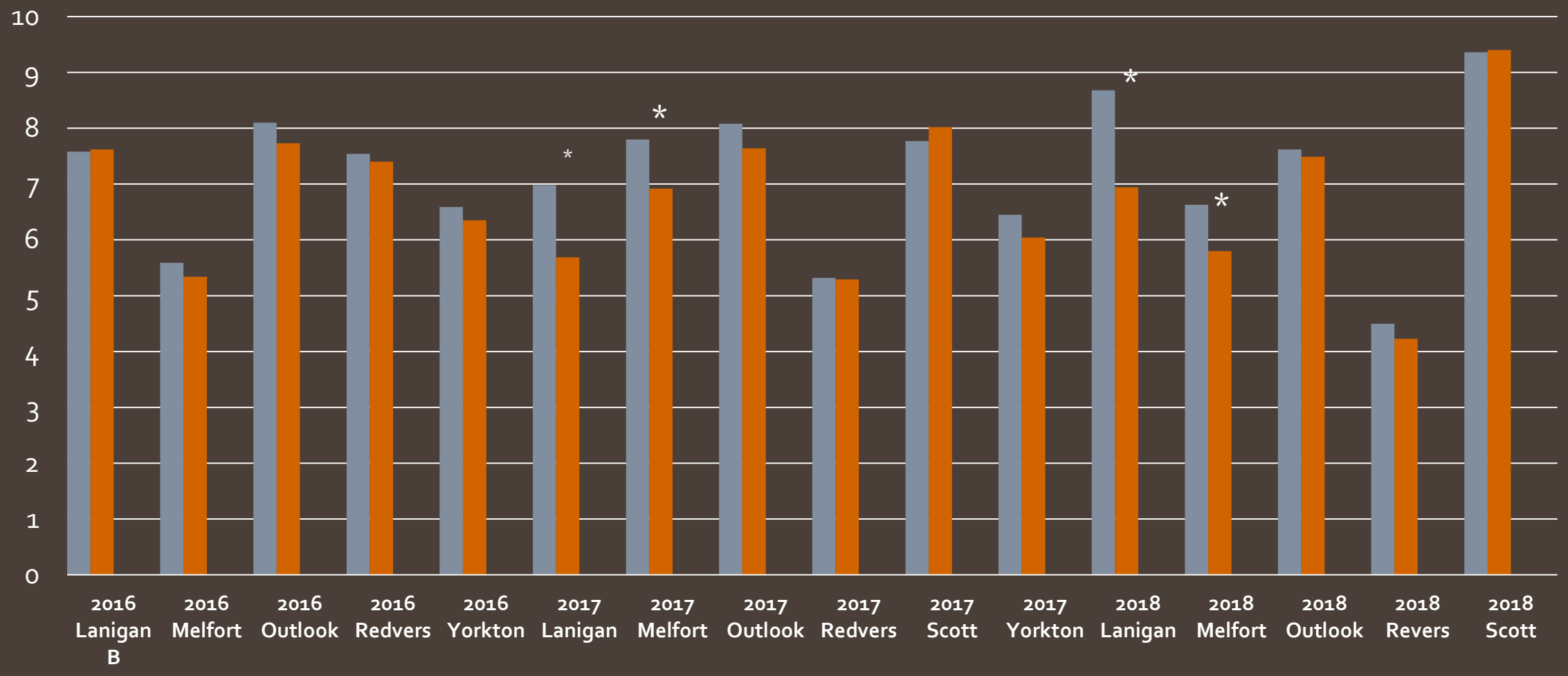
ANOVA results across 16 site-years

Corn Forage Quality

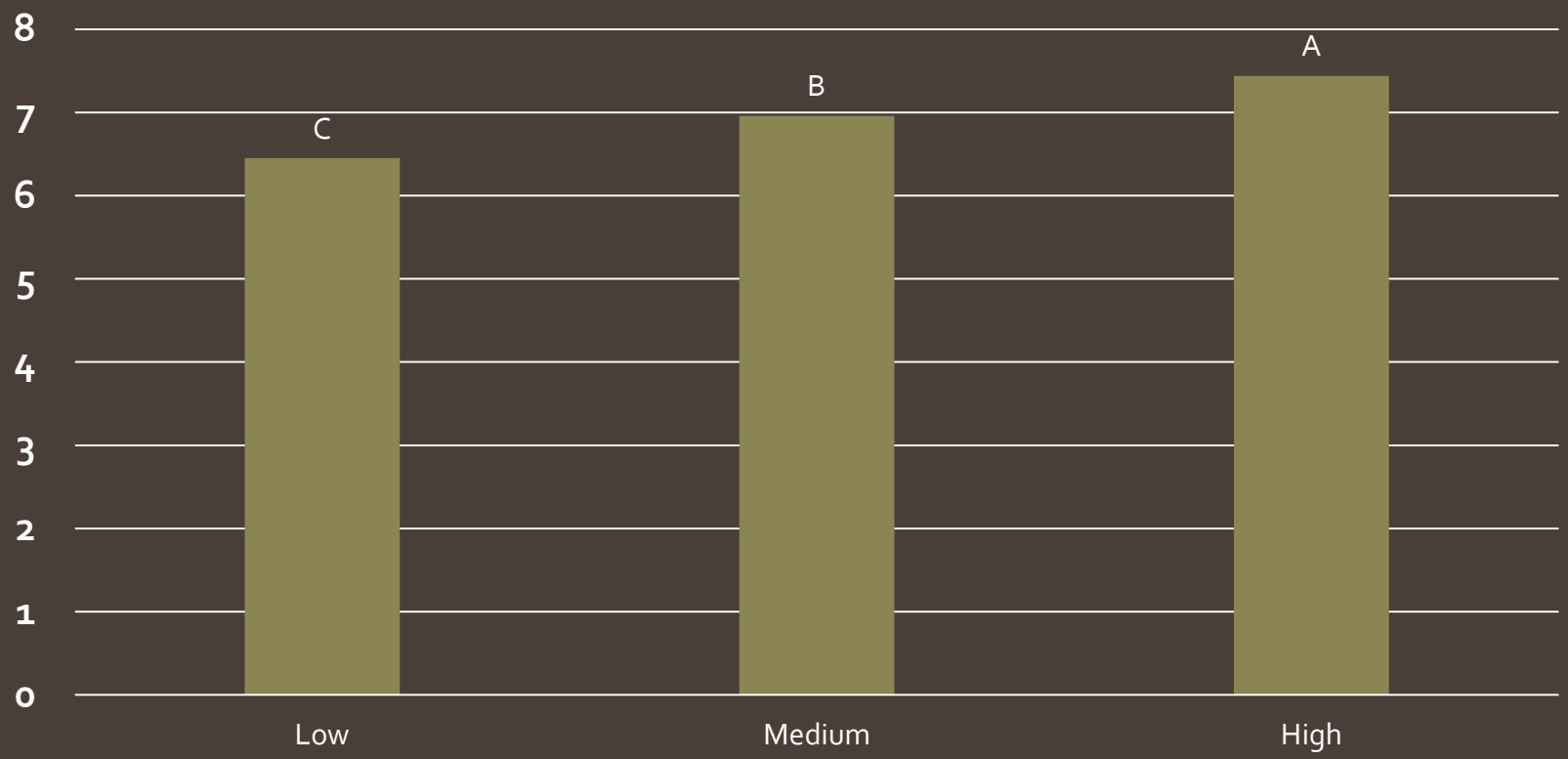
		P>F value				
Source	DF	CP	Sol. Protein	TDN	Starch	Sugar
Rep	2	0.7796	0.0302	0.9446	0.8368	0.9702
Site Year	15	<.0001	<.0001	<.0001	<.0001	<.0001
Hybrid	1	<.0001	<.0001	<.0001	0.1579	<.0001
Site Year*Hybrid	15	<.0001	<.0001	<.0001	<.0001	<.0001
N Rate	2	<.0001	<.0001	0.1256	0.8658	0.0305
Site Year*N Rate	30	0.0007	0.6035	0.9996	1.0000	0.9982
Hybrid*N Rate	2	0.287	0.9721	0.7605	0.6900	0.3573
Site Year*Hybrid*N Rate	30	0.6238	0.7418	0.9756	0.9528	0.7426
Seed Rate	2	0.0001	0.0018	0.2064	0.5380	0.9333
Site Year*Seed Rate	30	0.2829	0.61	0.6989	0.4388	0.1544
Hybrid*Seed Rate	2	0.1927	0.6745	0.1445	0.0666	0.7098
Site Year*Hybrid*Seed Rate	30	0.4591	0.7924	0.8711	0.9813	0.6928
N Rate*Seed Rate	4	0.7134	0.4466	0.8892	0.8772	0.1102
Site Year*N Rate*Seed Rate	60	0.9241	0.839	0.9994	0.9956	0.6731
Hybrid*N Rate*Seed Rate	4	0.6682	0.8628	0.6203	0.6444	0.5755
Site Year*Hybrid*N Rate*Seed Rate	60	0.9843	0.6462	0.6258	0.5900	0.8357

CP (%) by site-year x brand (P<0.001).

Difference between brand within site-year are denoted by asterisk.



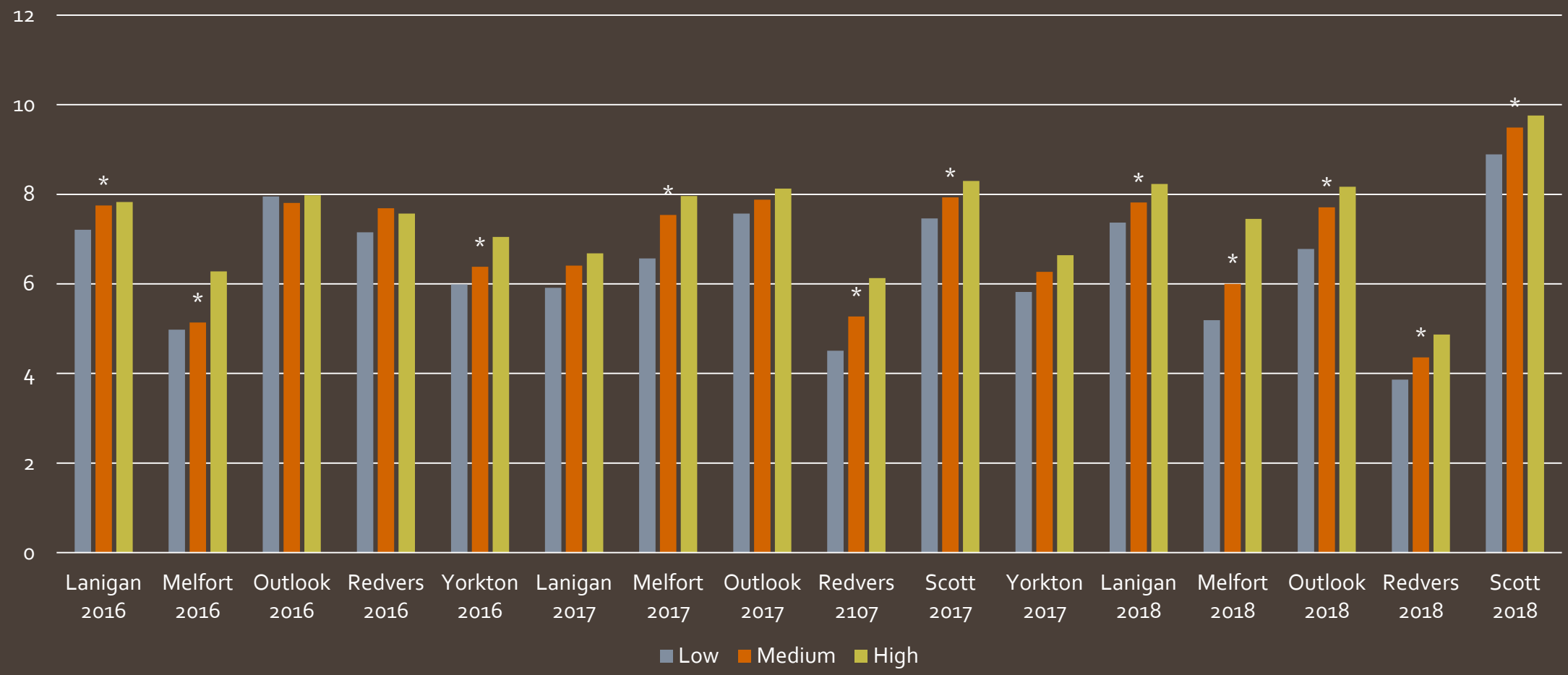
Effect of N-Rate on Crude Protein



- As would be expected, N fertilizer increased the CP concentration of the forage.

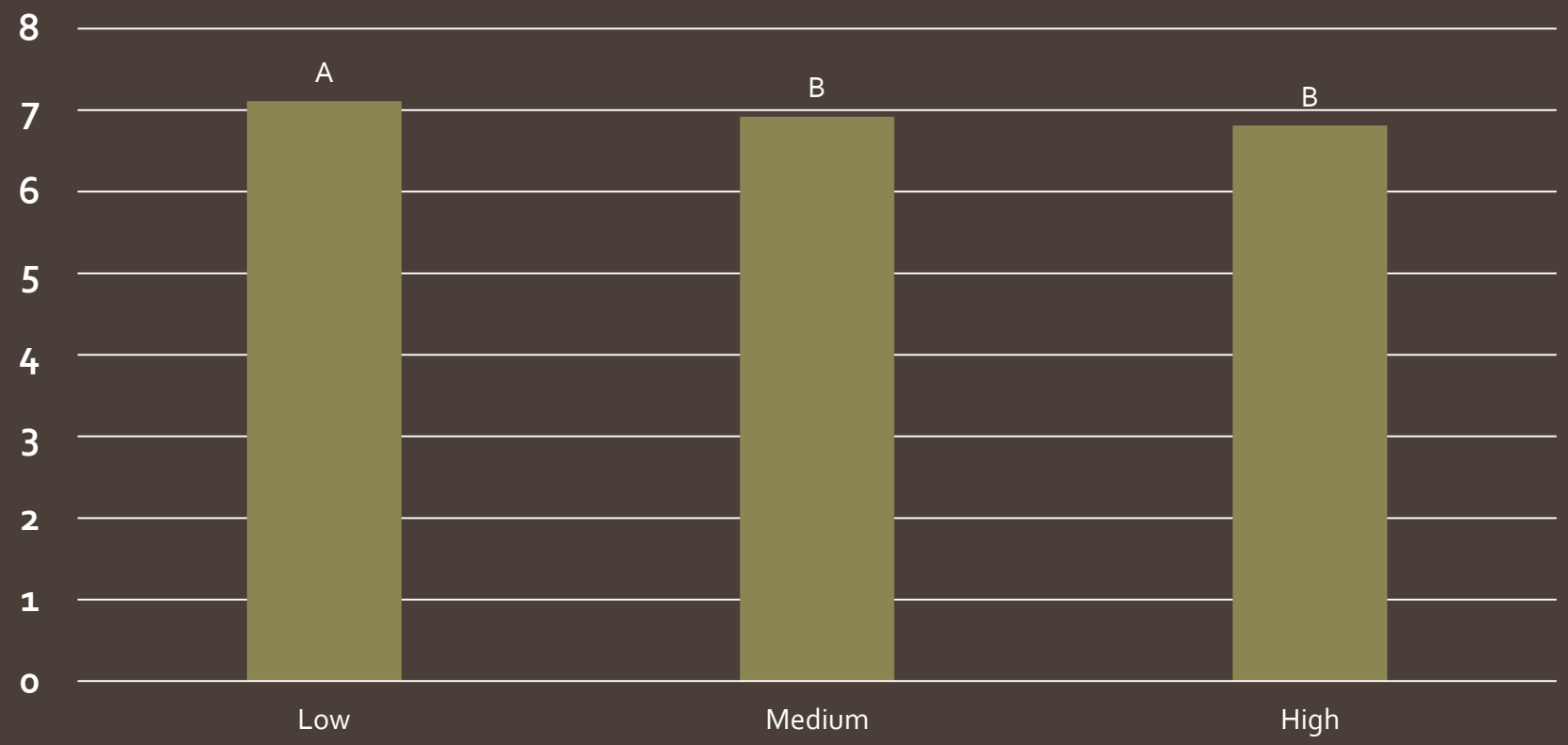
CP (%) by Site-Year x N-Rate

Difference between brand within site-year are denoted by asterisk.



- Significant effect at 11-site-years

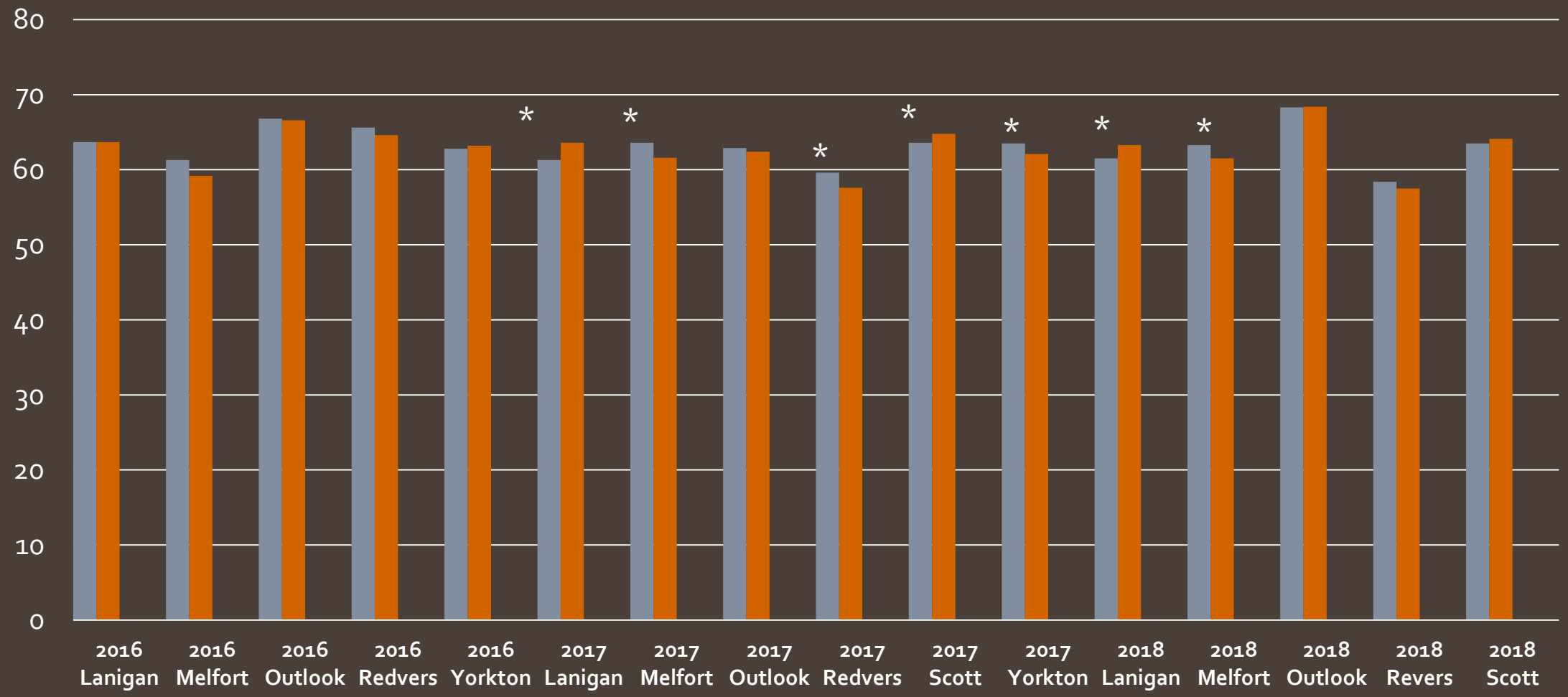
Effect of Seeding Rate on Crude Protein



- Increasing the seeding rate resulted in lower forage CP concentration
  - Although the differences are small (0.2 to 0.3%)

TDN (%) by Site-Year x Brand (P<0.001)

Difference between brand within site-year are denoted by asterisk



- Interaction is inconsistent, but significant for 8 site-years

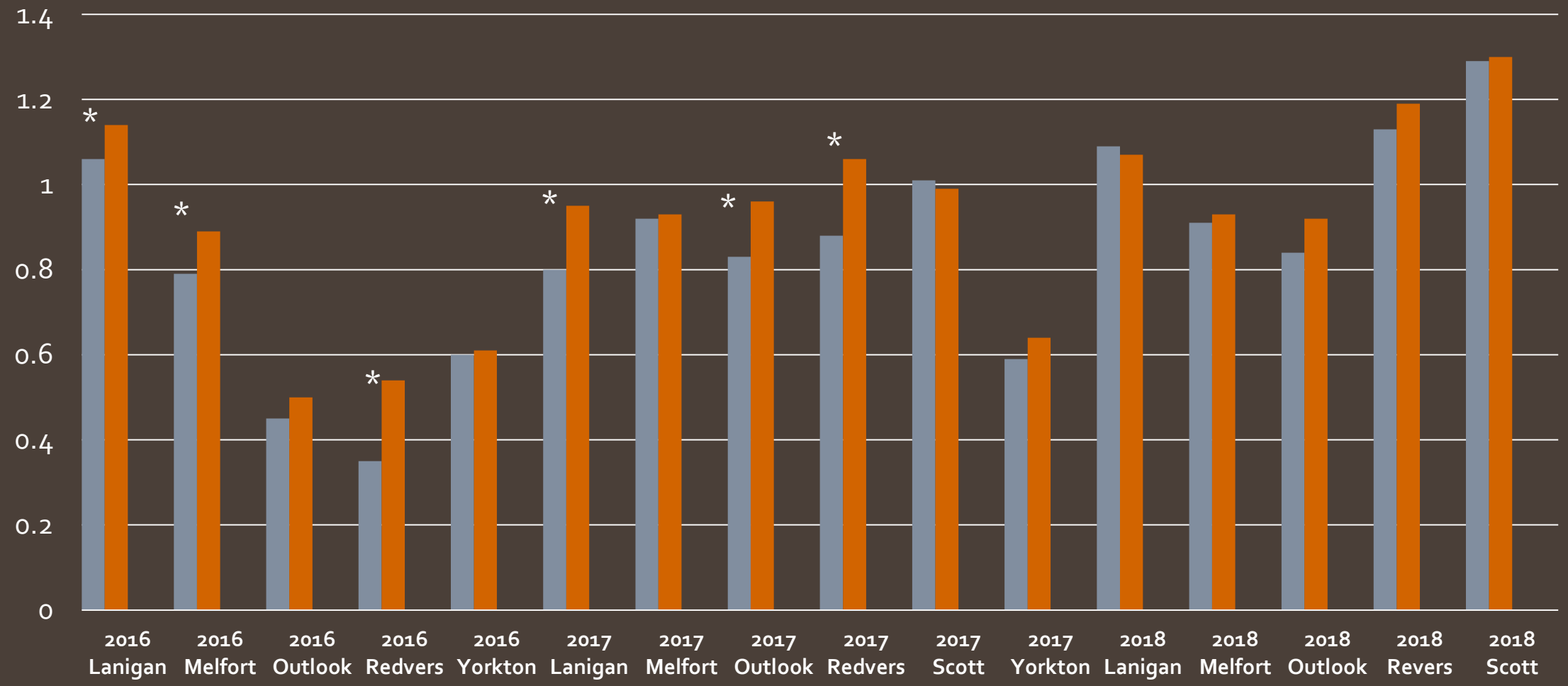
ANOVA results across 16 site-years

Mineral Content

		P>F value						
Source	DF	Ash	Chloride	Potassium	Magnesium	Calcium	Phosphorus	Sulfur
Rep	2	0.6078	0.2474	0.4555	0.9243	0.4811	0.1666	0.7961
Site Year	15	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Hybrid	1	0.0163	<.0001	<.0001	<.0001	<.0001	0.9836	<.0001
Site Year*Hybrid	15	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001
N Rate	2	0.0203	0.0329	<.0001	<.0001	<.0001	0.0002	<.0001
Site Year*N Rate	30	0.1921	0.8086	0.4403	0.4348	0.2213	0.8961	0.0086
Hybrid*N Rate	2	0.648	0.1189	0.1018	0.2854	0.0161	0.7275	0.3543
Site Year*Hybrid*N Rate	30	0.6978	0.6359	0.7003	0.0719	0.6409	0.899	0.2221
Seed Rate	2	0.6919	0.5019	0.0292	0.2545	0.9051	0.0204	0.0663
Site Year*Seed Rate	30	0.3873	0.0016	0.2873	0.7189	0.4026	0.2243	0.3507
Hybrid*Seed Rate	2	0.9769	0.4396	0.2263	0.3808	0.3611	0.6131	0.6716
Site Year*Hybrid*Seed Rate	30	0.9067	0.9432	0.9168	0.2999	0.996	0.4629	0.7791
N Rate*Seed Rate	4	0.2422	0.1853	0.9773	0.5431	0.2019	0.7721	0.5115
Site Year*N Rate*Seed Rate	60	0.9976	0.6164	0.3519	0.0853	0.9953	0.7987	0.641
Hybrid*N Rate*Seed Rate	4	0.5541	0.6362	0.2082	0.6	0.4727	0.259	0.6412
Site Year*Hybrid*N Rate*Seed Rate	60	0.9369	0.6691	0.6056	0.945	0.8978	0.0315	0.6185

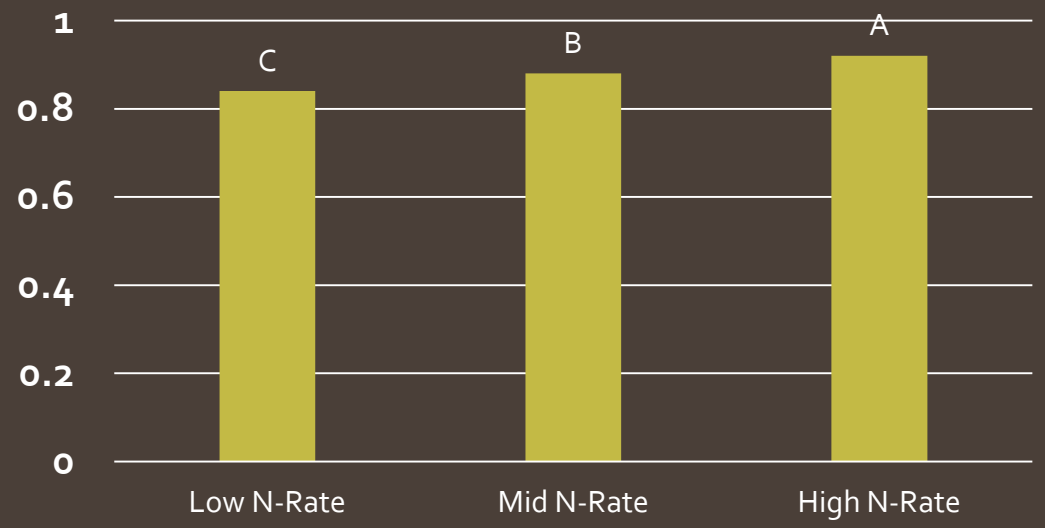
Effect of Site-Year x Brand Interaction on K-Concentration (%)

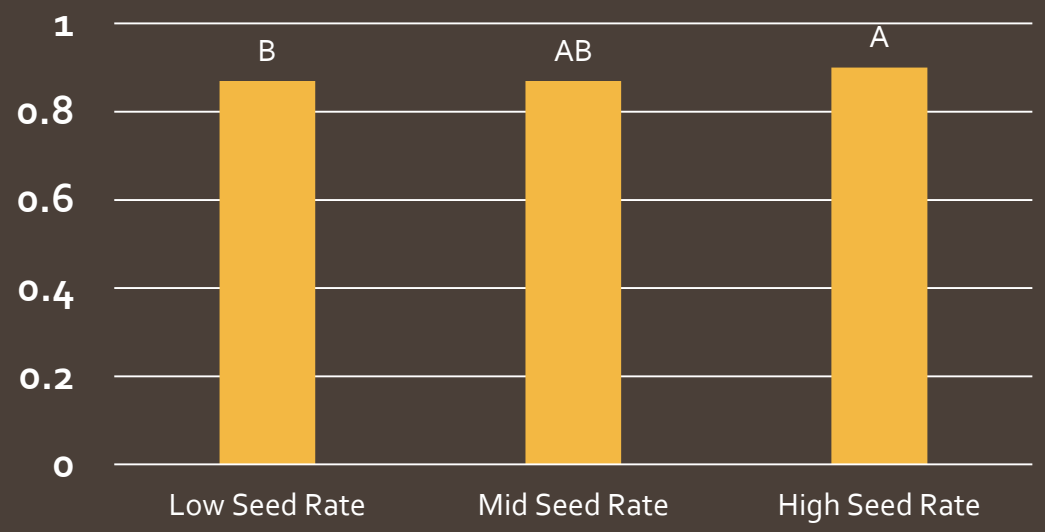
Difference between brand within site-year are denoted by asterisk



- Consistent brand interaction, significant for 6 site-years

Potassium Concentration (%) by N-Rate and Seeding Rate

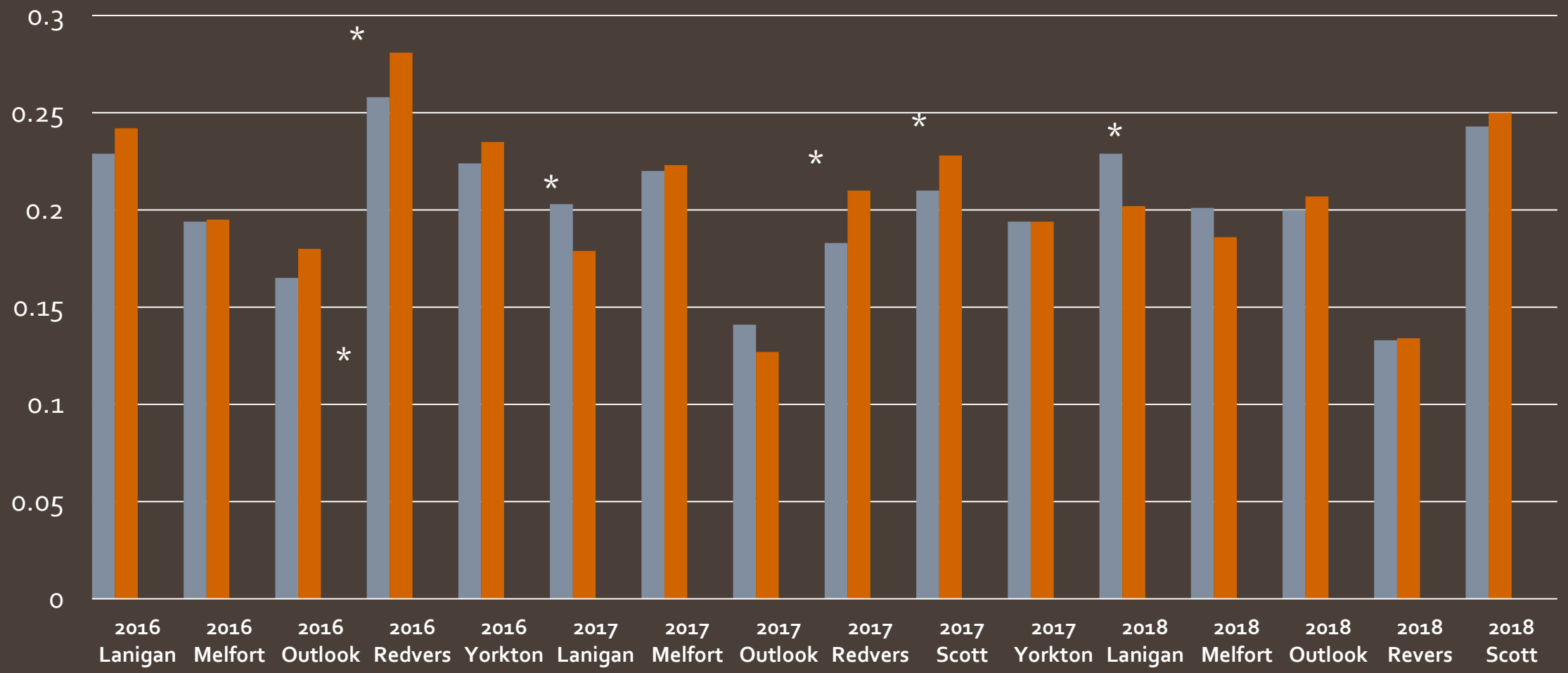




- N fertilizer increased the K concentration of the forage
- Higher seeding rate resulted in higher K concentration, although differences are small (0.03%)

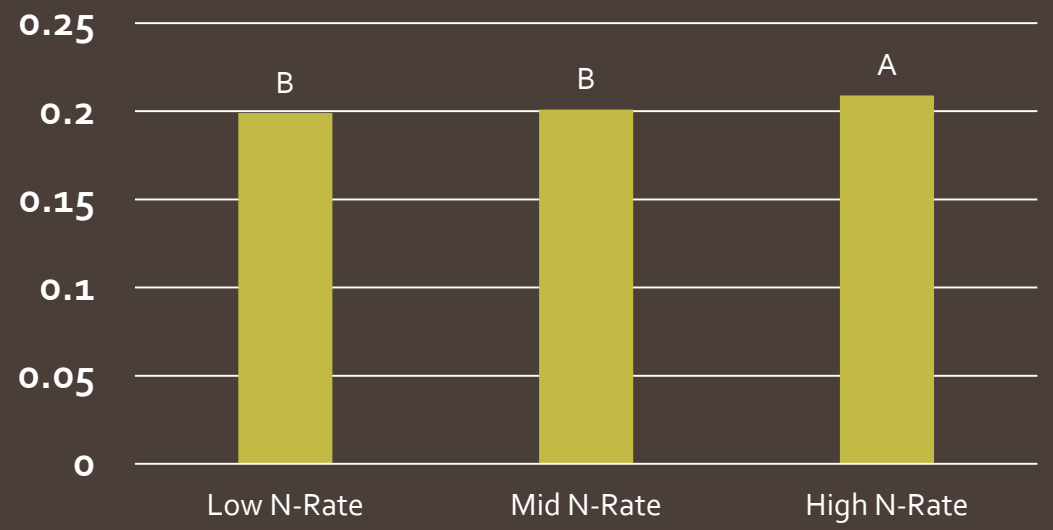
Effect of Site-Year x Brand Interaction on P-Concentration (%)

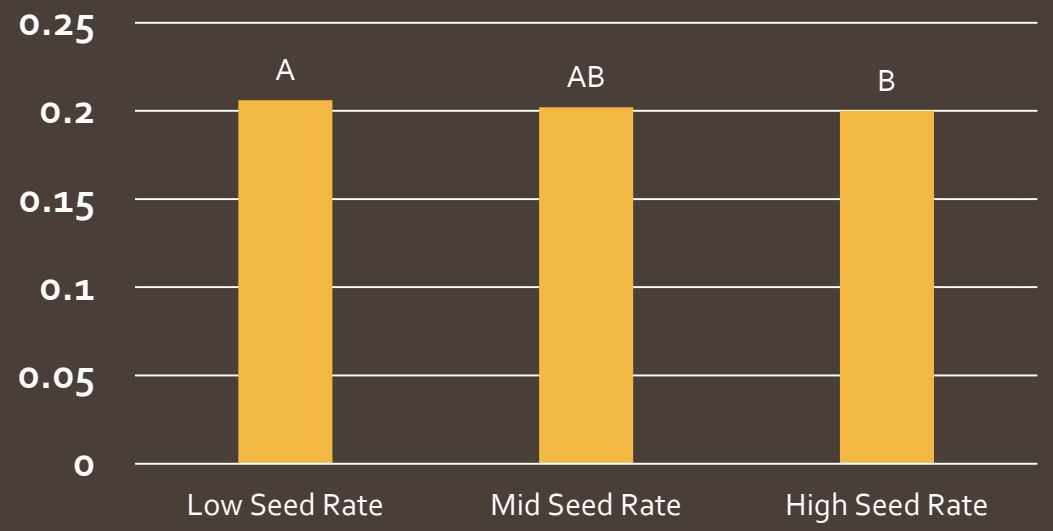
Difference between brand within site-year are denoted by asterisk



- The main of effect of hybrid (Brand) was not significant for P concentration.

Phosphorus Concentration (%) by N-Rate and Seeding Rate





- N fertilizer increased the P concentration
- Seeding rate resulted in lower P concentration, although differences are small (0.006%)

Forage Quality Summary

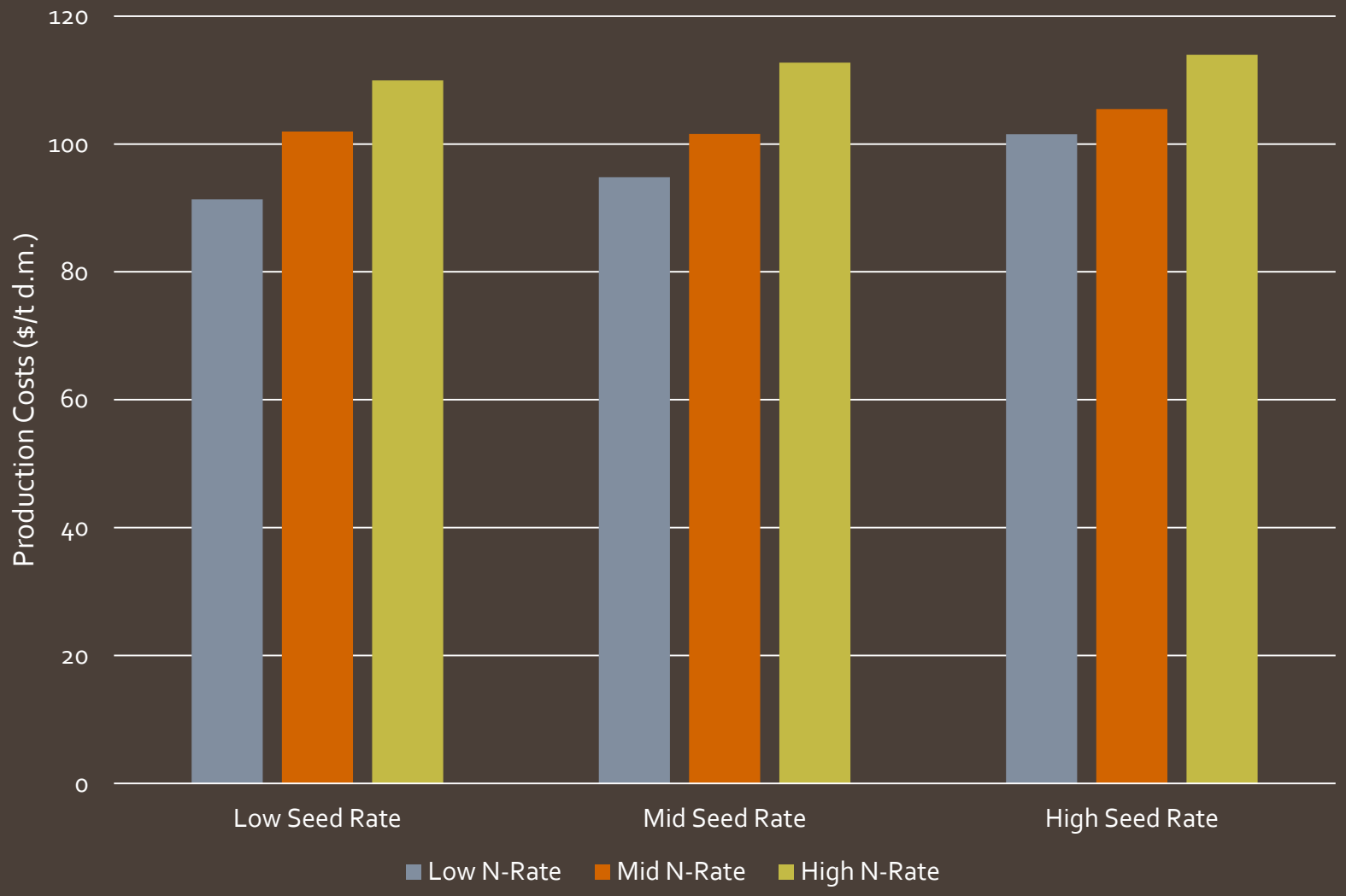
- Site-Year interacted consistently with Seed Brand; significant for CP, TDN, ADF, NDF
- N-rate increased Crude Protein concentration (as expected)
- P, Ca, and K increased with N-rate (within manageable levels)
- Higher Seeding Rate resulted in decreased Crude Protein and TDN
- Mineral concentrations for all samples were suitable for beef cow winter diets

Economics

Total input costs per tonne of dry corn biomass

Variable Expenses
- Seed
- Fertilizer
- Chemical
- Machinery Operating
- Crop Insurance Premium
- Utilities
- Interest on Variable Expenses

Fixed Expenses
- Building Repair
- Machinery/Building Investment
- Property Taxes
- Machinery/Building Depreciation
- Land Investment



Source: Saskatchewan Crop Planning Guide 2018

Conclusions

- Significant 'site-year x hybrid' interactions for forage yield and quality indicates that regional trial results will be useful for producer hybrid selection
- N-rate had a small and variable effect on forage yield and a significant effect on forage quality.
  - Current recommended N fertilizer rates are adequate.
- Reducing the seeding rate resulted in lower forage yield but higher CP concentration.
- TDN was not affected by N-rate or seeding rate
- Final economic analysis is in progress

Acknowledgements

- **Questions?**
- **Comments?**

- Contact :
- Charley Sprenger
- csprenger@pami.ca
- (204) 239-5445 ext 243