Seeding Year Yield and Forage Nutritive Value of Reduced Lignin and Conventional Alfalfa Varieties

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Introduction

- Alfalfa is widely used as a forage for herbivores due to its high nutrient content
- Grown as hay or haylage on over 3,000,000 acres in MN and WI (NASS, 2013)



Introduction

Hay&Forage Grower

Low- And Reduced-Lignin Alfalfas To Hit Market

Alforex and Forage Genetics International announce varieties

Oct 7, 2014

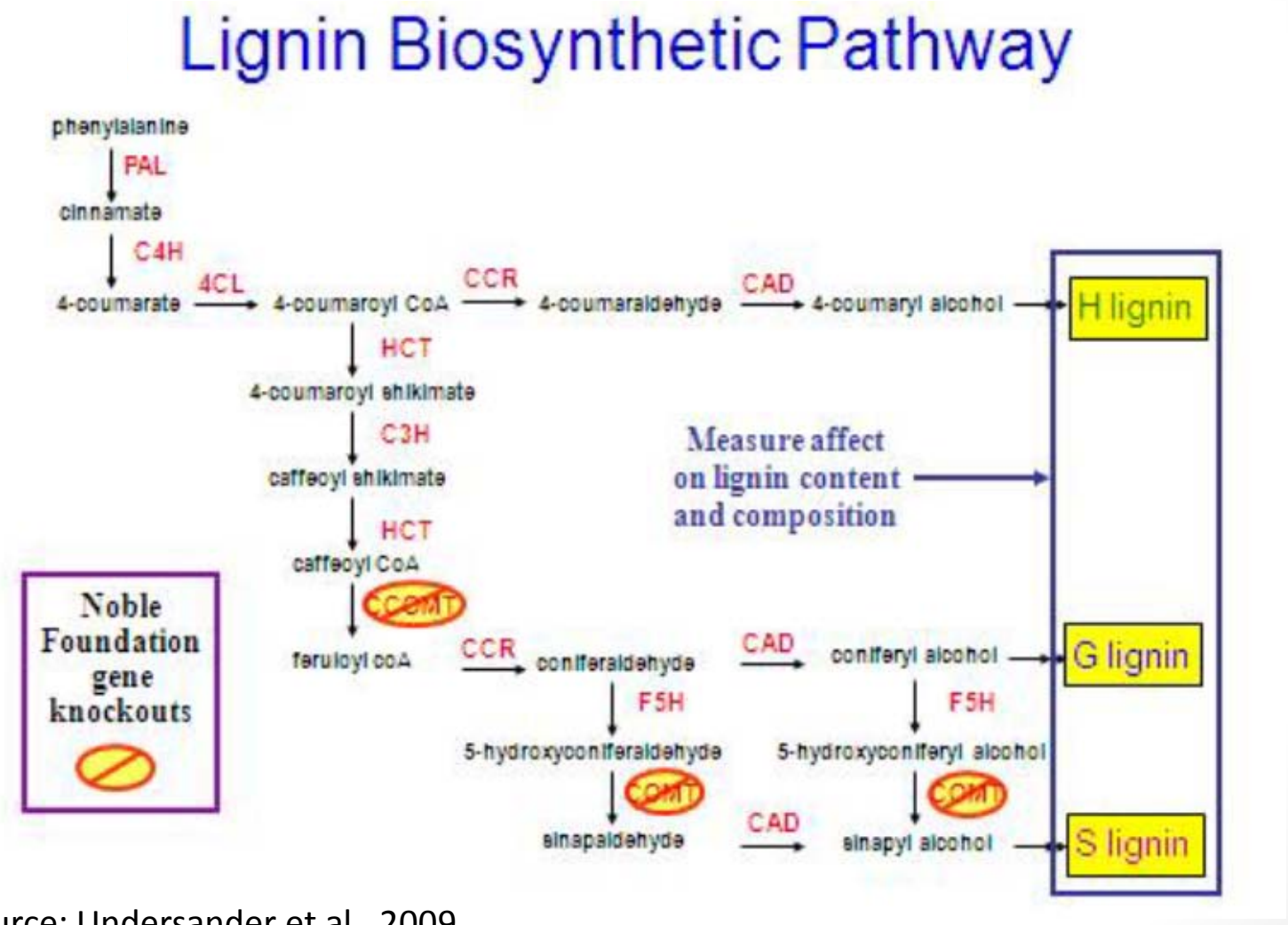
The Latest Breakthrough in Alfalfa Technology

Forage Genetics International introduces HarvXtra™ alfalfa, the industry's first quality-enhancing trait technology

In an effort to bring the industry's first quality-enhancing trait to market, Forage Genetics International (FGI) announces that the reduced lignin trait will be known as HarvXtra™ alfalfa. This breakthrough technology is designed to ease the "yield-versus-quality" trade-off currently faced by alfalfa producers by improving forage quality over a longer period. This provides growers with greater flexibility and a wider cutting window to maximize yield potential.

Source: http://www.foragegenetics.com/fgi/media/PDFs/HarvXtraAlfalfa_News-Release.pdf
http://hayandforage.com/alfalfa/low-and-reduced-lignin-alfalfas-hit-market

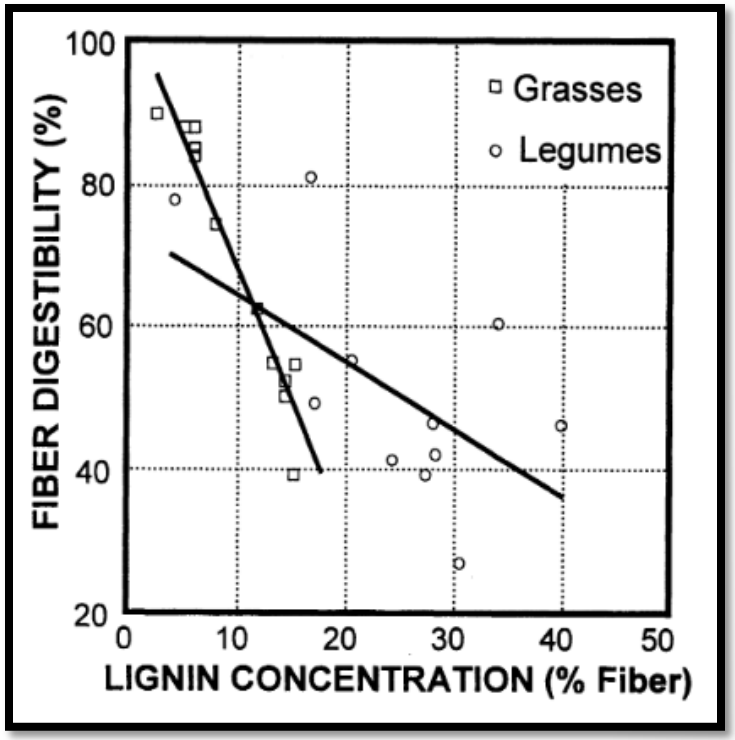
Introduction



Source: Undersander et al., 2009

Introduction

- Why do we want to reduce lignin levels?
  - Lignin is an indigestible component of plants
  - Binds to cellulose and hemicellulose and is a barrier to their digestibility (Morrison, 1979; Jung et al., 2012)
  - Cell wall digestibility negatively related to lignin concentration (Albrecht et al., 1987; Casler, 1987; Jung et al., 1997)

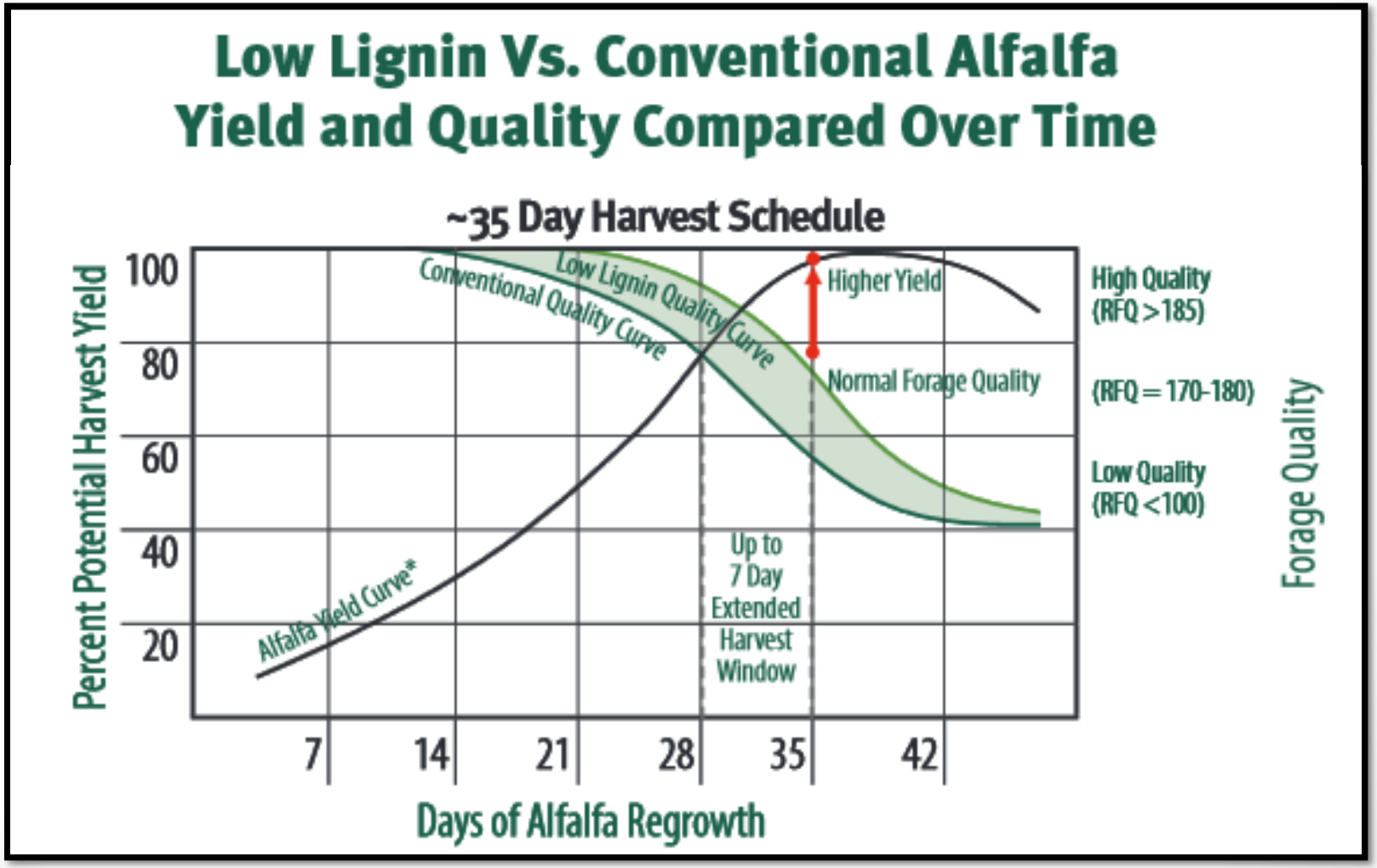


Source: Hatfield et al. 2007

Introduction

- Advantages of reduced lignin alfalfa varieties
  - Opportunity to increase the feeding value of alfalfa
    - Small changes in forage digestibility can impact animal performance (Casler and Vogel, 1999)
  - Provides increased management flexibility
    - Wider harvest window without loss of digestibility
    - Could allow for fewer harvest cuts per season
      - Less harvest costs and reduced field traffic

Introduction



Source: Alforex Seeds

Objectives

- Compare new reduced lignin alfalfa against traditional alfalfa varieties in the seeding year
  - **Forage yield**
  - **Forage nutritive value**
  - Plant maturity
  - Stand persistence
- Hypothesis: Reduced lignin varieties harvested at the same time as traditional varieties will have comparable forage yields but will be higher in forage nutritive value

Materials and Methods

Cutting Treatments

- Standard
  - 60d + 30d + 30d
- Standard + Fall
  - 60d + 30d + 30d + Fall
- Standard + Delay
  - 60d + 37d + 37d
- Delay + Fall
  - 67d + 45d + Fall

Alfalfa Varieties

- 54R02
- WL355RR
- DKA43-22RR
- HarvXtra

Materials and Methods

- Planted at 4 locations
  - Becker: April 27, 2015
  - **Rochester: April 30, 2015**
  - Rosemount: April 28, 2015
  - **Saint Paul: April 28, 2015**
- 5 replicates at each location
- Plot size 6.1 x 0.91 m

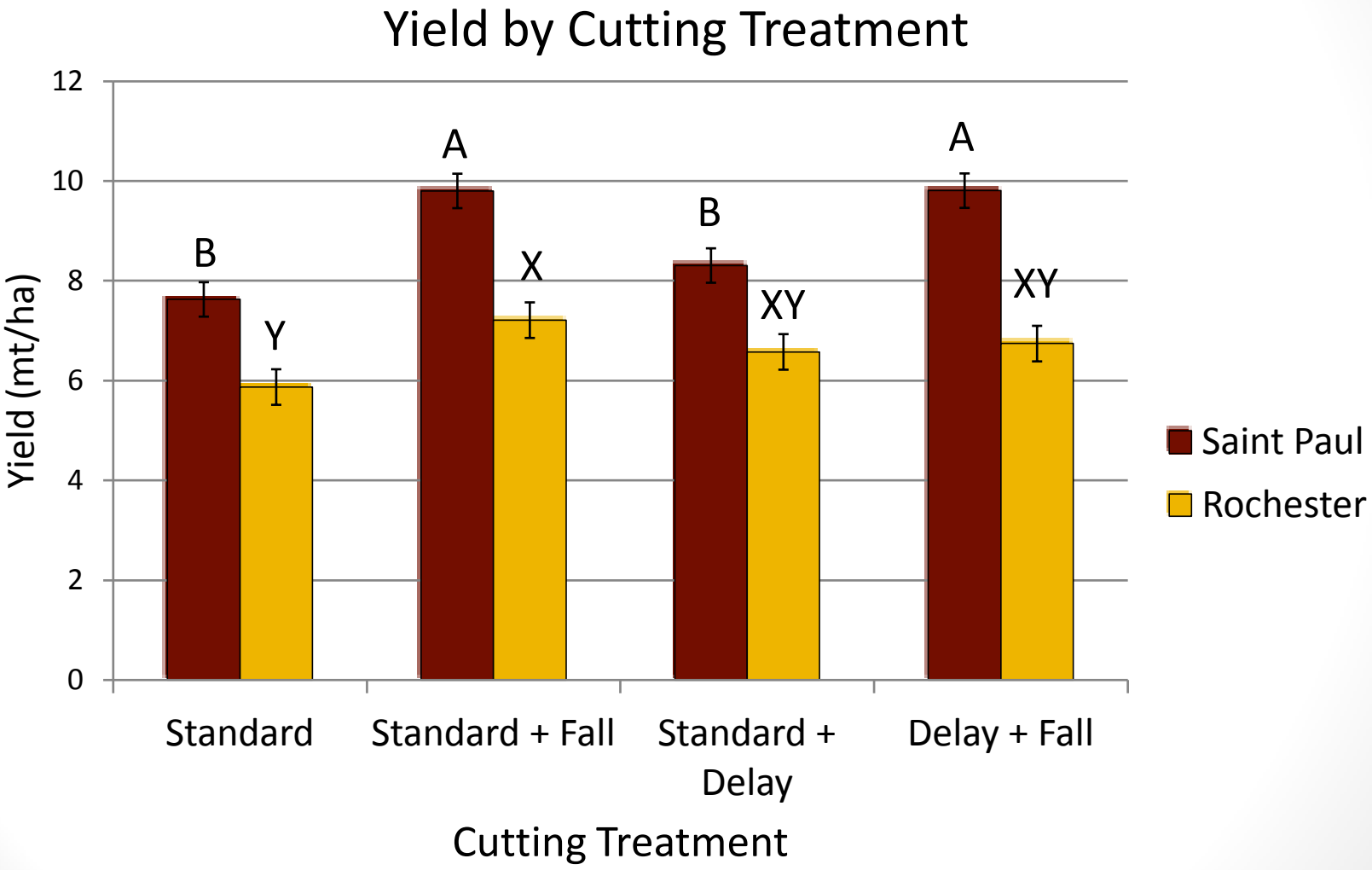
Materials and Methods

- Measured plant height
- Hand harvested duplicate samples from each plot
  - Maturity (Kalu and Fick, 1981)
  - Forage nutritive value
- Mechanically harvested whole plot with Carter Harvester for yield
- Took stem counts

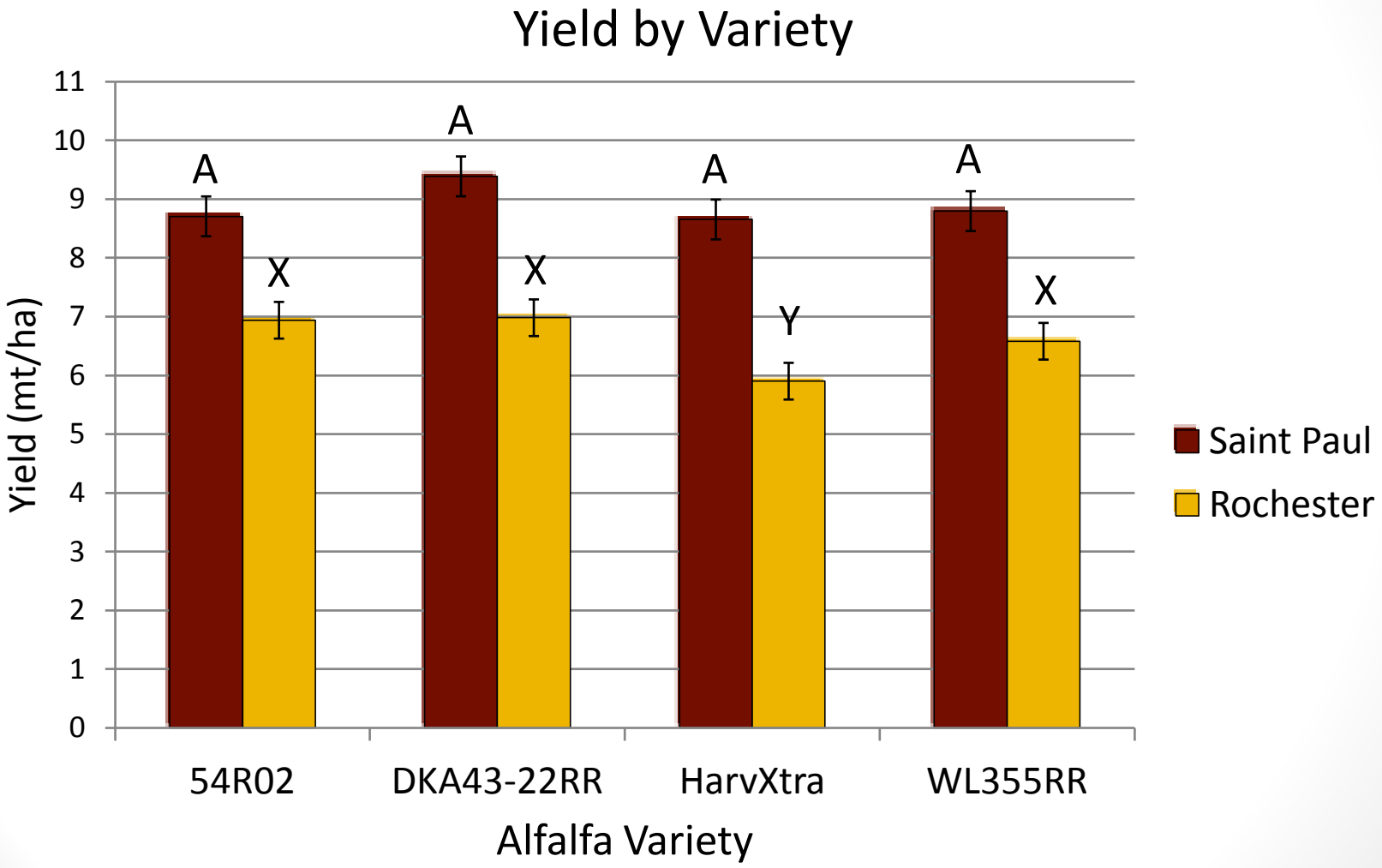
Statistical Analysis

- Data analyzed using Proc Mixed procedure of SAS
  - Statistical significance set at $P \leq 0.05$
  - Random effects – replicate
  - Fixed effects – cutting treatment, variety
  - Locations analyzed separately
- Main effects of cutting treatment and variety reported separately
- Yield reported as seasonal cumulative yield
- Forage nutritive values are reported for the second harvest

Results – Yield



Results – Yield



Results – Forage Nutritive Value

Saint Paul

Variety	NDF	ADF	CP	NDFD48
	% DM			
54R02	34.85	32.09^{a}	23.79	42.18^{b}
DKA43-22RR	34.52	30.93^{ab}	23.88	41.61^{b}
HarvXtra	34.02	29.69^{b}	24.31	45.25^{a}
WL355RR	34.21	30.77^{ab}	23.99	41.57^{b}

Within columns, means without a common superscript differ ($P \leq 0.05$)

Results – Forage Nutritive Value

Rochester

Variety	NDF	ADF	CP	NDFD48
	% DM			
54R02	40.48	35.59[a]	20.70	34.55[b]
DKA43-22RR	40.35	34.59[a]	20.74	35.42[b]
HarvXtra	39.26	32.46[b]	21.58	38.52[a]
WL355RR	39.78	34.57[a]	20.96	35.19[b]

Within columns, means without a common superscript differ ($P \leq 0.05$)

Discussion – Yield

- Yield by cutting treatment
  - Standard + Fall consistently higher yielding
    - 60d + 30d + 30d + Fall
  - Standard consistently lower yielding
    - 60d + 30d + 30d
  - Delayed cutting treatments have potential for equally high yields
- Yield by variety
  - Minimal differences between varieties
    - HarvXtra lower yielding at Rochester

Discussion – Forage Nutritive Value

- Forage nutritive value by variety
  - All varieties had similar NDF and CP content
  - Slight reduction in ADF concentration for HarvXtra
  - HarvXtra had increased NDFD48 over all traditional varieties

Discussion – Forage Nutritive Value

Study	Lignin Reduction	Fiber	Protein	Digestibility
Guo et al., 2001a	2.1 - 5.1%	--	--	--
Guo et al., 2001b	12 - 29% (stem)	↕ ADF; NDF	--	↑ NDFD
Marita et al., 2003	10 - 21% (stem)	↑ cellulose	--	--
Reddy et al., 2005	3.6 - 4.8%	↓ ADF; NDF	--	↑ IVDMD
Mertens and McCaslin, 2008	0.5 - 0.7%	--	--	↑ DMD; NDFD
Weakley et al., 2008	--	--	--	↑ NDFD
Undersander et al., 2009	3.7 - 12%	--	--	↑ NDFD
Getachew et al., 2011	13 - 24%	↓ ADF; NDF	↑ CP	↑ IVDMD
Li et al., 2015	Not significant	↓ NDF	Not significant	↑ NDFD

Conclusion

- Alfalfa yields improved with both 4-cut and delayed 3-cut systems
- Minimal differences between alfalfa varieties in yield
- All varieties had similar NDF and CP content
- Slight reduction in ADF concentration for HarvXtra
- HarvXtra had increased NDFD48 over traditional varieties

Future Research

- Analysis of other locations and variables
- Continuation of study in summer 2016
  - 30d, 35d, 40d, 45d
- Weekly sampling to develop new quality curves
  - Summer 2015
  - Spring and summer 2016
- Potential digestibility study

Thank You

This project was funded by the Minnesota Department of Agriculture