

# Getting More from Forages



Targeted plant modifications:

Pasture forages

---

Genetic selection to improve  
grasses and legumes for grazing

Michael Casler & Heathcliffe Riday



# Red Clover Breeding



Prairie du Sac, WI - Breeding Nursery

## Red Clover

- **Establishment and Management Versatility**
- **Less Persistent**

## Breeding Targets

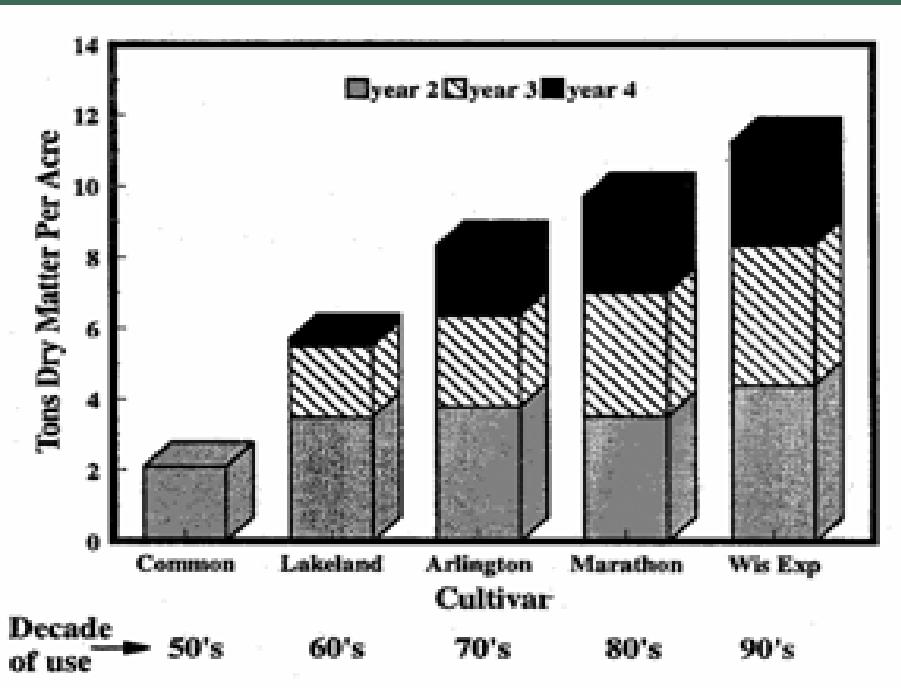
- **Increased Persistence**
- **Increased Yield**
- **Plant Vigor**



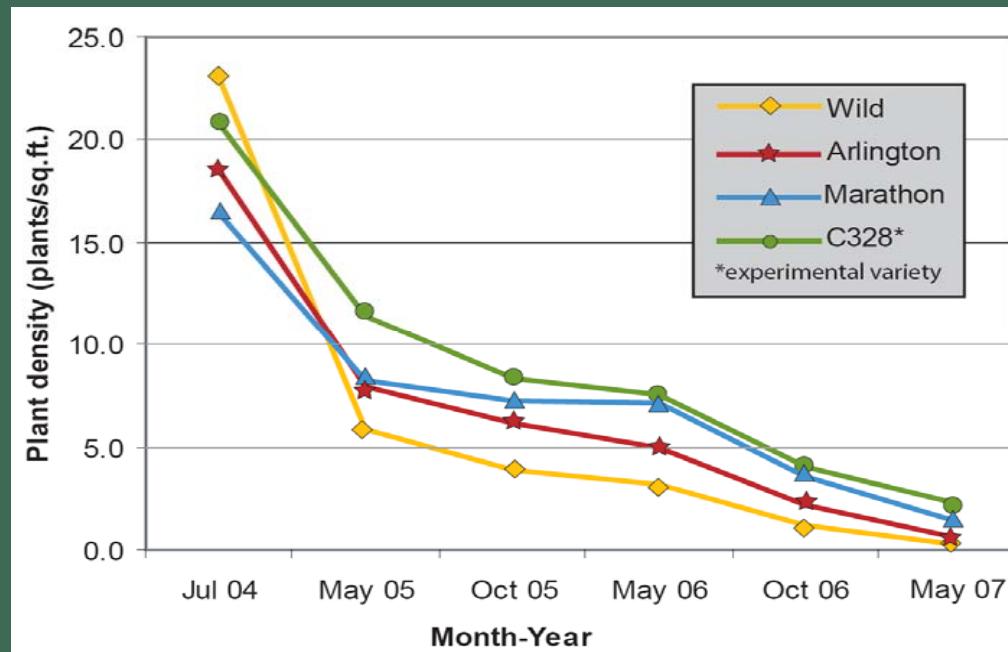


# Red Clover Breeding Results

50+ years of breeding at USDFRC has dramatically increased red clover persistence



Hay Management  
(Smith, 2000)



Rotationally Grazed in Grass Pasture  
(Riday, 2009)





# Kura Clover Breeding



Prairie du Sac, WI - Breeding Nursery

## Kura Clover

- **Very Persistent**
- **Difficult to Establish**

## Breeding Targets

- **Seedling Establishment**
- **Seed Production and Yield**
- **Plant Vigor**



# Kura Breeding Results

## 'Kura1' Germplasm Public Release, 2006

- Joint USDA-ARS & UW-Madison release (PI 643168)
- Broad based selection for rhizomatous spreading ability and vigor
- Kura1 foundation of current breeding efforts and future varieties

Arlington, WI Trial  
Established 2005

2005                      2006                      2007                      Trial Total

----- Mg ha<sup>-1</sup> DM -----

<b>Kura1</b>	<b>3.5</b>	<b>9.8</b>	<b>5.5</b>	<b>18.8</b>
'Endura'	3.2	9.3	4.7	17.2
'Cossack'	3.4	8.5	4.9	16.8
'Rhizo'	2.6	7.7	4.3	14.6
Alfalfa ('Genoa')	5.1	12.5	8.0	25.7
Red Clover (DFRC-Exp.)	6.0	10.8	5.8	22.6
LSD ( $p < 0.05$ )	0.7	1.1	0.6	1.7





# Birdsfoot Trefoil Breeding

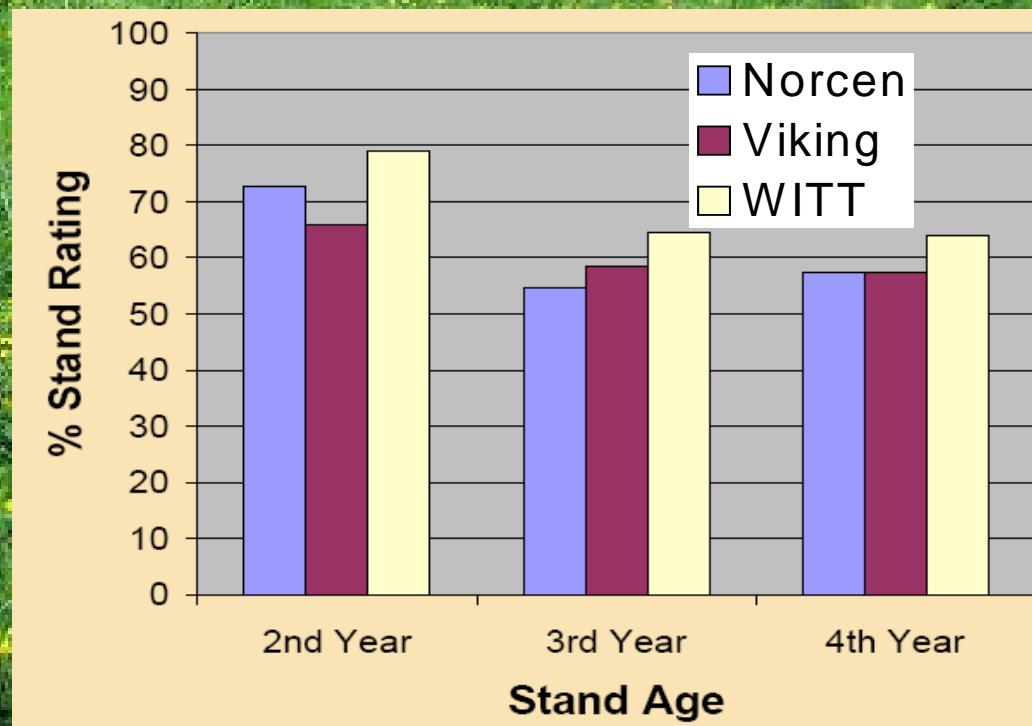
## Birdsfoot Trefoil - Non Bloating Legume

### New Cultivar 'WITT'

- Commercial License Granted to Allied Seed
- Seed to Market in 2-3 Years

**'WITT' had Superior Persistence Across 16 MN & WI Variety Trials**

Prairie du Sac, WI - Breeding Nursery



# Breeding-Approach Research

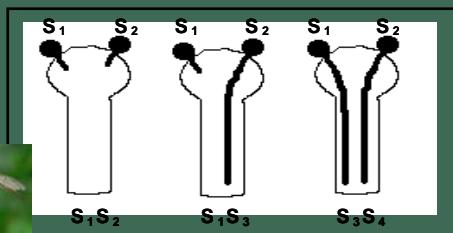
Leaf temperature -  
Selecting Increase Drought  
Tolerance



Non-Linkage Based  
DNA Marker Assisted  
Selection



Restricting Gametophytic Self-  
Incompatibility Alleles to  
Increase Population Hybridity



Using Near Infrared  
Spectroscopy to Predict  
Seedling Vigor



# Grass Breeding Activities

---

- Smooth bromegrass  
*Bromus inermis*
- Timothy  
*Phleum pratense*
- Orchardgrass  
*Dactylis glomerata*
- Reed canarygrass  
*Phalaris arundinacea*
- Meadow fescue  
*Festuca pratensis*
- Festulolium  
*Festulolium braunii*

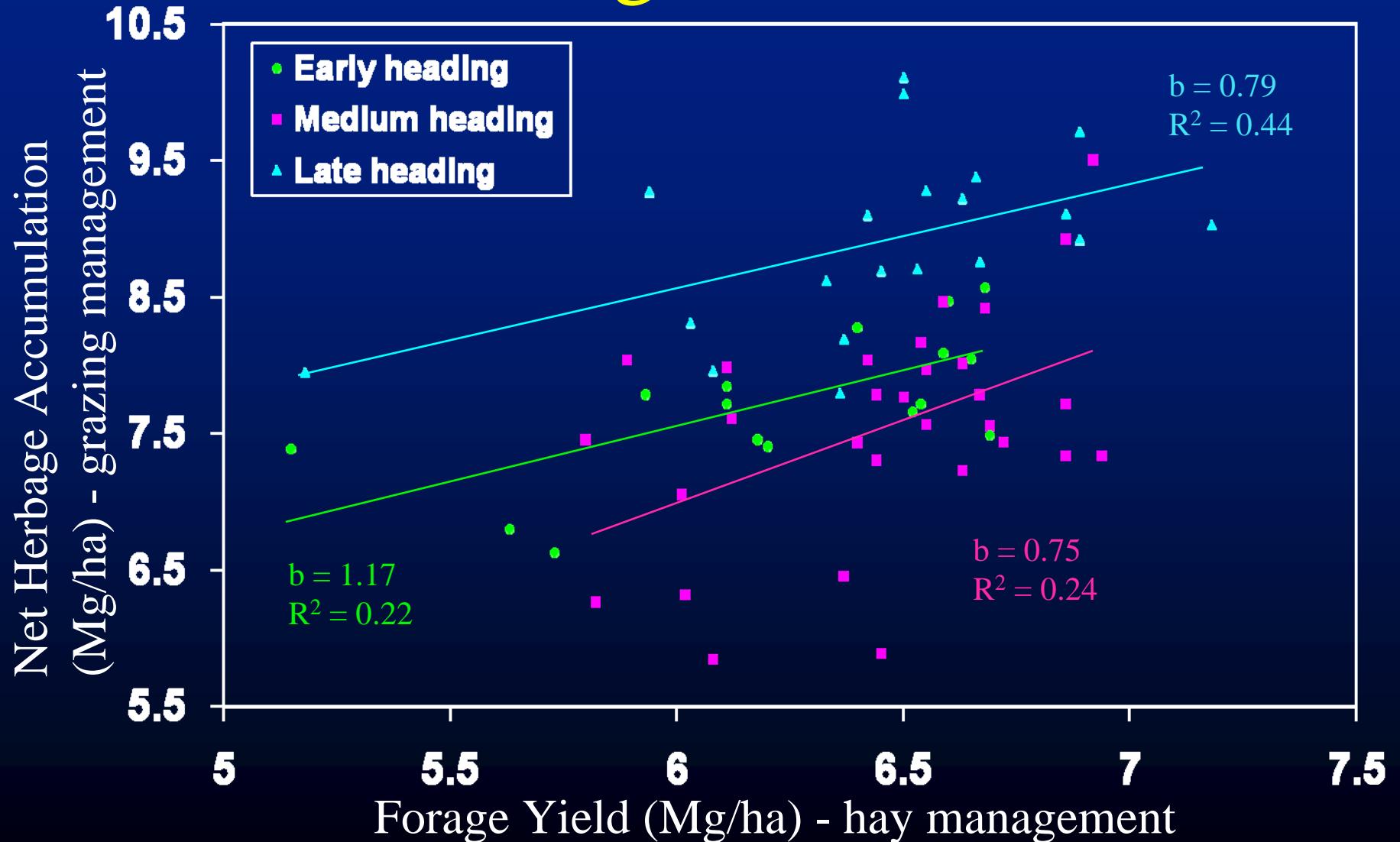


# Targets for Grass Breeding

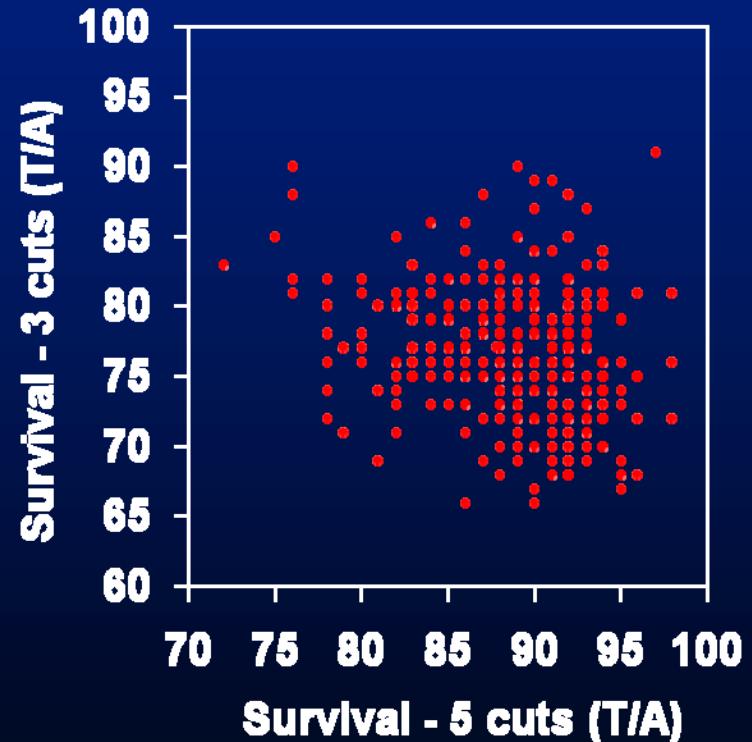
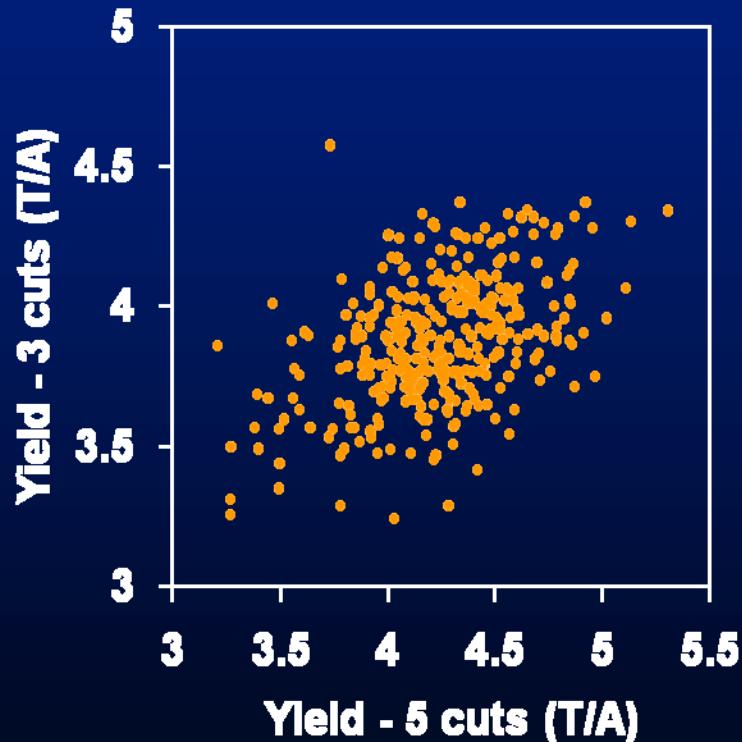
---

- Hay/Silage production
  - The focus of grass breeding since its beginning.
  - Many excellent, well-adapted varieties exist.
- Management-intensive grazing/Pastures
  - Virtually no breeding efforts until 1990.
  - Most breeding programs have shifted toward this goal.
- The best hay types are not necessarily the best pasture types and vice versa.

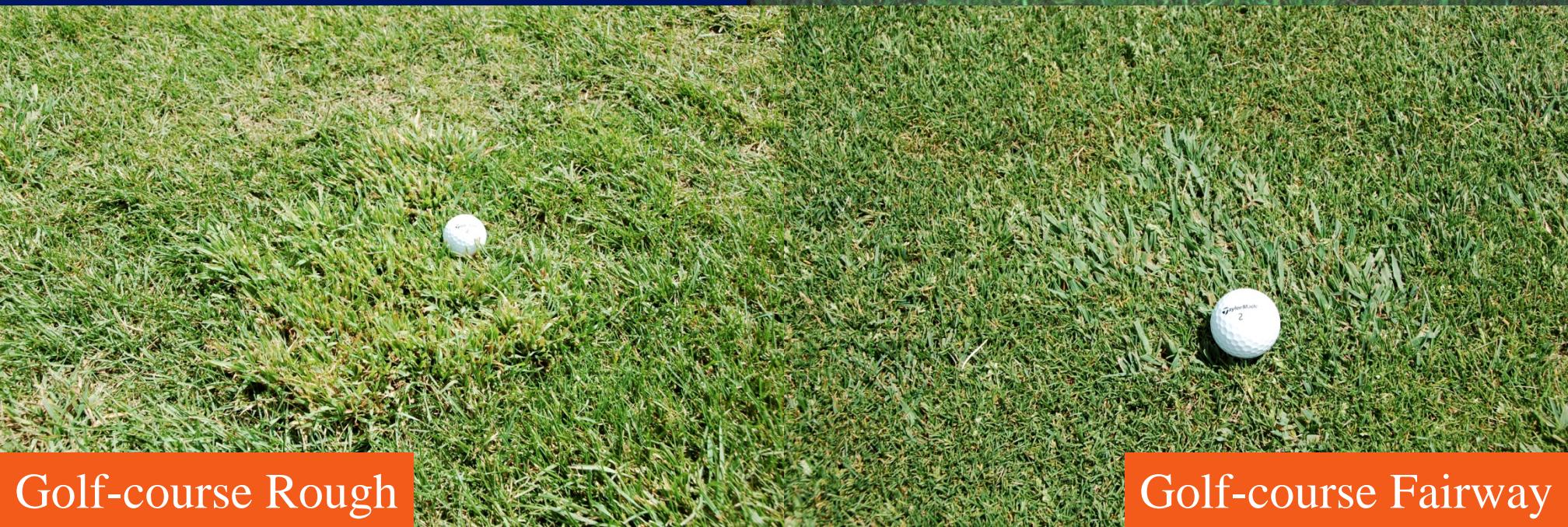
# Orchardgrass Varieties



# Evaluation of Timothy Breeding Lines: 3 cuts vs. 5 cuts



Breeding Grazing-  
tolerant  
Timothy and  
Bromegrass



Golf-course Rough

Golf-course Fairway

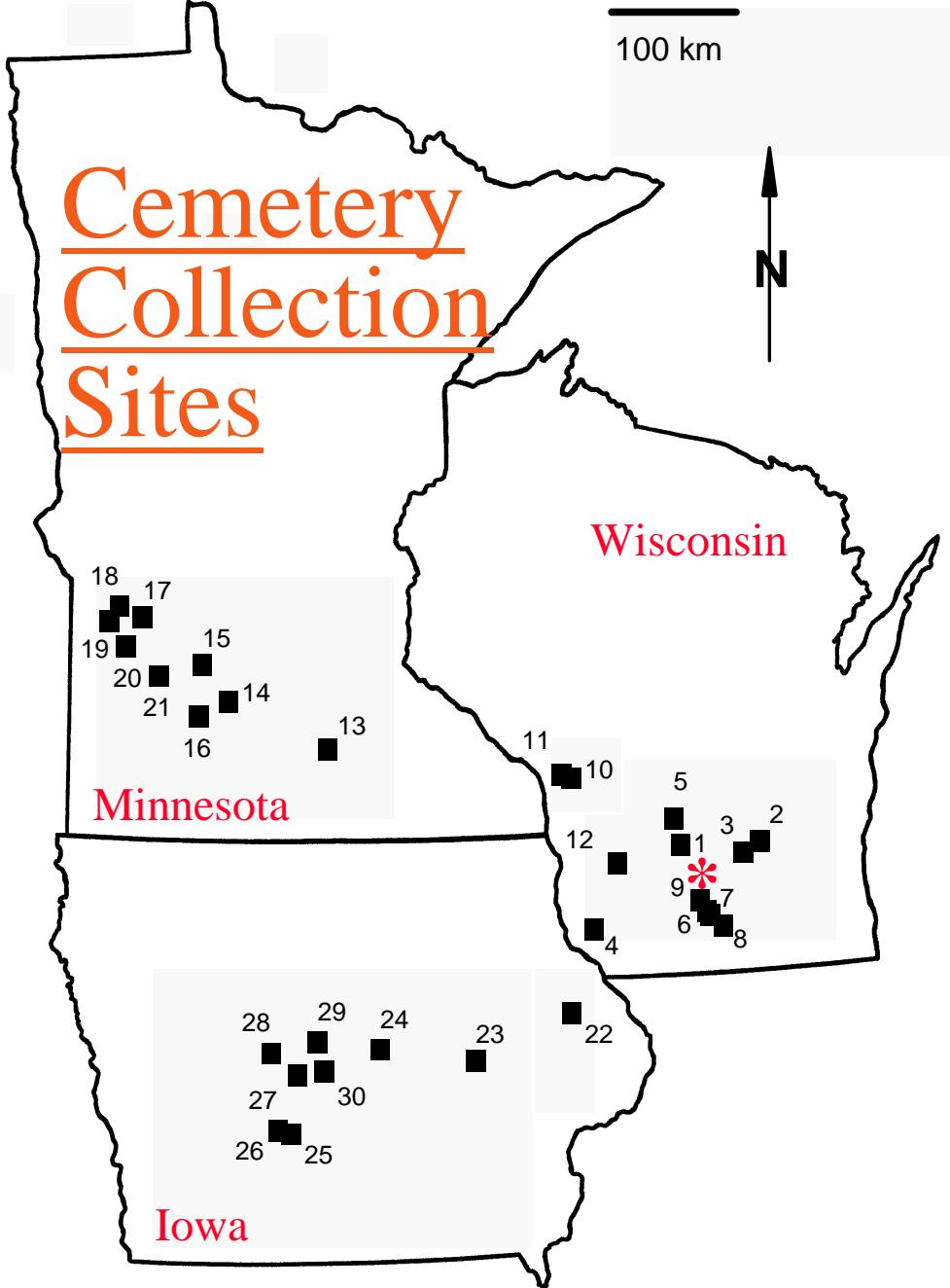
# Timothy from Old Turfs

---

Population	3 cuts	5 cuts
Elite forage selections	9.55a	8.63ab
Turf collections	9.37b	8.76a
Commercial cultivars	9.32b	8.55b

---

Turf types (golf fairways, golf roughs, cemeteries, home lawns, field lawns ) did not differ from each other.

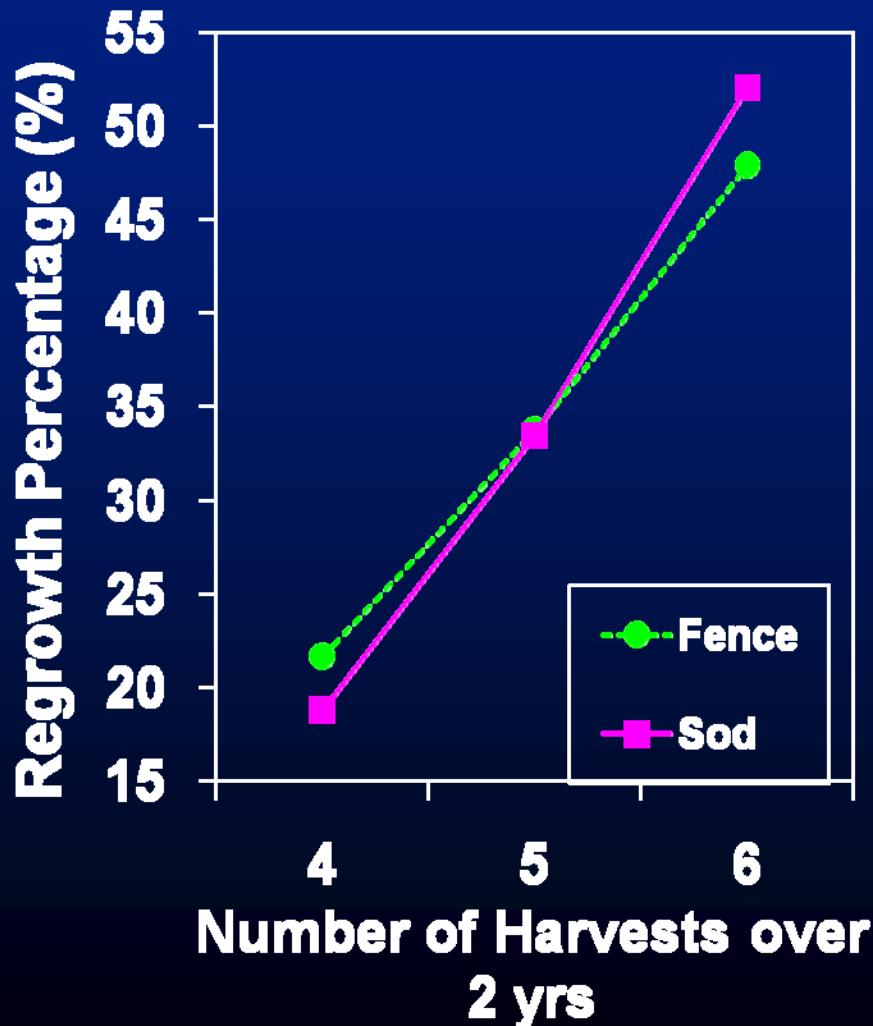
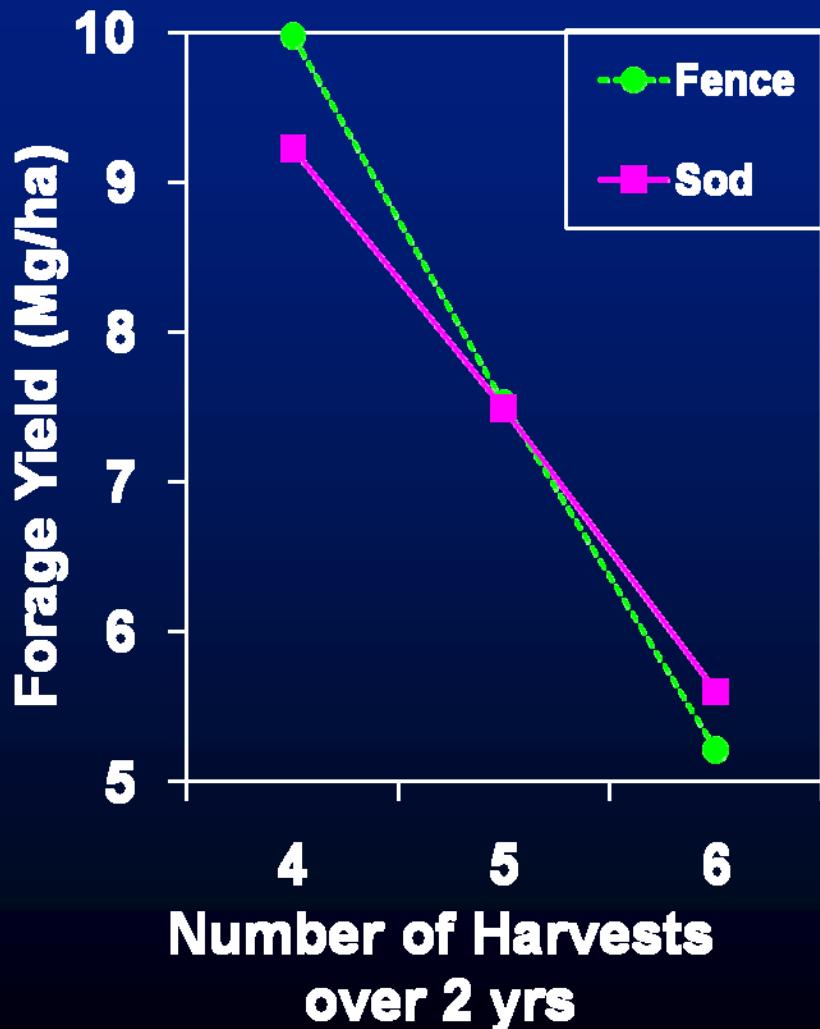


Differential natural selection and evolution in fence and sod.



# Forage Yield of Fence vs. Sod

## Smooth Bromegrasses: Belleville, WI

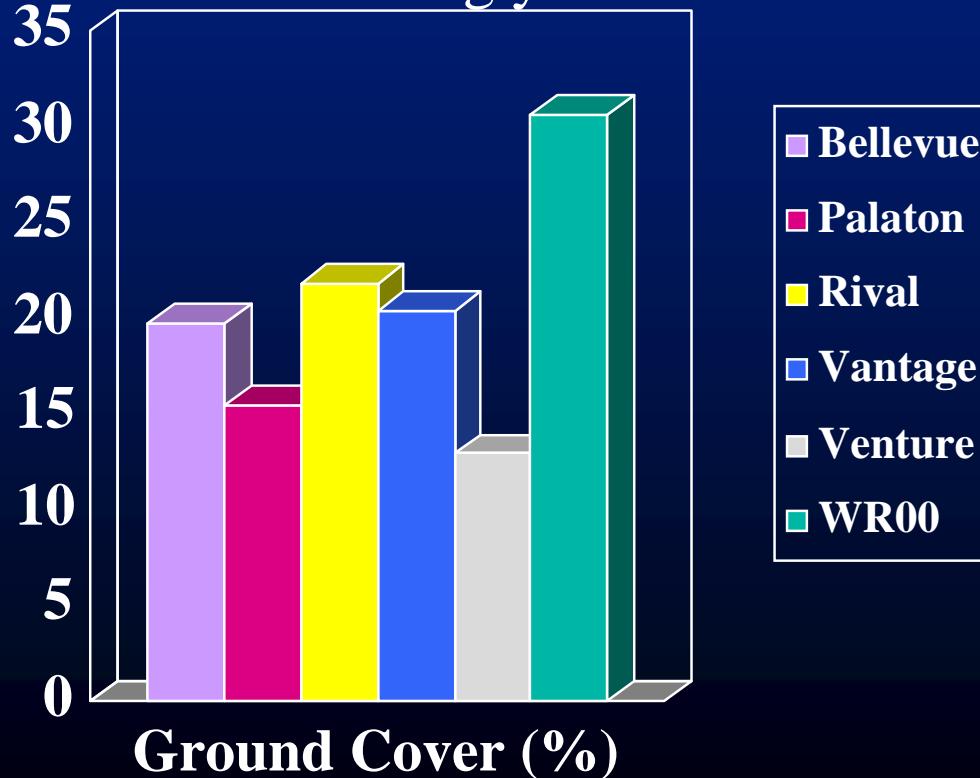


Reed Canarygrass: An excellent pasture grass that is very difficult to establish.

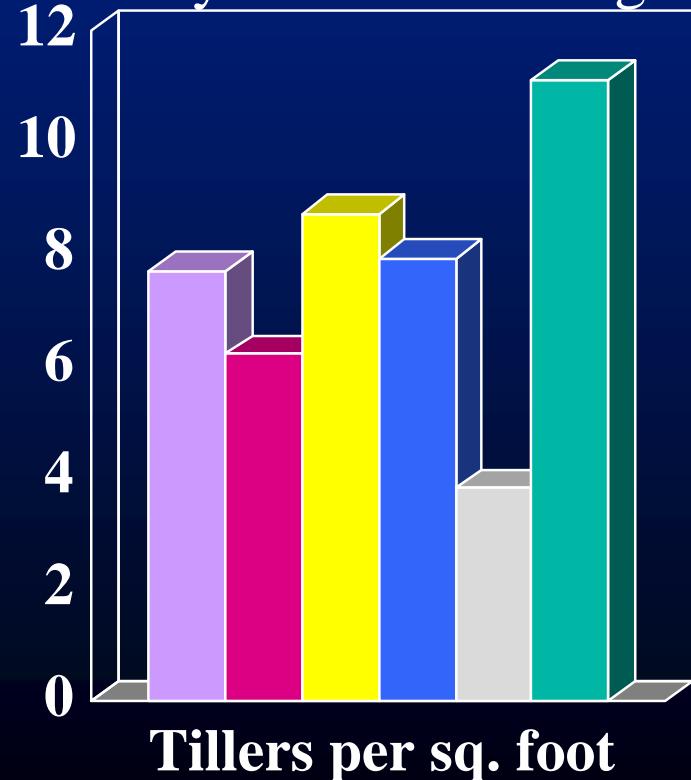


# Reed Canarygrass: Improving Establishment by Selection and Breeding

Ground cover:  
Fall seeding year.

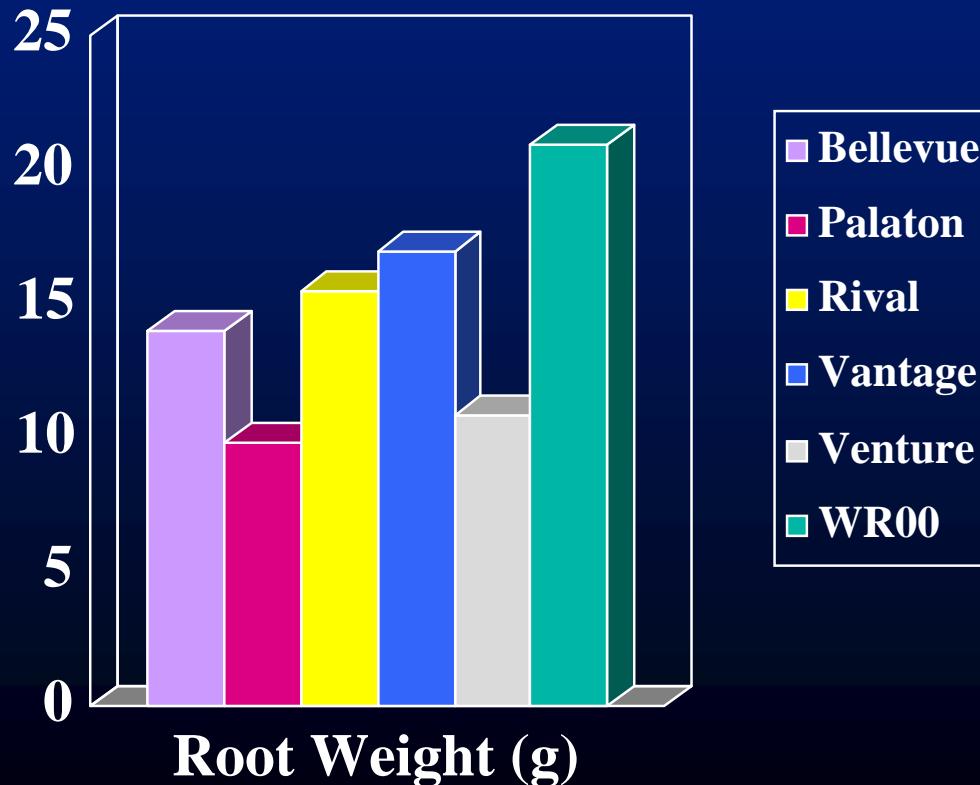


Tiller production:  
1 year after seeding.

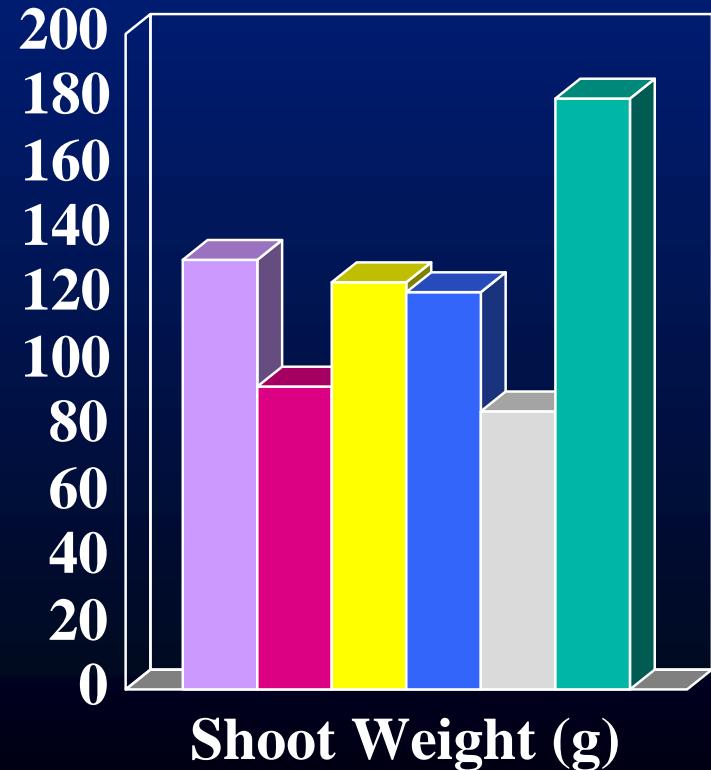


# Reed Canarygrass: Determining the Mechanism for Improved Establishment

Root weight:  
16 days after emergence.

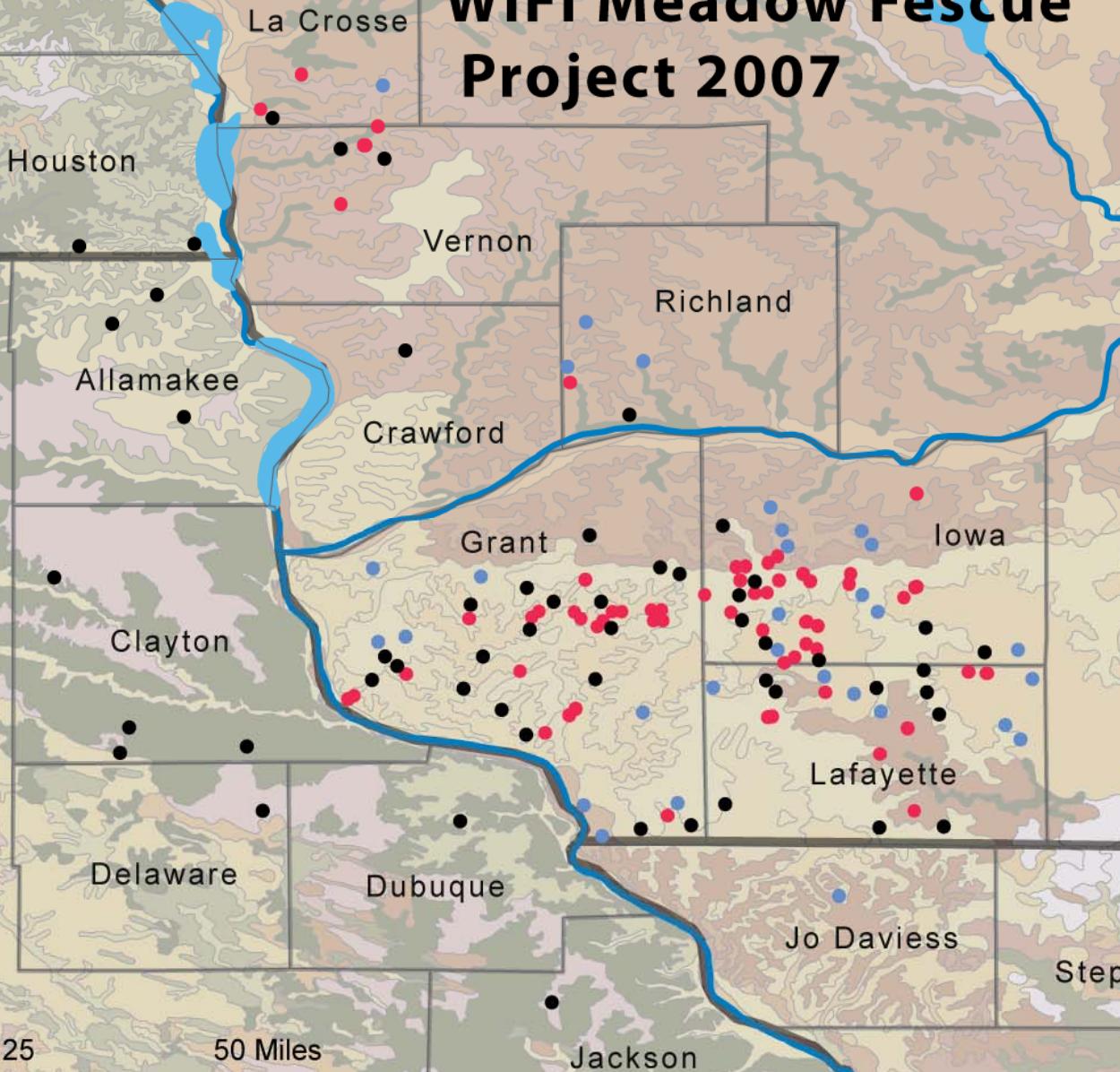


Shoot weight:  
30 days after emergence.



MN

# WIFI Meadow Fescue Project 2007



- Possible MF
- Probable MF
- Collected MF

IA

WI



IL

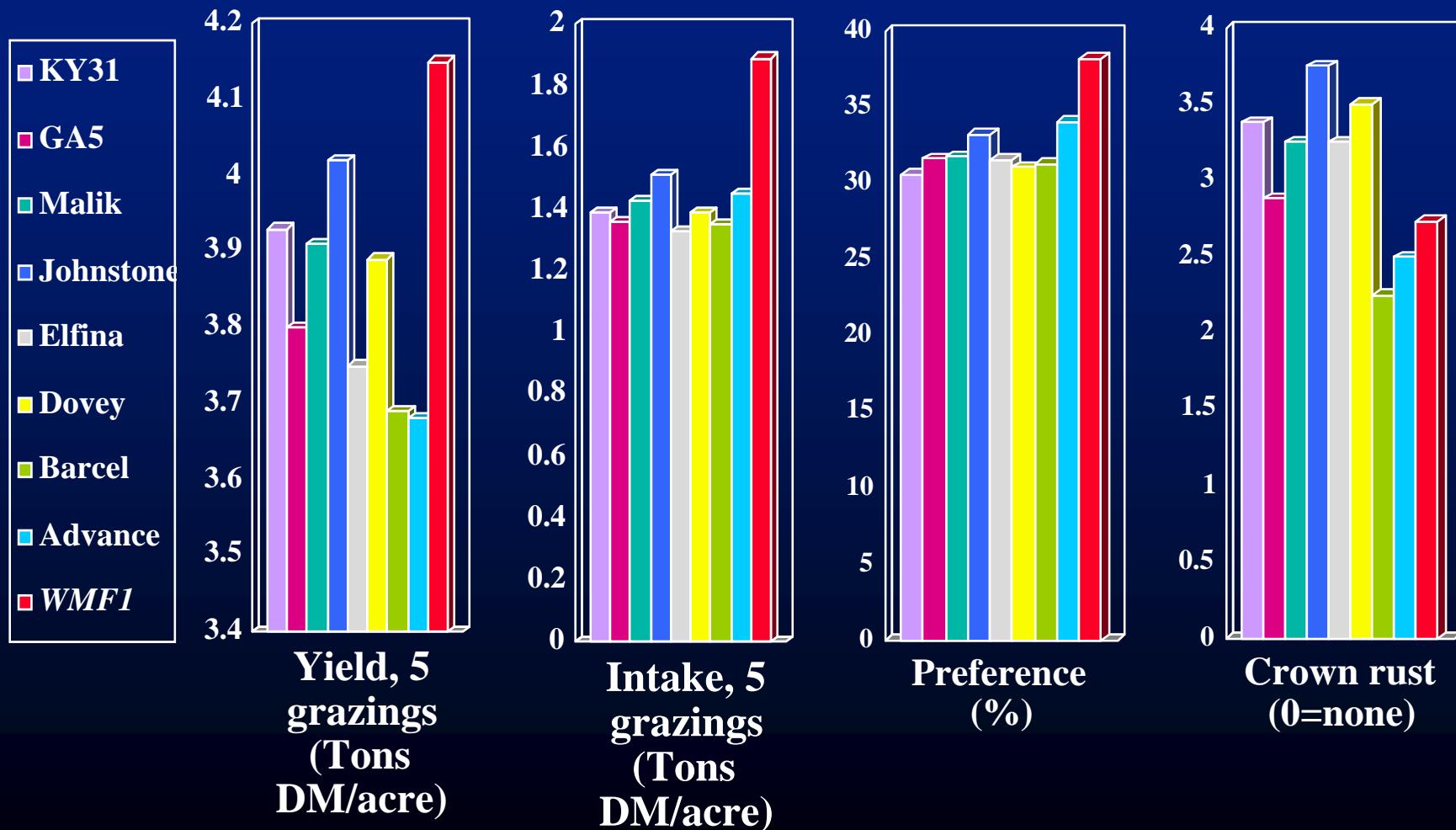
# “Local” Meadow Fescue

---

- Highly palatable, low fiber, high fiber digestibility.
- High levels of drought and cold tolerance.
- There are four subpopulations of meadow fescue within this unglaciated region of the north central USA.
  - Some geographic differentiation within the region.
  - Differential European origins.
  - Multiple introductions occurred over time.

# Meadow Fescue Breeding

WMF1 selected for high forage yield and intake



# 'Spring Green' Festulolium

---

- Meadow fescue x Perennial ryegrass hybrid.
  - Quality & establishment similar to ryegrass.
  - Drought tolerance similar to fescue.
- Selected for winter survival on-farm.
- Tested in 8 states from Minnesota and Iowa to New York and Virginia.
  - 52 vs. 40% survival (31% increase)
  - 3.98 vs. 3.91 T/A (2% increase)

# Freezing Tolerance in Festulolium

---

Variety	Survival at -11°C	Survival in Hardiness Zones 2-4 <sup>+</sup>	Survival in Hardiness Zones 5-7 <sup>*</sup>
	%	%	%
Spring Green	55	52	77
Tandem (parent)	14	37	72
Kemal (parent)	3	43	76

---

<sup>+</sup> Minnesota, Wisconsin, Iowa.

<sup>\*</sup> Kentucky, Ohio, Pennsylvania, Virginia.

# Non-heading Orchardgrass

---

- It flowers too early in the spring.
- Early flowering varieties are by far the most common.



# Non-heading Orchardgrass

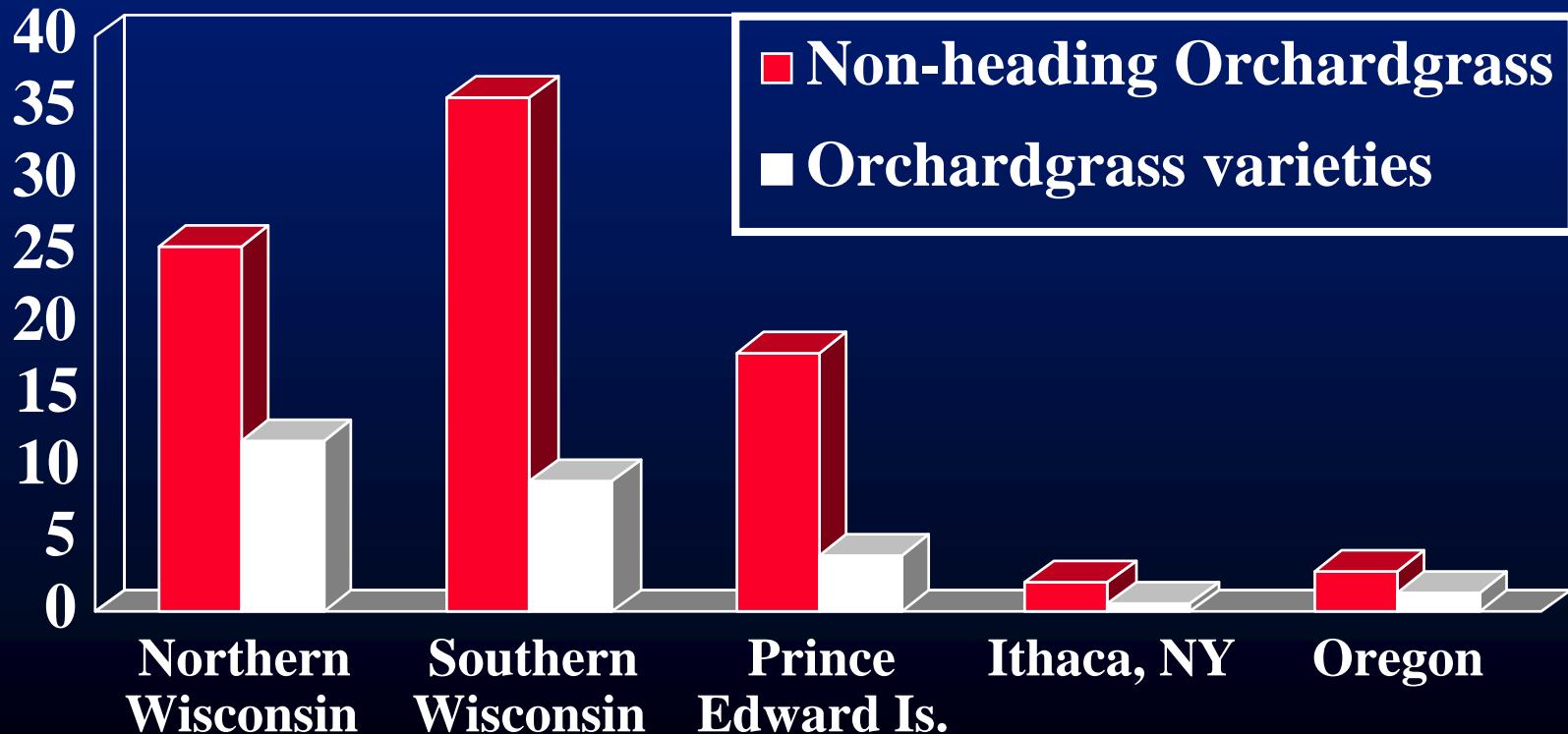
Arne Hovin, Clyde Berg, USDA-ARS, University Park, PA

Jerry Cherney, Cornell Univ.

Yousef Papadopolous, A&AFC, Prince Edward Is.

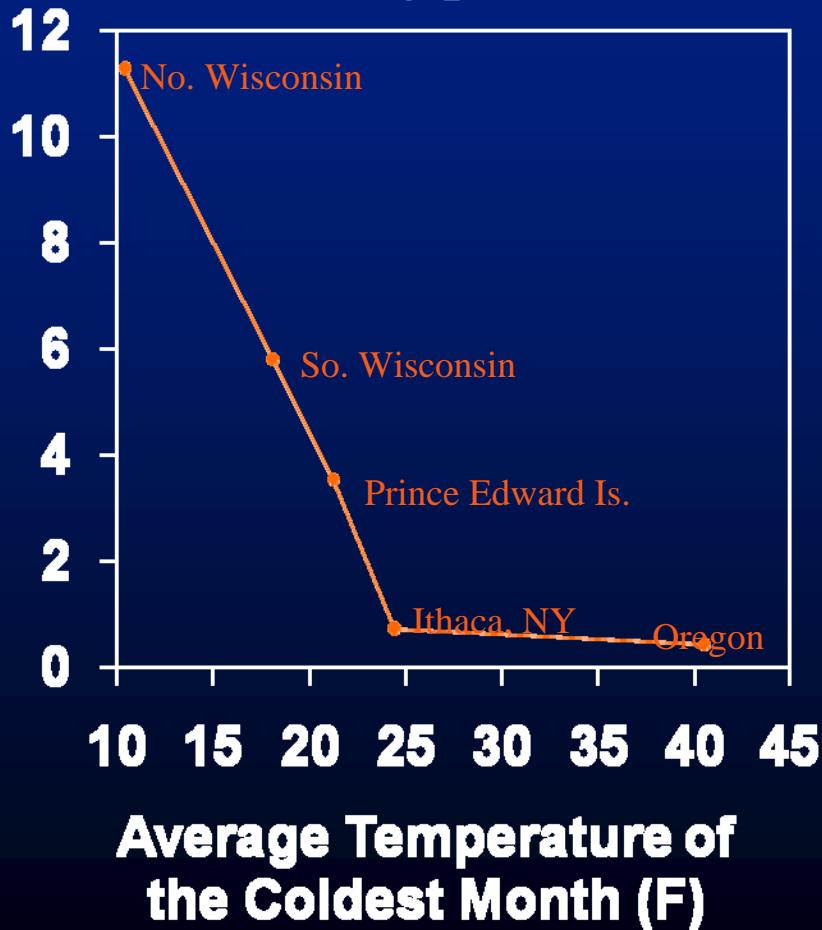
Reed Barker, Richard Johnson, Maria Jendarek, USDA-ARS

Non-heading plants (%)



# Non-heading Orchardgrass

Stable non-heading plants (%)



- Phase I: Completed.
- Phase II: Seed production in Oregon (feasibility)
- Phase III: Forage production and grazing in eastern North America (validation)

# Conclusions

---

- Although many forage breeding objectives require many years of effort, many species can be modified significantly to be adapted to defined management strategies.
- Genetic variation is the foundation of our ability to make significant changes to forage plants - development of an effective and efficient screening method is often the most important limitation to our ability to create these genetic modifications.