SWITCHGRASS FOR BIOMASS ENERGY: STATUS AND PROGRESS

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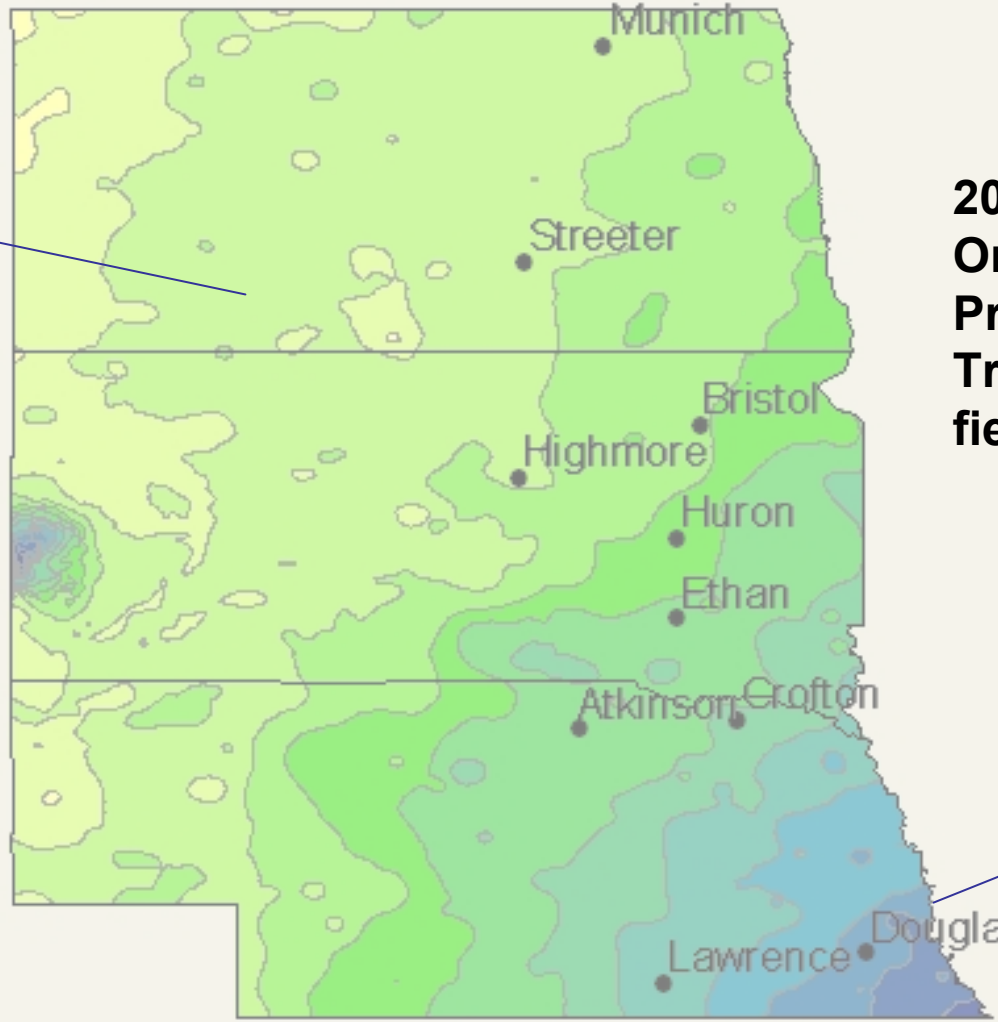
USDA-ARS Forage & Biomass Research Project- Lincoln,NE

- Switchgrass research - 1930's to present.
- Switchgrass domestication – breeding and management.
- Prior to mid-1990's, use by livestock had been emphasized.
- 1990 - began work to develop switchgrass into biofuels crop (DOE cooperative research)

Northern Plains Switchgrass Field Scale Production & Economic Trials

15”-17” Annual Precipitation



2000-2006 On-Farm Production Trials:15-20 acre fields

31”-33” Annual Precipitation

Energy Production in the Great Plains – On farm economic study.

- Field shown at left had a five year cumulative average cost of $30/U.S. ton switchgrass biomass including land costs.
- Average costs for 10 farms was $49/ton; experienced farmer's costs were $36/ton.
- Economic analyses in journal review (UNL Ag Economist)
- Data from trials being used for net energy balance analysis.
- Soils sampled before & after trials – C sequestraion research (ARS Lincoln & Mandan, ND.)

Switchgrass field in NE South Dakota in 2005. Yields averaged 4 tons/acre.

Take Home Lessons

- Economic production efficiency can be improved via research and producer training.
- Improved high yielding cultivars/hybrids with improved conversion efficiency are needed.
- Additional agronomic research on fertility, establishment, seed quality, & other factors.
- Feedstock harvesting and storage research needed.
- Adaptation and production trials in other potential biomass production areas are needed.

Switchgrass biomass energy Current Goals & Research

- Goals
- Full establishment in 1 year with 50% yield.
- Be at full production second year.
- Goal of 10T/A (Midwest); improved ethanol yield/ton.
- Fully documented environmental benefits

- Tools and Products
- Weed control, no-till planting, seed quality.
- Breeding - Biomass specific cultivars & F1 hybrids, improved conversion
- Molecular biology, cell wall modification & seed quality.
- Environ. studies/ C sequestration.

Establishment & Seed Quality

• Establishment weed control with improved herbicides

Improved seed quality & seed quality tests

Biochemical & molecular studies on mechanisms of switchgrass seed dormancy and germination.

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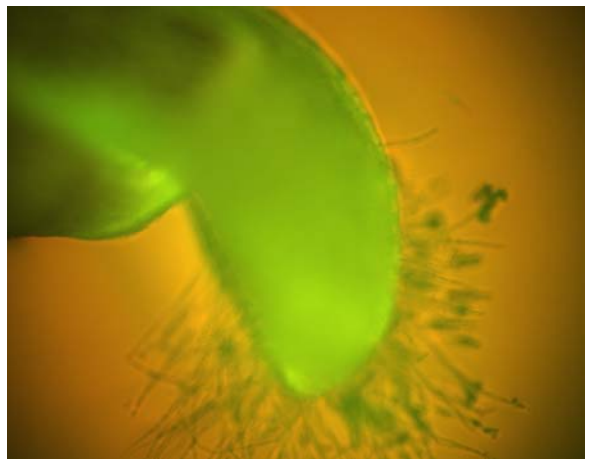
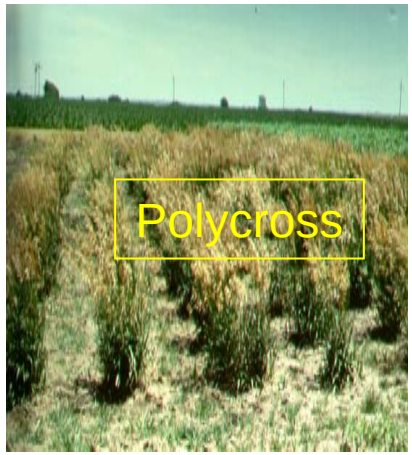
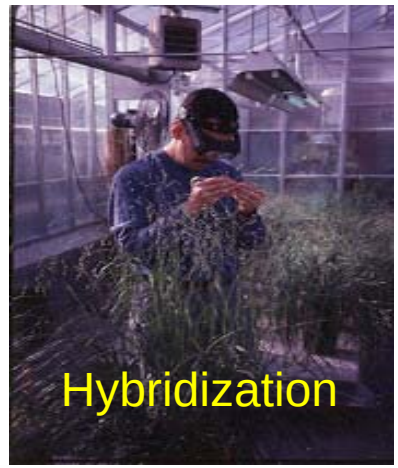


Fluorescence microscopy of switchgrass seeds incubated on FDA for 2 days

(Sarath et al., 2006. Planta 223:1154-1164)

Breeding improved grasses for biomass and grassland production systems: multi-step process.





Breeding Progress for Conventional Switchgrass Cultivars Yield Trial Mead, NE 2003-2005

Cultivar	Year released	Biomass yield (tons/acre)	IVDMD (%) (mature)
Trailblazer	1984	6.3	52.5
Shawnee	1995	6.5	54.8
NE 2000C1	**In seed increase**	**7.4**	**53.8**
NE Late YD C4	**In seed increase**	**7.0**	**55.2**

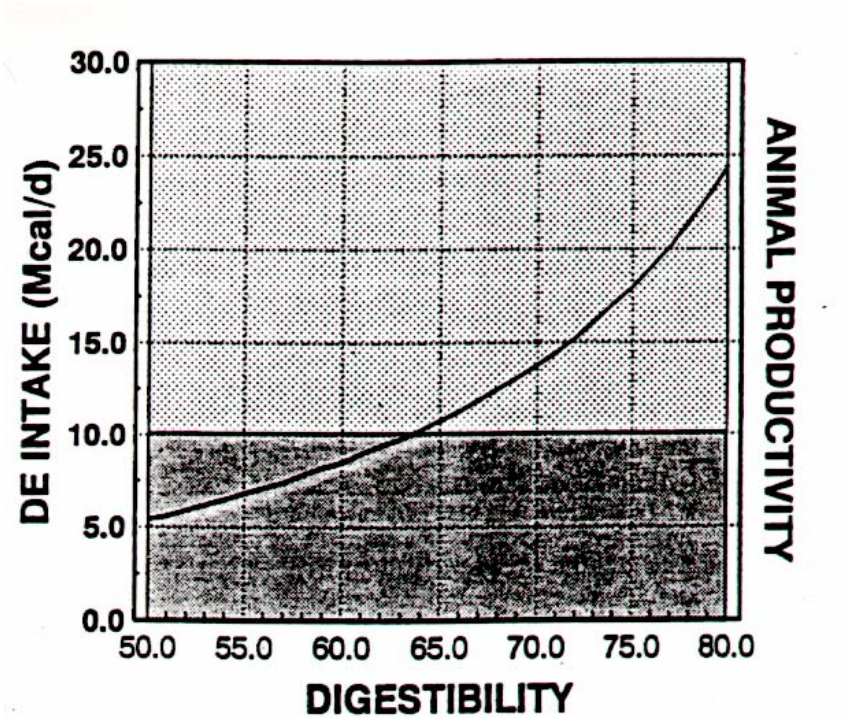
Improve biomass yields – hybrid cultivars

Strain	Yield tons/acre
Kanlow & Summer F1's	9.4
Kanlow	7.1
Summer	6.1

- Improved hybrid cultivars with modified cell walls could improve ethanol yields & reduce costs.

Biorefineries and Biomass Feedstock Quality

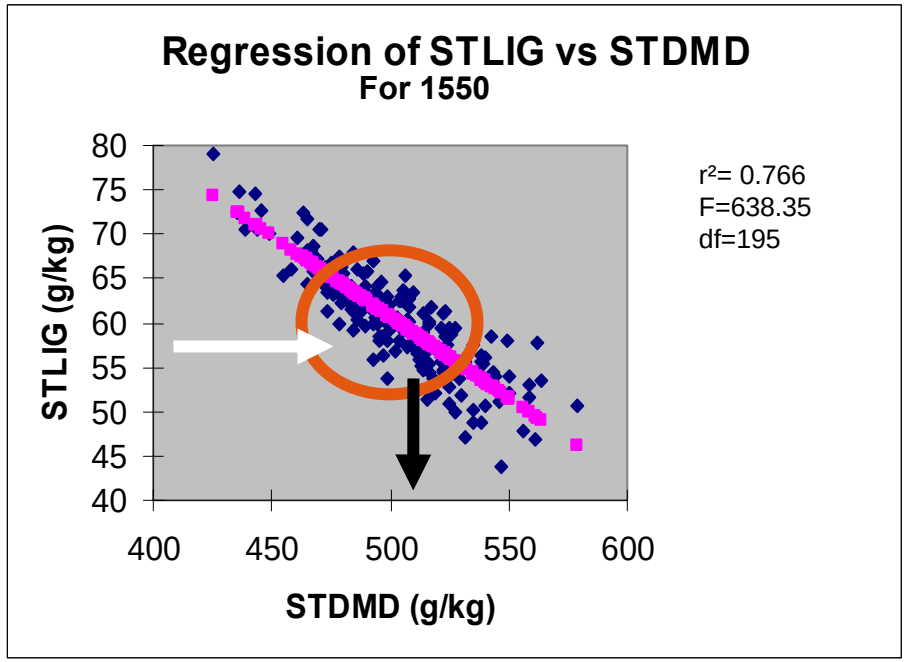
(source: Nebraska Ethanol Board)



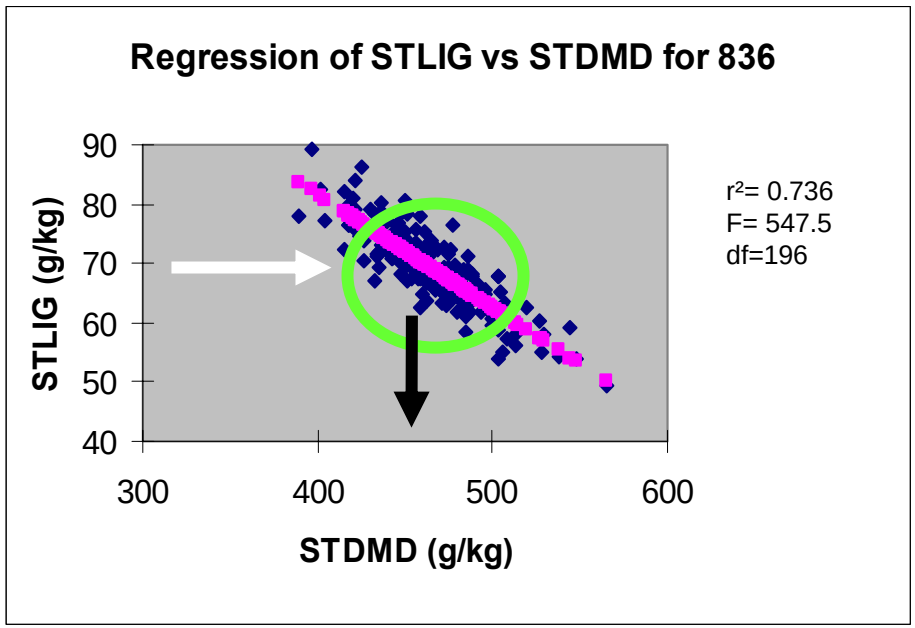
Switchgrass genetic variation in stem lignin (STLIG) & digestibility (STDMD)

Population: 3 cycles for High DMD

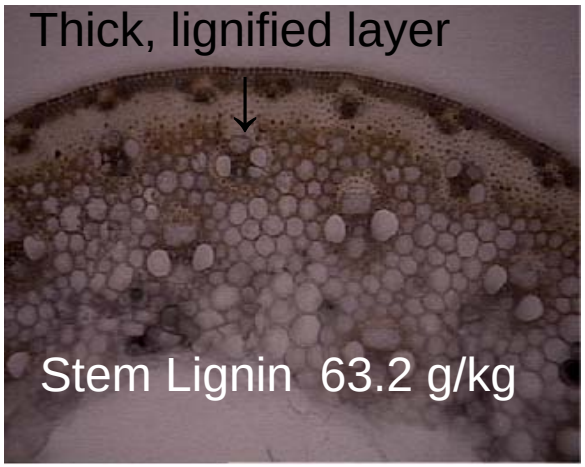
Each graph point is a two year mean of a switchgrass genotype

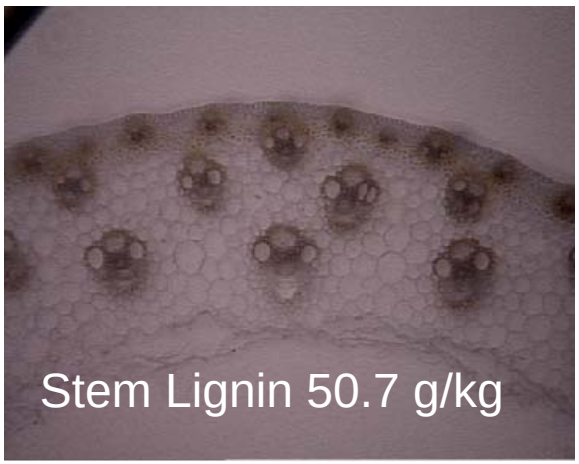


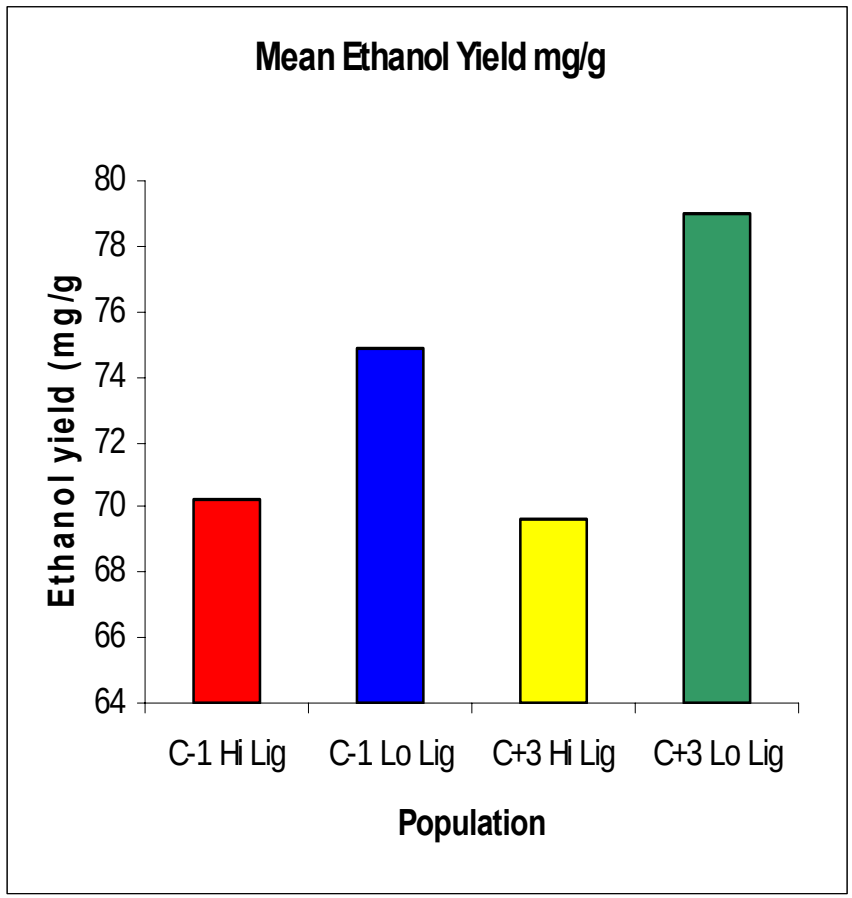
Population: 1 cycle for low DMD



Genetic effects on lignin, anatomy & ethanol yield from switchgrass cellulose

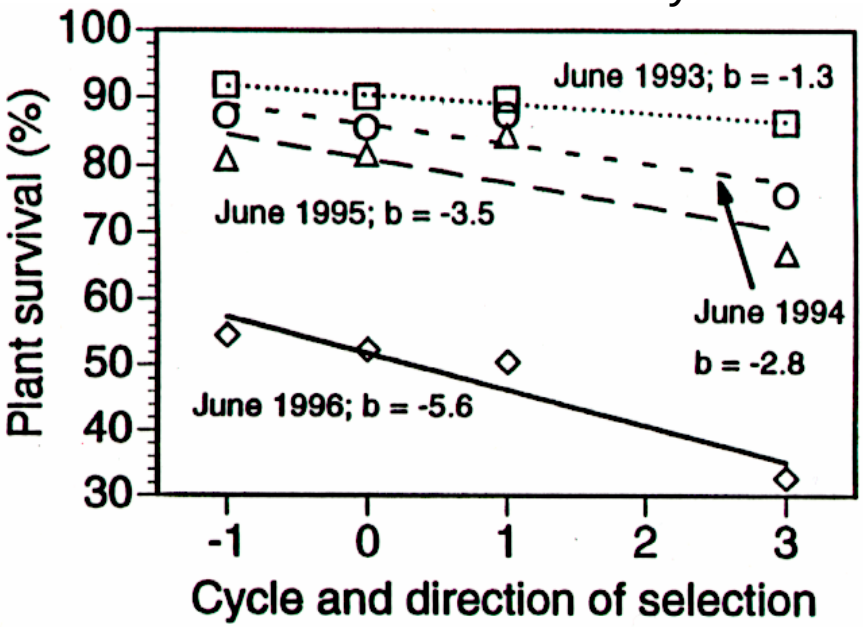






Modification of switchgrass cell walls can have adversely fitness effect – maintaining fitness must be part of improvement strategy.

Results of multi-cycle selection for increased forage digestibility without selection for yield or fitness.



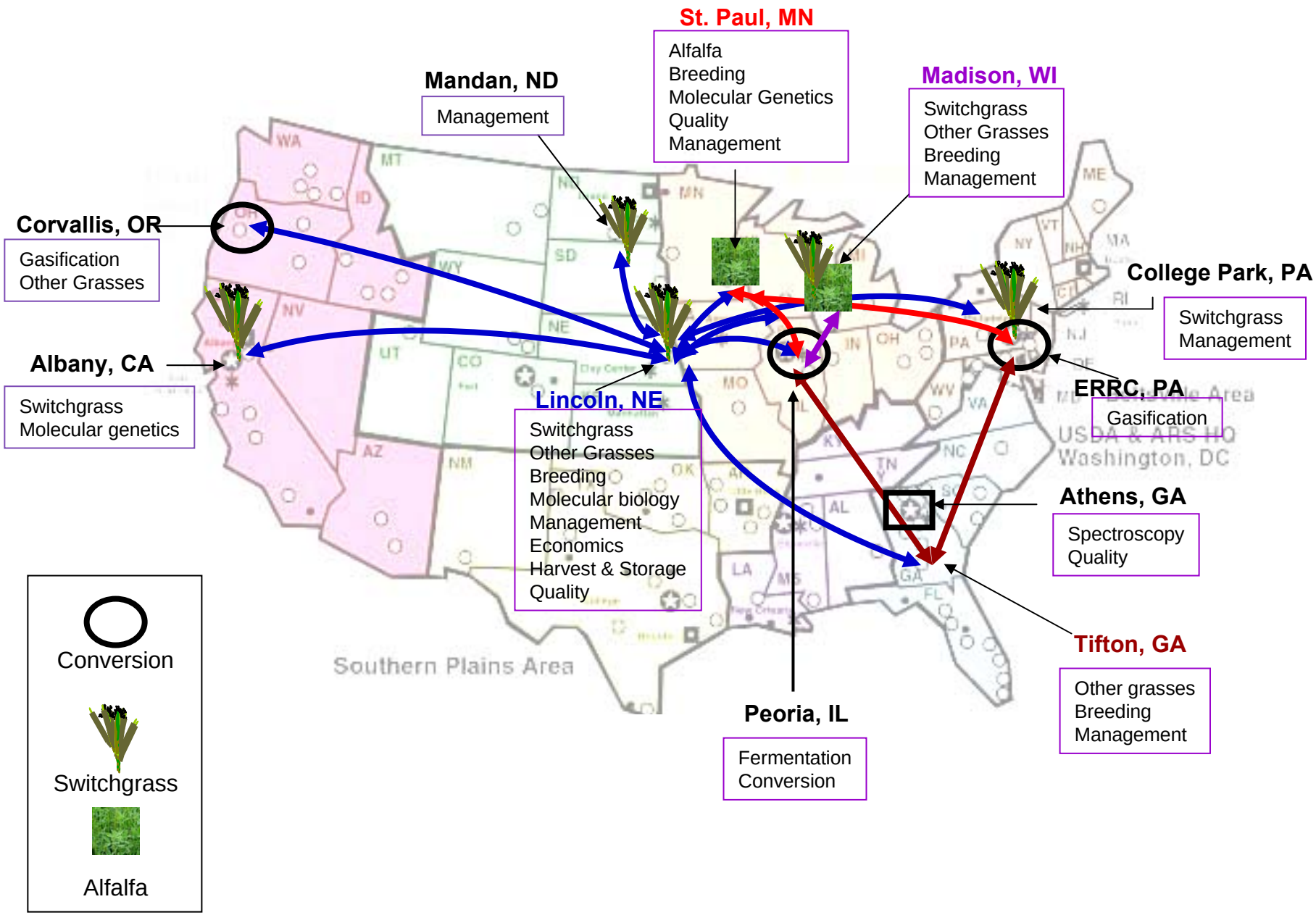
Means from multi-year trials at Mead, NE, Ames, IA, and Madison, WI.

Cycle 3 half-sib family nursery at Mead, NE showing differential winter kill among families.

Carbon sequestration Study- Corn vs Switchgrass, Mead, NE

- Quantify carbon sequestration on cropland converted to switchgrass.
- Compare to no-till corn.
- Ten year experiment in eastern NE established in 1998.
- In 2000, plots split and stover removed (50%) on split half of corn plots.
- Cooperative ARS-Ft. Collins (R. Follett) & NRCS National Soils Lab

ARS Switchgrass and other Herbaceous Bioenergy Crop Research



Bottom Line

- Switchgrass is an economically feasible biomass energy crop for use on marginal cropland.
- Improvements in genetics and agronomics will improve:
  - biomass yields
  - biomass quality
  - conversion
  - ethanol yield per acre