Cornell University
College of Agriculture and Life Sciences

Northeast Sun Grant
Regional Feedstock
Summit 11/11/07

Breeding bioenergy grasses for the Northeast

Hilary Mayton, Julie Hansen, Paul Salon, Jamie Neally, Chris Watkins, and Don Viands

Outline

- Overview Bioenergy Grass Research
- Bioenergy Crop Research
  - cultivar/species evaluation trials
  - seed treatment/quality
  - germplasm collection and screening
- Summary/future work

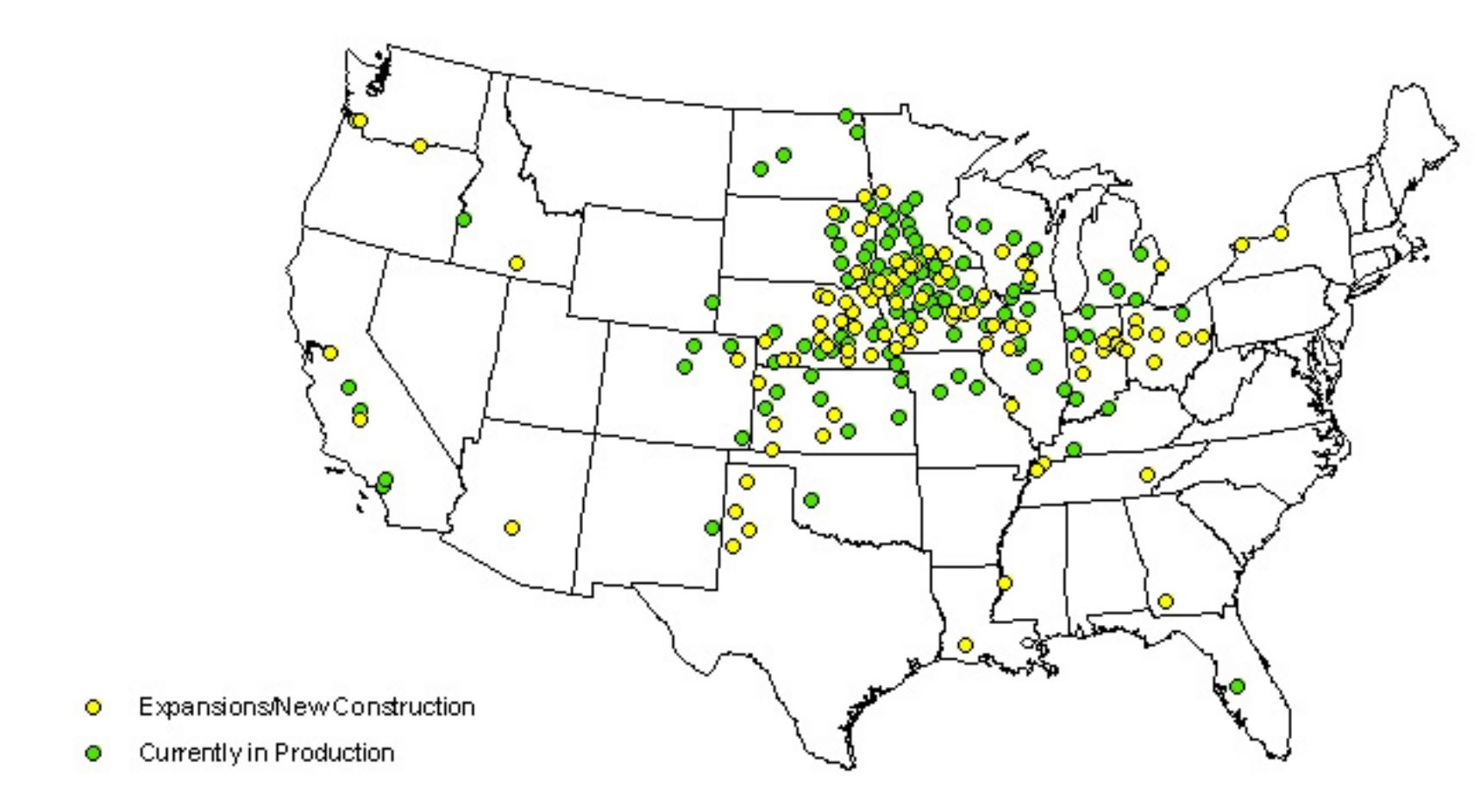
Premier Bioenergy Grass Crops

- Sugar cane – Brazil ~ 5 billion gallons
- Corn –US ~ 6 billion gallons

food vs fuel

sustainability

Ethanol Refineries



Bioenergy Crop Research

- U.S. Department of Energy Bioenergy Feedstock and Development Program
  - Oak Ridge National Laboratory – mid 1970's
    - Woody crops – willow, poplar, sycamore
    - Herbaceous crops - 1992 - switchgrass

native to US

drought tolerant

low nutrient requirements

high biomass production

extensive root system

adaptable diverse regions

Bioenergy Grass Research

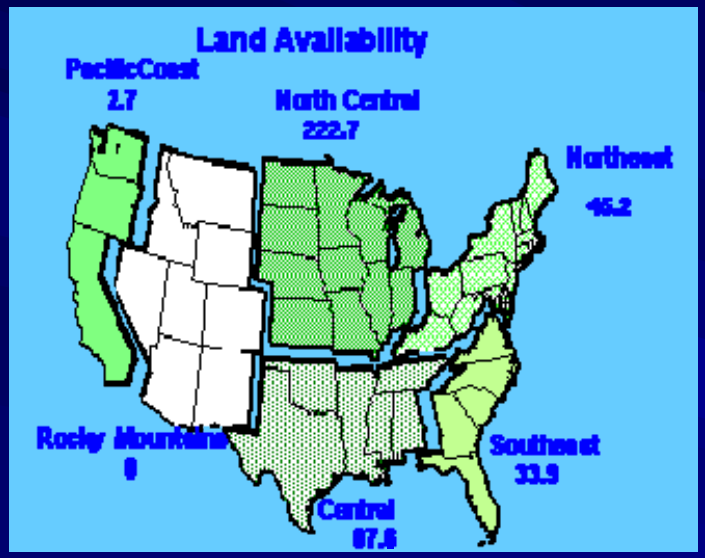
- Switchgrass (*Panicum vergatum* L.) – warm season C_4 perennial – 15-20 years
  - open pollinated genetically diverse
  - two ecotypes
    - lowland – tetraploid – warm moist
    - upland – octoploid – cool dry

Regional Research

North-central
South-central
Midwest
Southeast

- heritability
  - yield
  - quality
  - morphology
- molecular tools
  - markers
  - mapping populations
- breeding/cultivar improvement
  - restricted recurrent phenotypic selection
  - genotypic recurrent selection
  - transformation

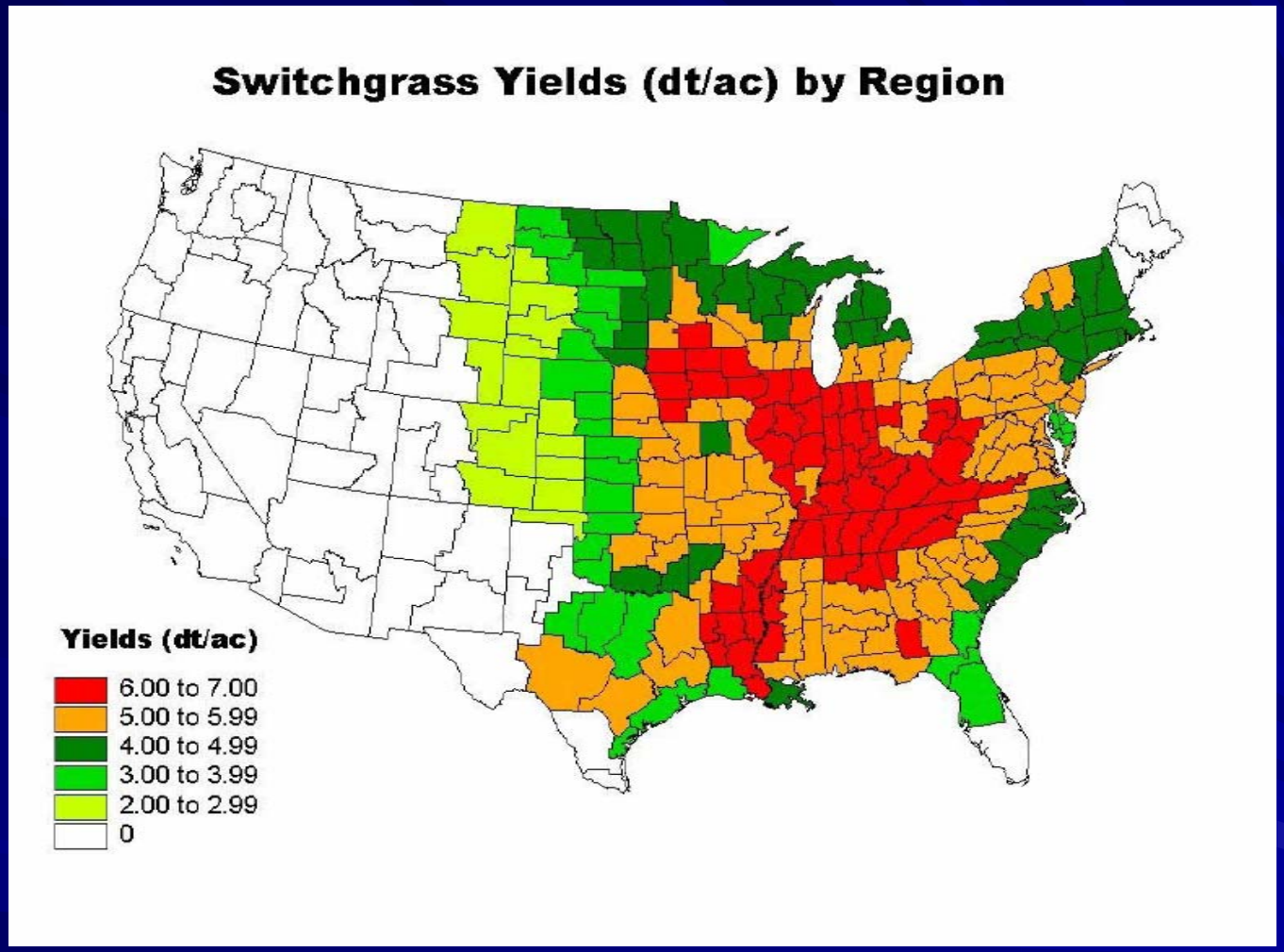
Northeast Land Availability and Potential Biofuel Production



(http://bioenergy.ornl.gov/papers/misc/cropenv.html)

State	Maximum Ethanol Production (gallons)
Connecticut	60,000,000
Delaware	52,000,000
Maine	240,000,000
Maryland	185,000,000
Massachusetts	99,000,000
New Hampshire	42,000,000
New Jersey	135,000,000
New York	1,100,000,000
Pennsylvania	650,000,000
Rhode Island	17,000,000
Vermont	107,000,000
Total	2.7 billion

Donovan and Rybeck, 1994



(http://bioenergy.ornl.gov/papers/misc/cropenv.html)

Outline

- **Overview Bioenergy Grass Research**

- **Bioenergy Crop Research**
  - **cultivar/species evaluation trials**
  - **seed treatment/quality**
  - **germplasm selection**

Cultivar Evaluation Field Trials

- Assess yield and quality in diverse regions
  - BTU's, cellulose, hemicellulose, lignin
- Determine best management practices
  - one cut, two cuts….. herbicide, fertilizer
- Collect data on disease incidence and severity
  - survey, identify pathogens
- Collect economic data
  - seed cost, establishment, maintenance, harvest, storage
- Calculate production costs

Cultivar Evaluation Field Trials

- **Warm season grasses**
  - switchgrass — *Panicum virgatum* L.
  - indiangrass — Sorghastrum nutans L.
  - coastal panicgrass — *Panicum amarulum* A.S. Hitch & Chase
  - big bluestem — *Andropogon gerardii* Vitman
  - eastern gamagrass — *Tripsacum dactyloides* L.
- Cool season grasses
  - reed canarygrass — *Phalaris arundinacea* L.
  - tall wheatgrass — *Thinopyrum ponticum /Elytrigia pontica*
  - brome grass — *Bromus inersis L.*
  - tall fescue — *Festuca arundinacea* L.

▲2007 Replicated plot trials

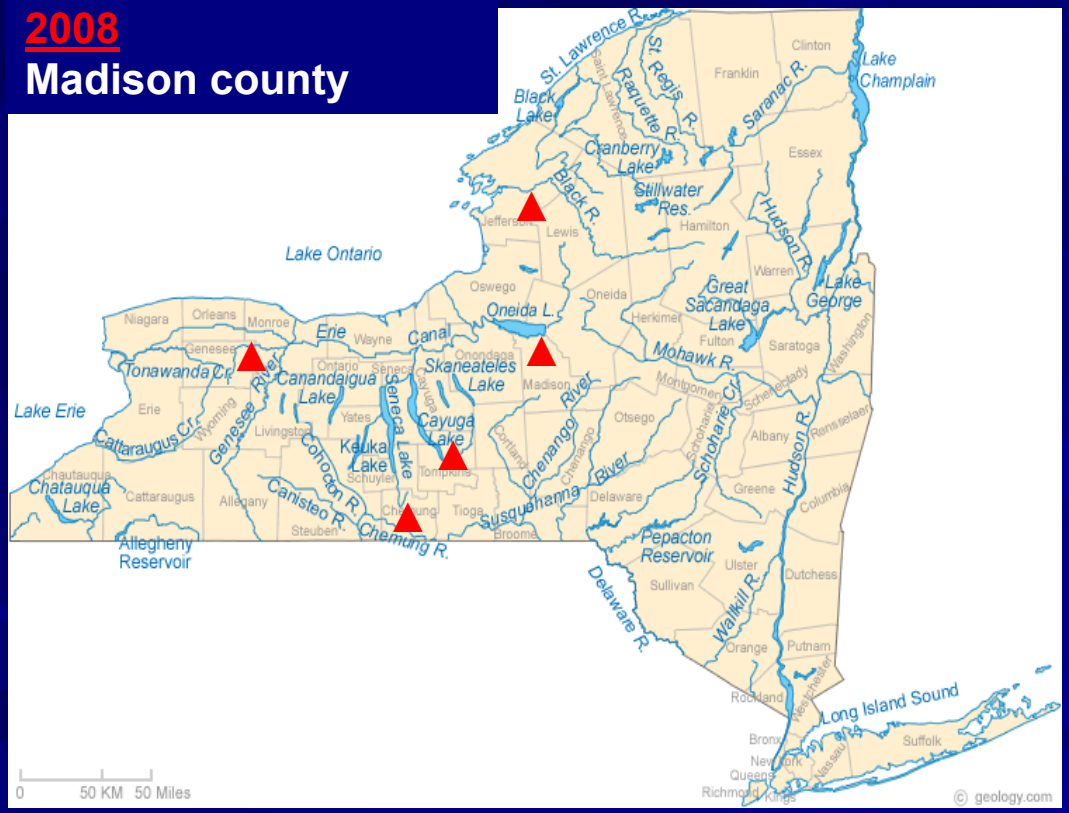
Tompkins County

Chemung County Big Flats NRCS Plant Materials Center

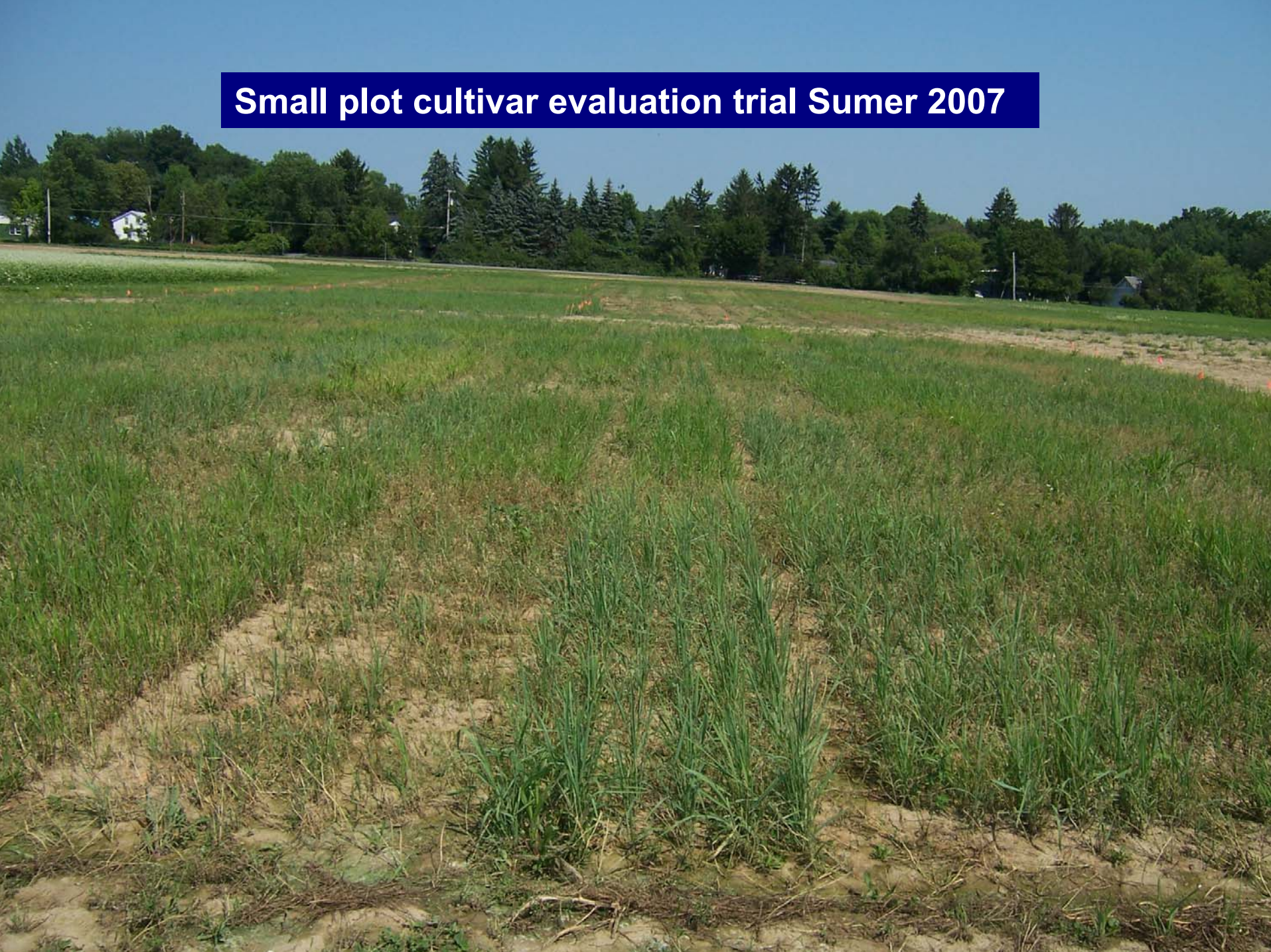
Jefferson County

Genesee County

2008
Madison county



Entry	Cultivar	Common name
1	Bonanza	big bluestem
2	Goldmine	big bluestem
3	Niagara	big bluestem
4	Atlantic	coastal panic grass
5	Pete	E.gamagrass
6	Blackwell	switchgrass
7	Carthage	switchgrass
8	Cave-in-rock	switchgrass
9	Cave-in-rock	switchgrass
10	Forestburg	switchgrass
11	Kanlow	switchgrass
12	Pathfinder	switchgrass
13	Shawnee	switchgrass
14	Shelter	switchgrass
15	Sunburst	switchgrass
16	Trailblazer	switchgrass
17	Nebraska 54	indiangrass
18	Nebraska 28	switchgrass
19	Rumsey	indiangrass
20	Pawnee	big bluestem
21	Mixtures-1	Cave-in-rock switchgrass Bonanza big bluestem
22	Mixtures-2	Sunburst switchgrass Niagara big bluestem
23	Mixtures-3	Cave-in-rock switchgrass Pete E.gamagrass
24	Mixtures-4	Niagara big bluestem Pete E.gamagrass


Small plot cultivar evaluation trial Sumer 2007

Small plot cultivar evaluation trial Sumer 2007

Small plot cultivar evaluation trial Fall 2007

Small Plot Trials 1st Year Establishment

% Stand New York County Trial Locations

Cultivar	Chemung	Genesee	Jefferson	Tompkins
Blackwell	91	87	80	88
Cave-in-rock	77	68	83	81
Forestburg	74	64	70	75
Carthage	74	mixture 1 (64)	Shawnee (75)	mixture 1 (73)
Shelter	71	63	83	72
Total	47	34	64	47

mixture 1 – Cave-in-rock (switchgrass) and Bonanza (big bluestem)

2007 Field Trials

■ 2007 Warm season grass strip trial locations

Dutchess

Genesee

St. Lawrence

Tompkins

■ 2008 Strip trial potential locations

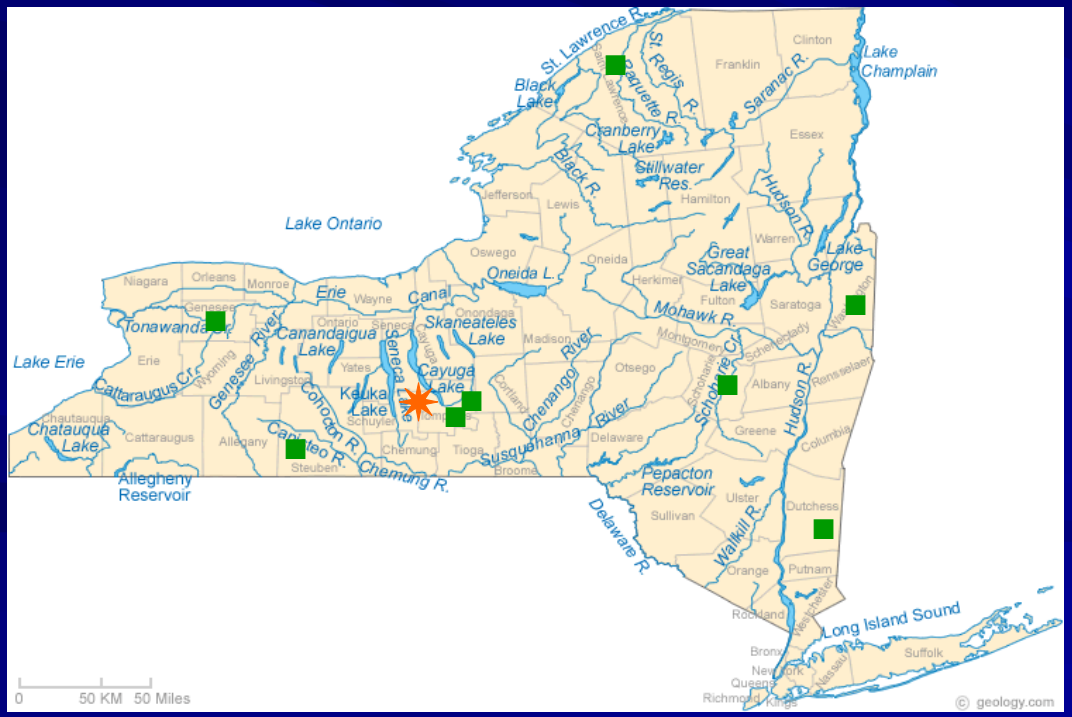
Tompkins

Schoharie County

Washington County

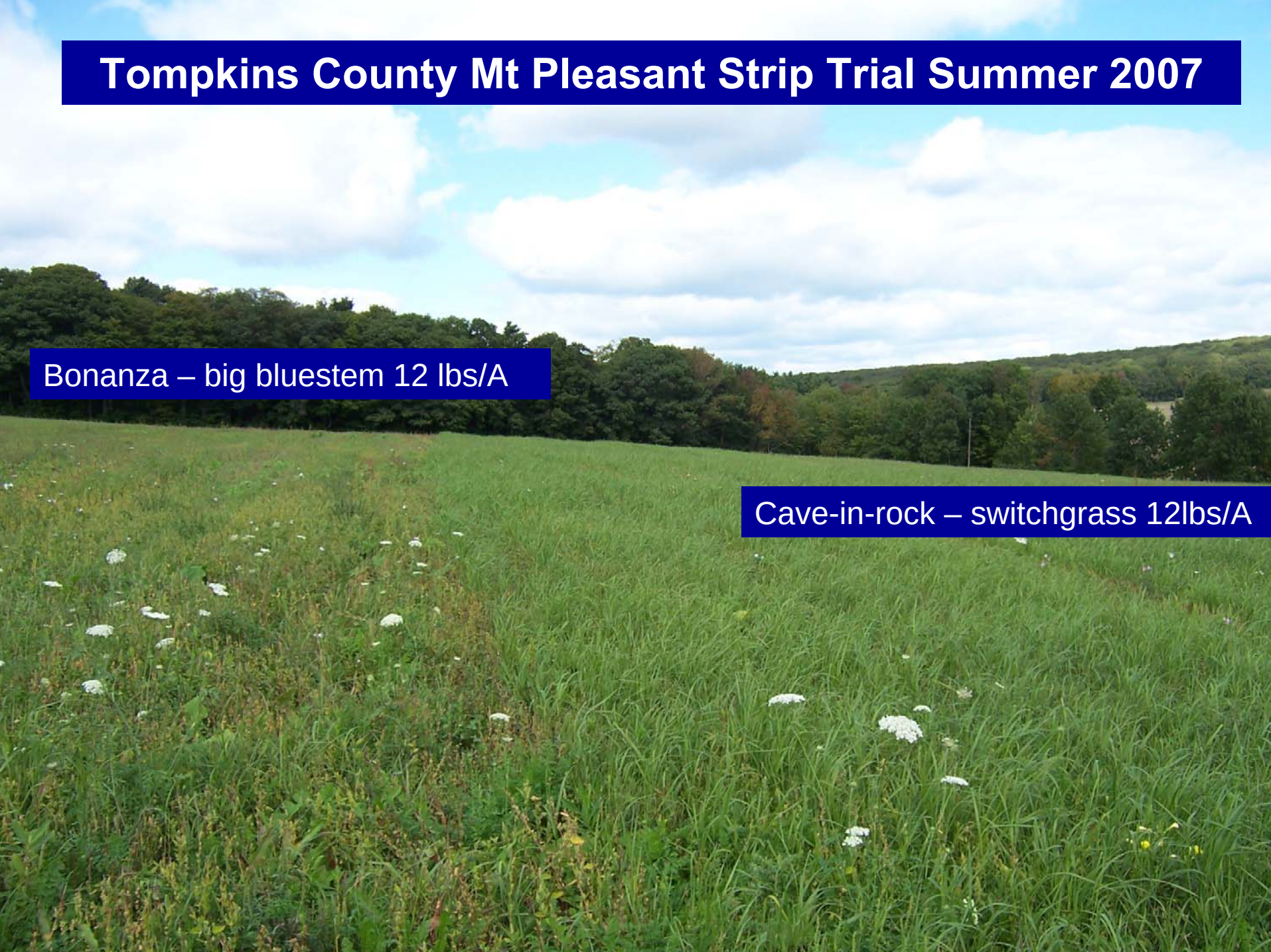
Steuben

Cultivar	Common name
Bonanza	big bluestem
Niagara	big bluestem
Atlantic	coastal panic grass
Pete	E.gamagrass
Carthage	switchgrass
Cave-in-rock	switchgrass
Sunburst	switchgrass
Trailblazer	switchgrass
Nebraska 54	indiangrass
Mixtures-1	Cave-in-rock switchgrass-Bonanza big bluestem
Mixtures-2	Sunburst switchgrass -Niagara big bluestem
Mixtures-3	Cave-in-rock switchgrass - Pete E.gamagrass
Mixtures-4	Niagara big bluestem-Pete E.gamagrass



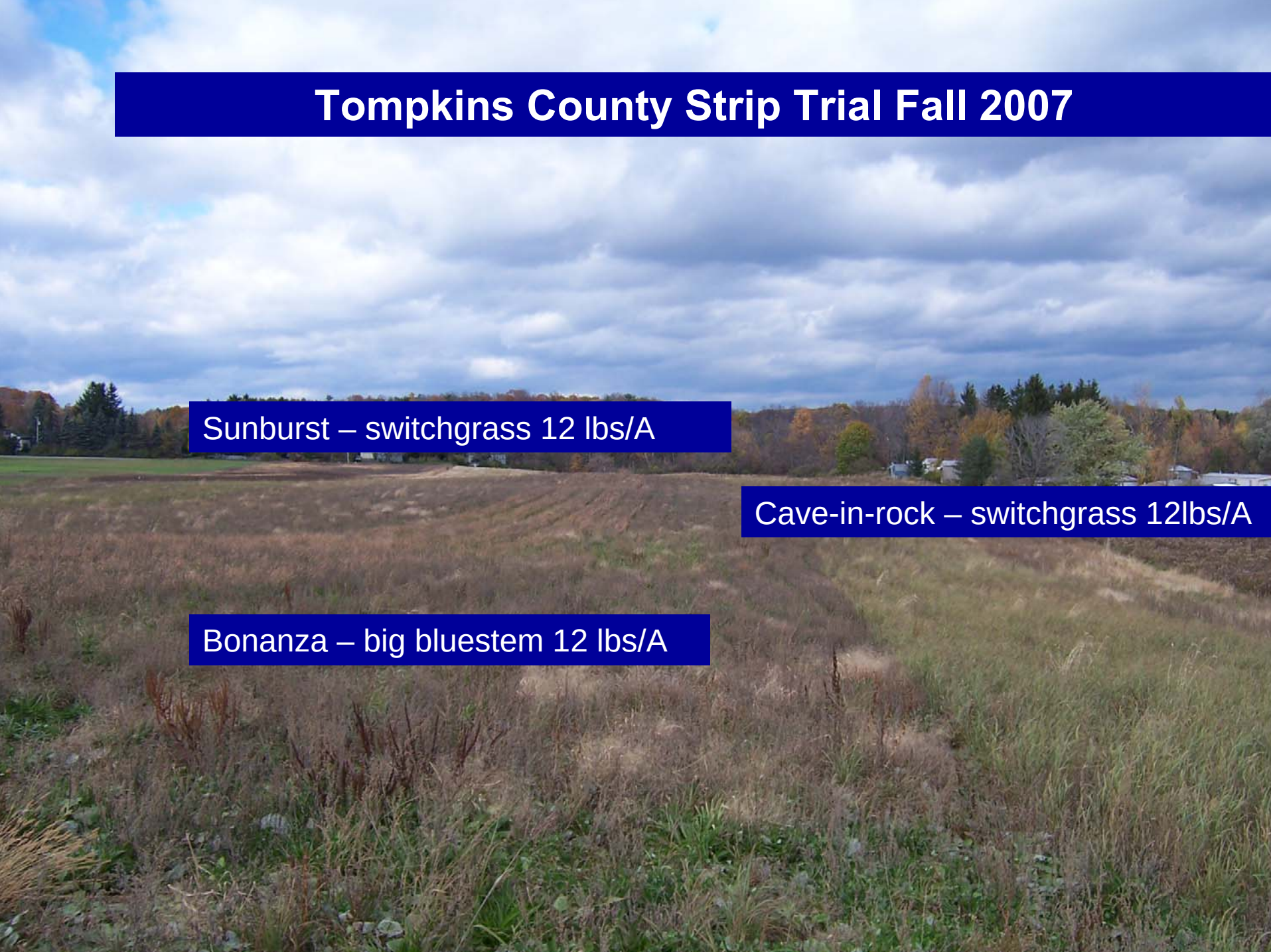
✷ 28 acres - Sun Center Laboratories, Cornell University

Tompkins County Mt Pleasant Strip Trial Summer 2007

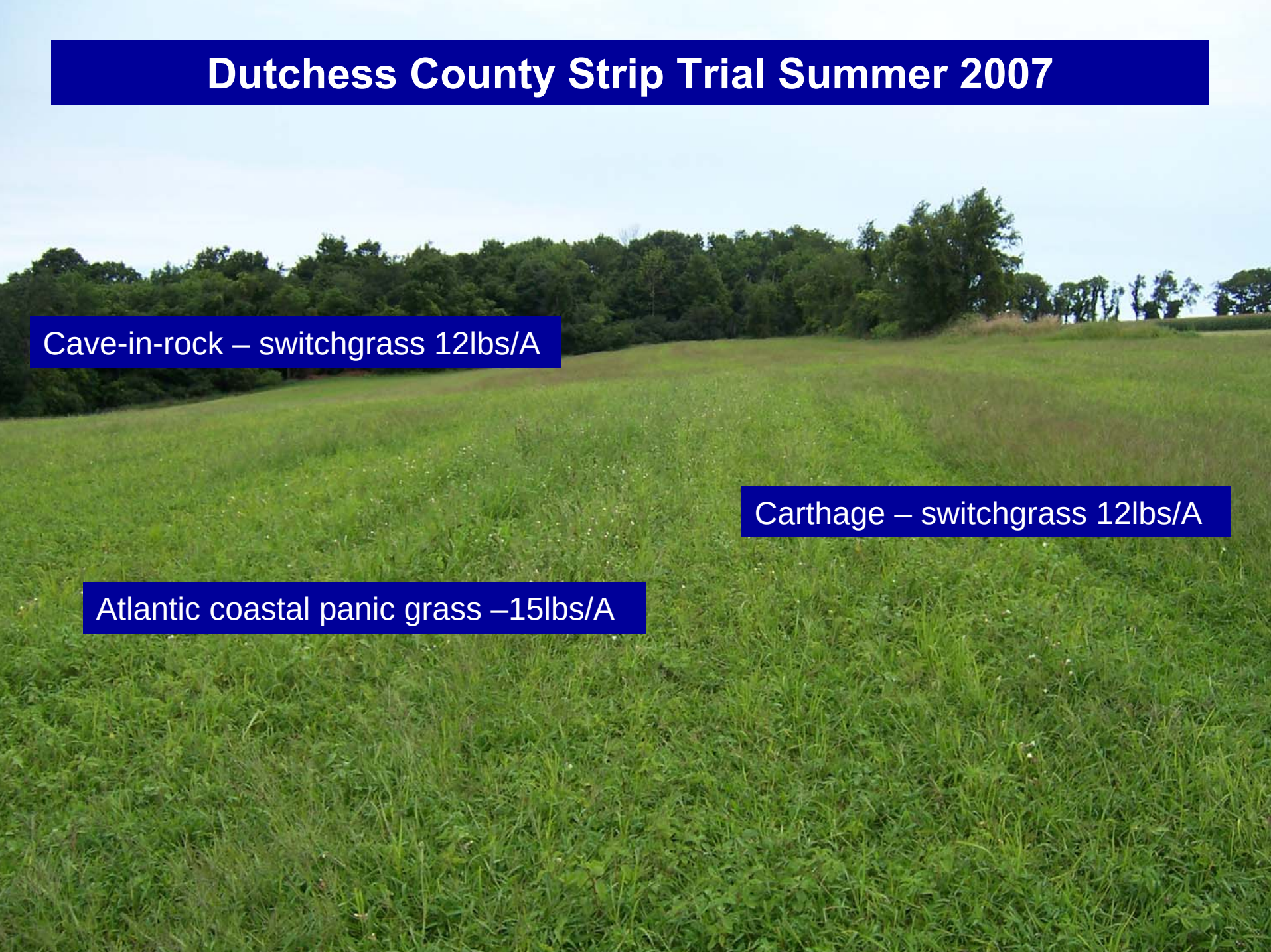


Tompkins County Mt Pleasant Strip Trial Fall 2007

Tompkins County Strip Trial Fall 2007



Dutchess County Strip Trial Summer 2007



Genesee County Strip Trial Summer 2007

♦ 2007 Cool season grass trials

Tompkins County

Chemung County Big Flats
NRCS Plant Materials Center

# Entries	Cultivar	Common Name
1	Alkar	wheatgrass
2	Jose	wheatgrass
3	Largo	wheatgrass
4	Alkar	wheatgrass
5	Enhance	tall fescue
6	Bull	tall fescue
7	Bellevue	reed canarygrass
8	Chiefton	reed canarygrass
9	Peak	bromegrass
10	York	bromegrass

Outline

- **Overview Bioenergy Grass Research**

- **Bioenergy Crop Research Northeast**

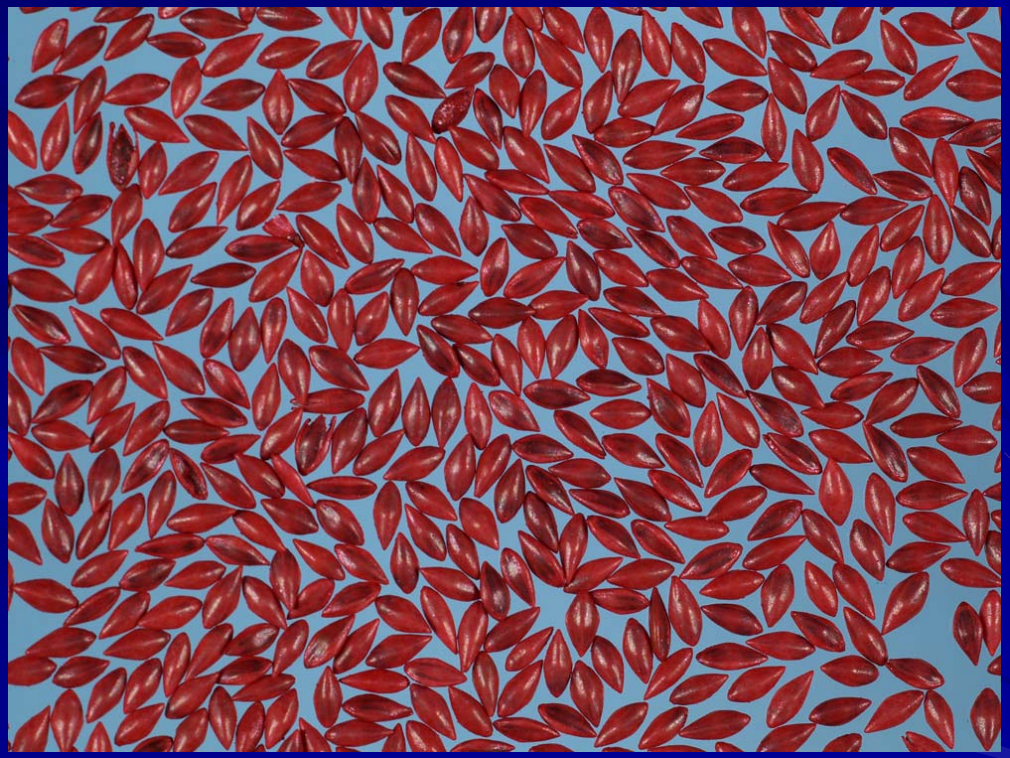
  cultivar/species evaluation trials
  seed treatment/quality
  germplasm selection

Switchgrass Seed Treatment Trial

- **Only Captan and Thiram are currently labeled**

- **New chemistry seed treatment fungicides**
  - **Raxil (Tebuconazole)**
  - **Dividend (Difenoconazole)**

- **Biological seed treatments**
  - **T-22(*Trichoderma harzianum*)**
  - **Bacillus spp. (TrigoCor 1448)**



Dr. Alan Taylor, Dept Horticulture Cornell University, Geneva, NY

Dr. Gary Bergstrom, Dept Plant Pathology, Cornell University, Ithaca, NY

2007 Field Trials

- **2007 Seed treatment trials**

Tompkins County
Chemung County Big Flats
NRCS Plant Materials Center

Trmts	Switchgrass	Seed Treatment
1	Sunburst	No Trt
2	Sunburst	Dividend Extreme
3	Sunburst	Raxil XT
4	Sunburst	Thiram 42S
5	Sunburst	T-22
6	Sunburst	Trigo Cor 1448
7	Shawnee	No Trt
8	Shawnee	Dividend Extreme
9	Shawnee	Raxil XT
10	Shawnee	Thiram 42S
11	Shawnee	T-22
12	Shawnee	TrigoCor 1448

Outline

- **Overview Bioenergy Grass Research**

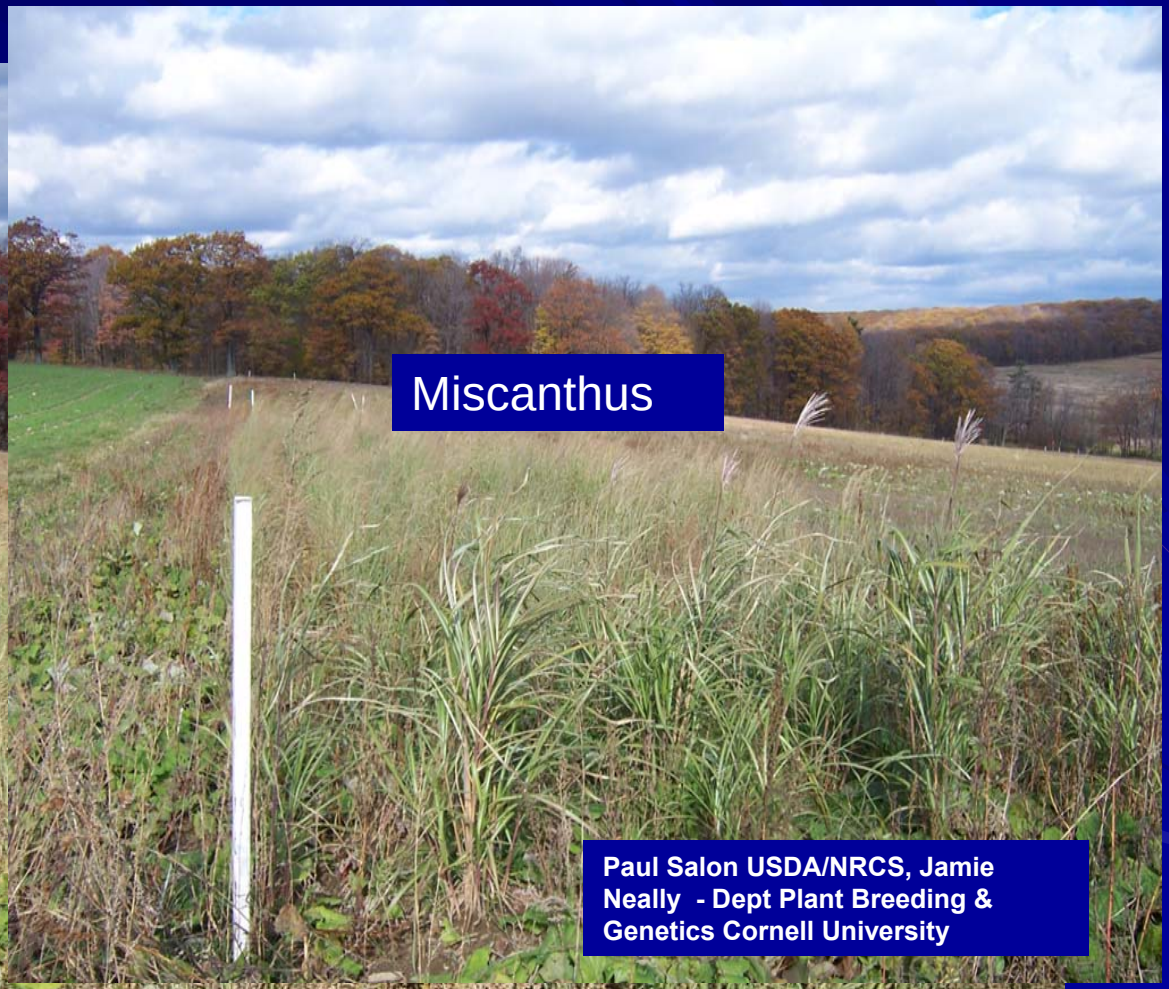
- **Bioenergy Crop Research Northeast**

  cultivar/species evaluation trials
  seed treatment/quality
  germplasm selection

Germplasm populations from Southern sources

evaluate for winter hardiness

selections 2008



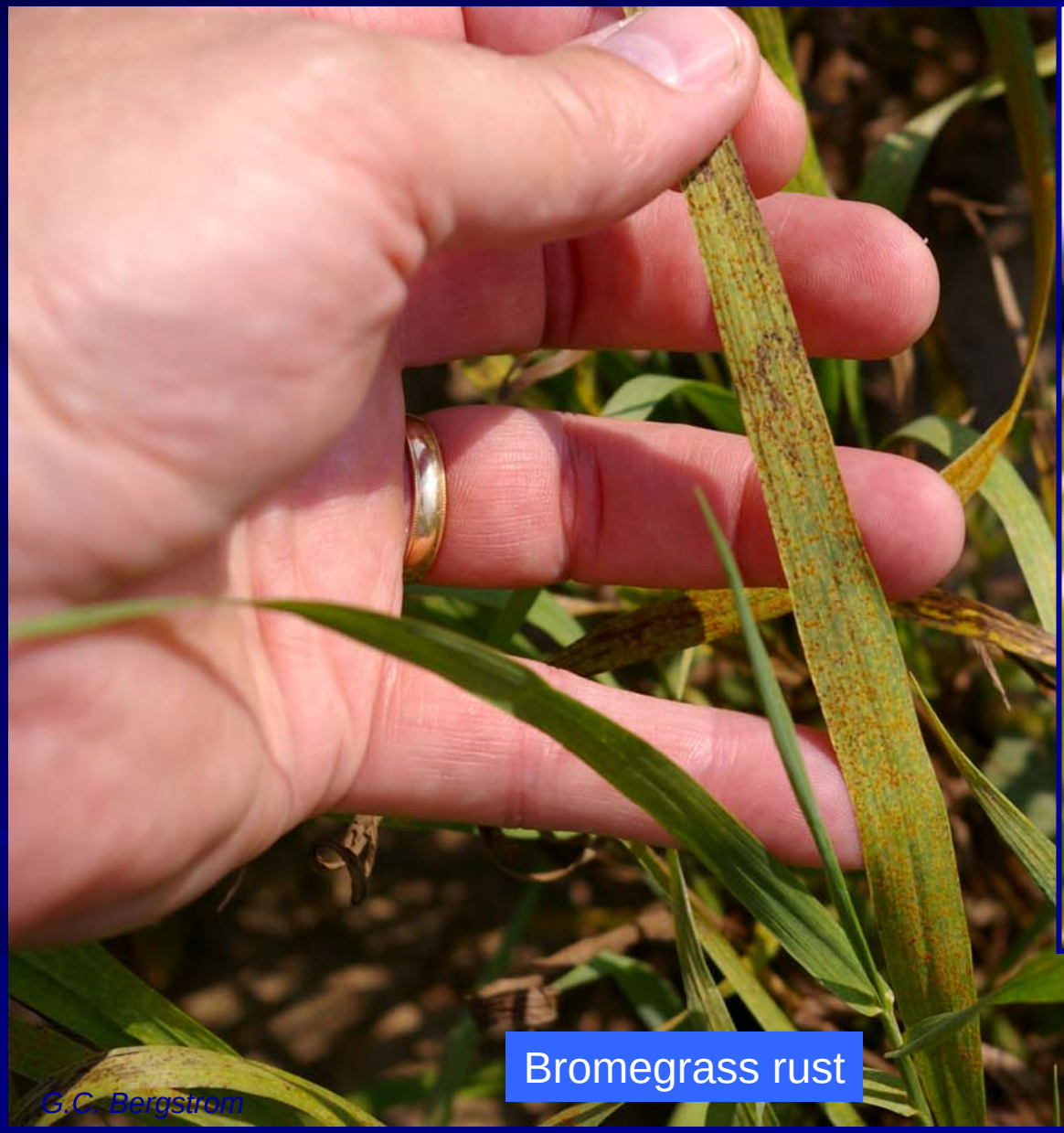
Paul Salon USDA/NRCS, Jamie Neally - Dept Plant Breeding & Genetics Cornell University

Initial Observations

Smut fungi

Leaf spot fungi

Rust fungi


Bromegrass rust
G.C. Bergstrom

Eastern gammagrass rust
G.C. Bergstrom

Overall Objective

Determine what is achievable.

- How much land is available in the Northeast for bioenergy crop production?
  - plant, harvest, transport, convert to biofuel products
- Biomass production?
- Potential for improvement?
  - plant breeding, management
- Cost?

Acknowledgements

Funding

New York Farm Viability Institute, Northern New York Agricultural Development Program, College of Agriculture and Life Sciences, Cornell University