Marginal lands in the Great Plains and Midwest

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Concern for Marginal Land is not New

"In its various applications, the word marginal has perhaps been too glibly used in recent years. As frequently employed, the phrase 'marginal land' is little more than a convenient expression for land that is barren, rough, inaccessible, or possessed of other undesirable characteristics or relationships."

Peterson and Galbraith 1932

Marginal lands in the Great Plains and Midwest

1. What is marginal land & why is it marginal?
2. What are the sustainability concerns?

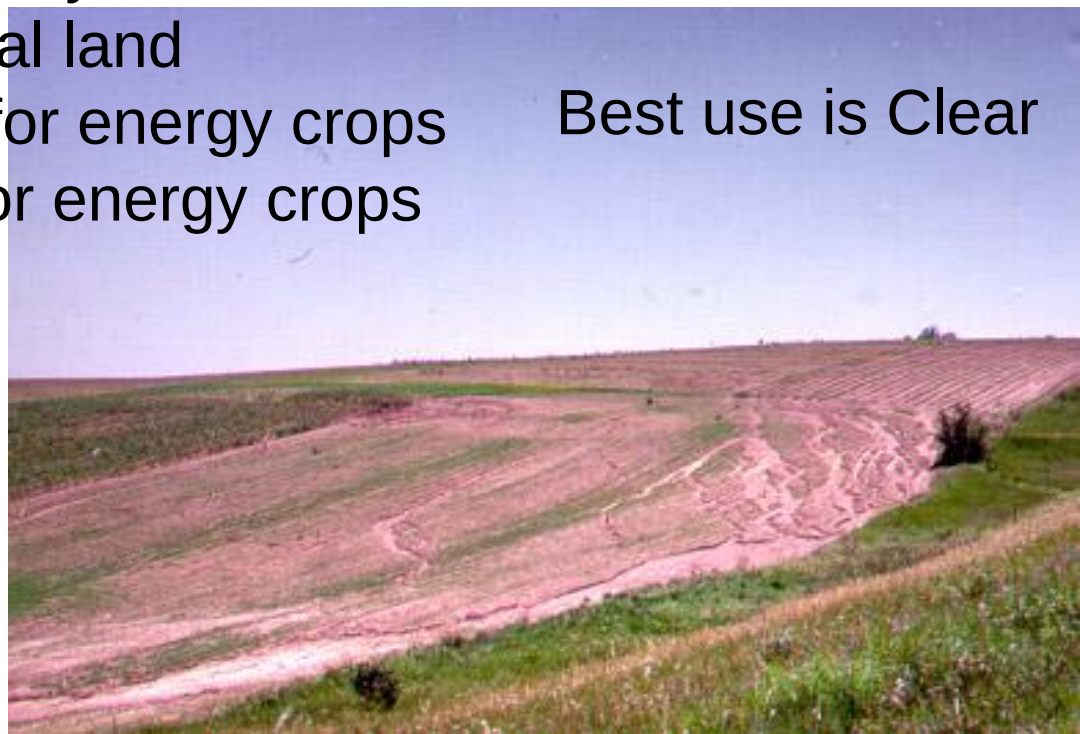
What is Marginal Land?

“Recent years have witnessed a growing interest in the possibilities of a more rational use of land resources in the United States…. The focal point of this interest in land use has in the past, and will probably continue in the future to be not on fertile or favorably situated areas, the agricultural use of which no one questions, but on those areas of such physical character or situation that the returns to production are either meager or precarious.”

Peterson and Galbraith 1932

What is Marginal Land?

- Marginal land is broad and often non-specific
- Werling et al. (2014) - farmland that is suboptimal for food crops
- Shortall (2013) used 3 separate definitions:
    1. land unsuitable for food production
    2. ambiguous lower quality land
    3. economically marginal land
    - 1 & 2 should be used for energy crops
    - 3 is likely to be used for energy crops



What is Marginal Land & Why is it Marginal?

- Examples of physical characteristics of marginal land
  - Size (small) or shape
  - Shallow soils
  - High erosion potential
  - Poor drainage
  - Soil characteristics (texture, pH, etc.)
  - Non-irrigated areas within irrigated fields
- Production based – land with long-term corn yields that are at least 25% below the county-wide average corn yield
- Marginal land does not need to be defined for the farmer
- May pose a conundrum for farmers – farming land that won't make a crop to collect crop insurance results in financial & ecosystem losses – other markets are needed

Sustainability Concerns with Marginal Land

- Economically ‘Best’ may not be sustainable & may result in environmental issues
- Environmentally ‘Best’ may not pay the bills

Sustainability Concerns with Marginal Land

Grasslands converted to annual crops: In the WCB, conversion has been concentrated on marginal lands characterized by high erosion potential, shallow soils, poor drainage, & less suitable climates for corn/soybean production.

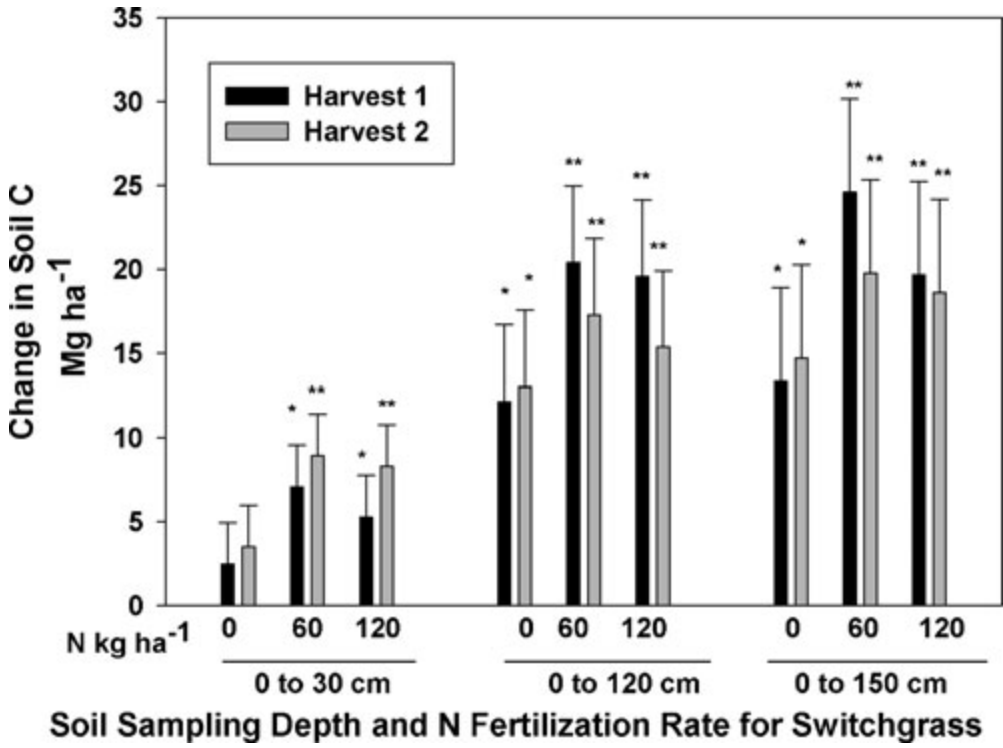
Wright & Wimberly 2013. PNAS

State	Grass to CS	CS to Grass	Grass net loss
	---------- hectares ----------		
ND	129,000	40,000	89,000
SD	256,000	73,000	182,000
MN	92,000	13,000	80,000
IA	195,000	42,000	152,000
NE	125,000	100,000	25,000
Total	797,000	268,000	**528,000**

Sustainability Concerns with Marginal Land Carbon Sequestration

<u>10-Year Study @ Mead, NE</u>

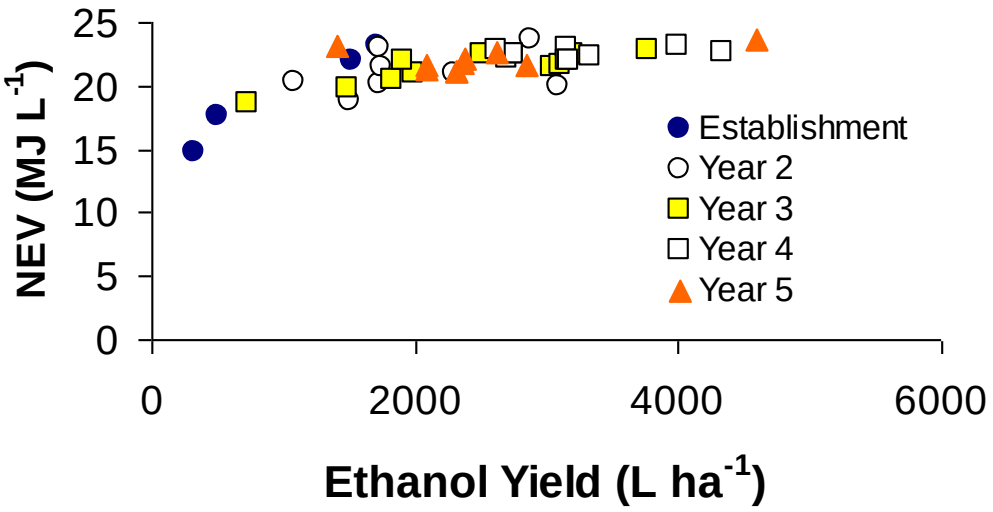
- 120 kg ha^{-1} N rate harvested after a killing frost had the greatest switchgrass biomass for the 10-y period with 5.1 tons acre^{-1} year^{-1}.
- Average annual SOC increase to 5' depth was 1 ton acre^{-1} year^{-1}.
- Two recent papers assumed average annual soil C storage rates for perennial grasses to be 0.12 to 0.25 tons acre^{-1} year^{-1}.
- Demonstrates the importance of sampling soil to 5' depth.



Follett et al. 2012 – Bioenergy Research

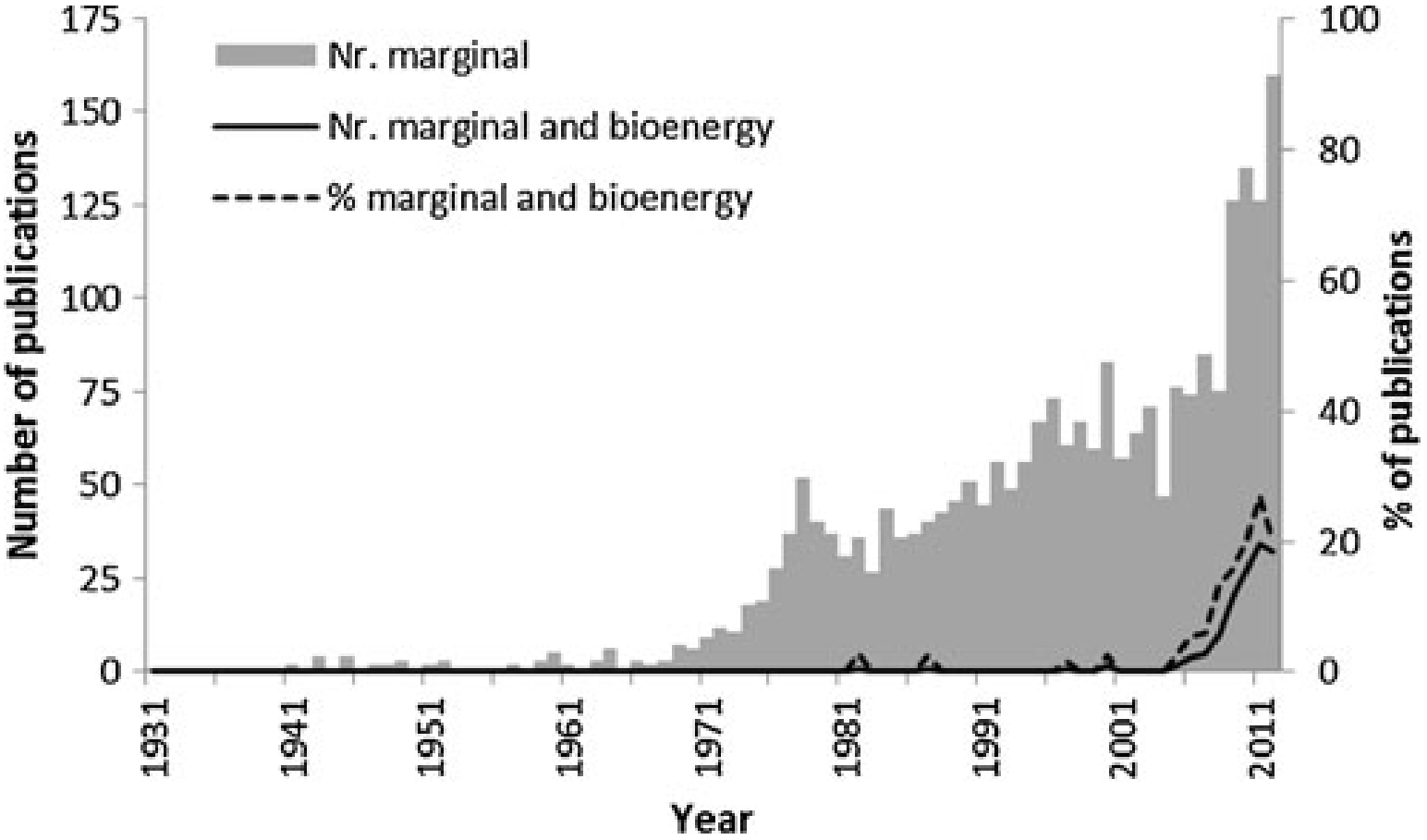
Sustainability Concerns with Marginal Land
Switchgrass on marginal land is net energy positive

- Switchgrass was grown on land that qualified for CRP on 10 farms in NE, SD, & ND for 5 years.
- Switchgrass produced 13X more energy as ethanol than was required as energy from petroleum
- Switchgrass produced 540% more renewable than non-renewable energy consumed on marginal land when properly managed



Schmer et al. 2008 – PNAS 105:464-469

Publications Indicate Growing Awareness of Marginal Land

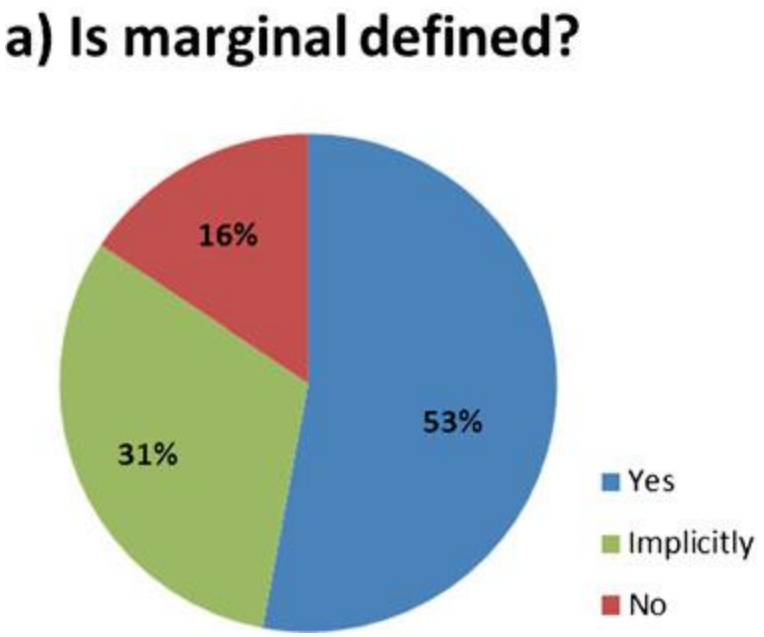


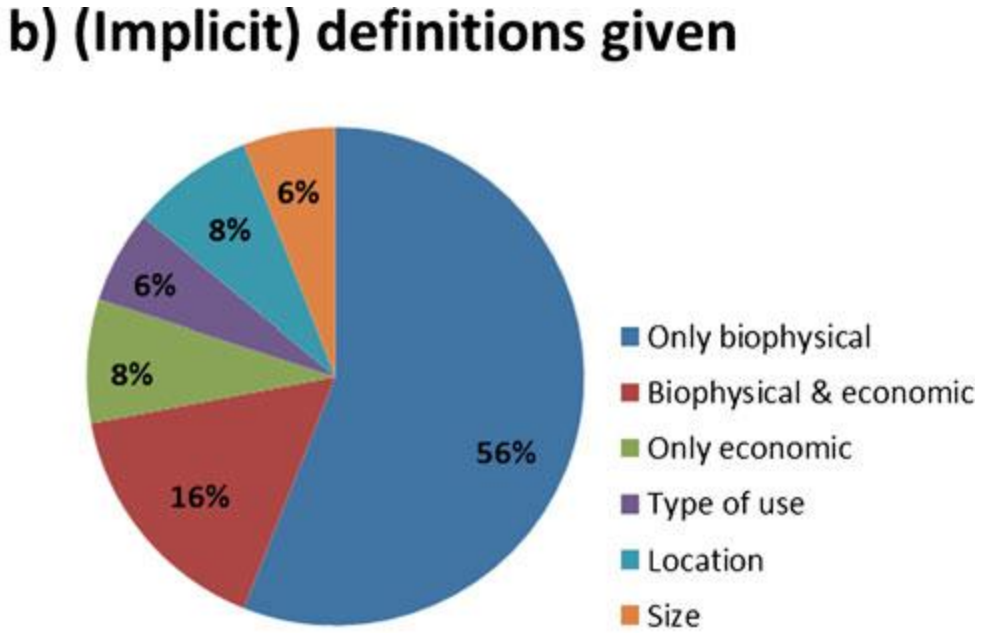
Number of Web of Knowledge-cited publications with marginal land(s) or marginal soil(s) in the topic (gray bars, 2,242 total) and publications also referencing bioenergy in the topic (solid line, 139 total). The dashed line indicates the percent of publications citing both marginal lands/soils and bioenergy.

Richards et al. 2014. Bioenergy Research

Many Publications Don't Define Why Land is Marginal

In our research, we need to do a better job of defining why land is marginal





Richards et al. 2014. Bioenergy Research

Perennial Grasses Provide More Ecosystem Services than Annual Crops

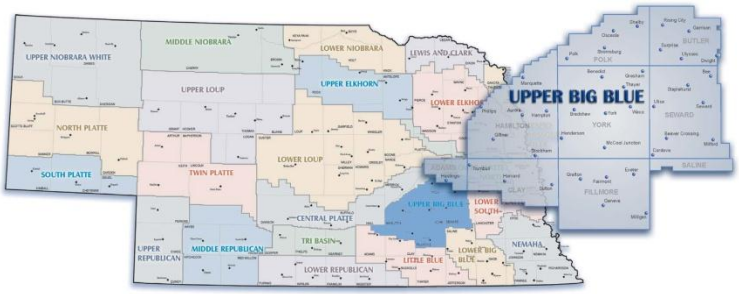
- Marginal lands - farmland suboptimal for food crops
- The ecological costs and benefits of growing annual grain crops for bioenergy on marginal lands are questionable.
- Perennial grasses provide an alternative to annual grains that increases biodiversity, sustains multiple ecosystem functions, & provides a multifunctional agricultural landscape.
- Switchgrass & prairie plantings had more plant, arthropod, and bird diversity than maize.
- Bioenergy policy that supports coordinated land use can diversify agricultural landscapes and sustain multiple critical ecosystem services.

Werling et al. 2014. PNAS

Perennial Grasses May Have a Significant Impact in Areas of Intensive Farming

One Township:

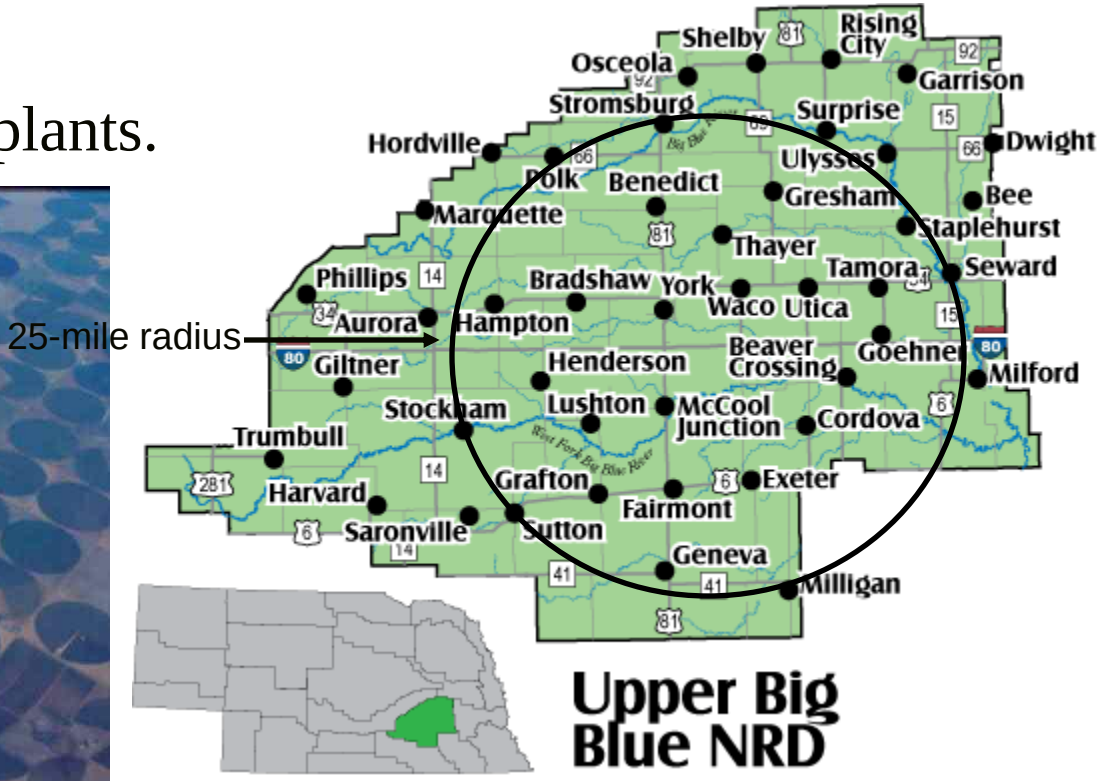
- 36 Sections
- 23,040 acres
- 129 pivots
- York County, NE



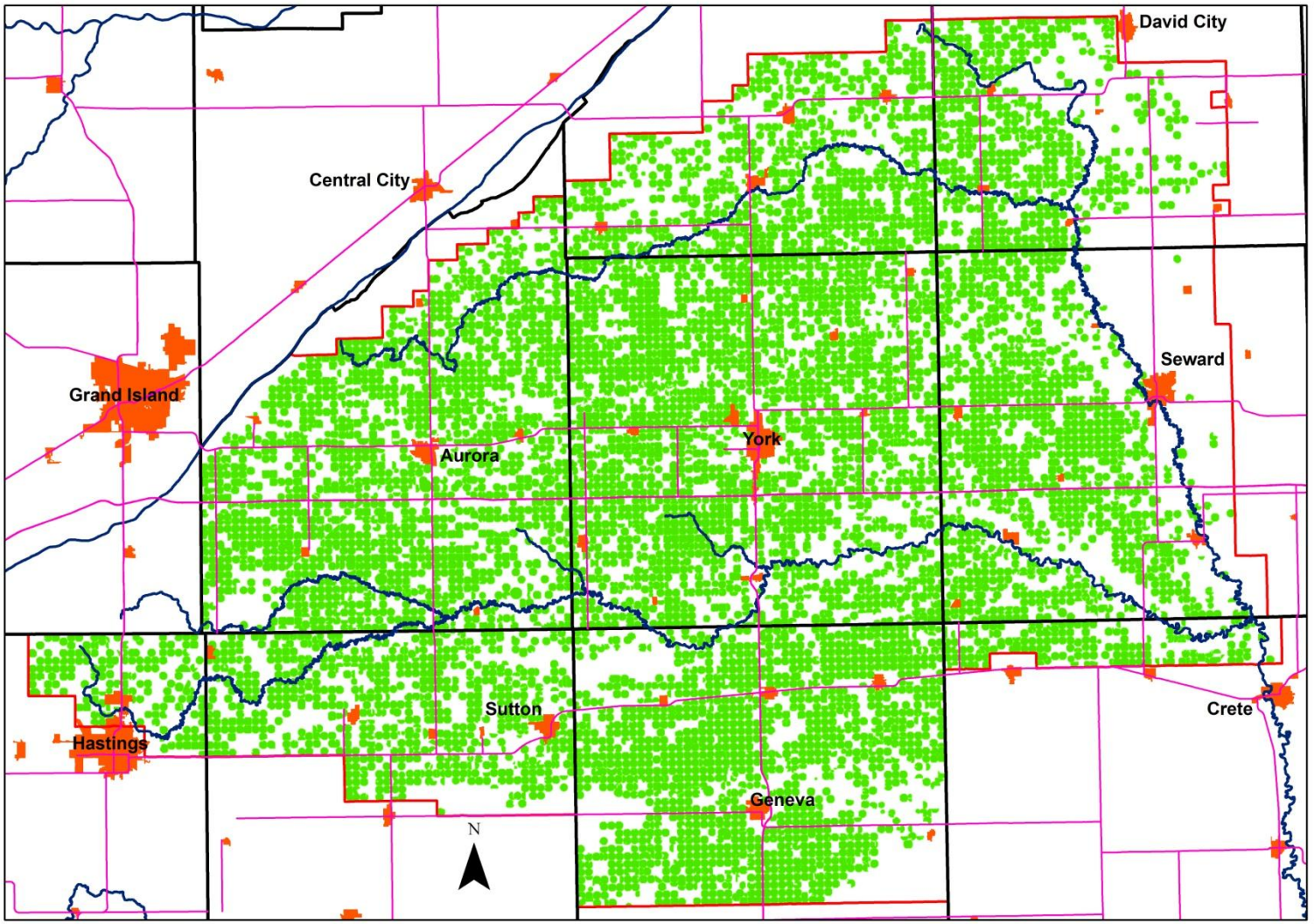
Perennial Grasses on Pivot Corners

A 50-million gallon Ethanol Plant Will Require:

- 125,000 acres of switchgrass assuming 5 tons/acre and 80 gallons of ethanol/ton of switchgrass.
- The Upper Big Blue NRD could grow 125,000 acres of switchgrass in pivot corners alone, enough for 1 50 MG plant at 5 tons/acre, or 2 50 MG plants at 10 tons/acre.
- Has 4 existing corn ethanol plants.



Upper Big Blue NRD Fuelshed



Pivots - 858,407 acres
Corners - 124,668 acres

Author: Daniel Uden

Perennial Grasses on Marginal Sites

NIFA-CAP Grant led by Iowa State University has allowed the expansion of yield trials and research plots at > 30 marginal sites in IA, IL, IN, MN, MO, NE, OH, PA, SD, and WI focusing on crop management practices (fertility & time of harvest) for existing and new high yielding biomass strains.

Liberty Switchgrass Release

- First bioenergy cultivar for Great Plains & Midwest
- Optimizing perennial grass return on marginal land will increase the awareness for its value

Mead, NE	Tons/acre
Liberty	**8.1**
Shawnee	**5.6**
DeKalb, IL	
Liberty	**7.3**
Shawnee	**5.7**

Marginal Land Summary

- We need to do a better job of reporting why land is marginal
- Research reports on marginal land are increasing (CAPs)
- Ecologically & economically best use of land may conflict
- Perennial grasses increase landscape-scale diversity
- Bioenergy policy that supports coordinated land use can diversify agricultural landscapes and sustain multiple critical ecosystem services (Werling et al.)
- Large land areas for perennial grasses are available even in the most intensively managed regions (pivot corners)
- Optimizing perennial grass return on marginal land will increase the awareness for its value (new cultivars)
- Creating markets will give farmers economically viable options & can overcome some of the environmental concerns (biomass)

Thank you!