Perennial biomass crops on environmentally sensitive land in the US

USDA-NIFA Projects

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Photo source: Mike Collins

National Institute of Food and Agriculture

Mission: *Invest in and advance agricultural research, education, and investment to catalyze transformative discoveries, education, and engagement to address agricultural challenges*

Sustainable Bioenergy and Bioproducts Program

Vision: *Facilitate the development of sustainable regional production systems for biofuels, biopower, industrial chemicals, and biobased products, through partnerships and collaboration, for increased rural economic vitality, ecosystems services, and national energy security.*

CAP awards support large-scale multimillion dollar projects to promote collaboration, open communication, and the exchange of information; reduce duplication of effort; and coordinate activities among individuals, institutions, states, and regions.

CAP participants serve as a team that conducts targeted research or research, education, and extension in response to emerging or priority area(s) of national need.

Coordinated Agricultural Project

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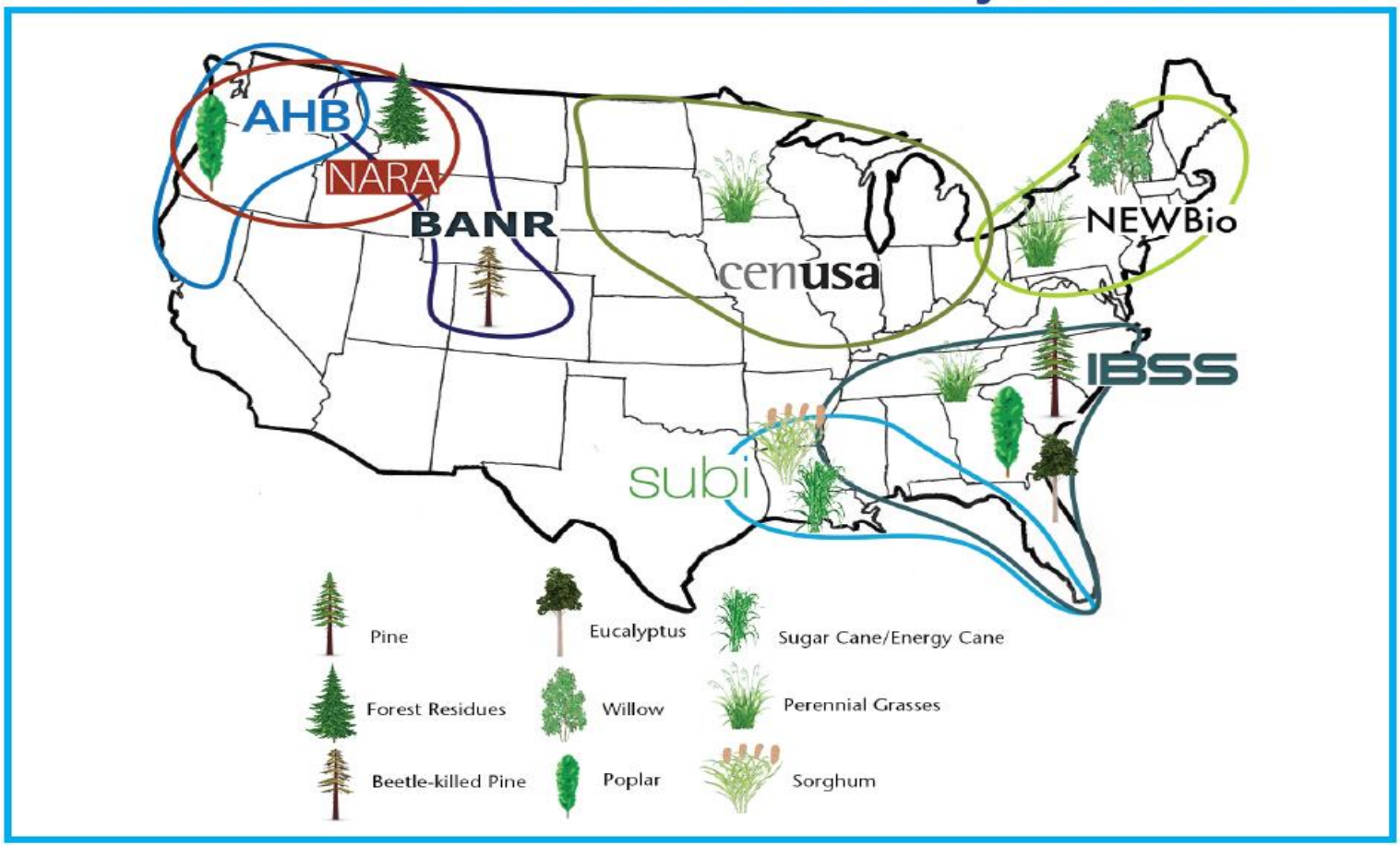
AFRI Biofuel Feedstocks and Project Locations



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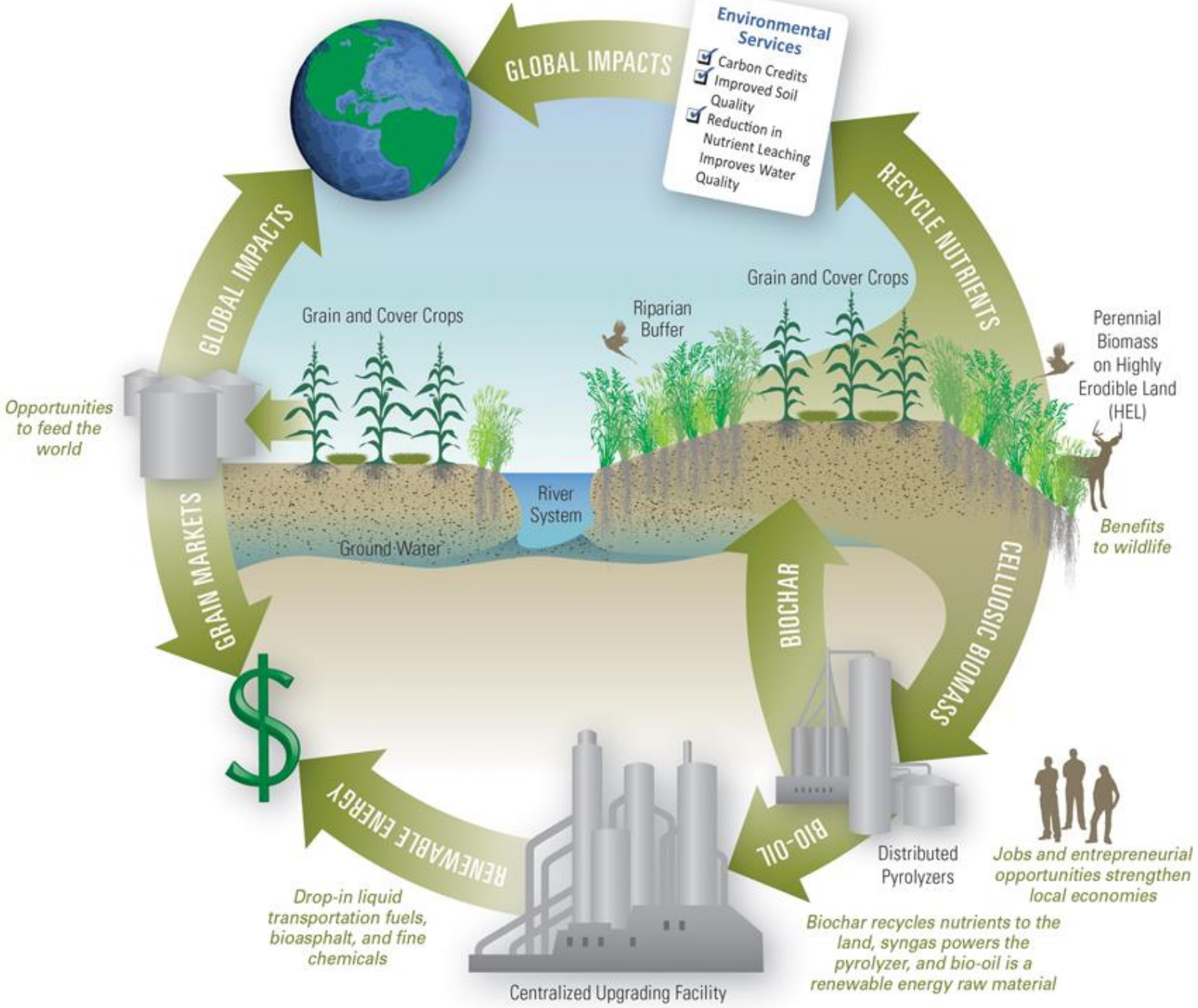
Sustainable Production and Distribution of Bioenergy for the Central USA

USDA United States Department of Agriculture National Institute of Food and Agriculture

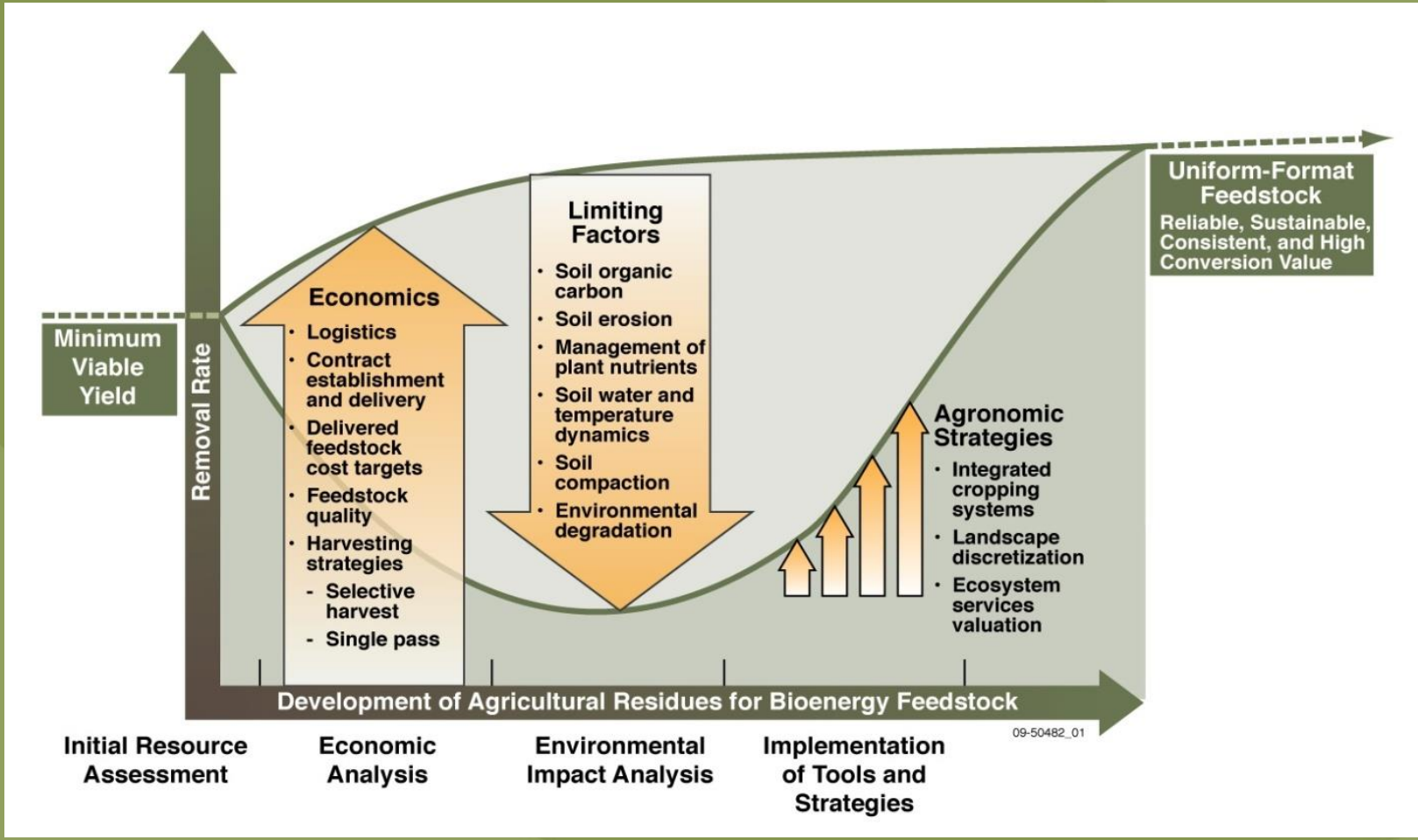
CenUSA Bioenergy is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the USDA National Institute of Food and Agriculture

Our **vision** is to create a **regional system** for producing advanced transportation fuels and other bio-based products from **perennial grasses** grown on land that is either unsuitable or **marginal** for row crop production. In addition to producing **advanced biofuels**, the proposed system will improve the sustainability of existing cropping systems by **reducing agricultural runoff of nutrients and soil** and increasing carbon sequestration.

Midwest Sustainable Biofuels Vision


GLOBAL IMPACTS
Environmental Services
Carbon Credits
Improved Soil Quality
Reduction in Nutrient Leaching Improves Water Quality
RECYCLE NUTRIENTS
GLOBAL IMPACTS
Grain and Cover Crops
Riparian Buffer
Grain and Cover Crops
Perennial Biomass on Highly Erodible Land (HEL)
Opportunities to feed the world
River System
Ground Water
Benefits to wildlife
GRAIN MARKETS
BIOCHAR
CELLULOSIC BIOMASS
RENEWABLE ENERGY
BIO-OIL
Distributed Pyrolyzers
Jobs and entrepreneurial opportunities strengthen local economies
Drop-in liquid transportation fuels, bioasphalt, and fine chemicals
Biochar recycles nutrients to the land, syngas powers the pyrolyzer, and bio-oil is a renewable energy raw material
Centralized Upgrading Facility

Economic Drivers and Limiting Factors



An illustration of competing economic drivers and limiting factors that must be balanced to achieve sustainable cellulosic feedstock supplies needed to support a transition from fossil to renewable fuels
(from Wilhelm et al. 2010. Industrial Biotechnology 6: 271–87)

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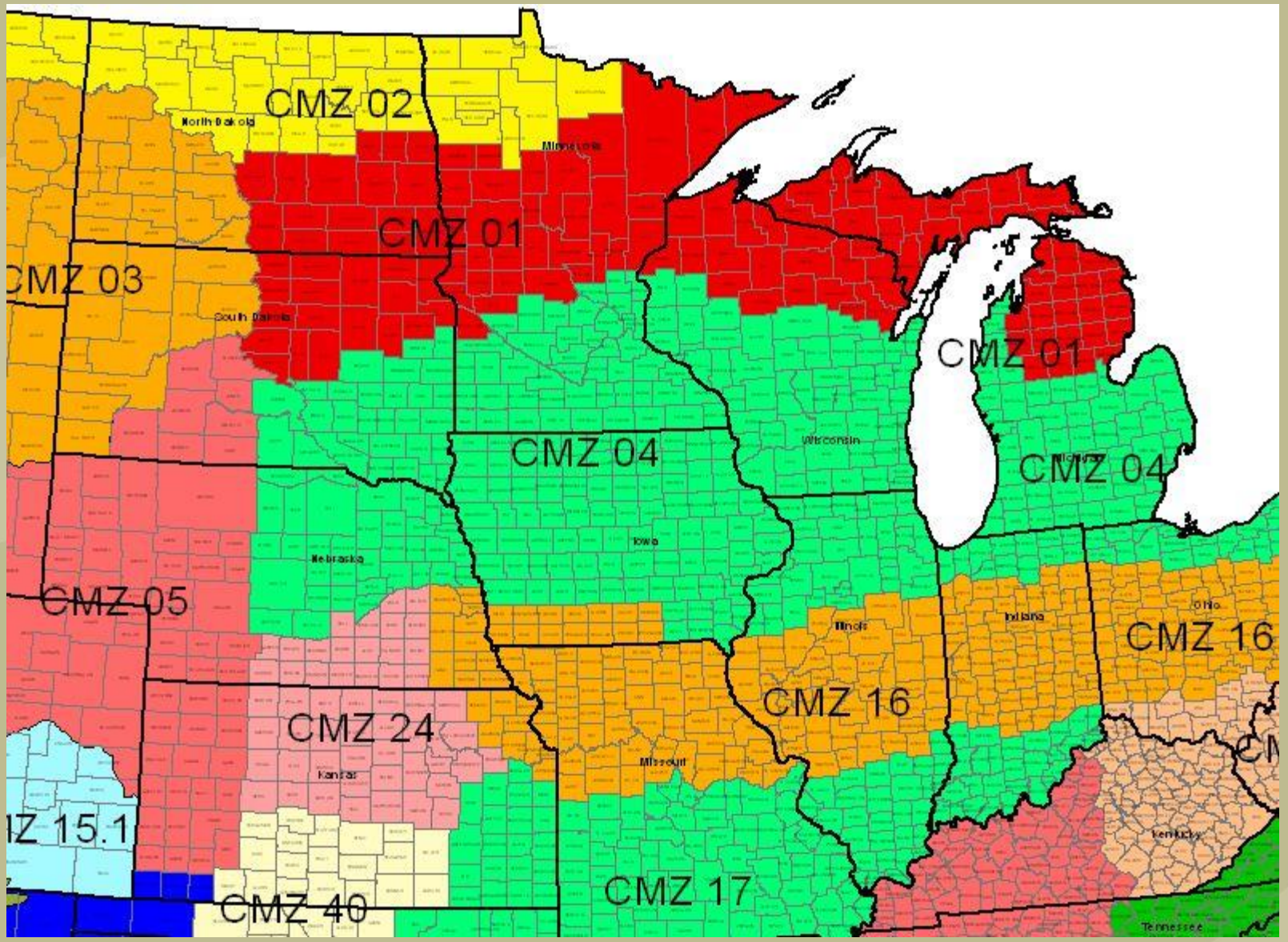
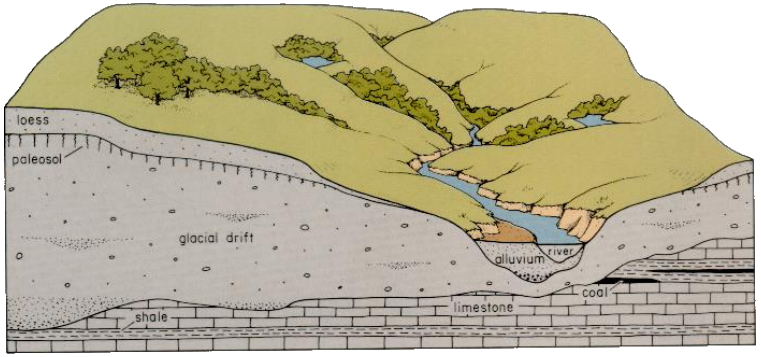
Crop Management Zones



Source: USDA-NRCS

Why these land classes?



Source: Jean Prior, 1991. Landforms of Iowa, UI Press.

Source: USDA NRCS

Source: Iowa State University

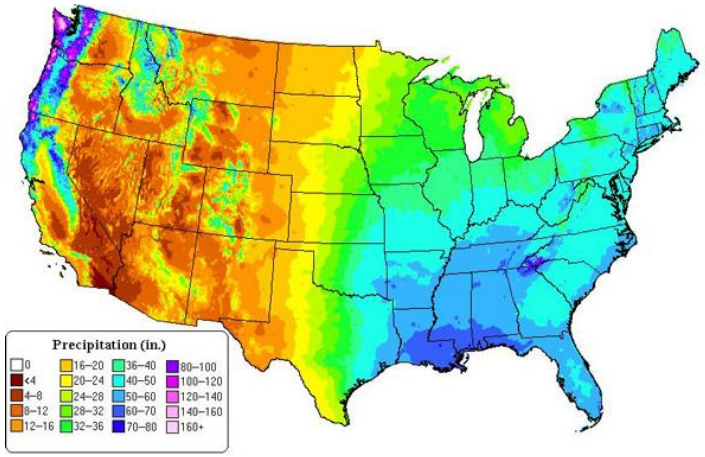
Source: Purdue University

Why these crops?

- High biomass yields
- Native species
- Reduce soil erosion
- Improve soil quality
- Increase carbon sequestration
- Reduce water runoff
- Increase water infiltration
- Provide wildlife habitat

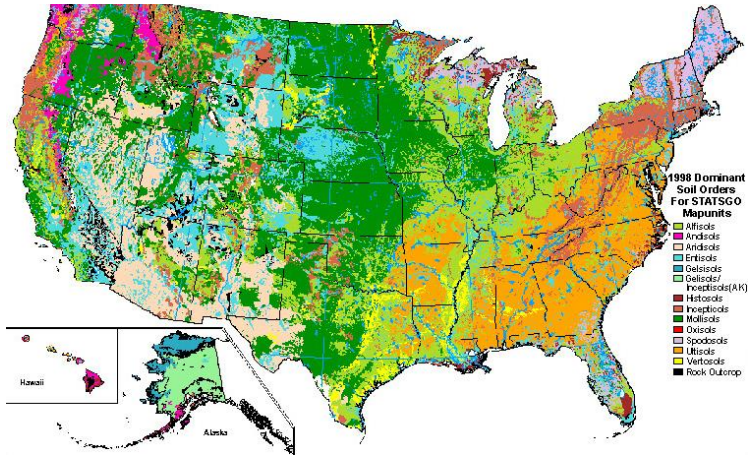
Why this region?

Precipitation



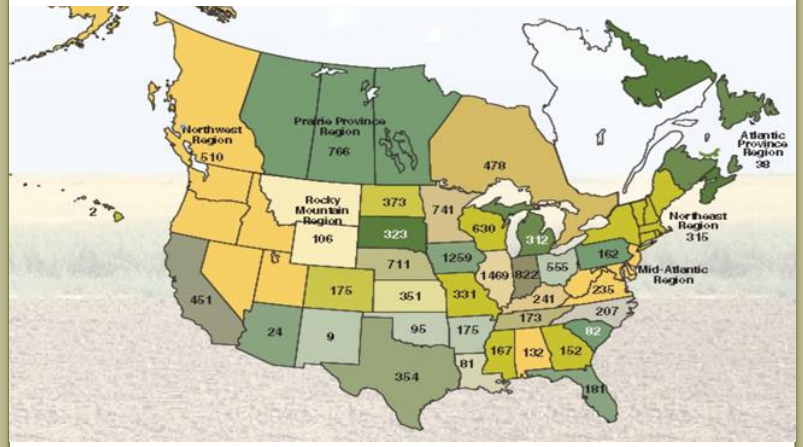
Source: USDA-NRCS National Water and Climate Center

Soils



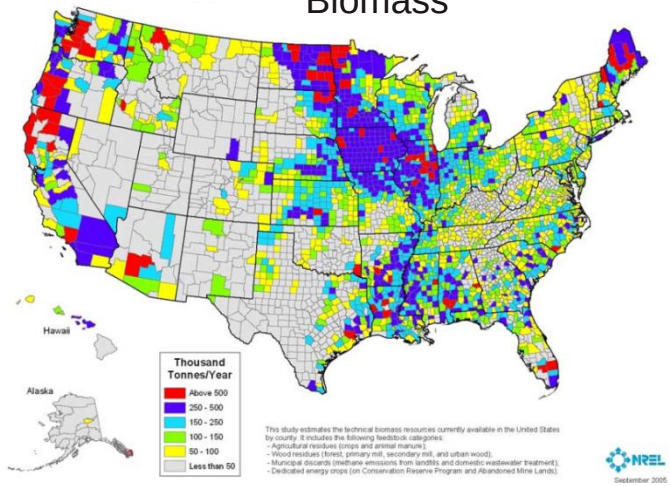
Source: USDA-NRCS

Crop Consultants



Source: American Society of Agronomy

Biomass



Source: USDOE-NREL

Why fast pyrolysis?

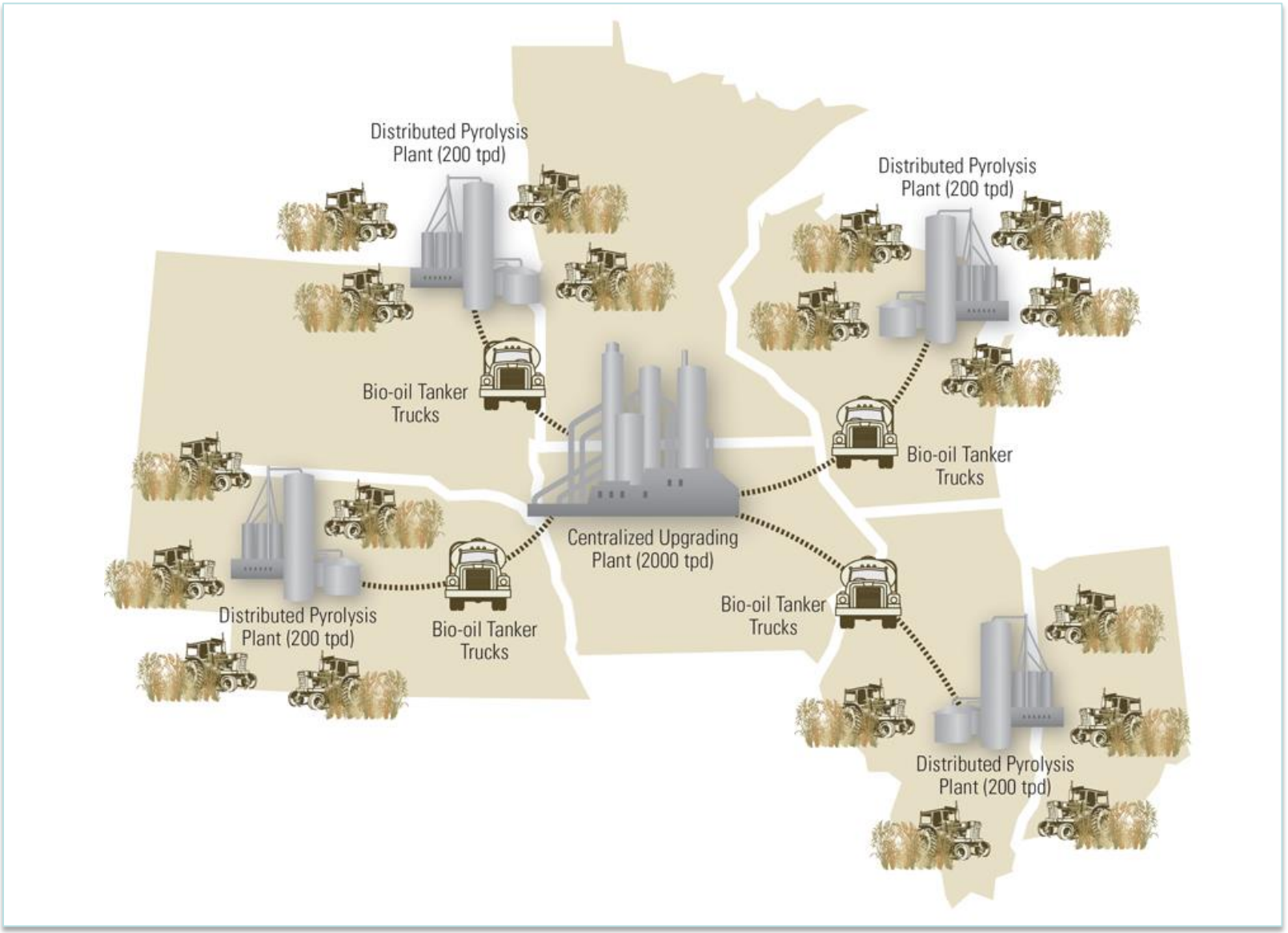
Rapid thermal decomposition of organic compounds in the absence of oxygen to predominately produce liquid product known as bio-oil.

Fast pyrolysis can be built at small scales suitable for distributed processing.

Co-product biochar is produced at yields of 12-20 wt% biomass.

Bio-oil is refined like petroleum into synthetic gasoline and biodiesel.

Distributed Processing



Herbaceous Biomass to Value-Added Products Via Fast Pyrolysis

Pyrolyzer

Product Recovery

Biochar

Heavy Ends

Light Ends

Fermentation

Lipids

Lipid Fuels

Phenolic Oligomers

Sugars

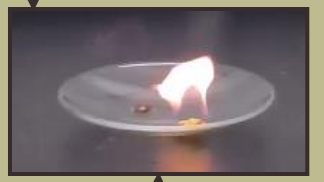
Bio-oil Co-firing Fuel

Bio-asphalt

Hydrocarbon Fuels

Fermentation Substrate

Gelled Fuel



Ethanol

Fermentation

1. Feedstock Development
2. Sustainable Production Systems
3. Feedstock Logistics
4. System Performance
5. Feedstock Conversion
6. Markets and Distribution
7. Health and Safety
8. Education
9. Extension and Outreach
10. Commercialization

Program Areas

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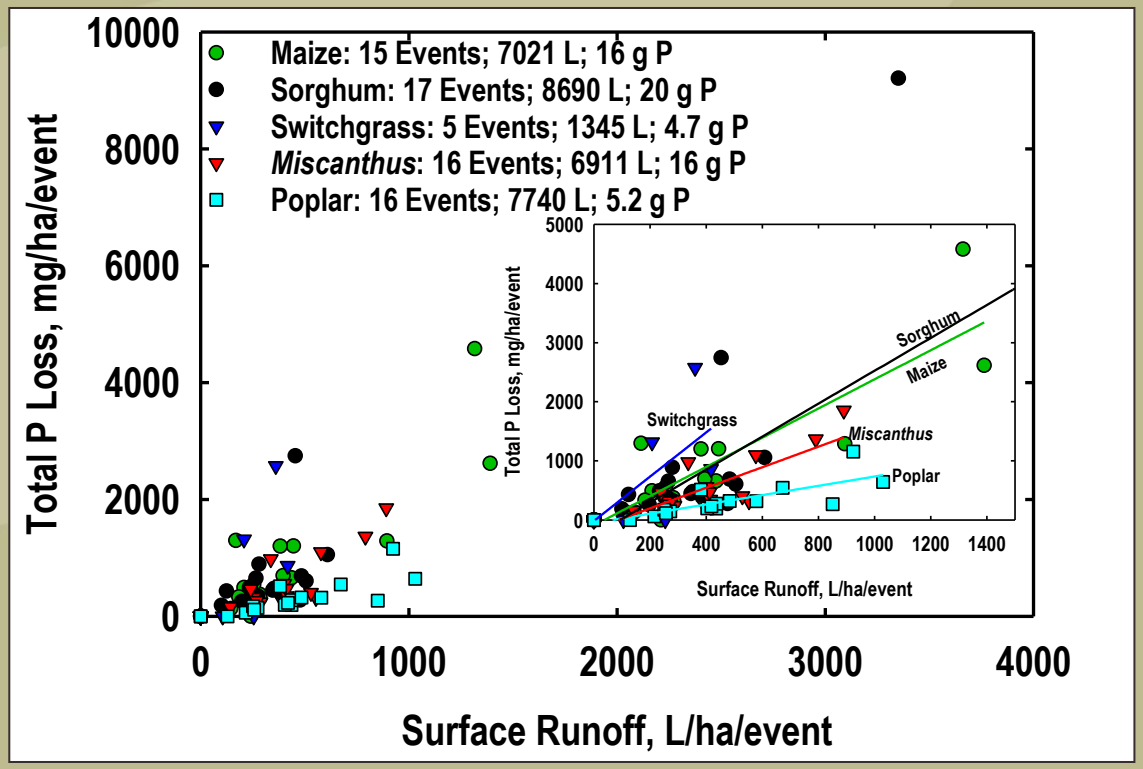
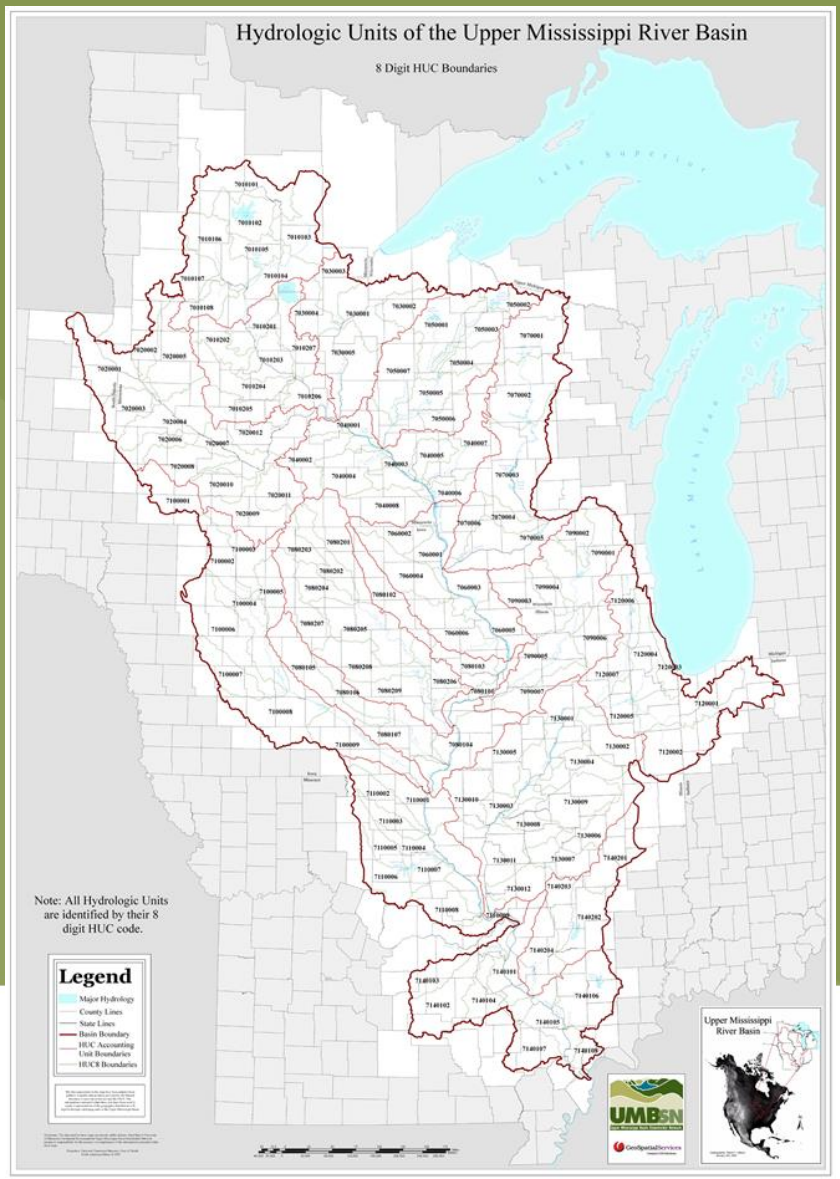
Relationship Between Surface Run-off and P Losses from Biomass Systems



Purdue Throckmorton Site 2014

Modelling Water Quality



CEAP Integration

Used 3 years of detailed farm management data, NRI, soil survey, conservation plan records, 47 years of weather to populate model

131 sub-basins in UMRB

Integrated SWAT and APEX models to evaluate the effects of existing conservation practices

Which locations should we target for perennial biomass crops?

Developed tradeoffs between costs and reductions in hypoxic zone size

Conservation Effects Assessment Project (CEAP)

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Enhancing Mississippi Watershed Ecosystems with Perennial Bioenergy Crops

September 23–24 | Depot-Renaissance, Minneapolis, Minnesota

United States Department of Agriculture

National Institute of Food and Agriculture

Mississippi River Gulf of Mexico Watershed Nutrient Task Force

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IOWA EPSCoR

CARD
Center for Agricultural and Rural Development

IOWA STATE UNIVERSITY
Bioeconomy Institute

Extension Energy and Environment Conference
September 23-26, 2014

Extension Agriculture and Energy professionals from 18 states attended and learned about growing perennial grasses for bioenergy

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CENUSA BIOENERGY IS SUPPORTED BY AGRICULTURE AND FOOD RESEARCH INITIATIVE COMPETITIVE GRANT NO. 2011-68005-30411 FROM THE USDA NATIONAL INSTITUTE OF FOOD AND AGRICULTURE.

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Sustainable Production and Distribution of Bioenergy for the Central USA

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Education

Provide rich interdisciplinary training and engagement opportunities for undergraduate and graduate students in all areas of bioenergy value chain to meet the workforce challenges of the emerging economy.

About CenUSA Bioenergy

Welcome to CenUSA Bioenergy. We are the home of an ambitious Iowa State University-based, USDA National Institute of Food and Agriculture (NIFA) sponsored, research project investigating the creation of a Midwestern sustainable biofuels and bioproducts system. This website is dedicated to sharing our work with everyone interested in a sustainable bioeconomy.

Iowa State University's Ken Moore is the project director for our of eight institution network: Iowa State University, Purdue University; University of Wisconsin; University of Minnesota; University of Nebraska-Lincoln; University of Illinois; University of Vermont; USDA Agricultural Research Service. Read more

Featured Video

www.cenusa.iastate.edu

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NEWBio

Northeast Woody/Warm-Season Biomass Consortium

Water Quality and Sustainable Bioenergy: Synergies for the Northeast U.S.

The NorthEast Woody/warm-season Biomass Consortium (NEWBio) is a coordinated agricultural project funded by the United States Department of Agriculture (USDA) - National Institute of Food and Agriculture (NIFA) - Agriculture and Food Research Initiative (AFRI) Competitive Grant no. 2012-68005-19703. NEWBio is a regional network of organizations dedicated to building robust, scalable, and sustainable value chains for biomass energy in the Northeastern U.S . NEWBio aims to overcome existing barriers and dramatically increase the sustainable, cost-effective supply of perennial warm-season grasses, short rotation woody crops, and winter annual energy crops while enhancing water quality, sustainable land management and other ecosystem services, and building vibrant communities.

PENNSTATE Cornell University Delaware State University Drexel University ESF INL Idaho National Laboratory OAK RIDGE National Laboratory THE OHIO STATE UNIVERSITY RUTGERS The University of Vermont Extension USDA ARS

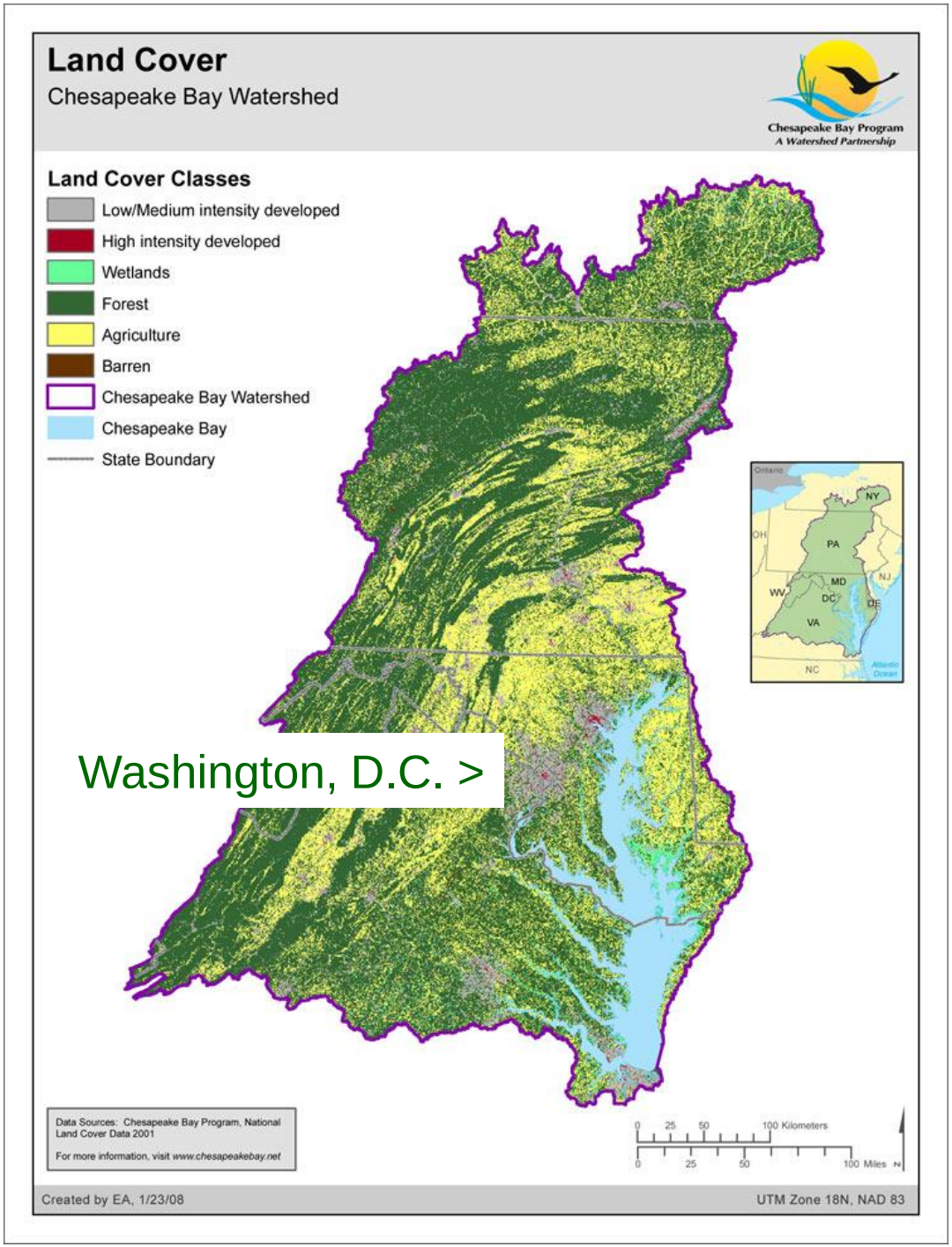
The Chesapeake Bay is the most productive estuary in the eastern U.S., but is seriously contaminated with nutrients and sediment.

Washington D.C. happens to sit on its shore.

$Billions have been spent to clean it up, but agricultural runoff remains the major challenge.

Land Cover in the Chesapeake Bay Watershed

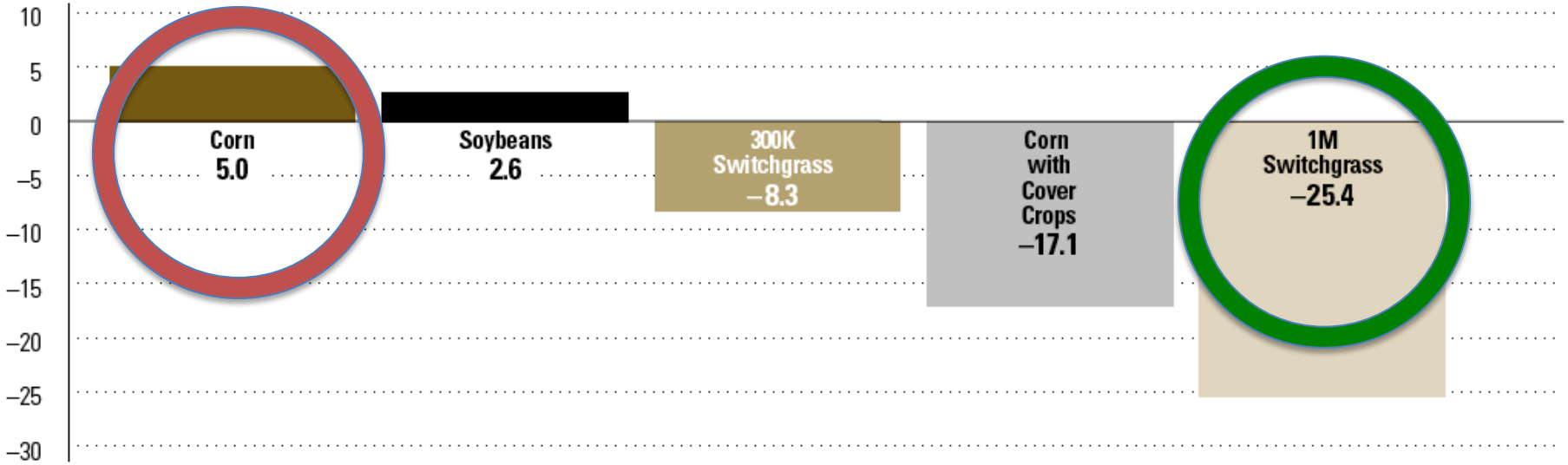
Map used by permission from Chesapeake Bay Commission



Biofuels and Water Quality: Blessing or Bane?

Maximum Nitrogen Load Changes for Biofuels

Millions of pounds per year of nitrogen delivered from the Chesapeake Bay watershed to the Bay under five modeling scenarios.



Assumptions for Alternative Scenarios:

- **Corn:** 300,000 additional acres of corn with typical levels of management practices
- **Soybeans:** 300,000 additional acres of soybeans with typical levels of management practices
- **300K Switchgrass:** 300,000 acres of switchgrass, converted primarily from hay and pastureland, with no fertilization
- **Corn with Cover Crops:** Cover crops on all existing and new (additional 300,000) corn acres and one quarter of all other row crops, watershed-wide.
- **1M Switchgrass:** 1 million acres of switchgrass, converted primarily from hay and pastureland, with no fertilization

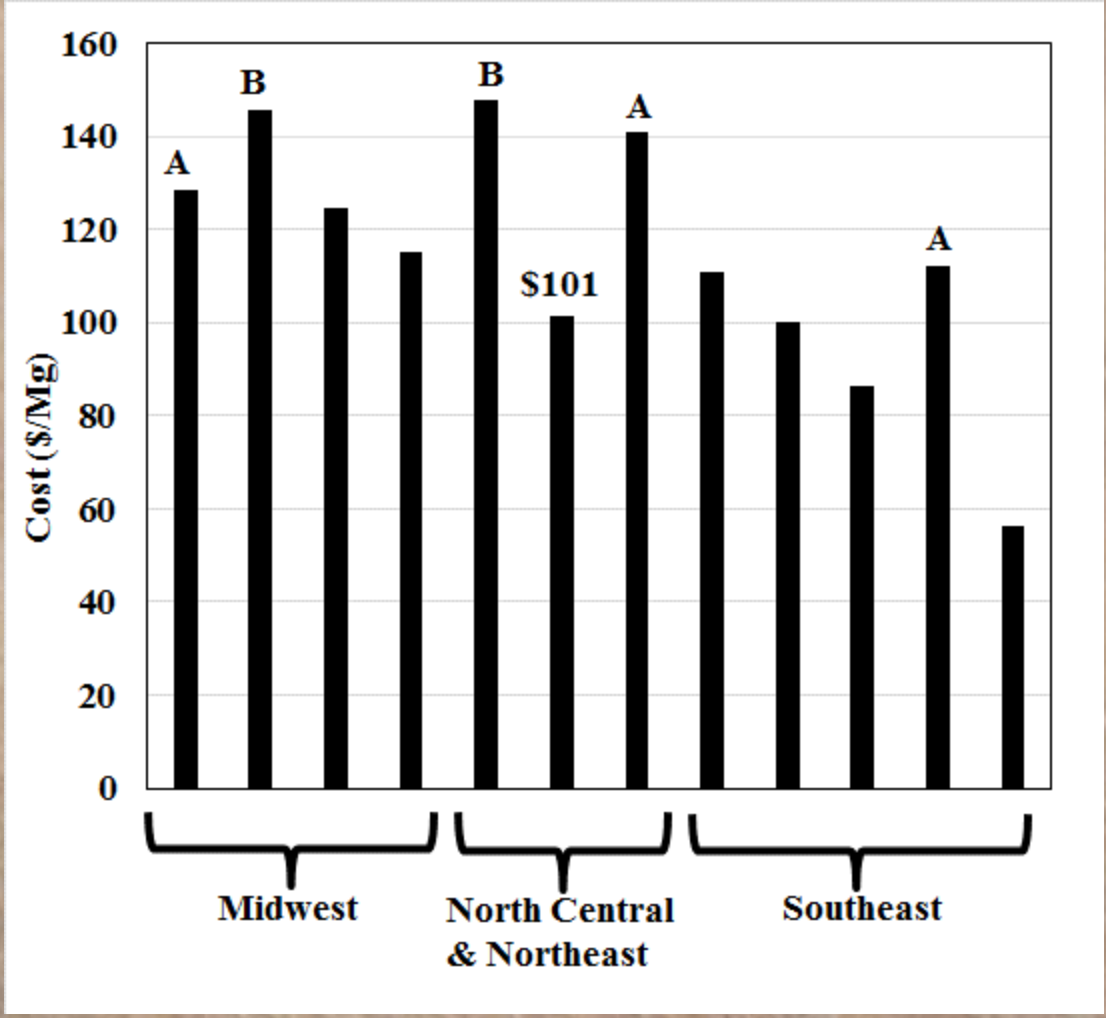
SOURCE: U.S. EPA CHESAPEAKE BAY PROGRAM OFFICE

Why payments for ecosystem services?

- *Conversion facilities may pay less for bioenergy feedstocks than farmers need to earn.*
- *Excess nutrients from agriculture are damaging water quality.*
- *Growing switchgrass instead of corn reduces excess nitrogen and improves water quality.*
- *In the Chesapeake Bay watershed, payments are already being made for agricultural practices that reduce excess nitrogen.*

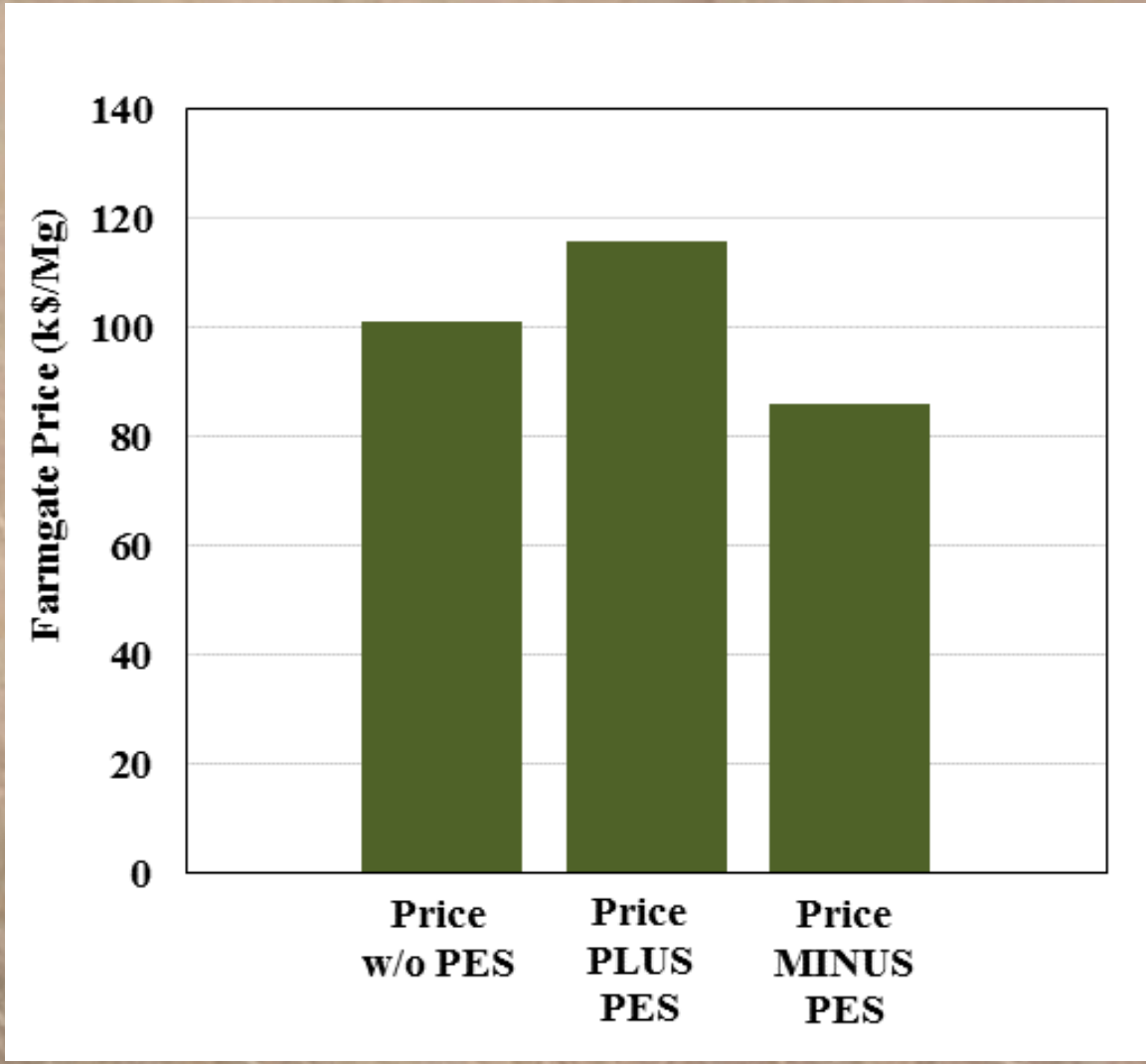
Can paying for water quality benefits make bioenergy more profitable?

Switchgrass price needed to equal profit from corn



Our results ($101/Mg) compared with published values for different US regions

Switchgrass price with and without payment for ecosystem service (PES) of reducing N loading to the Bay



The PES could be used either to increase the price paid to the farmer (see "PLUS") or reduce the cost to the buyer (see "MINUS").

USDA United States Department of Agriculture | National Institute of Food and Agriculture

NEWBio

Northeast Woody/Warm-season Biomass Consortium

Stay tuned at:

www.newbio.psu.edu

Supported by Agriculture and Food Research Initiative
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