Growing Energy Sustainably in the New Carbon Economy

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Facts about the Ethanol Industry

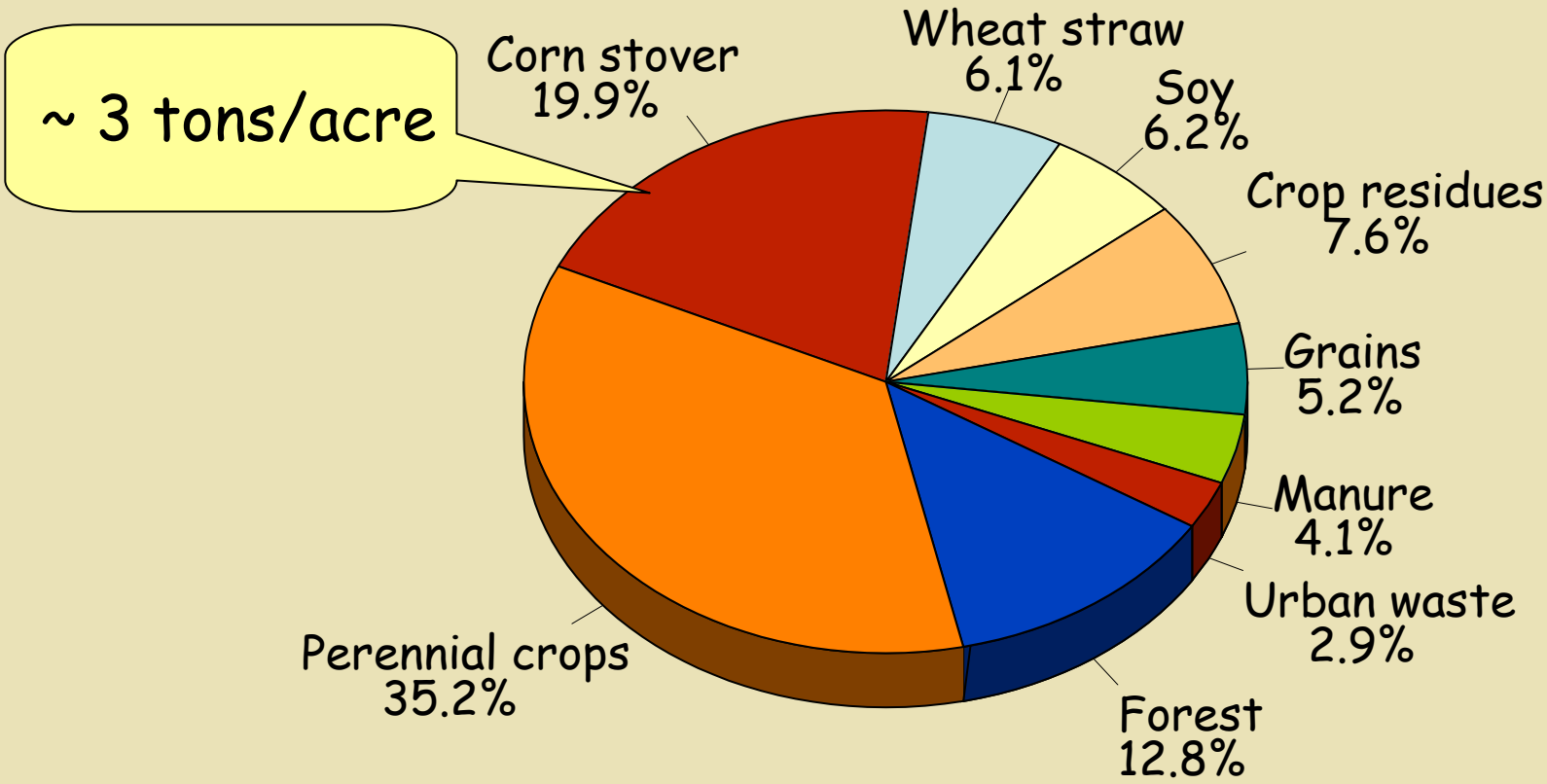
- 103 ethanol plants – 4.8 billion gallon capacity
- 46 ethanol plants under construction – 3 billion gallons capacity under construction
- 2 billion bushels of corn & other grain for ethanol in 2006 (13% of corn crop)
- Blended with 40% of gasoline supply
- Five-year average after tax return on investment in etOH plants can exceed 30%

Corn Grain Ethanol "Primes the Pump" for Cellulosic Ethanol

- At ~ 4-6% of gasoline replacement corn grain ethanol starts to significantly conflict with feed uses
- Limit for corn grain is ~12-15% gasoline replacement (all corn crop converted)
- Corn grain ethanol has established markets and built infrastructure

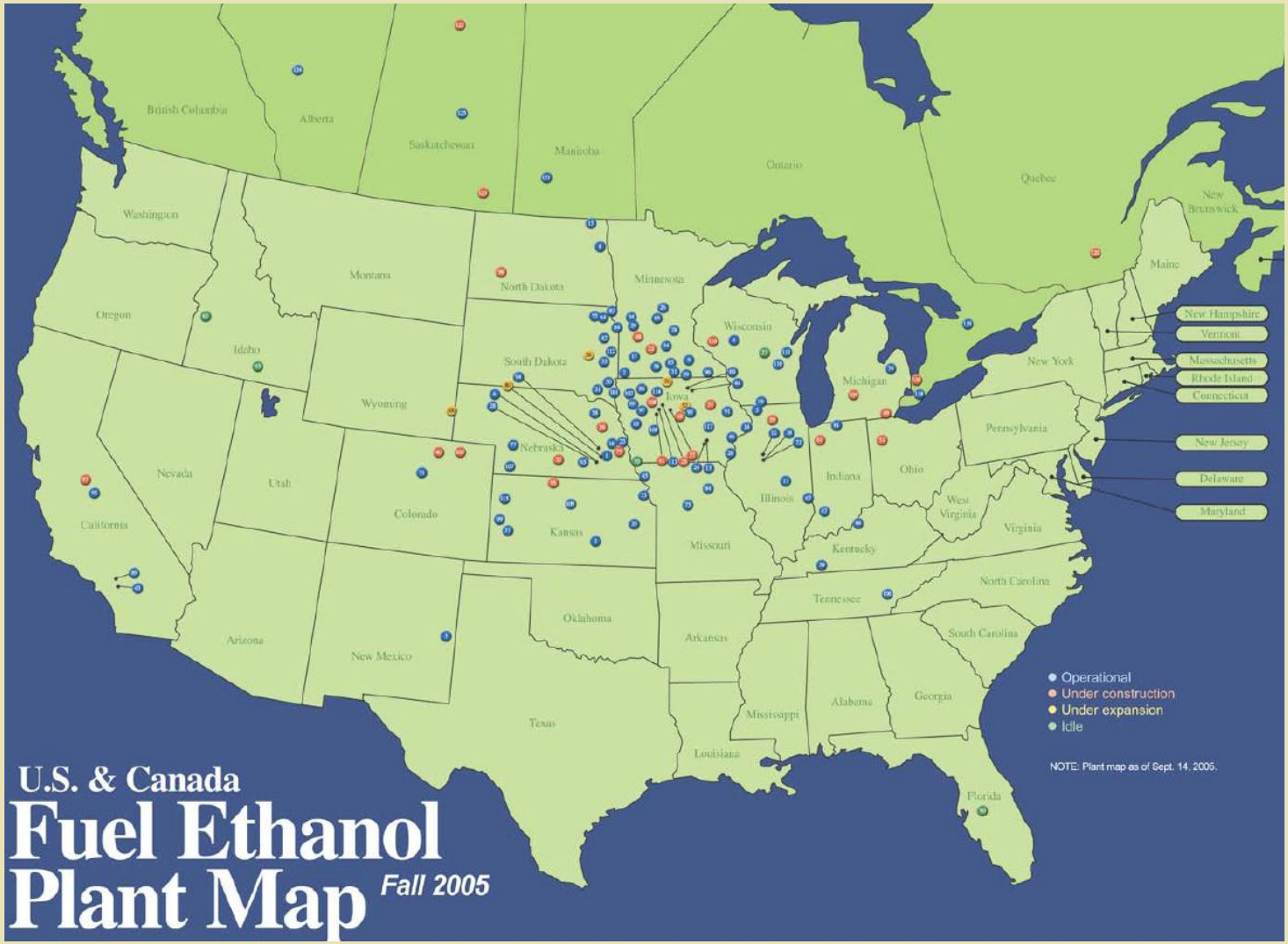
US Biomass inventory = 1.3 billion tons

Ethanol from Cellulose – The Next Wave

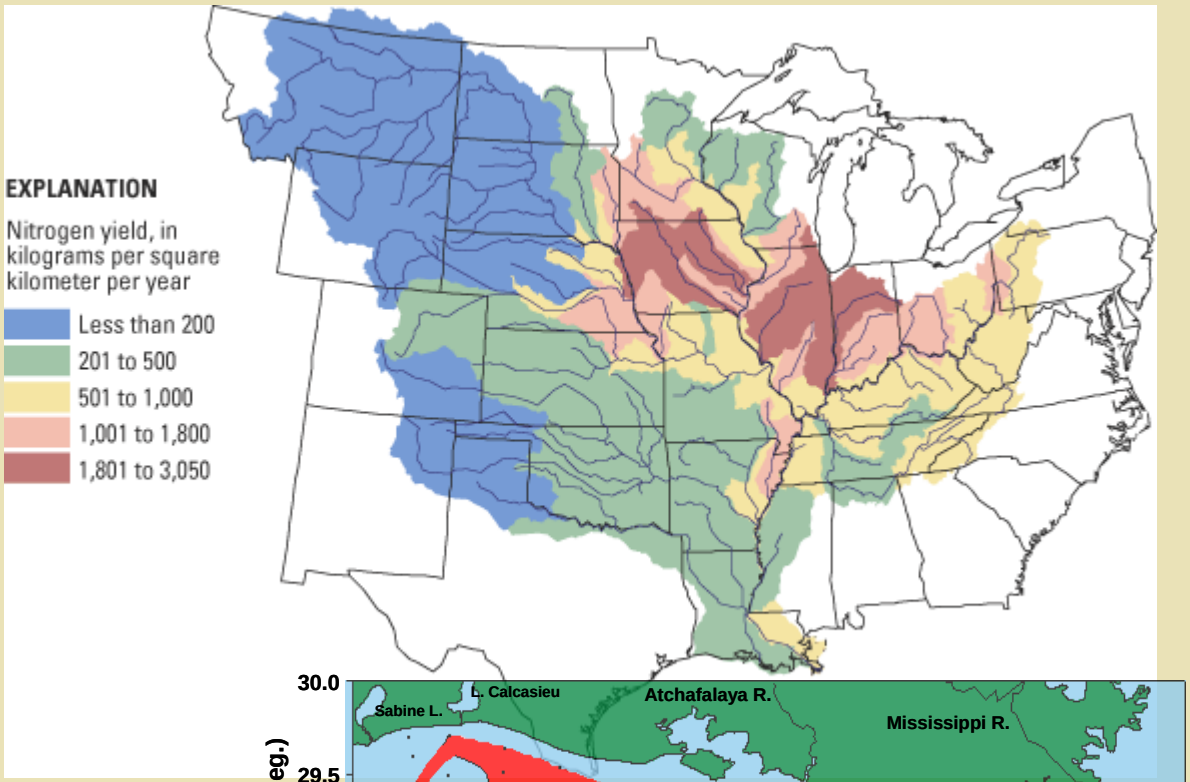


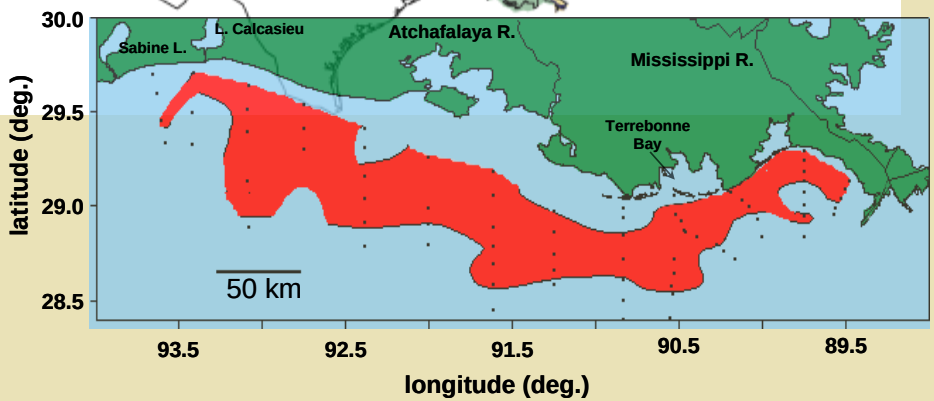
From: Billion ton Vision, DOE & USDA 2005

Ethanol plants follow corn



Impacts of Current Agriculture System





bottom dissolved oxygen less than 2.0 mg/L, July 1999

Soil Loss

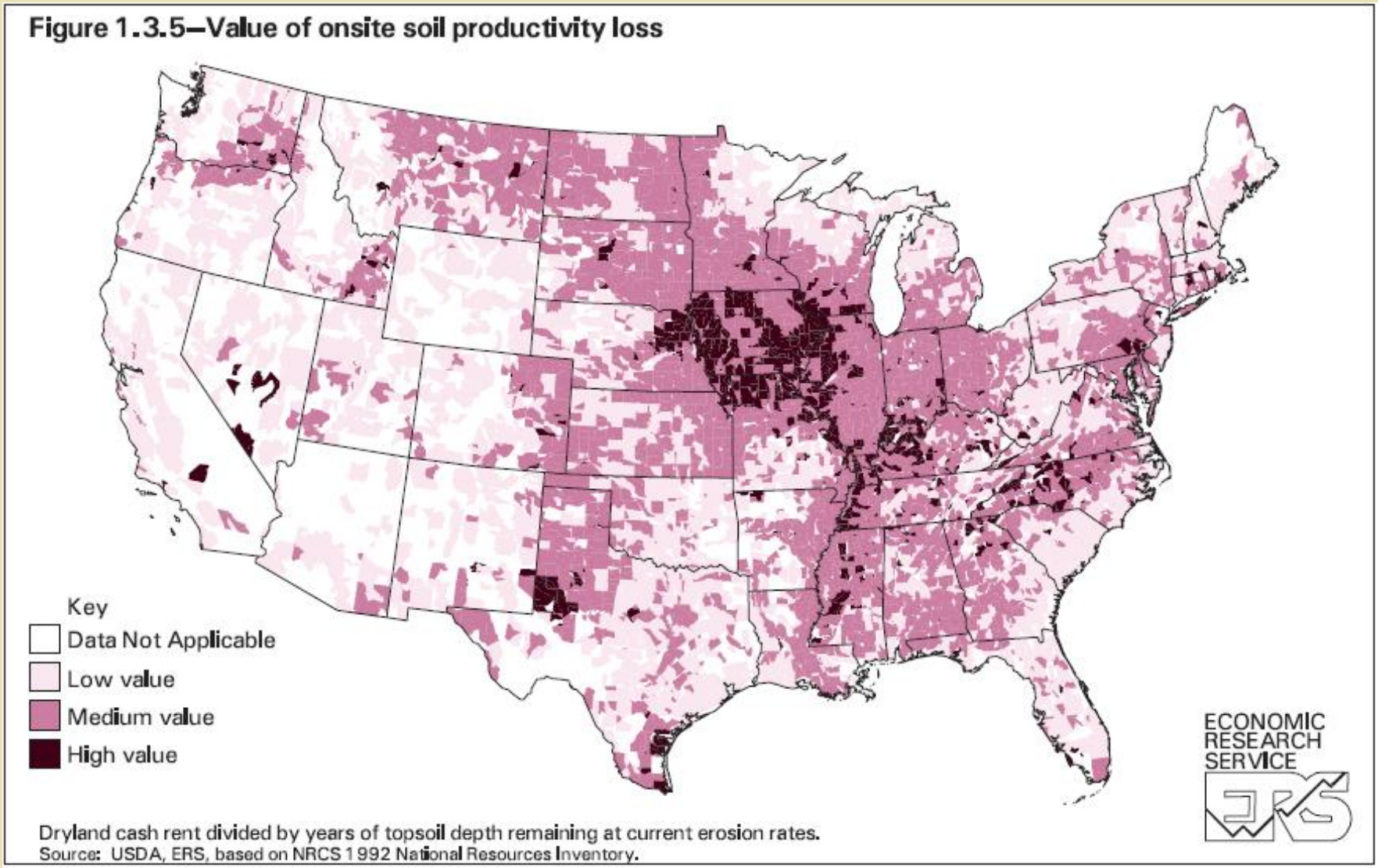
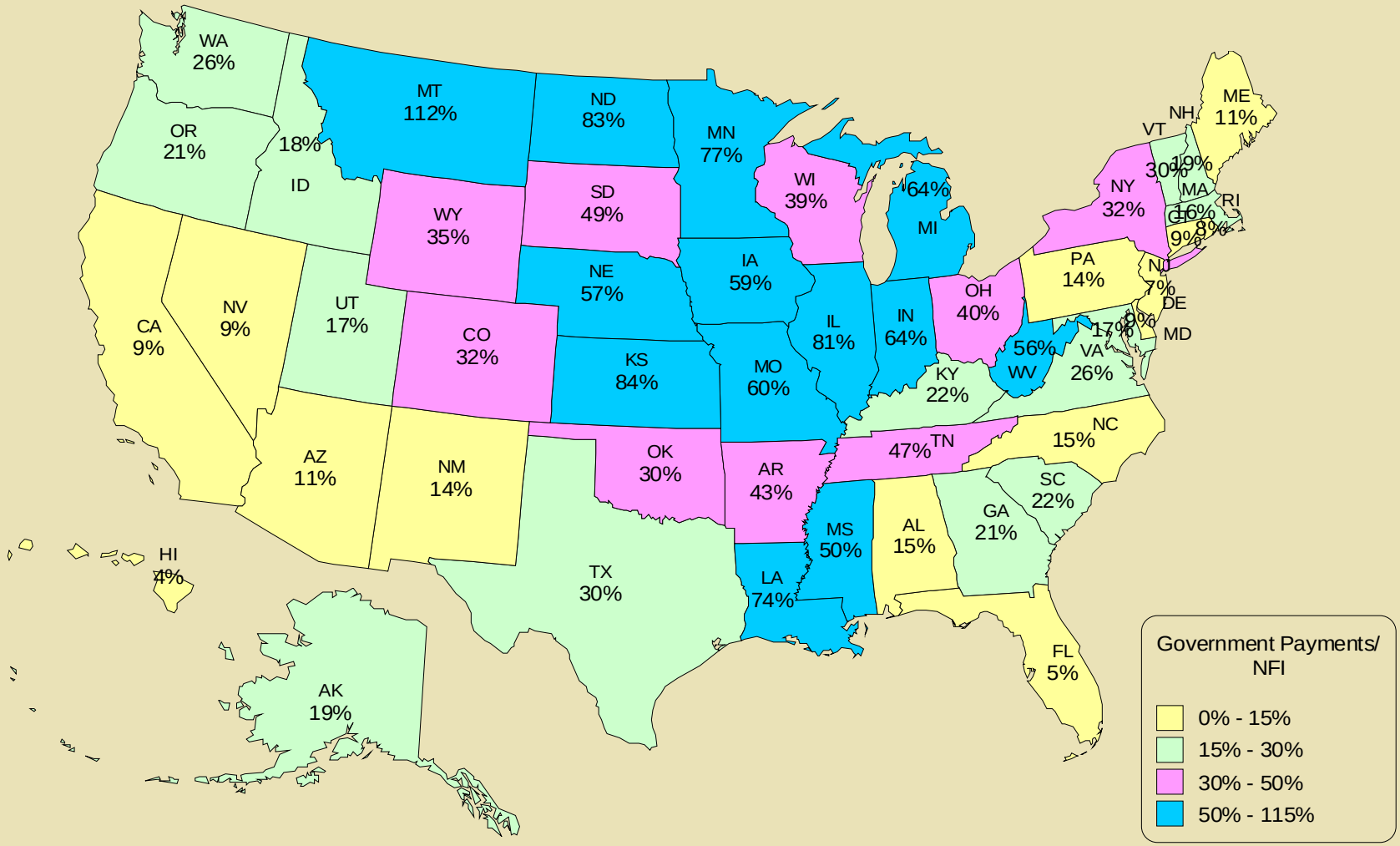


Figure 1.3.5—Value of onsite soil productivity loss
Key
Data Not Applicable
Low value
Medium value
High value
ECONOMIC RESEARCH SERVICE
ERS
Dryland cash rent divided by years of topsoil depth remaining at current erosion rates.
Source: USDA, ERS, based on NRCS 1992 National Resources Inventory.

Government Payments/Net Farm Income 2000 - 2004



Source:USDA/ERS

Biomass production in annual cropping systems

Missed opportunities for resource assimilation
and dry matter production

Montgomery County, Iowa
Source: USDA-NRCS

Root river in SE Minnesota joins the Mississippi.
Silt load is the result of a 2" rain in mid-July 2005.

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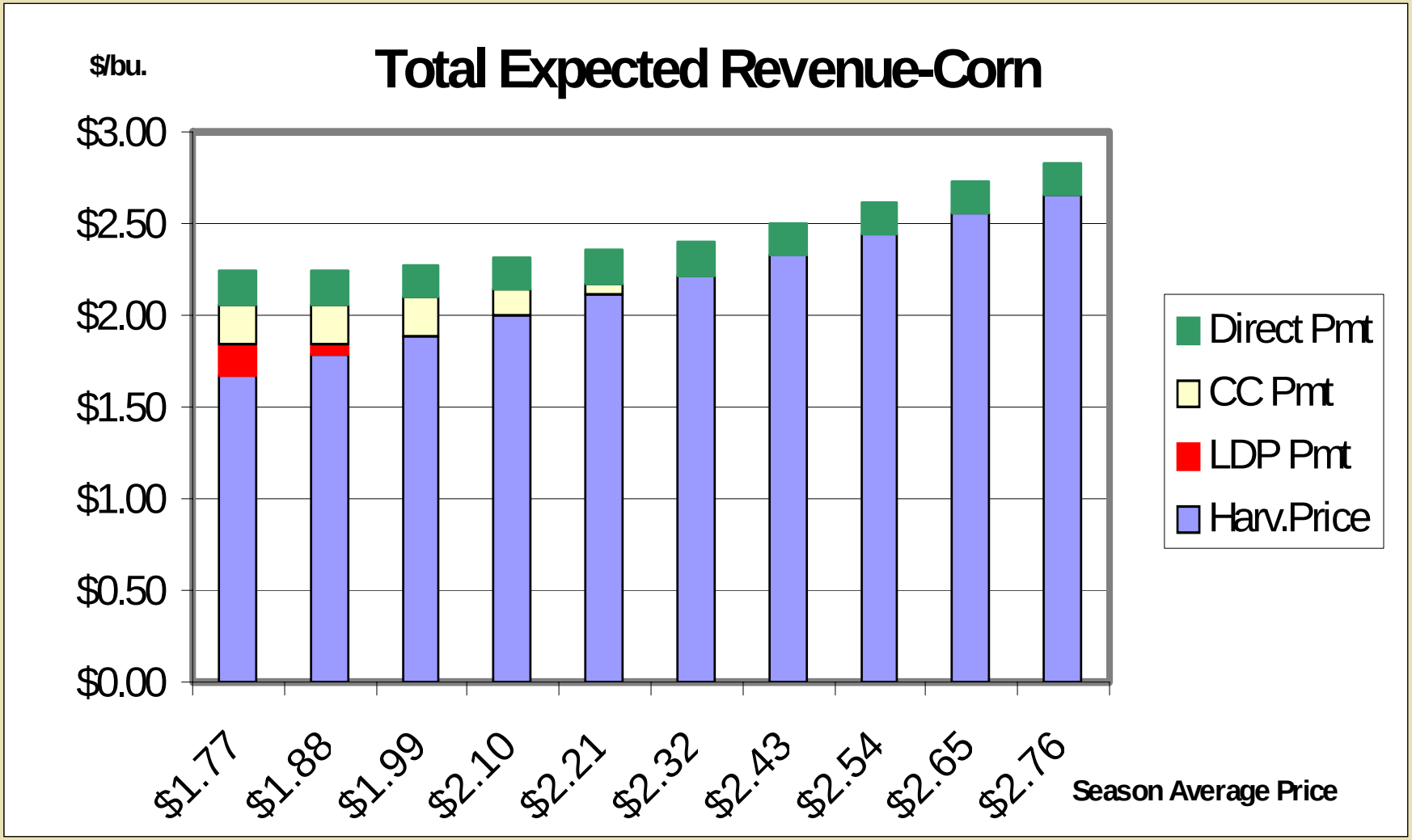
Perennial Panacea?

Perennial grasses can:

- Provide year-round ground cover, reducing erosion
- Use nutrients efficiently (i.e., lose little nitrogen)
- Build soil carbon

But…

Perennial Realities



Reimagining Agriculture

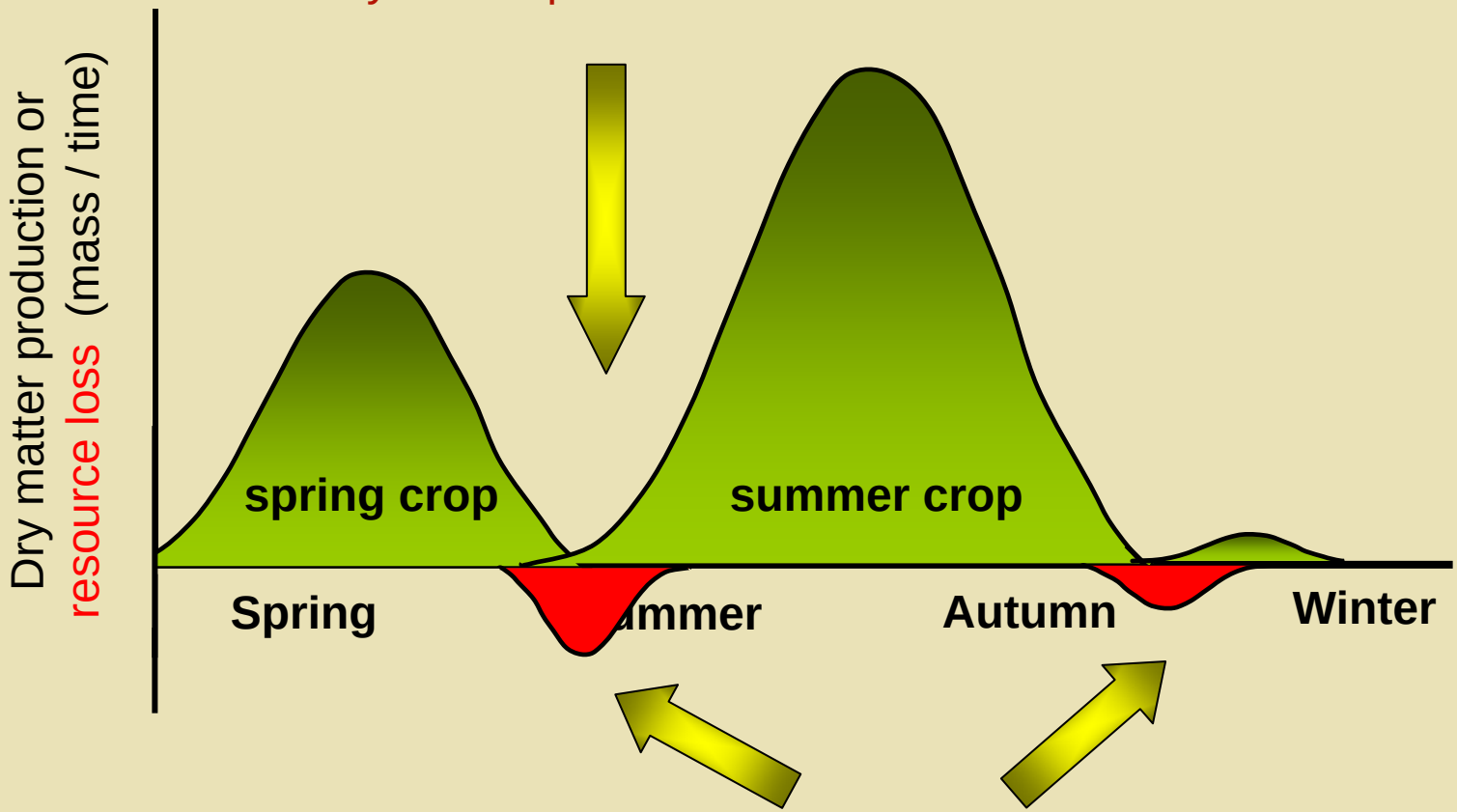
- Consider wider range of biomass crops
- New cropping systems
- New crop sequences
- Develop a fundamental understanding of biogeography of biomass crops and the mechanisms underlying exceptional plants

Example: Two crop sequences

- Idea: capture more sunlight and cover ground more of the time
- Solution: pair complementary cold season and warm season grasses
  - triticali + corn
  - triticali + sorghum x sudangrass

Biomass production in double crop systems

Tradeoff: Missed opportunity for resource assimilation and dry matter production



Reduced opportunities for resource losses

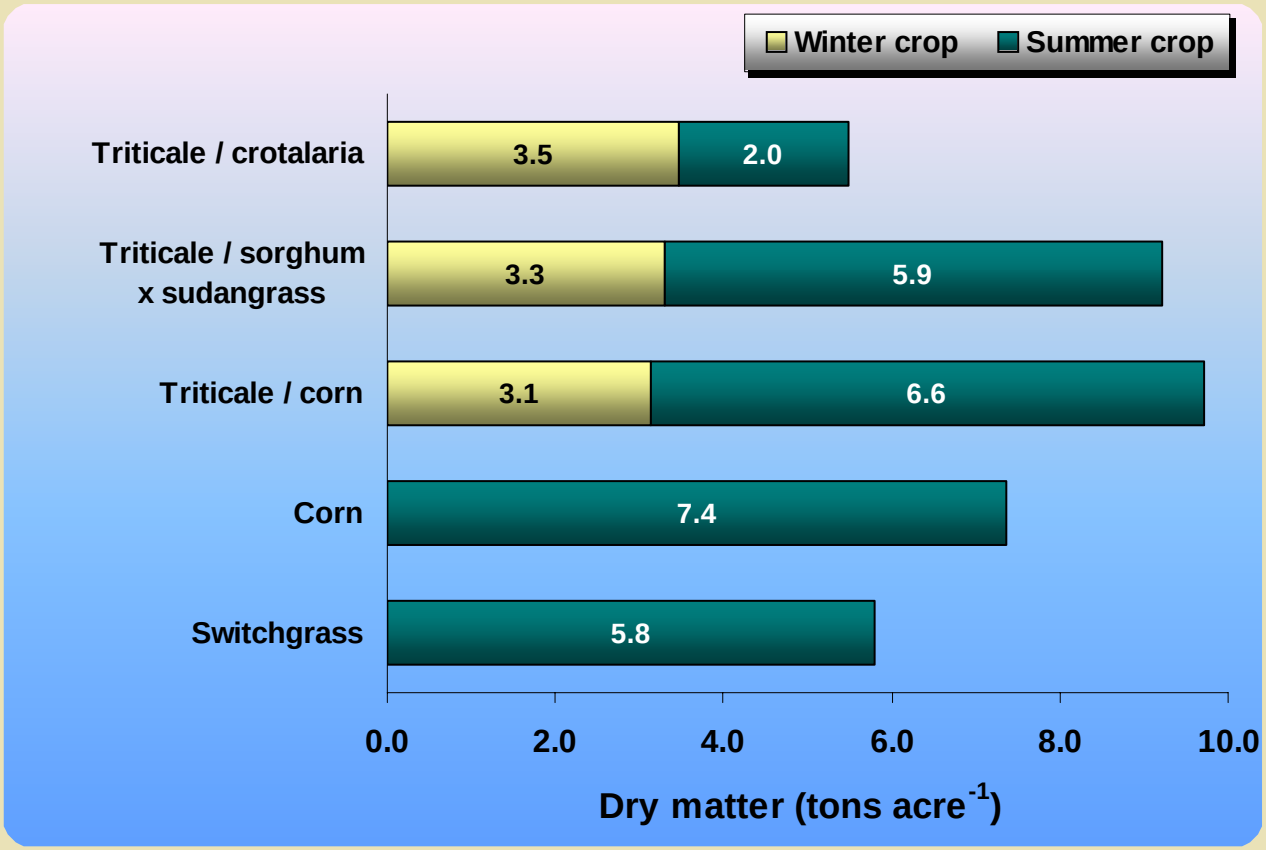
Biomass Production and Soil Cover:
Fall seeded triticale compared to sole-crop corn on May 20, 2006.

Photo: Andrew Heggenstaller

Spring Biomass Harvest:
Fall seeded triticale harvested on June 05, 2006.

Photo: Andrew Heggenstaller

Summer Crops Follow Triticale:
Double cropped sorghum x sudangrass and corn on July 26, 2006.



2006 production data
Ames, IA

source: A. Heggenstaller

In nature diversity provides productivity and resiliency

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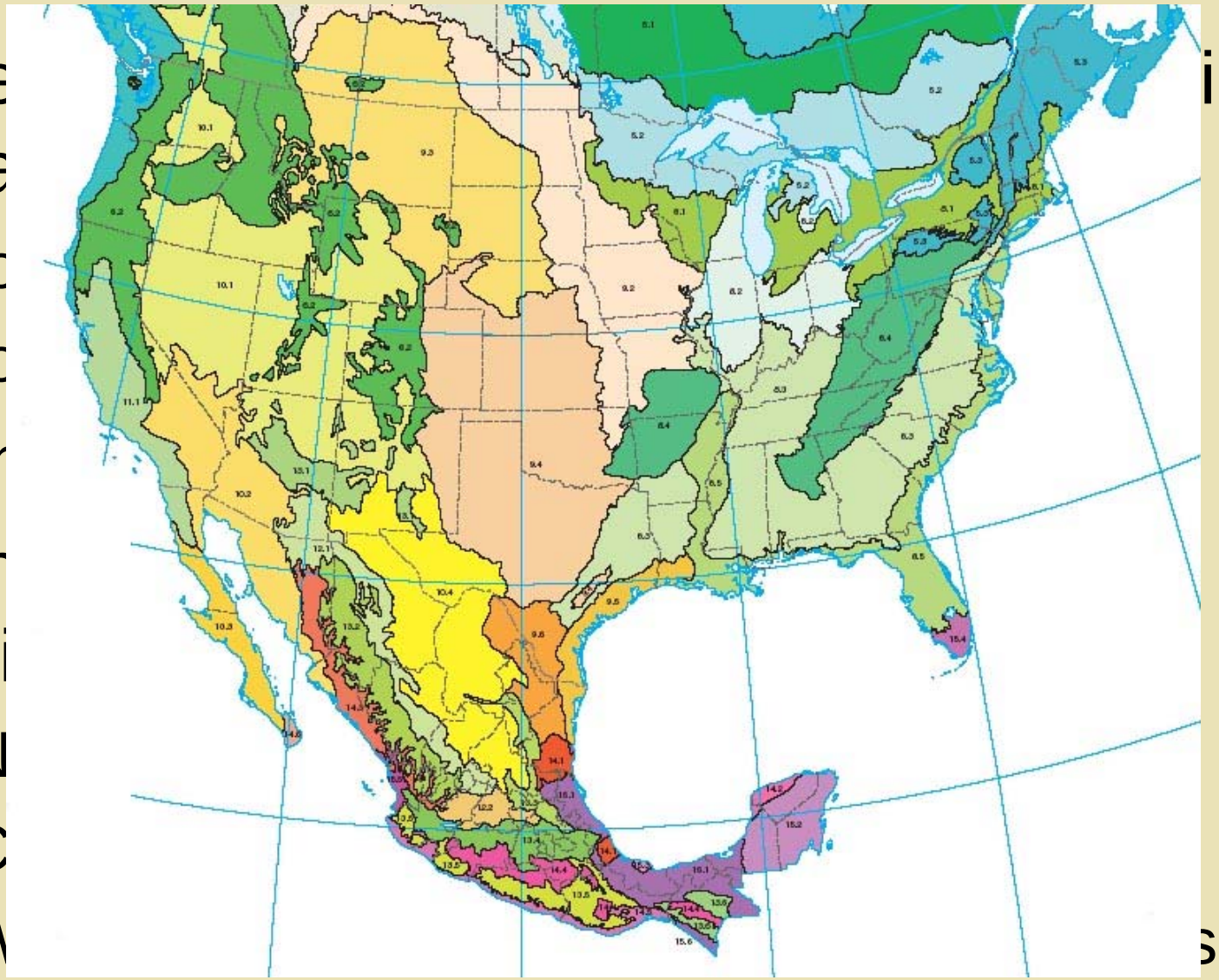

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Incentives to Reinvent Agriculture

- Current policies discourage high-yield, sustainable biomass cropping systems
- Create incentives for agricultural systems that can produce large amounts of biomass feedstock and food, along with environmental improvement
  - One option: fund the Conservation Security Program (CSP)

Developing a New Value Chain

- Corn grain ethanol has developed markets and some delivery infrastructure
- DOE has put investment in conversion technology
- Cellulosic feedstock supply research and development has seen relatively little investment
- We need new policies that reflect the objectives of the "new carbon economy" and help us realize its promise