Environmental Implications of Increased Biofuels Use in the U.S.

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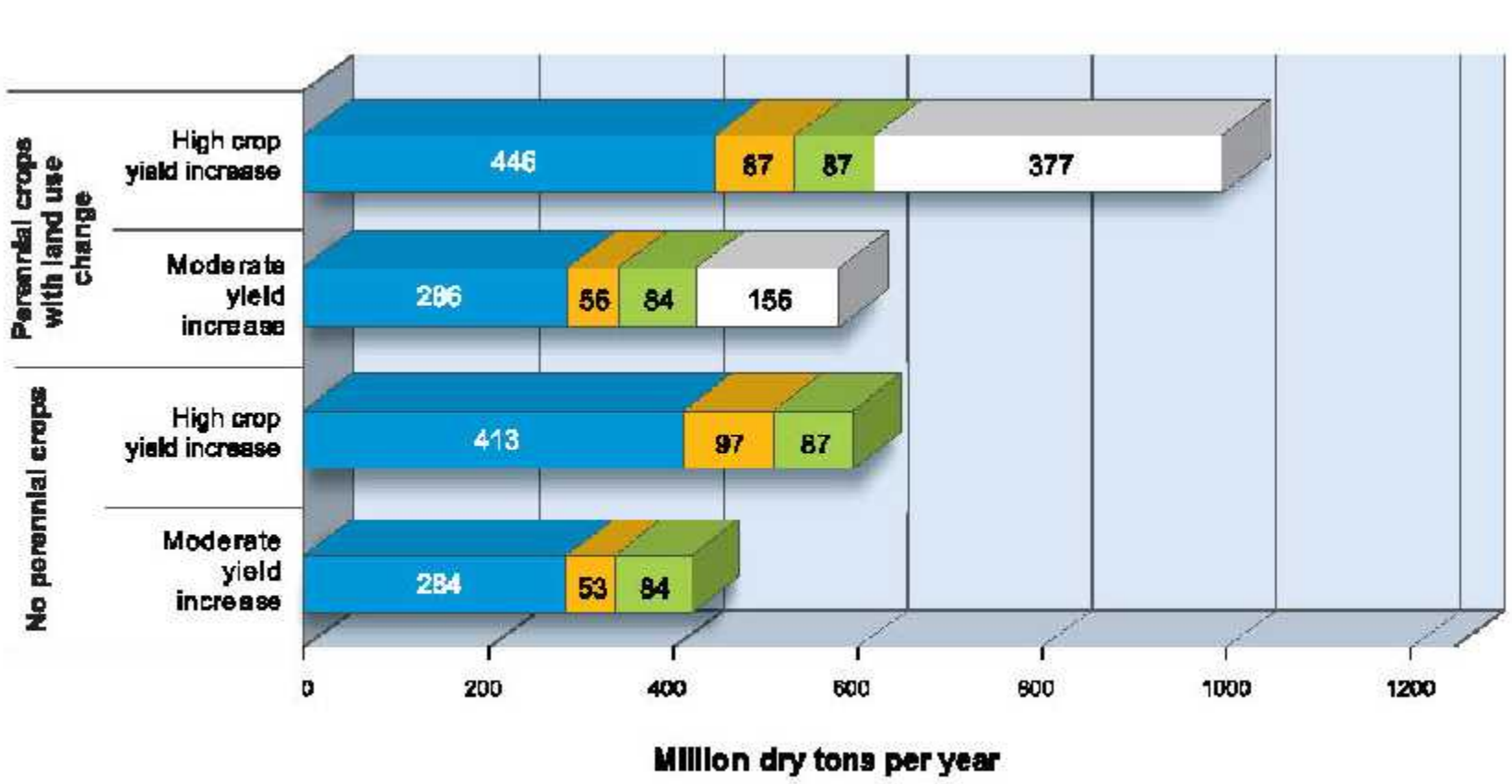
OAK RIDGE NATIONAL LABORATORY
ENERGY EFFICIENCY AND RENEWABLE ENERGY PROGRAM
U. S. DEPARTMENT OF ENERGY

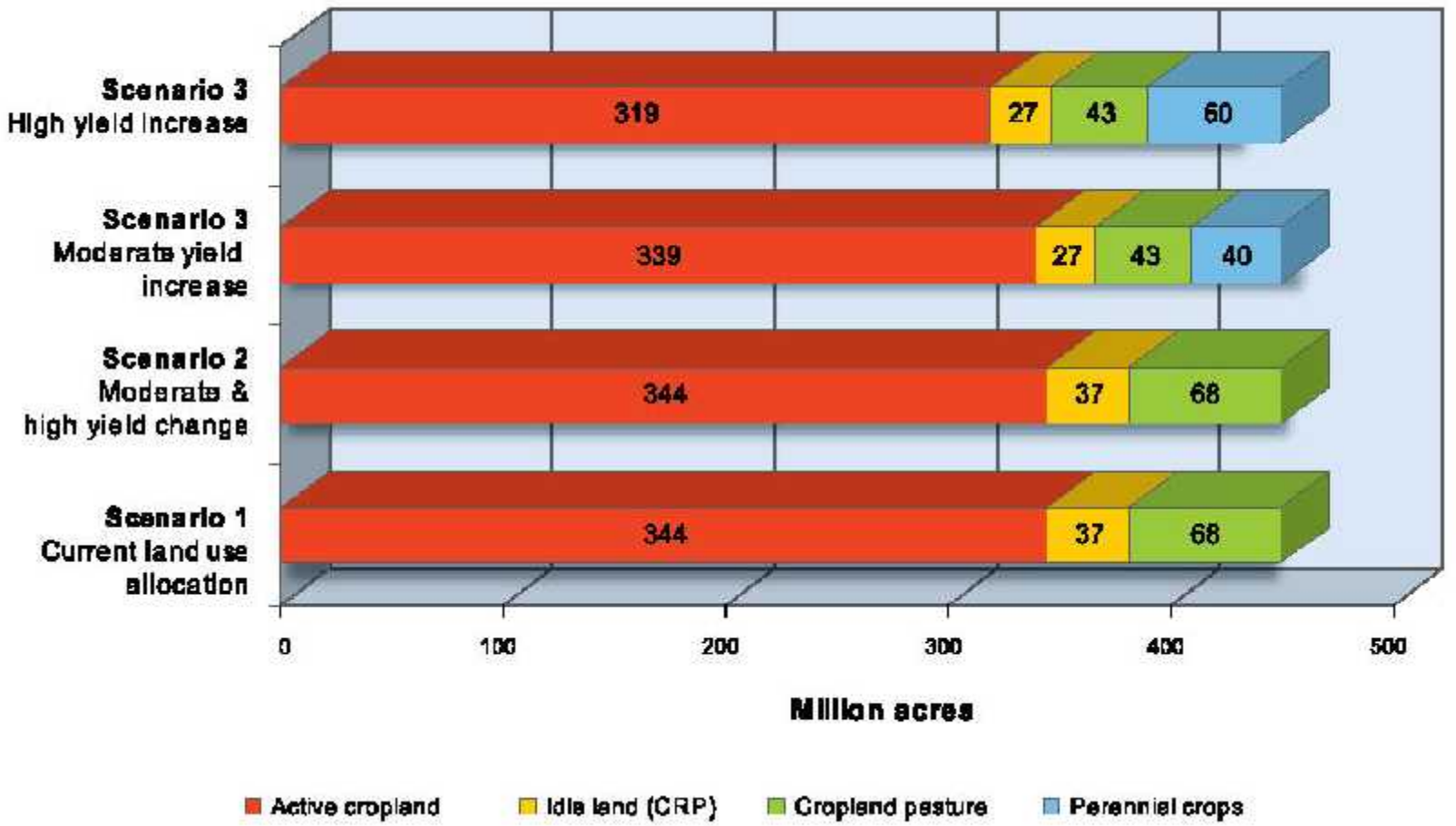
UT-BATTELLE

Agricultural Resource Summary

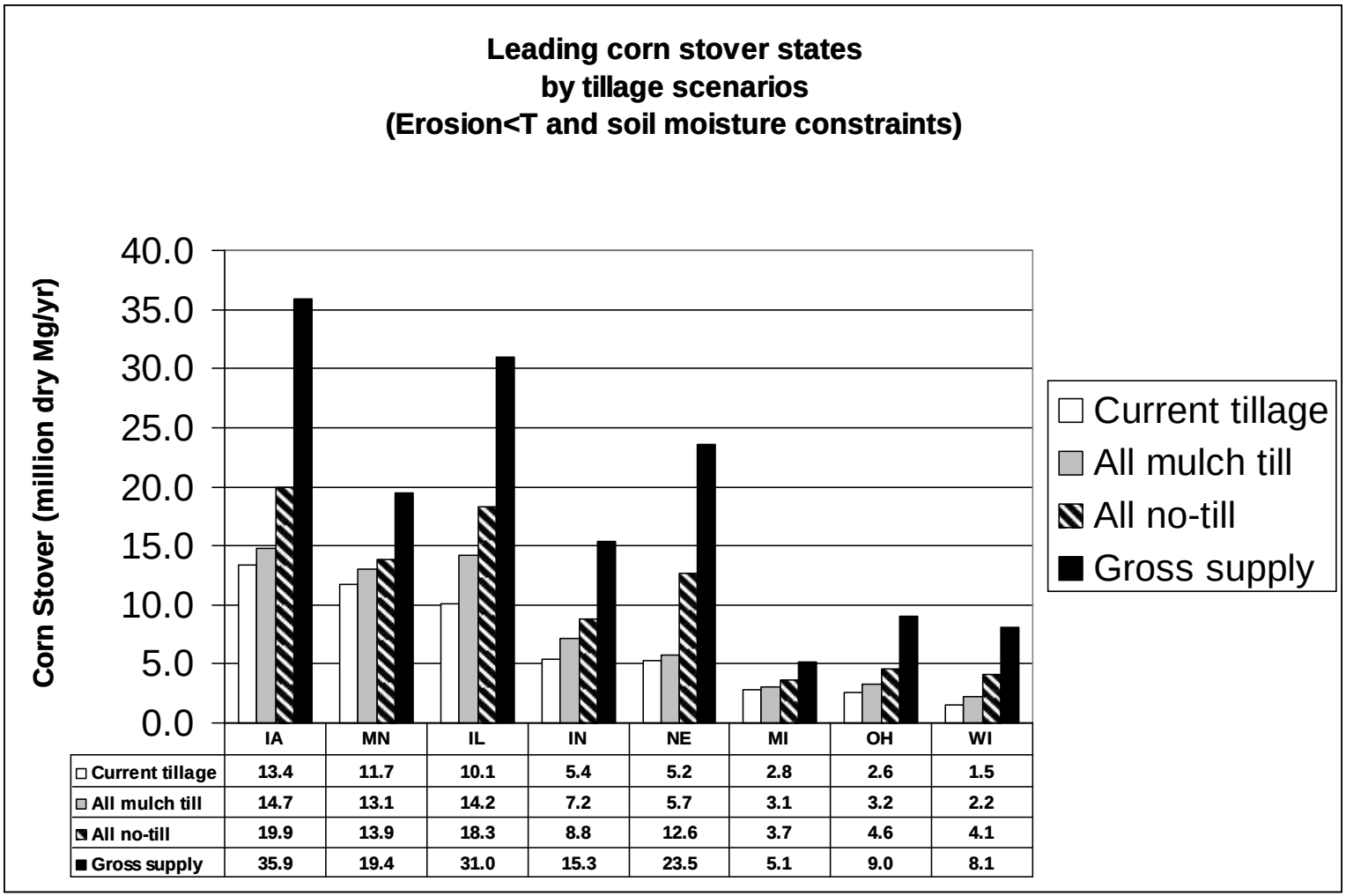
Sustainable agricultural resource potential exceeds 998 million dry tons



Billion Ton Supply Scenarios: Land Allocation Assumptions



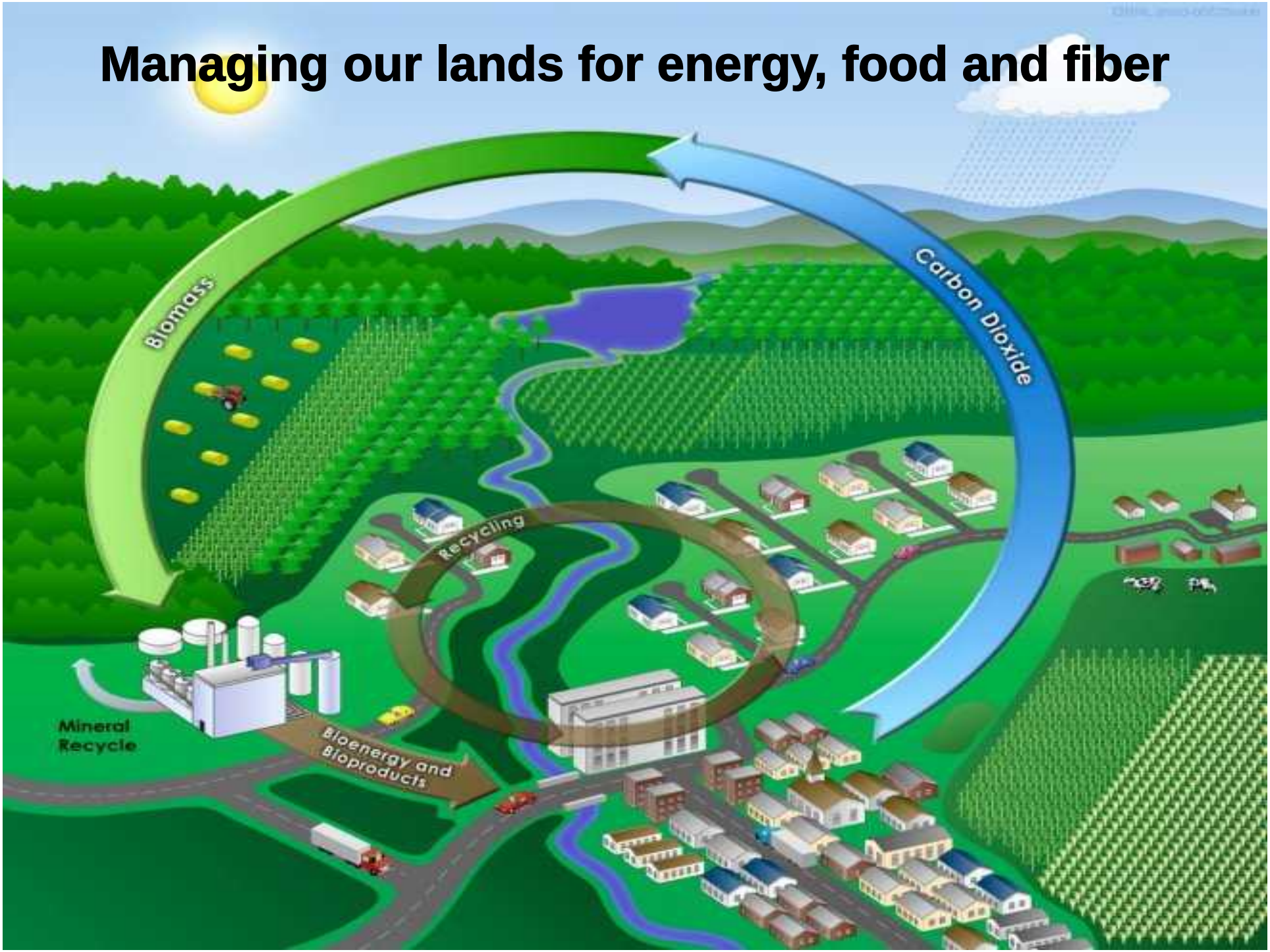
Corn stover use only beneficial if adequate levels left on the ground: depends on soils, climate and management



	IA	MN	IL	IN	NE	MI	OH	WI
Current tillage	13.4	11.7	10.1	5.4	5.2	2.8	2.6	1.5
All mulch till	14.7	13.1	14.2	7.2	5.7	3.1	3.2	2.2
All no-till	19.9	13.9	18.3	8.8	12.6	3.7	4.6	4.1
Gross supply	35.9	19.4	31.0	15.3	23.5	5.1	9.0	8.1

From: Graham et. al. Journal of Agronomy 99:1-11 (2007)

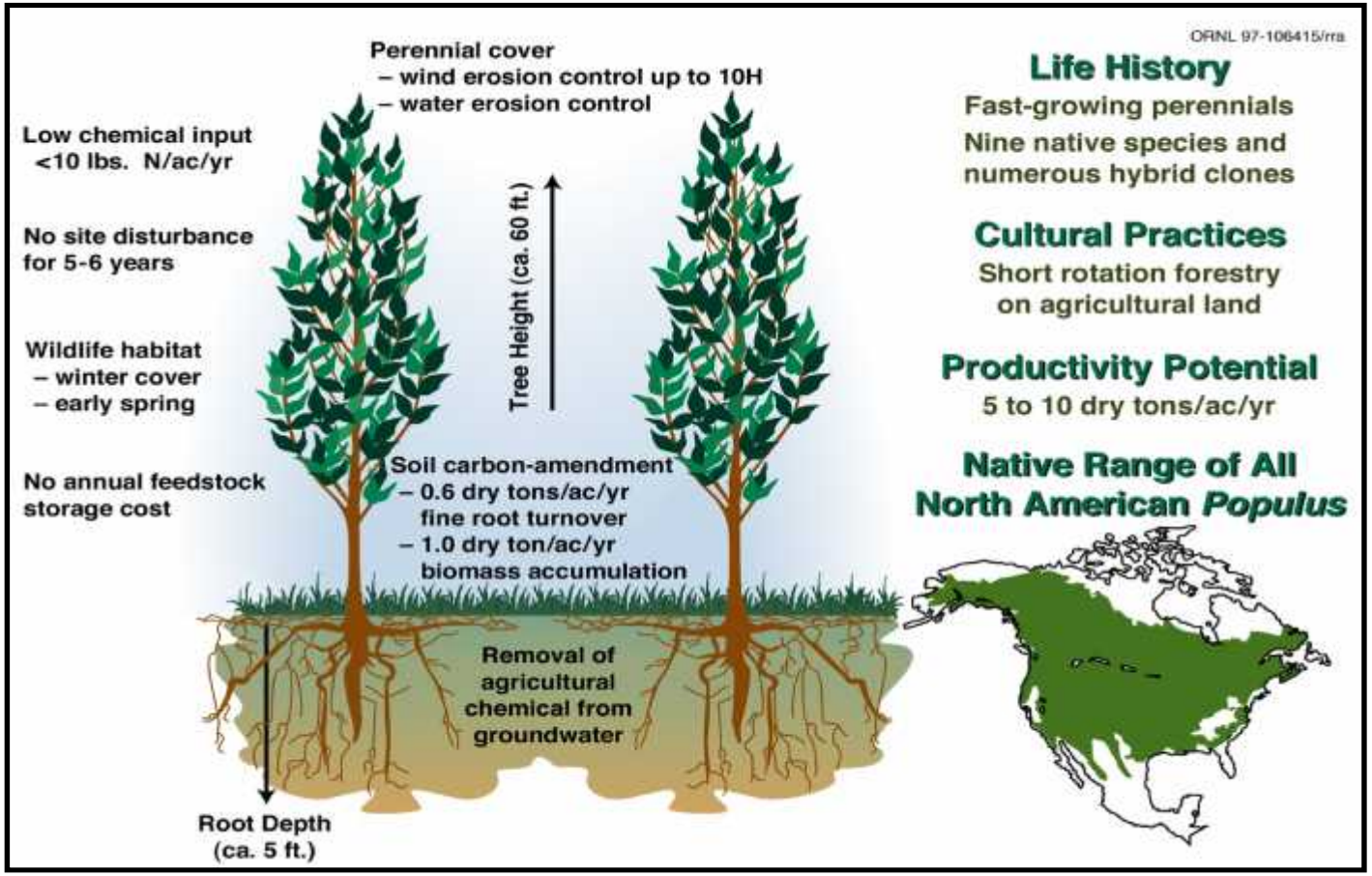
Managing our lands for energy, food and fiber



Biomass plantings within landscape contexts

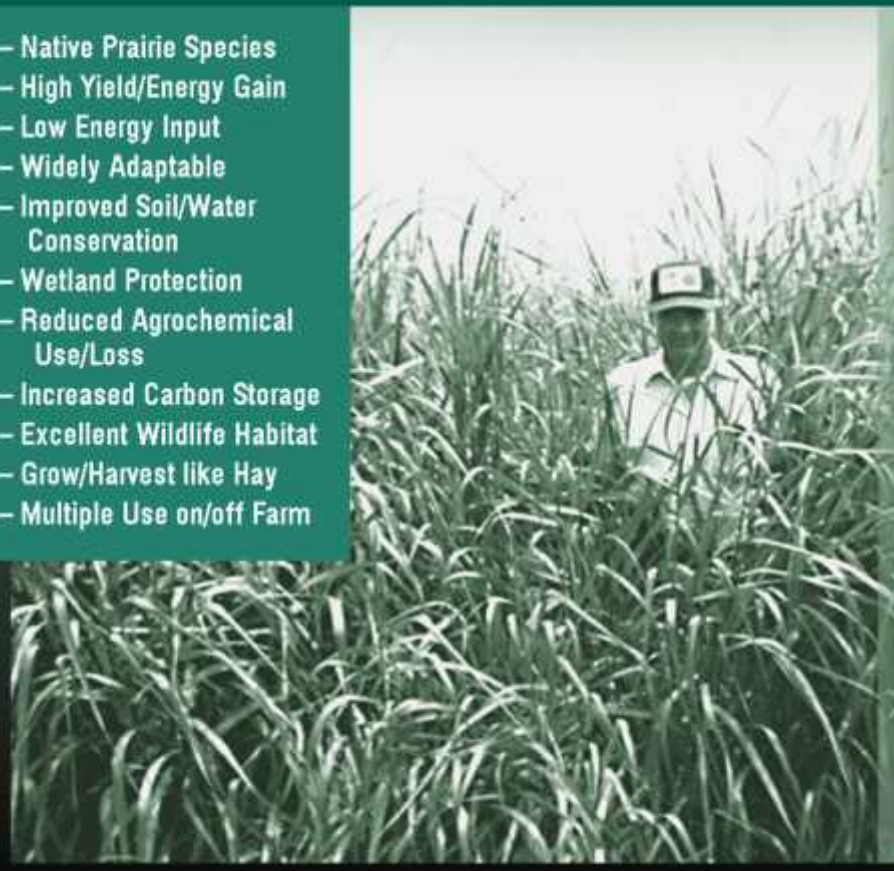
- Matching planting types with soil and site types increase site benefits and feedstock yields
- Biomass crops provide freeze, flood, and snow drift protection
- Buffer plantings (along waterways) can contribute to soil & water quality benefits, wildlife habitat, and aesthetics
- Using woody planting to link natural stands can expand wildlife corridors
- Multiple feedstocks can help ensure continuous supplies of resources for various end users as well as increase biodiversity

Poplar Attributes



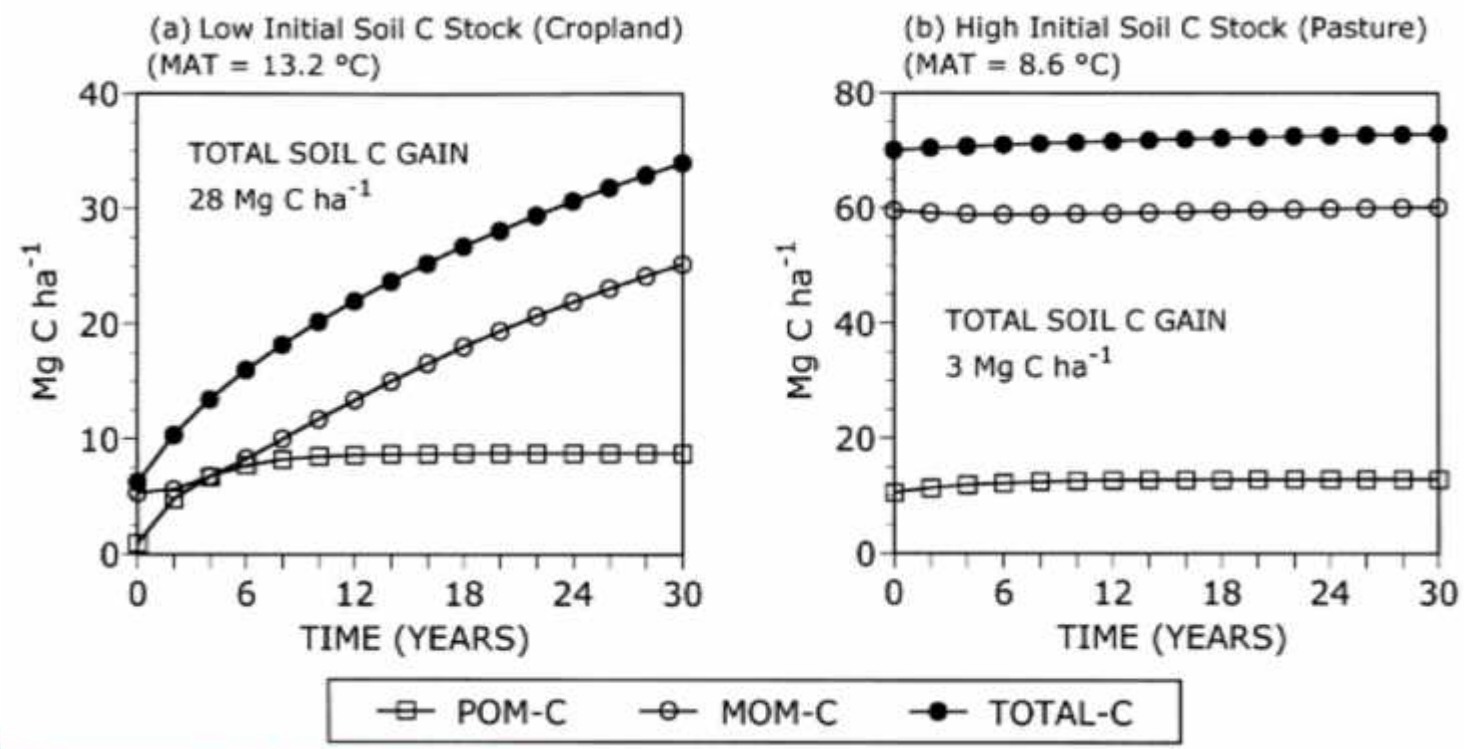
ATTRIBUTES OF SWITCHGRASS

- Native Prairie Species
- High Yield/Energy Gain
- Low Energy Input
- Widely Adaptable
- Improved Soil/Water Conservation
- Wetland Protection
- Reduced Agrochemical Use/Loss
- Increased Carbon Storage
- Excellent Wildlife Habitat
- Grow/Harvest like Hay
- Multiple Use on/off Farm

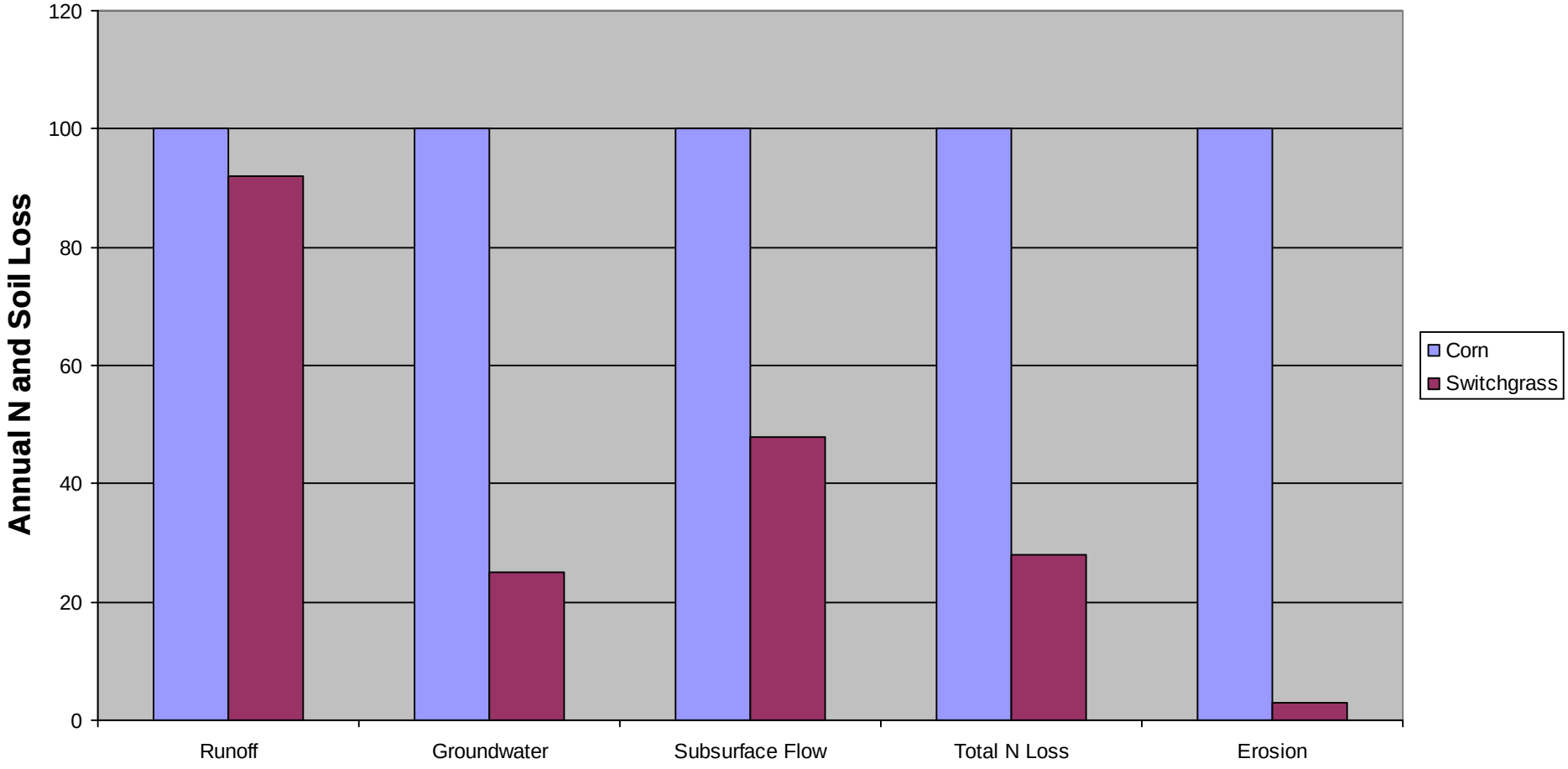


Switchgrass can significantly improve soil quality and stability, and increase soil carbon in cropland soils, because of high root to top ratio

Soil carbon gain modeled
Based on actual field data
Garten (ORNL)

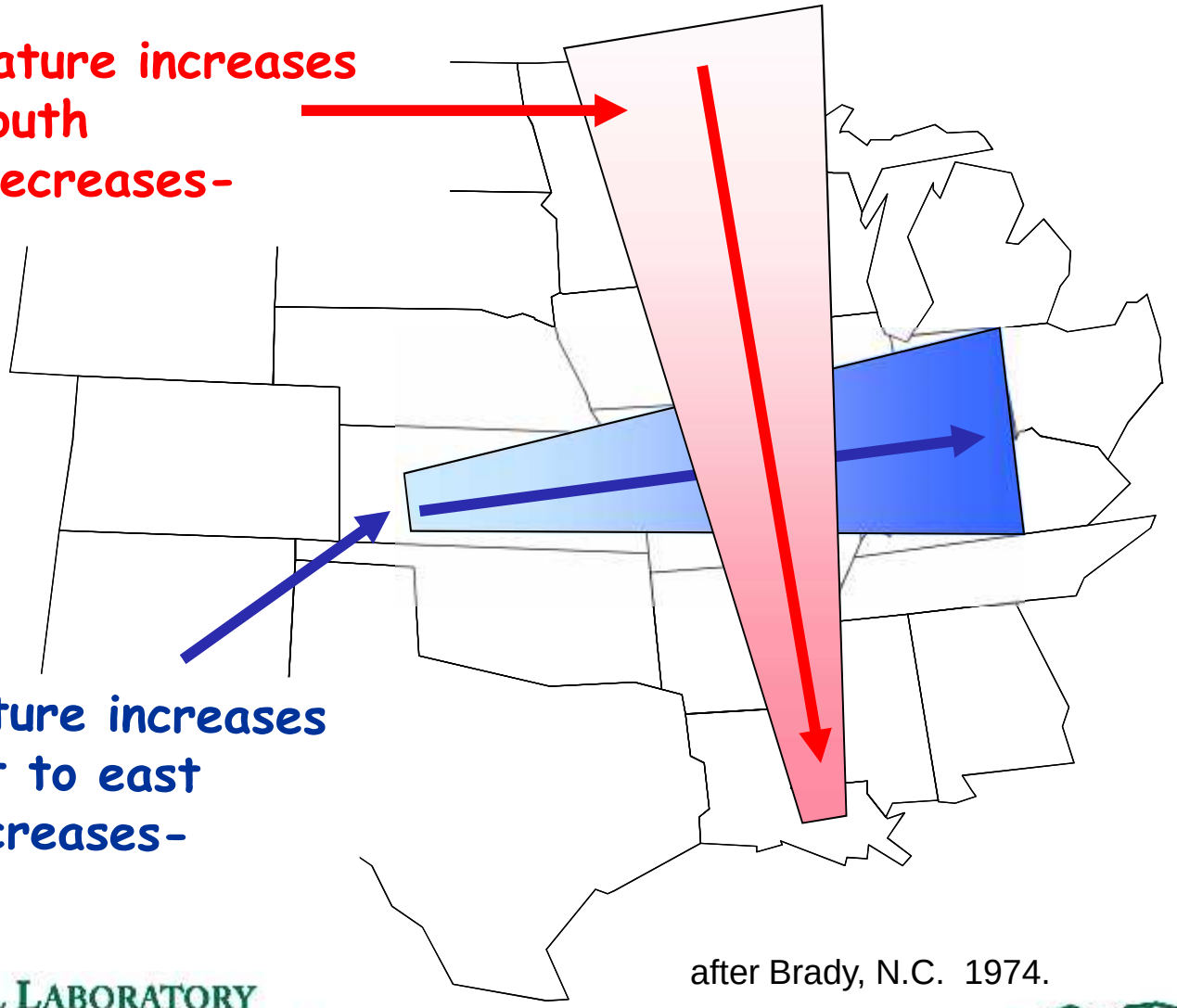


ALMANAC - Changes in N Loss and Erosion In Conversion of Corn to Switchgrass



Why specific environmental data from one region is not representative of whole US

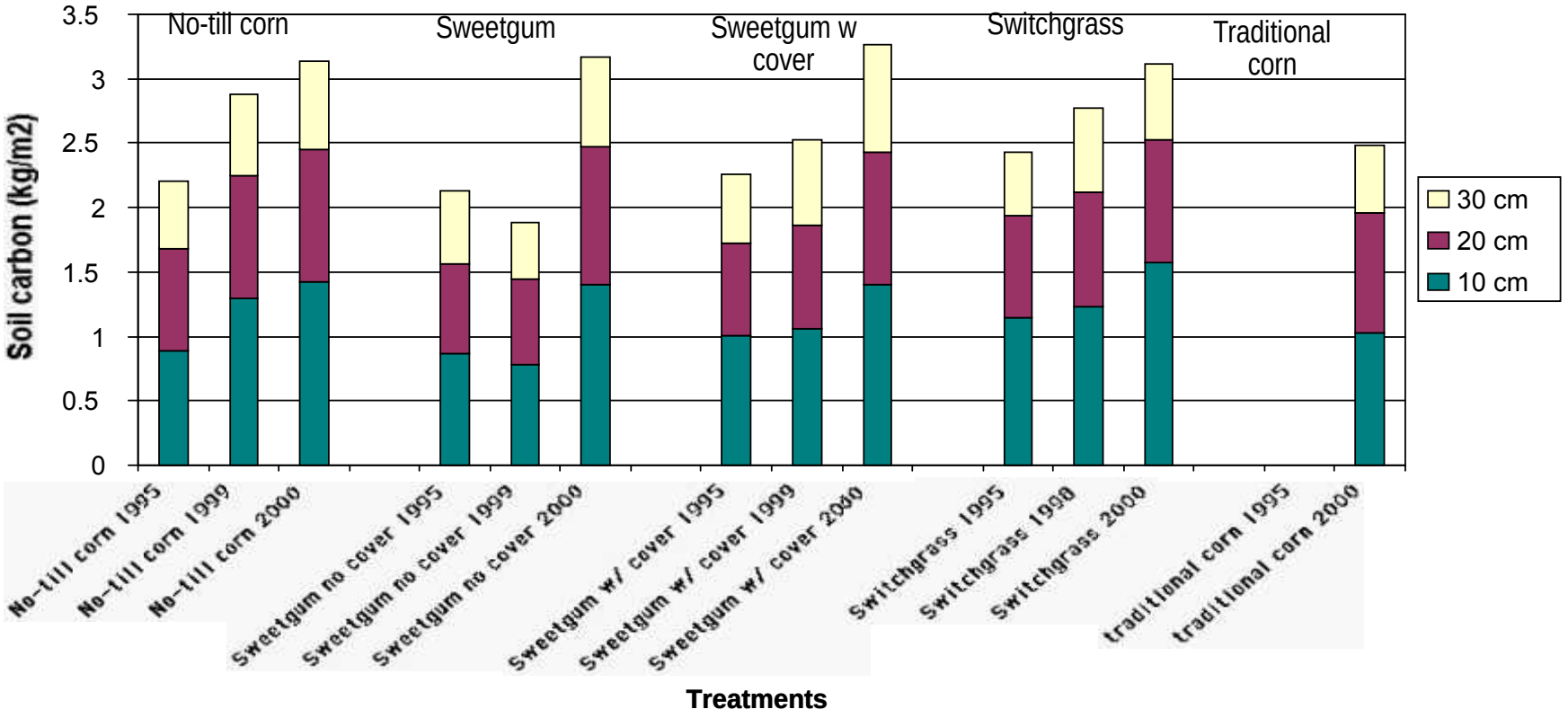
Average temperature increases from north to south
-SOM decreases-



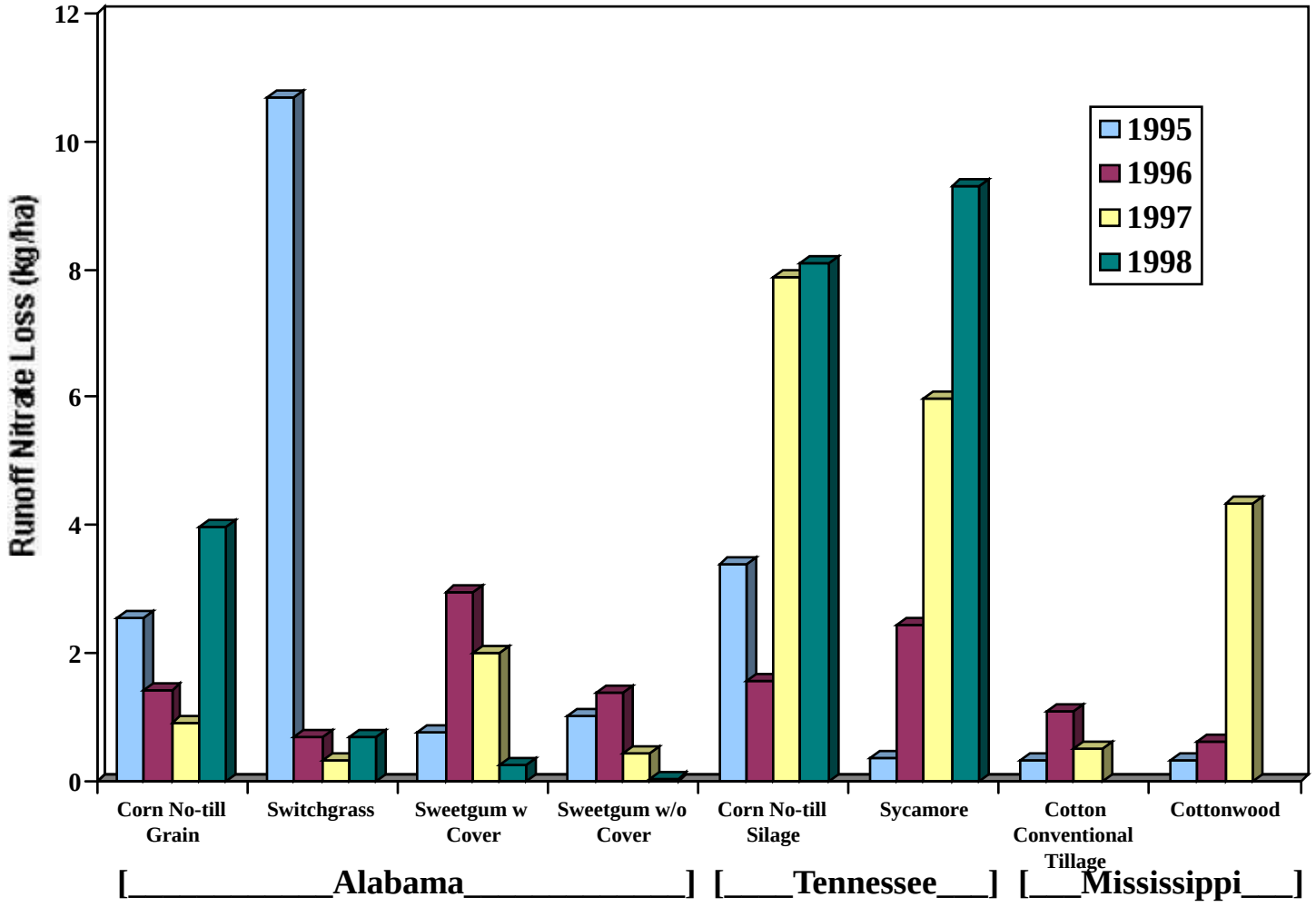
Effective moisture increases from west to east
-SOM increases-

after Brady, N.C. 1974.

Soil Carbon Comparisons at 0-30 cm for biomass and Ag crops in Alabama 1995, 1999, 2000



Nitrate Losses in Runoff
from biomass crops and Ag crops in the Southeast



Identified Ecological Benefits for Energy Crops

- **Increased soil carbon storage**
  - Varies across soils, regions, with soil quality, & initial OM content
  - Occurs through the soil profile & increases with crop age
    - End point for increases is not yet known
  - Management practices play a major role in OM accumulation and carbon increases
    - For residue (e.g., corn stover) removal where, when, and how much remain issues for soil carbon storage and soil quality
- **Improved soil quality and soil stability**
  - Perennial biomass crops increase soil porosity, infiltration, and nutrient availability
  - Soil cover provided by switchgrass and leaf litter provide wind and water erosion protection
    - Questions remain about sustainability of harvesting corn stover for ethanol
    - Questions remain about sustainability of multiple rotation harvesting

Identified Ecological Benefits for Energy Crops and related stakeholder concerns

- **Less nutrient and chemical migration**
  - Perennial cover helps reduce runoff & chemical transport particularly in early rotation
  - Matching nutrient input with crop needs & timing of application can minimize transport
  - Biomass crops increase soil water holding capacity and reduce spring flooding/nutrient losses
  - Extensive rooting systems reduce nutrient losses through the soil profile

- **Increased biodiversity**
  - Found for both woodland and grassland birds
  - Greater use by wildlife than agricultural crops, similar use to grasslands, and with age similar to natural forests
  - Location of biomass crops within the landscape is an important issue for use, continuity of habitat, and species diversity