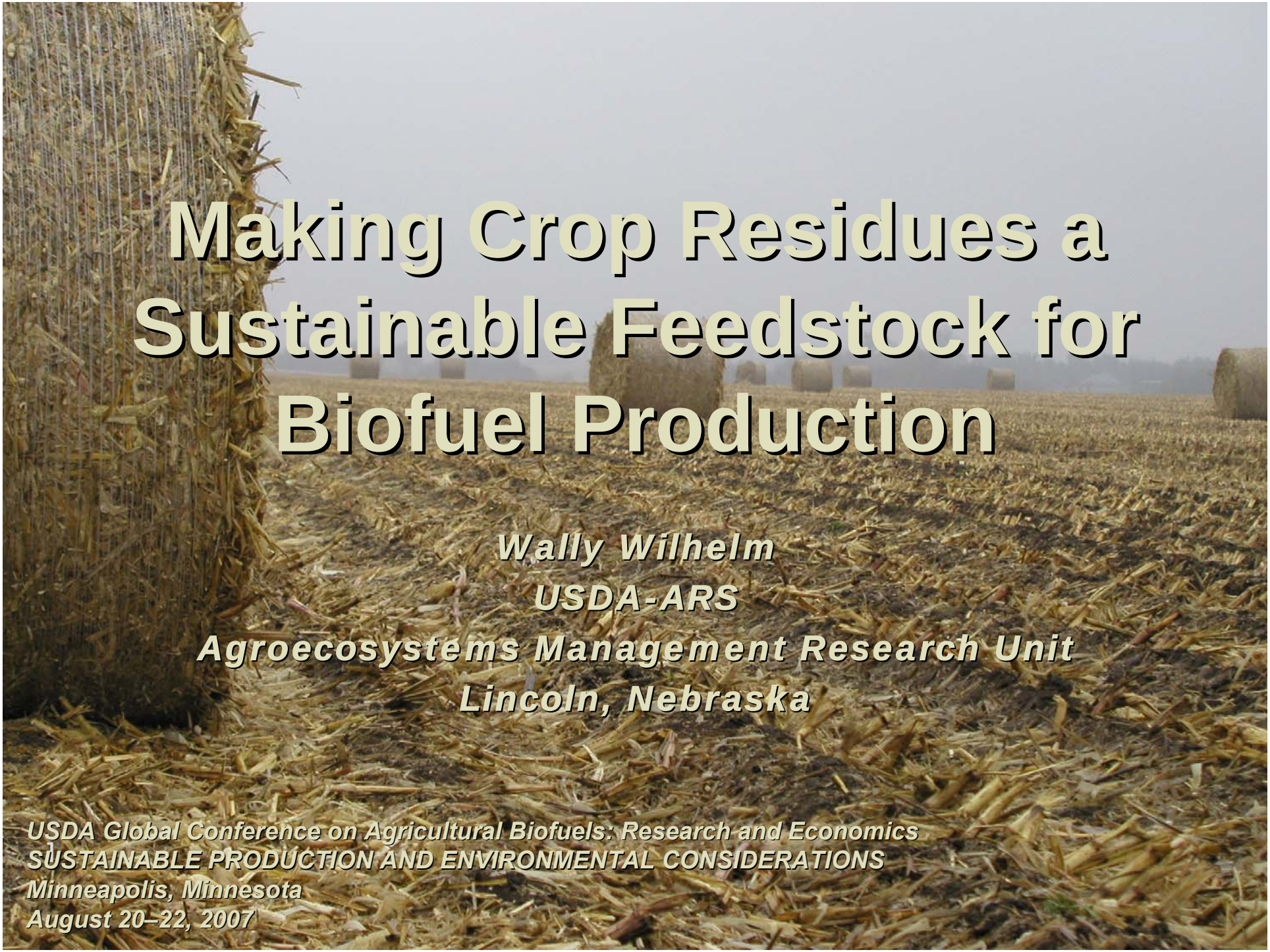

Making Crop Residues a Sustainable Feedstock for Biofuel Production

Wally Wilhelm
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Agroecosystems Management Research Unit
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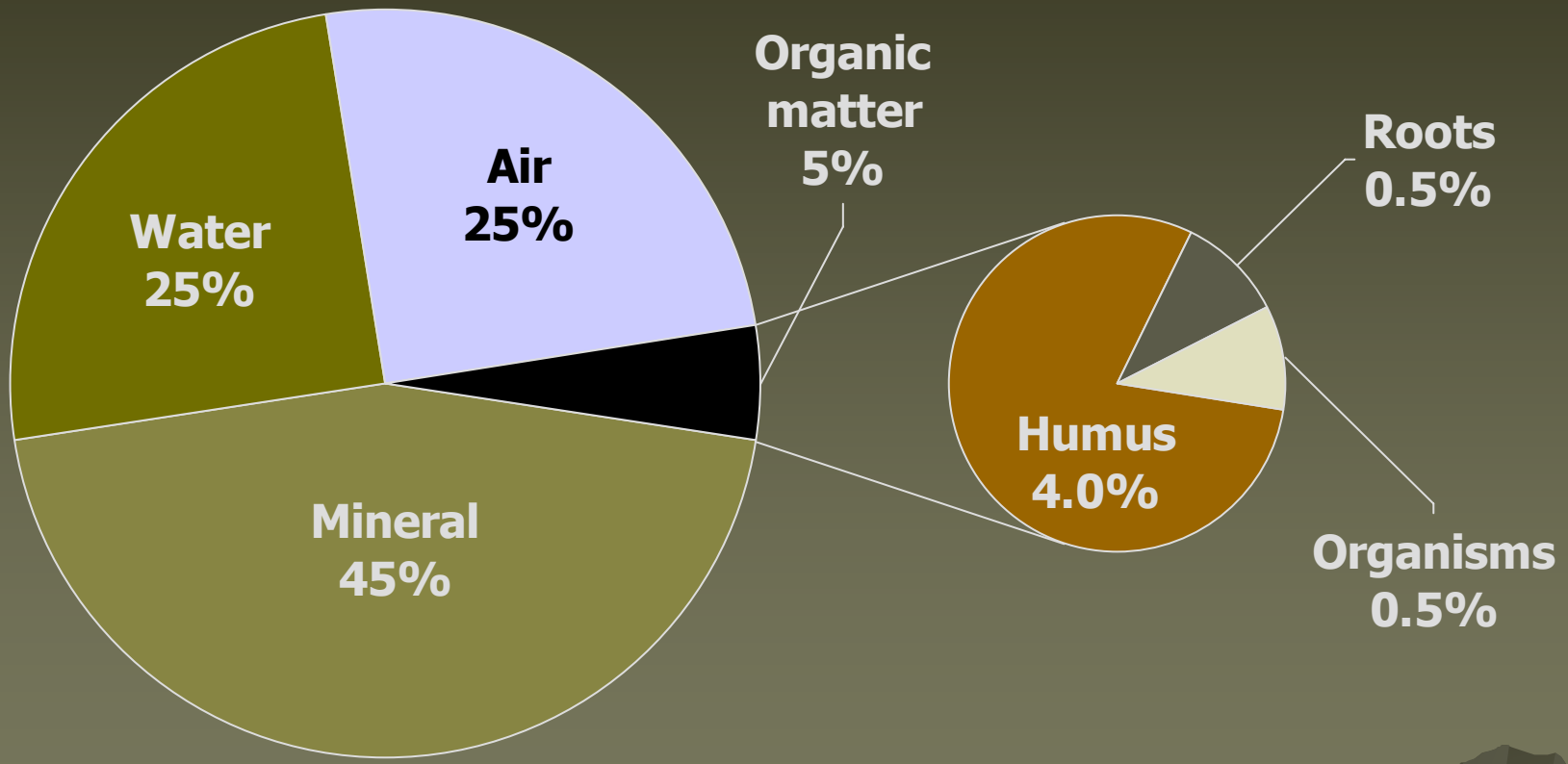
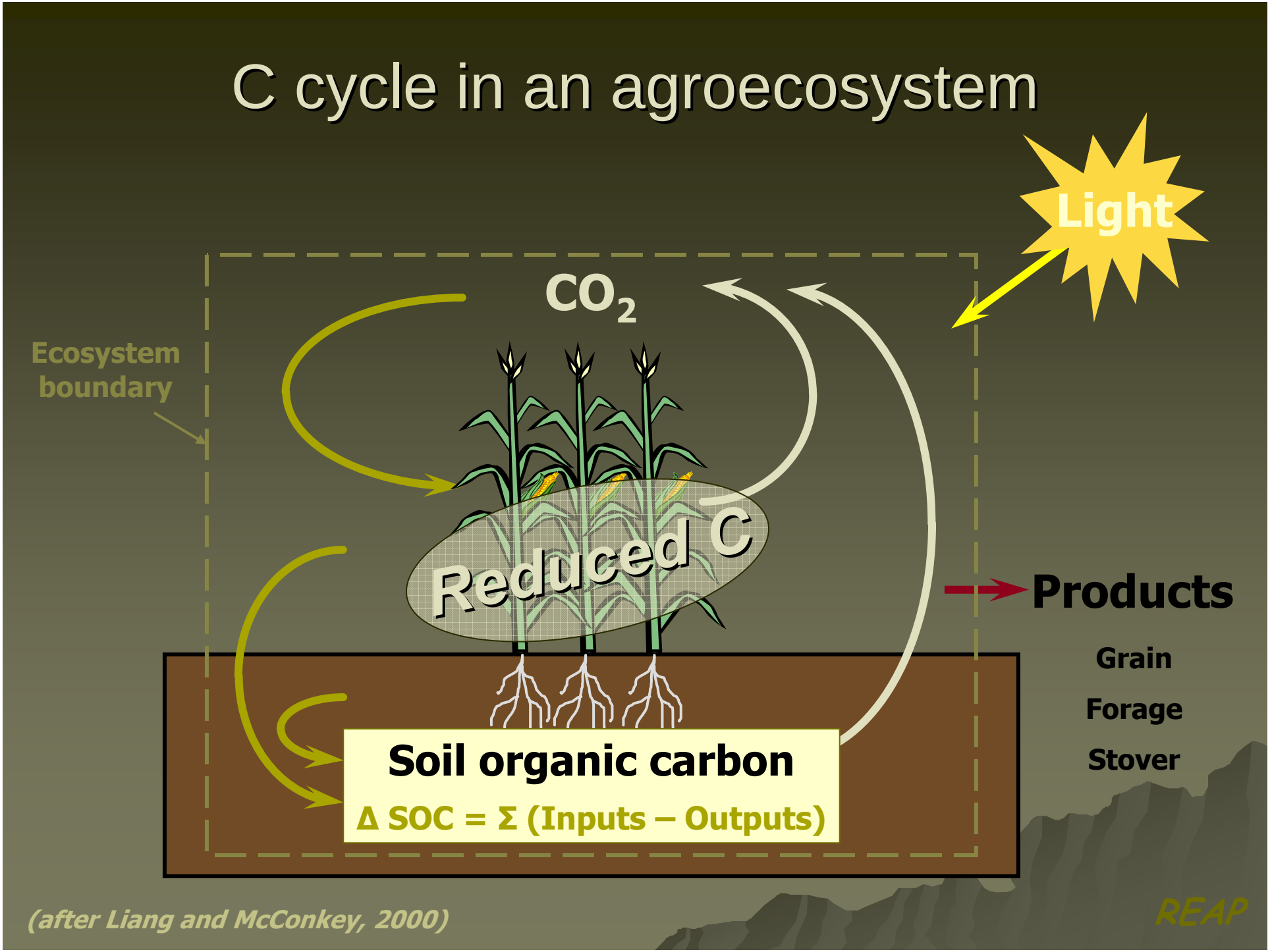
USDA Global Conference on Agricultural Biofuels: Research and Economics
SUSTAINABLE PRODUCTION AND ENVIRONMENTAL CONSIDERATIONS
Minneapolis, Minnesota
August 20–22, 2007


Our soil resource

Soil components



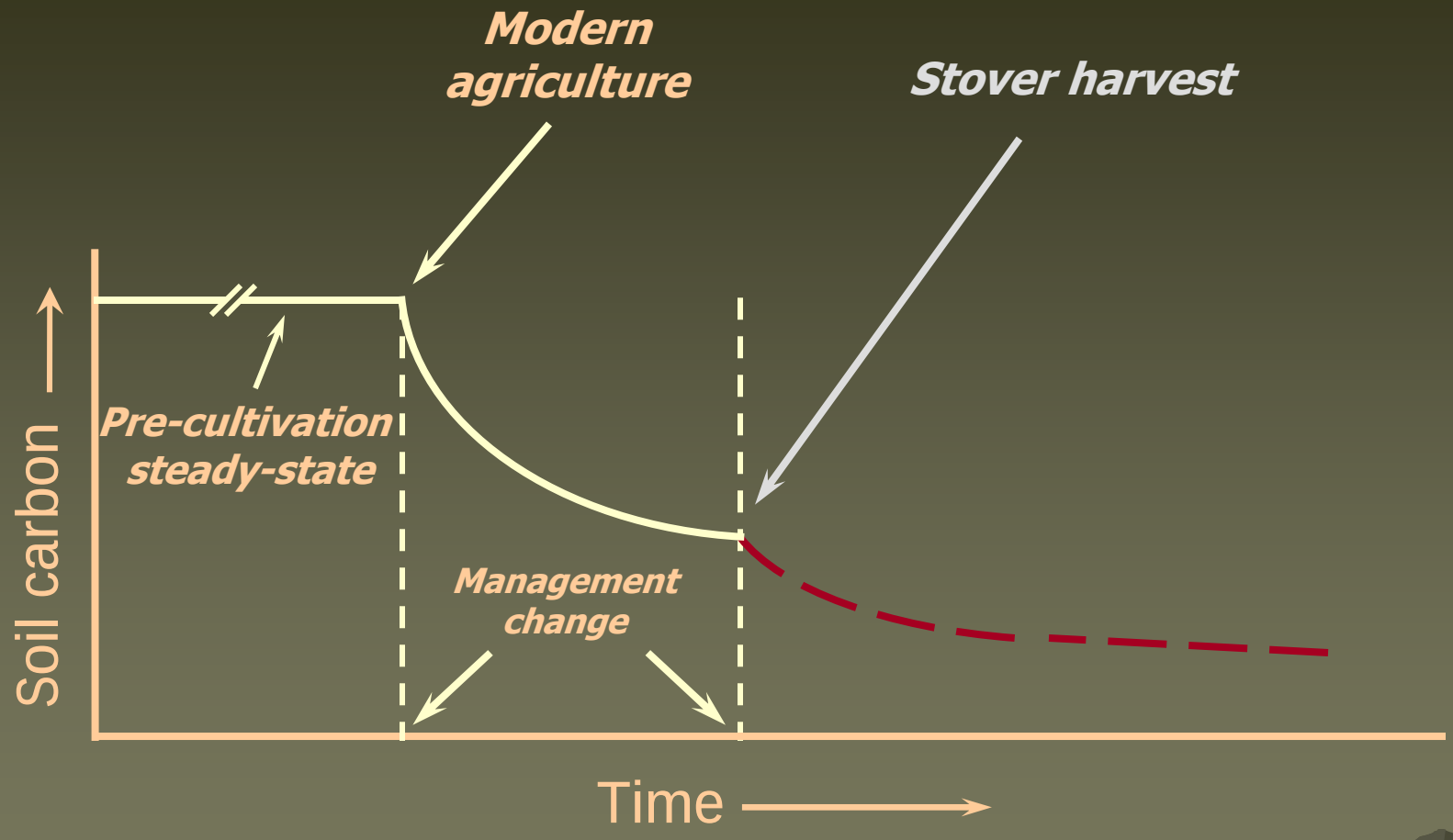
C cycle in an agroecosystem



(after Liang and McConkey, 2000)

REAP

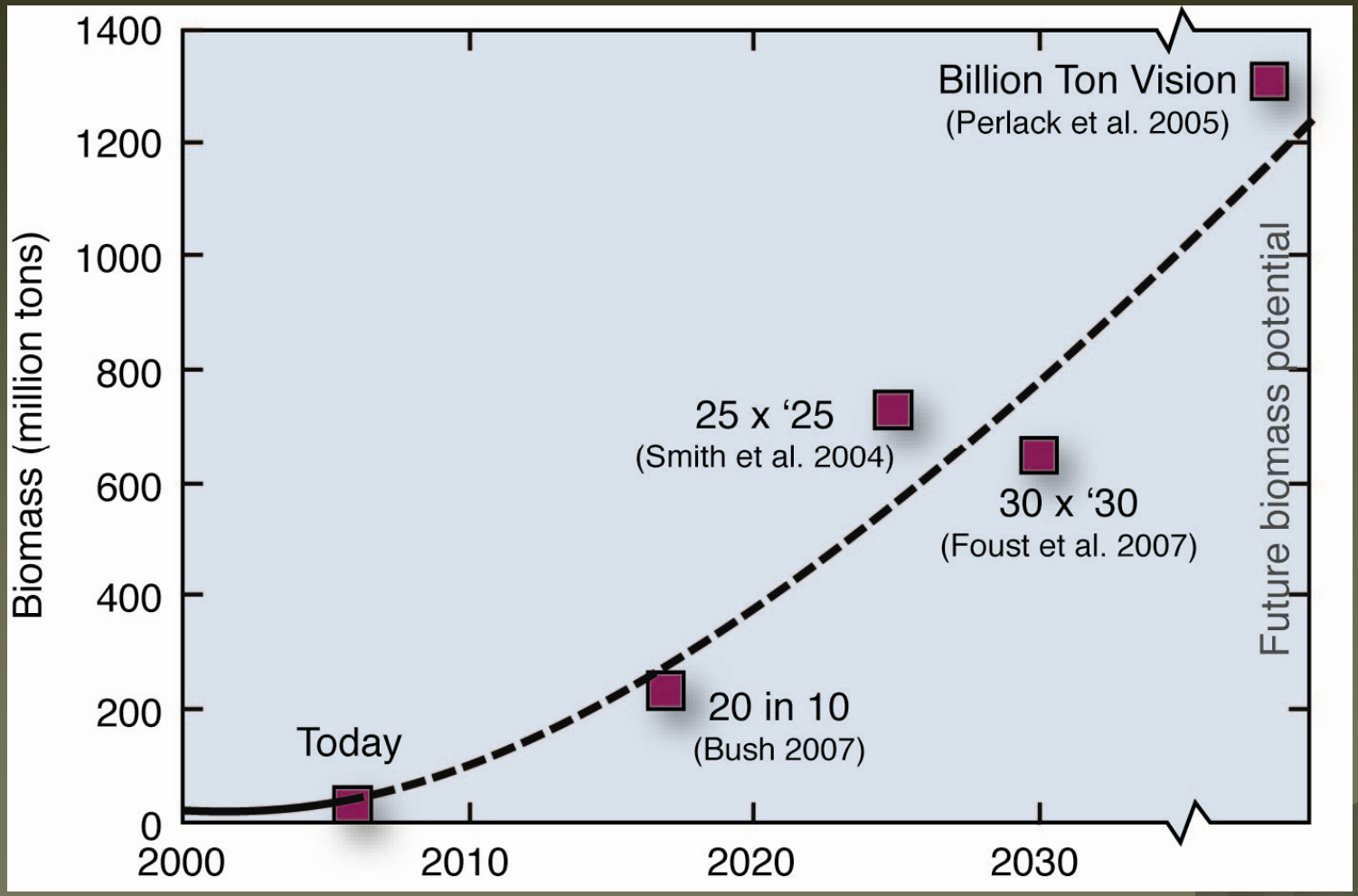
Agriculture and soil C change



Δ SOC = input - output

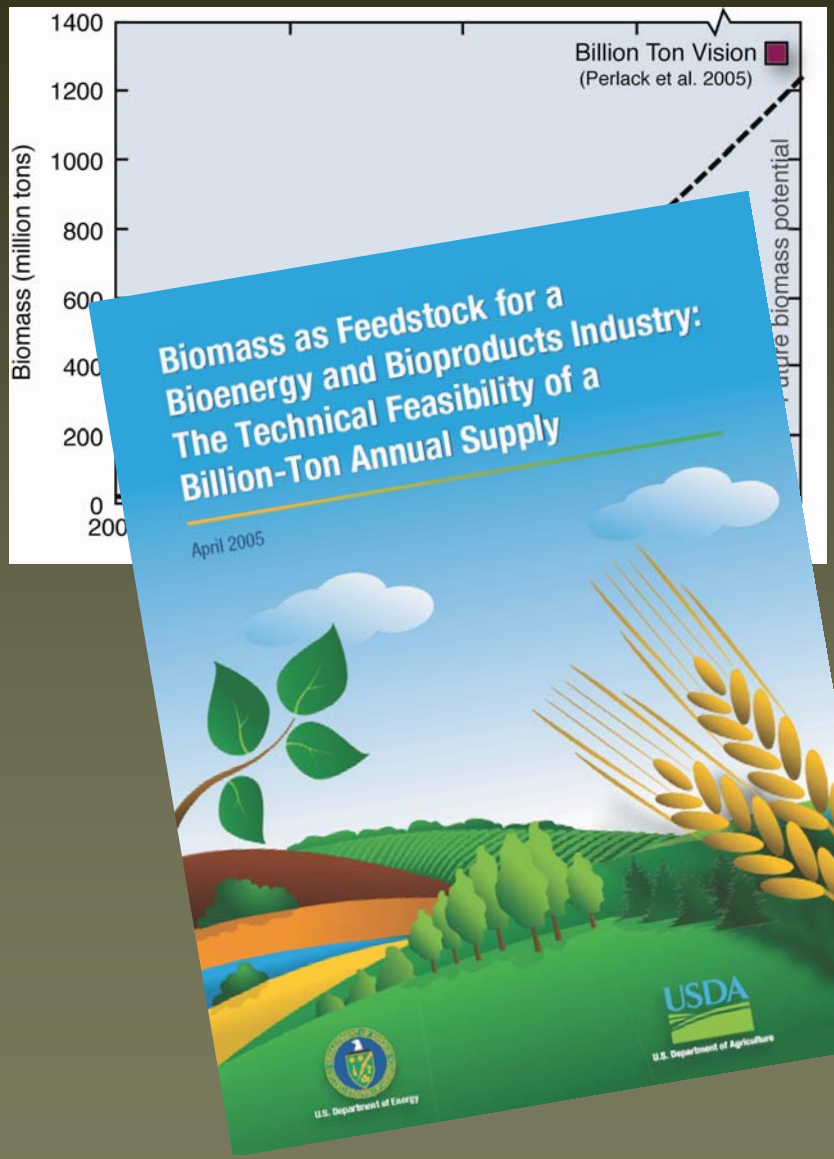
REAP

Biomass ethanol goals



REAP

Biomass ethanol goals



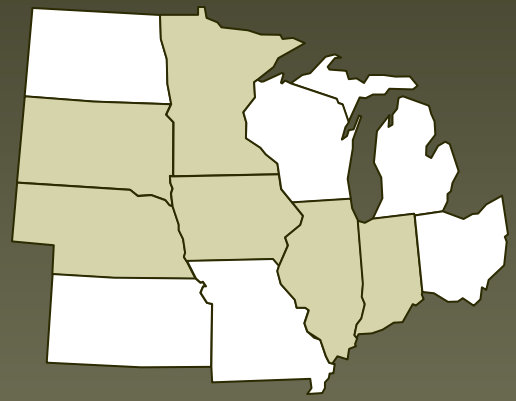
- Sustainably produce ONE BILLION TONS* of feedstock annually
  - Yield increase 50% by 2030
    - Corn and small grains
  - Residue/grain ratio for soybean increase from 1.5:1 to 2.0:1
  - Machine to recover 75% stover
  - No tillage adopted universally

(*0.91 billion Mg)

REAP

What is a ONE BILLION?

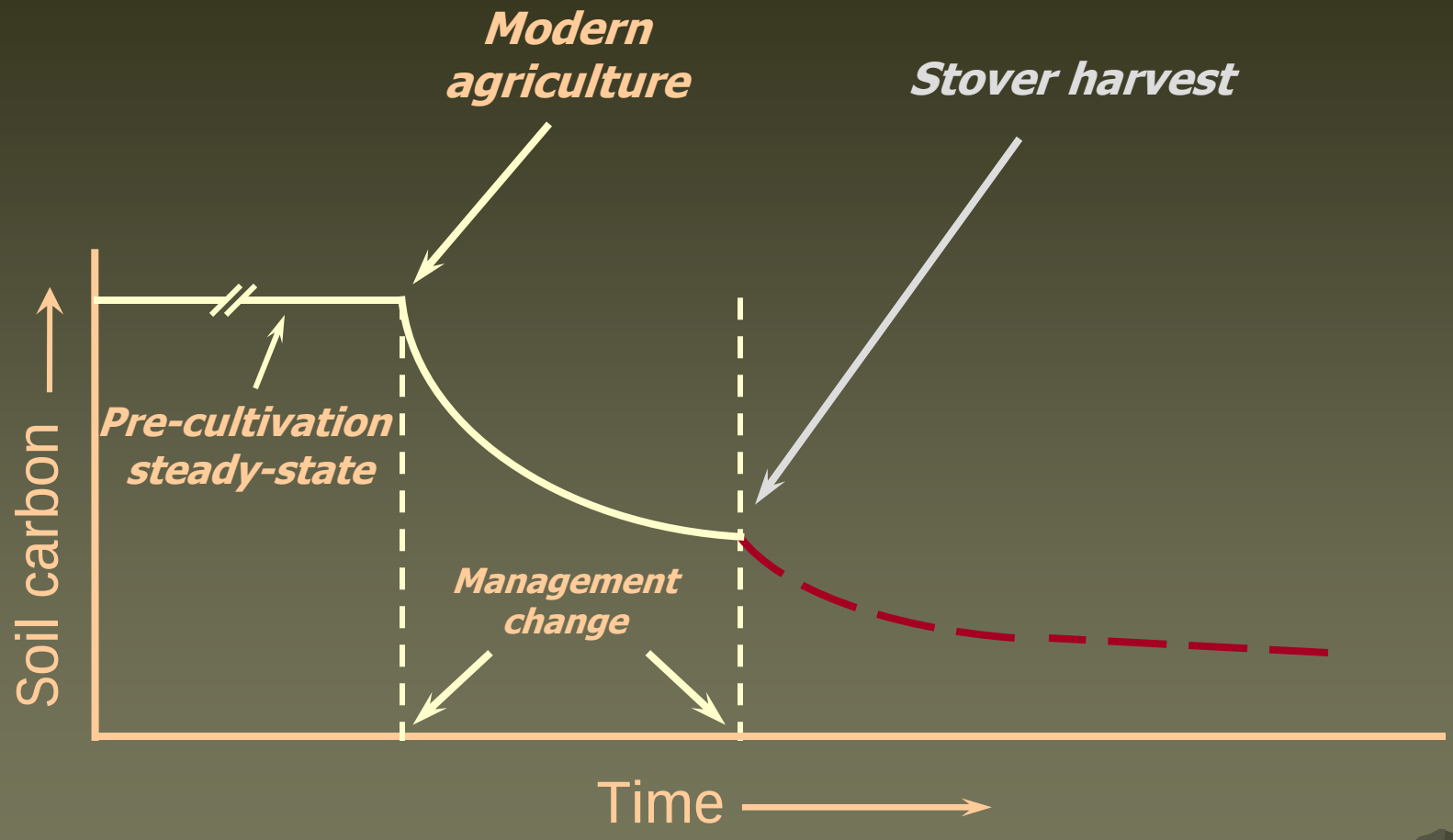
- Agricultural land (cropland plus hay and pasture land)
  - 5 ton ac^{-1}
  - 200 x 10^6 acres
    - 56% of North Central Region agricultural land
    - Iowa, Illinois, Nebraska, Minnesota, Indiana, and South Dakota (Total = 195.5 x 10^6 ac)
  - Six leading corn producing states in US



Expectations for agriculture

- Provide traditional outputs for an increasing world population
  - Food
  - Feed
  - Fiber
- Environmental services
  - Control erosion
  - Sequester C
  - Habitat
  - Water quality
- Replenish SOC/plant nutrients
- Renewable energy feedstock
  - 998 million tons (428 million ton from crop residues)

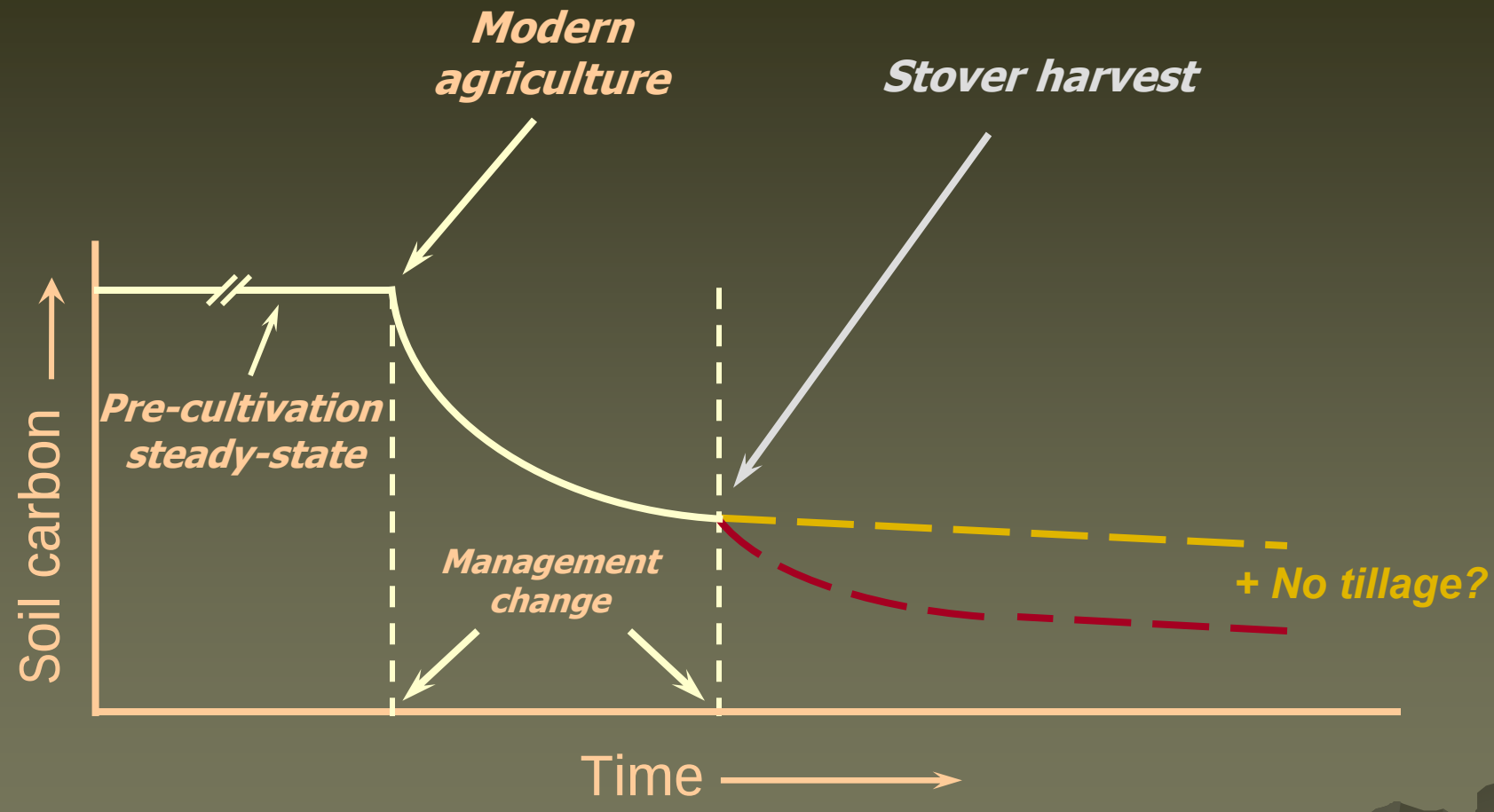
Meeting expectations sustainably



Δ SOC = input - output

REAP

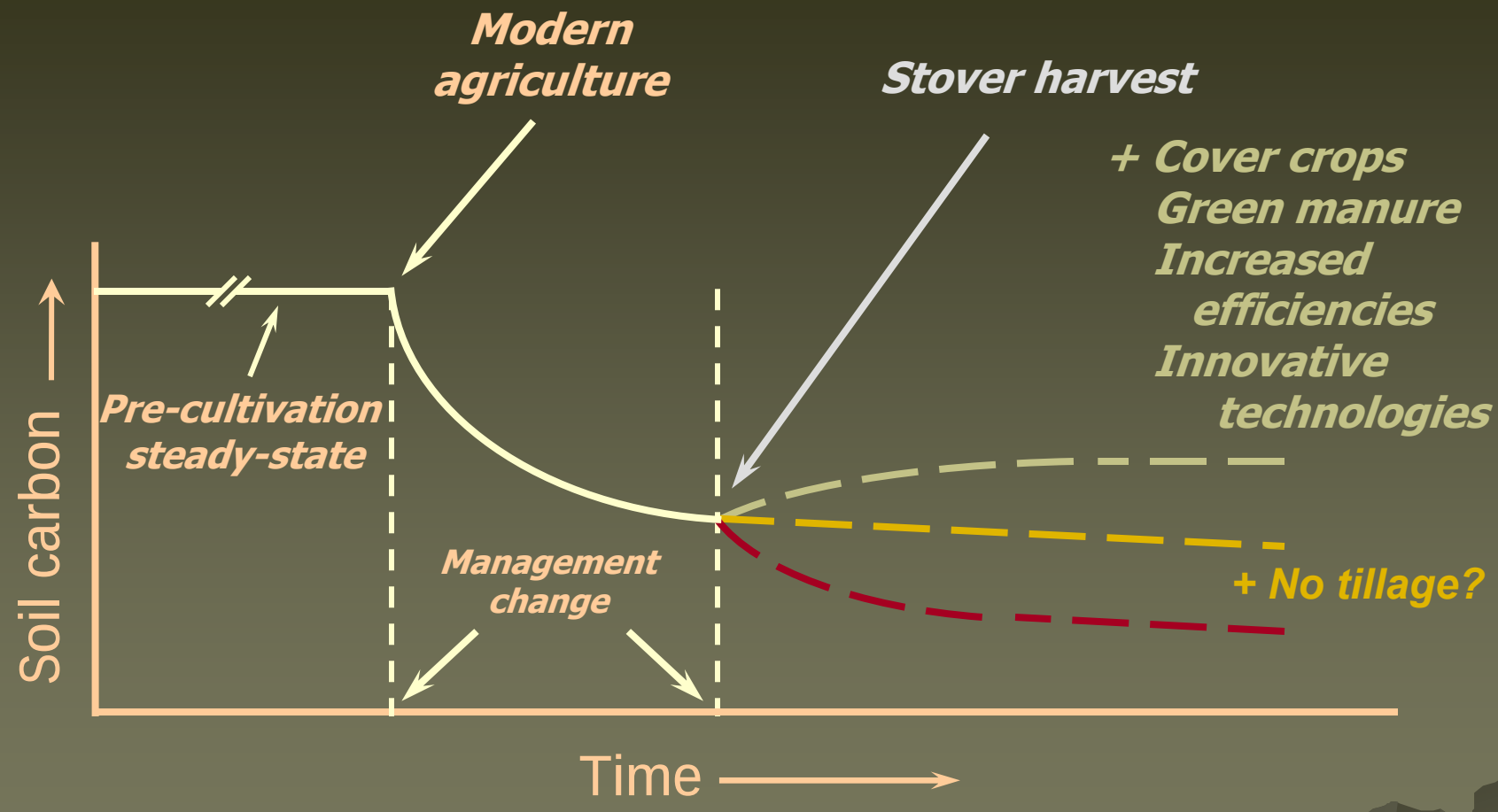
Meeting expectations sustainably



Δ SOC = input - output

REAP

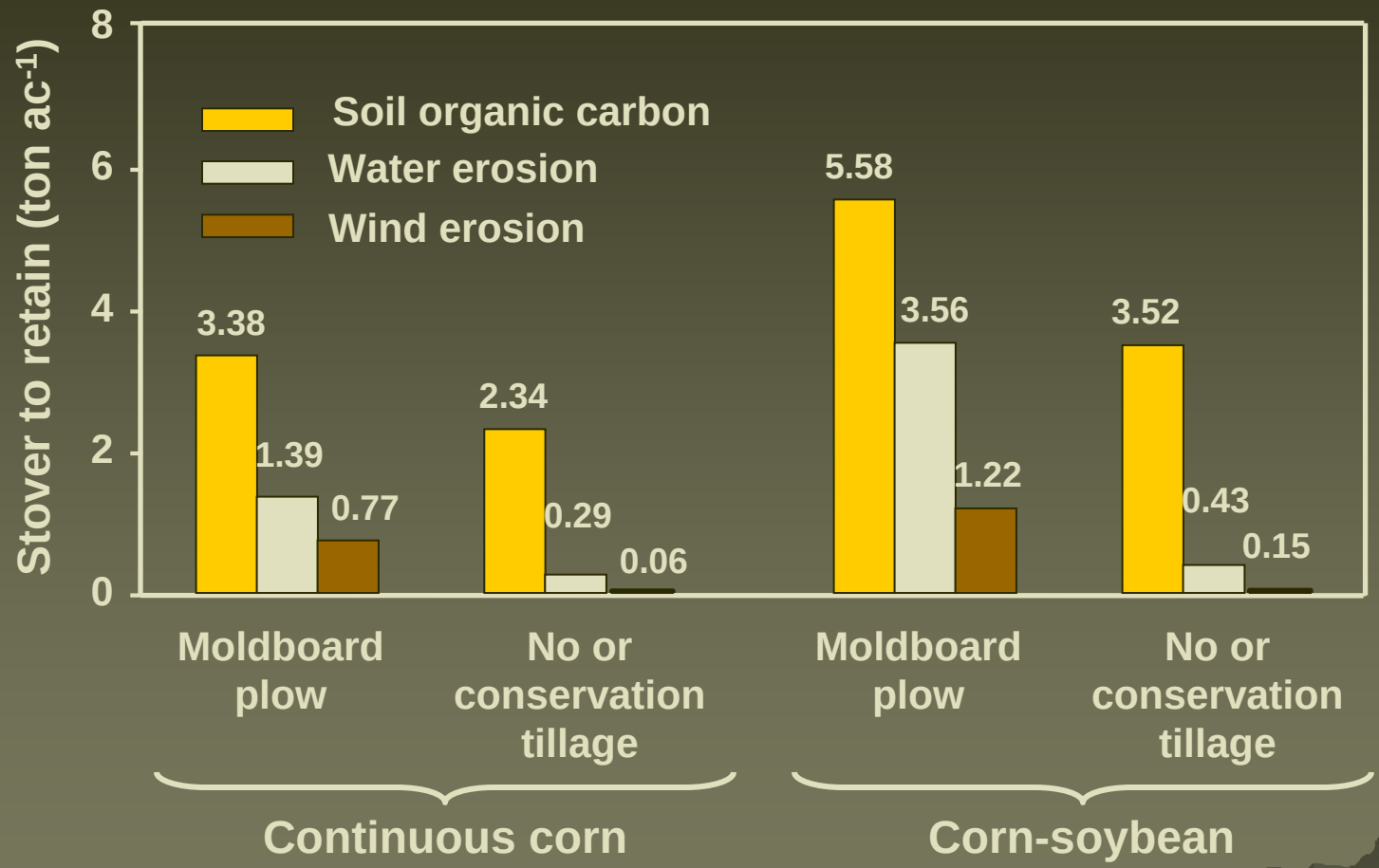
Meeting expectations sustainably



Δ SOC = input - output

REAP

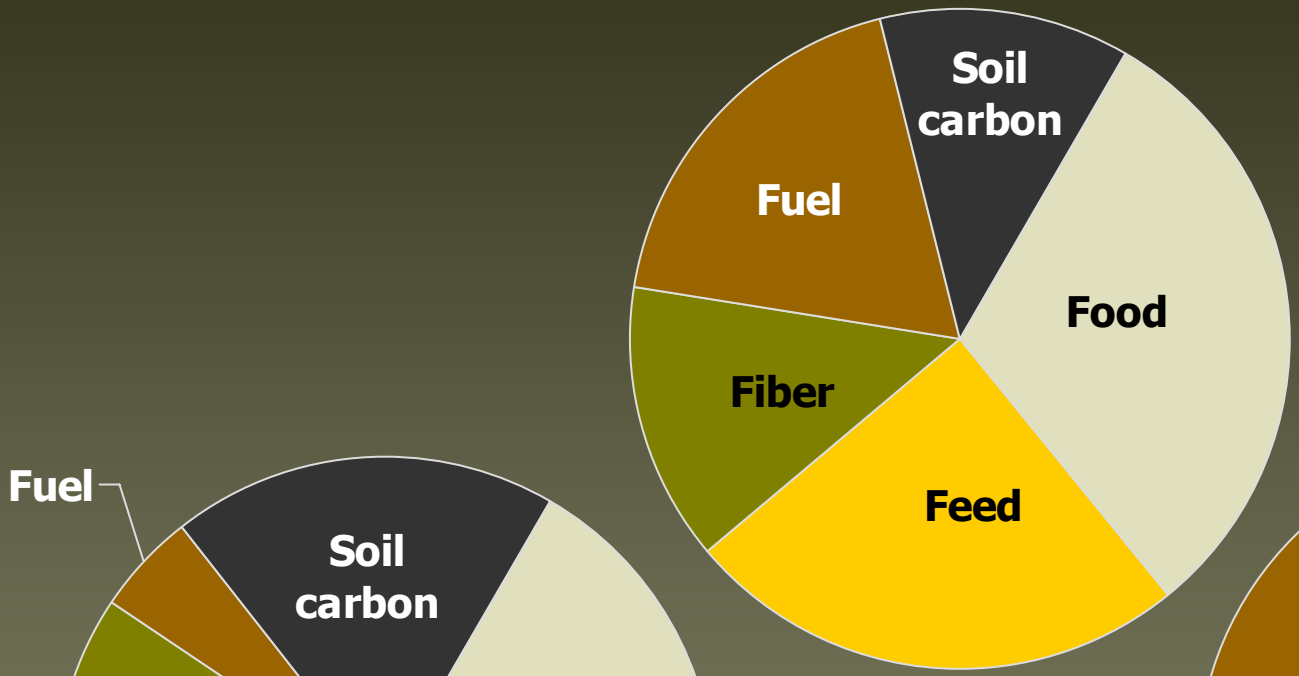
Factors limiting crop biomass removal

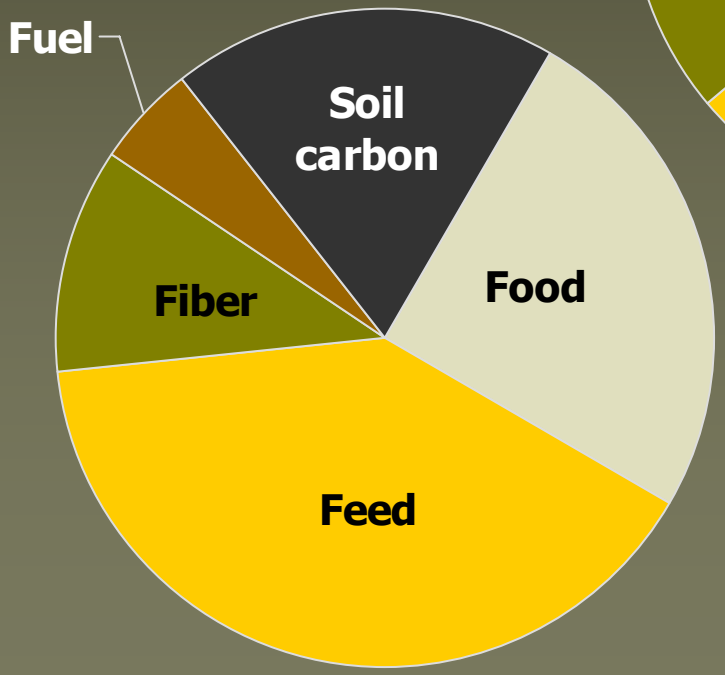


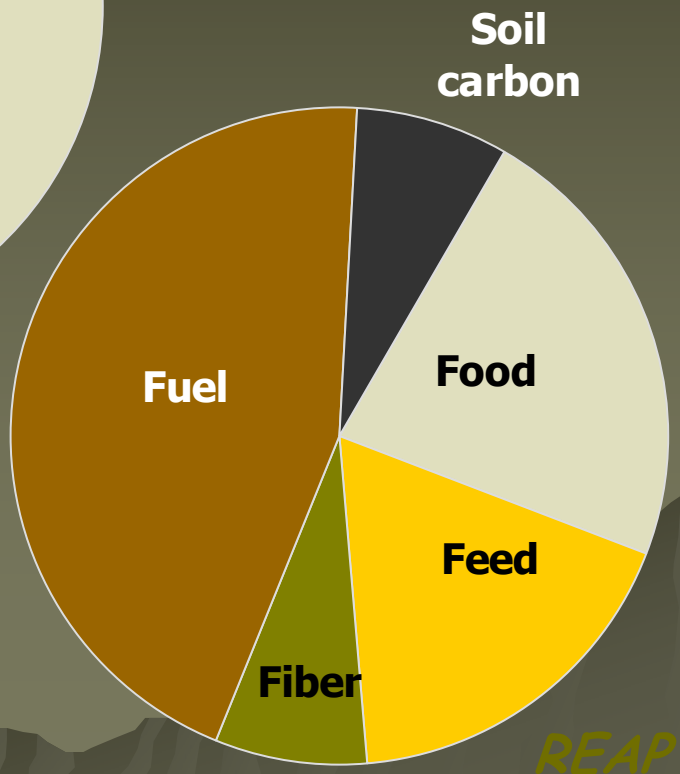
Wilhelm et al., Agron. J. (in press)

REAP

Biomass allocation

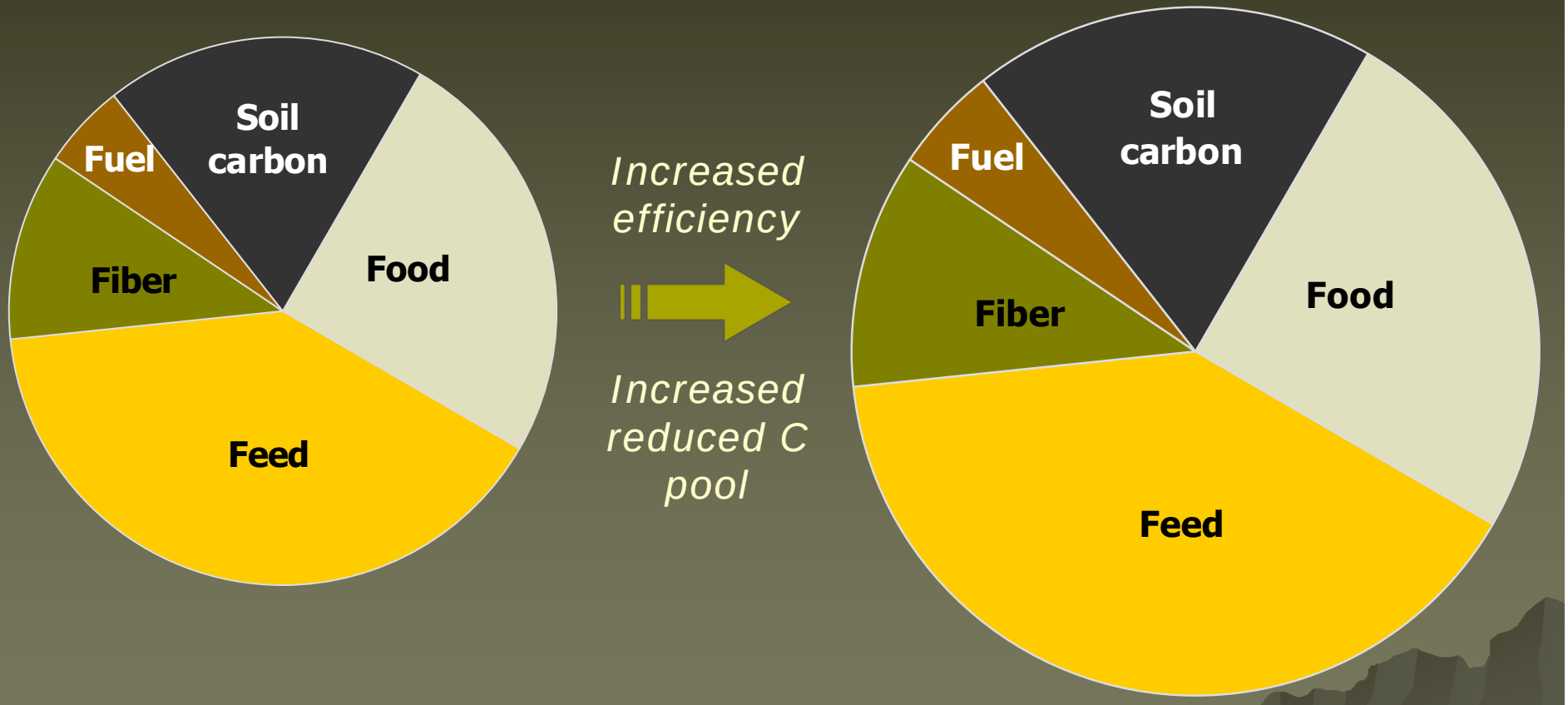






REAP

Increase total biomass production



REAP

Increased efficiency… Increased pool of reduced C

- Agronomy
  - Continuous green cover
  - Optimize planting patterns, cultivars, and cultural practices
- Soil science
  - Improve water and nutrient use efficiencies
  - Precision input application
- Crop breeding
  - Improve quality
  - Enhance stress tolerance
- Physiology/morphology
  - Canopy structure
  - Root structure and function
- Biochemistry
  - Modify metabolic pathways
  - Eliminated inefficiency (photorespiration)
- Genetic engineering
  - Convert C_3 species to C_4
  - Use green light
  - Use all energy in photons

REAP

ARS-Renewable Energy Assessment Project (REAP)

- Management practices
- Algorithm to guide sustainable harvest
- Decision support tools
  - How much residue must be retained?
  - Quantify benefits associated with retaining crop residues


Multiple biomass
Many technologies
Conservation
Reduced expectations
Asking, and answering, the right question