Soil and Crop Yield Response to Harvesting Crop Residues for Biofuel

REAP - Renewable Energy Assessment Project

Wally Wilhelm, Lead Scientist
USDA-ARS
Lincoln, NE

The problem

- Renewable motor fuel
  - 30 x ’30
  - 30% motor fuel from renewable sources by 2030
- Field after field of corn residue
  - ***“Going to waste”***
  - Potential source of biomass for energy
- Can crop residues be removed from the land sustainably?

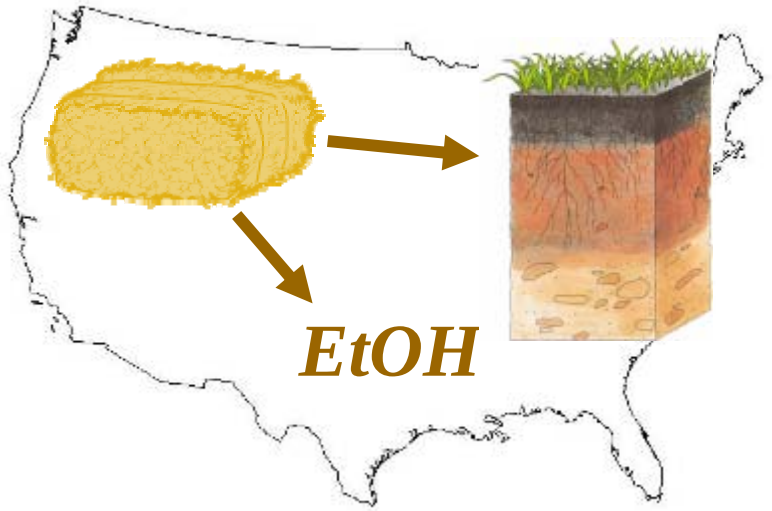
REAP

REAP Objectives

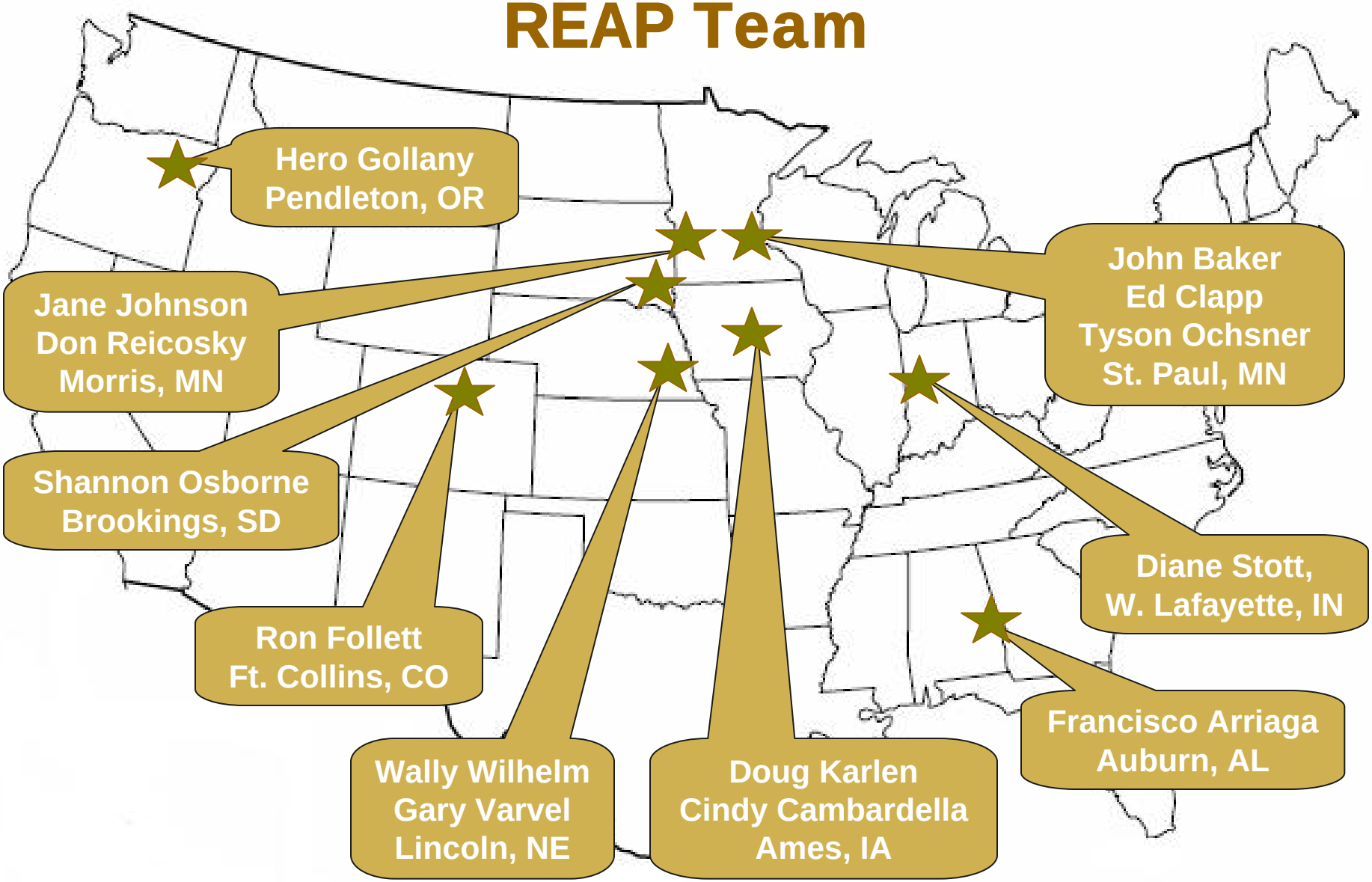
- Residue needed to maintain soil function and sustain production
- Trade-off for residue use as bioenergy versus soil carbon feedstock
- Algorithm to guide sustainable harvest of residue for biomass ethanol
- Management strategies for sustainable harvest of residue

REAP (NP 202 - Soil Resource Management)

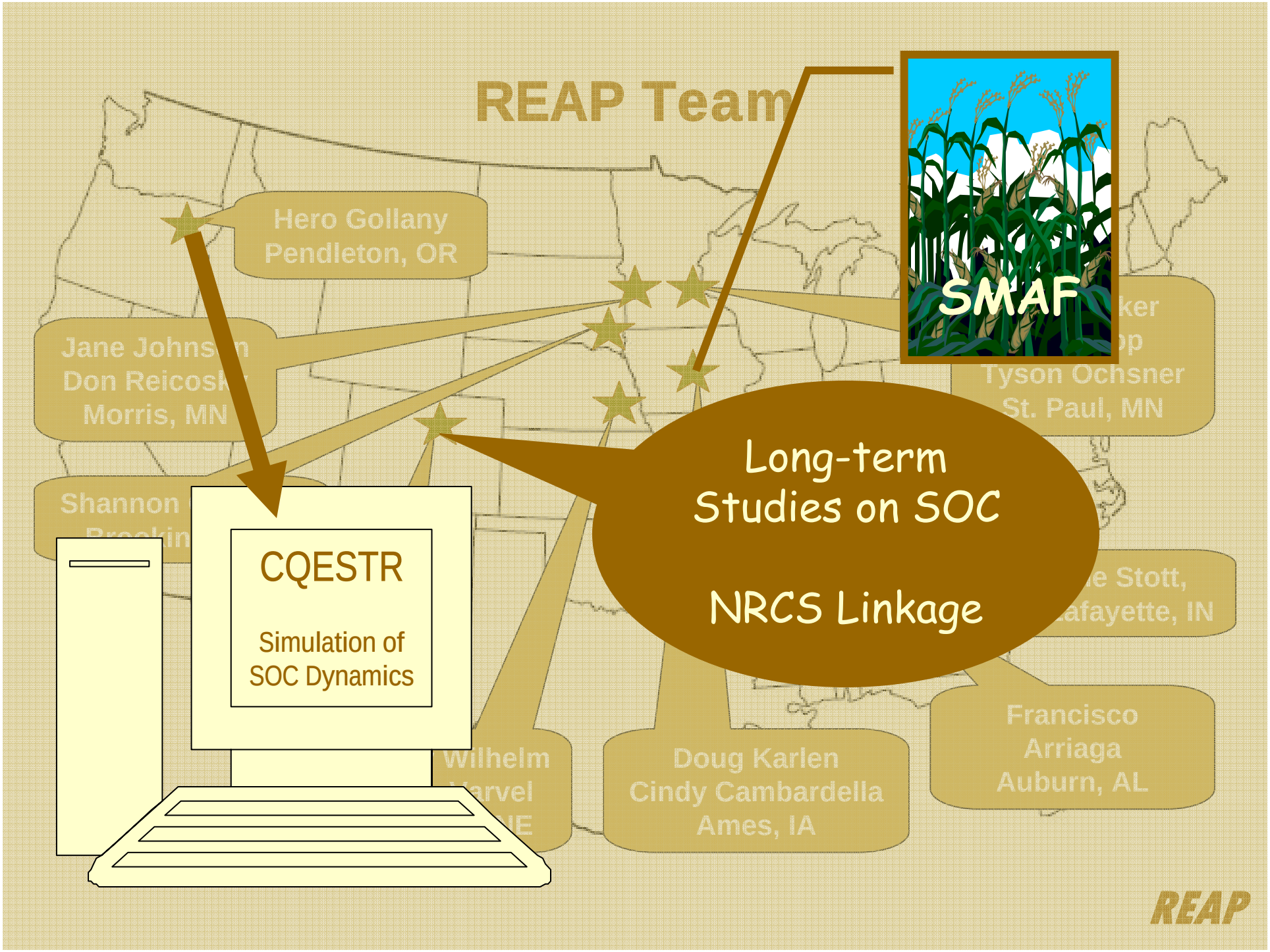
- Cross Location Research (CLR) project
  - Common objectives for efforts at several locations
  - Regional/National effort
- Funding
  - Existing local projects
- Staff
  - Volunteer
  - Commitment
  - Enthusiasm



REAP Team



REAP


REAP Team
SMAF
Hero Gollany
Pendleton, OR
Jane Johnson
Don Reicosky
Morris, MN
Tyson Ochsner
St. Paul, MN
Shannon
Brookin
Stott,
afayette, IN
Long-term
Studies on SOC
NRCS Linkage
CQESTR
Simulation of
SOC Dynamics
Wilhelm
Varvel
NE
Doug Karlen
Cindy Cambardella
Ames, IA
Francisco
Arriaga
Auburn, AL
REAP

Anticipated products

- Management practices
  - Sustainable harvest of residue
- Algorithm
  - Guide sustainable residue harvest
- Decision support tool and guidelines
  - How much residue must be retained?
  - Trade-off between bio-product and retention for soil carbon

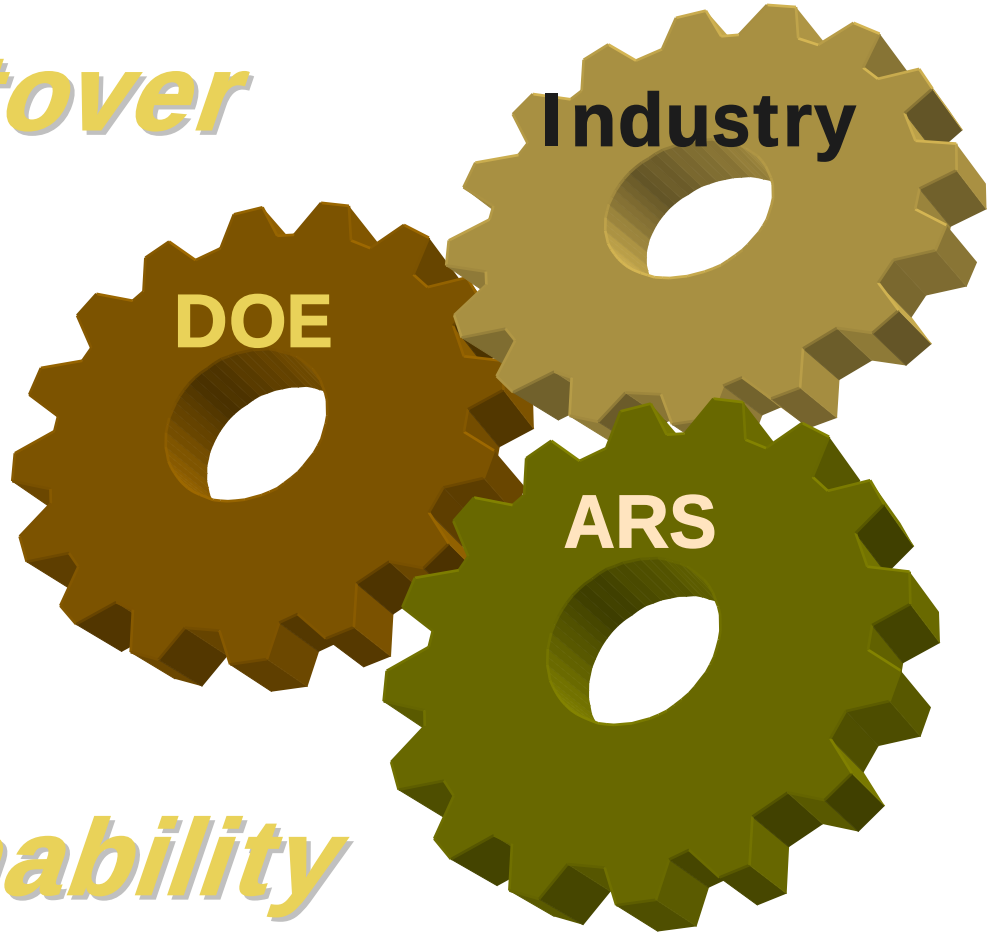
REAP

Customers

- Crop producers
- US Department of Energy
- Biomass ethanol producers
- Action agencies (e.g., NRCS, EPA)

REAP

DOE-ARS Cooperation



Stover

EtOH

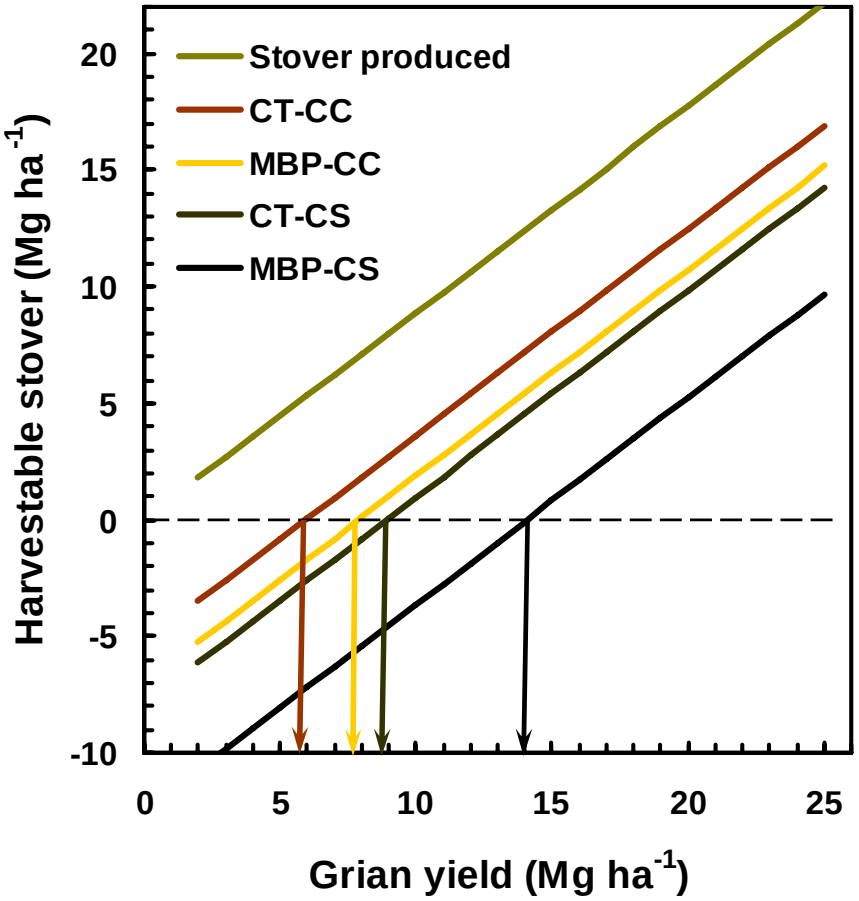
Sustainability

REAP

Residue needed to maintain SOC

Crop rotation	Tillage*	Mg ha^{-1}	n
Corn	mbp	7.5±1.0	6
Wheat	mbp	5.5±1.1	5
All	mbp	6.3±1.0	13
All	Chisel/nt	4.5±0.4	5

* mbp = moldboard plow
nt = no tillage

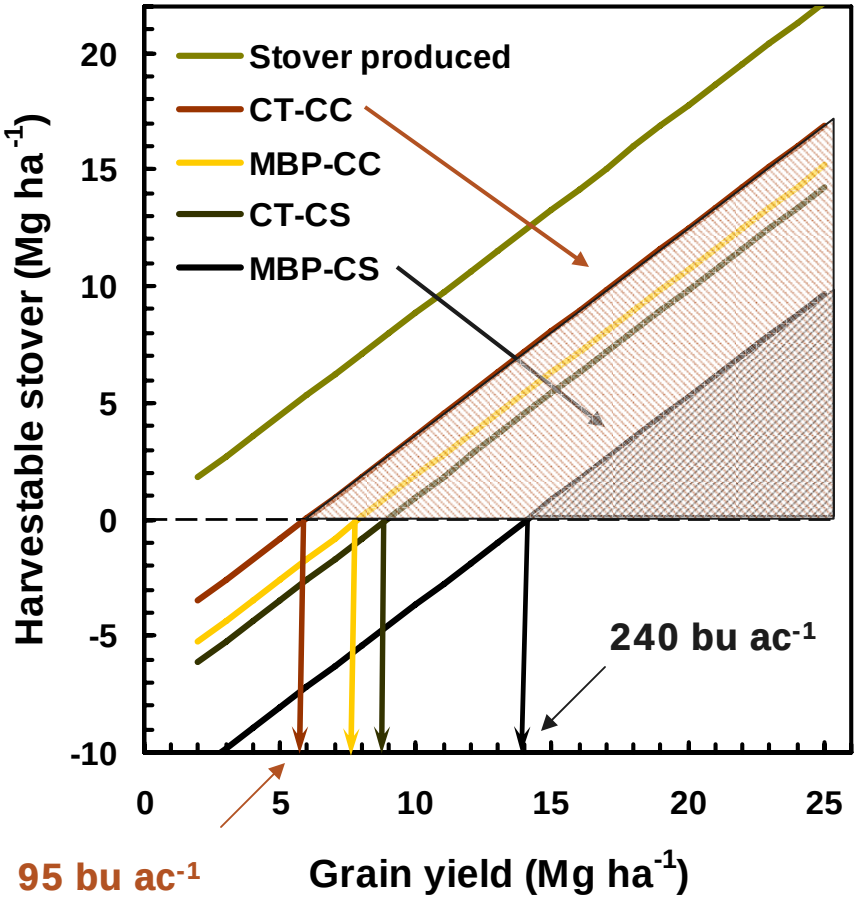


Johnson et al. 2006. Agron. J. 98:622-636.

Residue needed to maintain SOC

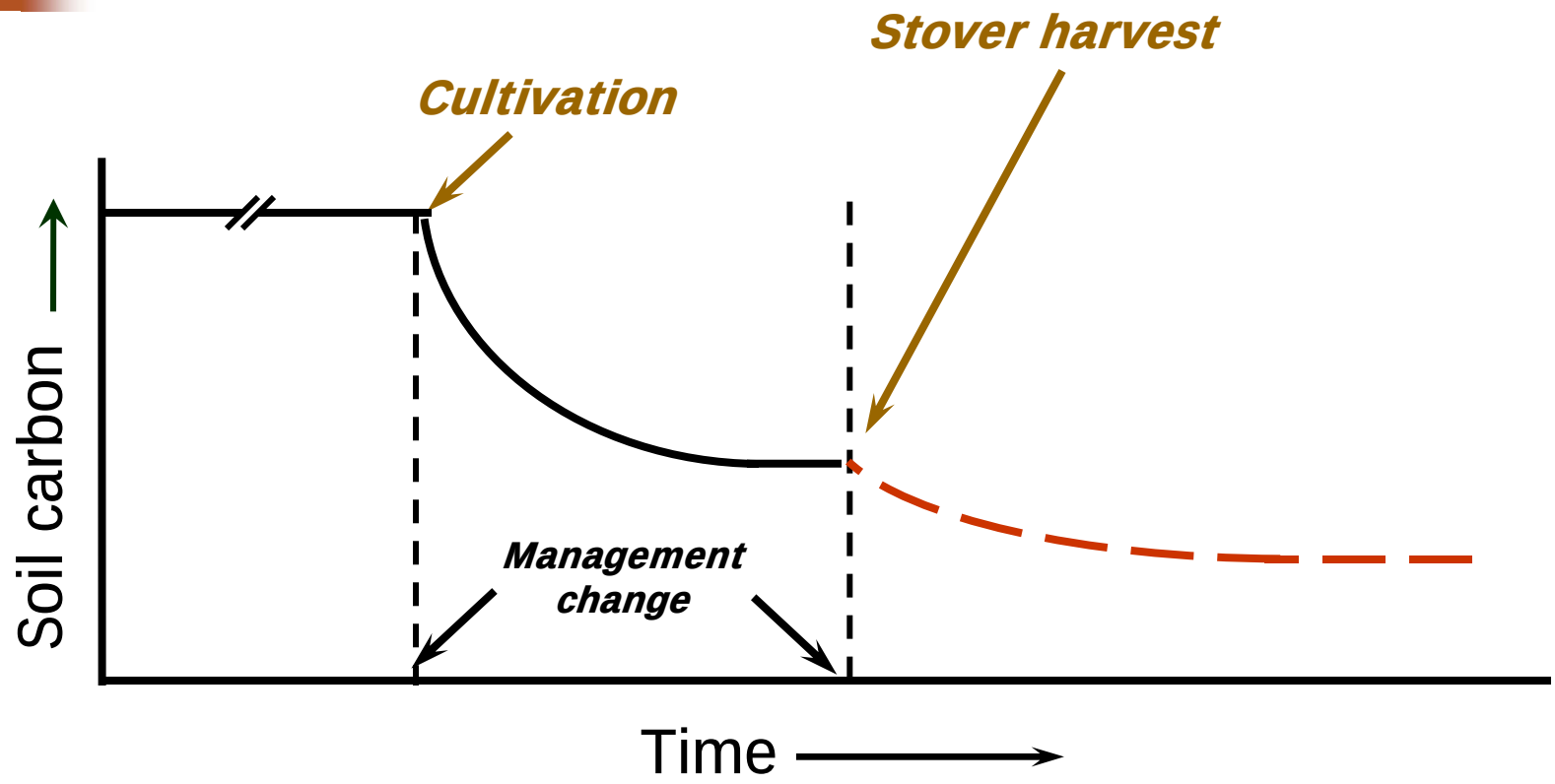
Crop rotation	Tillage*	Mg ha^{-1}	n
Corn	mbp	7.5±1.0	6
Wheat	mbp	5.5±1.1	5
All	mbp	6.3±1.0	13
All	Chisel/nt	4.5±0.4	5

* mbp = moldboard plow
nt = no tillage



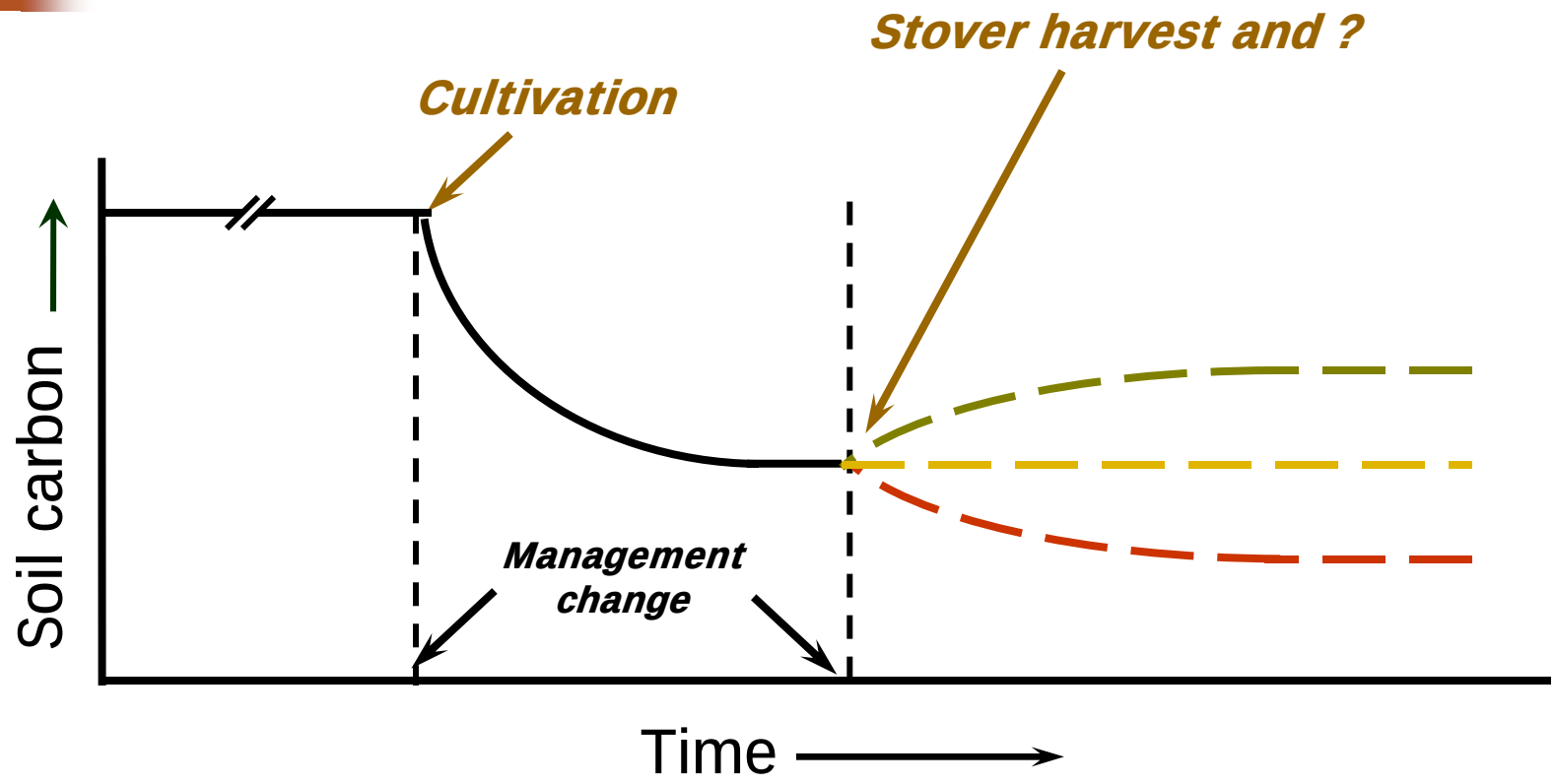
Johnson et al. 2006. Agron. J. 98:622-636.

Soil C change



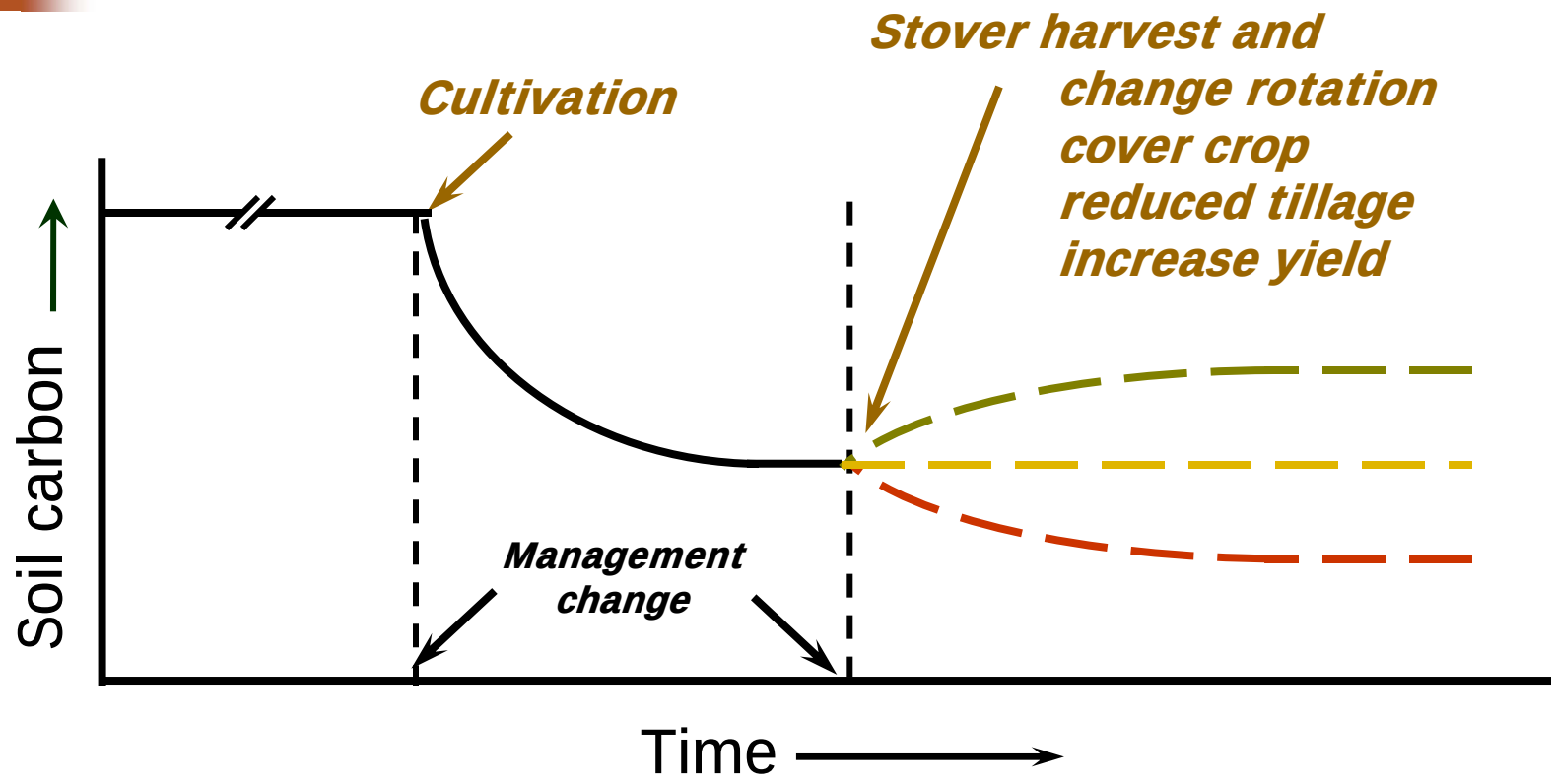
REAP

Soil C change



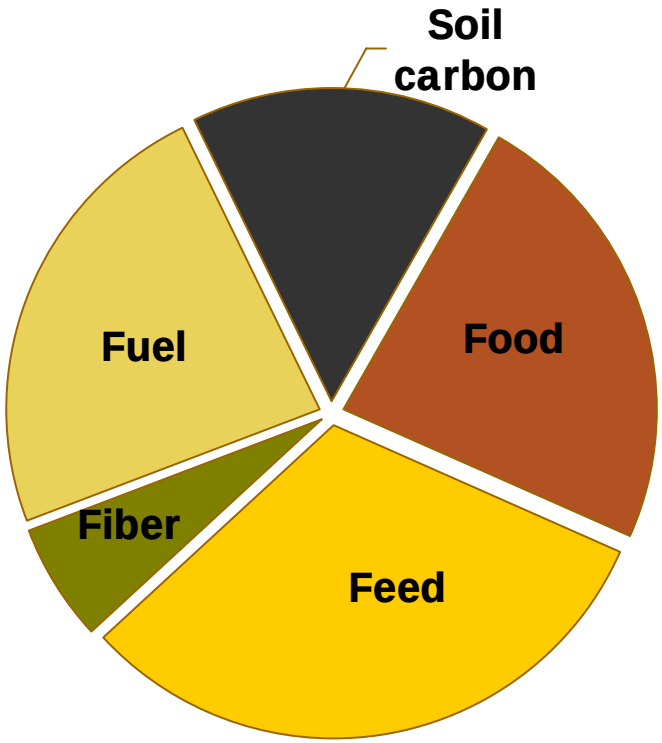
REAP

Soil C change

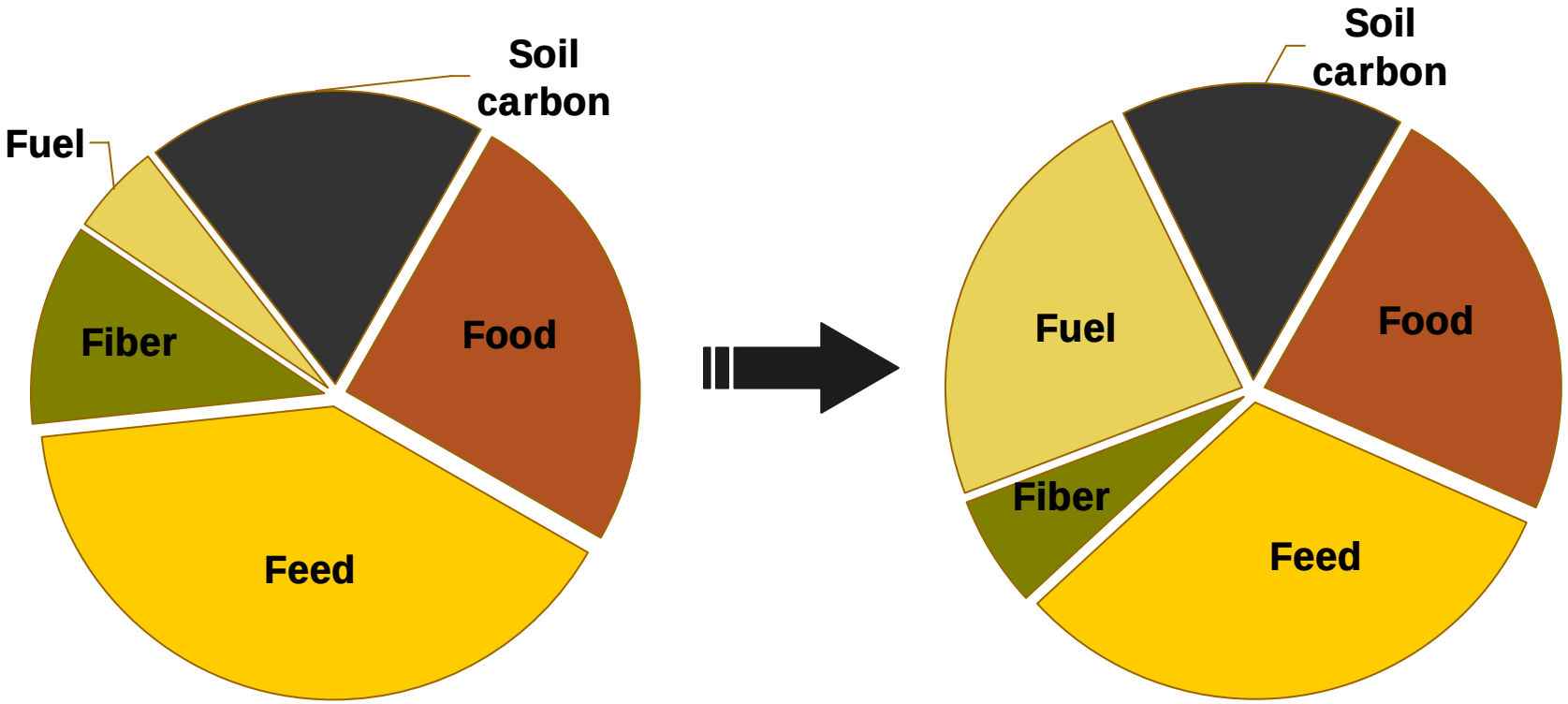


REAP

Change allocation of biomass

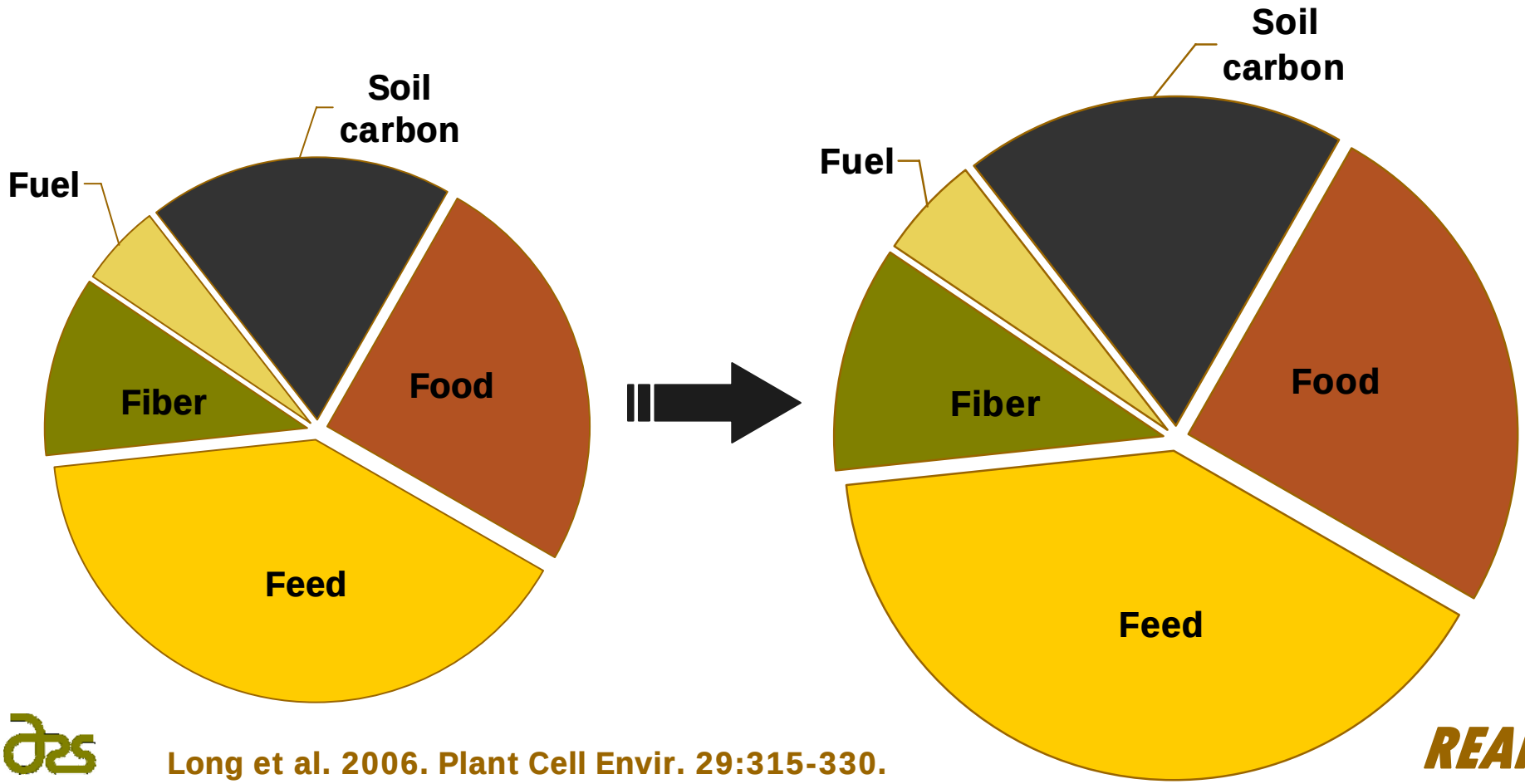


Change allocation of biomass



Change allocation of biomass vs. increase total biomass production

Increase photosynthetic efficiency 25%, from 4% → 5%



Long et al. 2006. Plant Cell Envir. 29:315-330.

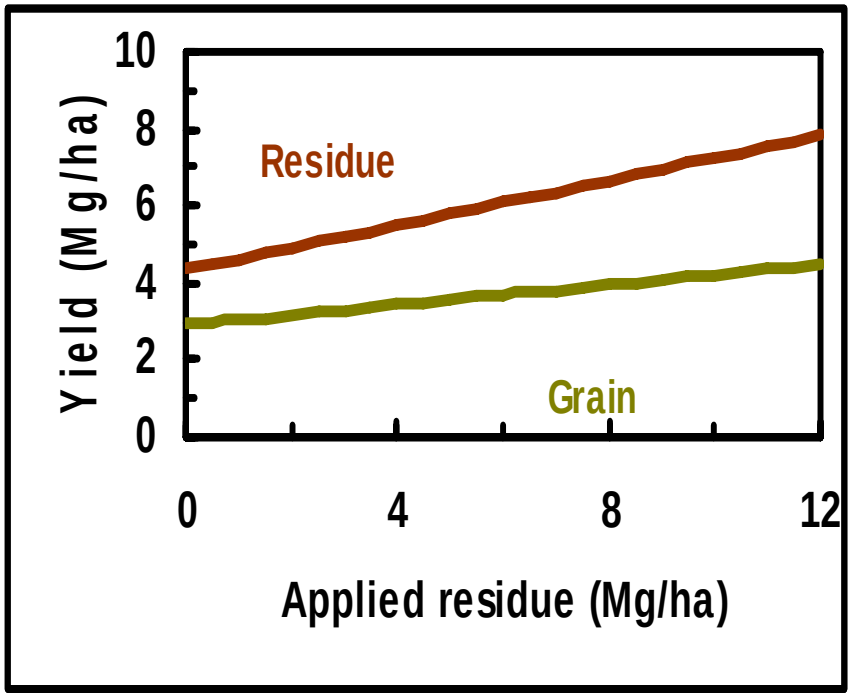
REAP

Residue Management Study

Over all years

(Wilhelm et al., 1986)

Y Variable	Coefficient				
	Intercept		Slope		r^2
	b_0*	SE	b_1**	SE	
Residue	4.34	0.31	0.29	0.04	0.86
Grain	2.91	0.17	0.13	0.02	0.80



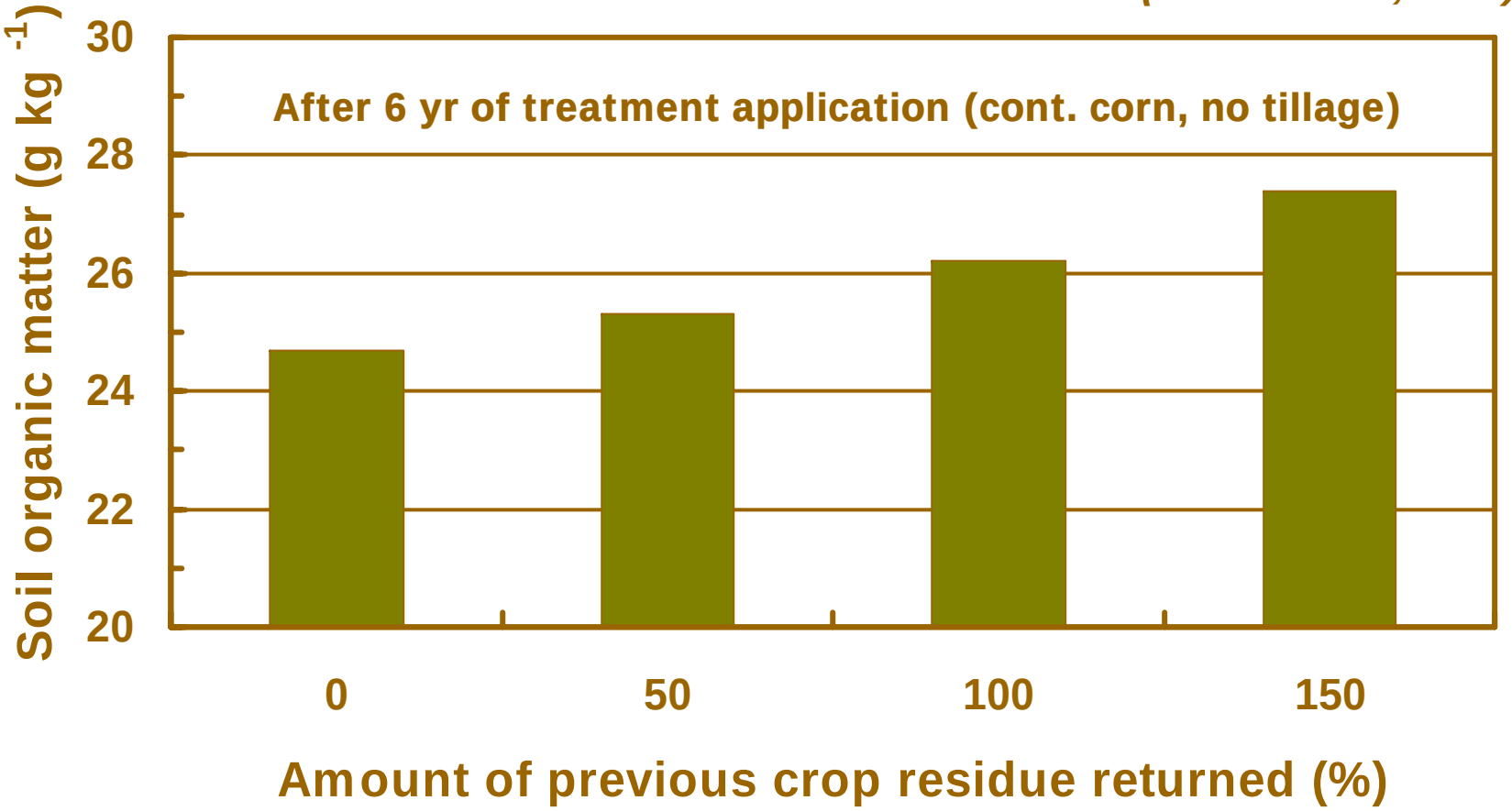
* Mg/ha

** Mg/ha / Mg/ha residue applied

REAP

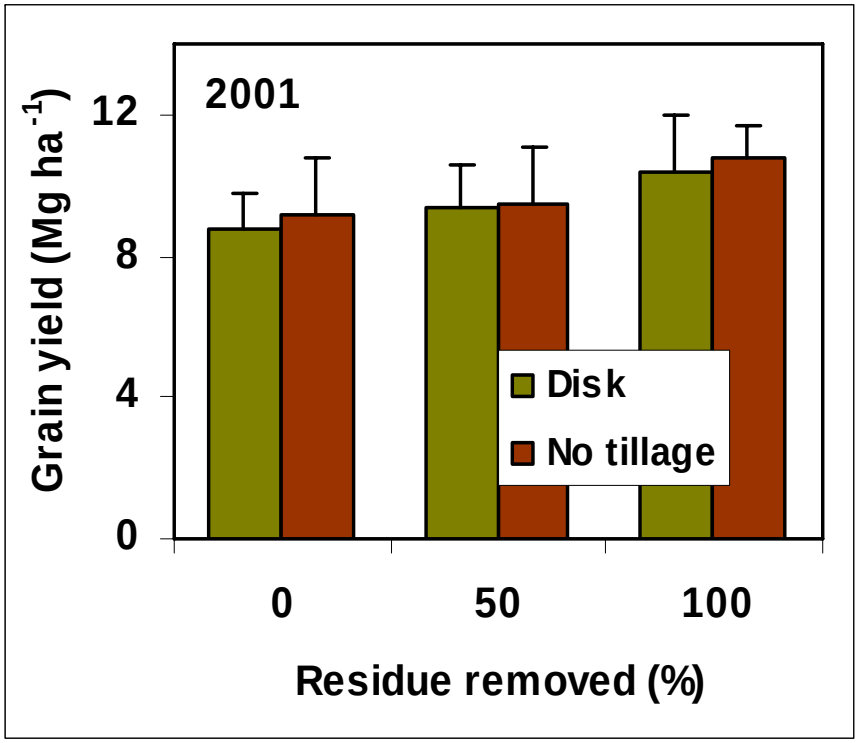
Residue Management Study
Soil organic matter (0-30 cm)

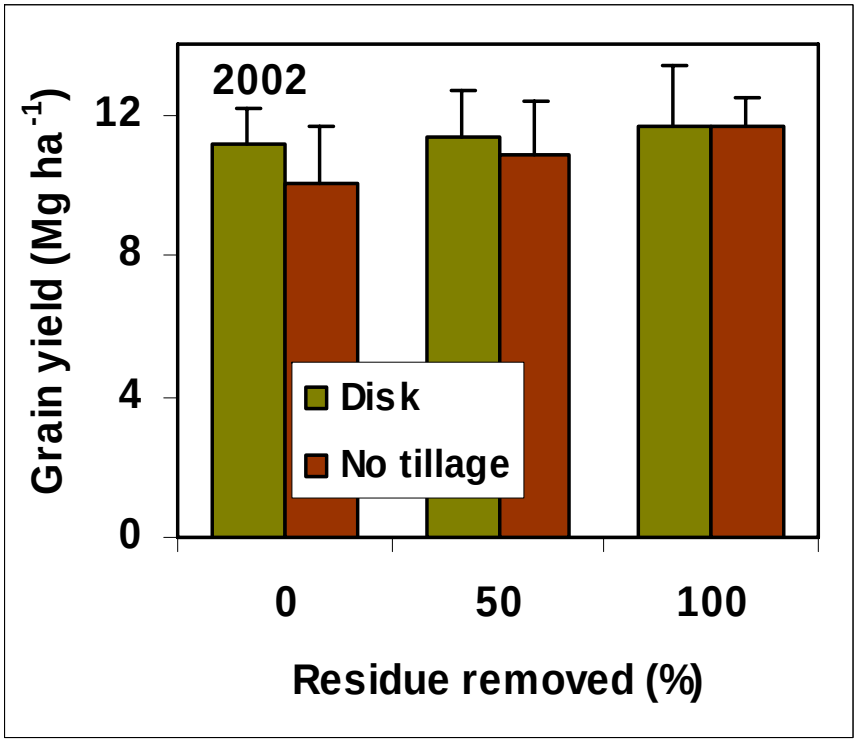
(Maskina et al., 1993)



REAP

Grain yield





REAP


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