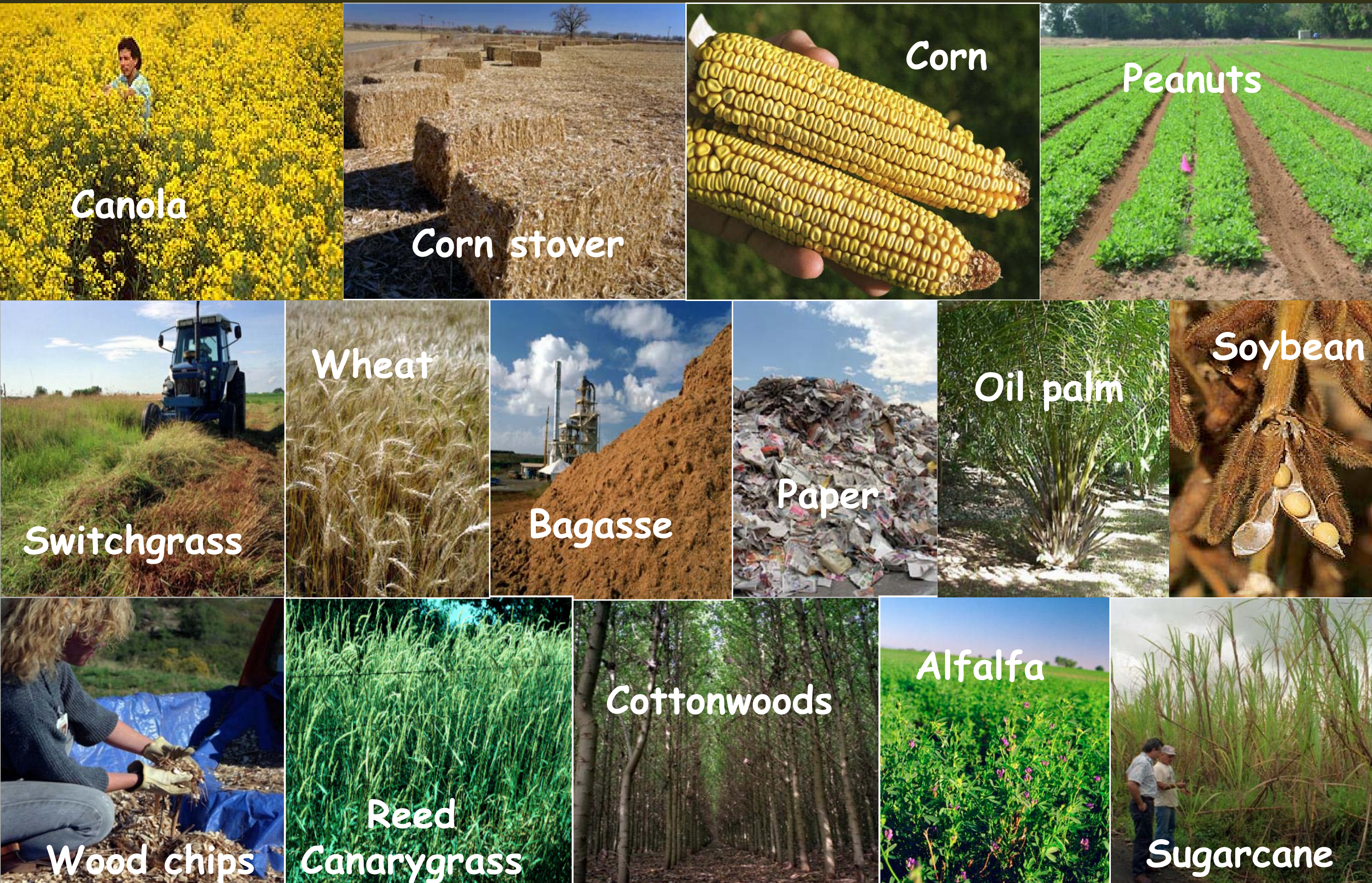
An Overview of ARS REAP

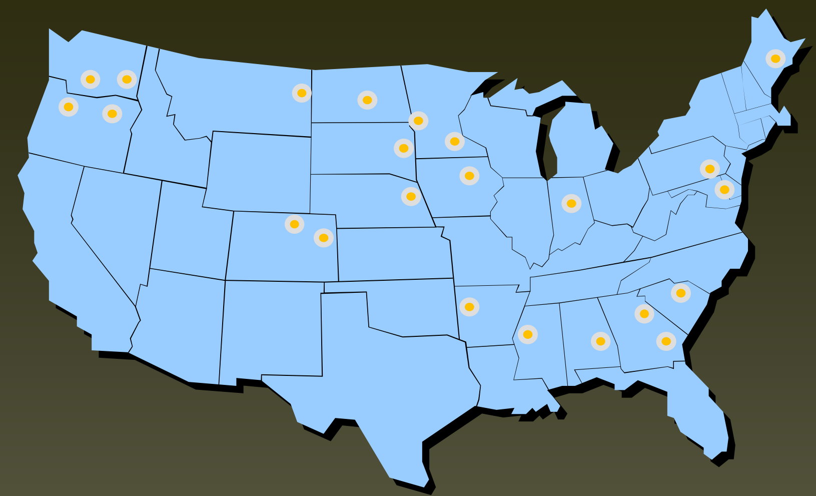


Presentation Outline

- The REAP Vision, Goals, and Focus
- REAP Activities and Partnerships
  - Literature evaluations
  - REAP & NRCS
  - REAP & the Sun Grant Regional Partnership
  - REAP & the "DAM Stover Project"
  - REAP & DOE/INL
- Emerging Efforts
  - Database Development
  - Bioenergy Buffers
  - A Landscape Vision

REAP

The Renewable Energy Assessment Project (REAP)



VISION

Sustainable Feedstock Production & Harvest

Goals

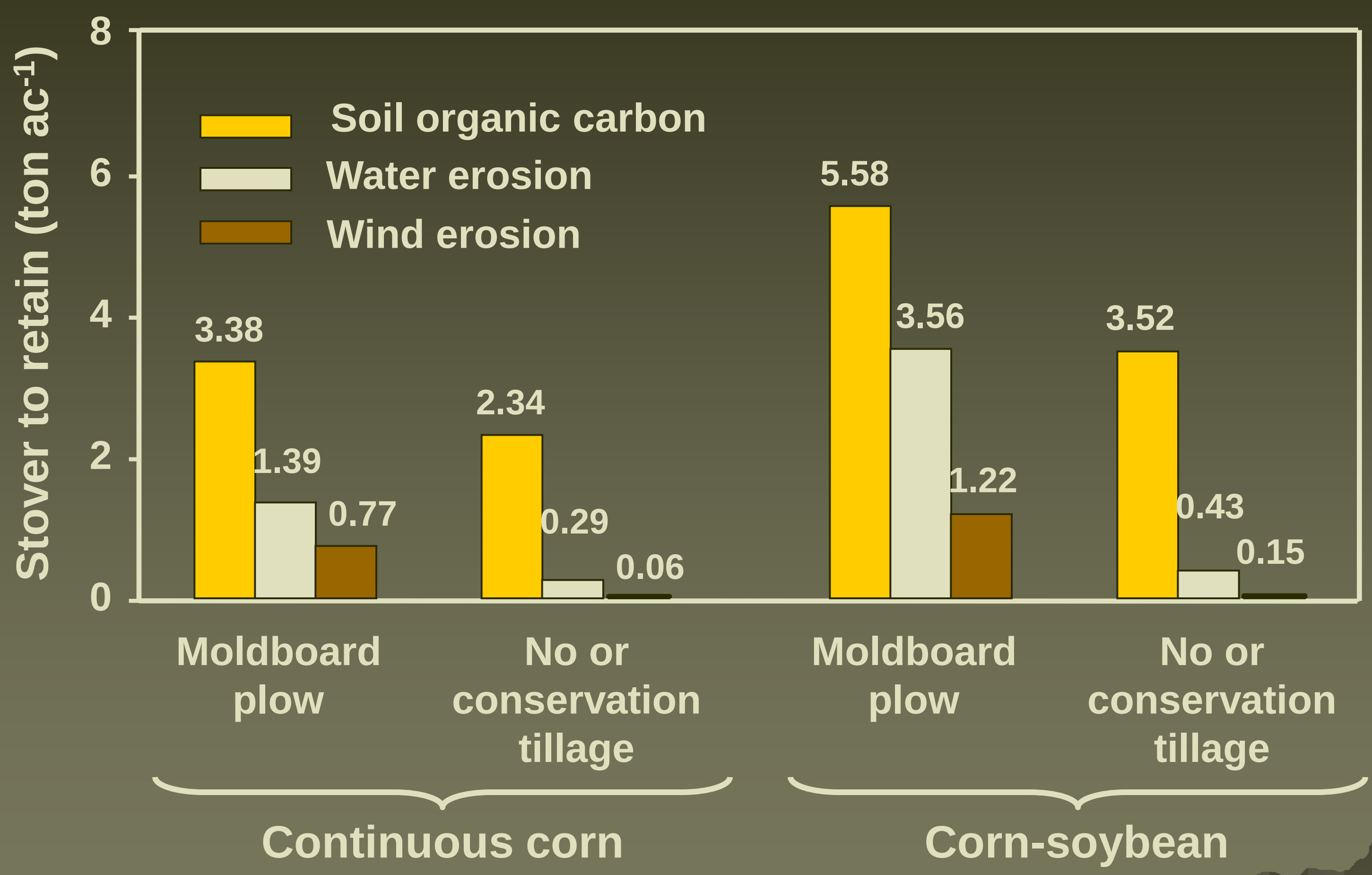
- Evaluate management practices
- Develop decision support tools
- Quantify tradeoffs between retaining or harvesting crop residues

Corn stover was initial focus but REAP now includes *miscanthus*, switchgrass, sweet sorghum, sugarcane bagasse, and CRP sites

REAP

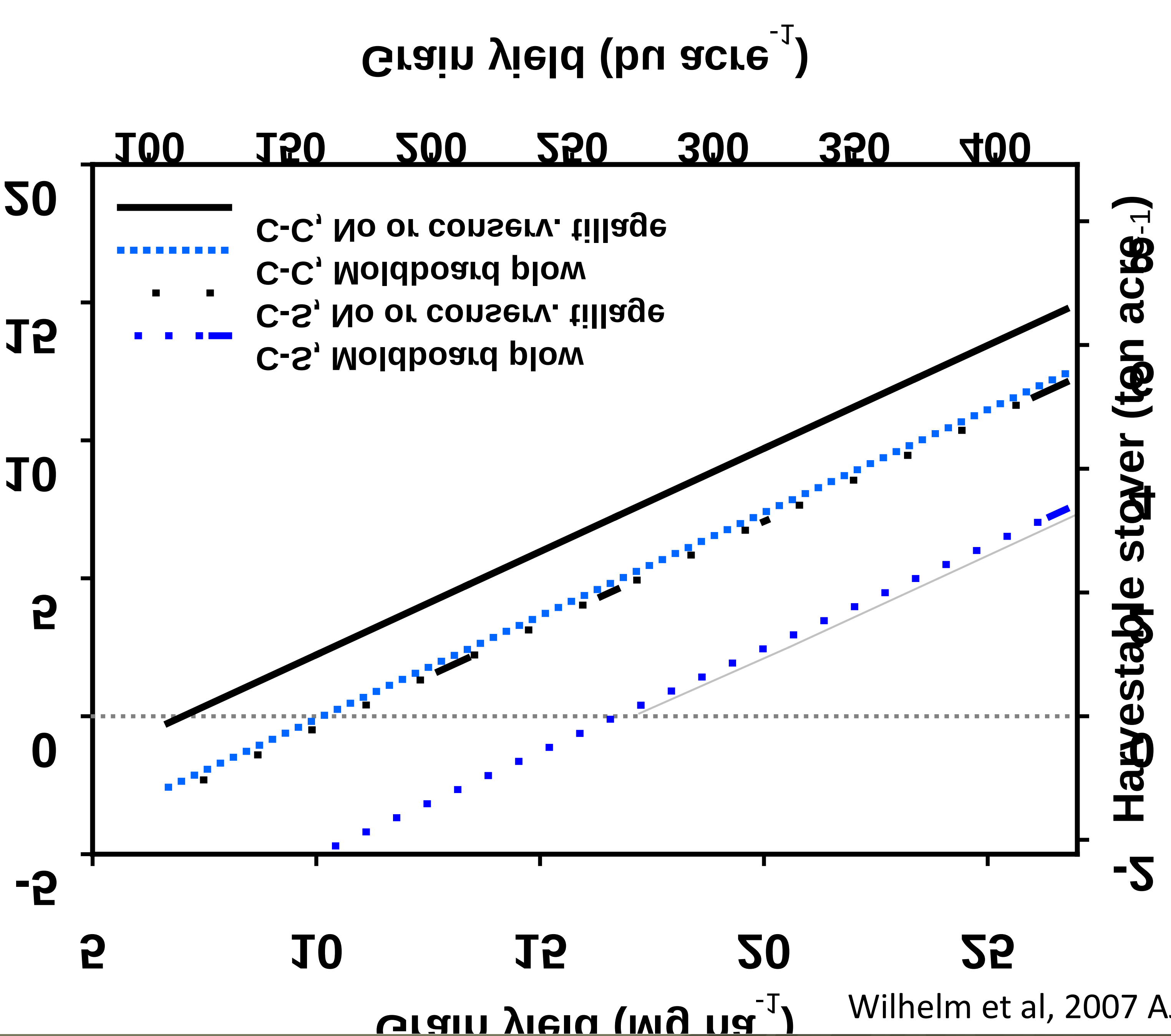
Literature Evaluations

Corn Stover & Soil Carbon

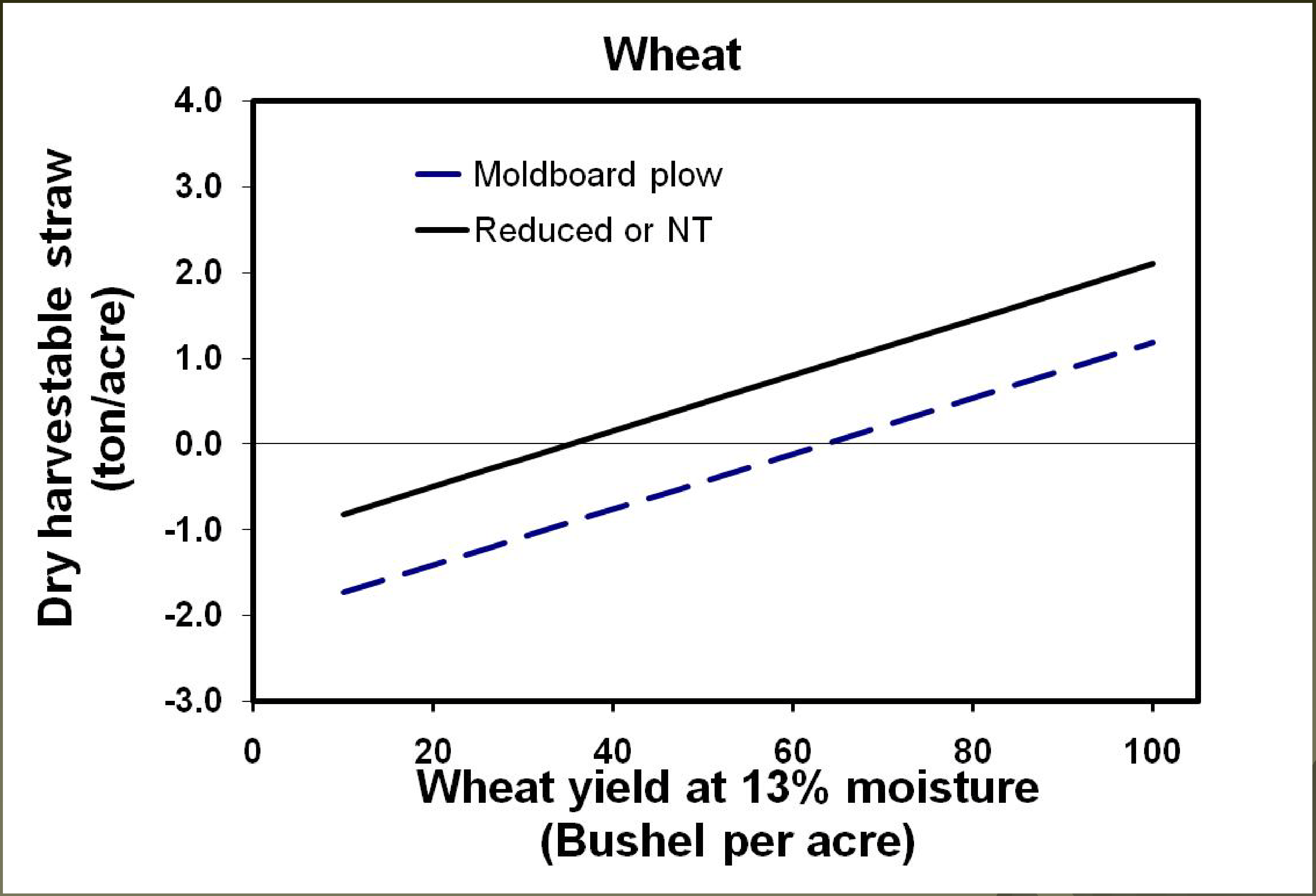


Wilhelm et al., Agron. J. 99:1665-1667

REAP



Wilhelm et al, 2007 AJ



USDA-ARS

Based on Johnson et al. 2006

REAP & NRCS Interactions

- QUESTION: How does harvest height affect the amount of stover left on the soil surface?
- REAP Response: Two multi-location publications
  - Vertical Distribution of Corn Stover Dry Mass… BioEnergy Res. Bioenergy Research 4(1):11–21.
  - Nutrient Removal as a function of cutting height. BioEnergy Res. 3:342-352.

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REAP & Sun Grant Interactions

- Lead Regional Corn Stover Partnership
  - Eleven ARS/university partnerships
  - Monsanto as the ARS industry partner
  - Includes field studies & corn stover tool
- REAP partners on all other feedstock teams
- Coordinate sustainability studies

REAP

3-Year Corn Stover Summary

- Short-term – limited residue harvest showed some positive and few negative effects
  - May be beneficial for overcoming Midwest cool, wet soil conditions that limit early-season corn growth
- Long-term – excessive harvest will decrease soil organic matter pools
  - Observed in humic acid, POM & other measurements
  - Will likely reduce N mineralization potential
- Harvest rates must be site specific
  - Rates could average 1 to 1.5 tons/acre on non-erosive land

REAP

REAP & the "DAM Stover Project"

D – John Deere

A – Archer Daniels Midland

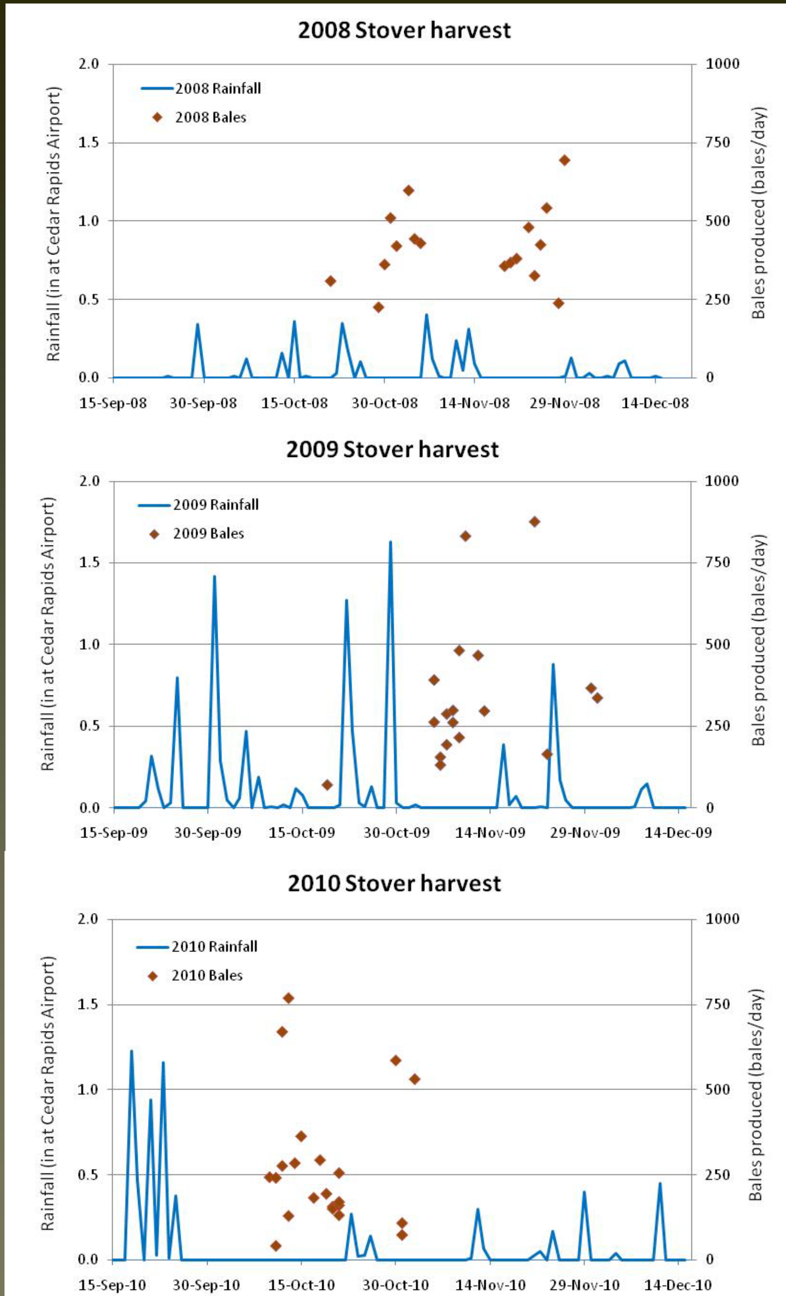
M – Monsanto

Harvest Statistics

	2008	2009	2010
Large round bales	6468	5693	4460
Large square bales	0	403	1567
Total harvest (dry tons)	2980	2799	2645
Baling rate (dry tons/ac)	1.2 ± 0.5	1.7 ± 0.6	1.3 ± 0.3
Enrolled fields	38	36	25
Harvested fields	25	21	24
Average corn yields	194	191	182

18 Participating farmers over the three years

REAP



3 unusual years = "average" weather

2008 – Delayed crop, frequent light rains, stover harvest during two breaks in rainfall, 17 harvest days

2009 – Very delayed crop, frequent heavy rains, stover harvest during longer break in rainfall, 18 harvest days

2010 – Early crop, excellent weather, 22 harvest days

This is "average" weather

- Harvest day defined as 3rd dry day
- 3.2 ± 0.5 harvest days/wk (1988-2009)
- Assume 6 week harvest window
- "average" is 19.2 harvest days
- 2008 – 2010 average – 19 harvest days/yr

Bühler/Inland 2500 Bale Carrier

REAP

DAM Stover Harvest Summary

- Stover harvests were improved each year as operators gained experience and better equipment was used.
  - Bale carrier (Bühler/Inland 2500), wider rake (New Holland HB5980), hardened balers (Case IH RB564) were key improvements
- Target harvest rates can be maintained on fields with simple topology
- There is still significant room for improvement.
  - Hardened large square baler, Jim Straeter's Corn Rower, variable rate raking/harvest technology
- Bale composition varies by field, by year and by bale.
  - Each year is different, no year is average
  - Nutrient replacement value averaged $10.00 per large round bale

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REAP & DOE/INL Activities

Sustainability – Wilhelm et al. 2010. Industrial Biotechnology 6:271-287.

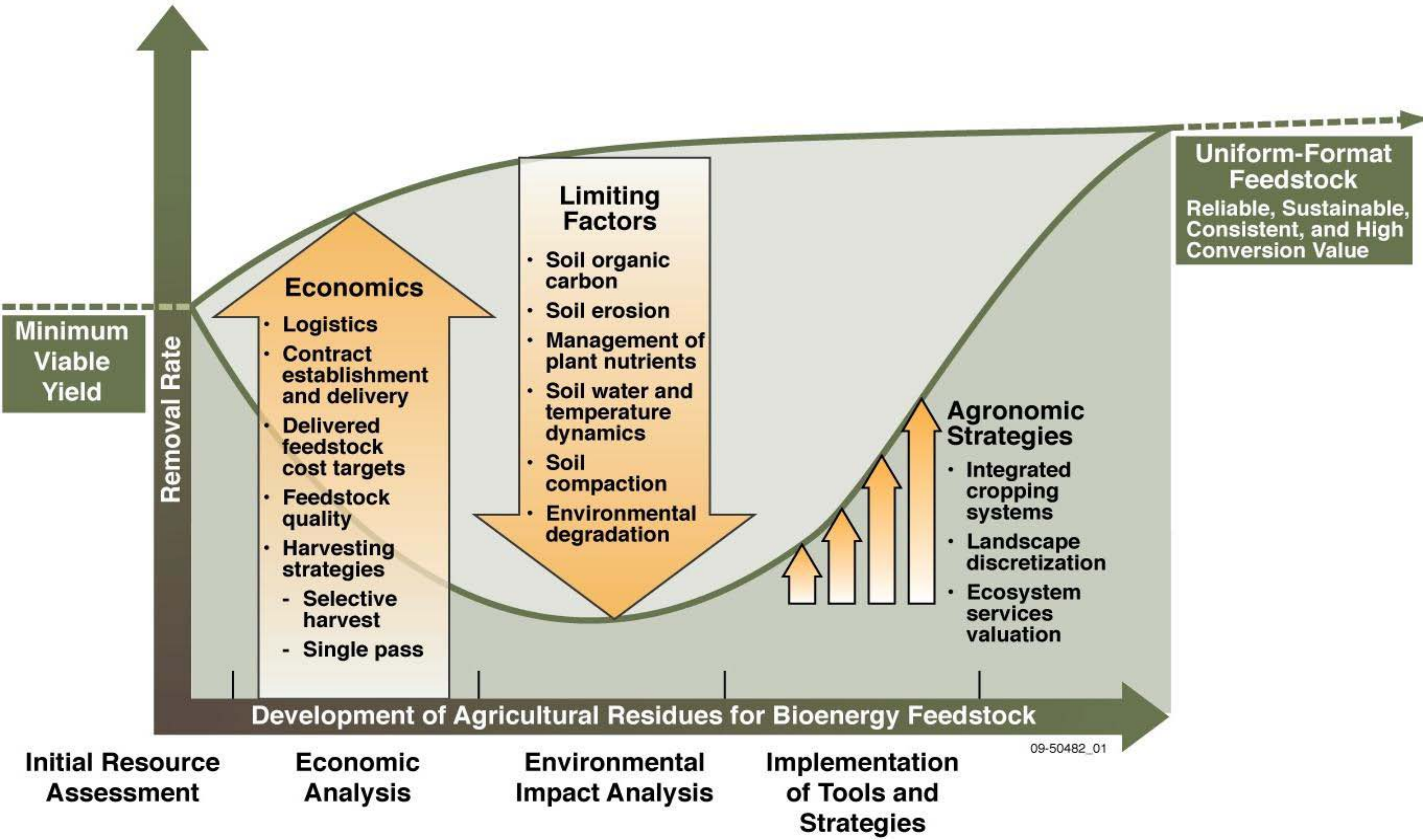
Developed NIR curve using fractionation samples from the NRCS study

Development of corn stover tool and transition to a "residue management tool"

Development of the landscape vision using multiple feedstock sources and the Process Demonstration Unit (PDU) to model a Pre-processing Depot infrastructure

REAP

Sustainability Requires Balance



Wilhelm et al., 2010. Balancing Economic Drivers & Limiting Factors. Ind. Biotech 6:271 – 287.

REAP & CSBP Interactions

CSBP – Council for Sustainable Biomass Production

REAP research data has been used to help guide on-farm evaluations and the initial testing of draft sustainable biomass harvest standard

Emerging Efforts

REAP Database Development

Bioenergy Buffers – A REAP, Monsanto, Mendel, Ceres, DuPont/Danisco & DOW AgroSciences white paper & research plan

Development of a Landscape Vision for biofuel feedstock production

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REAP Database Development

- Coordinated with ARS GRACEnet and CEAP database efforts
- A REAP "data dictionary" and basic structure are currently being finalized
- The database will be populated with information that can be downloaded and summarized for large scale assessments

REAP

"Bioenergy Buffers"
Creating Sustainable Agricultural Landscapes

- Concept: Plant a nonfood perennial bioenergy crop (switchgrass, *Miscanthus*, etc.) as a buffer strip around all sides of conventional row crop fields

- Width set to fit single pass of widest equipment (~15-30')
  - ~7.5 M acres (for 20' strip around all US corn and soybeans fields)
- Herbicides now available to help with establishment

Bioenergy Buffers Provide Multiple Ecosystem Services

- Improved water quality
- Additional wildlife habitat
- Enhanced "C-questration"
- Sustainable energy source
- Endangered species protection
- Mitigation of spray drift

REAP

Developing a landscape vision

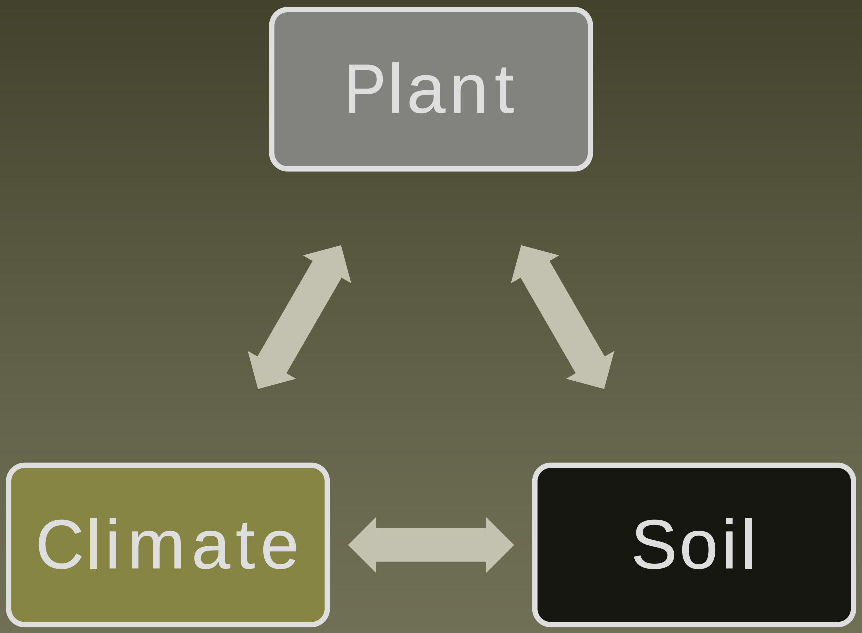
How Do You Implement this Vision?


What are the water quality impacts of current practices?
What are the air quality impacts?
Is the soil improving or degrading?
Do we have the best spatial arrangement of plants on the landscape?
Are crop and livestock production affecting environmental quality?
What cropping system is best for the landscape?
Assess Current Practices

Quantify Productivity, Variability and Risk

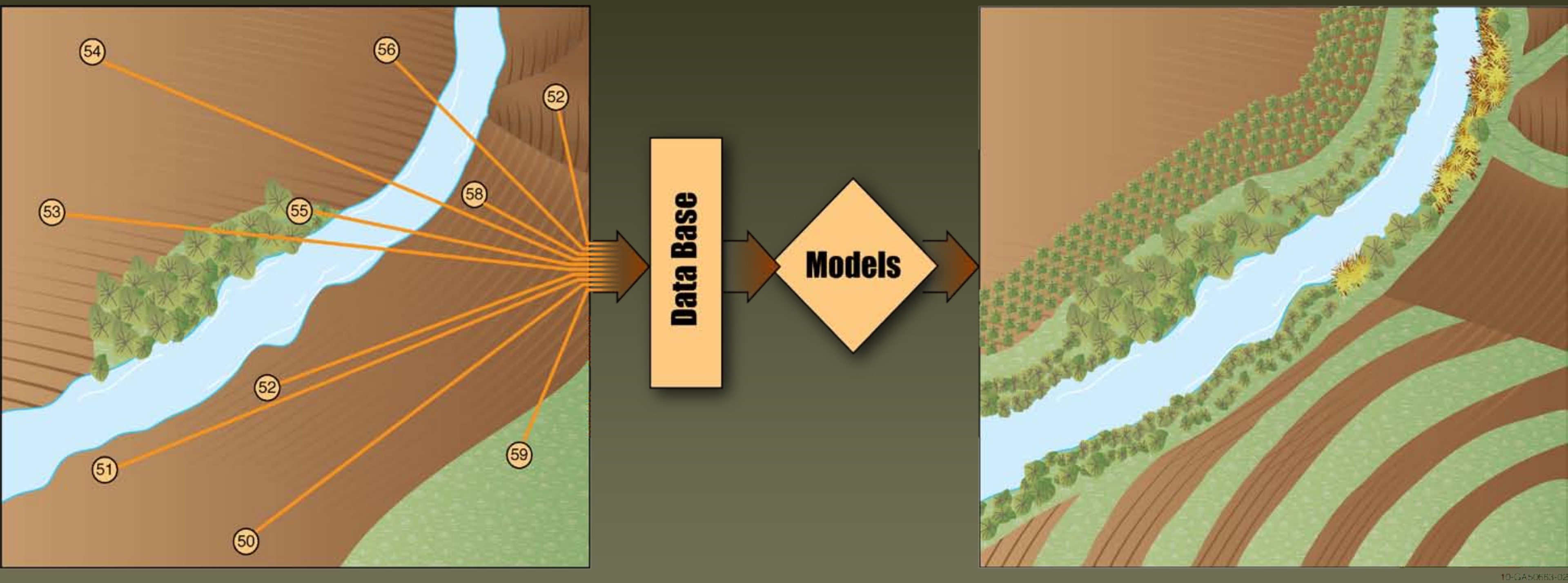
What's Causing the Variability?

- Plant
  - Genetics
  - Disease
  - Weeds/Pests
- Soil
  - Chemical – pH, N, P, K
  - Physical – BD, PAWC
  - Landscape effects
    - Runon
    - Runoff
    - Drainage
- Climate
  - Rainfall/Irrigation
  - Temperature regimes
  - Humidity
  - Solar radiation



REAP

Design, Implement & Verify New Strategies

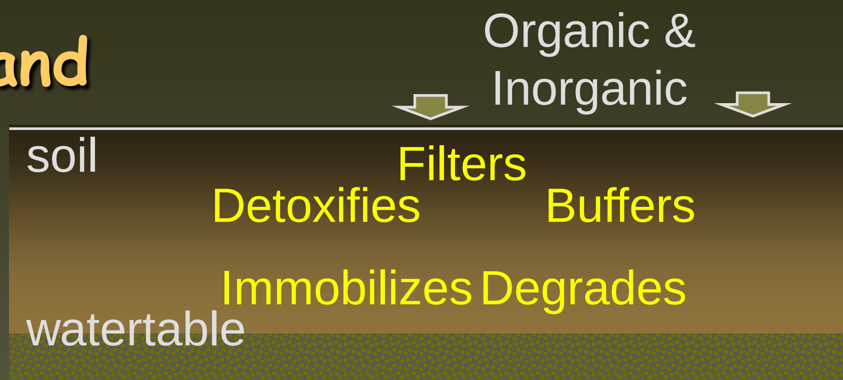


- For example – integrate bioenergy feedstock crops into sustainable watershed-scale production systems by using integrated simulation models and plot-scale data.

REAP

Evaluate For All Ecosystem Services

- Filtering and Buffering

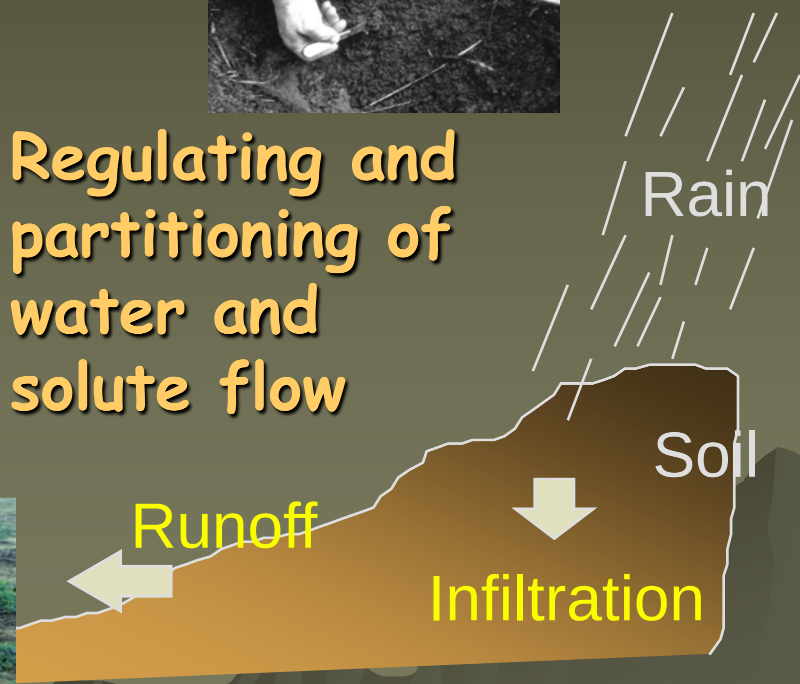


Wildlife

Economics

Community

- Regulating and partitioning of water and solute flow



- Storing and cycling nutrients

REAP

Sustainability is REAP's Vision