Balancing Bioenergy Opportunities on Our Natural Resource Base

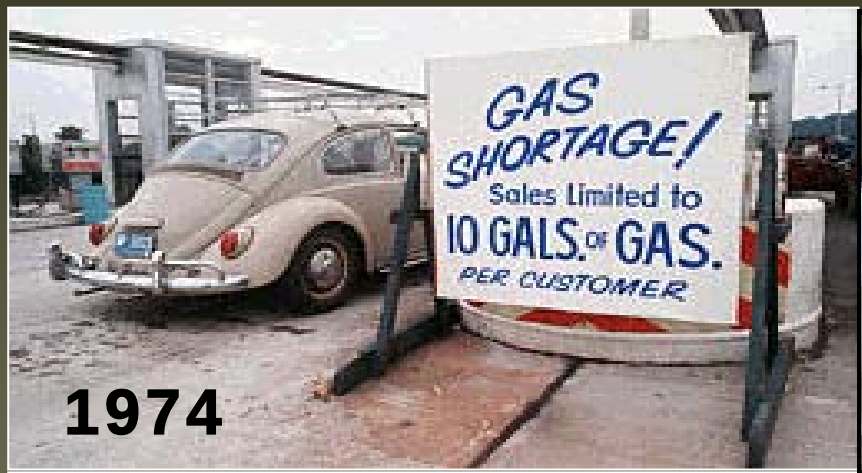
Douglas L. Karlen
USDA-ARS, Ames IA

Presentation Outline

- Why is there interest in bioenergy?
- Why is there concern about bioenergy?
- How is USDA-ARS addressing these questions?
- What has cooperative field research shown?
- What are the next steps?

REAP

America's Energy Appetite



1974

1979

2007

Proposed Bioenergy Plans

Plan	Goal	Time	Feedstock	Agency
Energy Policy Act of 2005	7.5 billion gal ethanol	2012	2.7 billion bu	Congress
20 in 10	20% of gasoline use (35 billion gal)	2017	12.5 billion bu (440 million tons biomass)	2007 State of the Union Message
25 x '25	25% of US energy consumption (85 billion gal + 400 billion kw)	2025	600 to 750 million tons biomass	Ag Energy Working Group
30 x '30	30% of gasoline used in 2004 (60 billion gal)	2030	1 billion tons	DOE


GAS
ALCOHOL
ANTI-FREEZE
Alcohol from Grain
Mixed with Gasoline
Keystone Steel & Wire Co.
GASOLINE
42-224

First Generation Feedstocks

Corn Grain Ethanol Surge

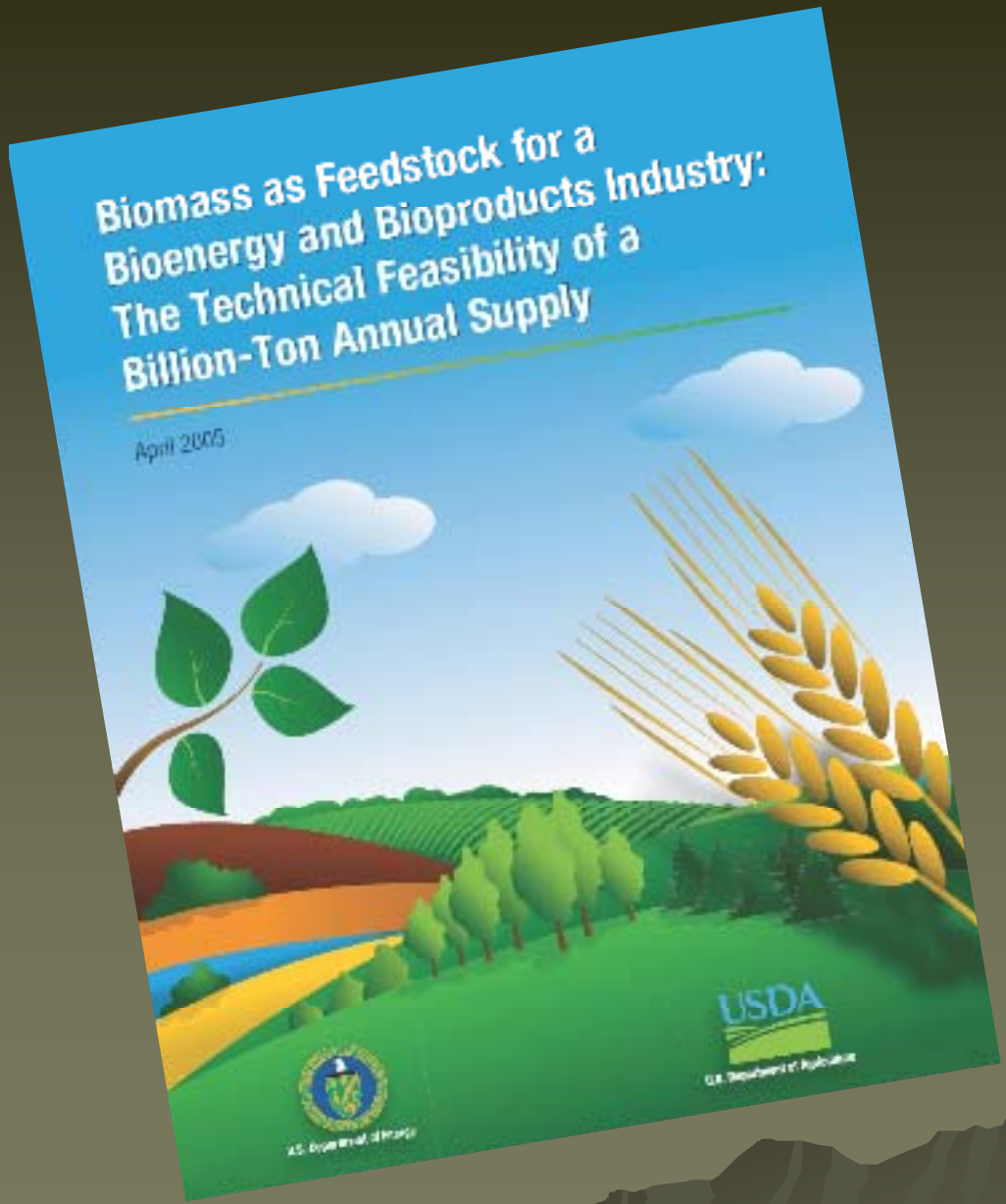
- Designed to provide a commodity market for corn grain more than an alternative liquid transportation fuel
- Resulted in 15% increase in corn acres planted in Illinois, Indiana, Iowa, Ohio, Michigan, Minnesota and Wisconsin for 2007 (NASS, 2007)
- At 2.7 gal bu^{-1}, the 7.5 billion gal EtOH in the '05 Energy Bill required 2.7 billion bu corn

Grain Ethanol Continued

- 2.7 billion bu corn accounted for ~20% of the 2007 corn grain that was produced (~13.5 billion bu)

- CONCERNS
- Potential for soil loss of 21 lbs gal^{-1} @ if erosion occurs at current "T" values (4.9 t $acre\ yr^{-1}$) (Sand, 2006)
- Potential increased loss of 211 million lbs of N to streams & rivers (Elobeid et al, 2006; Wisner, 2007)
- Potential increased loss of 20 million lbs of P to streams & rivers

What Are Our Alternatives?



REAP

Biomass for Bioenergy

Forestry – 368 million tons

Agriculture – 998 million tons

- Perennial energy crops – 377 million tons
- "Wastes" – 87 million tons
- Grain – 87 million tons
- **Crop residues – 428 million tons**
  - **Corn stover – 256 million tons**

(projected estimates; Billion Ton Report, Perlack et al 2005)

Comprehending the Challenge

Football Field

If 1 ton = 1 sq in
1 billion tons = 145 football fields

Round Bales

5 ft, 1000 lb, laid end-to-end
1.89 million miles
75 times around the earth

"Billion Ton" Concerns

- No actual supply curves
- No documented monetary constraints
- Environmental impact was focused solely on wind and water erosion
- Generally considered crop residues as "wastes"

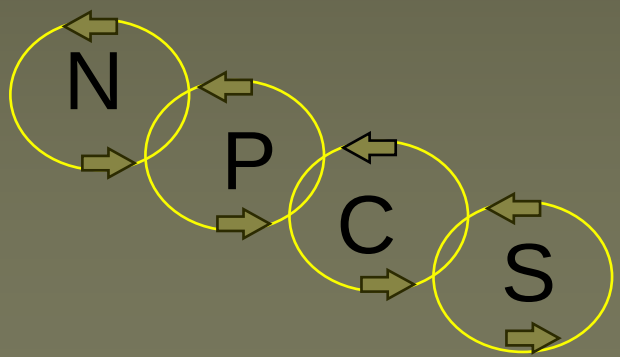
Crop Residues Reduce Erosion

Crop Residues "Feed the Critters!"

Biological Activity

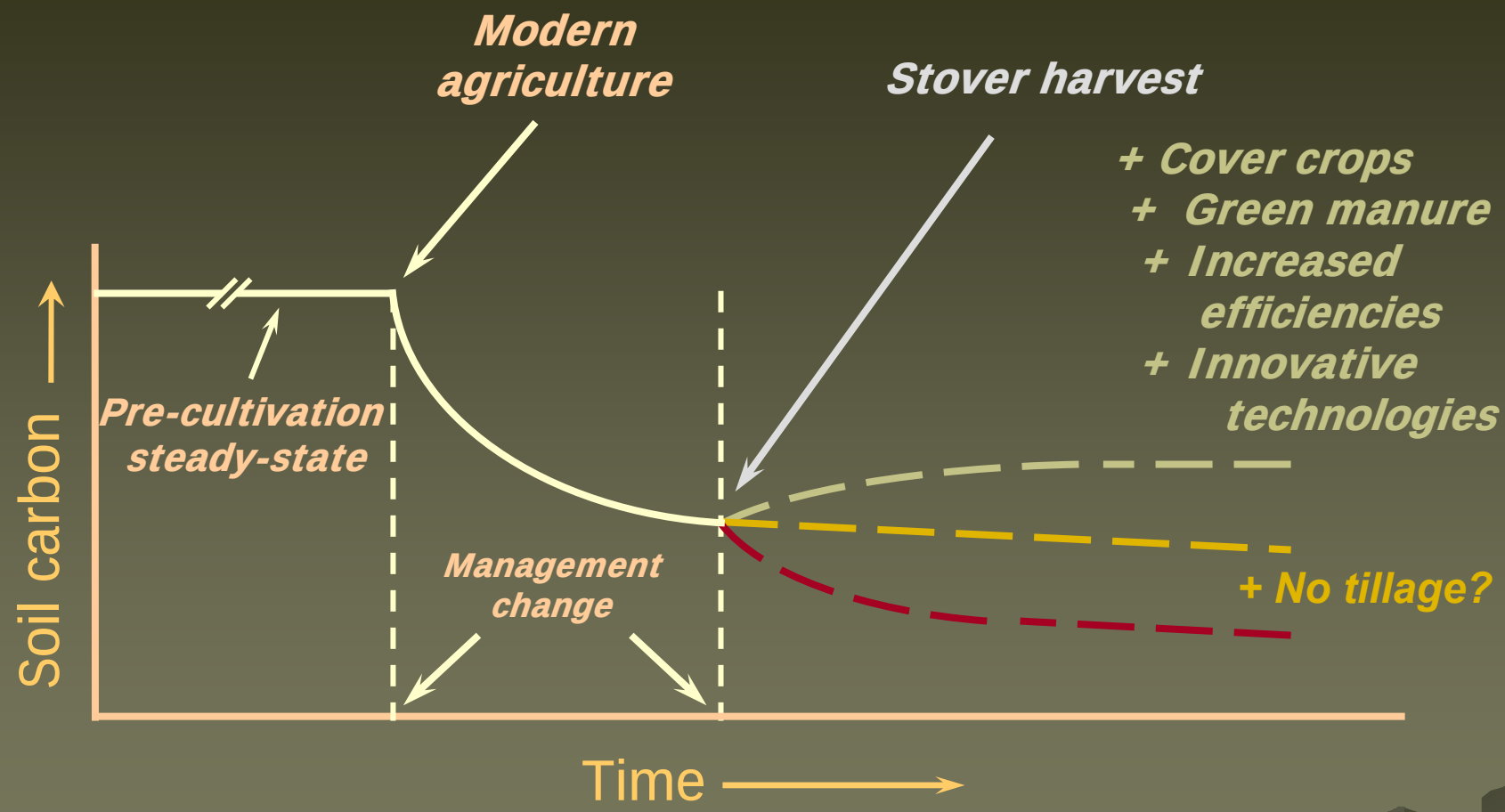
Crop Residues Build the Soil

Soil Structure



Nutrient Cycling Good Plant Rooting

Meeting the Challenge Sustainably



Δ SOC = input - output

REAP

Critical Take-Home Point

Crop residues are not trash!

They have multiple roles that help sustain soil resources

"Economic growth that destroys ecological support systems is neither sustainable nor truly progress"

REAP

ARS-Renewable Energy Assessment Project (REAP)

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

VISION

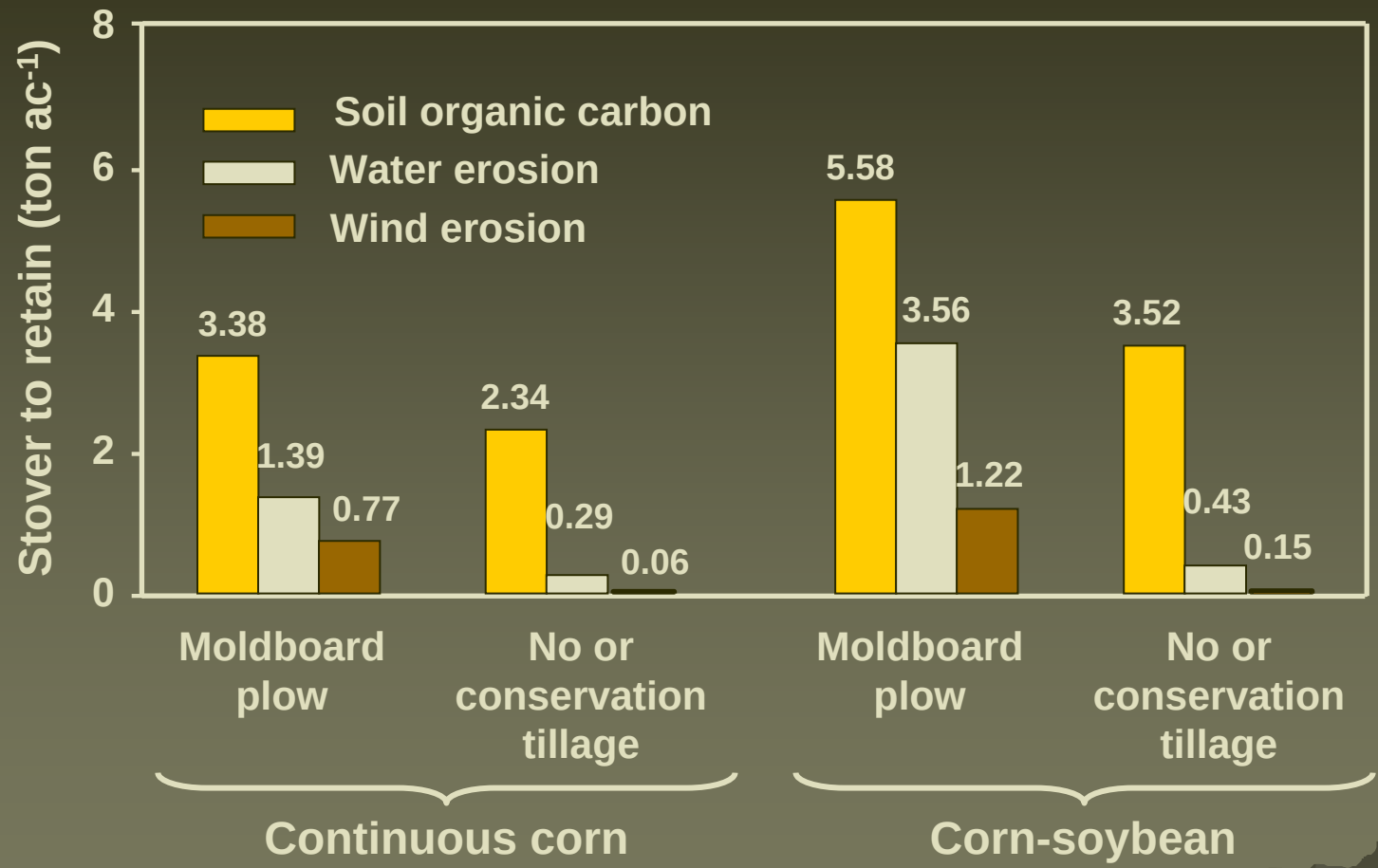
Sustainable Feedstock Production & Harvest

REAP

Biomass Harvest – Risk Analysis

- Benefits
  - Renewable
  - Domestic
  - Reduces release of fossil CO_2
  - Additional farm commodity
- Risks
  - Decreased surface residues
  - Increased erosion
    - Off-site nutrient and sediments
  - Decreased SOM
  - Decreased productivity
  - Other – loss of winter cover, habitat

Factors Limiting Crop Biomass Removal



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

REAP

Field Studies at Ames, IA

Participants and Questions

- Collaborative with Drs. S.J. Birrell (ISU) & C.W. Radtke, Idaho National Lab (DOE)
- Evaluating continuous corn & corn/soybean rotations
- Four crop residue harvest scenarios
- Nutrient removal
- Feedstock quality
- Soil quality impact

Macro-Nutrient Removal

Stover Harvest Scenario	Ranges for Three Hybrids ('05 & '06)		
	N	P	K
	---------- lb ac^{-1} ----------		
Whole plant	17 - 45	2 - 4	29 - 38
Cob & top 50%	12 – 28	2 – 4	23 - 28
Bottom 50%	4 - 12	0.5 - 0.7	5 – 12

Total Nutrient Replacement Cost

Stover Harvest Scenario	Average for Three Hybrids ('05 & '06)		
	$ ac^{-1}	$ ton^{-1}	$ gal EtOH^{-1}
Whole plant	$ 27.71	$ 9.67	$0.121[†]
Cob & top 50%	$ 18.47	$ 9.49	$0.118
Bottom 50%	$ 7.39	$ 10.10	$ 0.126

[†] Assumes 80 gal EtOH ton^{-1} biomass

Unanswered Questions

- Effects of Climate Change
  - As the amount & intensity of precipitation increases, soil erosion increases
- Land Tenure Questions
  - Short-term focus
    - Increases monoculture and N fertilizer rates
    - Increased N losses and decreased soil C
    - Decreased surface residues – higher erosion


What's Next?
Multiple biomass sources
Many new technologies
Emphasis on conservation
Refinement of expectations
Asking & answering the right question

What Can Farmers Do?

Retained

No cover

Removed

Winter rye, triticale, spring oat, wheatgrass and other crops are being evaluated

Reduce tillage intensity & use cover crops

What Can Policy Makers Do?

- Encourage landscape diversity in all bioenergy legislation. Doing so will make it possible to address bioenergy, air quality, water quality, global warming (through C sequestration) & rural economic problems at the same time.
- IF the policies are implemented as an entire agricultural system.

What Can We Do?

First & foremost – do something; follow your passion and interest; questioning, writing, public policy, changing habits, continue learning …

Conserve energy – lights, vehicles, home heating/cooling, car pooling …

Finally, help others understand that agriculture is complex; no simple solutions, but progress is possible.


Questions?