Research and Development Needs for Sustainable Corn Stover Harvest

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Technical Advisory Committee
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Presentation Overview

- Corn stover harvest – Why? Why not?
- What has the USDA-ARS REAP – DOE Regional Corn Stover – Sun Grant Partnership learned?
- What are some remaining critical research and development needs?

US-EPA and others identified corn stover as an economical feedstock because of:

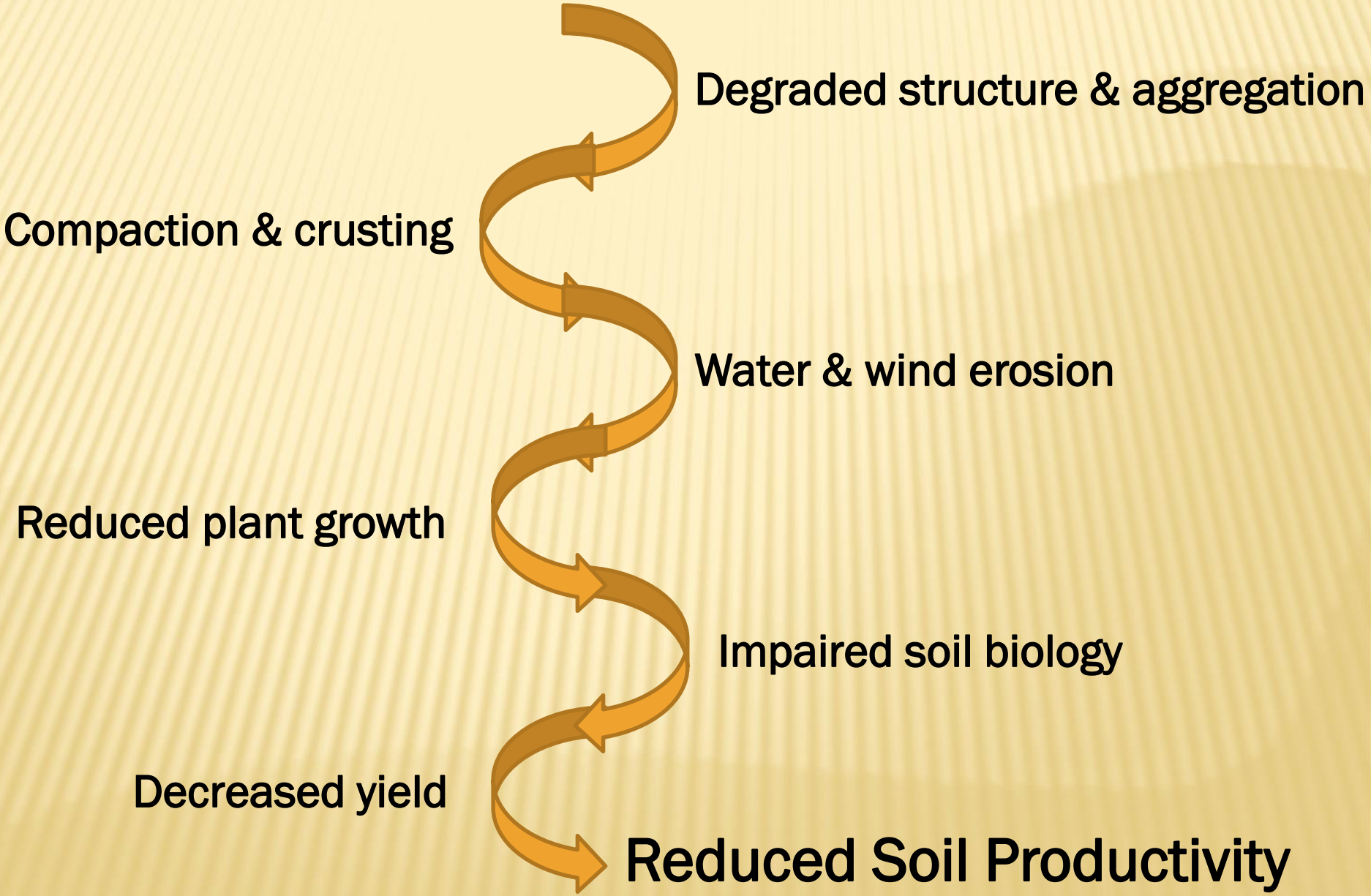
- The extensive area on which corn is grown (planted on an average of 97,272,000 acres in 2011 – 2013)
- The relatively high crop productivity (an average of 11.9 billion bushels of grain for those years)
- A 0.5 harvest index which indicates an average stover production of 282 million tons per year
- The potential to reduce crop residue management costs by harvesting a portion of the stover

BUT – stover is also important for soil health!

2013 winter erosion in Story County, Iowa

2013 corn production site in Green County, Wisconsin

Excessive Stover Harvest Can Result in:



What has the REAP/Regional Partnership Done?

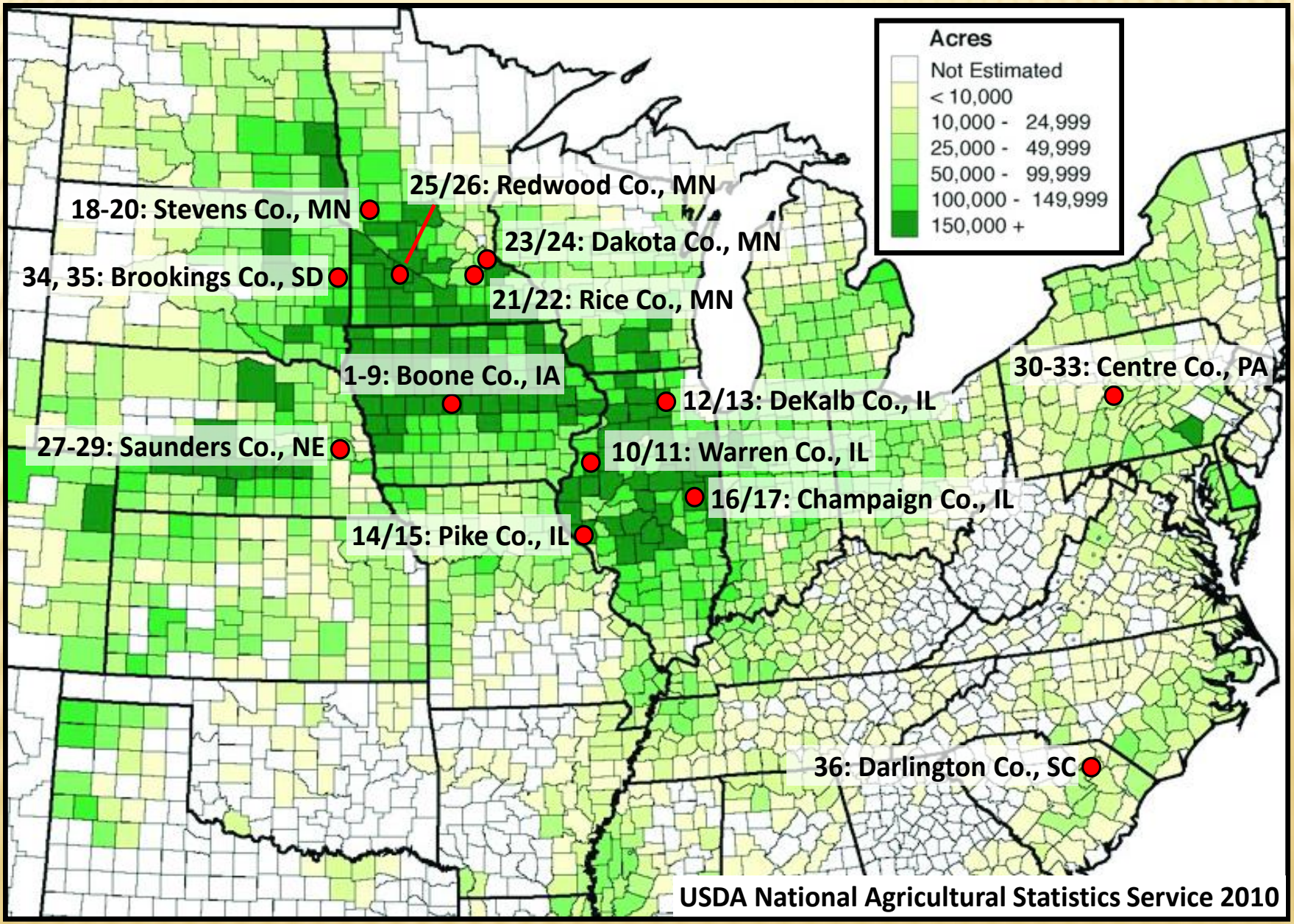
- Compiled 239 site-years of stover harvest data
  - Effects on subsequent grain and stover yields
  - Effects on soil organic carbon (C) & aggregation
  - Effects on microbial community
  - Effects on GHG emissions

- Prepared a special 2014 issue of **BioEnergy Research**

- Developed the **Landscape Environmental Assessment Framework (LEAF)** and other tools to:
  - Estimate available residue
  - Quantify economics
  - Ensure ecosystem service benefits are sustained

This involved ARS, DOE, university, and private industry partners

REAP/Regional Partnership Sites



Utilized Multiple Harvest Technologies

University Park

Lincoln

Ames, Morris & St. Paul

Florence

Industry Collaborators

What we have learned?

- Corn grain yields ranged from 5.0 to 14.3 Mg ha^{-1} (80 to 227 bu/acre)
- Average grain yield response to stover harvest was minimal:
  - 9.8, 10.1, and 10.1 Mg ha^{-1} (156, 160, and 160 bu/acre) for:
  - No, moderate (3.9 Mg ha^{-1} or 1.7 tons/acre), or high removal (7.2 Mg ha^{-1} or 3.2 tons/acre)
- Sustainable stover harvest rates are site specific – averages are meaningless
- Appropriate residue harvest may encourage Midwest producers to adopt no-till corn production practices

Nutrient Removal Lessons

- Compared to grain only, moderate stover harvest (3.9 Mg ha^{-1}) increased N, P, and K removal by 24, 2.7, and 31 kg ha^{-1}
- Similarly, high stover harvest (7.2 Mg ha-1) increased N, P, and K removal by 47, 5.5, and 62 kg ha^{-1}
- Nutrient removal estimates (especially K) were generally greater for samples collected at physiological maturity than at combine harvest because of translocation and leaching from upper plant parts
- Long-term crop and soil monitoring must be continued

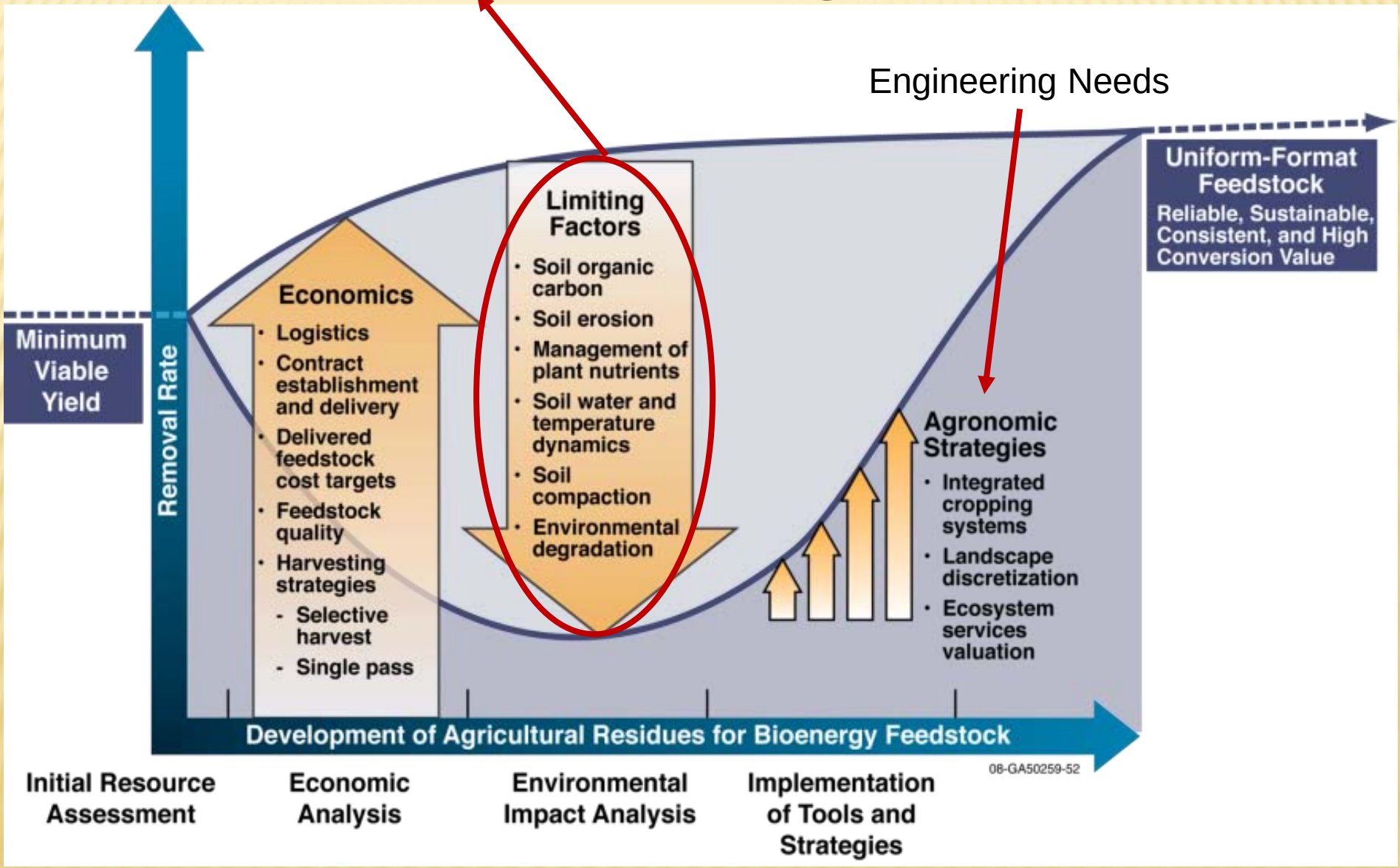
Other Lessons

- For sites with insufficient grain yield (≤ 11 Mg ha^{-1} or 175 bu ac^{-1}), ten years of stover harvest, even with no-tillage, reduced POM (particulate organic matter) accumulation suggesting SOM maybe declining
- Insufficient yields shifted the dry aggregate distribution toward smaller soil aggregates
- Insufficient yields resulted in undesirable shifts in the microbial community
- Overall, sustainable supplies of corn stover may be lower than initially projected because of weather-induced yield variability

Strategies to Ensure Sustainability

- Encourage the entire biomass industry to understand the economic driver – limiting factor model
- Support development of self-regulating strategies such as the Biomass Market Access Standard (BMAS)
- Continue long-term, multi-location, trans-disciplinary research through public-private-partnerships
- Continue to develop management tools such as LEAF

Balancing economic drivers and limiting factors for sustainable bioenergy production



The Biomass Market Access Standard (BMAS) Web-Based Tool:
Implementing Cost-Effective and Credible Bioenergy Sustainability Certification

Facilitated by:
Jody Endres (the University of Illinois at Urbana-Champaign) and Tim Rials, the University of Tennessee-Knoxville

Technology Summary

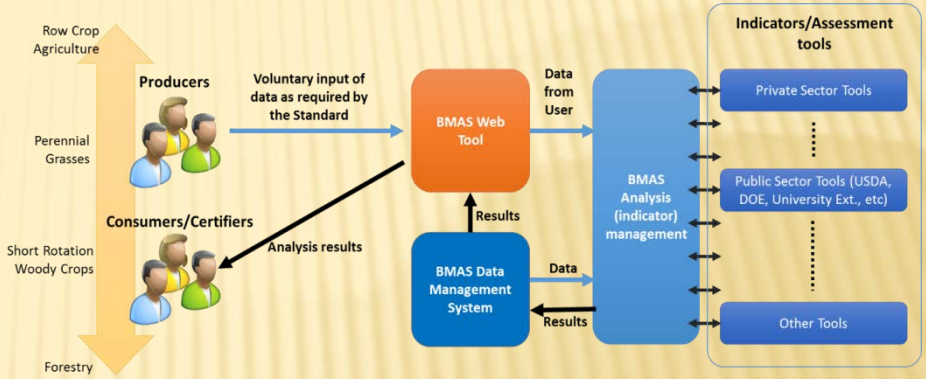
- Web-based tool to facilitate producer, consumer (e.g. the biorefinery) and certifier interactions
- Sustainability measurements provide certification/verification
- Short videos and reference materials provide to help users understand each sustainability indicator

Technology Impact

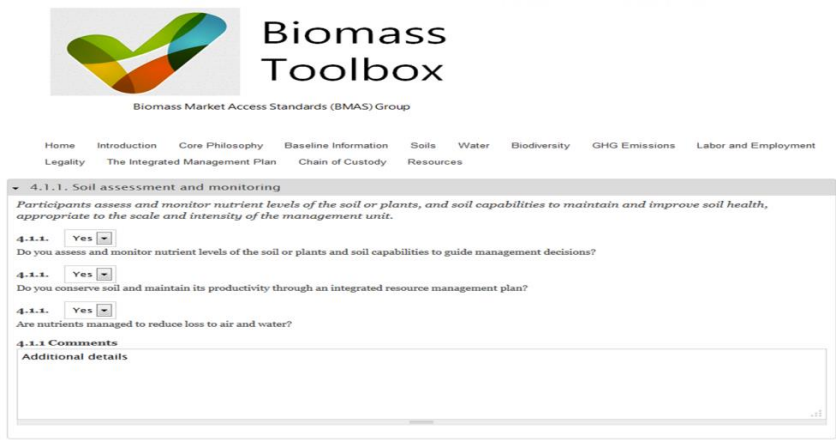
- Reduces inefficiencies and supply chain costs through sustainable practices and impact assessments
- Displaces need for regulatory approaches and reduces risk by proactively measuring and verifying improvement
- Addresses both agricultural and short rotation woody biomass markets
- Facilitates forestry certification to existing standards for landowners who desire more diverse landscapes

Proposed Targets

- Complete sustainability standards with quantitative metrics and performance targets
- Design an implement the first ever web tool for bioenergy certification using science-based data and analytics



The BMAS Web-Based Tool's Front-, Middle- and Back-End Interfaces



The BMAS Front-End Interface Prototype

Enabling better decision making for sustainability

The BMAS Website

https://www-app2.igb.illinois.edu/bmas/

The ATIP Public-Private-Partnership (PPP)

- The ATIP Foundation, LLC is a 501(c)(3) non-profit entity that serves as a formal technology transfer facilitator with the USDA
- At the request of USDA-ARS, the ATIP Foundation has established a PPP to enhance research on sustainable soil health for multiple agricultural land uses entitled "Healthy Soils, Healthy Landscapes, Vibrant Economies"
- Any assistance from BRDB in identifying potential NGOs, private industry, or other groups who may be interested in learning more about the PPP will be appreciated

LEAF – A Tool to Guide Future Research

Additional Research Needs

- Effective and efficient strategies for including cover crops in stover harvest systems
- Low-disturbance equipment for incorporating animal manures to improve soil health and increase harvestable stover supplies
- No-tillage technologies that incorporate site-specific, on-the-go seeding and seedbed adjustments to help encourage adoption of those practices
- Innovative harvest methods and new uses for perennial crops to diversify crop rotations for improved soil health, increased yield, and sustainable stover supplies

Critical Needs for Sustainable Stover Harvest

- Crop insurance or other incentives for increased landscape diversity to support both bioenergy feedstock and commodity (food/feed) production
- NGO & private sector contacts for the ATIP REAP PPP
- Educational information showing that stover harvest is site and preferably sub-field specific and therefore does not need to result in soil degradation
- Crop insurance or other incentives to encourage producers who harvest corn stover to significantly decrease tillage intensity

Summary & Conclusions

- REAP/Regional Partnership recommendations for sustainable stover harvest
  - Decrease tillage intensities
  - Utilize cover crops
  - Implement sub-field stover harvest and tillage management practices

- LEAF is an effective assessment and planning tool that warrants further research, development, validation, and implementation

Developing Sustainable Stover Harvest Strategies is Just a First Step Toward Solving Multiple Energy and Ecosystem Challenges

Any Questions?