Biofuel Feedstocks: Questions for Agriculture

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Scope

- Why examine feedstocks now?
- Which feedstocks concern agriculture?
- Where will feedstock production expand/emerge?
- How will land use be shaped?
- What are the likely consequences for the environment?
- When will the transformations of agriculture occur?
Interagency Feedstock Team

- USDA, DOE and EPA
- Tasked by the Biomass Research and Development Initiative board to:
  - Assess availability, cost and infrastructure requirements for new and emerging feedstocks
    - Economic
    - Sustainability
    - Greenhouse Gas
Feedstock analysis: Why?

- Recent legislation and policy initiatives have made biofuel production and use a focus of the future U.S. energy system.

- The majority of feedstocks will come from agricultural land, using both established and developed crops and production practices.

- This ‘new’ demand will have implications for the agricultural land base, markets for non-bioenergy agricultural products and environmental quality.
Feedstock analysis: Which?

• Feedstocks can be classified by the maturity of the crop production system and conversion technology
  – First generation: **corn**, sugar, soybeans, vegetable oils
  – Second generation (short-term): **crop residues**, forest residues
  – Second generation (longer-term): **switchgrass**, miscanthus, willow, hybrid poplar
Feedstock analysis: How much?

- 13.1 billion bushels of corn in 2007, a record, grown on 93.6 million acres (highest since 1944)
- To meet the needs for food, feed, and fuel in 2016, we’ll need an estimated 14.6 billion bushels of corn
- To meet EISA, we’ll need cellulosic feedstock on the order of 70 million tons
Feedstock analysis: Where?

- How will crop production respond to biofuel facility location, transportation infrastructure, and land suitability?
  - Geographic distribution

- Implications for land allocation
  - Shifting from traditional crops to biofuel feedstock
  - Reintroduction of idle (possibly marginal) land
  - Conversion of set-aside land
Ethanol plant and feedstock density

Ethanol Production Capacity Intensity based on Current and Proposed Plant Capacities

Source: USDA Economic Research Service analysis of the Renewable Fuels Association and other ancillary sources, 2007
Co-product (DDG) use

Current and planned ethanol production capacity 6-07 and potential DDG consumption by livestock and poultry

Source: ERS analysis of Renewable Fuels Association, USDA Agricultural Census 2002 and Dhuyvetter, Kastens and Boland, 2005
Irrigated cropland and ethanol plant location

Source: ERS based on 2002 Census of Agriculture data and 2007 Renewable Fuels Association data.
Concern for declining groundwater tables

Source: ERS based on 1999 USGS Digital map data and 2007 Renewable Fuels Association data.
Modeling framework

- Regional Environment and Agriculture Programming (REAP) model
  - Integrated crop, livestock and agricultural product supply/demand model
  - Relationship between production practices and environmental outcomes

- Key assumptions:
  - No competition from non-traditional biofuel feedstocks
  - No yield growth
    (e.g., from introduction of GMO or starch-optimized varieties)
REAP regions
Regional crop shifts: Corn acreage

Change in planted corn acres
Regional crop shifts: Soybean acreage

Change in planted soybean acres
Conservation lands

Change in Conservation Reserve Program acres

- Increase from baseline
- Decrease from baseline
Feedstock analysis: How?

- Land stewardship involves choices regarding:
  - Crop/rotation
  - Tillage/soil management
  - Input use: Water, fertilizer
  - Participation in conservation programs
    - Land retirement
    - Working lands
Production practice: Rotation

Change in continuous corn rotation

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Increase from baseline
Decrease from baseline
Production practice: Tillage

Change in ratio of conservation tillage to conventional tillage
Input use: Fertilizer

Change in nitrogen fertilizer use

Increase from baseline
Decrease from baseline
Feedstock analysis: What?

• Changes in production practices lead to changes in fertilizer and pesticide use. These changes, in turn, affect soil, water, and air quality.

• The increase in demand for corn and land will change the equilibrium of other agricultural markets.
  – Feed for livestock
Environmental effects: Soil erosion

Change in total soil erosion

Increase from baseline
Decrease from baseline
Environmental effects: Nitrogen Leaching

Change in nitrogen leached to groundwater

- Blue: Increase from baseline
- Orange: Decrease from baseline
Feedstock analysis:

**When?**

- Farmers have shown that they are very responsive to changing signals in the market
  - But, what about untested crops?

- For the next generation of feedstocks: Which to come first, the crops or the technology?
  - Research & development
  - Economic incentives
  - Market arrangements
Summary

• Expansion of demand for established crops coupled with demands for unproven commodities will challenge the resiliency and adaptability of the agricultural production system.

• Critical issues:
  – How rapidly technological innovations become commercially viable
  – How effectively required infrastructure is developed
  – How farmers respond to market signals
Summary

• Changes in land use and production practice will have consequences for soil, water and air quality
  – The extent of these changes will vary regionally
  – Policy and technology will influence consequences

• The agricultural landscape that eventually emerges will depend on incentives and programs that have yet to be defined
ERS Research

• No fewer than 21 biofuels themed projects
• Overview of past and current endeavors at:
Without implication...

- Paul Westcott, ERS
- Noel Gollehon, NRCS
- Aziz Elbehri, ERS
- Vince Breneman, ERS
- Marcel Aillery, ERS