Weaning off Corn: Crop Residues and the Transition to Cellulosic Ethanol

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The Energy Independence and Security Act of 2007 is the latest juncture on a policy pathway to stimulate biofuel production. Consequently, new markets for agricultural products will be created—indeed, new agricultural products will be created.
EISA production targets

- Cellulosic
- Other Advanced
- Corn
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 newly 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.
Conventional Crop Residues

• All major crop residues considered, but they vary in residue to grain yield

• Fraction of residue available for collection varies by tillage regime, and affects soil erosion potential, embodied nutrients, and soil carbon
  – For this analysis, we limit harvest to 50% from no-till, 30% from reduced tillage, and 10% from conventional tillage
  – 17 lbs N per ton of residue needs to be replaced
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
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
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
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:
  – National market for commodities; no local variation
  – Modest yield growth in row crops
REAP regions
More Cellulosic Capacity -> Less Corn?

- The 15 billion gallon corn ethanol “ceiling” has usually been treated as an immutable fact.
- What will be the upside/downside of cellulosic coming on line soon AND being allowed to substitute for corn ethanol as stipulated by EISA?
Some Hypotheses

• Less land for corn required
  – although more stover would be needed, there is an ample supply – up to a limit
• Movement into no-till systems
• Environmental impacts would be somewhat offset
Crop prices

Cellulosic production (billion gallons)

Price relative to 4.25 billion gallon demand

- Corn
- Sorghum
- Barley
- Oats
- Wheat
- Rice
- Soybeans
Planted acreage

Cellulosic demand (billion gallons)

Million acres

Total (right axis)

Corn (left axis)
Regional acreage effects

Cellulosic production (billion gallons)

Change in planted acres relative to 4.25 billion gallon demand (million acres)

Lake States
Corn Belt
Northern Plains
National environmental effects

Cellulosic production (billion gallons)

Index relative to 4.25 billion gallon demand

- Sheet erosion
- Nitrogen to surface water
- Nitrogen to estuaries
- Nitrogen to groundwater
Regional environmental effects

Northeast
Lake States
Corn Belt
Northern Plains
Appalachian
Southeast
Delta
Change in tillage practice

Acreage in major tillage systems (million acres)

- No till
- Reduced
- Conventional

Cellulosic demand (billion gallons)
Summary

- The transition to cellulosic will have benefits because of the existence of an essentially “free” good – crop residue
  - Carbon storage not considered
- Replacing some corn ethanol capacity with cellulosic will ease some of the pressure of agricultural land
- There does not seem to be a need to rush into switchgrass; this can wait until cellulosic technology becomes “proven” with residue
• Environmental effects are mixed as a result of added fertilizer application
• Producers that can market residue along with grain will see a boost in revenues, but producers where crop residues cannot be sold will take a hit from lower crop prices
• As value of residue increases, there is incentive to harvest more than is sustainable, potentially increasing environmental consequences