Corn stover harvesting: potential supply and water quality implications

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Corn stover

- All the plant material that is not grain
- Presently not actively traded
  - Local markets, stalks used for livestock bedding
- Considered as a potential bioenergy feedstock
  - For co-firing with coal
  - For ethanol production via second generation biofuels production technologies
    - High energy content, possibly “cleaner” technology
    - 2008 Energy Bill mandates the majority of the U.S. production of ethanol production coming from the 2nd generation technologies

If corn stover becomes a widely traded commodity water quality may suffer

- Collection of corn stover precludes residue recycling
  - Leaving residues on field surfaces or incorporating them into soil by tillage contributes to
    - Maintaining soil carbon levels, controlling nutrient runoff, preventing from water and wind erosion
- Viable corn stover market would increase the profitability of corn relative to other crops
  - Higher corn acreage
    - High nutrient use and loss might lead to worsening nutrient run-off
    - Corn monoculture usually requires higher tillage intensity

The overall environmental impact of collecting and marketing corn stover

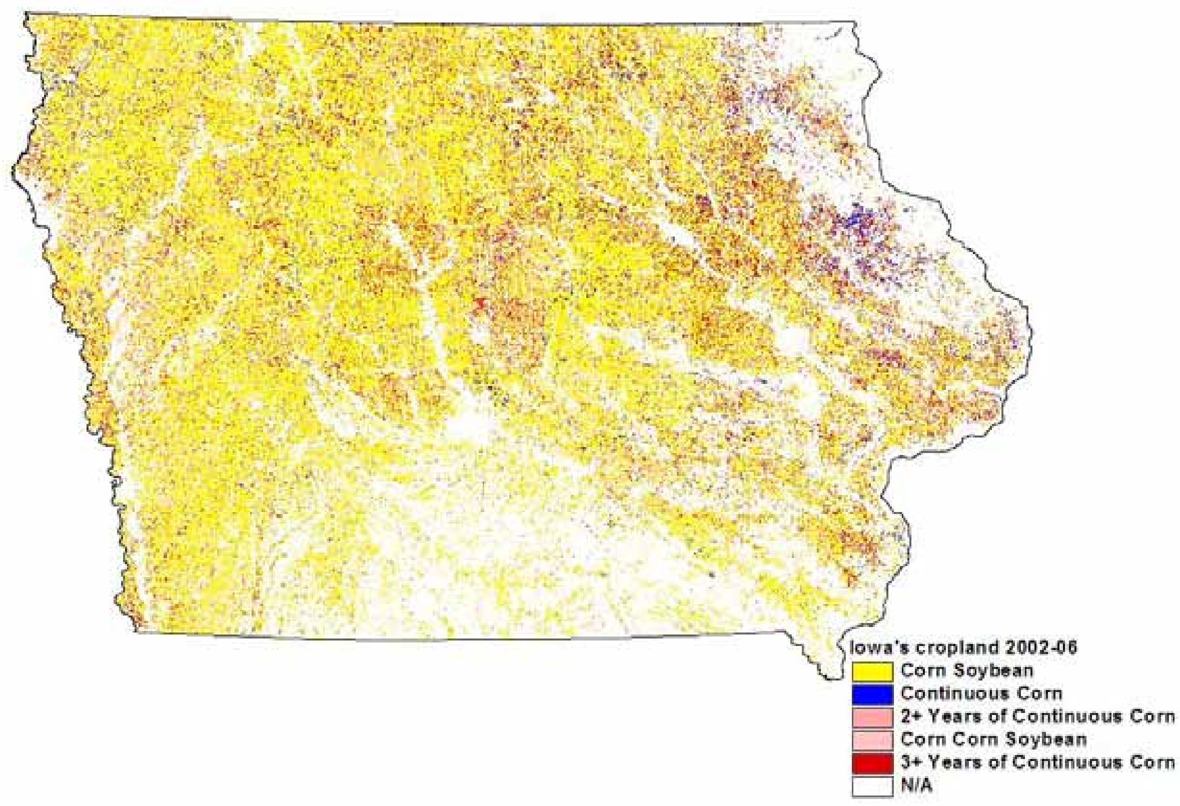
- Is largely unknown
- Large scale, rough estimates (Gallagher et al 2003, Perlack et al 2005, Graham et al 2007)
  - Use county-level or coarse-level data
  - Merely calculate the amount of stover that could be produced with the current level of corn production
- Unanswered questions
  - How corn stover prices would affect the use of land and the environmental outcomes of crop production

This study

- Assesses the consequences of a viable corn stover market on
  - Spatial distribution of corn production
  - Economic availability of corn residue
  - Associated water quality indicators: N runoff, P runoff, soil erosion
- Linked models: economic, geographical, and environmental (EPIC)
- Novel level of spatial detail: GIS-based, field-level data
- State of Iowa

Data

- Cropland use baseline: USDA/NASS remote sensing crop cover maps 2002-2006
  - Historical rotations using a 30 sq.m grid
- SSURGO
- Corn Suitability Rating (CSR)



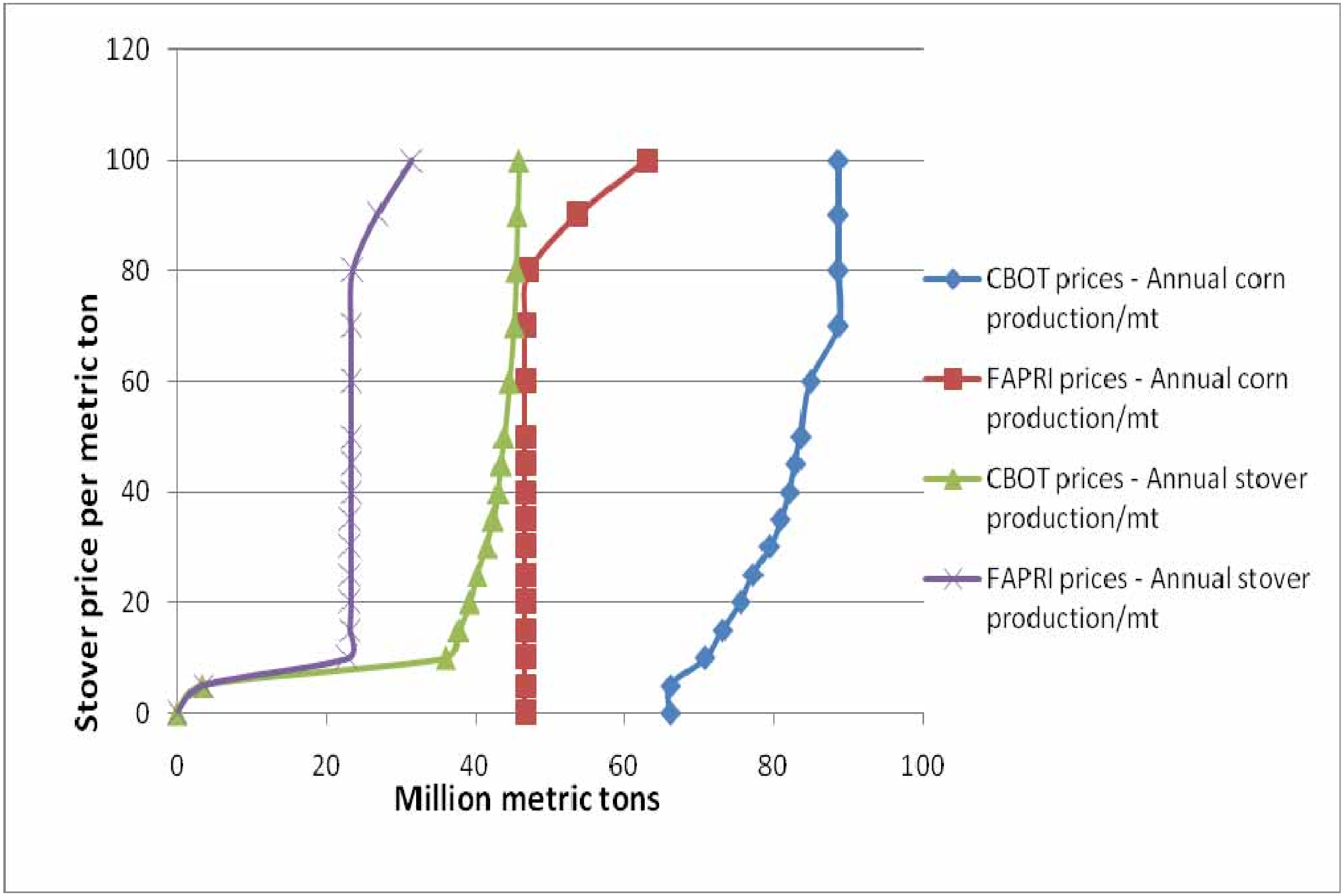
Data continued

- Baseline tillage system is not known. Based on previous assessments, we assume
  - No-till on all HEL land
  - Conventional till on all non-HEL land in CC
  - Mulch till on the rest of the land in baseline
- Scenarios are compared to the baseline
  - Corn stover prices from $5/MT to $100/MT
  - Crop prices:
    - FAPRI forecast: $3.9/bu corn, $9.8/bu soybeans
    - CBOT futures contracts: $6.7/bu corn, $14.7/bu soybeans

Simulating field-by-field farmers' choices

- Given
  - Corn stover, corn, soybean, diesel fuel, fertilizer prices
- Farmers maximize expected profits by choosing
  - Rotation (CC, CS, or CCS)
  - Tillage (no-, mulch-, or conventional till)
    - Rates of fertilizer application under alternative rotation-tillage systems are assumed to be fixed at the historically typical levels
  - Whether to harvest 50% corn stover or not
- N, P, and sediment losses simulated with EPIC

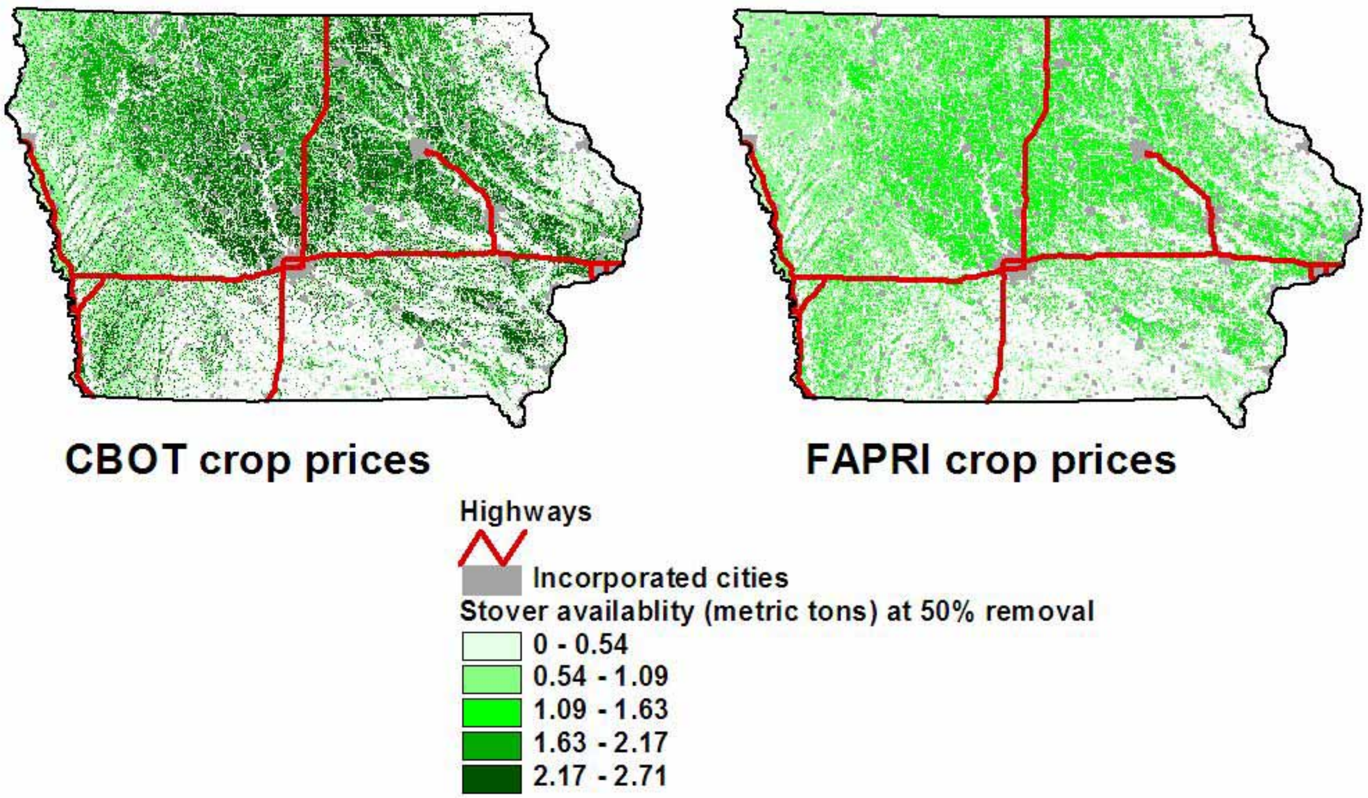
Results: corn and corn stover supply



Results

- Primary product (corn and soybean) markets are very important
  - CBOT prices result in much higher corn acreage than the FAPRI prices
    - Without corn stover markets, there are 4.6 mln acres in CC under CBOT vs. no acres in CC under FAPRI
    - At $25/MT stover, 5.8 mln acres would covert from CS to CC under CBOT vs. no acres convert from CS to CC under FAPRI
  - Spatial distribution of saleable stover differs between CBOT and FAPRI prices

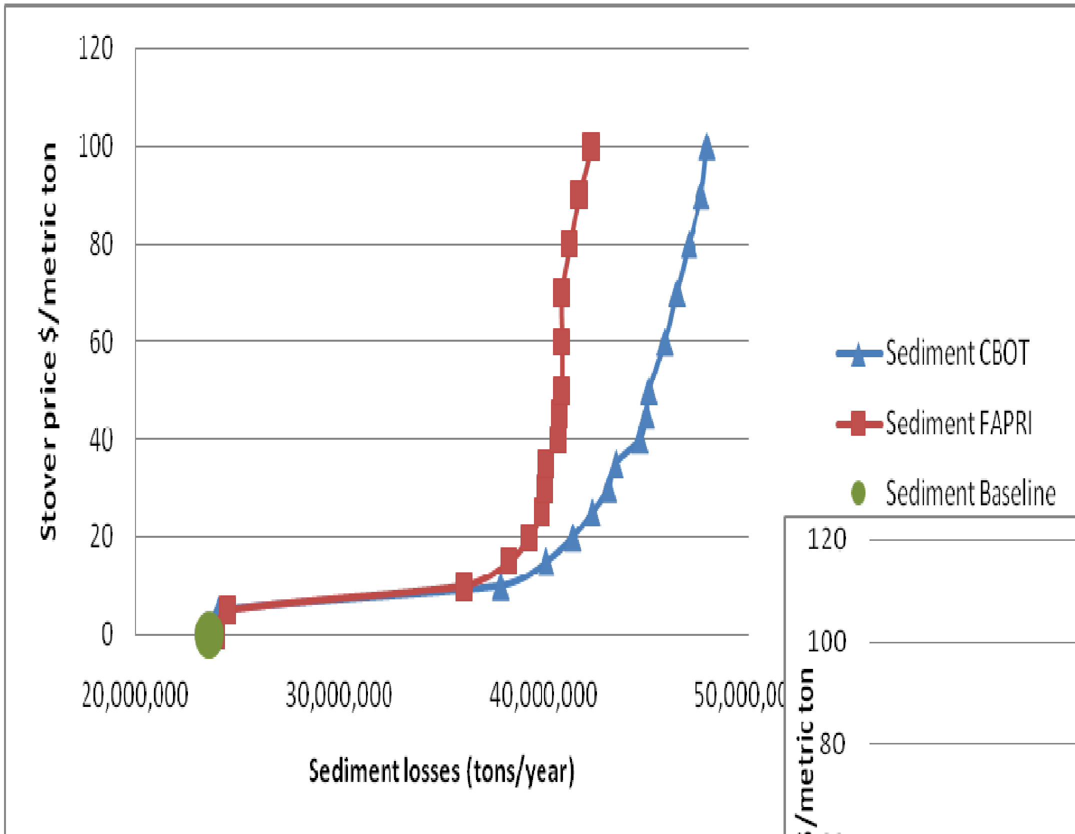
Spatial distribution of corn stover availability at $25/MT

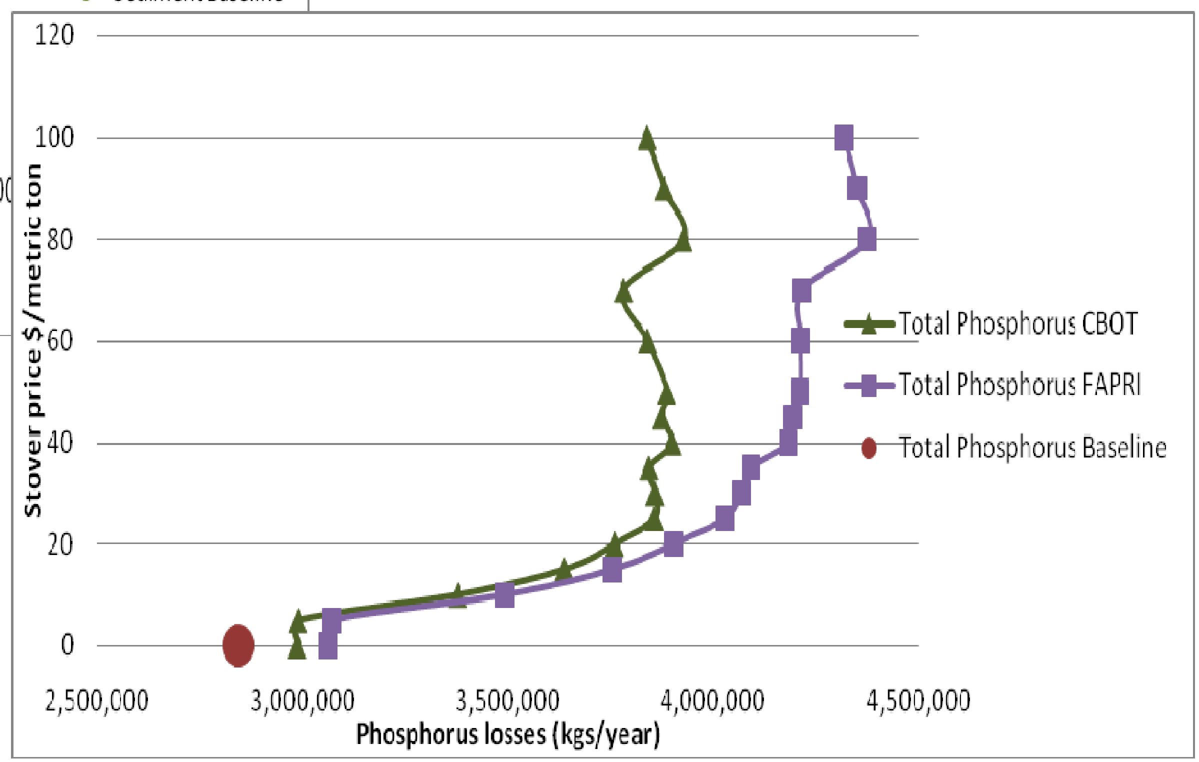


Environmental effects of corn stover removal

- For stover prices above $20/MT all environmental indicators are worse than the baseline
- Primary product (corn and soybean) markets are still very important
  - Sediment and N losses are bigger under the CBOT prices
  - P losses are bigger under the FAPRI prices
    - Relatively high level of P application in soybean years (45 kg/ha)
    - P runoff is controlled by precipitation; impact of precipitation is mediated by its timing and the amount of vegetative cover
    - Lack of residue in the soybean years

Edge-of-field environmental impacts





Concluding comments

- Strong evidence for potential increases of corn in rotations and tillage intensity in response to a viable corn stover market
- Corn stover collection would increase N, P, and sediment losses
- Uncertainty in predicting the primary commodity prices translates into uncertainty in predicting farmers' choices of rotations and their water quality impacts
- Our analysis is limited to edge-of-field impact.
  - Next step: SWAT