Corn Residue Harvest and Inefficient Groundwater Extraction

Juan Sesmero and Aaron Cook

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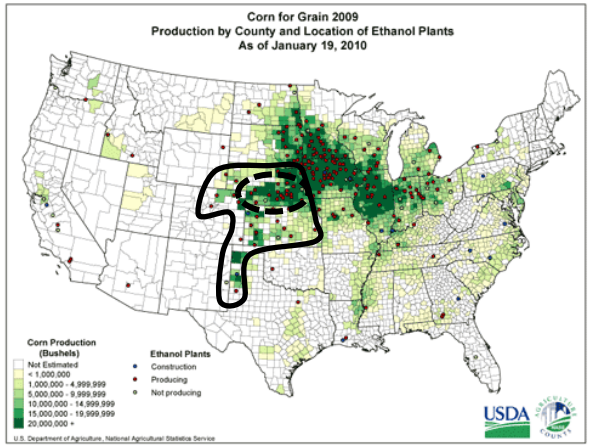
Motivation

- Corn residue promising feedstock to meet RFS cellulosic requirement.
- Irrigated corn belt candidate area: high yields/continuous corn
- Removal of stover decreases soil moisture (e.g. Doran et al., 1984; Power et al., 1998) which reduces yield unless more irrigation is applied.
- Concern about pressure on groundwater.



Theory

- Inefficient over-extraction occur in common access resources.
- Welfare losses due to over-extraction can be empirically negligible depending on aquifer properties (Gisser-Sanchez)
- Welfare losses of over-extraction (if any) should be included in "social costs" of stover-based energy.

Research question

- What are the likely welfare losses associated with groundwater over-extraction caused by corn residue harvesting?

Model

- Farmer maximizes present value of future stream of profits subject to soil water dynamics and groundwater stock dynamics.

$$\underset{(h_t,w_t)}{Max}\int_0^{\infty} e^{-rt}\left(g_t p_y + \left[g_t h_t\left(p_h - c_h^b\right) - c_h^a\right] - \left(c_0 + c_1 H\right)w_t\right)$$

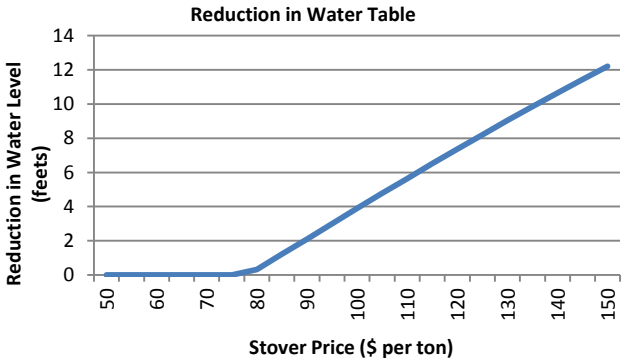
$$\dot{I}_t = I_o + dg_t\left(1 - h_t\right) - I_t$$

$$\dot{H}_t = \frac{1}{AS}\left[R + \left(\gamma - 1\right)\left(w_t + \sum_{j \neq i} w_j\left(H\right)\right)\right]$$

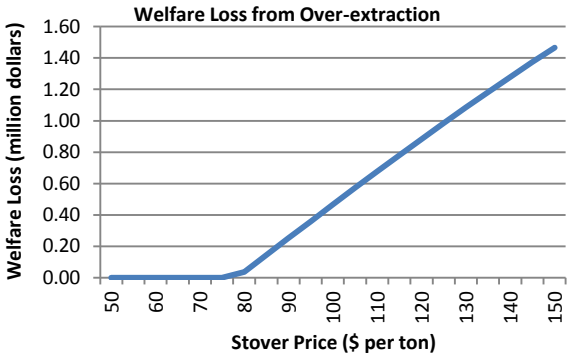
h_t : stover harvest rate
g_t : yield
p_y : net revenue/bu corn
$p_h - c_h^b$: net revenue/ton stover
H : water level
w_t : irrigation rate

- **Feedback Nash Equilibrium (FE) in linear strategies** compared to **efficient** solution.
- Model calibrated with observed data and results of agronomic experiments.

Preliminary Results (mean)



Preliminary Results (mean)



Conclusions

- Results suggest welfare losses of over-extraction may not be negligible in western Nebraska, Kansas, and Texas
- Under western NE conditions the FE supplies 112MGY at $100 per dry ton. Efficient solution only for 2.56MGY. The efficiency loss associated with market supply is 600 million dollars

Data Sources

- USDA – NASS
- Doran et al., 1984; Power et al., 1998

Authors Information

[1] Agricultural Economics, Purdue University. Phone: 765-494-7545. Email: jsesmero@purdue.edu
[2] Agricultural Economics, Purdue University. Email: cook94@purdue.edu