Investment Decisions and Policy Analysis: can energy crops compete with agriculture? A real options approach to landowner returns.

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BACKGROUND

Second generation ethanol feedstocks could come from many sources, most of which have to compete for land.

We developed a model that estimates landowner option values for converting land from agriculture to:

I. Switchgrass (*Figure 1*)
II. Hybrid Poplar (*Figure 2*)

These energy crops are currently not allowed on public forest lands. Can they compete for private agricultural lands?

Figure 1: Switchgrass (UTIA, n.d.).

Figure 2: Hybrid Poplar Trees (Doll, n.d.).

SHORT-TERM OBJECTIVES

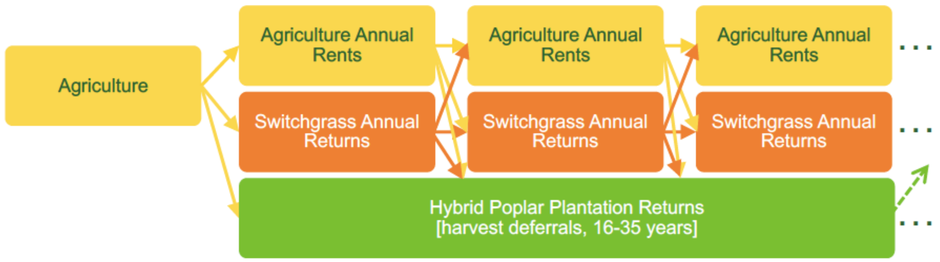
To investigate the conditions under which second generation feedstocks might be able to financially compete with agricultural land uses considering:

- Co-production opportunities (i.e. ethanol with electricity or pellets)
- Market volatility (i.e. product prices, costs, changes over time)
- Site specific conditions (i.e. land prices, distance to mills)
- Policies (i.e. ethanol subsidies).

PROJECT OVERVIEW

THE REAL OPTIONS MODEL

- Option values are estimated as the difference between the value of agricultural land that considers future potential energy crop allocations, and the value of land assumed to stay in agriculture.
- The landowner seeks to maximize the value of their land, which could be increased by the flexibility of real options.
- Expected future values of private land under alternative uses are compared; the highest assessment dictates the land use.
- Over time, the landowner has the options to switch between land uses, and to postpone the harvest of hybrid poplar.



- Future volatility of prices is based on historical data: 50,000 price paths are simulated for ethanol, electricity, pellets, and agricultural land values.
- Two co-production scenarios are compared: ethanol with electricity versus ethanol with pellets.
- The model simulation period is 65 years.

KEY ASSUMPTIONS

- We consider land located 10km from a future biorefinery, with a starting agricultural land value of 1000 $/ha, producing a poplar mean annual increment of 19.59 m^3/ha/ year and a switchgrass yield of 12.3 oven dried tonnes/ ha/year.
- Discount rates vary according to the wait time before returns are collected: 4.37% is applied to annual returns from agriculture and switchgrass, and 5.63% is applied to the 16-35 year wait before harvest of hybrid poplar.
- Conversion costs from agriculture to energy crops are zero, while conversion costs from forestry and switchgrass to bare land are 354 $/ha and 40.77 $/ha, respectively.
- The model is run with assumptions of ethanol production subsidies of 0.11, 0.21, and 0.31 $/L.
- Future ethanol, electricity, and pellet prices are modeled according to mean reverting processes.
- Future agricultural land values are modeled based on a geometric random walk.

THEME OVERVIEW

Biomass

We already know how to create fuels from certain types of biomass, but many other feedstocks can potentially be transformed in a similar manner. In order to identify new viable sources, we must develop more a sophisticated understanding of the technological processes that might be used to convert biomass to fuel, and assess the potential business cases for adopting certain sources that might have other economic uses, or compete with established cash crops. We can also explore the potential for tailor-made fuels for the transportation sector, developed from biological sources.

EXPECTED OUTCOMES

EXPECTED LAND USE CONVERSIONS

- The model produces estimates of option values, which influence the expected proportion of the 50,000 trials that allocate land to growing energy crops.
- Energy crops do not enter into the land use schedule at the current ethanol production subsidy level of 0.11$/L.
- Energy crops do not enter into the land use schedule in the ethanol and pellet co-production scenario.
- Hybrid poplar enters into the land use schedule under co-production of ethanol with electricity, with a subsidy level of 0.21$/L. Switchgrass does not.
- With an ethanol production subsidy level of 0.21$/L, hybrid poplar appears to be the financially favored energy crop.

Ethanol Subsidy	Option Value	Proportion of Draws where Hybrid Poplar Out-competes Agriculture			
		Year			
($/L)	($/ha)	1	10	30	50
0.21	3.75	0	0.001	0.07	0.13
0.31	980.87	1	1	0.91	0.81

SUMMARY

- Dedicated energy crops are not likely to financially out-compete agriculture without higher subsidies.
- The future of the second generation ethanol industry will likely rely on a portfolio of feedstocks.
- Future work will look to forestry and agricultural residues as feedstocks.

EXTERNAL PARTNERS

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