Choosing the Right Feedstock: Cost, Risk, and Sustainability Considerations

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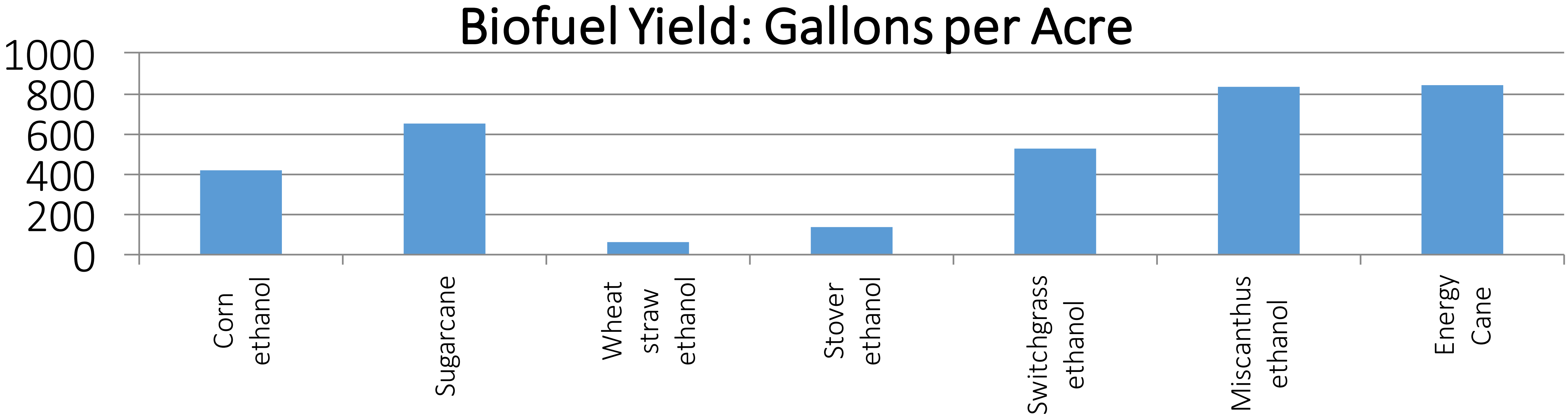
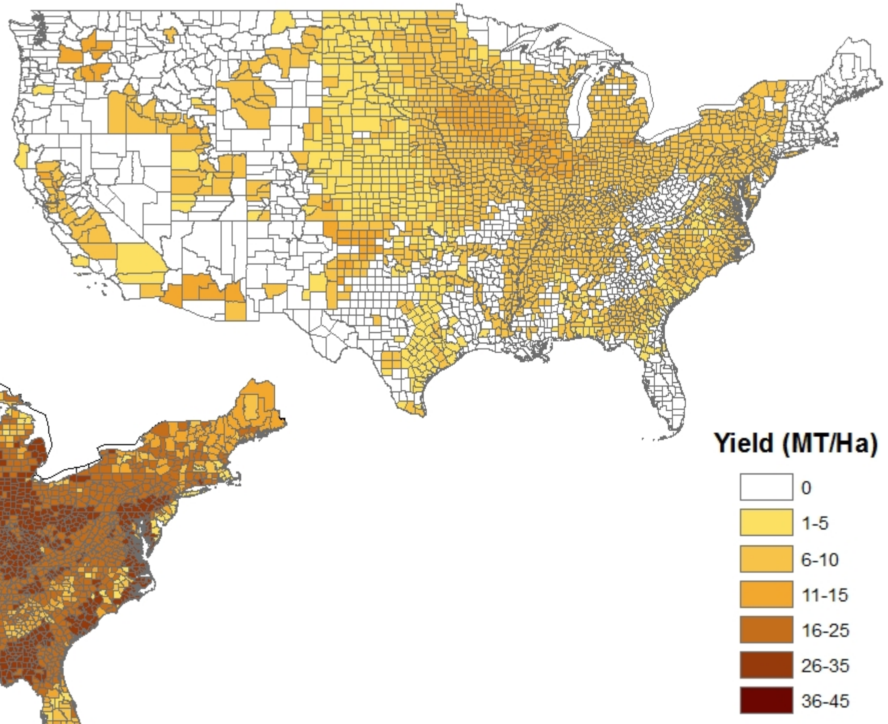
Choice of Feedstocks for Biofuels



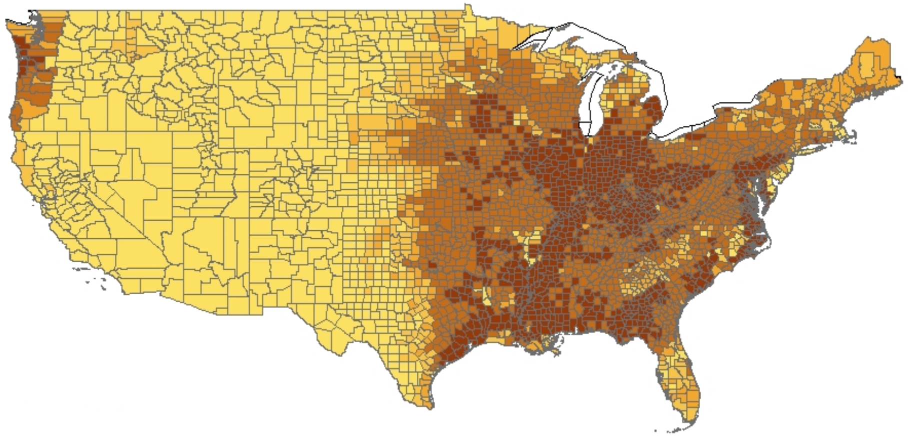
Feedstock Costs

- Location matters: yields
- Energy Crops:
  - Life-span of 10-15 years or more: Long term commitment
  - Lags in establishment
  - Upfront establishment costs:
  - Cost of alternative uses of land: foregone returns to land
- Crop Residues
  - Readily available
  - Sustainable harvest to residue ratios
  - Replacement nutrients
  - Low yields, larger collection area

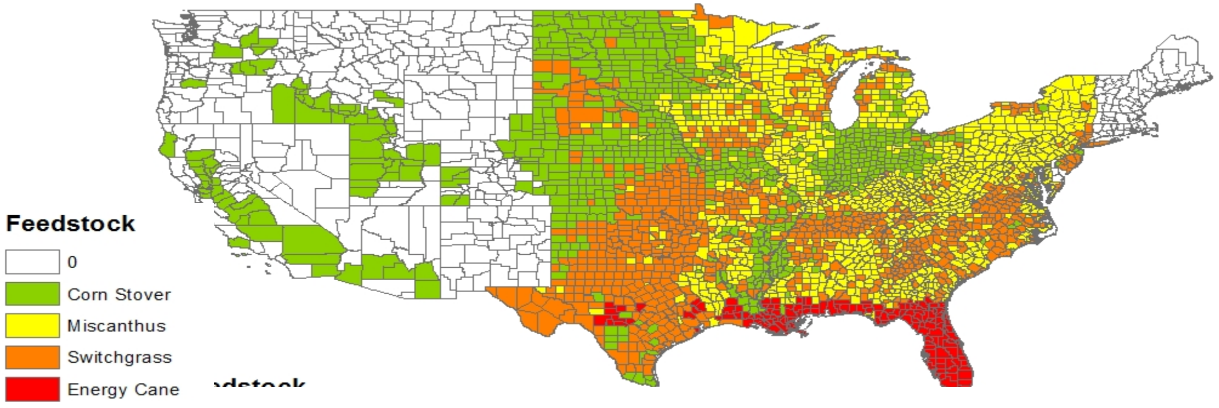
Corn Stover Yield (NASS)



Miscanthus Yield



Least Cost Feedstock Choice



Calculating the Cost of Feedstock Production

http://www.farmdoc.illinois.edu/pubs/FASTtool.asp?category=risk

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Home

Finance

FAST Tools

☐	Biomass Crop Budget Tool – Corn Stover	2155k	2/17/2016	?	
The corn stover budget tool provides estimates of the breakeven price of that the producer would need to receive to cover the costs associated with the harvesting, collection, and storage of the stover.					
☑	Biomass Crop Budget Tool – Miscanthus and Switchgrass	1848k	6/9/2015	?	
The miscanthus and swithgrass budget tool provides estimates of the breakeven price of biomass that the producer would need to receive each year to match the returns earned under their current land use.					

FAST

Biomass Crop Budget Calculator - Miscanthus and Switchgrass

Continue

Updated 6/10/2015

This program allows a user to calculate the annualized farmgate cost of producing miscanthus and switchgrass over the lifespan of these crops. This annualized cost can be interpreted as the breakeven price that a producer needs to receive each year over the life of the crop in order to cover all costs, including the opportunity cost of land. The program provides default production and expense estimates based on location, but allows users to modify these to reflect their growing conditions and operations. The default values are based on 10 years of research data from experimental miscanthus and switchgrass plots across the US. Default values for other expenses are based on published studies, information from agronomists and environmental and crop scientists at the University of Illinois.

For recent updates on this tool and other FAST tools, visit us at www.farmdoc.illinois.edu

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Support Provided By: Agricultural and Consumer Economics

RMA United States Department of Agriculture Risk Management Agency

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Calculator Overview

- Excel-based, similar to *FAST* tools available through the *farmdoc* extension project website
    - Users will be able to download and use on their own computers or devices that can run Excel
- Inputs
    - Required: State and county, energy crop choice, current crop rotation or land use
    - Various optional inputs to tailor to current prices and individual farm's productivity and cost structure
- Outputs
    - Current crop budget
    - Energy crop budget and breakeven biomass price
    - BCAP program incentives and adjusted breakeven biomass price

Biomass Crop Budget Calculator - Miscanthus and Switchgrass

Select Your Location, Energy Crop, and Current Land Use

State	**Illinois**
County	**Champaign**
Biomass Crop	**Miscanthus**
Current Use of Land	**Corn after Soybean, Conventional -Till**

Continue to:
Agronomic Assumptions

Annual Discount, Interest, and Inflation Rates

Discount Rate[1]	2.0%
Interest on Operating Loans[2]	7.0%
Inflation Rate[3]	0.0%

[1]Discount rate should reflect the time value of money for the user, or the rate of return they would be willing to accept for investing a dollar today.

[2]Interest rate on loans used to finance annual operating costs.

[3]Assumed annual inflation rate over time.

Energy Crop Budget

	Year1	Year2	Year 3+	Annualized
Miscanthus				
Harvested Yield[1] at 15% moisture (tons/acre)	0.0	7.5	15.1	13.4
Harvested Yield at 0% moisture (tons/acre)	0.0	6.4	12.8	11.5
Delivered Yield[2] at 15% moisture (tons/acre)	0.0	5.5	11.0	9.8
Input Expenses ($/acre)				
Nitrogen (N)	$9.09	$9.09	$9.09	$9.09
Phosphorous (P)	$5.29	$5.29	$5.29	$5.29
Potassium (K)	$16.37	$16.37	$16.37	$16.37
Lime	$0.00	$0.00	$0.00	$0.00
Herbicides/Pesticides	$19.12	$19.12	$0.00	$2.89
Seed	$1,049.98	$157.50	$0.00	$91.89
Preharvest Expenses ($/acre)				
Disking	$0.00	$0.00	$0.00	$0.00
Plowing	$14.07	$2.11	$0.00	$1.23
Harrowing	$5.91	$0.89	$0.00	$0.52
Airflow Spreader	$3.36	$3.36	$3.36	$3.36
Planting	$35.31	$5.30	$0.00	$3.09
Chemical Application	$5.41	$0.81	$0.00	$0.47
Harvest Expenses ($/acre)				
Mowing/Conditioning	$0.00	$12.67	$14.91	$13.61
Raking	$0.00	$4.02	$4.73	$4.31
Baling	$0.00	$40.70	$75.44	$67.09
Staging, and loading	$0.00	$33.87	$79.70	$70.19
Storage	$0.00	$17.97	$42.28	$37.24
Interest on operating inputs	$76.99	$14.52	$2.15	$8.79
Total Operating Expenses ($/acre)	$1,240.90	$343.58	$253.32	$335.42
Land Rent Opportunity Cost Estimat	$404.75	$411.62	$418.48	$416.92
Total Operating Expense and Land C	$1,645.65	$755.19	$671.80	$752.35
Breakeven Biomass Price ($/ton				**$75.64**

[1]Harvested yield refers to yield before harvest and storage losses

[2]Delivered yield refers to yield after harvest and storage losses have been accounted for

[3]Land Rent Opportunity Cost Estimate accounts for estimated returns from the current use of land selected

Do you plan to enroll in the Biomass Crop Assistance Progra Yes

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Corn and Soybean Budgets

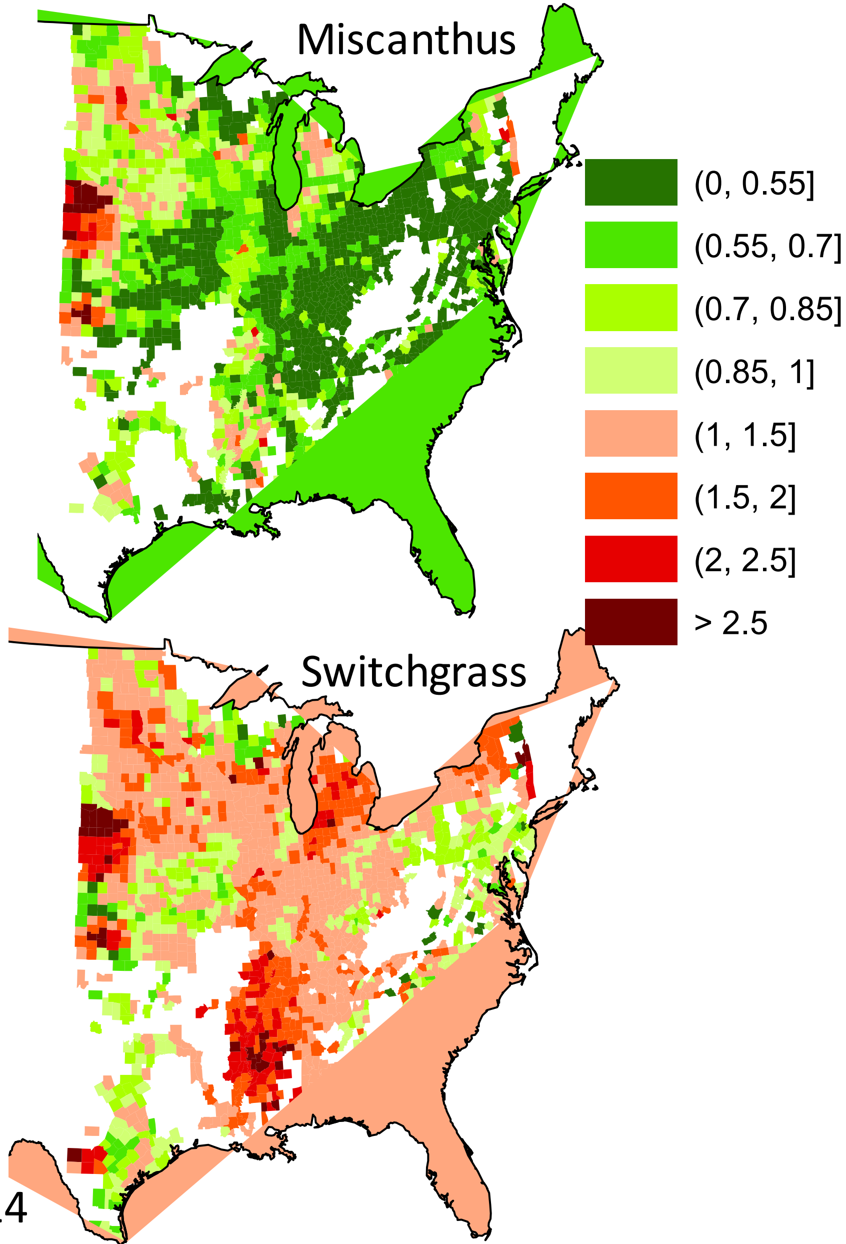
Back to:
Location Selection

Back to:
Crop and Input Pri
Land Rental Rat

Other Factors Affecting Feedstock Production

- Riskiness of producing energy crops
  - Yield risks vary spatially
    - Possibility of crop failure with significant loss of investment
    - Offsetting benefits from diversification of crop/feedstock portfolio
- Upfront investment costs
  - Time preferences of producers: present value of future returns
  - Liquidity/credit constraints
- Opportunity cost of converting land to energy crops also variable
  - Depend on farm policies to support annual crops
  - Subsidized crop yield/revenue insurance
- Price of biomass: depends on policy and oil prices
- Risk of refinery shutdown
- Thin markets for biomass with limited processors
  - None/few alternative uses other than bioenergy
  - Low density, bulky/costly to transport long distances
- Spot market sales of biomass risky
  - Farmers and refineries bears price and demand risks

Riskiness of Yield Compared to Corn



Miao and Khanna, 2014

Risk Sharing Through Contract Design

- Need for long term production/marketing contracts between farmers and processors
- Land leasing contract (Vertically Integrated Production):
  - Refinery bears yield risk, biomass and biofuel price risk; farmer bears risk of land cost
- Fixed price per ton of biomass contract:
  - Farmer bears yield risk and cost of land risk while refinery bears the biofuel price risk
- Profit sharing contract: percent of revenue paid to farmers:
  - Farmer bears yield risk and cost of land risk; shares the biomass price and biofuel price risk with refinery

Cost-Sharing Contract Attributes

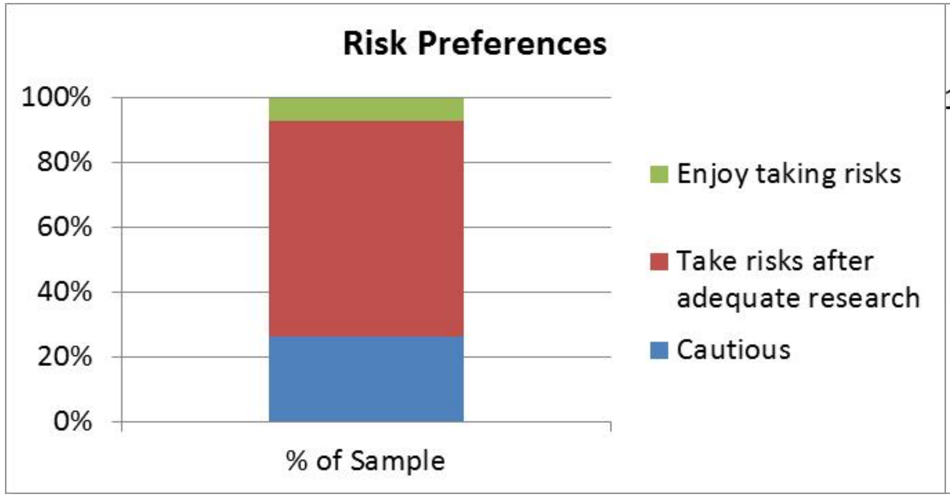
- Sharing of establishment costs
- Need for farmers to acquire crop-specific equipment for field operations (learning/transactions costs)
- Duration of the contract
- Terms of the contract: What are farmers willing to trade-off
  - between risks vs returns,
  - current costs vs future returns?

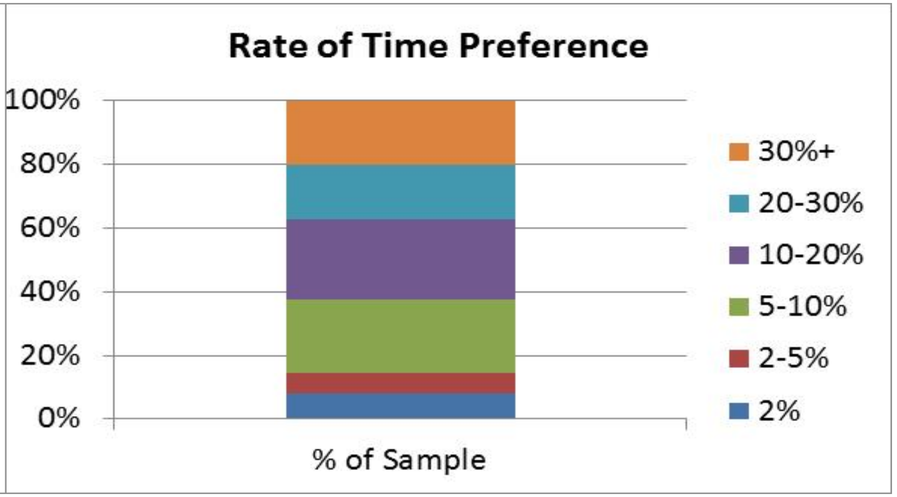
Farmer Survey: Willingness to grow energy crops

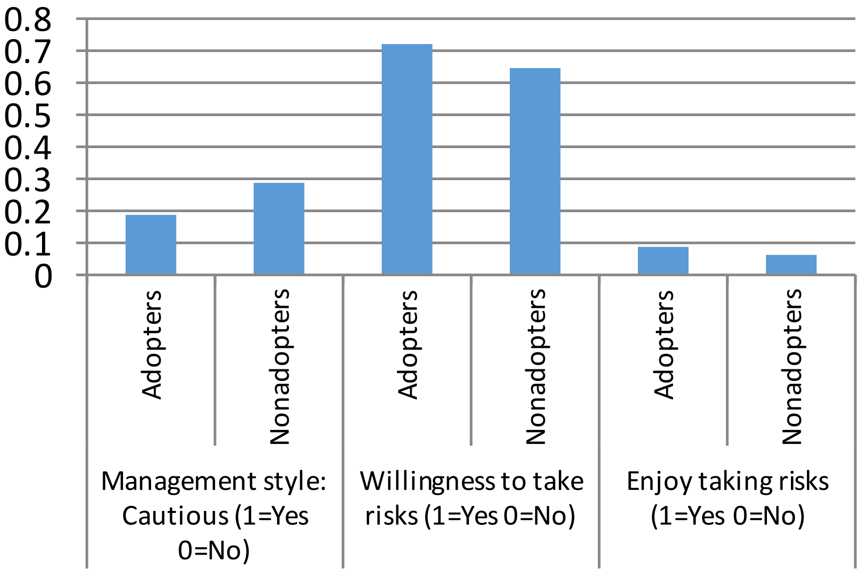
- Random sample of farmers from five states: IL, IN, KY, MO, TN
- Choice Experiment: Preference for crop-contract features
- Risk Preferences:
  - How would your neighbors describe your management style?
    - Cautious; Willing to take risks after adequate research; Enjoy taking risks in my business
- Time Preferences
  - Accept a cash amount of $1000 today or $X in 5 years with certainty

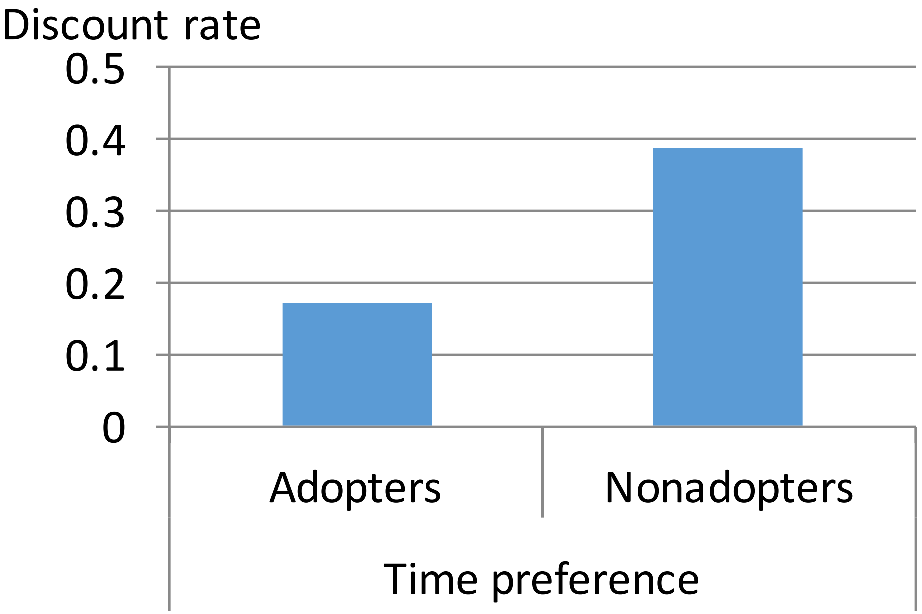
Contract Attributes and Levels in the Choice Experiment	
Attributes	Levels
Length of the contract	5 years, 10 years
Establishment cost shared by refinery	0, 25%, 50%, 75%
Crop specific equipment	Required, not required
Net gain in annual income per acre	5%, 10%, 15%, 20%
Variability in annual incomes	25%, 50%

Farmer Characteristics and Preferences









Farmer Willingness to Make Trade-Offs in Contract Features

- Adoption less likely by farmers with
  - High discount rates
  - High returns to existing use of land
  - Revenue crop insurance for row crops

- Contracts preferred that provide
  - Higher net income and less variable income
  - Lower establishment cost share
  - No crop-specific investment in equipment

- Farmers willing to pay
  - 2-3% of net gain in income for a 1% higher share of establishment cost being borne by the biorefinery
  - 8-10% of returns to avoid acquiring crop-specific equipment

Khanna et al (2016)

Environmental Sustainability of the Biofuels

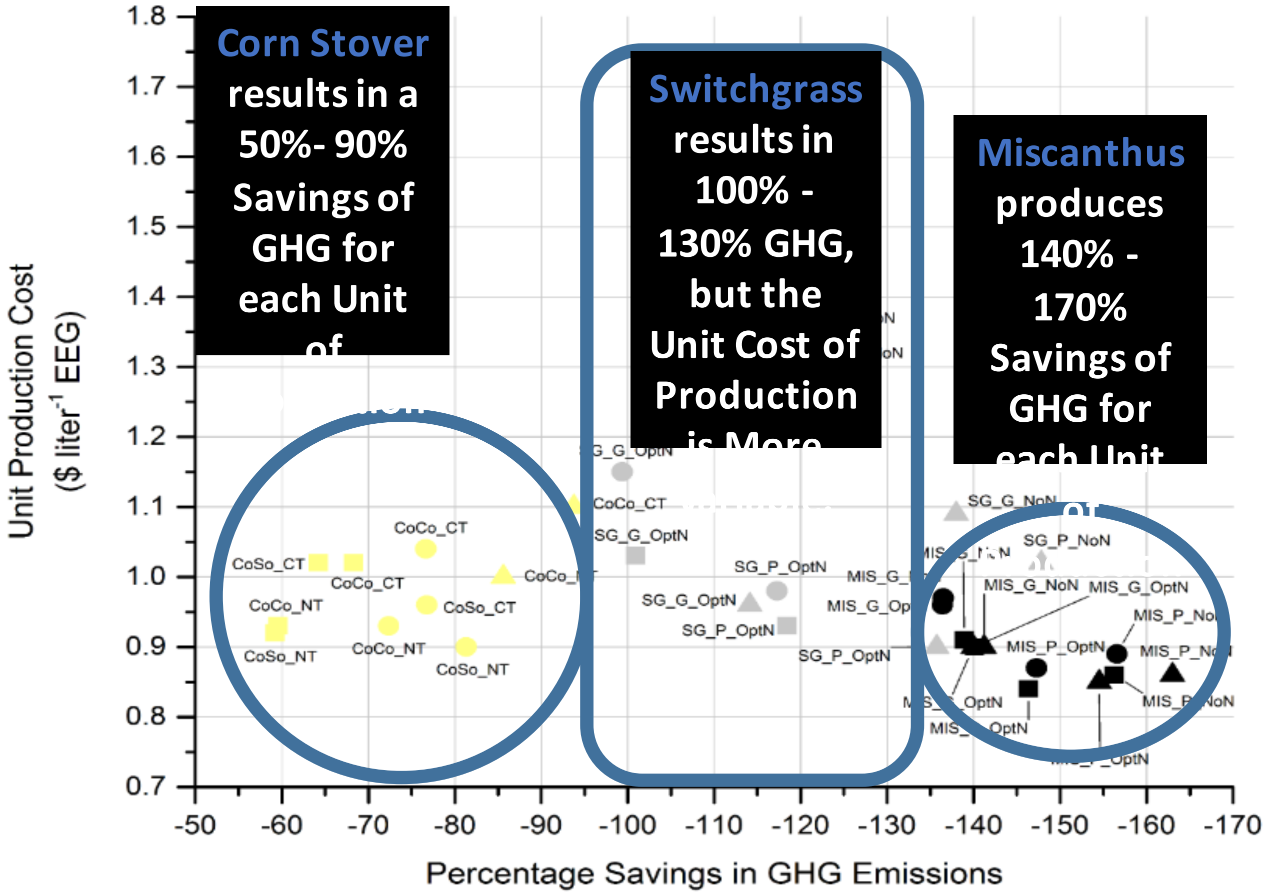
High yielding, low input energy crops

- Can be grown on less productive land
  - Low direct and indirect land use effect
- Low to negative greenhouse gas intensity
- High soil carbon sequestration
- Prevent nutrient run-off

Impact of corn stover depends on

- Rate of residue collection
- Tillage practices

- Relatively higher greenhouse gas intensity than energy crops



(Dwivedi et al., 2015
Huduburg et al., 2016)

Ecosystem Service Provisioning Water Quality Impacts

Nitrates

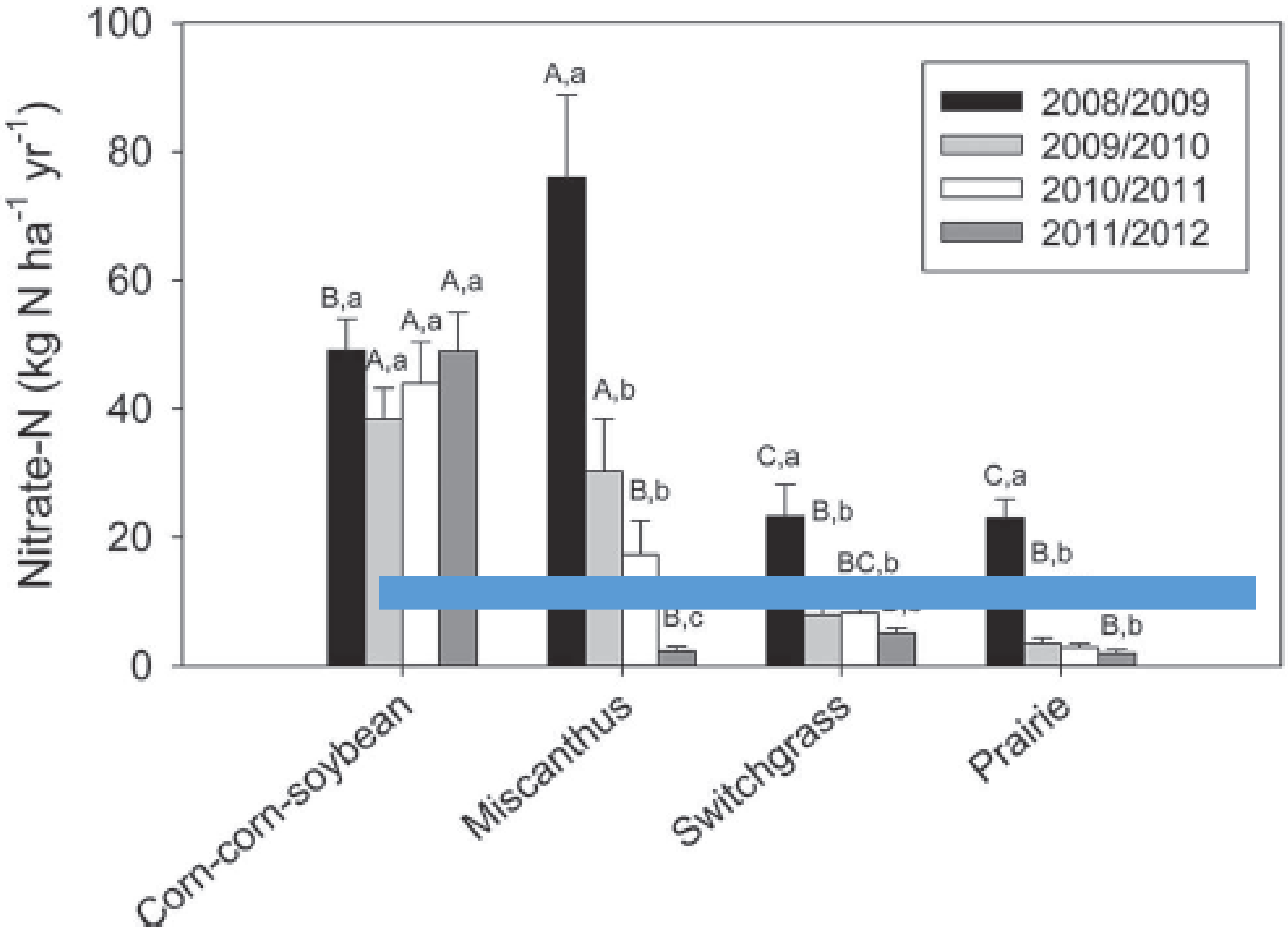
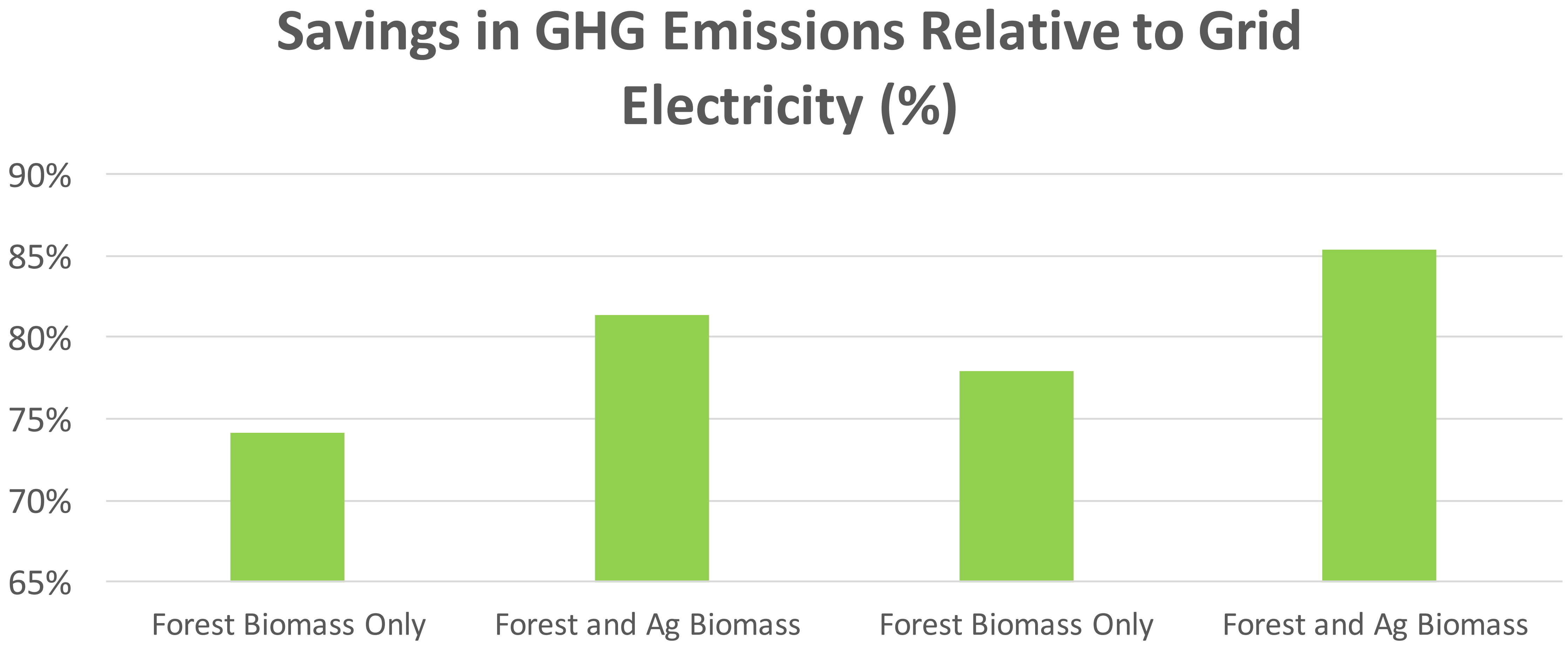


Fig. 1. Annual nitrate N leaching (April to April) at 50 cm soil depth

- Energy grass nitrate loads = only 10% of total corn nitrate loads after 4 years of establishment
- Corn stover can reduce nitrate loading but increase erosion and sediment run off.
- Limits on stover removal rate are critical for ES provisioning.

Smith et al., 2010

GHG Intensity of Pellets for Electricity Generation



Wang et al., 2015

In Sum: Trade-offs in Feedstock Choice

- Optimal feedstock choice will vary by location and yield is critical to profitability

- Compared to conventional crops/residues, energy crops offer
  - Environmental sustainability, lower yield risk but high upfront costs and need for long term investments
  - Potentially high profitability risk due to high fixed costs

- Motivating risk-averse, present-biased farmers, with credit constraints to grow energy crops will require
  - Contracts under which refineries bear much of the risk and establishment costs
  - Policies such as the Biomass Crop Assistance Program
  - Assured long term mandate for advanced biofuels through the RFS

Questions?

Publications

Miao, R. and M. Khanna, “Are Bioenergy Crops Riskier than Corn? Implications for Biomass Price,” *Choices*, 29(1), 6 pages, 2014.

Wang, W., P. Dwivedi, R. Abt, and M. Khanna, “Carbon Savings with Transatlantic Trade in Pellets: Accounting for Market-Driven Effects” *Environmental Research Letters*, 10 (11), 2015.

Hudiburg, T.W., W.Wang, M. Khanna, S. P. Long, P. Dwivedi, W.J.Parton, M. Hartmann, and E.H. DeLucia, “Impacts of a 32 Billion Gallon Bioenergy Landscape on Land and Fossil Fuel use in the US,” *Nature Energy*, 1:15005, 2016.

Khanna, M., J. J. Louviere, and X. Yang, “Motivations to Grow Energy Crops: The Role of Crop and Contract Attributes,” *Agricultural Economics*, 2016

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