



cenusa bioenergy

## **Sustainable Production and Distribution of Bioenergy for the Central USA**

Agro-ecosystem Approach to Sustainable Biofuels Production via the Pyrolysis-Biochar Platform (USDA-NIFA AFRI CAP) • Grant no. 2011-68005-30411

# Switchgrass Cost of Production

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# Presentation outline

- Introduction
- Previous research on switchgrass production costs
- Factors affecting feedstock costs
- Current production costs
- Take home lessons

# Switchgrass: An energy crop for marginal lands



- EPA predicts 2.8 million acres will be in switchgrass by 2022.
- Switchgrass used in a rotational system.
- Provide ecosystem services.
- Positive energy flow.



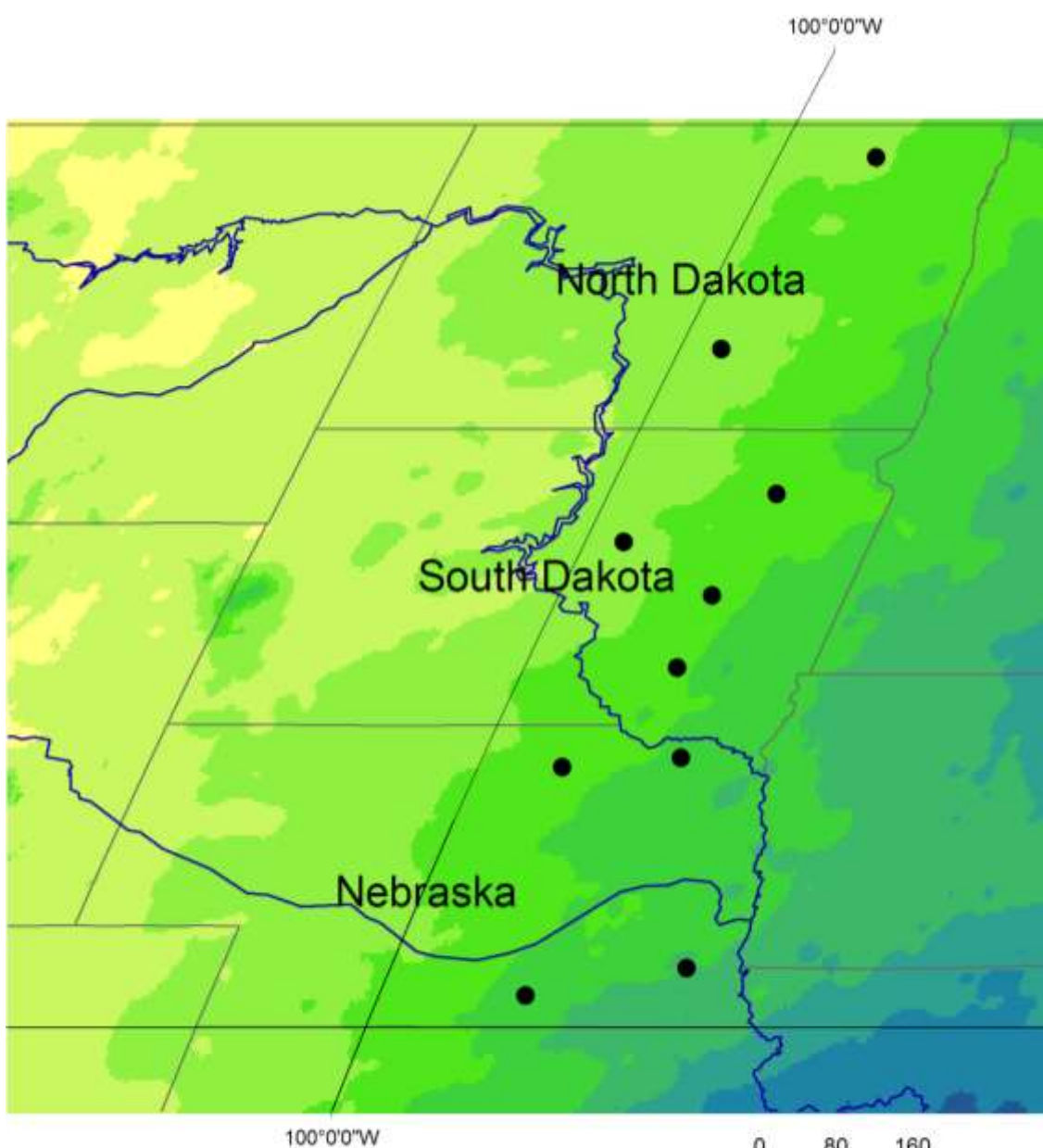
# Three main questions with cellulosic bioenergy



# Northern Plains On-Farm Switchgrass Field Scale Trials

- Cooperating farmers were identified via assistance from USDA-NRCS state and district offices and University Extension Service staff.
- Fields were chosen based on characteristics for enrollment in CRP.
- Trial initiated in 2000 (2000-2005).
- Two farmers had previous experience growing switchgrass.





**Annual Precipitation (2000 to 2005)**



- USDA-ARS provided seed of adapted cultivar.
- Fields were planted for Nebraska farmers, others used available drills.
- Harvest dates were either at heading or after a killing frost.



# Field Management

- Each farmer was provided with written instructions which included:
  - Field preparation
  - Planting
  - Weed control
  - Fertilization
  - Harvest timing
- No penalties for not following instructions which converted them into guidelines.



# Establishment Year

- No-till establishment was used where feasible.
- Pre-emergence herbicide application.
- In NE in 2000, only atrazine was available.
- In 2001, research data for the use of Paramount herbicide (quinclorac) was available.



# Fertilization

- Recommended rate was 20 lbs N per DT of biomass based on results of *Vogel et al., 2004, Agronomy J. 94:413-420.*
- Rates recommended for use changed based on previous year and current year precipitation. Rates actually used by farmers varied from recommendations.
- No P or K applications



# Farm scale production cost of switchgrass for biomass



**Switchgrass field in NE South Dakota. Field shown had a five year cumulative average cost of \$35/U.S. ton including land costs.**

- *Perrin et al., 2008 BioEnergy Research*
- On-average, farm gate costs (5 yr) were \$60 ton<sup>-1</sup> (\$0.68 per gallon of ethanol delivered).
- Extrapolated farm gate costs (10 yr) were \$54 ton<sup>-1</sup>.

# Nebraska



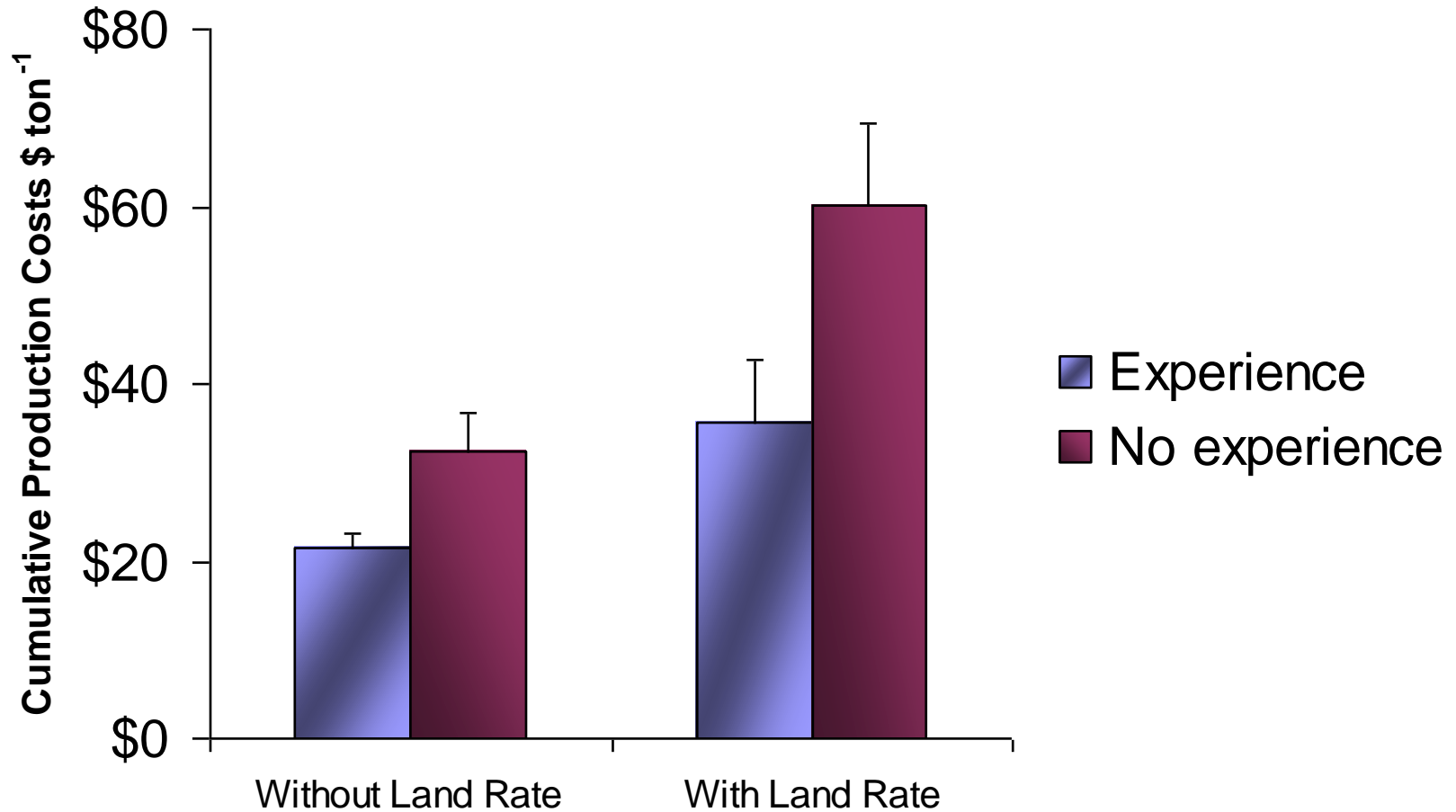
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# South Dakota

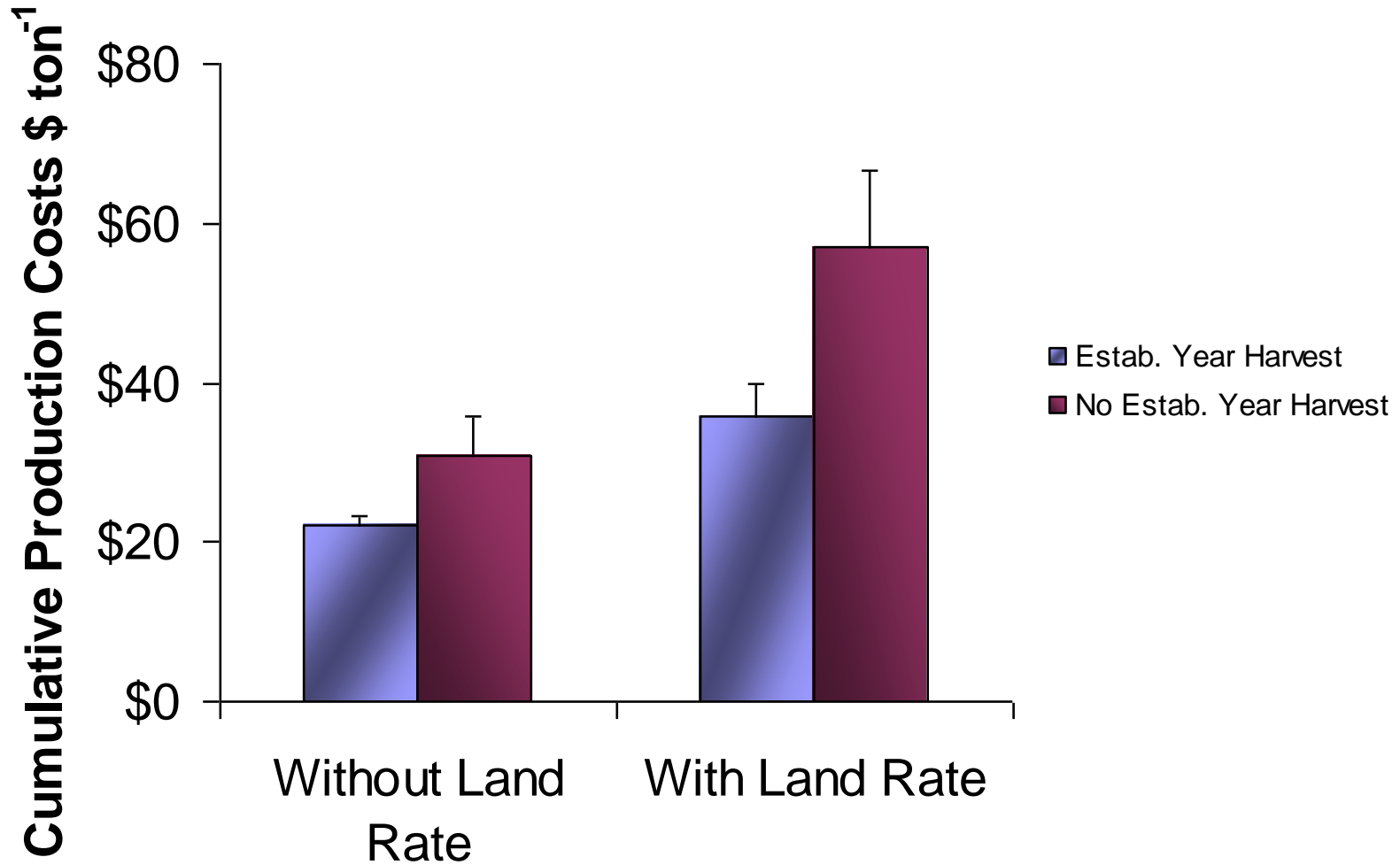


# Producer Experience

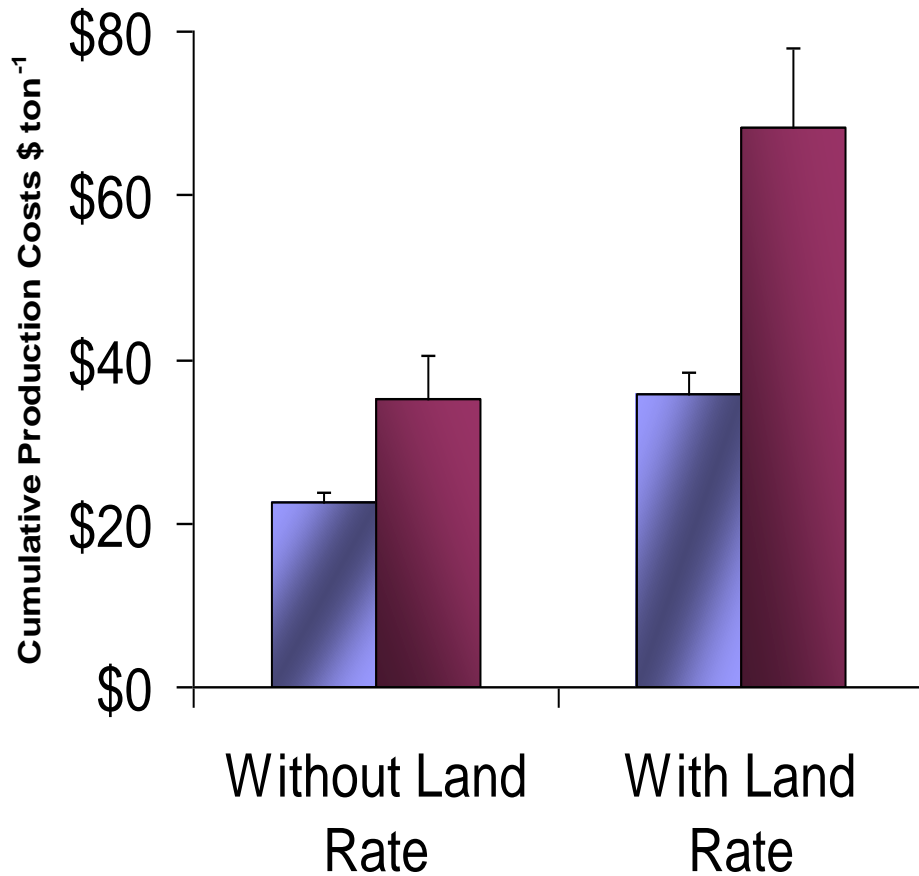




# Establishment year harvest



# Weed Control

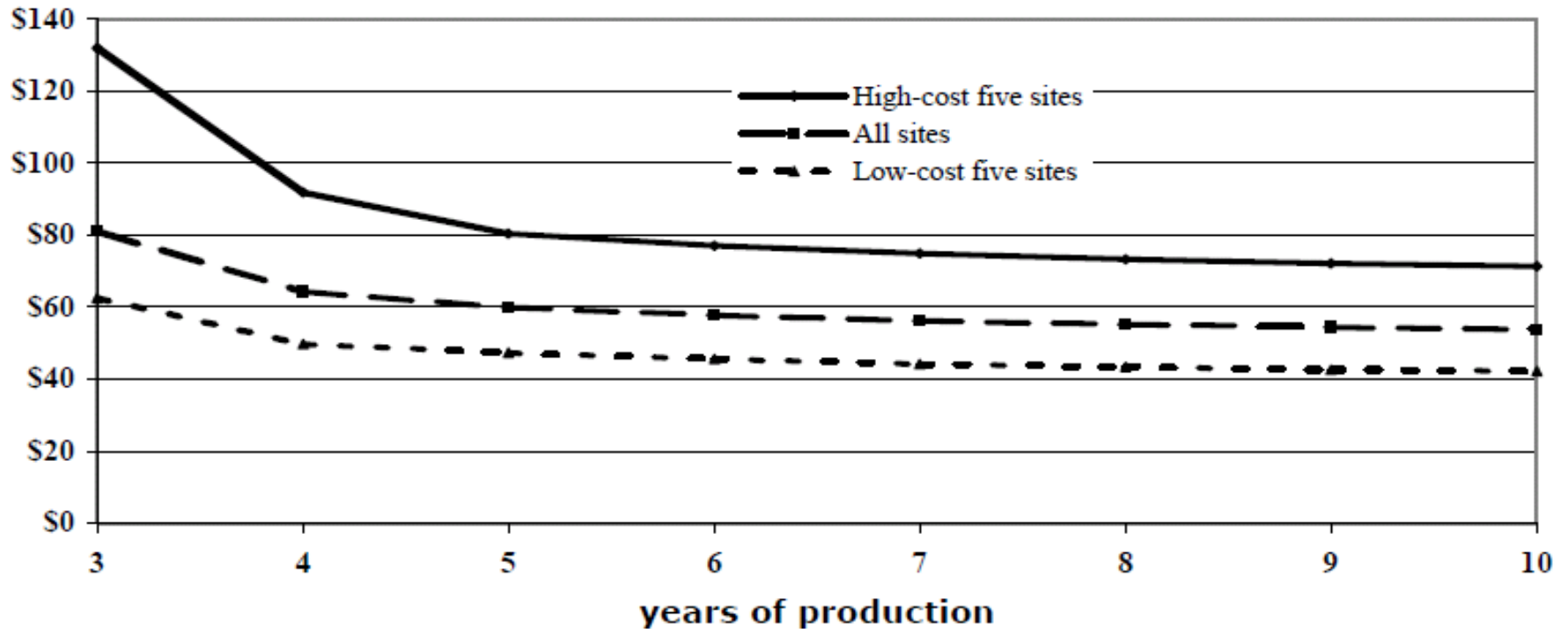


■ Quinclorac  
■ No Quinclorac





# Production costs per ton over time



# Conclusions from the on-farm trial

- Highest costs are in the establishment year.
- Establishment year harvest lowers overall costs.
- Effective weed control in the establishment year is essential.
- Stand duration.
- Proper management is critical (experience matters).
- High yielding sites had lowest costs per ton.



# Current production costs

- *Biomass supply schedules for Great Plains delivery points (2012) Perrin et al., Biomass and Bioenergy.*
- Updated feedstock costs for switchgrass in Nebraska.
- Major differences between the two studies.
  - Custom rates prices have increased.
  - Land rental costs have increased.



# Current production costs

- Switchgrass farm gate cost estimates are \$64/ton.
- Delivered costs were  $\geq$  \$73/ton.
  - Amortized over 10 years.
  - Analysis assumed 3 tons/acre yield production.
  - 25% of total costs are fixed.

# Current production costs

## Establishment (\$/acre)

Operation	<i>Perrin et al. 2012</i>	Adjusted rent
Tillage	\$ 22.00	
Seed	\$ 60.00	
Herbicides	\$ 43.00	
Land Rent	\$ 55.00	\$79 to \$165
Reseeding	\$ 45.00	
<b>Total</b>	<b>\$225.00</b>	<b>\$250 to \$335</b>

# Current production costs

## Post-establishment (\$/acre)

Operation	<u>3 ton/acre</u>	<u>6 ton/acre</u>	<u>9 ton/acre</u>
Fertilizer	\$30.00	\$ 30.00	\$ 30.00
Swath harvest	\$12.00	\$ 15.00	\$ 15.00
Baling	\$53.00	\$108.00	\$160.00
Bale transport	\$ 9.00	\$ 18.00	\$ 26.00
Loading	\$ 5.00	\$ 10.00	\$ 15.00
Land Rent	\$55 to \$165	\$55 to \$165	\$55 to \$165
Annualized estab. (10-yr)	\$34 to \$50	\$34 to \$50	\$34 to \$50
Total \$ per acre	\$198 to \$324	\$267 to \$393	\$335 to \$461
Total \$ per ton	\$66 to \$108	\$45 to \$66	\$37 to \$51



# Current production costs

- Primary costs
  - Land rental costs
  - Baling
  - Establishment costs
- Doubling of fertilizer price?
  - Increases farmgate cost by \$3 to \$10 per ton
- Transportation costs to biorefinery
  - Adds \$3 to \$5 per ton

# Switchgrass market price

- Market price has not been determined.
- Hay prices as a possible indicator.
- Contract
  - 5 yr contract
  - 10 yr contract
- Dependent on:
  - Region
  - Conversion efficiency and cost
  - Feedstock availability
  - Business models
- Other incentives
  - BCAP
  - Price on carbon

# Farmer participation

- Profitability
- How will switchgrass fit in their farming enterprise?
  - Crop diversification
  - Wildlife habitat
  - Soil improvements
- Rural improvement
- Time management



# Feedstock costs and availability

- Agricultural residues are expected to have lower initial costs than dedicated energy crops.
- Dedicated energy crops will become more important as the cellulosic industry matures.
  - Provide higher yields with lower energy inputs.
  - Reduce risks in feedstock availability.
  - High yielding switchgrass is similar to residue harvest costs (\$37-\$51 per ton)



# Take Home Lessons

- Herbaceous energy crops such as switchgrass will be a new crop and there will be learning curve.
- Farmer education and training will be critical.
- Economic production efficiency can be improved via research and producer training.

# Take Home Lessons

- Establishment Year – Economically Critical
  - Weed Control
  - Use high quality seed
  - No-till establishment
  - Previous crop
- Cultivar selection
  - Next generation varieties





# References

- Perrin et al., Switchgrass cost of production: data from on-farm trials, 2000-2005 available at <http://digitalcommons.unl.edu/ageconfacpub/37/>
- Perrin et al., 2012. Biomass supply schedules for Great Plains delivery points *Biomass and Bioenergy*.

# Thank You

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