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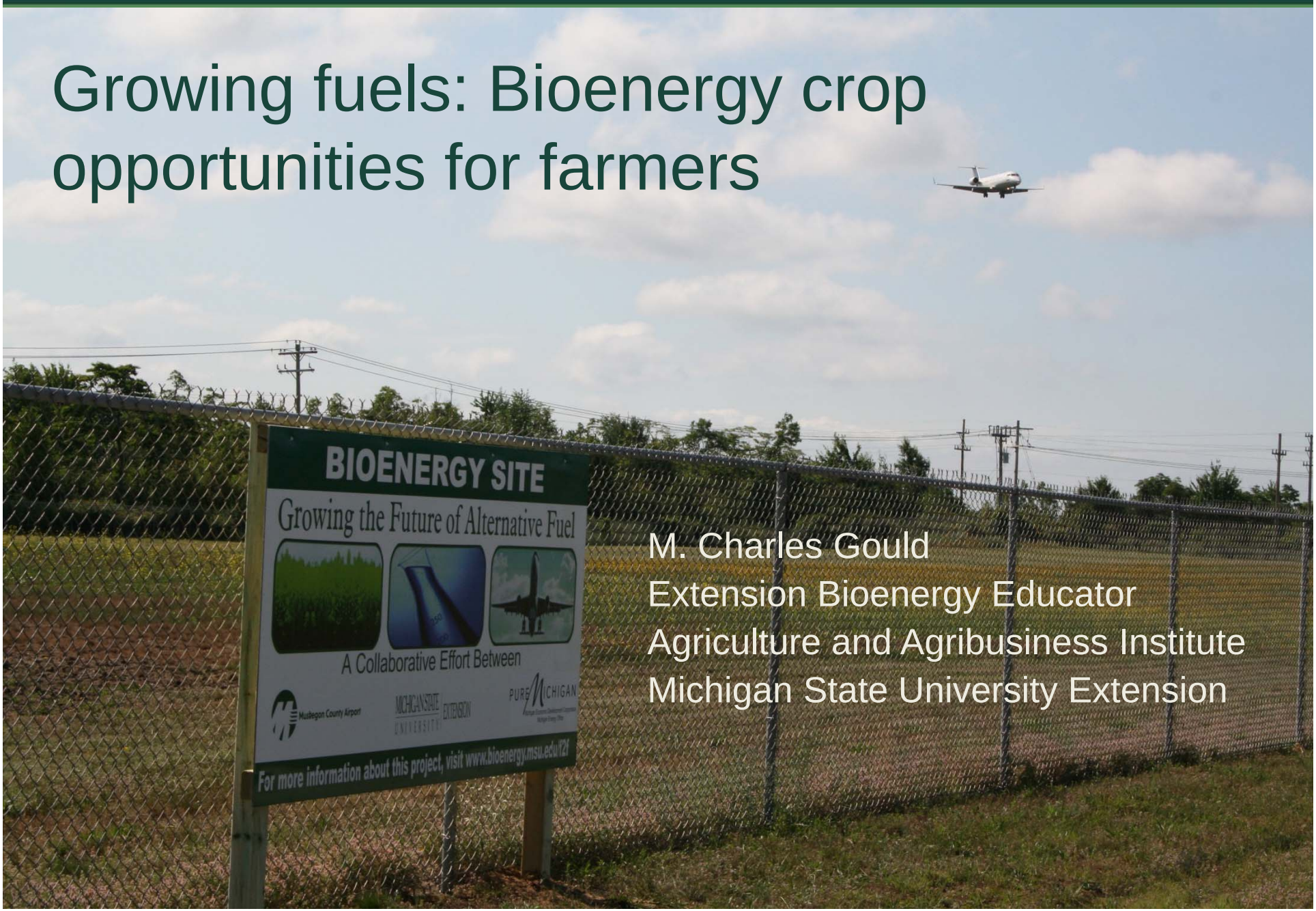
Growing fuels: Bioenergy crop opportunities for farmers



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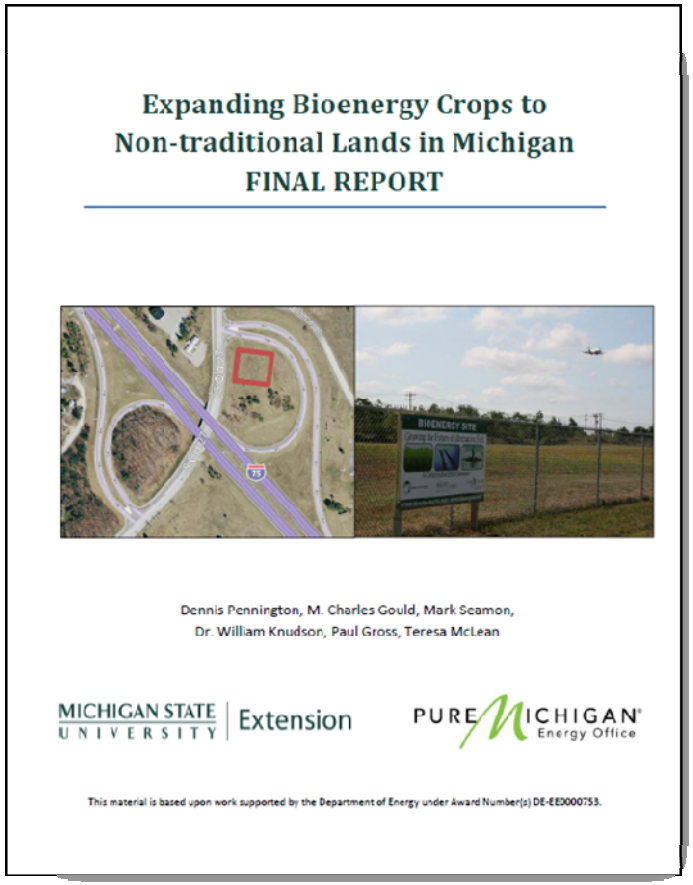
Presentation overview

- Definitions.
- Establishing bioenergy crop markets.
- Potential bioenergy crop opportunities for Michigan farmers.



Expanding Bioenergy Crops to Non-traditional Lands in Michigan
FINAL REPORT

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PURE MICHIGAN Energy Office

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What are bioenergy crops?

- Bioenergy crops are defined as any plant material used to produce bioenergy.
- Bioenergy is “energy derived from recently living material such as wood, crops, or animal waste.”
- Bioenergy can contribute to reducing the overall consumption of fossil fuels.
- Bioenergy crops have the capacity to produce a large volume of biomass, high energy potential, and can be grown in marginal soils.
- Bioenergy crops can take the form of solid material (biomass) for combustion or liquid products (biofuels) that can be used to power vehicles.
- Both biomass and biofuels can be derived from dedicated energy crops, agricultural co-products or waste materials.

Fast growing poplar at the MSU Kellogg Biological Station. Photo credit: Charles Gould

Dipti and Priyanka (2013)

Potential Woody Biomass Feedstock in Michigan

Source of Biomass	Maximum Inventory Estimate (dry metric tons/year)	Estimate of Availability for Biomass Supply Chain (dry metric tons/year)
[a]Unharvested Annual Growth	4.7 million dry MT/yr	1.0 million dry MT/yr
[b]Logging Residues from Current Removals	1.2 million dry MT/yr	0.9 million dry MT/yr
[c]Recovered Mortality	4.6 million dry MT/yr	1.2 million dry MT/yr
Unused Mill Residues	1.4 million dry MT/yr	0.013 million dry MT/yr
[d]Energy Plantations	7.5 to 8.5 million dry MT/yr	1.9 to 3.4 million dry MT/yr
[e]Urban Tree Wood	1.1 to 1.3 million dry MT/yr	0.8 to 1.0 million dry MT/yr
Total Potential Biomass in Michigan	20.5 to 21.7 million dry MT/yr	5.8 to 7.5 million dry MT/yr

Establishing Bioenergy Crop Markets

- Freeways to Fuel Project Phase I (2010)*
  - Purpose: To explore the feasibility of growing, harvesting and utilizing bioenergy crops on non-traditional cropland that include areas along Michigan roadways and vacant urban lots for energy use such as biofuel, heat and electricity production.
- Freeways to Fuel Project Phase II (2012)*
  - Purpose: To demonstrate that bioenergy crops could be grown on non-traditional land in Michigan.
  - Eleven sites including highway right of way, airport, vacant urban land and marginal farmland were selected to represent the geographic diversity of the state.

* Both projects were funded by grants through the Michigan Agency for Energy.

Freeways to Fuel Projects

- What did we learn?
  - Growing bioenergy crops on marginal land
    - There is approximately **17,000 acres** of land within **State Game Areas** under cultivation or in pasture.
    - It is estimated that there is **5,000 acres in Detroit** and **1,242 acres in Flint** that could potentially be used to grow bioenergy crops.
    - Bioenergy crops (oilseed crops) can be grown on marginal ground, but there are inherent limitations to producing high yielding bioenergy crops on marginal land (low water holding capacity, high water holding capacity, poor soil structure, fertility and high water table/frequent ponding).
    - Most of these limitations can be mitigated or reduced with proper management.
    - Growing bioenergy crops has the potential to generate **economic activity and jobs** on land that currently does not generate income or jobs.

Freeways to Fuel Projects

- What did we learn?
  - Growing bioenergy crops on airport property.
    - Michigan has over **200 municipal airports**. The Bishop Airport, Muskegon County Airport, Metro Detroit Airport and Willow Run Airport indicate there are approximately **50, 500, 1,169 and 814 acres** respectively of potentially useable land for bioenergy crop production.
    - The Federal Aviation Administration (FAA) is concerned that bioenergy crops will attract large bodied or flocking avian species that could pose a threat to aircraft.
    - FAA said that additional research would be needed in order to grant long term land use for bioenergy crop production.
    - Has the greatest potential.

Freeways to Fuel Projects

- What did we learn?
  - Growing bioenergy crops on highway right-of-ways.
    - An estimate of limited access highway and right-of-way areas that could be utilized for bioenergy crop production is between **9,516 and 11,895 acres**.
    - Bioenergy crop production will be challenging due to limited parcel size of right-of-ways, poor soils, and getting farm equipment on/off highways.
    - The process of obtaining MDOT permits is especially burdensome and time consuming. Current regulations, the permit application process, and fees would need to be changed and adapted to allow for utilization of right-of-ways for bioenergy crop production.

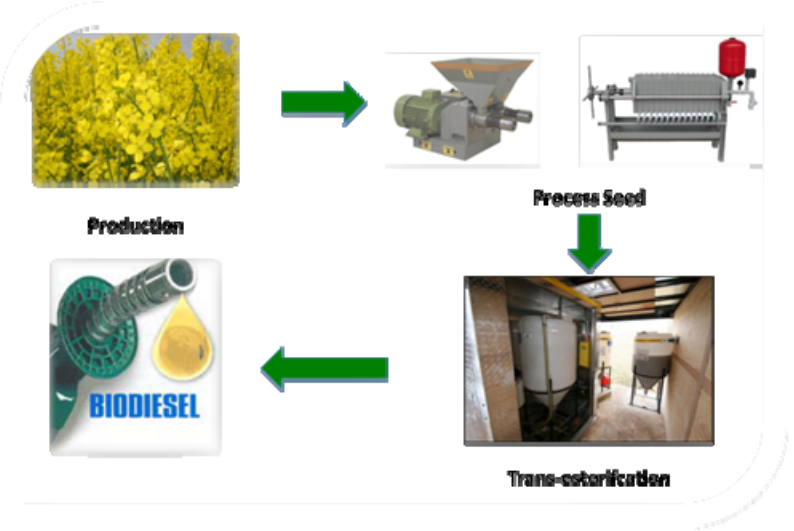
Freeways to Fuel Projects

- What did we learn?
  - Growing bioenergy crops on agricultural land.
    - Bioenergy crops can be grown successfully in Michigan.
    - For some bioenergy crops there are no registered herbicides for weed control.
    - General lack of knowledge about growing some bioenergy crops.
    - Given the relative rates of return, farmers can almost certainly obtain higher profits from growing crops such as corn and soybeans.

Canola field in Michigan. Photo credit: Charles Gould

Freeways to Fuel Projects

- What did we learn?
  - Bioenergy crop markets.
    - There are well **established markets** for some bioenergy crops (soybeans), however the market and supply chains for bioenergy crops are generally not well developed.
    - Michigan lacks the capacity to crush oilseed crops (canola, camelina, pennycress and Oriental mustard) and densify biomass crops.



Process of making biodiesel. Source: Dennis Pennington

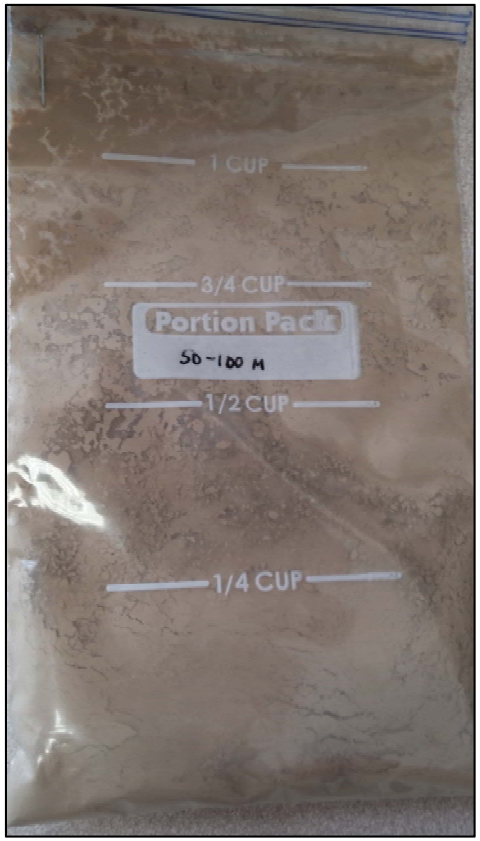
Establishing Bioenergy Crop Markets (Switchgrass)

- Switchgrass Densification Feasibility Study
  - The MSU Product Center is conducting a feasibility study to determine the viability of a facility to manufacture high quality switchgrass pellets for home heating use and cubes for industrial heating use.

Left side: Densified hardwood sawdust brick.
Right side: Densified switchgrass brick.
Photo credit: Charles Gould

Establishing Bioenergy Crop Markets (switchgrass)

- Fiber reinforcement in thermoplastic composites.
- Chemicals from sugars.
- Fuels
  - Bio-oil
- Paper products and packaging materials.
- Mulch.
- Cattle feed.



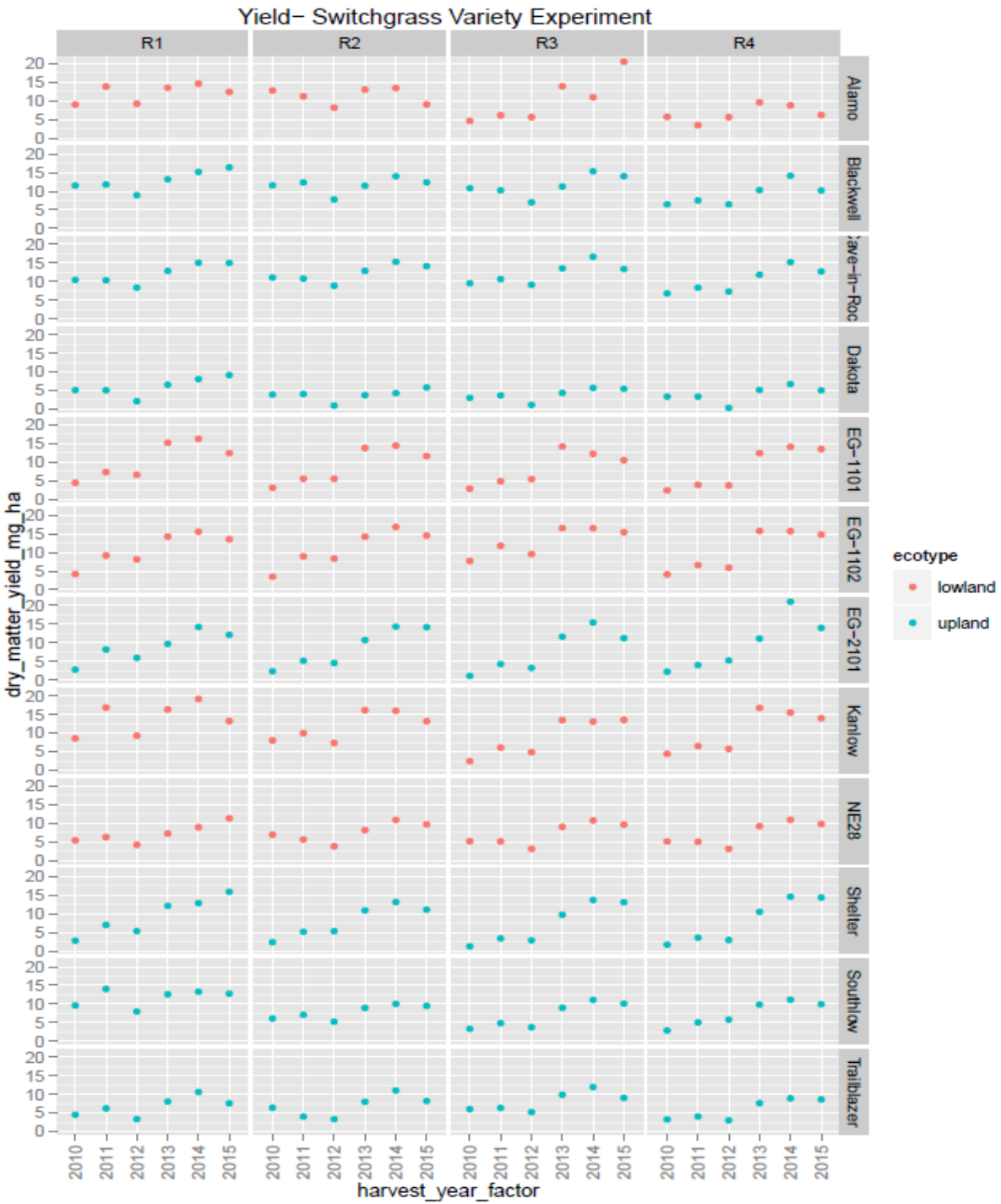
Fiber pulverized to 50-100 microns. Photo credit: Charles Gould

Cost of Production

- Farm production costs vary considerably but budget estimates suggest that farm gate cost, including land rent, is $75-80 per dry ton.
    - Averaged over a 6-8 year period, and includes the establishment cost spread out over that time, and the cost of harvesting and moving bales to the edge of the field.
    - Assumes 3.4 tons of DM per acre yield.

Baling switchgrass. Photo credit: Charles Gould

Source: Perrin, et al, 2010.



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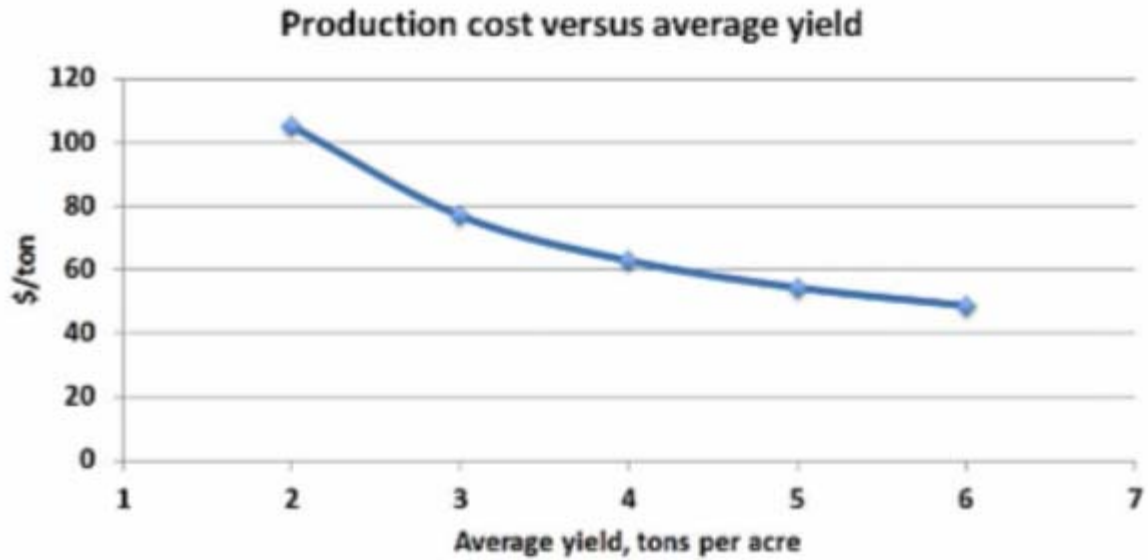
- Note that many varieties exceeded 10 mg/ha (4.5 T/ac) DM yield per acre.
- Lowland varieties did very well this far north.

The effect of yield on cost of production

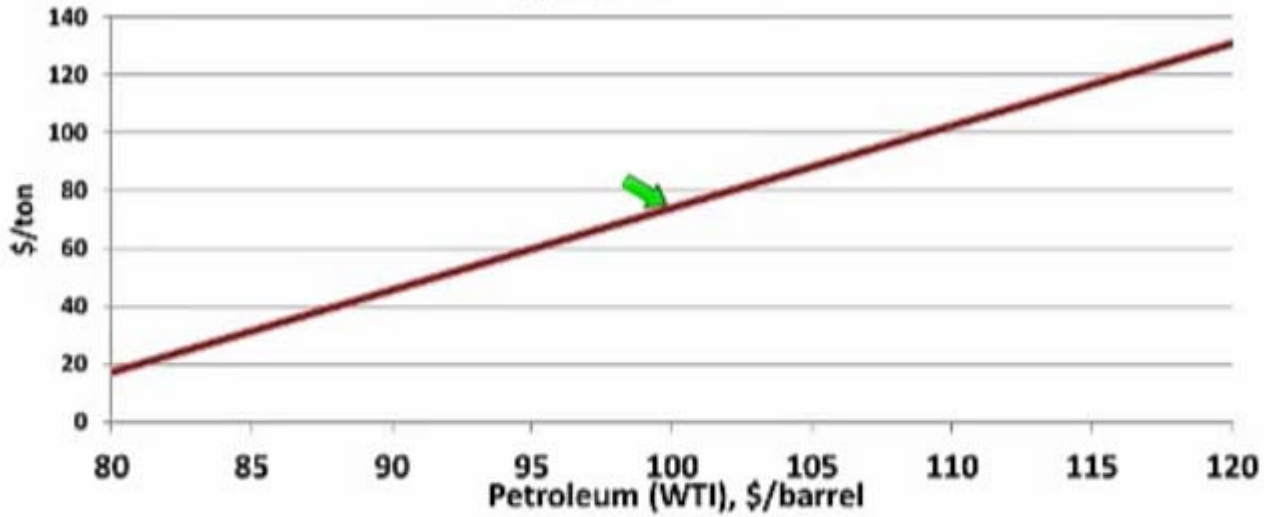


Here I adjust the budget from the previous slide to reflect cost for different average yields realized over years 2-5. The cost per ton falls from $77 to $63 if average yields could be increased from 3 to 4 t/ac. The average yield achieved on 20-acre fields by ten cooperating farmers, 2001-2004, ranged from 2.4 to 4.7 tons/acre (Perrin, et al).

Source: Perrin, et al, 2010.

Willingness to pay for switchgrass for cellulosic ethanol

Estimated maximum willingness to pay at the farm gate for switchgrass for ethanol production.

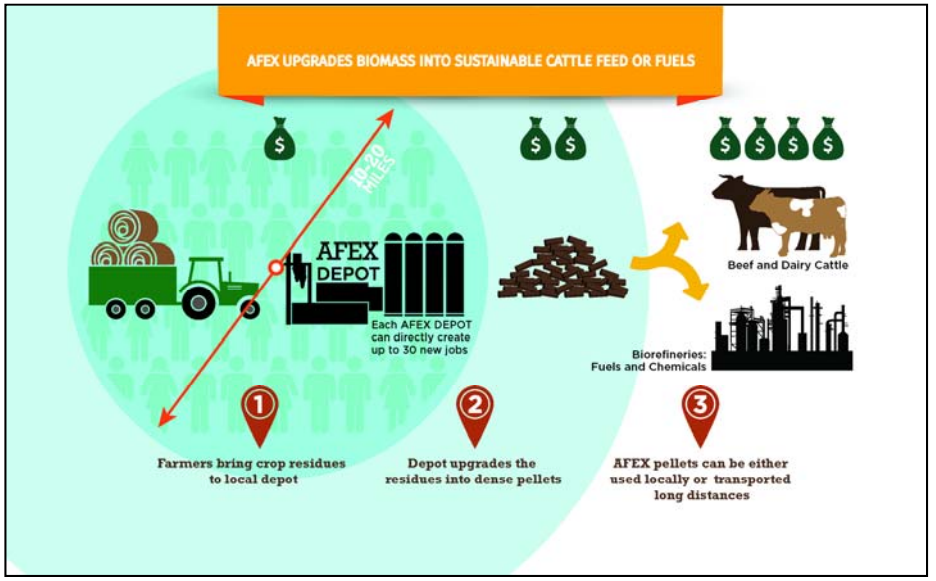


This graph shows the maximum willingness to pay for switchgrass, as calculated from Brown data on the previous slide. Oil price must be at nearly $100/bbl, for processors to be able to pay for switchgrass at current production costs. WTP will probably be lower than shown here, because (1) all the plants under construction have higher capital costs than estimated by Brown, (2) switchgrass must compete with cheaper corn stover as a feedstock. Note: spot markets are not likely to arise – cellulosic feedstock will be contracted between producer and processor

Source: Perrin, et al, 2010.

Establishing Bioenergy Crop Markets (Stover)

- AFEX Project
  - Harvesting the C5 and C6 sugars from cellulosic materials.
  - Sugars can be converted into fuels and plastics.
  - Fiber byproduct
    - Potential cattle feed
  - Biomass depots



Source: MBI

Michigan Corn Stover Project* Summary (CAUTION – preliminary!)

- Bale storage
  - High moisture bales have higher protein and ash, but lower ethanol yields.
  - The longer bales are stored the lower the ethanol yields, energy value, and digestibility but higher protein.
- Feed trial
  - Cattle are the most efficient on non-stover diets, but are gaining well on all diets.
- Cover crop treatment
  - Cover crop adds moisture and protein but decrease ethanol yields.
  - More indigestible fiber and less energy with a later harvest.

Baled corn stover. Photo credit: Dennis Pennington

* Funded by Project GREEEN and the Corn Marketing Program of Michigan.

Establishing Bioenergy Crop Markets

- The Michigan Biomass Inventory is an interactive screening tool that allows users to:
  - Locate biomass feedstocks
  - Estimate energy conversion requirements
  - Calculate a net energy balance
  - Identify limiting factors
- http://mibiomass.rsgis.msu.edu/

Conclusion

- There are many acres of non-traditional cropland that could be used to grow bioenergy crops.
- Bioenergy crops can be grown on marginal ground but in most cases will require mitigation.
- Markets that add value to bioenergy crops and are not tied to liquid fuels are being developed.

Biomass being burned in a gasifier at Northwest Missouri State University. Photo credit: Charles Gould.

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Thank you!