

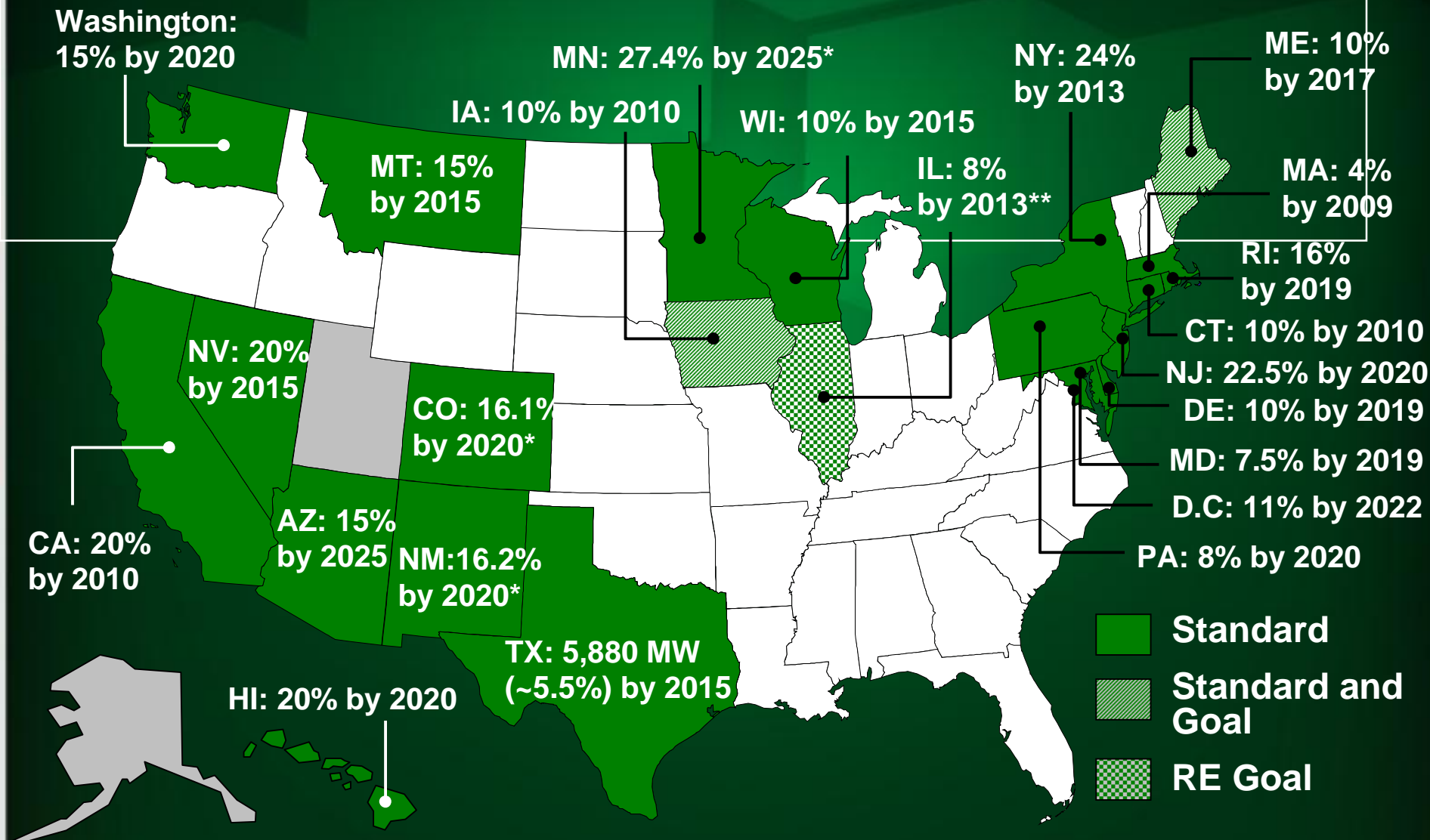
Agricultural
Feedstocks:
What's Probable in
2015?

Probable Renewable Scenarios: 2015

Primary agricultural sources for renewable energy through 2015:

- Wind--Electricity
- Vegetable Oils--Biodiesel
- Corn Starch--Primary ethanol source
- Cellulose—direct combustion
/gasification, biomass to gas, some liquid
ethanol, woody biomass shows most
promise

Renewable Electricity Standards



Probable Ethanol Feedstock Scenarios: 2015

**Feedstocks *do* compete with each other.
And they compete with other land uses.**

“Winners” will be judged on:

- **Delivered feedstock costs** (land use, refiner profitability)
- **Return per acre** (land use, grower profitability)
- **Ethanol yields per acre** (land & logistics costs, land use)
- **Ethanol yield per ton** (logistics, carbon implications)
- **Refinery capital costs** (return on investment)
- **Production costs** (return on sales)
- **Perceived environmental impact** (political and social ramifications can trump economic considerations)

Probable Renewable Scenarios: 2015 Dedicated Cellulose to Liquid

- What we're pretty sure we know:
 - Cellulose has promise, but, we've got a lot to invent and a lot to learn. The goals set by the Energy Bill should enable us to explore the potential
 - 2015 is only 7 years from now

Probable Renewable Scenarios: 2015

Cellulose to Liquid: Land Allocation

- Cellulosic to liquid requires technology breakthroughs and higher prices at the farm than initial projections:
 - DOE and other studies started @ \$35/ton and continue to move upward
 - Iowa State (Duffy 2007) pegs 4 TPA switchgrass production costs at \$82/ton, plus \$30/ton storage/handling/hauling.
 - With total costs at >\$110 per ton before farmer margins, dedicated energy crops face more challenges than previously estimated

Probable Renewable Scenarios: 2015

Cellulose to Liquid: Land Allocation

Dedicated crops on productive corn ground

- **6 TPA** Iowa switchgrass yields in 2015 (70 GPT ethanol yield)
 - @ \$110 per ton price, **\$1.47 per gallon** feedstock cost-- counting 10 cent per gallon lignin co-product value
 - @\$6.45 /bu, **\$1.47 per gallon** feedstock cost-- counting DG value (less with fractionation technology)
- **9 TPA** Iowa switchgrass yields in 2015 (90 GPT ethanol yield)
 - @ \$110 per ton price, **\$1.12 per gallon** feedstock cost-- counting 10 cent per gallon lignin co-product value
 - \$4.95 corn, **\$1.12 per gallon** feedstock cost--counting DG value (less with fractionation technology)

Land Use, Grower Profitability: Iowa Switchgrass Vs. Iowa Corn

	Corn	3 TPA Switchgrass Yield	6 TPA Switchgrass Yield	9 TPA Switchgrass Yield	
Cost Per Acre*	\$367	\$226	\$333	\$440	Cost Per Acre**
Bushels Per Acre	\$175	3	6	9	Tons Per Acre
Gross Per Acre	\$1129	\$988	\$1095	\$1202	Gross Per Acre
\$ Per Bushel	\$6.45	\$329	\$182	\$133	\$ Per Ton
Net before Land and Labor	\$762	\$762	\$762	\$762	Net before Land and Labor

* Iowa State 2008 Corn Budget

** Duffy 2007 (altered cost for consistent fertilizer pricing to 2008 Ia. St. Corn Budget)

Land Use, Grower Profitability: Iowa Switchgrass Vs. Iowa Corn

	Corn	Demonstrated Switchgrass Yield	2X Switchgrass Yield	3X Switchgrass Yield	
Cost Per Acre	\$ 367.00	\$ 226.00	\$ 333.00	\$ 440.00	Cost Per Acre**
Bushels Per Acre	175	3	6	9	Tons Per Acre
Gross Per Acre	\$ 866.25	\$ 725.25	\$ 832.25	\$ 939.25	Gross Per Acre
\$ Per Bushel	\$ 4.95	\$ 241.75	\$ 138.71	\$ 104.36	\$ Per Ton
Net (before interest, land and labor)	\$ 499.25	\$ 499.25	\$ 499.25	\$ 499.25	Net (before interest, land and labor)

* Iowa State 2008 Corn Budget

** Duffy 2007 (altered cost for consistent fertilizer pricing to 2008 Ia. St. Corn Budget)

Substantial Incentives Required to Convert From Corn

\$110/ton & 70 GPT = \$1.47/gal \$6.45/bu & 3 GPB= \$1.47/gal

- If there were no farm bill payments for corn, 3 TPA @\$110.00 per ton energy crop would require a \$219.00/ton (\$658.00 per acre) subsidy to compete with 175 BPA corn @\$6.45 per bushel
- If there were no farm bill payments for corn, 6 TPA @\$110.00 per ton energy crop would require a \$72.00/ton (\$435.00 per acre) subsidy to compete with 175 BPA corn @\$6.45 per bushel
- If there were no farm bill payments for corn, 9 TPA @110.00 per ton energy crop would require \$23/ton subsidy (\$212.00 per acre) to compete with 175 BPA corn @6.45 per bushel

What Will Farmers Grow on Ground Not Suited for Corn?

	Corn	Switchgrass	Switchgrass	Switchgrass	
Cost Per Acre	\$ 202.00	\$ 456.49	\$ 546.49	\$ 606.49	Cost Per Acre**
Bushels Per Acre	112	6	12	18	Tons Per Acre
Gross Per Acre	\$ 722.40	\$ 976.89	\$ 1,066.89	\$ 1,126.89	Gross Per Acre
\$ Per Bushel	\$ 6.45	\$ 162.82	\$ 88.91	\$ 62.61	\$ Per Ton
Net (before interest, land and labor)	\$520.40	\$ 520.40	\$ 520.40	\$ 520.40	Net (before interest, land and labor)

**University of Georgia study and Georgia custom rates, 2002

Cellulose Has Some Discovery And Inventing Left To Do

- **Capital Costs**: USDA estimates 4-5X starch today
- **Process**: Still deciding between enzymatic and thermochemical
- **Scale**: To be determined after process and logistics
- **Production Costs**: will drive process, scale, and be driven by feedstock and capital costs
- **Logistics**:
 - Today agriculture hauls 750 million tons in total
 - Energy bill requires another 275 million tons if we can get yield up to @70 GPT cellulose, and keep corn at 110 GPT.

Crop Residue Collection and Provisioning Economic Analysis

- Field Speed
- Efficiency
- Harvest Delay
- Nutrient Removal
- Storage
- Handling
- Transportation
- Capital
- Labor
- Systems Complexity
- Profit Expectations
- Sustainability

Sustainability of Crop Residue Removal

Soil Quality

Soil Carbon Sequestration
Reduced Soil Erosion
Improved Water Infiltration
Many Others



Fossil Fuel Offsets

Greenhouse Gas Reduction
Energy Independence
Rural Development
Many Others

**Crop and Soil
Benefits**

Crop Residue

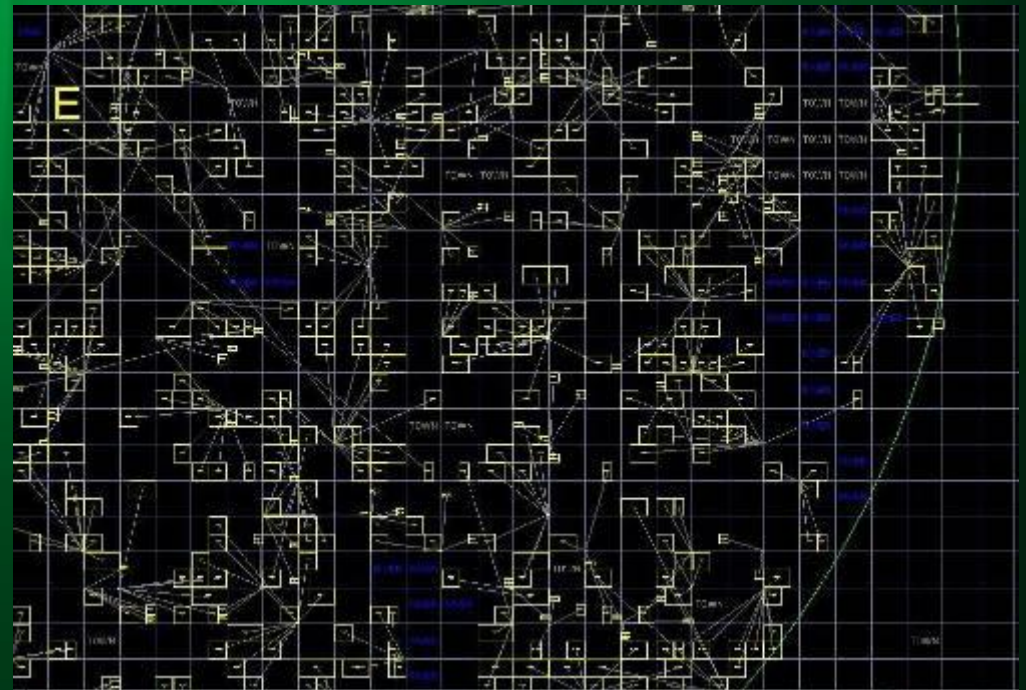
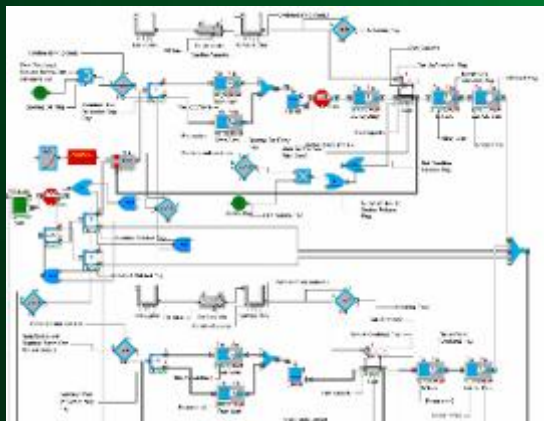
**Renewable Energy
Benefits**

- Win-wins are always preferred
- Invariably trade-offs arise
- How do you balance or weigh the various benefits?
- How about the many other factors considered in a “cradle-to-grave” comprehensive life cycle analysis?

Corn Stover Collection Activities



Simulation of Feedstock Provisioning

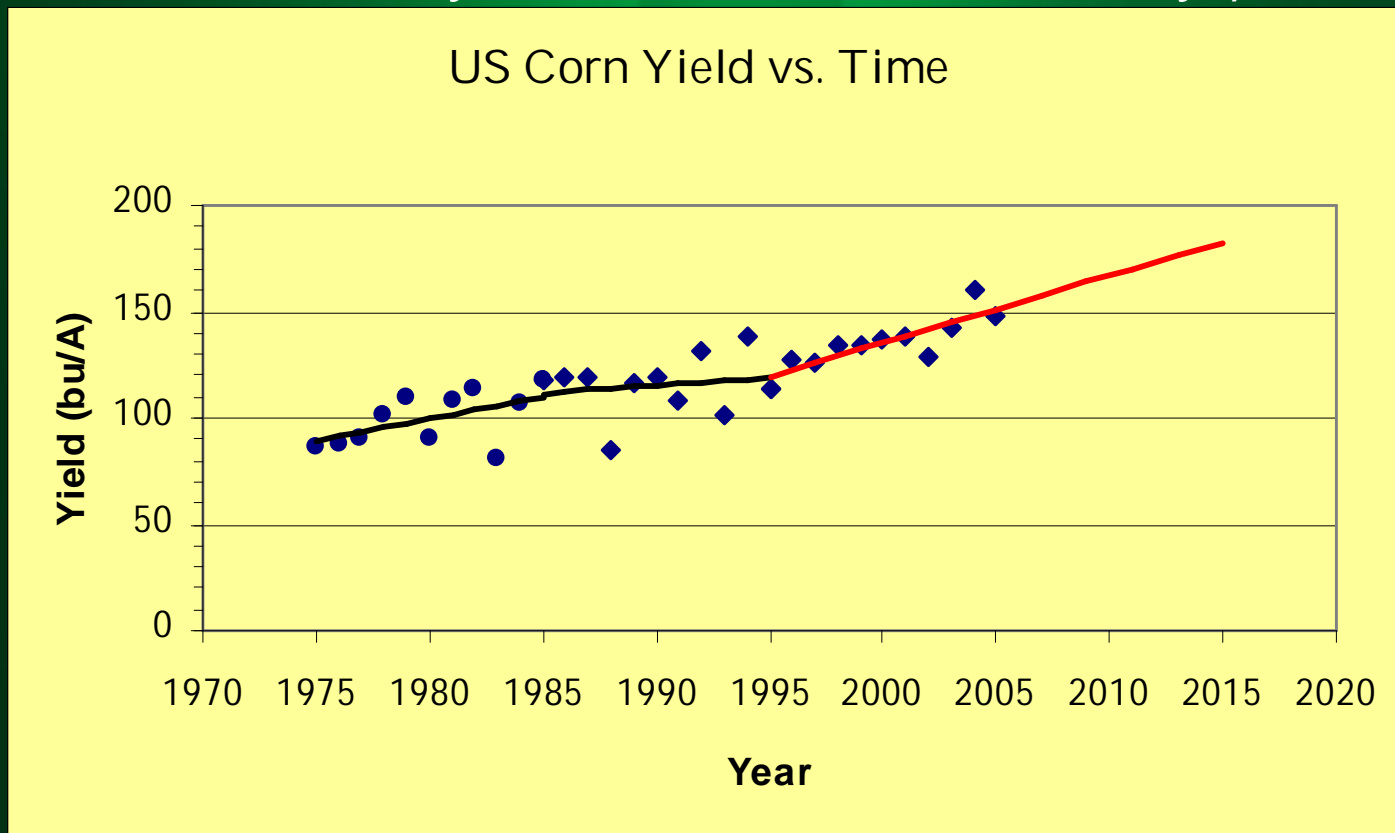


Or, do uses and methods and crops evolve (at an accelerated pace)?

- Fractionation technology to use pericarp?
- Direct combustion of cellulose?
- Biomass to gas?
- Cellulosic energy sources for starch and cane refineries?
- Crop residue collection from more productive land?
- Joint feedstock operations?
- Dedicated energy crops and refineries in areas not traditionally suited to crop production?

Corn Technology Continues to Develop

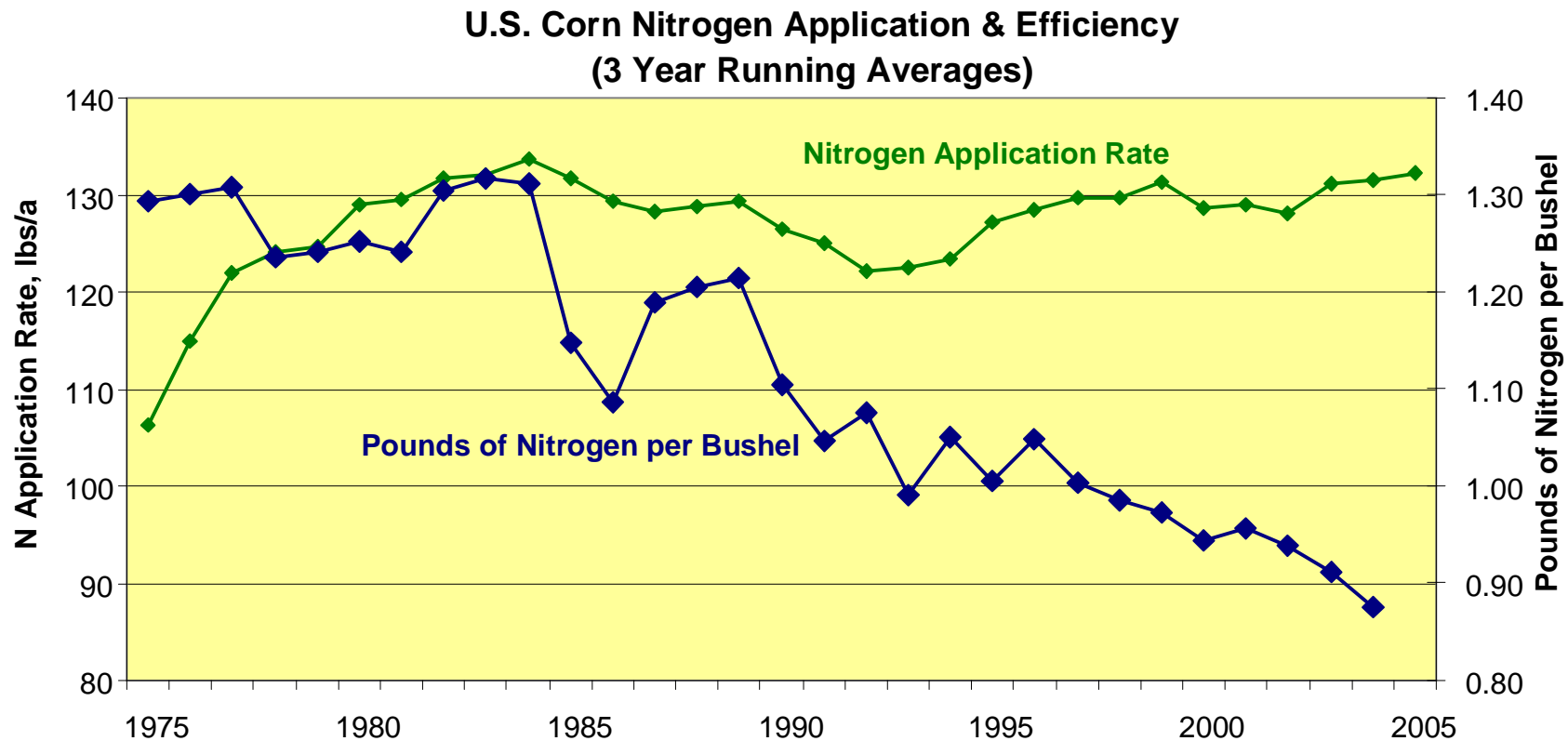
- Molecular breeding and trait stacking show remarkable corn yield changes going forward (1975-'95 +1.83 BPA/yr. 1995-'06 +3.23 BPA/yr)



Genetics Continue to Increase Capabilities

- Drought Tolerance
- Multiple modes of insect protection
- Nitrogen efficiency
- Yield (bushels per acre)
- Yield (ethanol per bushel)
- Corn oil content
- Ethanol production efficiencies
- Soybean yield
- Soybean oil content

Nitrogen Use Efficiency in Corn



Note: One pound of nitrogen = 24,500 Btus

Future Corn Breeding Advancements



Control

**Drought
Tolerant**



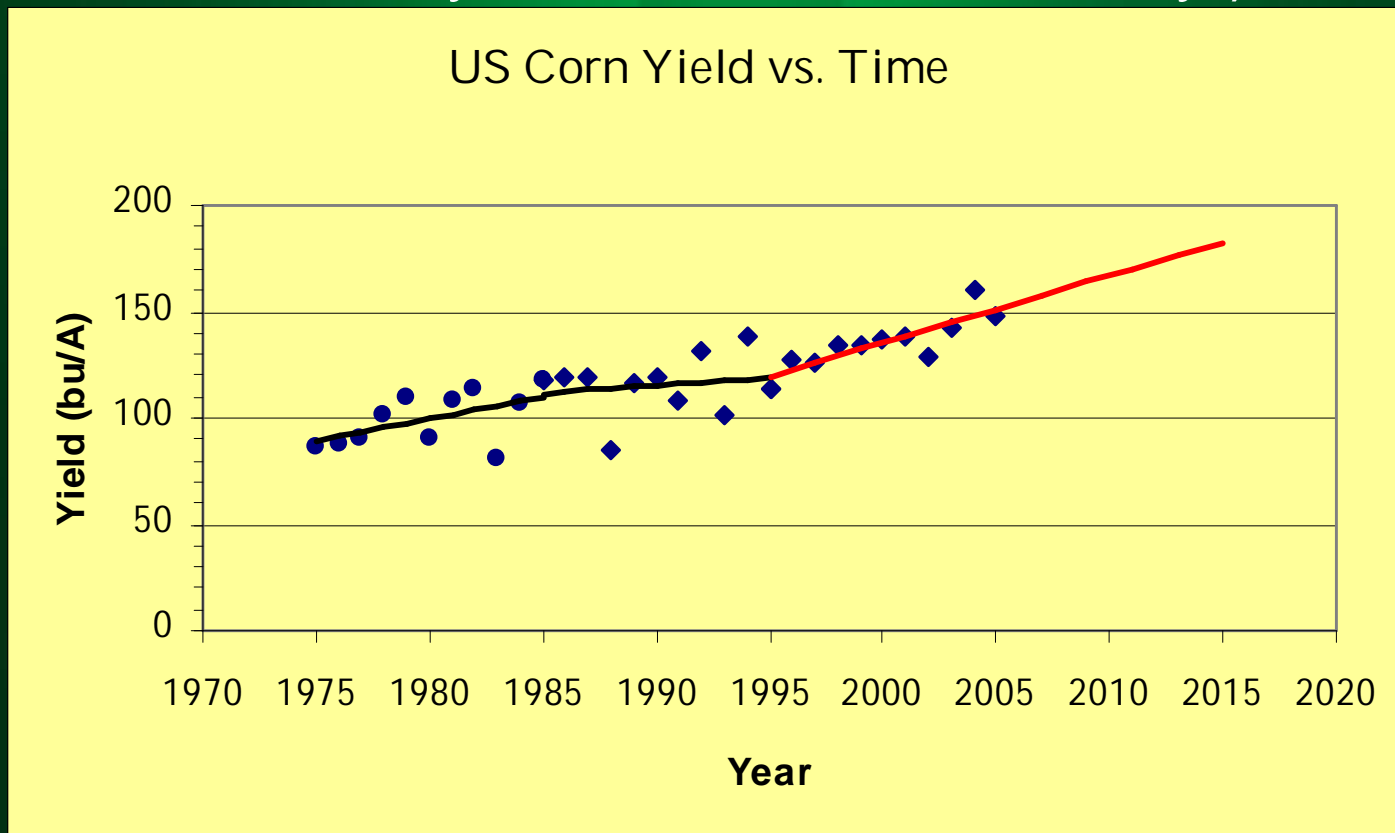
**Nitrogen
Efficient**

Control

Future breeding advancements will increase corn yields, improve nutrient use efficiency, reduce damage from stress, and change corn composition.

Corn Technology Continues to Develop

- Molecular breeding and trait stacking show remarkable corn yield changes going forward (1975-'95 +1.83 BPA/yr. 1995-'06 +3.23 BPA/yr)



Probable Renewable Scenarios: 2015

Starch Ethanol

- '95-'06 trend line (before multiple stacks) delivers 188 BPA (15.6BBu.) in 2015
- 15.6 B bushel corn crop allows:
 - 19 billion gallons of ethanol, and
 - Corn exports equal to 2006, and
 - HFCS production equal to 2006, and
 - The same amount of whole corn feed as 2006, and
 - Increases total feed supplies by 26%, (because of 90 billion pounds of additional DDGs) and
 - With fractionation technology, increases vegetable oil feedstocks by almost 200% (Corn oil alone could enable B5)

Logical Conclusions:

- **Use the land we have as wisely as we can so that we optimize the production of food, feed, fuel and fiber.**
 - Where corn yields well, it probably makes the most sense to grow corn.
 - Where switchgrass (et al.) yields well, it may be more efficient than growing corn on those same acres.
 - Where cane yields well, we should probably grow cane.
 - Where crop residues can be harvested while maintaining soil and environmental health, we should probably harvest crop residues
 - Where trees grow well and corn doesn't, woody biomass shows strong promise
 - And, as always, what we do must be sustainable

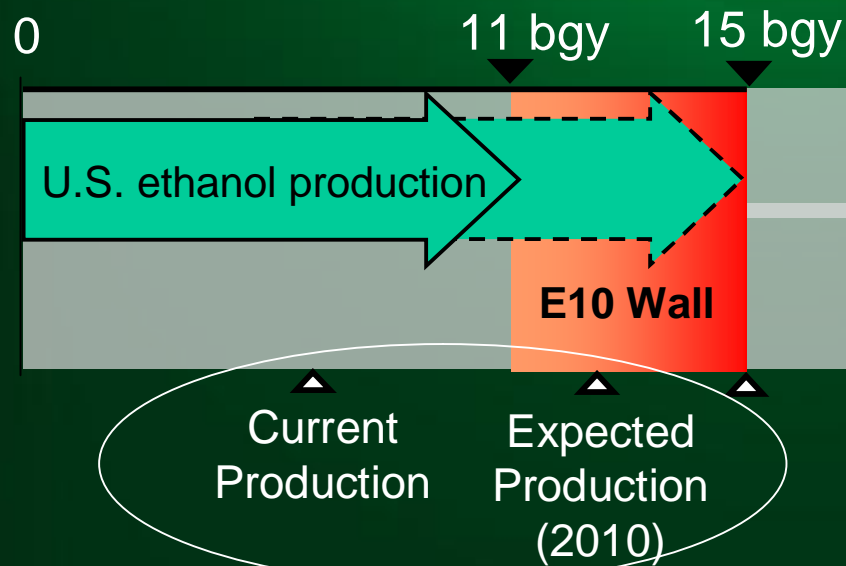
E10?? E_{xx}?? E85??
3 Things To Remember

- **Desire and Demand do not always equate.**
- **There *are* technical issues with mid-level ethanol blends.**
- **Move toward a better balance of investment to create enough demand to keep up with supply innovation**

The flex fuel revolution – Creating a demand for ethanol beyond E10

United States

- +/-1500 E85 stations (out of 170,000 nationwide)
- 6 million of 230 million vehicles are FFV
- Major U.S. vehicle manufacturers planning FFV ramp-up (50% of 2010 Production at Ford, Chrysler and G.M.)
- When does the U.S. hit the E10 wall and what can be done?



The combination of E85 / FFV infrastructure, transportation logistics, and markets for distillers grains could slow ethanol expansion (corn or cellulose) when we get to 11-15 B. gallon range. Expansion of E85 availability is very important.

One thing those of us in agriculture know:

The supply of agricultural commodities has a remarkable track record of keeping up with demand.

Probable Renewable Scenarios: Immediate Action Items

- Invest in Demand. Find technology that allows universal performance **and** universal emissions compliance with blends well above E10. Do it now.
- Invest in E85 distribution infrastructure. Do it now.
- Invest in biodiesel distribution infrastructure. Do it now.
- Invest in fractionation milling upgrades at ethanol plants to increase utilization of corn oil.
- Increase Flex Fuel vehicle availability as rapidly as possible.
- Invest in new biodiesel feedstock research
- Invest in cellulosic research, both biomass to liquid and direct combustion.
- Invest in food crop residue collection to maximize feedstock potential.

Probable Renewable Scenarios: Action Items

- Ensure we optimize our land resources-- planting cellulose on acres that could otherwise produce food *and* feed *and* fuel may not be in our best interests
- Trying to grow corn where trees do better doesn't make sense either
- Invest in more efficient use of nitrogen fertilizers to increase food, feed, and fuel production AND protect the environment
- Answer negative competitive claims about renewable energy. Take them seriously. Answer them honestly.

ETHANOL ECONOMICS--2007

- Ethanol added \$47.6B to GDP
- Ethanol added 238K jobs, including 46K in manufacturing sector
- Ethanol generated \$3.6B in State and Local taxes
- Ethanol generated \$4.6B in Federal tax revenues (against \$3.4B in subsidies)
- Ethanol reduced trade deficits \$16.5B in 2007 (@\$72.20/barrel)
- Displaced +/- 5% of oil imports

BUREAU OF LABOR STATISTICS CPI "SHOULD" PRICES

	1974 Price	2007 Price	2008 CPI "Should Price"	Difference	
PONTIAC LEMANS PONTIAC G6	\$ 3,417.62	\$ 21,116.45	\$ 14,627.41	\$ 6,489.03	31%
GALLON OF GAS	\$ 0.53	\$ 3.28	\$ 2.27	\$ 1.01	31%
LB. OF HAMBURGER	\$ 0.63	\$ 3.11	\$ 2.70	\$ 0.41	13%
LOAF OF BREAD	\$ 0.28	\$ 1.59	\$ 1.20	\$ 0.39	25%
POSTAGE STAMP	\$ 0.10	\$ 0.41	\$ 0.43	\$ (0.02)	-4%
GALLON OF MILK	\$ 1.39	\$ 3.78	\$ 5.95	\$ (2.17)	-57%

Agricultural Supply Holds Down Prices

	1974 Price	3/27'08 CBOT/CME OR CASH NEARBY OR LATEST	2008 CPI "Should Price")	Difference	
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FAT CATTLE	\$ 28.60	\$ 88.62	\$ 122.41	\$ (33.79)	-38%
CWT OF MILK	\$ 8.05	\$ 18.01	\$ 34.45	\$ (16.44)	-91%
BUSHEL OF WHEAT	\$ 4.57	\$ 10.14	\$ 19.56	\$ (9.42)	-93%
LB. OF COTTON	\$ 0.42	\$ 0.73	\$ 1.80	\$ (1.07)	-146%
BUSHEL OF BEANS	\$ 7.81	\$ 13.27	\$ 33.43	\$ (20.16)	-152%
BUSHEL OF CORN	\$ 3.58	\$ 5.55	\$ 15.32	\$ (9.77)	-176%
LIVE HOGS	\$ 33.70	\$ 39.80	\$ 144.24	\$ (104.44)	-262%

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Disposable Income Spent on Food: 1974: 13.4%
2006: 9.9%

Agricultural Supply Holds Down Prices

Disposable Income spent on food 1974:	13.4%
Disposable Income spent on food 2006	9.9%

Agricultural Supply Holds Down Prices

Disposable Income spent on food 1974:	13.4%
Disposable Income spent on food 2006	9.9%
Disposable Income spent on food 2007 (+4%)	10.3%

Agricultural Supply Holds Down Prices

Disposable Income spent on food 1974:	13.4%
Disposable Income spent on food 2006	9.9%
Disposable Income spent on food 2007 (+4%)	10.3%
Disposable Income spent on food 2008 (proj.)	10.8%

Agricultural Supply Holds Down Prices

Disposable Income spent on food 1974:	13.4%
Disposable Income spent on food 2006	9.9%
Disposable Income spent on food 2007 (+4%)	10.3%
Disposable Income spent on food 2008 (proj.)	10.8%

**If food prices increase
another 4.5% in 2008, by
December food will only
cost 19% less than it did in
1974.**