The Ohio State University
Agricultural, Environmental and Development Economics
Ohio State University Extension

Biofuels: Causes and Effects

Matthew C. Roberts
(614) 688-8686
roberts.628@osu.edu
http://aede.osu.edu

Stephen Colbert's Tips on Being an Expert

(Wired Magazine, August 2006)

- Pick a field that can't be verified
- Be sure to use lots of abbreviations and acronyms
- Don't be afraid to make things up
- Don't limit yourself to current knowledge
- Get an honorary PhD
- Make a habit of name-dropping

Outline

- Why Alternative Energy?
- The Ethanol Market: How Much and How Long?
- Ethanol and Energy Balance
- Cellulosic Ethanol

Why Biofuels?

Environment

- Reduce C, SOx, NOx
  - Anti Coal
  - Nuclear?
  - Solar, Wind, Biomass
  - Energy Conservation
  - Pro Cellulosic Ethanol
  - Unsure about Corn Ethanol and Biodiesel.
  - Brazilian Ethanol?

National Security

- Energy Self-Sufficiency
  - Pro Coal
  - Pro Nuclear
  - Solar, Wind, Biomass
  - Energy Conservation
  - Pro Ethanol of all types
  - Pro Biodiesel
  - Brazilian Ethanol?

Rural Development

- Economic Revival
  - Coal?
  - Pro All Biofuels
  - Anti Imported Biofuels

Energy Solutions…

Fast

Cheap

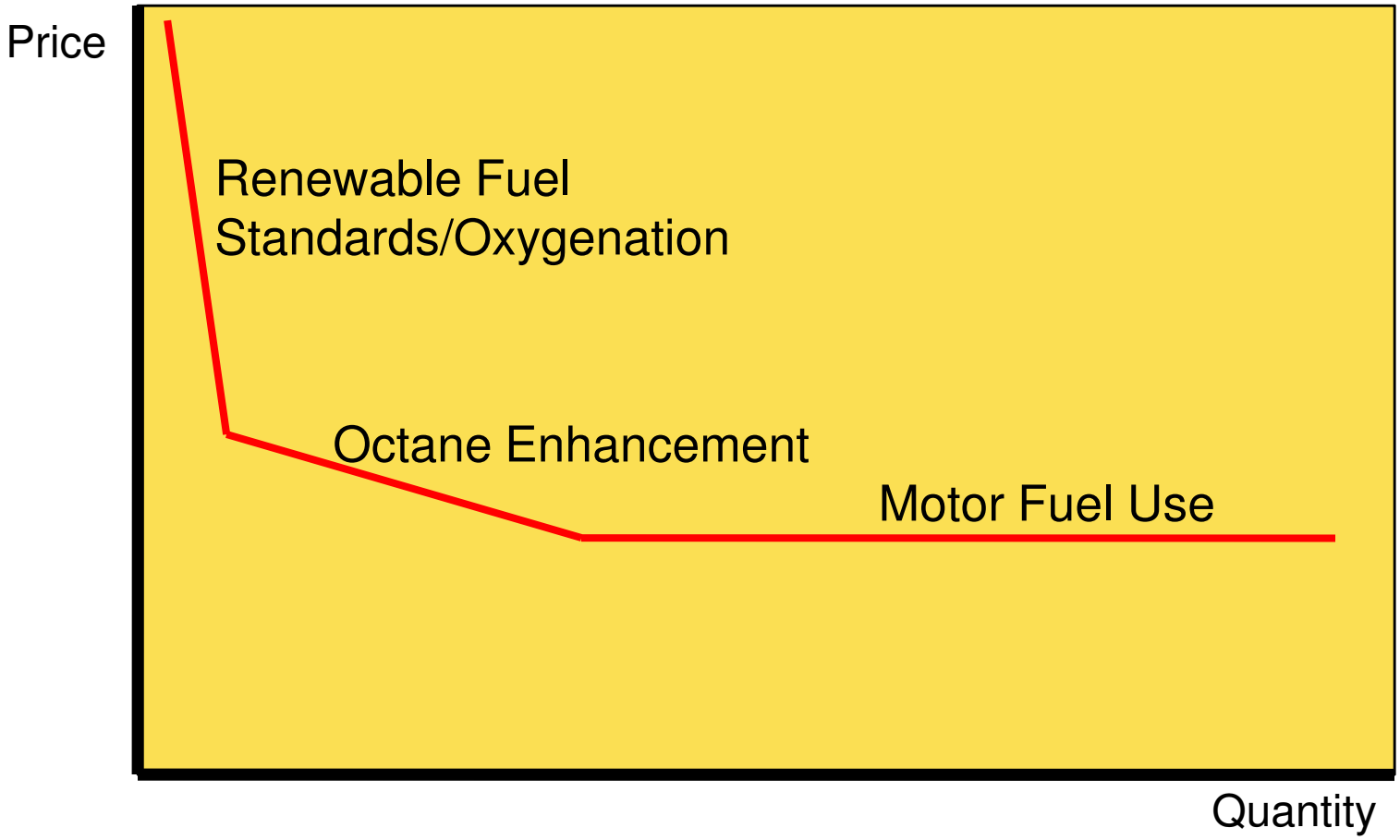
Good

Pick Any Two.

Some Energy Statistics

- In 2005, the US
  - consumed 139.9bn gallons of gasoline. (EIA)
  - produced 3.9bn gallons of ethanol. (RFA)
  - imported 65% of all petroleum.
- Other Helpful Stats:
  - 1 bushel corn = 2.7 gallons ethanol
  - 7.5lbs soy oil = 1 gal B100

Demand Curve for Ethanol



Ethanol Drivers: Economic Profits

Plant Received Price		1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75
subtract VEETC		0.49	0.74	0.99	1.24	1.49	1.74	1.99	2.24
Plus Average Taxes		1.11	1.36	1.61	1.86	2.11	2.36	2.61	2.86
Retail Gasoline Price		1.48	1.81	2.15	2.48	2.81	3.15	3.48	3.81
Corn Price	2.00	-20%	1%	21%	42%	63%	84%	105%	126%
	2.50	-30%	-9%	12%	33%	53%	74%	95%	116%
	3.00	-40%	-19%	2%	23%	44%	64%	85%	106%
	3.50	-50%	-29%	-8%	13%	34%	55%	75%	96%
	4.00	-59%	-39%	-18%	3%	24%	45%	66%	86%
	4.50	-69%	-48%	-28%	-7%	14%	35%	56%	77%
	5.00	-79%	-58%	-37%	-16%	4%	25%	46%	67%

Assumptions:

- 75mgpy Plant
- $2/gpy Construction Cost
- 8% Interest Rate
- DGS =75% of Corn
- $8/Dtherm NG
- 3g denatured/bushel
- E85 sells for 80% of gasoline
- 60% equity, 40% debt

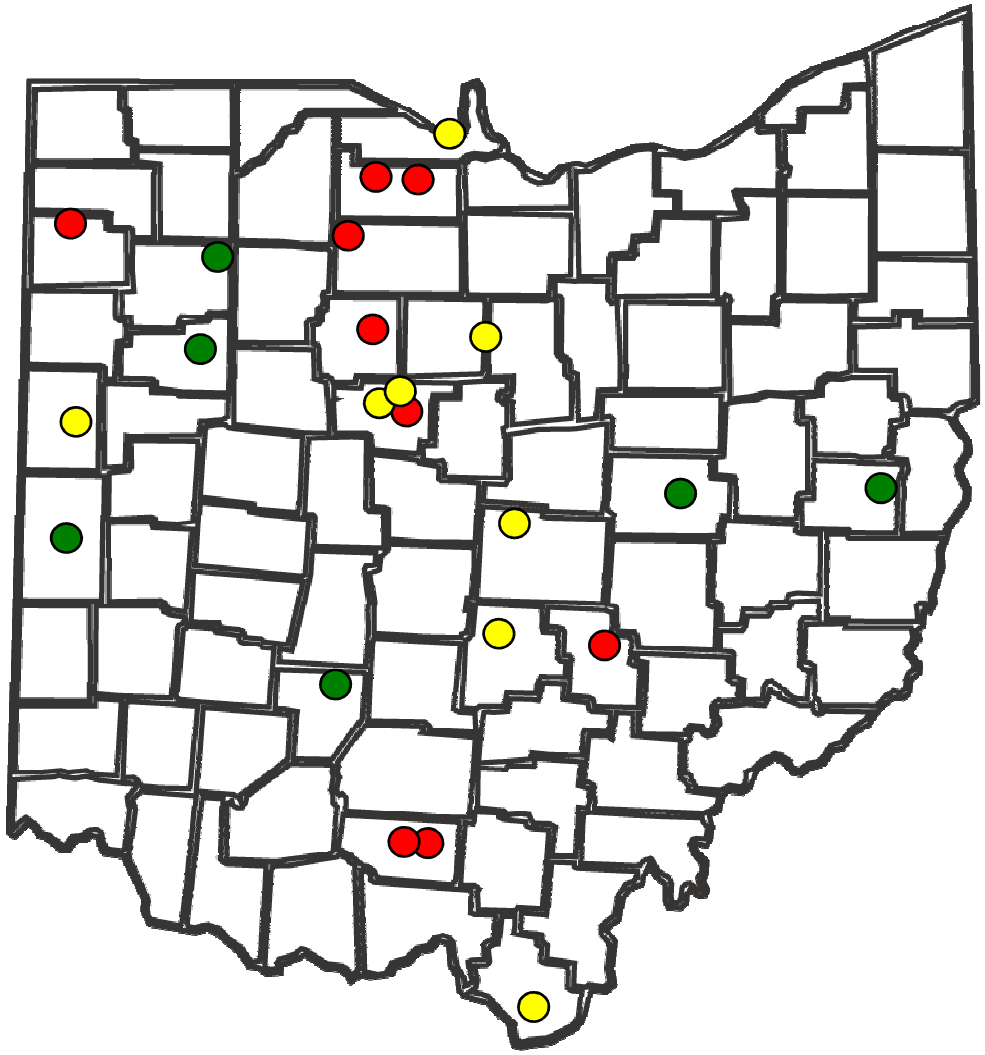
Source: 'ethanolsuccess.xls' spreadsheet model by Doug Tiffany, available at: http://www.agmrc.org/agmrc/commodity/energy/ethanol/ethanol.htm

Ethanol Drivers: Shutdown Point

Plant Received Price		1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75
subtract VEETC		0.49	0.74	0.99	1.24	1.49	1.74	1.99	2.24
Plus Average Taxes		1.11	1.36	1.61	1.86	2.11	2.36	2.61	2.86
Retail Gasoline Price		1.48	1.81	2.15	2.48	2.81	3.15	3.48	3.81
Corn Price	2.00	-0.03	0.22	0.47	0.72	0.97	1.22	1.47	1.72
	2.50	-0.09	0.16	0.41	0.66	0.91	1.16	1.41	1.66
	3.00	-0.19	0.06	0.31	0.56	0.81	1.06	1.31	1.56
	3.50	-0.22	0.03	0.28	0.53	0.78	1.03	1.28	1.53
	4.00	-0.44	-0.19	0.06	0.31	0.56	0.81	1.06	1.31
	4.50	-0.56	-0.31	-0.06	0.19	0.44	0.69	0.94	1.19
	5.00	-0.68	-0.43	-0.18	0.07	0.32	0.57	0.82	1.07
	5.50	-0.79	-0.54	-0.29	-0.04	0.21	0.46	0.71	0.96
	6.00	-0.91	-0.66	-0.41	-0.16	0.09	0.34	0.59	0.84
	6.50	-1.03	-0.78	-0.53	-0.28	-0.03	0.22	0.47	0.72
	7.00	-1.15	-0.90	-0.65	-0.40	-0.15	0.10	0.35	0.60

Source: 'ethanolsuccess.xls' spreadsheet model by Doug Tiffany, available at:
http://www.agmrc.org/agmrc/commodity/energy/ethanol/ethanol.htm

Ohio Corn Ethanol Plants (3-15-07)



- Under Construction
- Seeking Permits - not under construction
- Working with ODOD but have not applied for permits

Subsidies

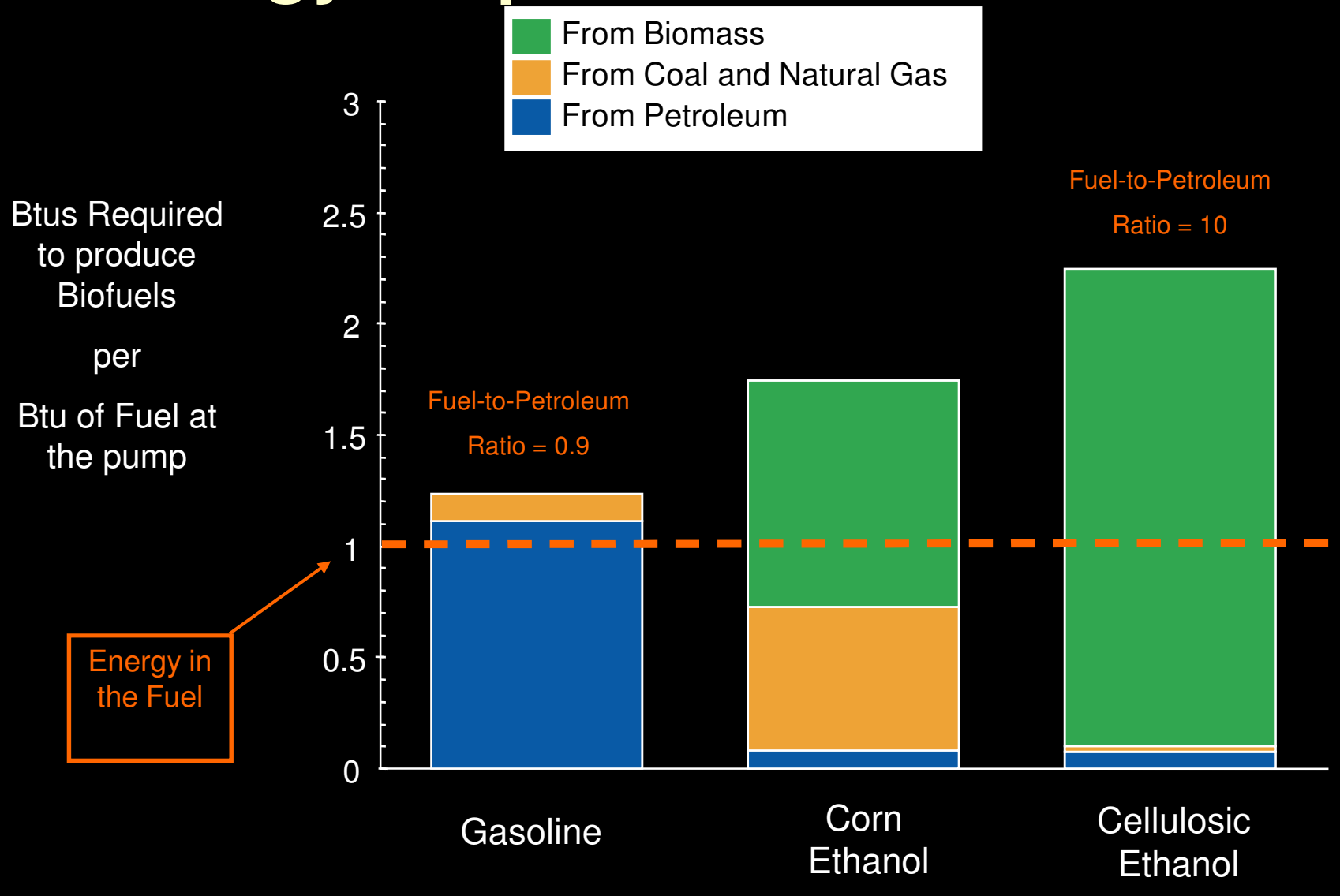
- Ethanol VEETC: 51c/g excise tax credit.
- Various minor state/local credits.
- Oil Production/Refining:
  - Roughly $2bn/year in 2000
  - Higher now b/c of oil prices…$5bn?
  - But…optimal tax on gasoline ~$1/g; 50c higher…
  - Optimal tax on corn ethanol only 35c higher…
  - Should national security be priced?

Energy Balance…

It doesn't matter.

- According to Dr. Fred Michel, FABE, it takes about 2.4 units of energy to make one unit of energy of cellulosic ethanol.
  - *But about 2.2 of those are solar energy*…

Energy Required to Produce Fuels



Based on "Well to Wheels Analysis of Advanced Fuel/Vehicle Systems" by Wang, et.al (2005).

Energy Balance…

- There is *no* energy shortage!
  - First Law of Thermodynamics
  - There is a shortage of energy that is *compatible* with the existing infrastructure.
- In different forms, energy has different values:
  - Coal: $1.66/mmBTU
  - NG: $8/mmBTU
  - Gasoline: $21/mmBTU
    - 1 Gal Gasoline=10lbs Coal

So what does matter?

What metrics matter?

- Carbon balance:
  - Ethanol Today: 14% better than gasoline
  - CO2 Intensive Ethanol: 1% worse than gasoline
  - Cellulosic: 88% better than gasoline
- Petroleum Balance:
  - Gasoline: 1.1:1
  - Ethanol Today: 0.05:1
  - Cellulosic: 0.08:1

What metrics matter?

- Gasoline Today: 110% Oil, 3% NG, 5% Coal
- Ethanol Today: 5% Oil, 30% NG, 40% Coal
- Cellulosic: 8% Oil, 2% NG, -2% Coal

Source: Farrell, et al. *Science,* 27 January 2006

Acreage Needed For Ethanol

					100% Productivity			*90% Productivity*		
	Ethanol	Corn to	E(Yld)	Total	Harv Ac	Plant Ac	Add'l to	Harv Ac	Plant Ac	Add'l to
Year	bgpy	Ethanol	bu/ac	Use	Needed	Needed	06/07	Needed	Needed	05/06
07/08	8.68	3.10	152.41	12.50	82.02	88.19	***9.89***	82.13	90.25	**11.95**
08/09	11.28	4.03	154.98	13.43	86.66	93.18	***14.88***	87.28	95.92	**17.62**
09/10	12.98	4.63	157.58	14.03	89.06	95.77	***17.47***	89.96	98.86	**20.56**
10/11	14.27	5.10	160.24	14.50	90.48	97.29	***18.99***	91.53	100.58	**22.28**
11/12	15.70	5.61	162.93	15.01	92.11	99.04	***20.74***	93.35	102.58	**24.28**
12/13	17.27	6.17	165.67	15.57	93.97	101.05	***22.75***	95.41	104.85	**26.55**

- Where does the land come from?
  - Corn displaces soybean
  - Soybean displaces wheat
  - Corn displaces cotton
  - CRP to corn
  - Sorghum?
- Benign Assumptions:
  - China remains exporter
  - Non-ethanol use flat
  - Exports at 2bn bu/year

Where is the land now?

	2006 Plantings	Available?
Corn	78.6	n/a
Soybeans	75.6	13
Wheat	57.3	7
Upland Cotton	15.0	3
Sorghum	6.3	0
Barley	3.5	0.5
Oats	4.2	0.5
Hay	9.0	2.0
CRP	34.0	2.0
Total	283.5	28

(million acres)

… but at what yield and price?

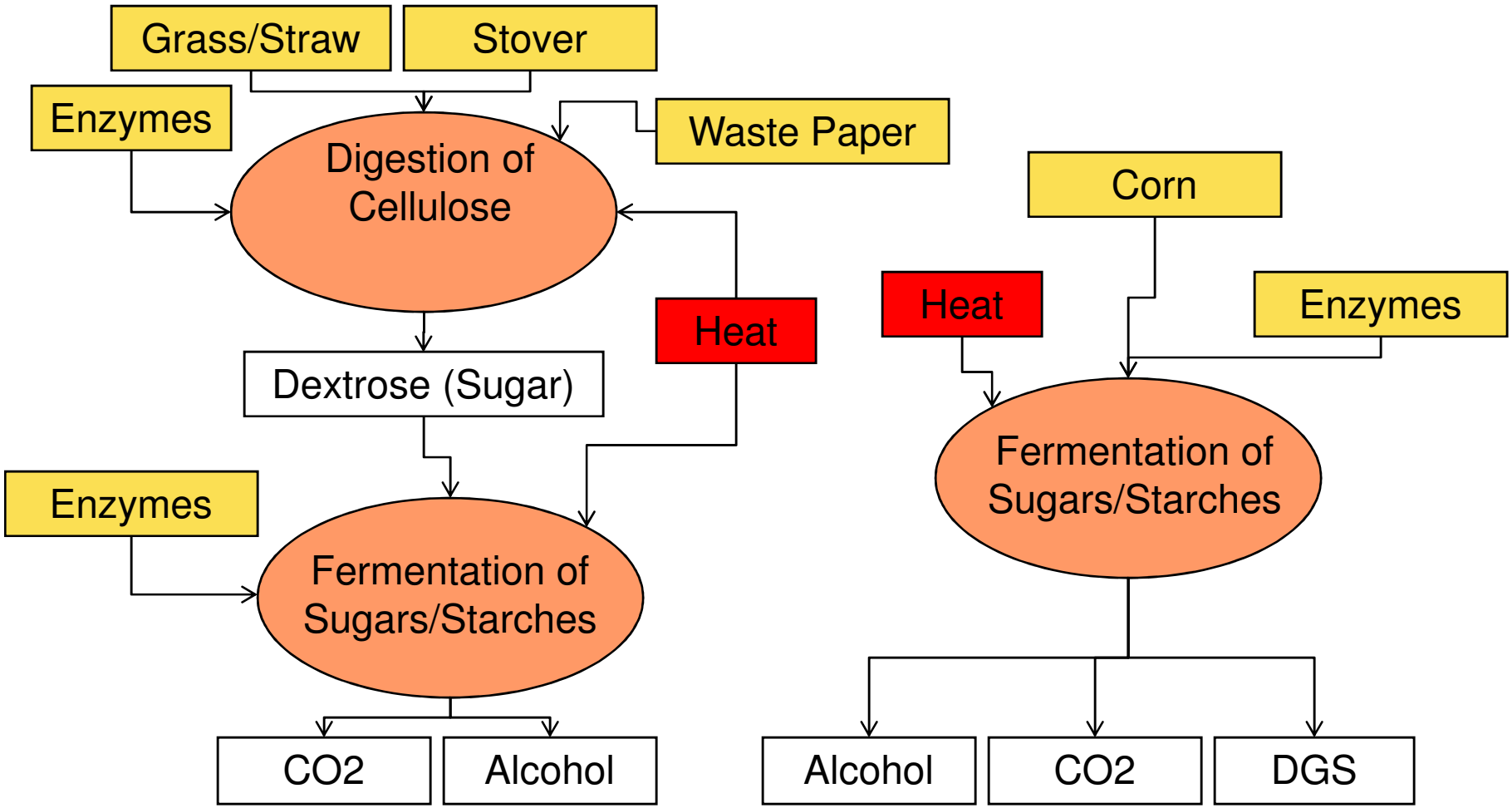
Acreage Details…

- If all Corn Belt states go 2:1 corn:bean, that is 17.7m more corn acres.
  - Will happen fastest in WCB, more full-time farmers, generally better soils.
- Soybean net acreage losses will be smaller as soybeans will displace wheat in Great Plains.
- In 2007, ~1.2m acres of cotton to corn.
- Sorghum unlikely to lose acres, may gain.

Acreage Details…, cont'd

- Hay/Forage is a big question mark. Generally low quality land, but at sufficient prices, can still be profitable.
- CRP: Best land is also likely to be most sensitive: buffer strips, etc.
- Most land available from 2006-2009 already resigned.
  - About 7.7m has not yet. Likely good ground.
  - Will CRP rates go up in 2007 Farm Bill? Yes.
  - Some will leave, but many like stewardship/stability of CRP

Ethanol Production Methods



Cellulosic Ethanol

- Still 5 years away…maybe…
- Hurdles
  - Technological: Enzymes that act quicker at a lower temperature.
  - Logistical: Cutting, Storing & Moving all that material.
  - Agronomic: How much is your stover worth?
  - Ecological: CRP switchgrass for fuel vs. habitat

Where's the Silver Bullet?

- There isn't one…
  - The fuels situation is a many-faceted problem.
  - It requires a many-faceted solution.
  - Each part has trade-offs
    - What role does self-sufficiency play?
    - What role does climate change play?
    - How strongly does the government want to incent behavior?

Thank You For Your Time

If you would like a copy of this presentation, please email me, citing the date and location of the presentation.

Matt Roberts

(614) 688-8686

roberts.628@osu.edu

http://aede.osu.edu/people/roberts.628