Growth in Renewable Fuels and Effects on Feeds Markets

Douglas G. Tiffany
Department of Applied Economics
University of Minnesota

Minnesota Nutrition Conference
September 20, 2005

Topics to be Discussed

- Status of U.S. Ethanol & Biodiesel Production
- Key features of Energy Bill Affecting Feed Markets
  - Implications for Ethanol Production
  - Implications for Biodiesel Production
- Review USDA Analysis of Energy Bill
- Review Ethanol Economic Sensitivity
- Review Biodiesel Economic Sensitivity
- Consider Domestic Livestock Consuming Populations
- Consider Prevailing and Projected Energy Prices----
- Consider Firm Responses
- Implications for the Feed Business---Bonanza or Hardship

Status: U.S. Ethanol & Biodiesel Production

- Ethanol's capacity continues to grow rapidly. (Approx. 4 Bill. Gallons in 2005 or 3% of U.S. gasoline supply.)
- Ethanol plants have been quite profitable in recent years, but returns can be volatile.
- Biodiesel is experiencing growth; but it starts from a much lower level. (25 million gallons in 2004)
- Biodiesel can never comprise as high a share of distillate supply due to limited feedstock supplies.
- Dominant feedstock is soybean oil, although recycled oils can be used.
- Ethanol and biodiesel receive substantial subsidies.

Key Features of Energy Bill

- Boosts production of ethanol & biodiesel in several ways
- Corn-based ethanol will dominate.
- Reformulated Gasoline Standards will be removed to allow more flexibility to marketers of gasoline.
- “Renewable Fuel Standard” Credits will be established and traded.
- Cellulosic ethanol is encouraged.

Annual Production Targets for Renewable Fuels

- 2006 4.0 Billion Gal.
- 2007 4.7 Billion Gal.
- 2008 5.4 Billion Gal.
- 2009 6.1 Billion Gal.
- 2010 6.8 Billion Gal.
- 2011 7.4 Billion Gal.
- 2012 7.5 Billion Gal.

Do we have enough corn to supply the expanding ethanol industry?

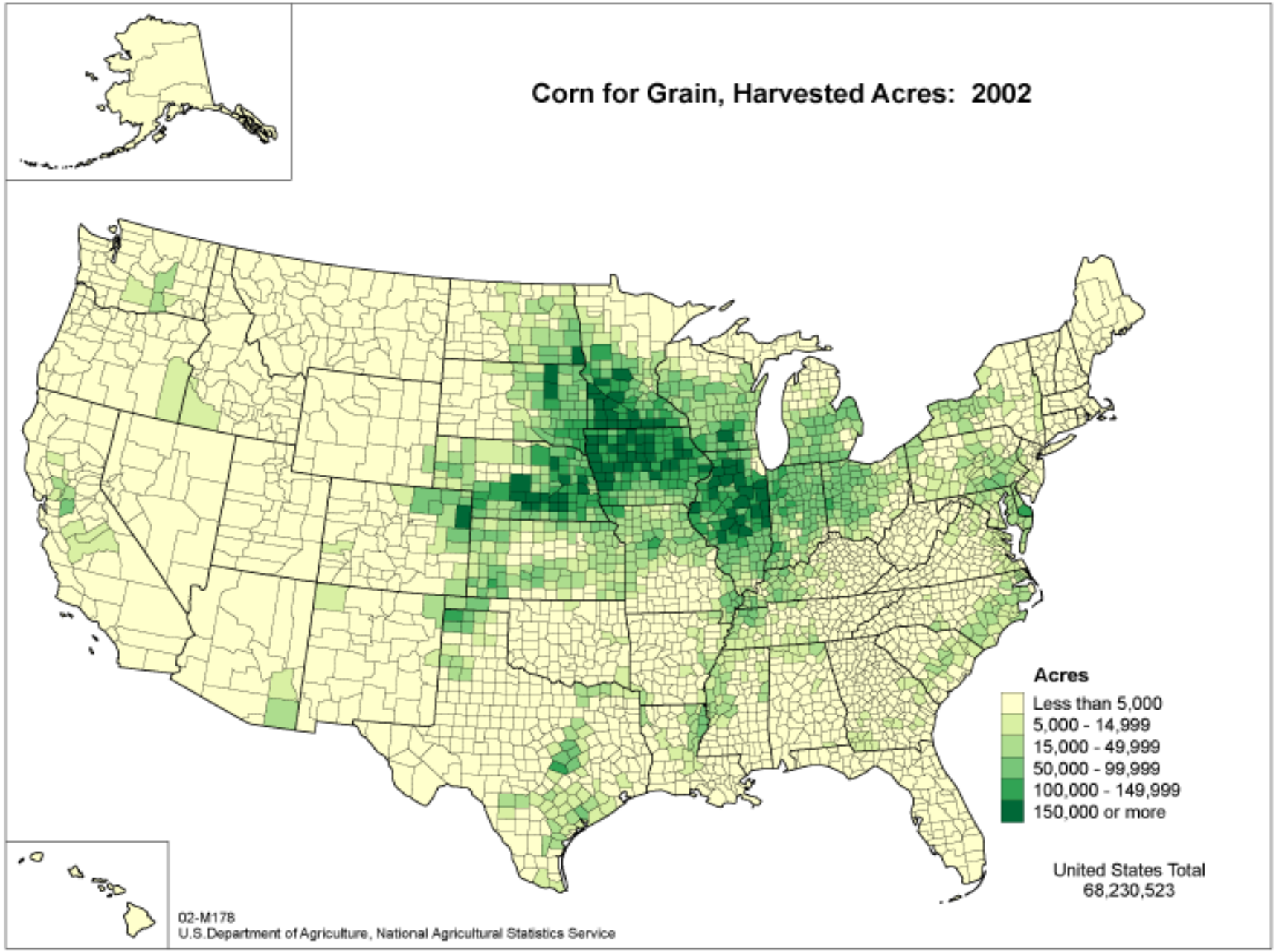
Year	Ethanol Prod. (Bil.Gal)	Corn Use For Ethanol (Mil. Bu.)	Corn Crop* (Mil. Bu.)	% Corn Crop
03/04	3.4	1,259	10,089	10
04/05	3.7	1,370	11,741	12
05/06	4.0	1,482	10,985	13
06/07	6.0	2,222	10,850	20

- Will need to increase corn acres by shifting land from soybeans or from CRP. Each billion gallons requires about 370 million bushels, or 2.5 to 3 million acres of corn. We may need to shift acres from soybeans and CRP.

* USDA estimates.

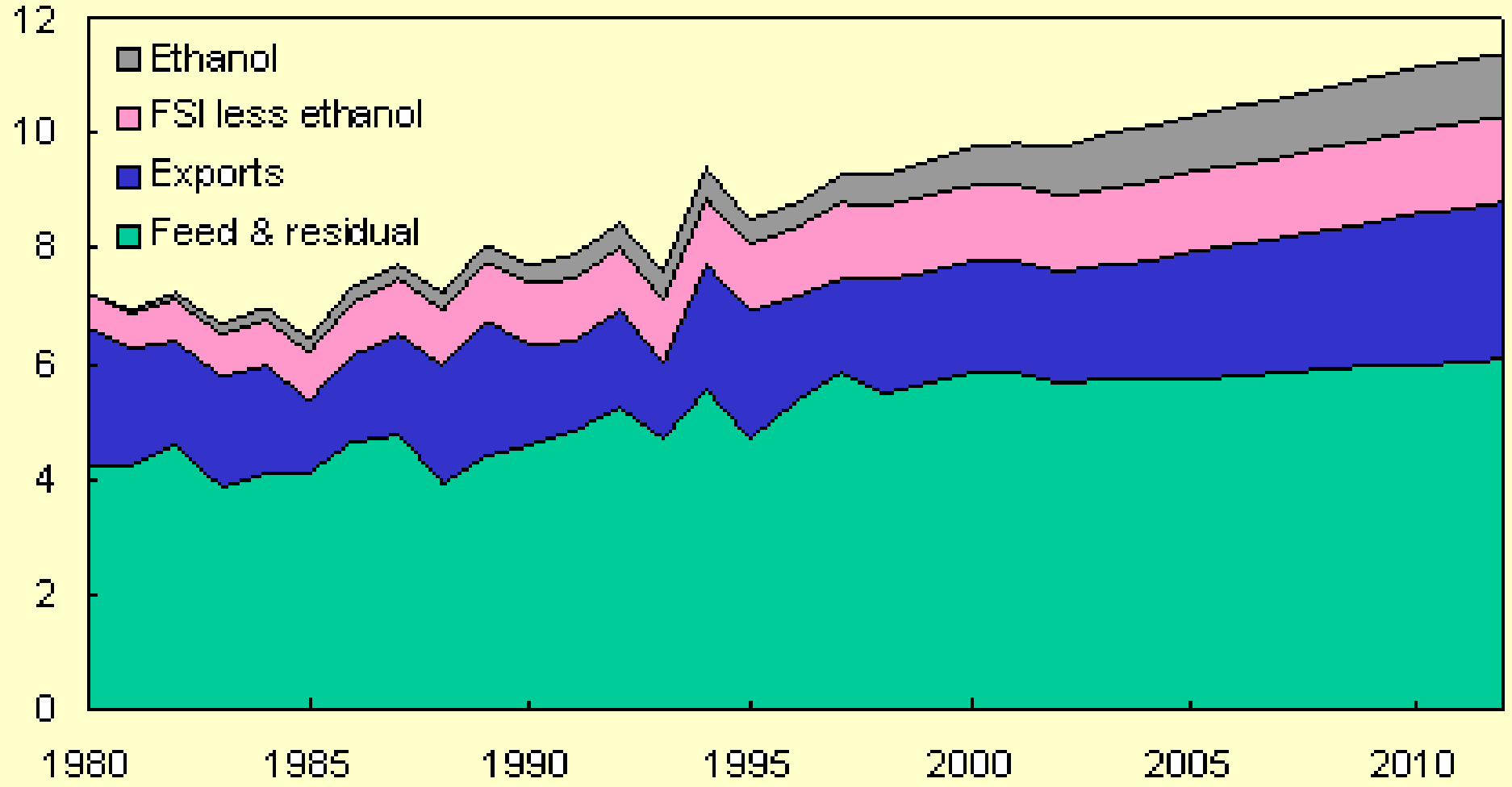
USDA Analysis of Energy Bill through 2012

- Additional ethanol will primarily be derived from corn at dry-grind facilities.
- Corn prices will increase 8% ($.30 per bushel) increase in U.S. by 2012.
- Ample DDGS supplies will reduce prices of SBM 7%.
- Demand to make biodiesel will raise soy oil price 6%.
- Corn acres will rise 3.5%.
- Soybean acres will rise 3%.
- Broiler and turkey production will expand due cheaper SBM.
- Production of all other livestock will decline due to higher corn prices.
- Expect biomass ethanol and biodiesel to be more important after 2012.


Corn for Grain, Harvested Acres: 2002
Acres
Less than 5,000
5,000 - 14,999
15,000 - 49,999
50,000 - 99,999
100,000 - 149,999
150,000 or more
United States Total
68,230,523
02-M178
U.S. Department of Agriculture, National Agricultural Statistics Service

U.S. corn use

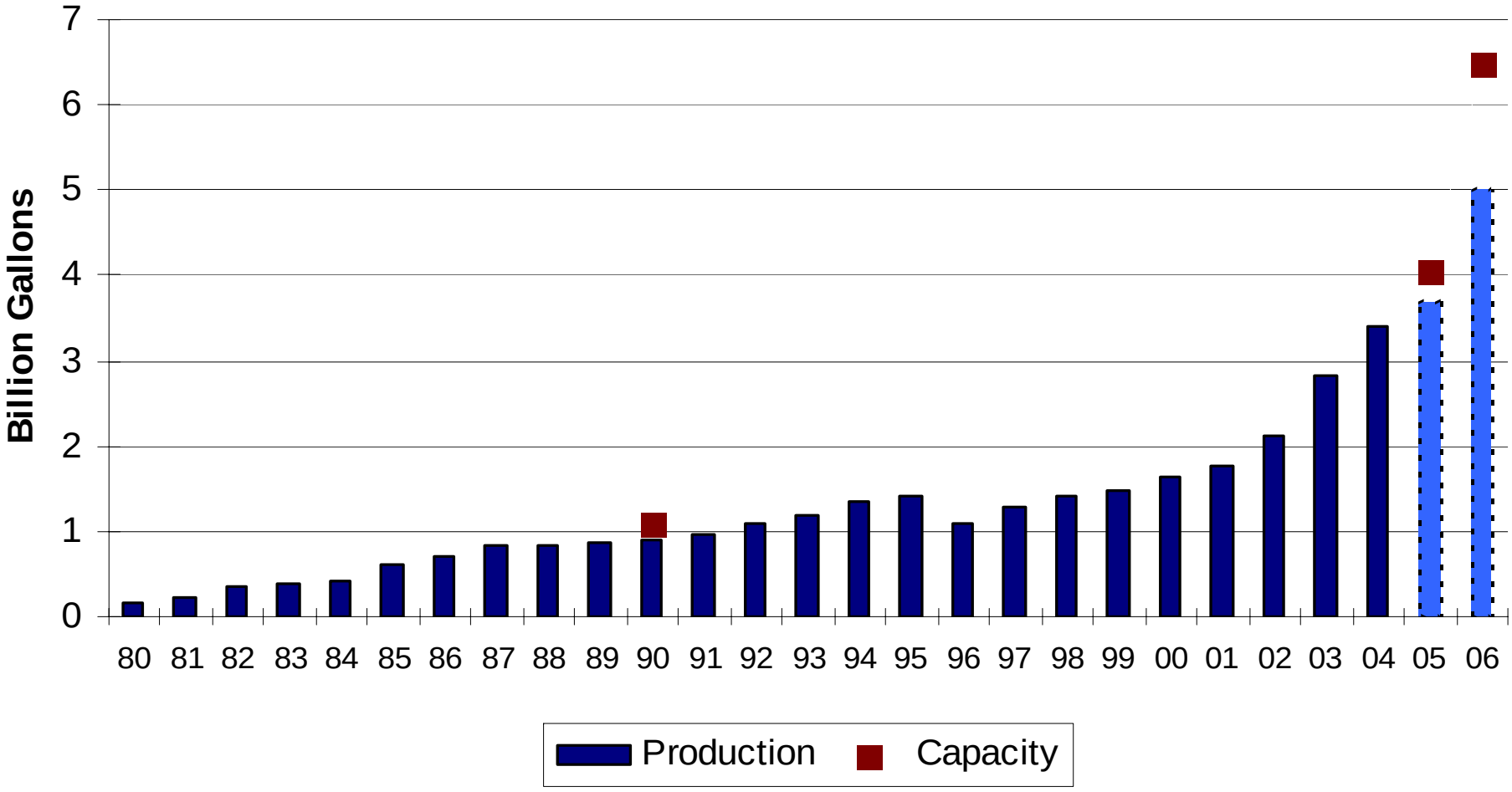
Billion bushels



Source: *USDA Agricultural Baseline Projections to 2012*, February 2003.
Economic Research Service, USDA.

Ethanol Production

Historic U.S Production 1980-2004 with Projections for 2005-06



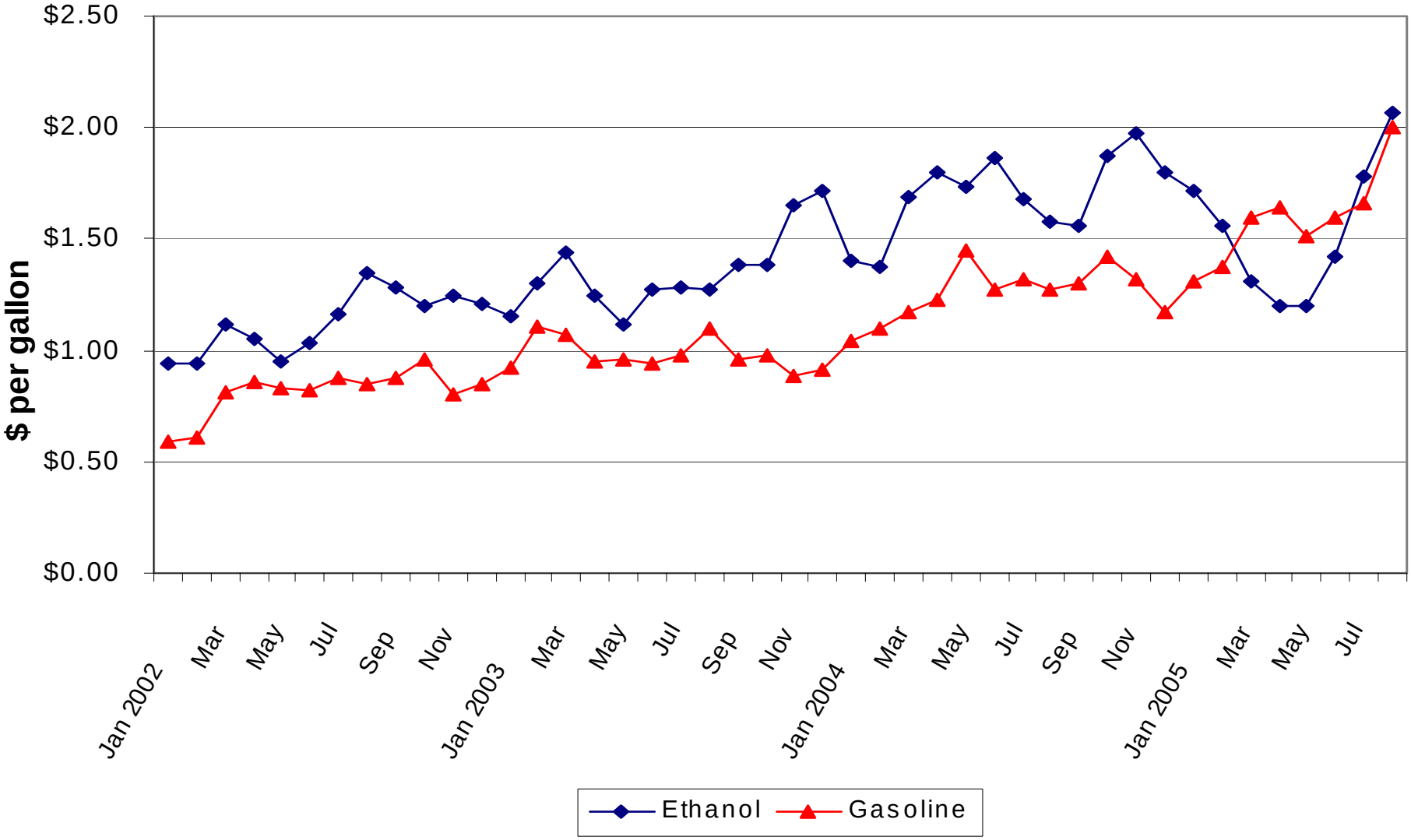
Source: RFA , BBI International and Ethanol Producer Magazine.

Four Market Segments For Ethanol in 2004.	Million Gallons	%
• Oxy-fuel program	290	8
• Reformulated Gasoline	1,950	55
• Octane booster &blending	1,050	29
• State Mandate (MN)	280	8
Total	3,570	100

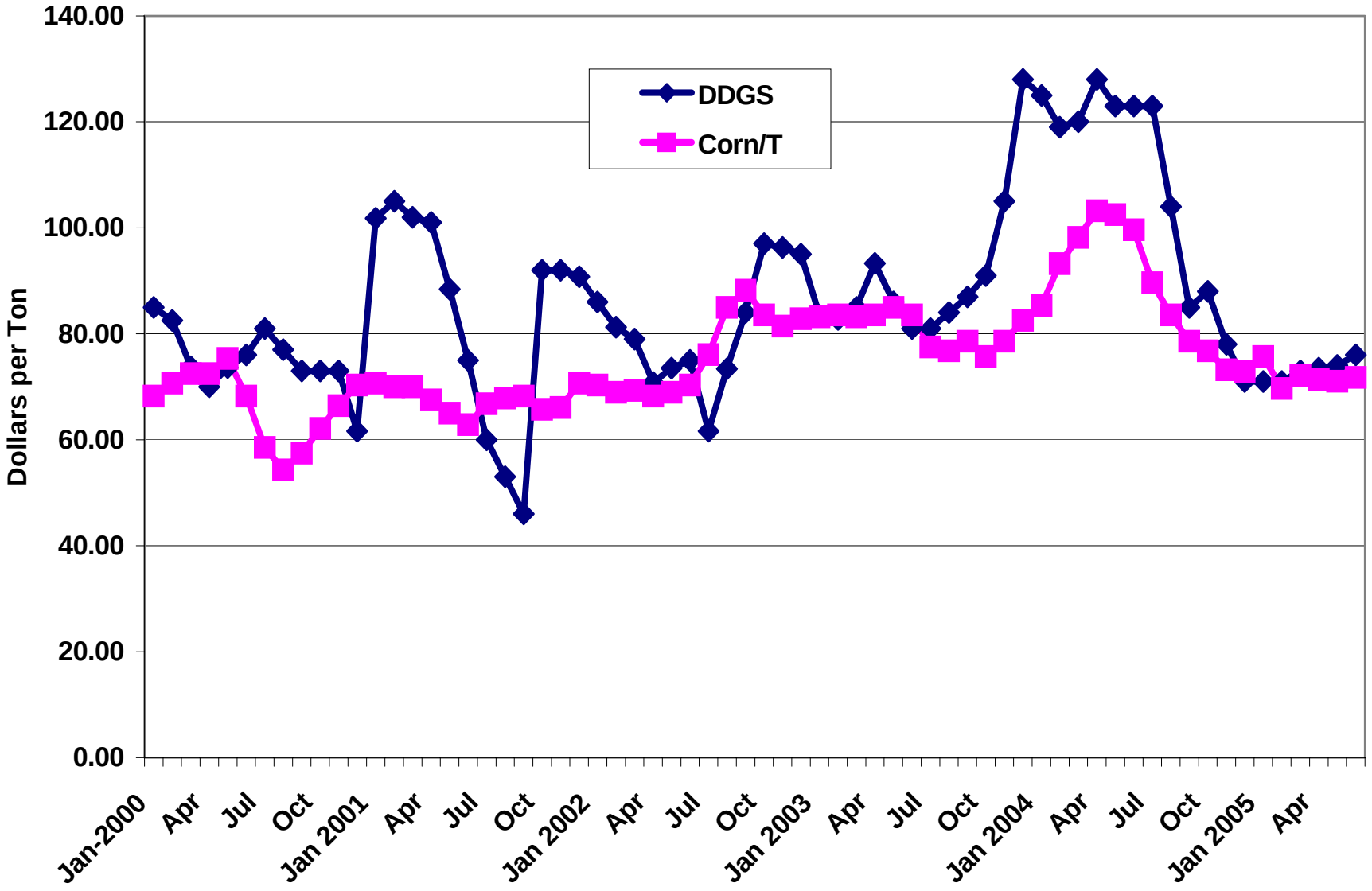
U.S. produced 3.41 and imported 0.17 . The total is up from 2.8 in 2003. Domestic production for 2005 should be close to domestic use.

Monthly Rack Ethanol & Gasoline Prices (01/02-08/05)

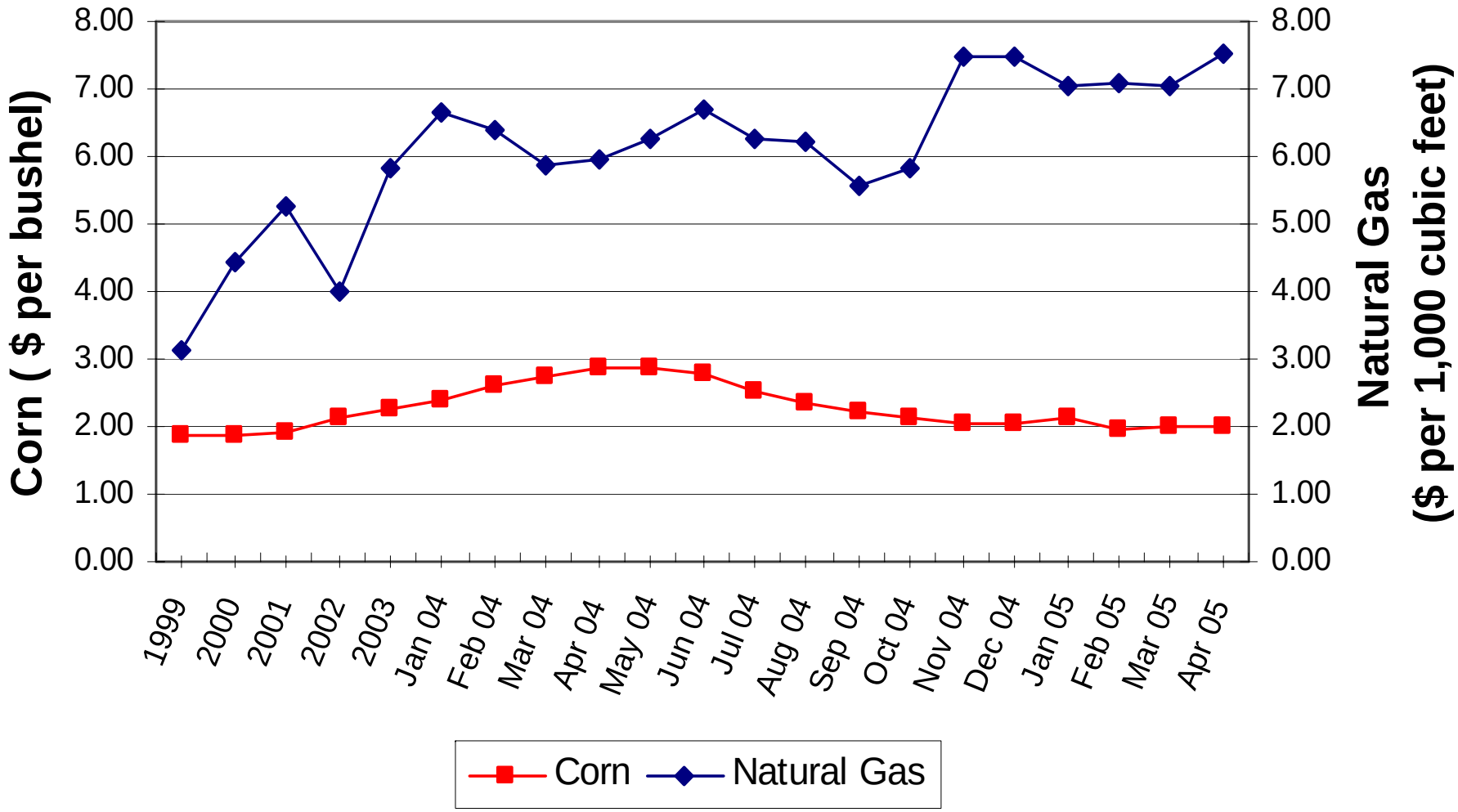
Source: Nebraska Energy and Nebraska Ethanol Board



Prices of DDGS and Corn per Ton from Jan. 2000 through June 2005



Corn and Natural Gas Prices, 1999-2005



Source: U.S Energy Information Administration, and USDA National Agricultural Services

2003 Project Goals & Methods
(Tiffany and Eidman)

- Goal: Describe and Quantify Factors of Success in Dry-Grind Ethanol Production
- Steps in Research
  - Conduct Interviews of Plant Personnel & Bankers—to Learn Factor Inputs, etc.
  - Develop Spreadsheets to Measure Plant Profits
  - Interpret Results
  - Advise Farmers/Investors, Bankers Policymakers

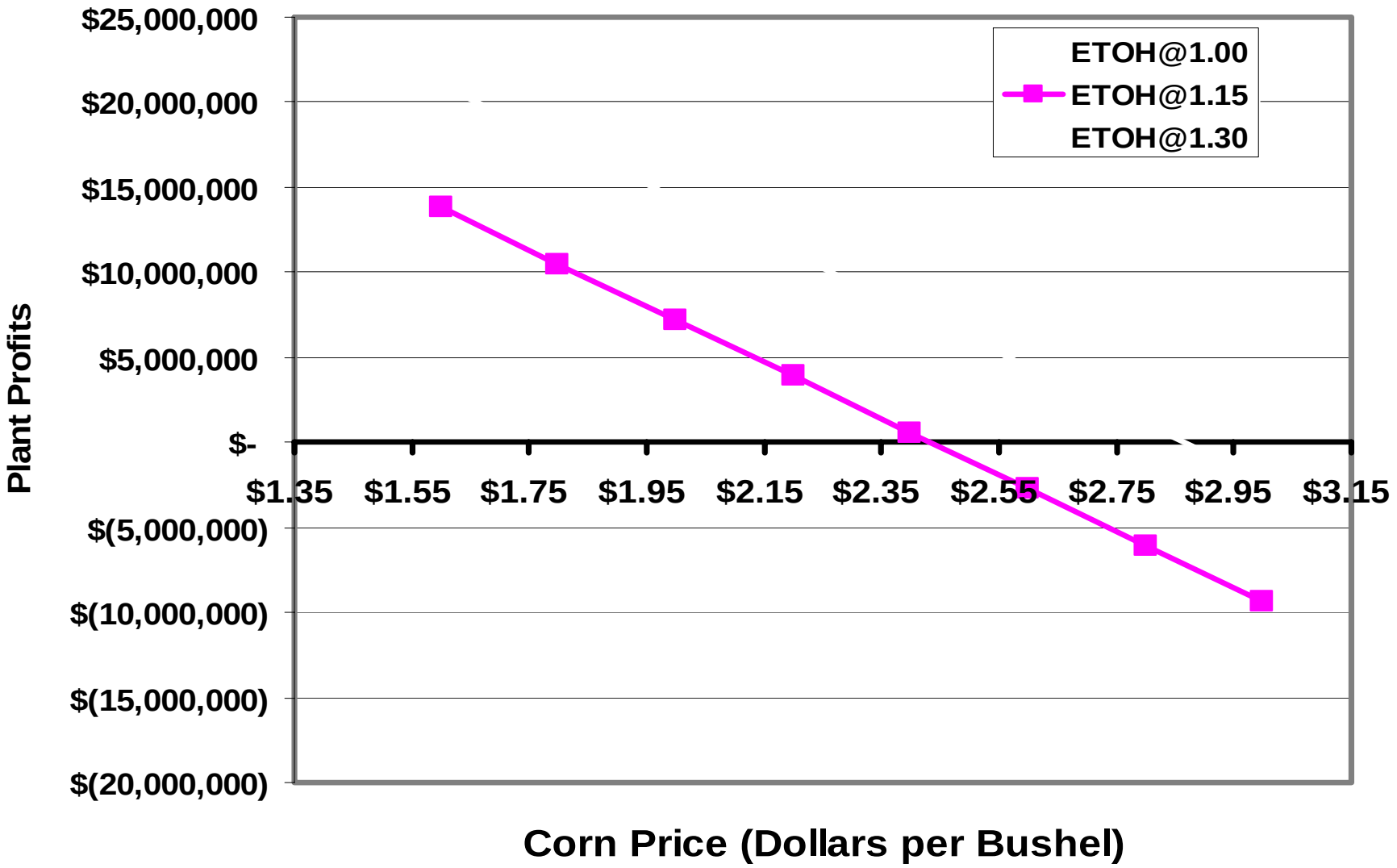
2	**Ethanol Dry Mill Spreadsheet**		by Douglas G. Tiffany, University of Minnesota				
3	7/23/03 20:30	Cost/Denat. Gal. Ethanol	Ranges for Column C				Plant Totals
4	**Nameplate Ethanol Prod. (Denat. Gal.)**	**40,000,000**					
5	**Investment per Nameplate Gallon**	**$1.5000**	$1.00- $2.00			Plant Cost	$ 60,000,000
6	**Factor of Nameplate Capacity**	**1.2000**	(80%- 150%)				
7	**Debt-Equity Assumptions**						
8	Factor of Equity	**0.40**					
9	Factor of Debt	**0.60**				Initial Debt	$ 36,000,000
10	Interest Rate Charged on Debt	**0.07**					
11	Rate of Return Reqd. by Investors on Equity	**0.12**					
12							
13	**Conversion Efficiency Assumptions**				Annual Production		
14	Anhydrous Ethanol Extracted (Gal. per Bu.)	**2.750**	2.5-2.85 gal/bu		Bushels Ground	Denat. Gallons	
15	DDGS per Bushel (lb. per Bu.)	**18**	15-22 lb./bu		**16,581,843**	**48,000,000**	
16	CO2 extracted per Bushel (lb. per Bu.)	**18**	15-22 lb./bu				
17							
18	**Establishment of Gross Margin**	Price per Unit			Revenue/Bu. Ground	Revenue/Gal. Denatured Sold	Plant Totals
19	Ethanol Price (denatured price) $/gal.	**$1.15**	$.80 to $1.60		$3.3289	1.1500	$ 55,200,000
20	DDGS Price $/T	**$80.00**	$60-$120		$0.7200	0.2487	$ 11,938,927
21	CO2 Price ($ per Ton liq. CO2)	**$6.00**	$2- $12 / liq.Ton		$0.0540	0.0187	$ 895,420
22	MN Prod. Subsidy/gal.Denat. Ethanol	**$0.00**			$0.0000	0.0000	$ -
23	Federal Small Producer Subsidy						$ -
24	CCC Bioenergy Credit						$ -
25	Revenue per Unit				$4.1029	$1.4174	**$ 68,034,347**
26	Corn Price Paid by Processor ($ per bu.)	**$2.20**	$1.70---$3.25		$2.2000	$0.7600	**$ 36,480,055**
27	Gross Margin				**$1.9029**	**$0.6574**	**$ 31,554,292**
28							

	Operating Expenses Per Bushel	Price per Unit		Cost /Bushel Ground	Cost /Gal. Denatured Sold	Plant Totals
30	Natural Gas Price ($ 1,000,000 Btu)	**$4.50**	($1.50-$9.00/Dtherm)			
31	LP (Propane) Price ($ per gallon)	**$0.70**	$.55-$.72 / gal.			
32	Factor of Time Operating on Propane	**0.02**	0-.12			
33	BTU's of Heat fr Fuel Req./ Denat. Gal.	**35,000**	28,500-55,000			
34	Combined Heating Cost			$0.4623	$0.1597	$ 7,665,569
35	Electricity Price ($ per kWh)	**$0.05**	$.025-$.090/kwh			
36	Kilowatt Hours Required per Denat.Gal.	**1.090**	(.85-1.2 kWh/denat. gal.)			
37	Electrical Cost			$0.1578	$0.0545	$ 2,616,000
38	Total BTU's of Fuel and Electricity	45,900				
39	**Total Energy Cost**			**$0.6200**	**$0.2142**	**$ 10,281,569**
40		**Cost/Denat. Gal. Ethanol**				
41	Enzymes	**$0.0480**		$0.1389	$0.0480	$ 2,304,000
42	Yeasts	**$0.0220**		$0.0637	$0.0220	$ 1,056,000
43	Other Proc.Chemicals & Antibiotics	**$0.0200**		$0.0579	$0.0200	$ 960,000
44	Boiler & Cooling Tower Chemicals	**$0.0050**		$0.0145	$0.0050	$ 240,000
45	Water	**$0.0060**	$.005-.010	$0.0174	$0.0060	$ 288,000
46	Denaturant Price per Gal.	**$0.7000**		$0.1013	$0.0350	$ 1,679,952
47	**Total Chemical Cost**			**$0.3937**	**$0.1360**	**$ 6,527,952**
48						
49	Depreciation based on C49 asset life	**15**	Years	$0.2412	$0.0833	$ 4,000,000
50	Maintenance & Repairs	**$0.0125**		$0.0362	$0.0125	$ 600,000
51	Interest Expense			$0.1520	$0.0525	$ 2,520,000
52	Labor	**$0.0450**	$.04--$.06	$0.1303	$0.0450	$ 2,160,000
53	Management & Quality Control	**$0.0136**	$.010-$.022	$0.0394	$0.0136	$ 652,800
54	Real Estate Taxes	**$0.0020**		$0.0058	$0.0020	$ 96,000
55	Licenses, Fees& Insurance	**$0.0040**	.0030-.0050	$0.0116	$0.0040	$ 192,000
56	Miscellaneous Expenses	**$0.0135**	$.01-$.03	$0.0391	$0.0135	$ 648,000
57	**Total of Other Processing Costs**			**$0.6555**	**$0.2264**	**$ 10,868,800**
58	**Total Processing Costs**			**$1.6692**	**$0.5766**	**$ 27,678,321**
59	**Net Margin Achieved Per Unit**			**$0.2337**	**$0.0807**	**$ 3,875,971**
60	**Farmer-Investor Reqd. Return on Equity**	**12.00%**		**$0.1737**	**$0.0600**	$ 2,880,000
61	**Increment of Success/Failure to Meet Required Return**			**$0.0601**	**$0.0207**	$ 995,971
62						
63	**Ethanol Plant Profits for Shareholders and Principal Reduction**			**$3,875,971**	**$3,875,971**	**$ 3,875,971**

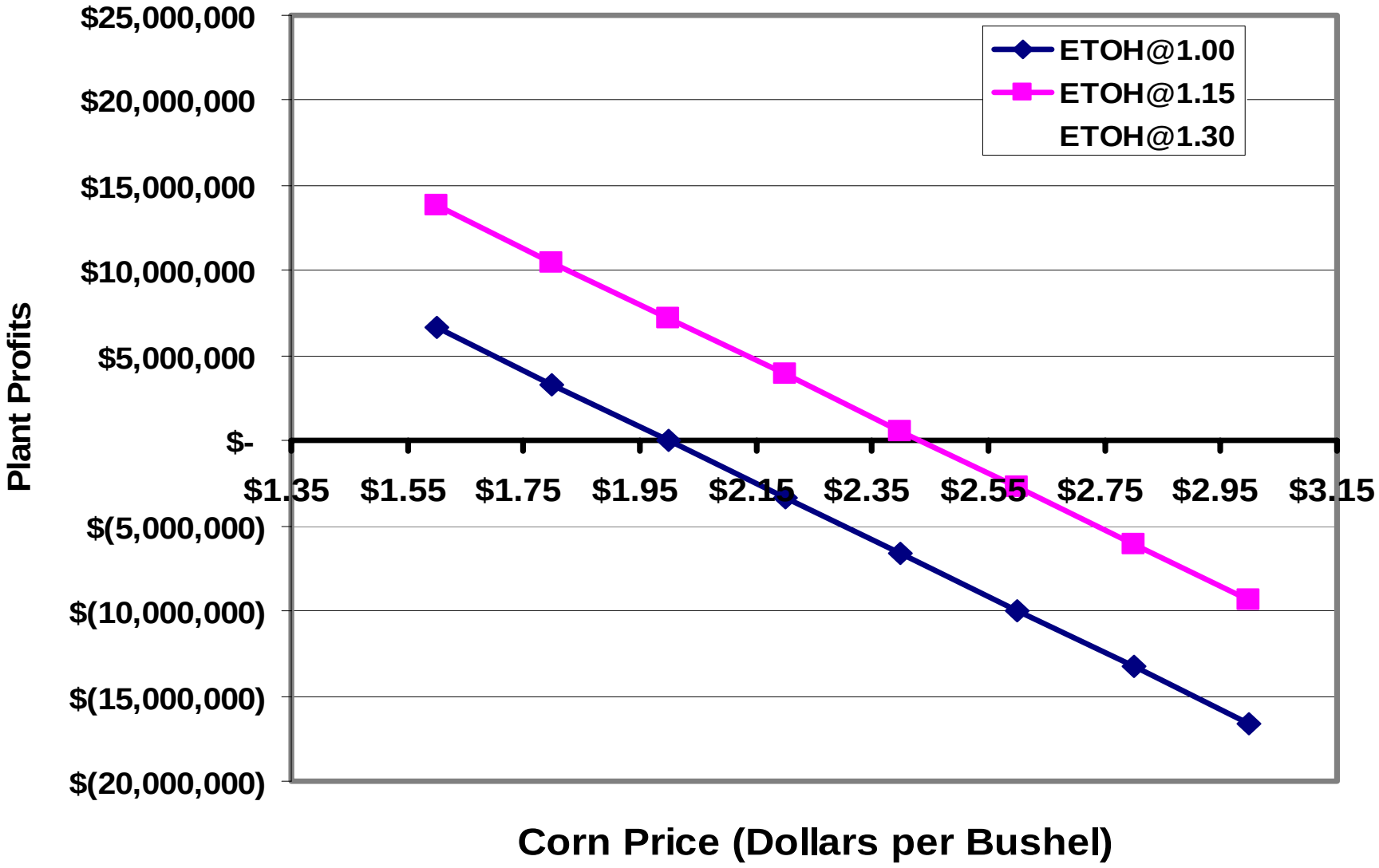
Review Ethanol Economic Sensitivity

- Key factors affecting profits
  - Ethanol price
  - Corn price
  - Natural gas price
  - DDGS prices
  - Wet vs. Dry Distillers Grains Products
- Sensitivity of individual and multiple factors

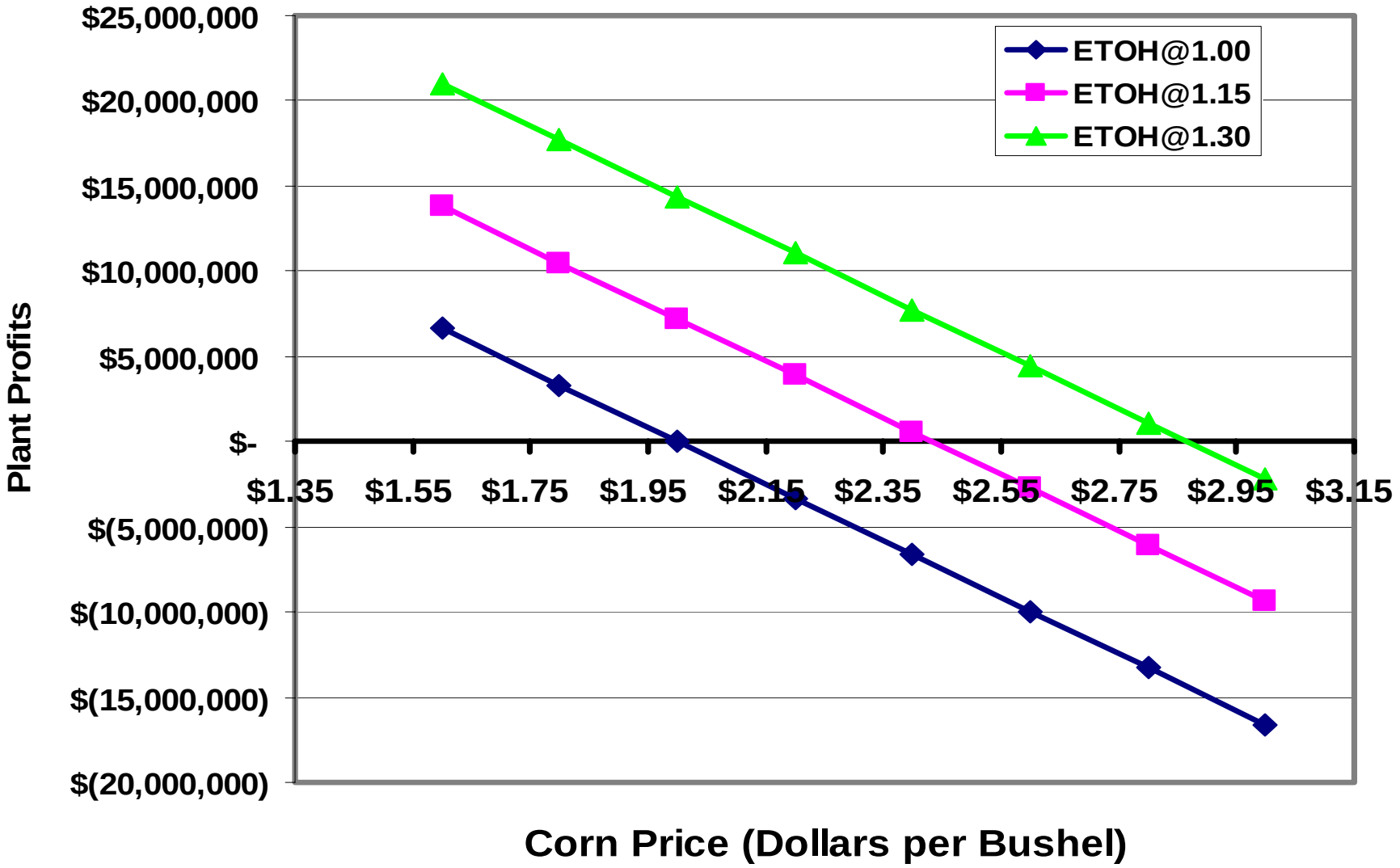
Net Margins of 40 MM Gal./Yr. Dry-Grind Plant for Corn Price-Ethanol Price Combinations



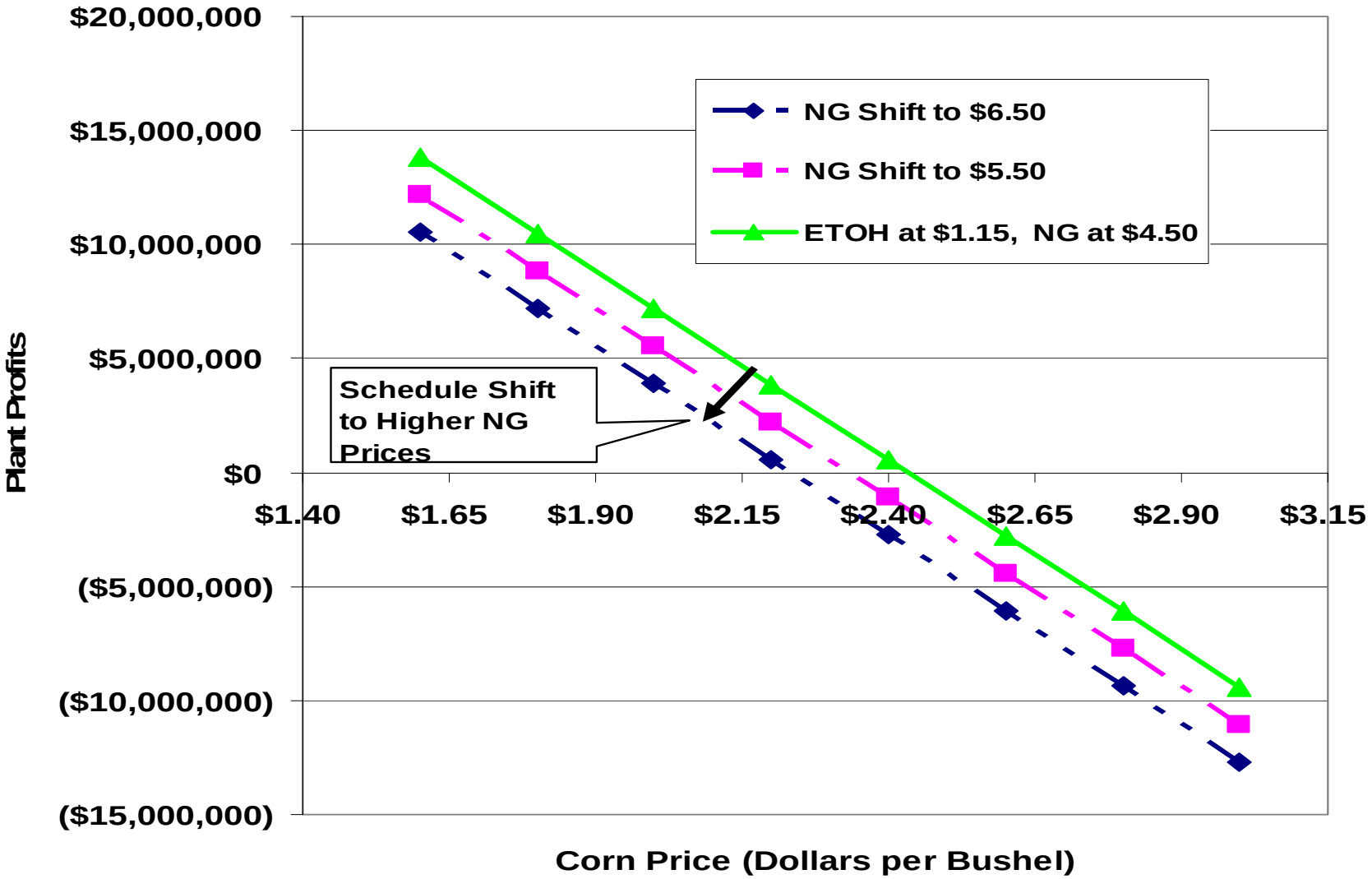
Net Margins of 40 MM Gal./Yr. Dry-Grind Plant for Corn Price-Ethanol Price Combinations



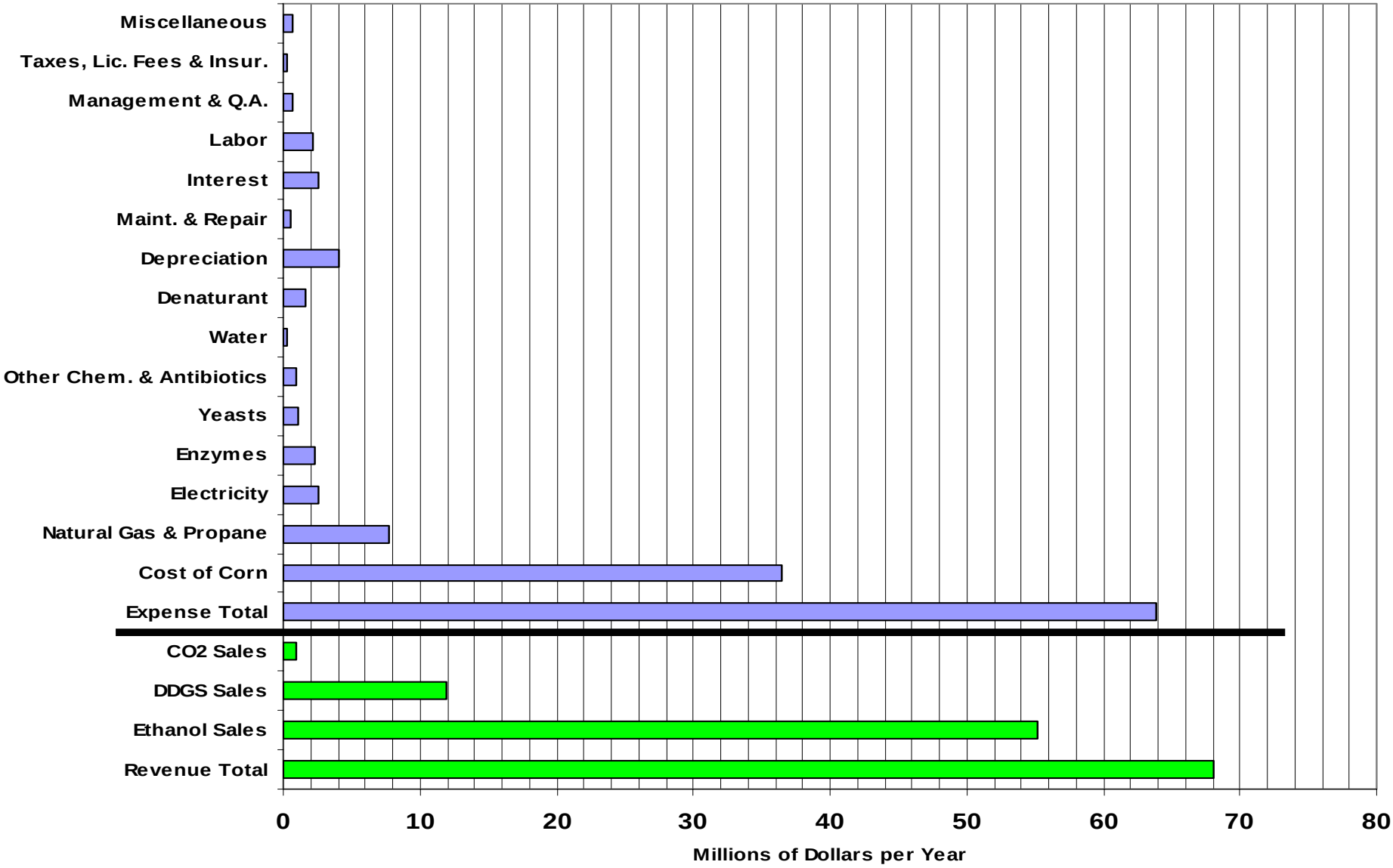
Net Margins of 40 MM Gal./Yr. Dry-Grind Plant for Corn Price-Ethanol Price Combinations



Dry-Grind Net Margins for Various Corn Prices Shift as Natural Gas Rises to $5.50 , $6.50 from $4.50 per Dekatherm; Ethanol @ $1.15/Gal.



Revenues and Expenses for 40MM Dry Mill Plant at Baseline Conditions



Typical Dry Grind Revenue Categories (5 yr.)*

- Ethanol Sales 80%
- DDGS Sales 19%
- CO2 1%
- Total 100%

Five Key Factors & Baseline Levels

- Corn Price---- $2.20 per bushel
- Ethanol Price---- $1.15 per gallon
- Nat. Gas Price----$4.50 per dekatherm
- Ethanol Yield---- 2.75 gal.(anhyd)/bushel
- Capacity Factor of Nameplate----1.20

Conclusions: Sensitivities

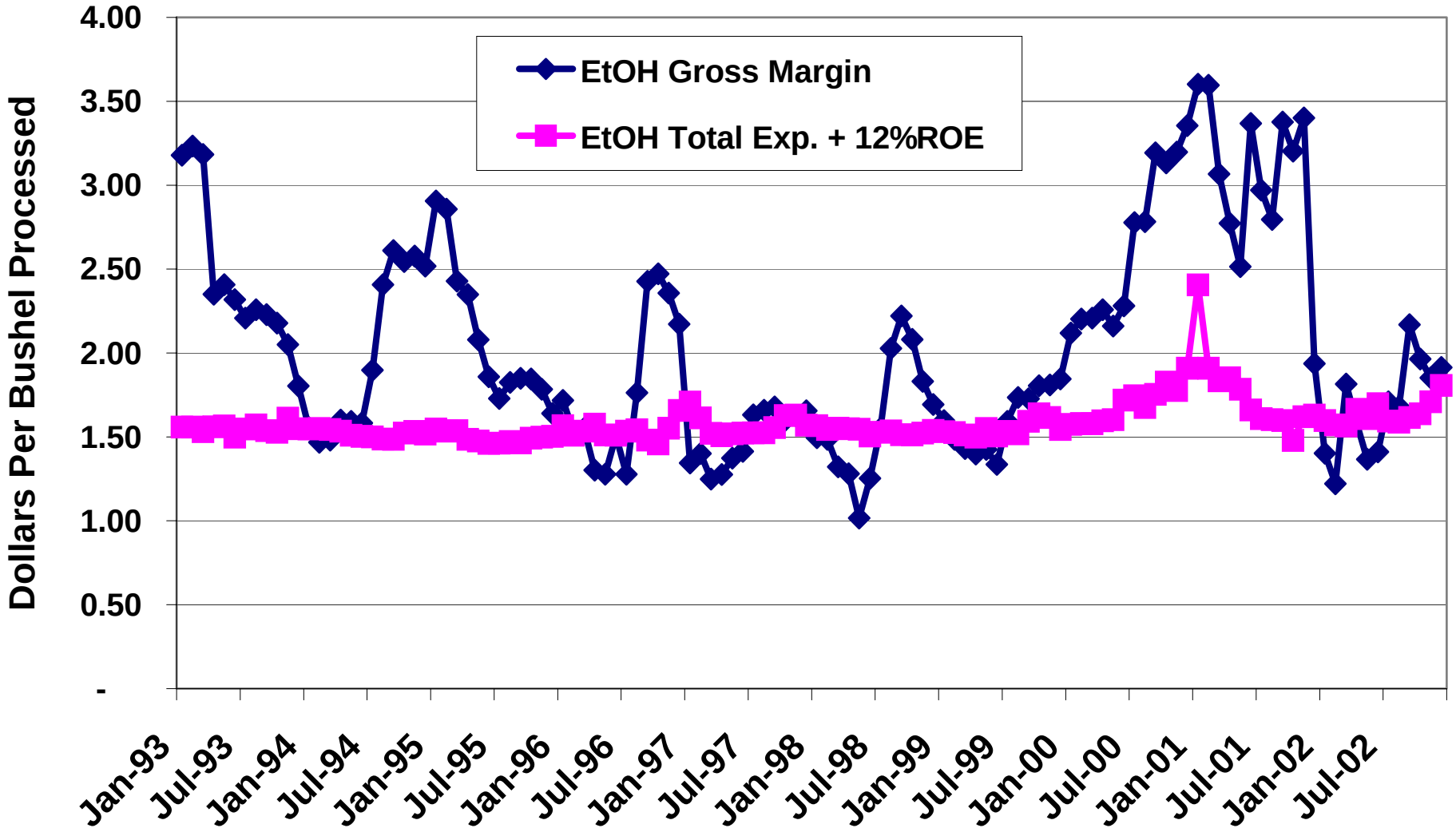
- Favorable economics with low corn prices, high gasoline prices, low natural gas prices, low interest rates.
- From Baseline Conditions:

  -Corn Price--- Zero profits above $2.43 per bu.

  -Ethanol Price--- @$1.15--- profits of $.15/ bu.,
  @$1.35--- profits of $.56/ bu.

  -Natural Gas Price rise to ($6.85) from baseline levels of $4.50/ dekatherm wipes-out profits.
- Ethanol Yield per Bushel —very important
  - 2.75 gal./bu (typical today)
  - 2.36 gal./bu--- wipes out profits at baseline

Retrospective Ethanol Gross Margins, Operating Expenses plus 12% ROE of 40MM Dry Mill Plant from 1/93-12/02



Fractionation for Dry-Mills

- Quick-Germ Technology– uses more enzymes, depends on favorable sale of corn oil (Univ. of Illinois)
- Quick-Fiber Technology—offers opportunity for greater through-put, but altered DDGS product characteristics (Univ. of Illinois)
- Others--- Some more mechanical, others more enzymatic in separation
  - Frazier, Barnes
  - FWS
  - GrainValue
  - Etc.

Utilization of DDGS as Fuel

(Morey, Tiffany, Hatfield)

Est. Annual Energy Cost/Savings for 40 MM Gal. Ethanol Plant ($MM)

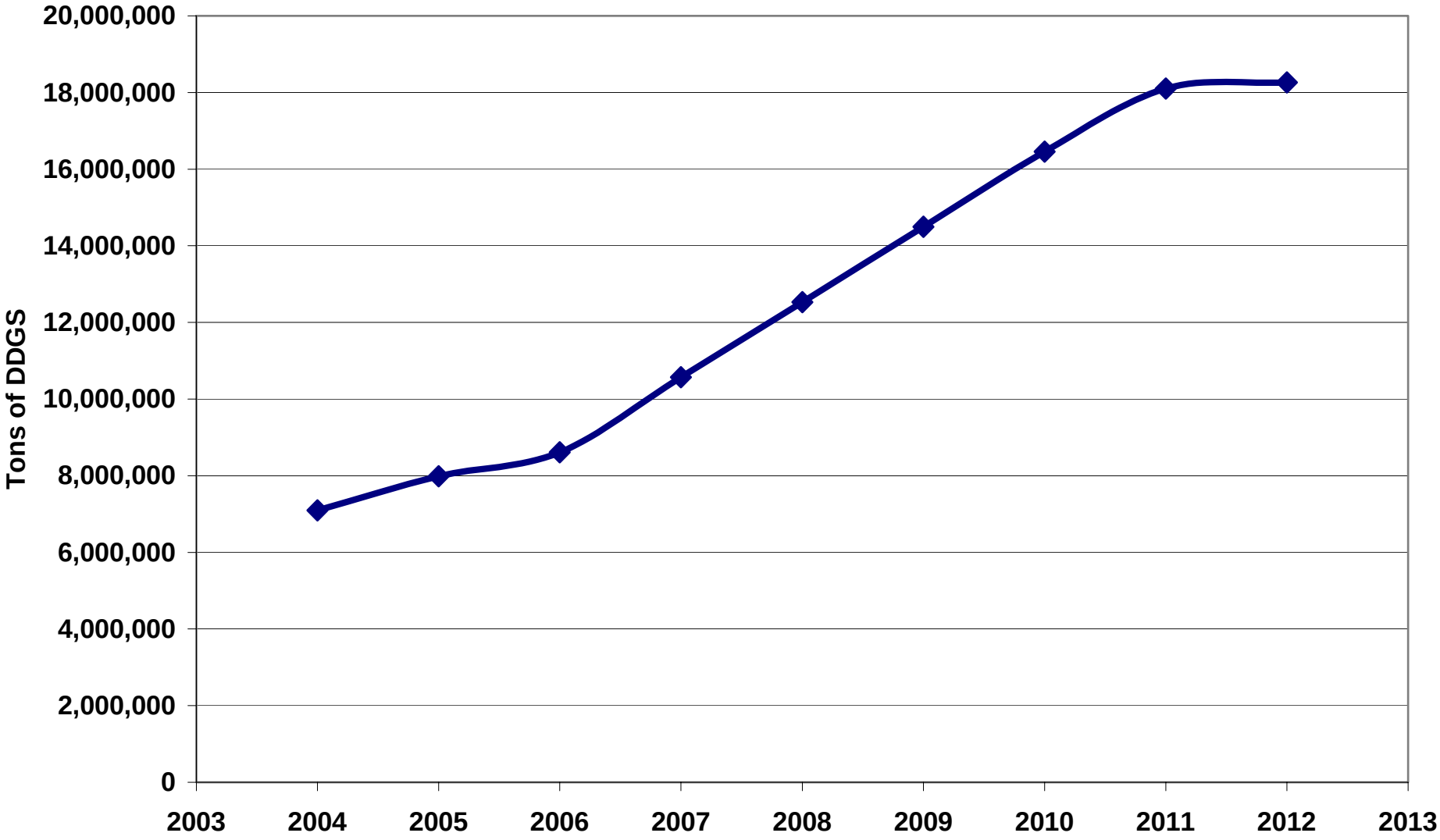
DDGS @ $73 per ton

Natural Gas Price ($/MM Btu)	Proc. Heat	CHP	CHP $.03/ KWH	CHP $.045/KWH
$5.28	1.7	3.1	5.0	6.9
$6.33	3.3	4.8	6.6	8.6
$7.39	4.9	6.4	8.2	10.2
$8.44	6.5	8.0	9.9	11.8
$9.50	8.2	9.6	11.5	13.4

Current Firm Responses

- Ethanol Plants replacing NG with Coal
- Ethanol Plants replacing NG with DDGS and other Biomass
- DDGS are produced at dry-grind ethanol plants in amounts sufficient to provide process heat, electricity in co-generation, and electricity to sell on grid.
- Ethanol Plants switching from DDGS to WDGS

Projected DDGS Available in U.S. for Feeding or Burning 2004-2012, Assuming Steady Exports



Implications of Greater Supplies of Distillers Byproducts

- Need improvements in DDGS attributes

  - Standardize DDGS grades based on nutrient content, amino acid digestibility, particle size and bulk density.

  - Improve flowability to reduce caking
- Greater utilization of WDDG by Beef and Dairy
- Utilization of DDGS as biomass fuel in the plant
  - Can provide process heat, on-site electricity, electricity to sell
  - Remarkable to have biomass fuel arrive at plant in proportion to requirements
- Fractionation technologies enhance economics by
  - Increasing throughput
  - Decreasing process heat and enzyme costs
  - Improving portfolio of products

Ethanol Summary

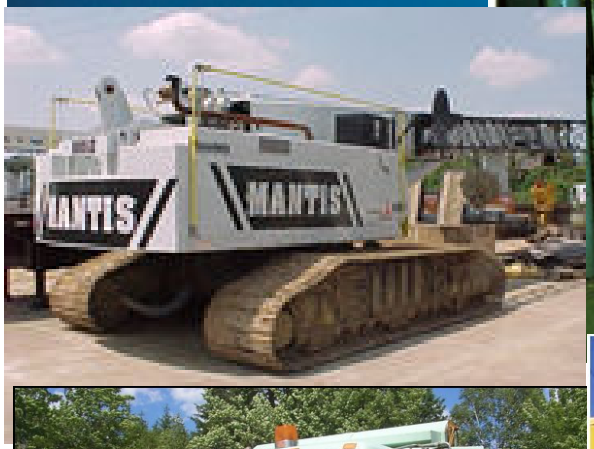
- Ethanol production has been profitable, but it will soon face disruption of traditional markets as oxygenate in mandated markets.
- Usage of ethanol by petroleum marketers is hindered by
  - Technical issues at refineries in removing more volatile fractions
  - Inability to utilize pipelines to transport ethnaol
- Ethanol Markets will witness

  - increased use of ethanol as a fuel extender

  -increased use of ethanol as an octane booster

  - the closing of older and smaller ethanol plants
- Ethanol plants are
  - turning to coal and biomass in response to high NG Prices
  - seeking more opportunities to feed WDDG products
  - Investigating fractionation technologies to increase capacity, diversity their portfolio of byproducts, and segregate less valuable fractions for use as fuel.

Markets for Biodiesel



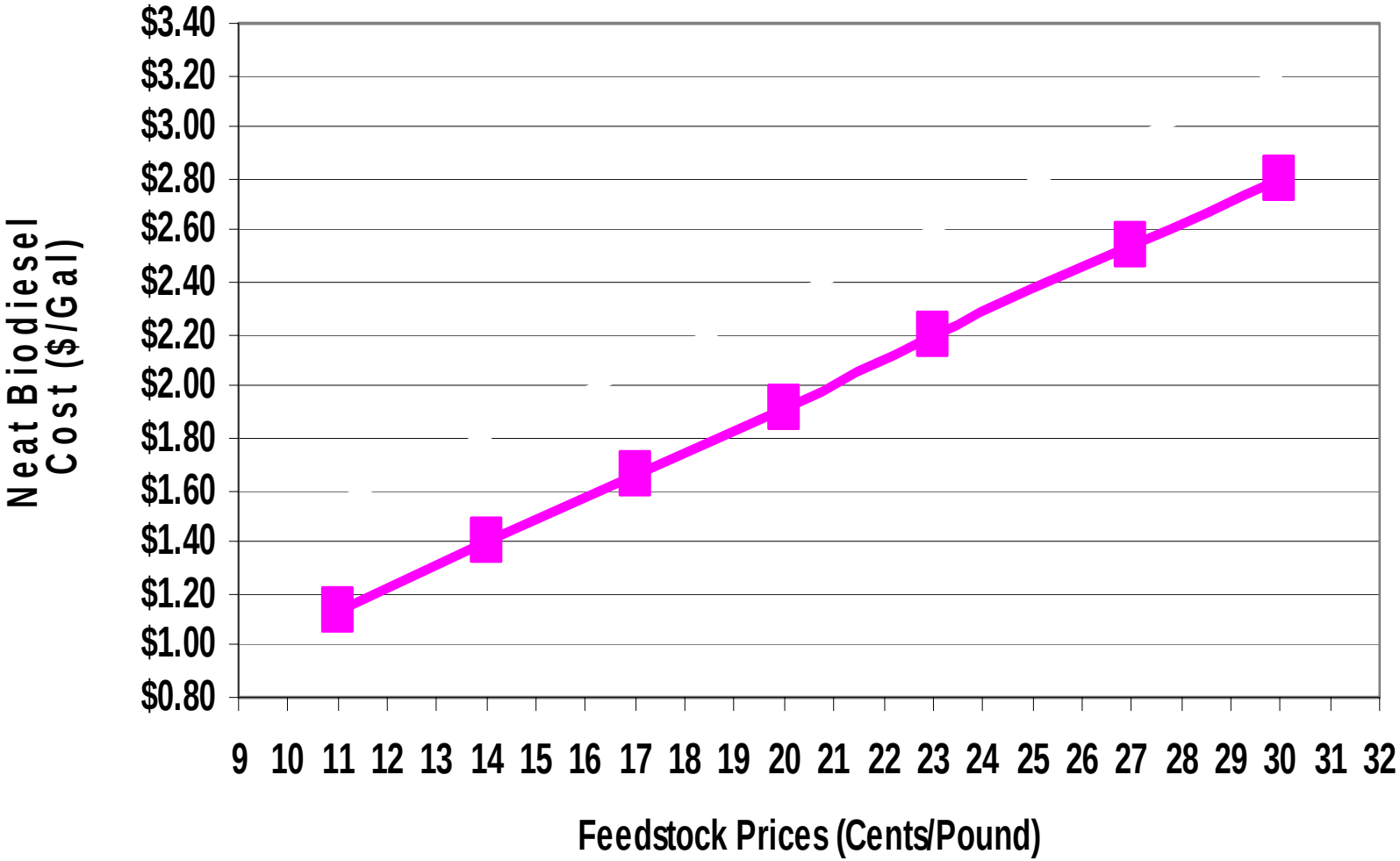
Biodiesel Economic Sensitivity

- Smaller Market than Ethanol
- Diesel Usage in the U.S. – approx. 1/3 of Gasoline
- MN Per Capita Usage
  - 500 gal. of Gasoline, 160 gal. of Diesel
- Biodiesel has been more Costly than Petro-Diesel
- Excellent Fuel w/low Emissions; Usually Blended
- Low Blends Enhance Lubricity in Low-sulfur Diesel Fuel
- U.S. Production Levels of Biodiesel at 30 MM gal. in 2005 vs 450 MM gal. in Europe
- Niche Markets to Reduce Emissions—mines, buses

Production Economics of Biodiesel

- Highly dependent on cost of feedstock, whether vegetable oils such as rapeseed oil, soybean oil, sunflower oil, yellow grease, or animal fats.
- Haas, et al. estimate soy oil is 86% of cost
- Other ingredients used---
  - methanol (made from Natural Gas)
  - Catalysts such as KOH and NaOH
- Crude glycerol is a by-product

Biodiesel Costs from 10 Million Gallon Plant
Feedstock Prices & 15% ROR (Tyson, NREL)



Potential Biodiesel Production:

- If all U.S. fat and oil feedstocks were processed for biodiesel 13.3% of U.S. diesel supply could be replaced.--- (Duffield et al.)
- Minnesota could produce 47% of its diesel requirement if all soybeans produced in the state were crushed and the oil used for biodiesel.

U.S. Feedstocks for Biodiesel
(Eidman)

- Vegetable Sources

• Soy Oil	18,309 MM lb	2,378 MM gal.
• Corn Oil	2,436 MM lb	316 MM gal.
• Oth. Crop	1,691 MM lb	271 MM gal.
• Subtotal	22,436 MM lb.	2,965 MM gal.

U.S. Biodiesel Feedstocks (cont.)

- Recycled and Animal Sources

• Yellow Grease	2,656 MM lb.	345 MM gal.
• Lard	1,090 MM lb	142 MM gal.
• Edible Tallow	1,894 MM lb	246 MM gal.
• Inedible Tallow	3,696 MM lb.	480 MM gal.
• Subtotal	9,336 MM lb.	1,213 MM gal.
• Total Supply	32,173 MM lb.	4,178 MM gal.

Near Term Biodiesel Supplies

Source: (NREL)

Feedstock	Mil lbs	Mil gal	Percent
Soy	4,572	594	34
Brown grease	3,808	495	28
Inedible Tallow & Yellow grease	3,348	435	25
Corn	1,209	157	9
Everything else	684	89	5
Total	13,793	1,770	100

On-road Diesel Demand (mil gal/yr)	32,062
Biodiesel supplies as a % Diesel Demand	5.6%

Projected Production Costs for Diesel Fuel by Feedstock, 2004-2013 (2002 Dollars/Gal) (EIA)

Marketing Year	Soybean Oil	Yellow Grease	Petroleum	Soybean Oil with Credit	Yellow Grease with Credit
2004/05	2.54	1.41	0.67	1.54	0.91
2005/06	2.49	1.39	0.78	1.49	0.89
2006/07	2.47	1.38	0.77	1.47	0.88
2007/08	2.44	1.37	0.78	1.44	0.87
2008/09	2.52	1.40	0.78	1.52	0.90
2009/10	2.57	1.42	0.75	1.57	0.92
2010/11	2.67	1.47	0.76	1.67	0.97
2011/12	2.73	1.51	0.76	1.73	1.01
2012/13	2.80	1.55	0.75	1.80	1.05
Means	**2.58**	**1.43**	**0.76**	1.58	0.93

U.S. Biodiesel Market: How Big? How Fast?

- 30 Million Gal. of B100 sold in U.S. 2004 with support from Bioenergy Credit.
- On Sept. 29, Minnesota Biodiesel Mandate starts.
- In mid-2006 “lubricity” market kicks-in.
  - 1% blend would require 470 MM gal. in 2010
  - 1% 630 MM gal. in 2020

Conclusions: Biodiesel

- Biodiesel Production in the U.S. has been slow compared to Europe.
- Capacity is apparently in place for considerable production; however, infrastructure to blend may be lacking.
- Biodiesel Tax Credit Should keep biodiesel price nearly equal to petro-diesel
- Niche markets will be important, such as school transit buses, and heating oil
- National market will be to serve as lubricity agent in Ultra Low Sulfur Diesel Fuel
- Lacking Biodiesel Tax Credit, yellow grease will be competitive with Soy Oil
- Tallow and Lard may be bid away from uses in feeding, which have been diminishing due to BSE and other animal health issues.

If my projections are wrong, check with my Complaint Department next year at this meeting.

Contact Information

- dtiffany@dept.agecon.umn.edu
  (612) 625-6715

- Ethanol Spreadsheet:
  http://www.agmrc.org/energy/info/ethanolsuccess.xls

- Staff Paper:

  http://www.apec.umn.edu/staff/dtiffany/staffpaper03-7rev.pdf

  "Agriculture as Producer and Consumer of Energy," (Farm Foundation) book chapter by Vernon Eidman