

Fractionation, Feed Ingredient Allocation, and Environmental Balance of Corn to Ethanol

Fuel Ethanol Workshop

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Updated for IGQI Advisory Committee

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Corn Composition

	Starch	Protein	Oil	Ash	Sugar	Fiber	Total	% Total
Whole Corn	73.4	9.1	4.4	1.4	1.9	9.8	100	100
Endosperm	87.6	8.0	0.8	0.3	0.6	2.7	100	82.9
Germ	8.3	18.4	33.2	10.5	10.8	18.8	100	11.0
Bran	7.3	3.7	1.0	0.8	0.3	86.9	100	6.1

Why

Fractionate?

- ✓ Improved fermenter efficiency
- ✓ Reduced energy usage
- ✓ Reduced water usage
- ✓ Diversified product stream (? +/-)
- ✓ **Policy justification/more EtOh**

Percentage of Total Nutrients in Corn Fractions

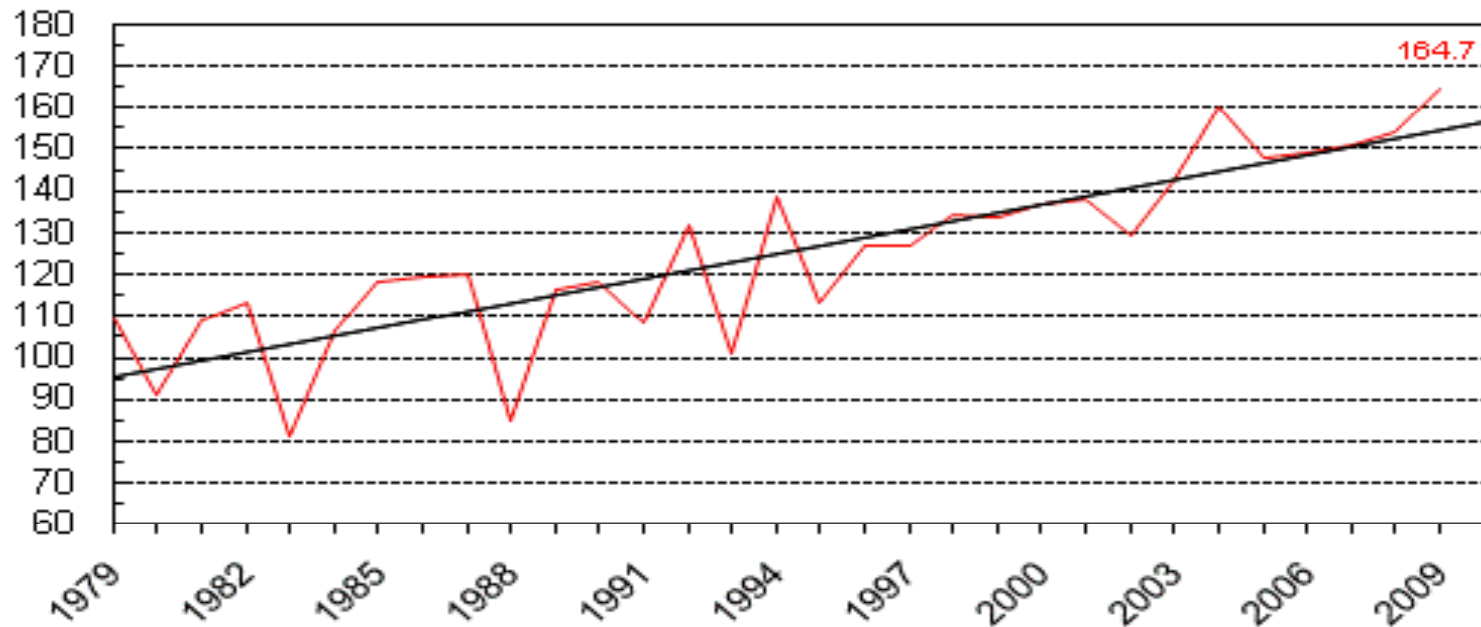
	Endosperm	Germ	Bran
Starch	99	1	1
Protein	73	22	2
Oil	15	83	1
Ash	18	83	3
Sugar	26	63	1
Fiber	23	21	54
Lysine	47	32	21
Lysine % product	0.18	0.90	
Lysine % protein	2.2	4.9	



U.S. Corn Yield



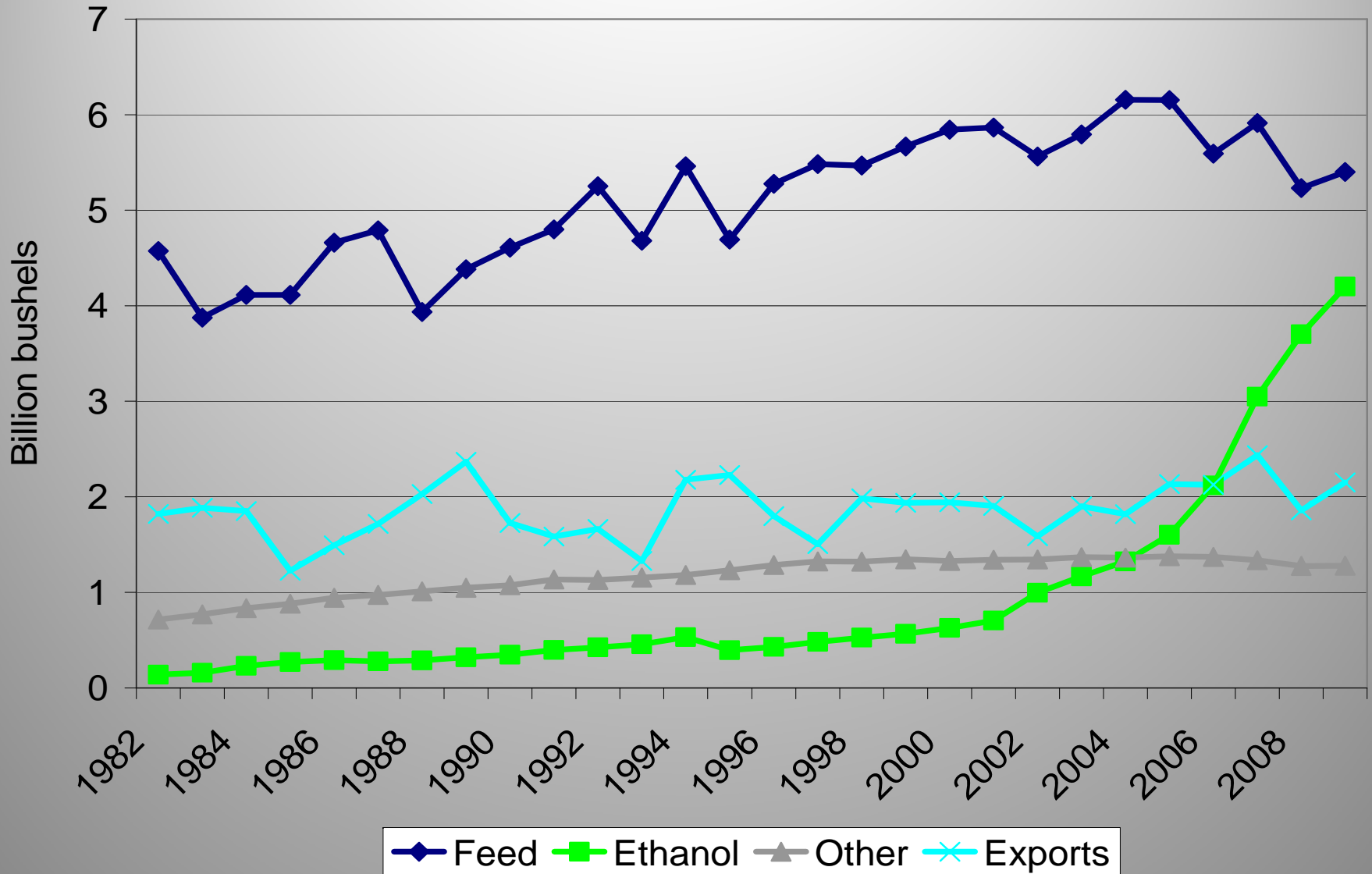
Bushels/Acre



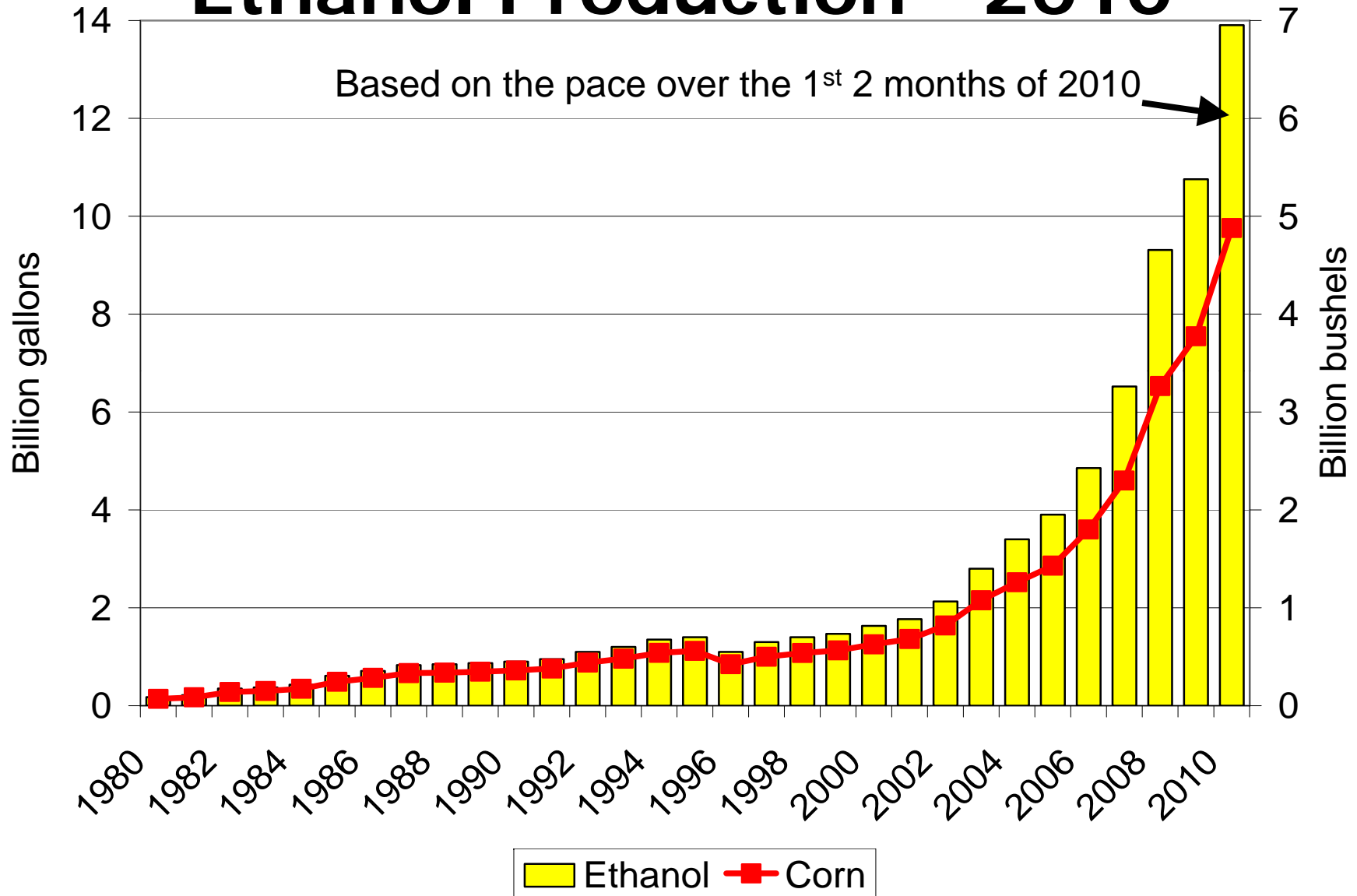
USDA NASS
5-11-10

**Overall = 2.1 bu/a/yr; Last 10 = 3.5 bu/a/yr; Seed industry = 4-6 bu/a/yr (forward)
~400-500 million bu/year increase
Nitrogen use: 1.0-1.1 lb/bu down to 0.7 lb/bu**

Corn Use



Ethanol Production - 2010



Iowa Ethanol Production and Corn Usage

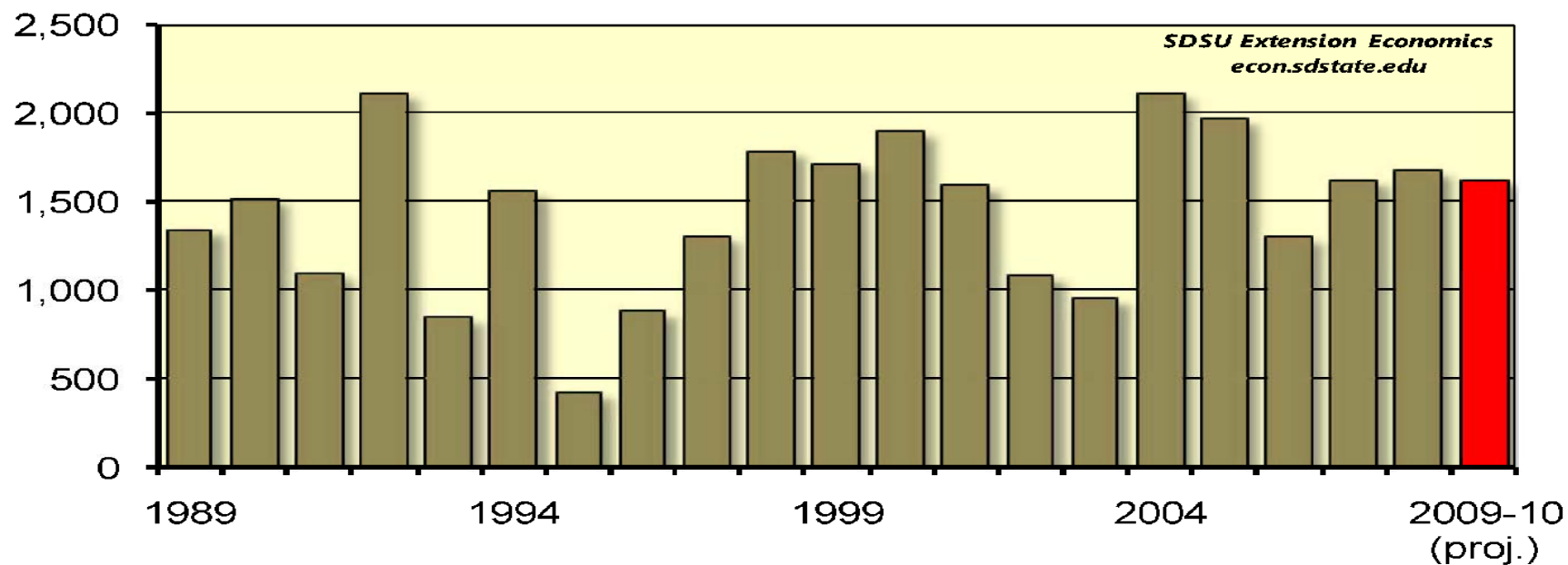
<i>Summary Statistics May-2010</i>	<i>n</i>	<i>Ethanol Produced mil gal/yr</i>	<i>Corn Used mil bu/yr</i>	<i>DGS 000 tons/yr</i>
<i>Current Dry-grind Plants</i>	<i>34</i>	<i>3,280</i>	<i>1170</i>	<i>10,237</i>
<i>Expansions and new construction</i>	<i>1</i>	<i>277</i>	<i>98</i>	<i>857</i>
<i>Wet Mills</i>	<i>4</i>	<i>500</i>	<i>178</i>	<i>1,557</i>
<i>Nearby Iowa</i>	<i>11</i>	<i>636</i>	<i>227</i>	<i>1,986</i>
<i>Total</i>	<i>50</i>	<i>4,693</i>	<i>1,673 (69% of 2009)</i>	<i>14,637</i>

Are We Running Out of Corn?



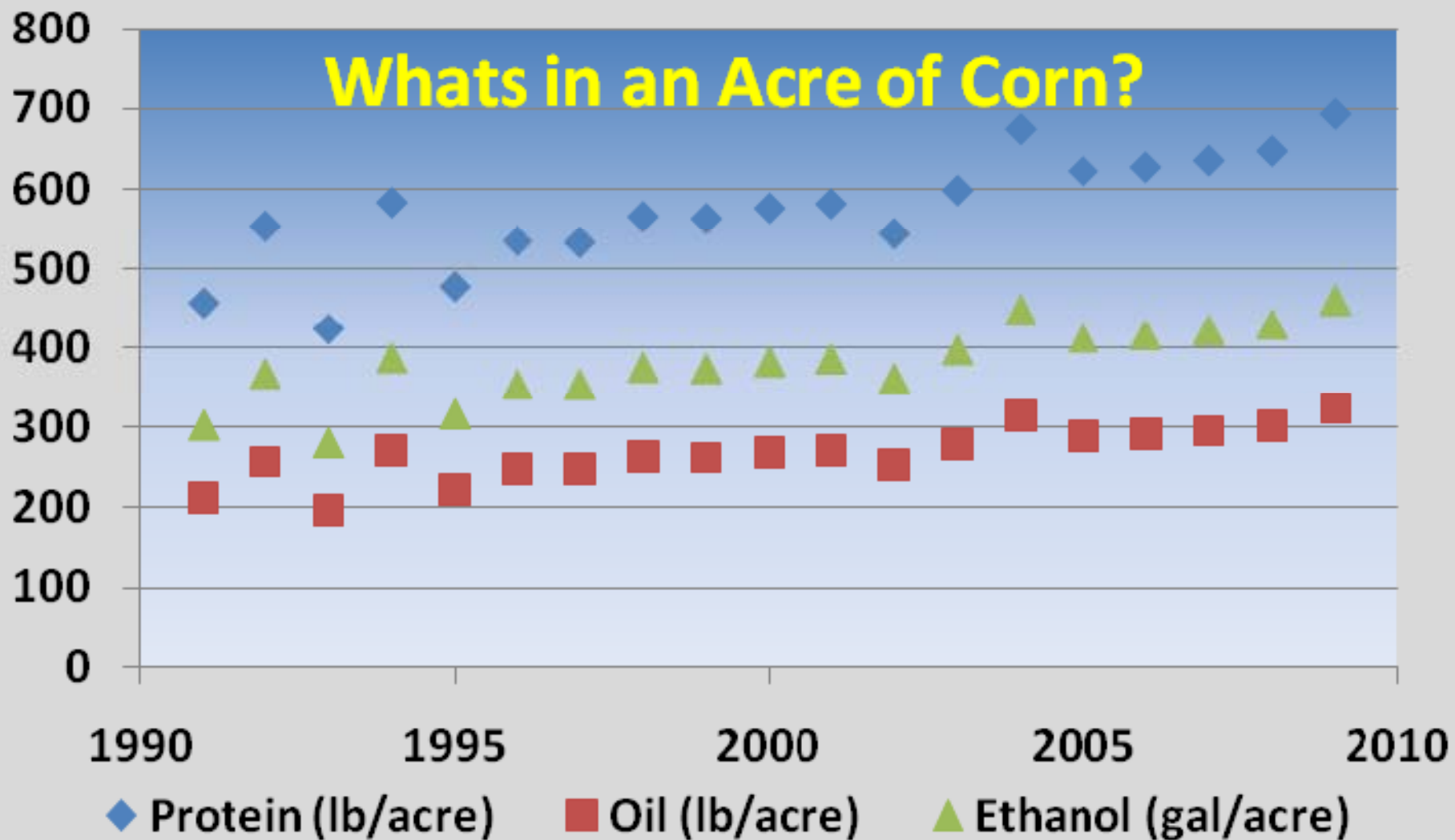
South Dakota
Cooperative Extension Service

U.S. Corn Ending Stocks (million bushels)

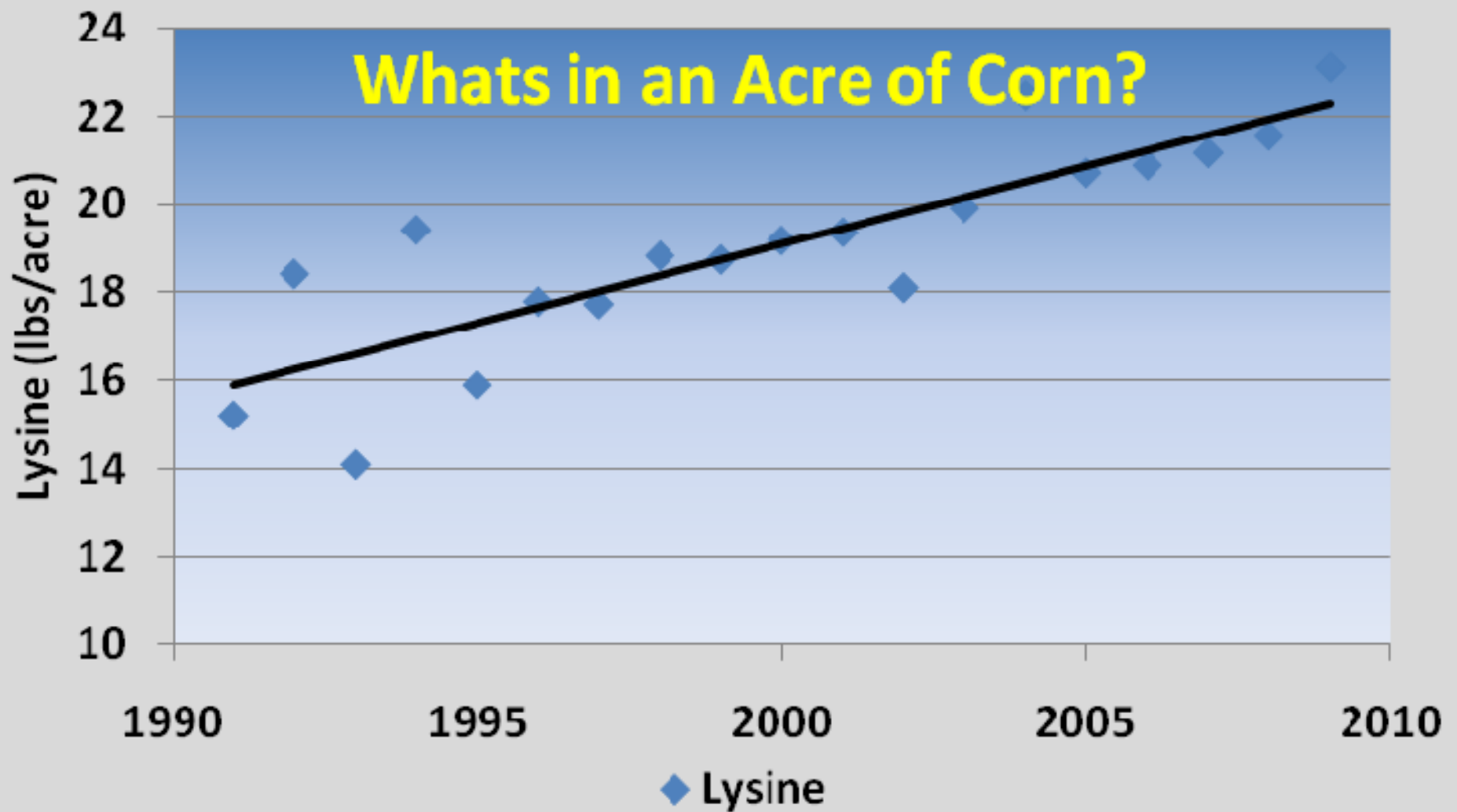


Sources: USDA - National Ag Statistics Service and Economic Research Service


Whats in an Acre of Corn?



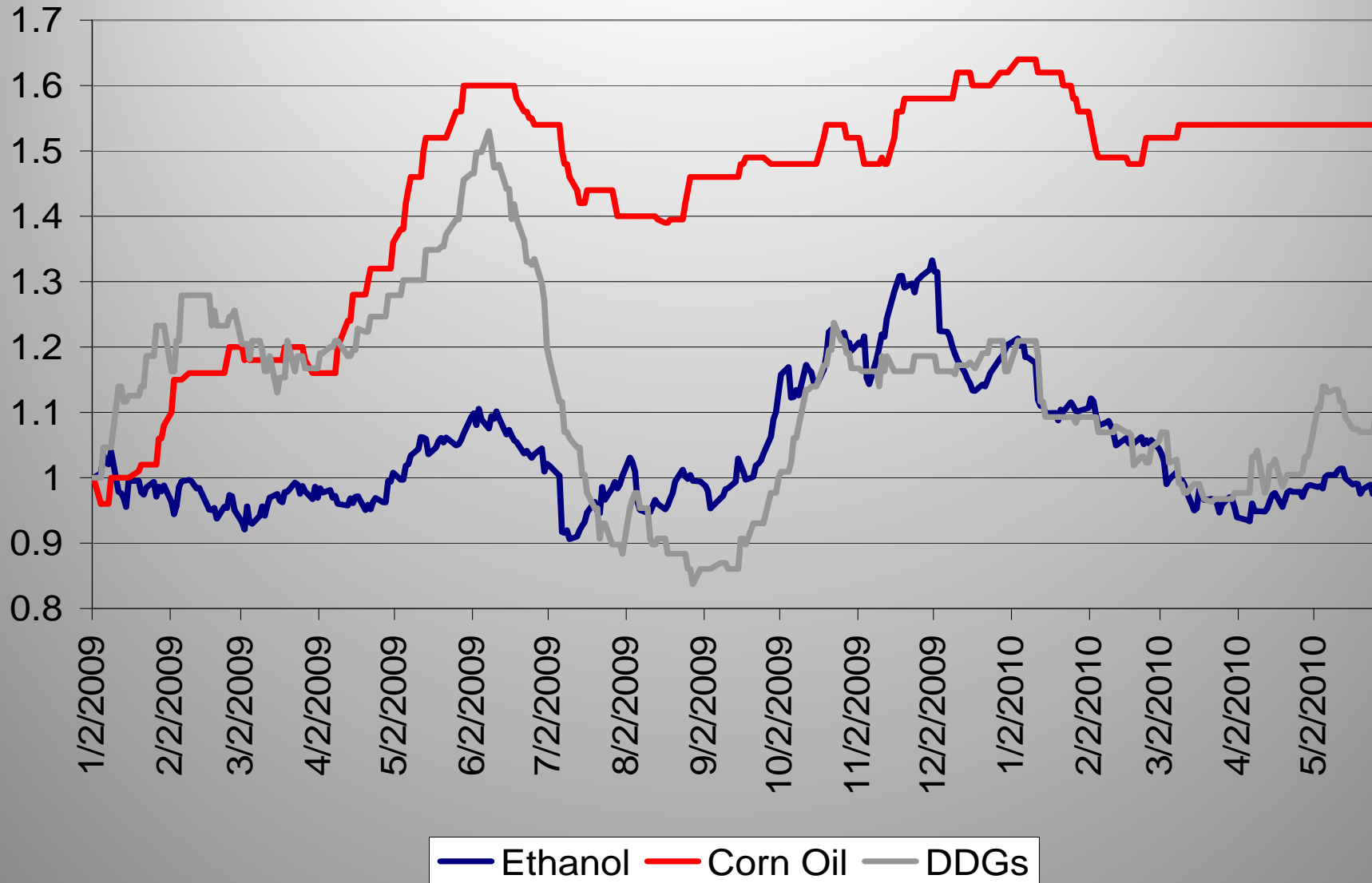
Whats in an Acre of Corn?



Typical Fractionation Products

- Ethanol (less); 2%  =0.06 gal/bu
- DDGS @42-47% protein; lower quality but more digestible (IL, SD studies)
- Bran
- Oil; ~1.4 lb/bu @ 80% extraction of germs (up to 0.6 -0.7 bgy of biodiesel @ 80% conversion on 4 bln bu of corn)

Relative Prices (Jan. 2009 = 1)



Drying Costs

- EPA estimates (2007): 32,300 BTU/gal
- Equates to 2636 BTU/lb of water
 - 70% moisture DDGS dried to 12%

Impact of Fractionation

Lb DDGS/ bu	BTU/bu	% of Ethanol
17.8	90440	43%
13.5	68785	33%

Capital Costs

- Range from \$10 million to \$40 million for a 50 million gallon ethanol plant
- The inclusion of corn oil extraction technologies moves costs to the higher end of the spectrum
- Most vendors point to a payback period of under 3 years

Variable Costs

- Decreased energy needs per gallon for:
 - Liquidification and cooking
 - Distillation
 - Drying of distillers grains and solubles
- Possible energy generation from bran
- Could reduce energy demand by nearly 50%

Product Streams - Example

Corn costs: \$3.48 per bushel, Illinois ethanol plant report
(USDA-AMS, as of May 28, 2010)

Traditional ethanol plant:

2.8 gallons of ethanol @ \$1.58/gallon	= \$4.42
17.75 lbs. of DDGS @ \$116.71/ton	= <u>\$1.04</u>
Revenues per bushel	= \$5.46

Ethanol plant w/ fractionation:

2.72 gallons of ethanol @ \$1.58/gallon	= \$4.30
13.5 lbs. of high protein DG @ \$127/ton	= \$0.86
5 lbs. of germ @ \$148/ton	= \$0.37
3 lbs. of bran @ \$65/ton	= <u>\$0.10</u>
Revenues per bushel	= \$5.63

Summary

- Fractionation:
 - Improves energy efficiency and water use
 - Creates more and different products
 - Strengthens justification for corn to ethanol
 - Makes more material available to monogastric animals (swine, poultry, people)
- Need
 - Update of policy information; complete system
 - Analytics and feed formulation
 - Marketing strategies; cost analysis
 - Financing justification

Cooperation with fractionation companies

3-4 companies have offered to work with us to help us analyze and describe the possible co-products from a dry-grind ethanol plant that incorporates front-end fractionation. It will also describe efficiencies gained (or lost) by incorporating fractionation and changes in GHG generation.

A recent discussion with engineers from one of the companies raised the following questions:

- Will fractionation help reduce the sulfur content in distillers grains?
- Will fractionation help reduce phosphorus levels in distillers grains?
- In what fractions would mycotoxins be accumulated?
- Can fractionation help reduce the need for antibiotics in the fermenters?

This company's justification for adding fractionation greatly depends on the value of food-grade oil. We propose to assume that oil will be fuel-grade and focus more on the value of the nutrients in the various fractions.

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