

Current technologies and status of grain-based biofuels

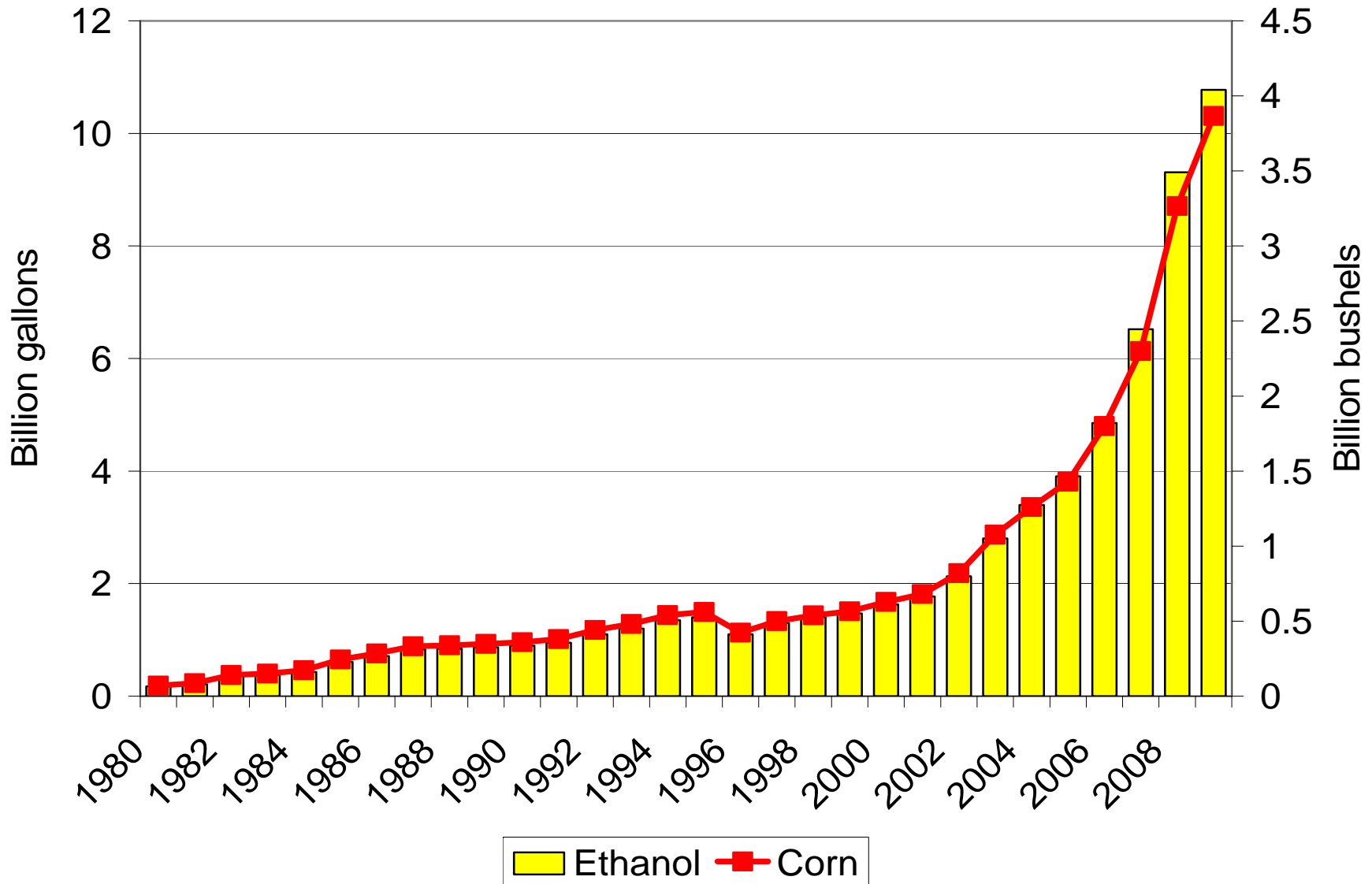
***Growing the Bioeconomy
Iowa State University
Ames, IA
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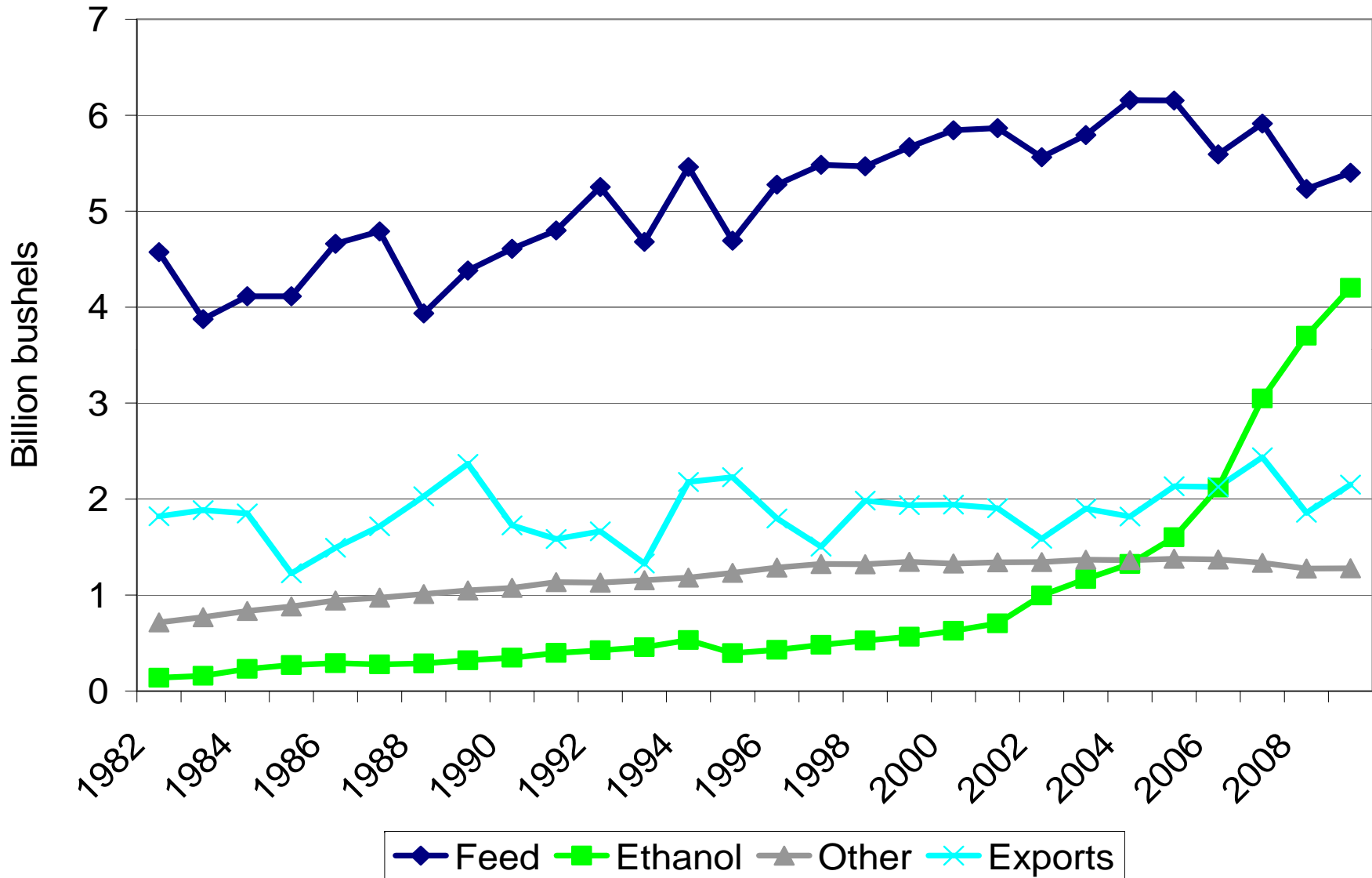
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Ethanol Production & Corn Use



Corn Use

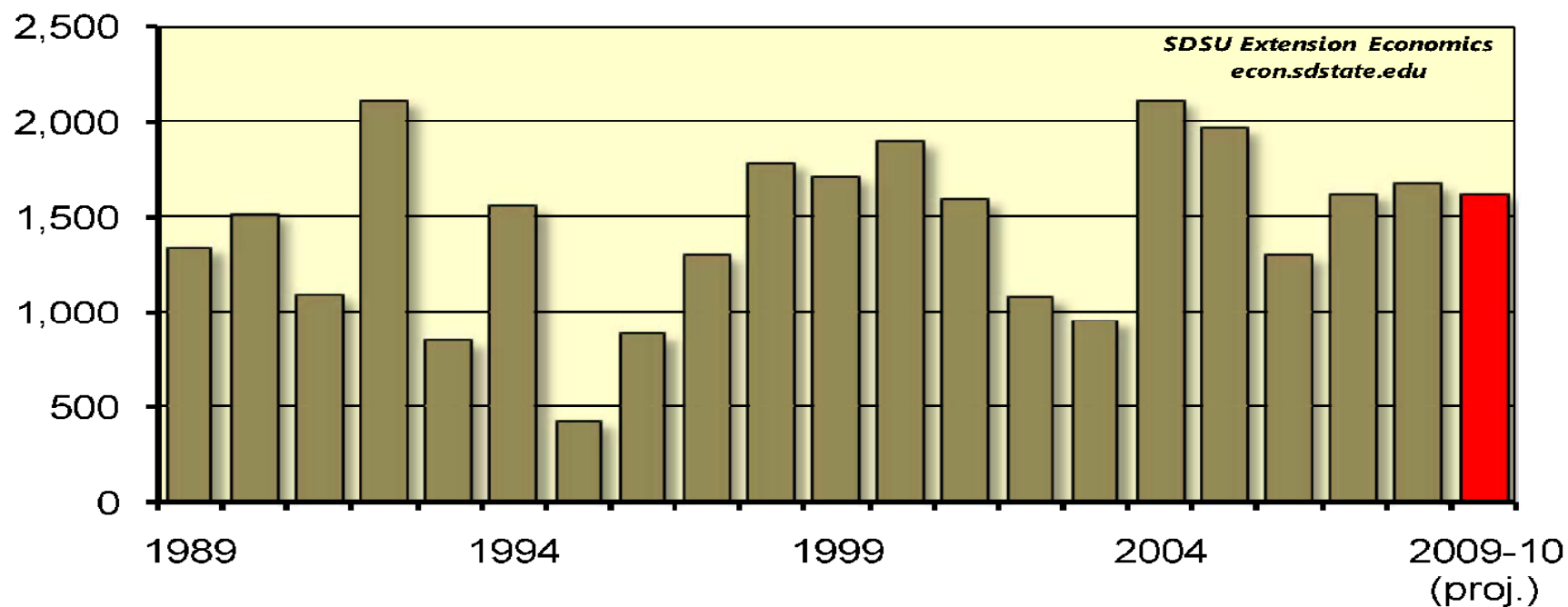




South Dakota
Cooperative Extension Service

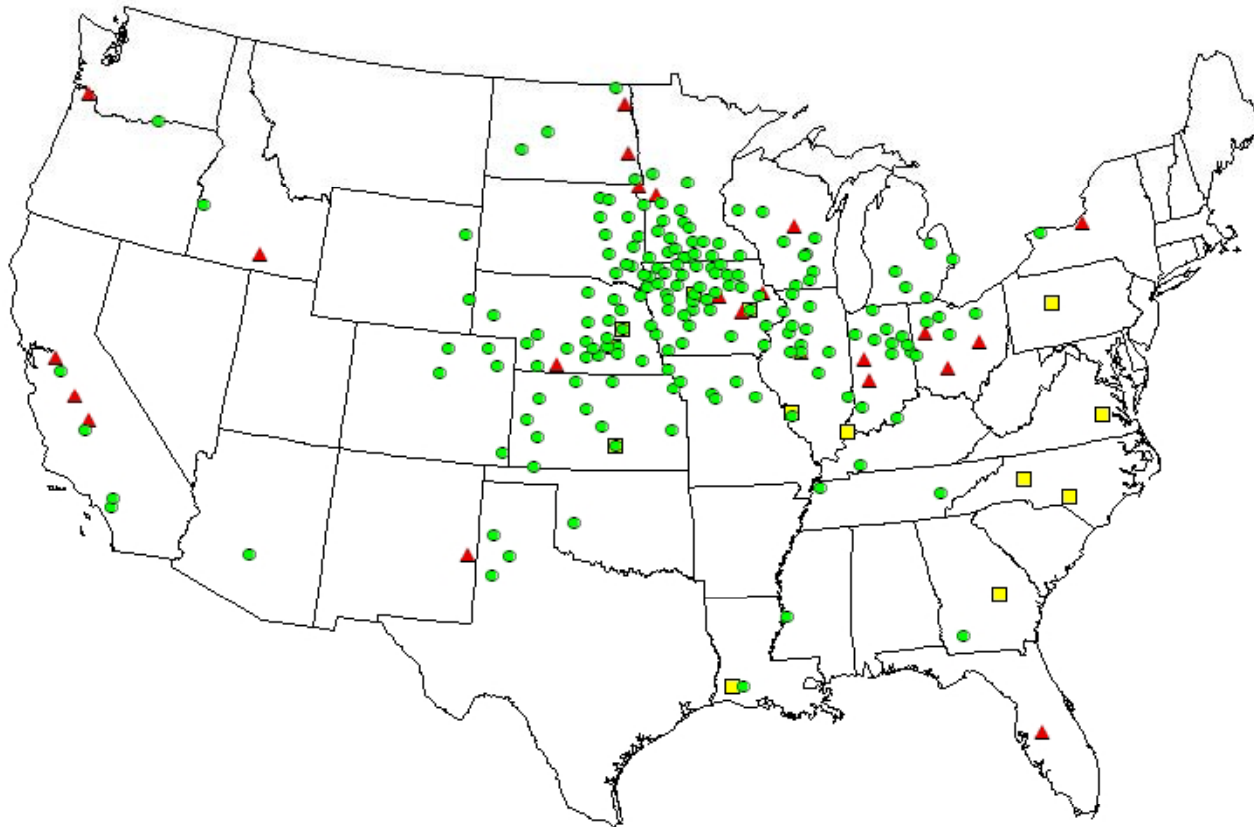
U.S. Corn Ending Stocks

(million bushels)



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

Ethanol Plants



Operating plants
184 Plants in USA
in 26 states 11.7 BGY
40 Plants in Iowa 3.2 BGY

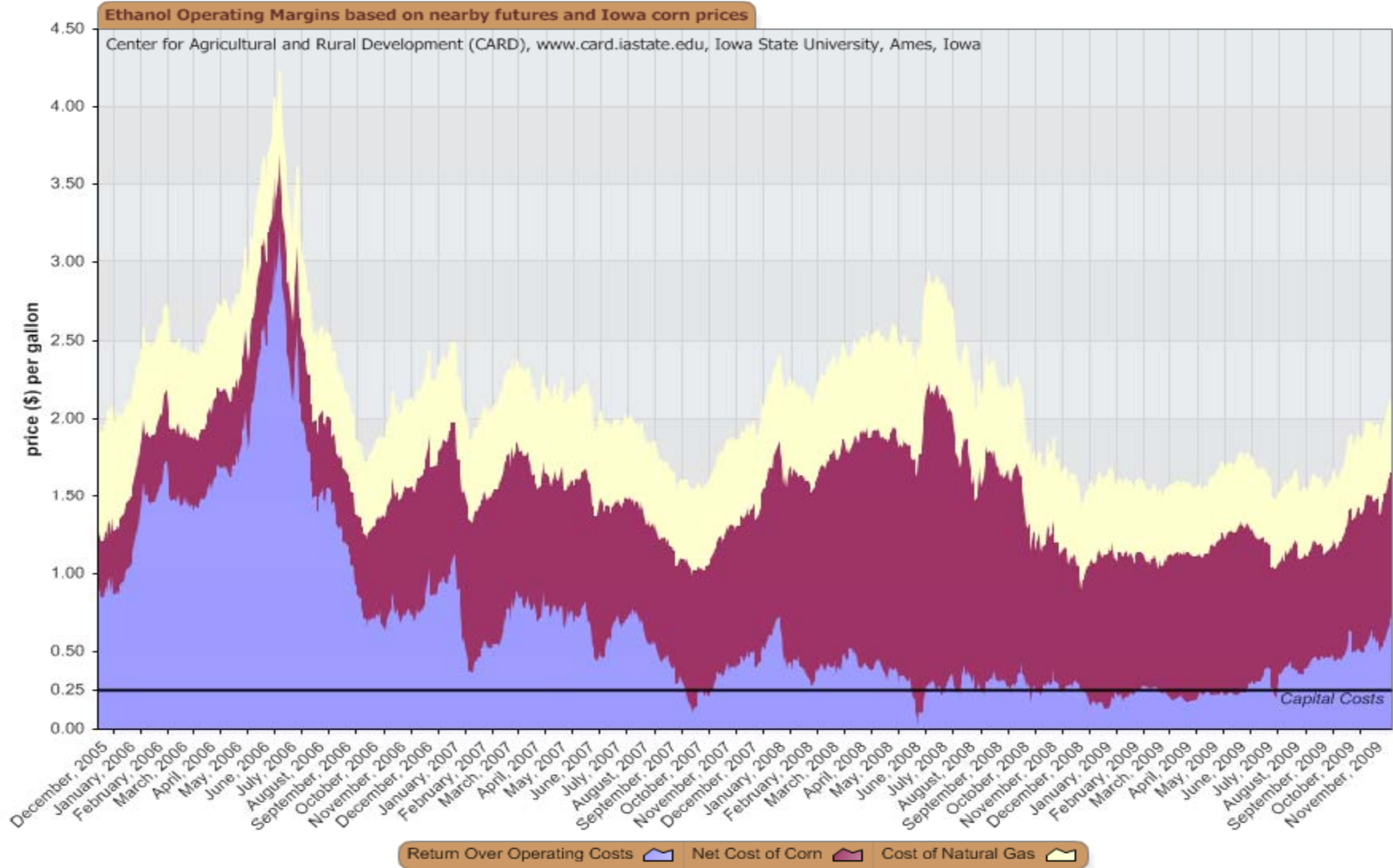
Construction/expansion
21 Plants in USA 1.4 BGY
2 Plants in Iowa 0.4 BGY

● Operating ▲ Not Operating ■ Under Construction

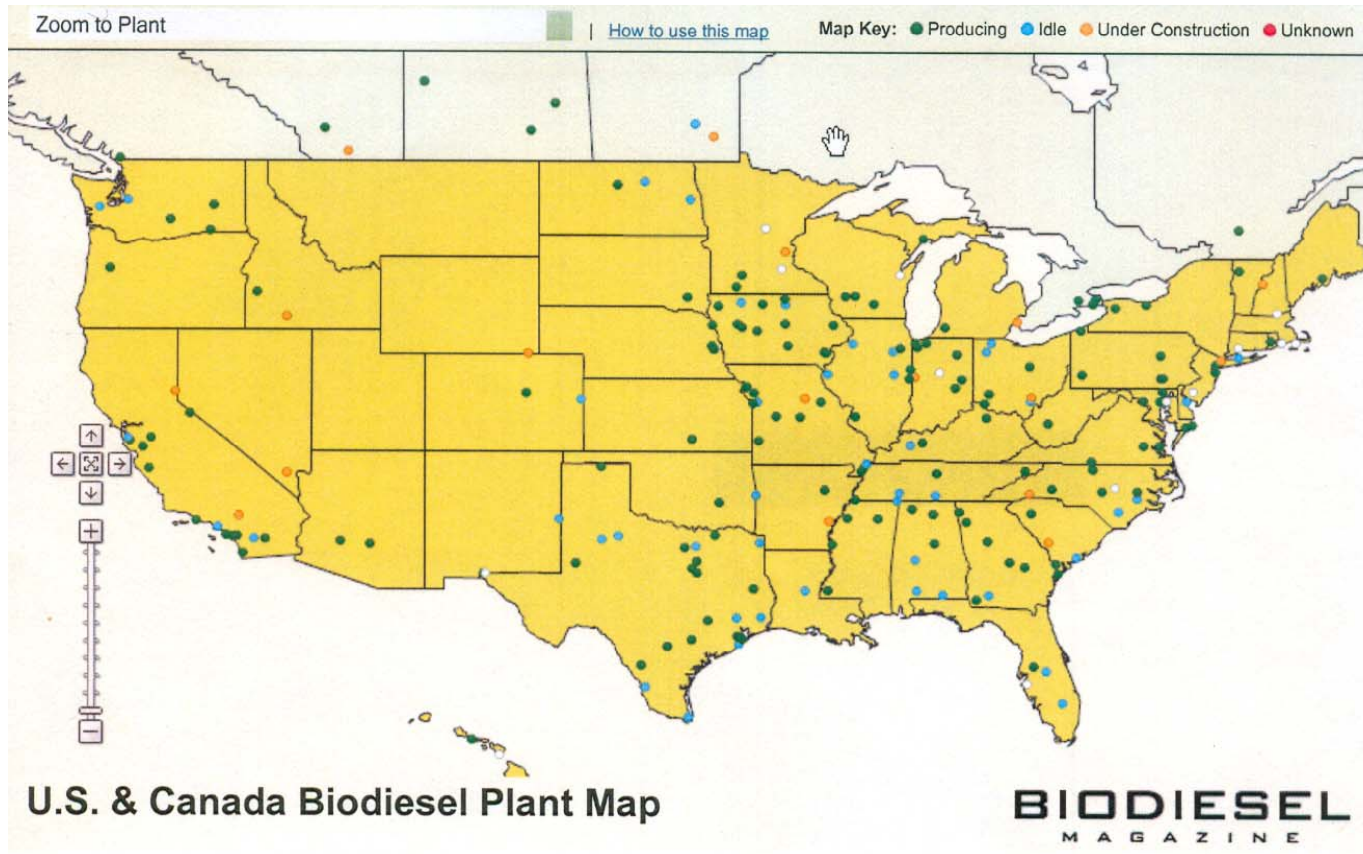
Iowa Ethanol Production and Corn Usage

Summary Statistics - July 2009	n	Ethanol Produced mil gal/yr	Corn Used mil bu/yr	DGS 000 tons/yr
Current Dry-grind Plants	35	2,706	982	8,278
Expansions and new construction	2	375	134	1,139
Wet Mills	5	490	175	1,487
Nearby Iowa	11	636	227	1,931
Subtotal	53	4,207	1,518 ~65%	12,835

Ethanol Margins



Biodiesel Plants in USA



Operating Plants
173 Plants in USA
2.7 bgy capacity
15 operating in Iowa
322.5 mgy production

Source: Biodiesel Magazine

Iowa Biodiesel Production

15 soy biodiesel plants

322 mgy total capacity

Production capacity for 64% of the maximum biodiesel that could be made from Iowa's soybean oil production (June 2008 – May 2009)

What Could Corn Oil Add?

	Grain Yield (bu/acre)	Oil Yield (lb/acre)
Soybeans	46	501
Corn	171	342

2008 Avg. Yields

10.9 lb oil/bu soybeans

2.0 lb oil/bu corn

What Could Corn Oil Add?

	Max. Oil (MM lbs)	Biodiesel (MM gal)
Soybeans	4845 (4870)	497 (499)
Corn	4377 (4583)	449 (587)
	9222	946 (1086)

Plant capacity

322 mgy

34% (30%)

Assume 7.8 lb/gal oil and 80% biodiesel yield

USDA – NASS:

9.67 mil ac soybeans; 12.80 mil ac corn harvested in 2008

9.72 mil ac soybeans estimated' 13.40 mil ac corn estimated in 2009

What About the Acreage Split?

	DDGS (mln ton)	SBM (mln ton)	Protein (mln ton)	Oil (bln lb)	Lysine (bln lb)
2006	17.4	11.3	9.9	9.8	1.14
2007	20.8	9.8	10.1	9.7	1.07

Issues: Protein quality (amino acids)
Energy content (starch, oil)

Yield and Nutrients

Bu/A	Protein (lb/A)	Oil (lb/A)	Lysine (lb/A)	Fuel (gal/A)
Corn				
150	630	302	21	420
250	1050	504	35	700
Soybeans				
50	1050	555	83	56
80	1680	888	133	89

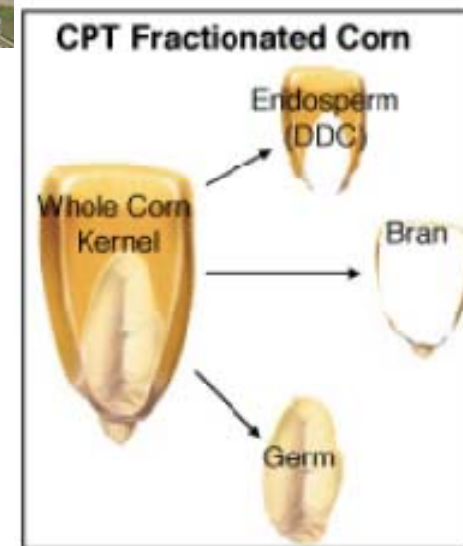
Food, Feed and Fuel

- **Most evaluation has been done by looking back, at what was produced, at what wages were paid in rural areas, at subsidized prices.**
- **\$4 - \$7 corn has produced net returns of over \$500 per acre, in some cases more.**
- **Will the yield trendline stay the same?**
- **Supply Chain Agronomics**

What's fractionation?

*Process by
which **bran**,
germ and **endosperm**
are separated, usually at the
beginning of the process.*

- We have a distribution issue.
Not a total quantity issue.



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?

Looking for:

- ✓ Improved efficiency
- ✓ Reduced energy usage
- ✓ Reduced water usage
- ✓ Diversified product stream

Fractionation Technologies

- MOR Technologies
- Corn Value Products
- Langhauser Associates
- FC Stone Carbon LLC and Maize Processing Innovations
- Buhler Inc.
- Cereal Process Technologies
- FWS Technologies
- American Milling Group
- ICM Inc.
- POET
- Renessen LLC
- Delta-T Corporation

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:
 - Liquification and cooking
 - Distillation
 - Drying of distillers grains and solubles
- Possible energy generation from bran
- Could reduce energy demand by nearly 50%

Product Streams

Corn costs: \$3.75 per bushel, Illinois ethanol plant report
(USDA-AMS, as of Nov. 20, 2009)

Traditional ethanol plant:

2.8 gallons of ethanol @ \$2.17/gallon	= \$6.08
17.75 lbs. of DDGS @ \$130/ton	= <u>\$1.15</u>
Revenues per bushel	= \$7.23

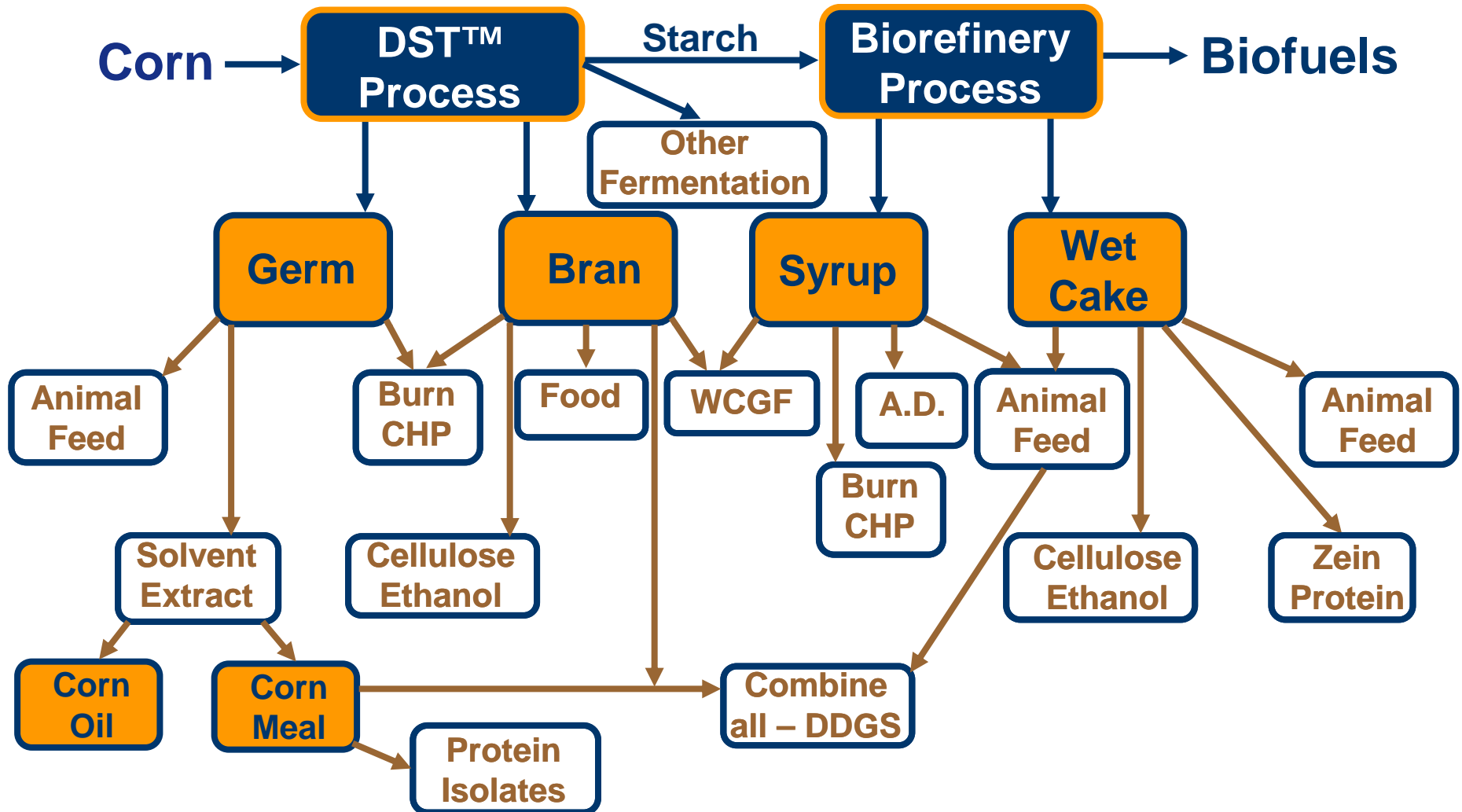
Ethanol plant w/ fractionation:

2.72 gallons of ethanol @ \$2.17/gallon	= \$5.90
13.5 lbs. of cattle protein DG @ \$140/ton	= \$0.95
5 lbs. of germ @ \$155/ton	= \$0.39
3 lbs. of bran @ \$80/ton	= <u>\$0.12</u>
Revenues per bushel	= \$7.36

Distillers Grains Properties

Constituent	Typical Value*	Fractionation Change
Dry matter	90%	No change
Crude Protein	26%	Increase
Crude Fat	9%	Decrease (germ)
Crude Fiber	15%	Decrease (bran)
Ash	5.5%	Decrease (bran)
Flowability	Poor	Better (oil out)
<i>Ethanol Yield (cook)</i>	<i>2.8 g/bu</i>	<i>Less (0.1-0.2)</i>
<i>Ethanol Yield (cold)</i>	<i>3.0 g/bu</i>	<i>Less (0.1-0.2)</i>

Tapping into Many Markets



Summary

- Grain-based biofuel volume is still rising
- Grain revenues encourage productivity; higher input costs encourage efficiency
- Feed-food uses of corn are not falling
- New processing technologies will distribute grain components more efficiently and reduce process inputs.
- System/supply chain agronomics

Acknowledgements

Iowa Grain Quality Initiative
www.iowagrain.org

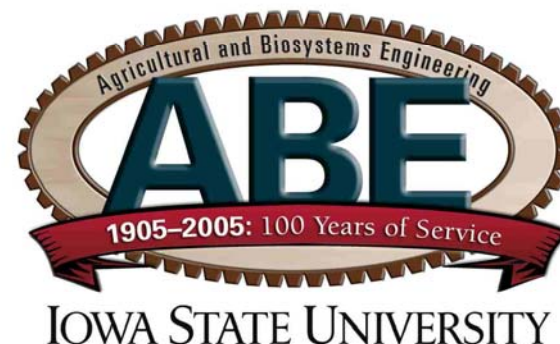
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**Iowa Renewable Fuels Association
Renewable Fuels Association
National Biodiesel Board
Ethanol Producer Magazine
Biodiesel Magazine
USDA - NASS**



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