

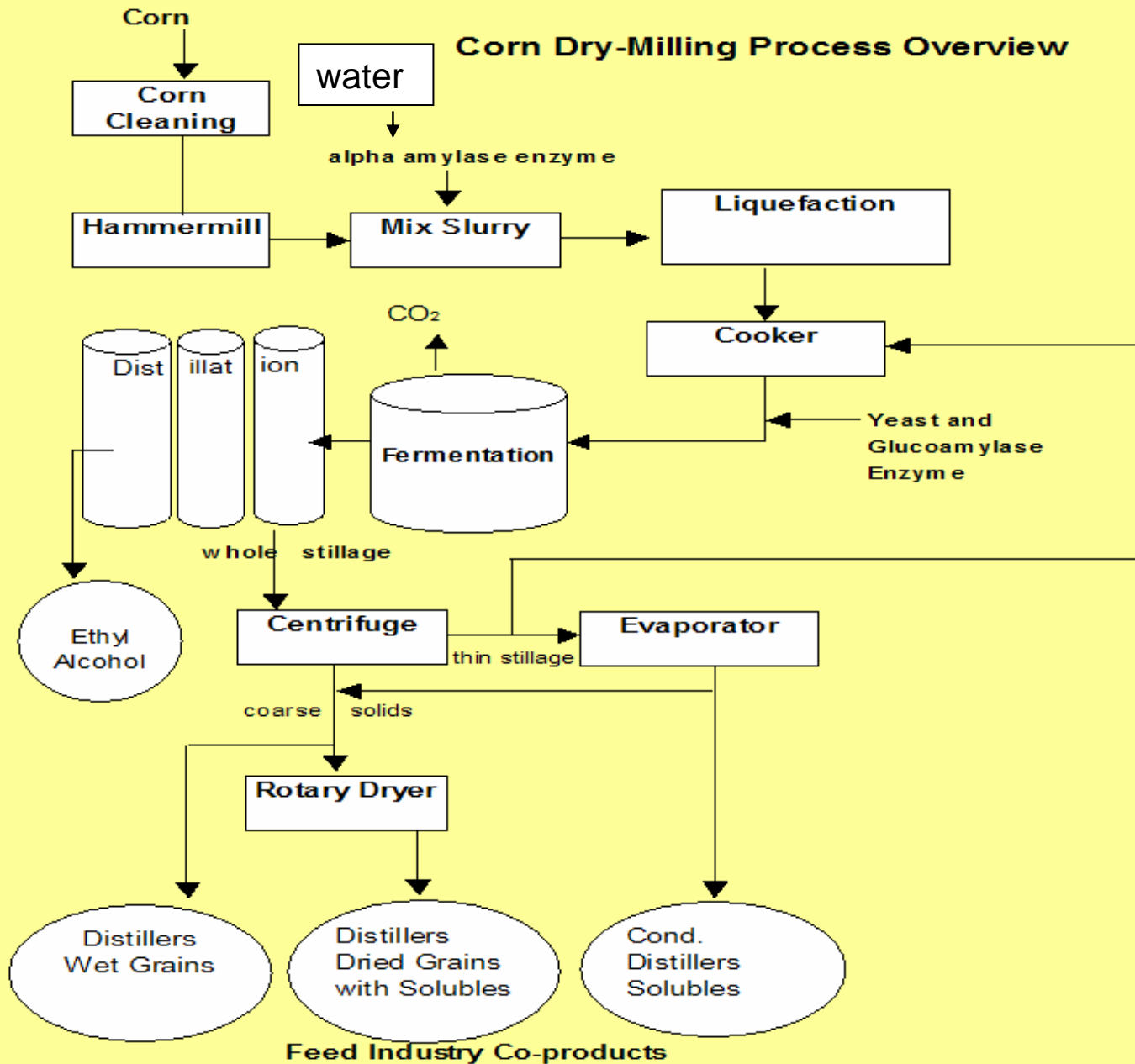
Ethanol: The national supply of distillers grain & corn consumption in 2007, 2008, 2009

Ron Plain, Ph.D.

Professor of Agricultural Economics

University of Missouri-Columbia

<http://web.missouri.edu/~plainr>



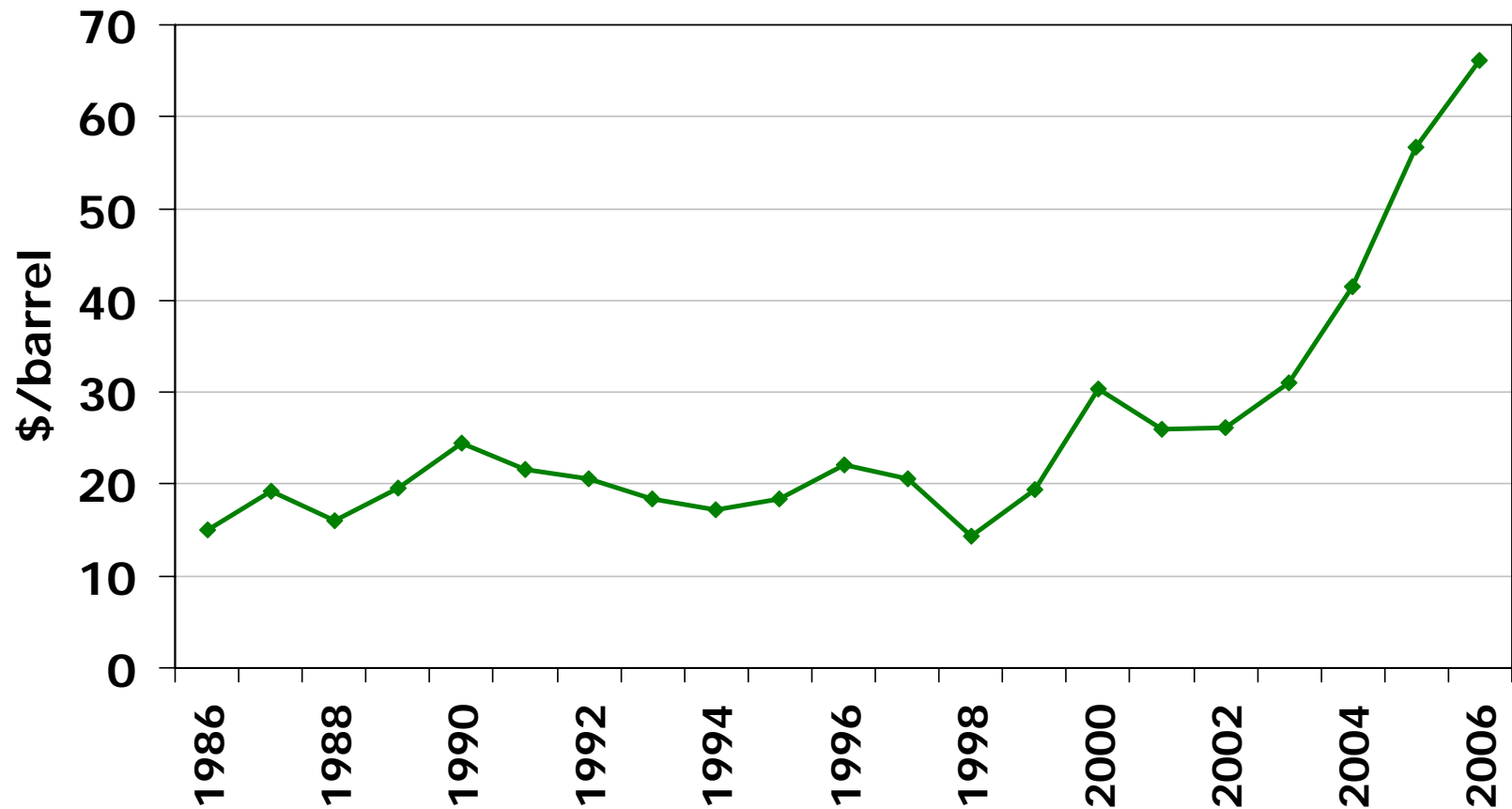
A bushel of corn will produce ~2.75 gallons of ethanol, 17 lbs of CO₂ and 17 lbs of DDGS



Oil Prices

Spot Crude Oil Prices 1986-2007

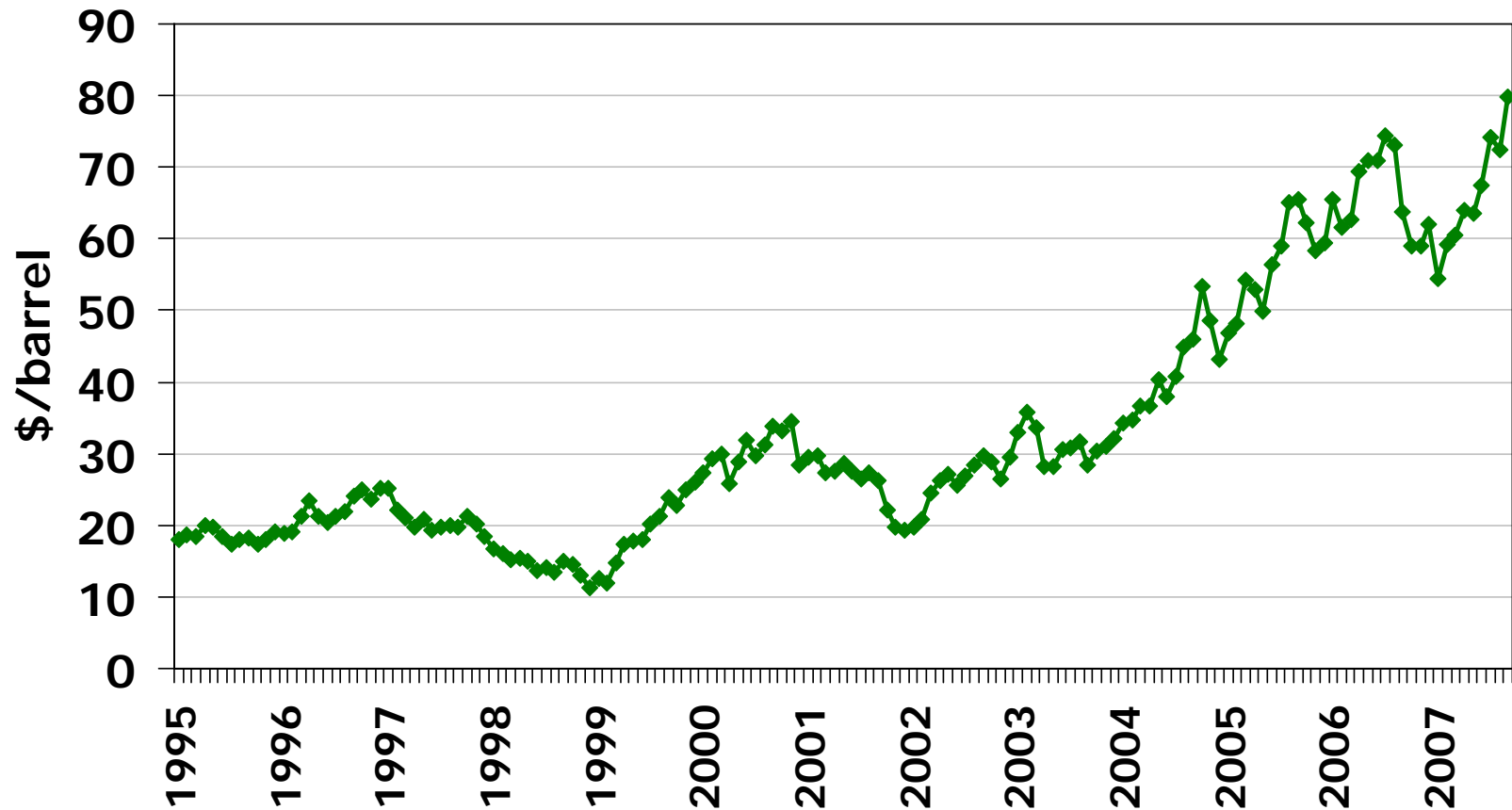
WTI, Annual Average Price, Cushing, Oklahoma



Source: U.S. Energy Information Administration

Spot Crude Oil Prices 1995-2007

WTI, Monthly Average Price, Cushing, Oklahoma



Source: U.S. Energy Information Administration

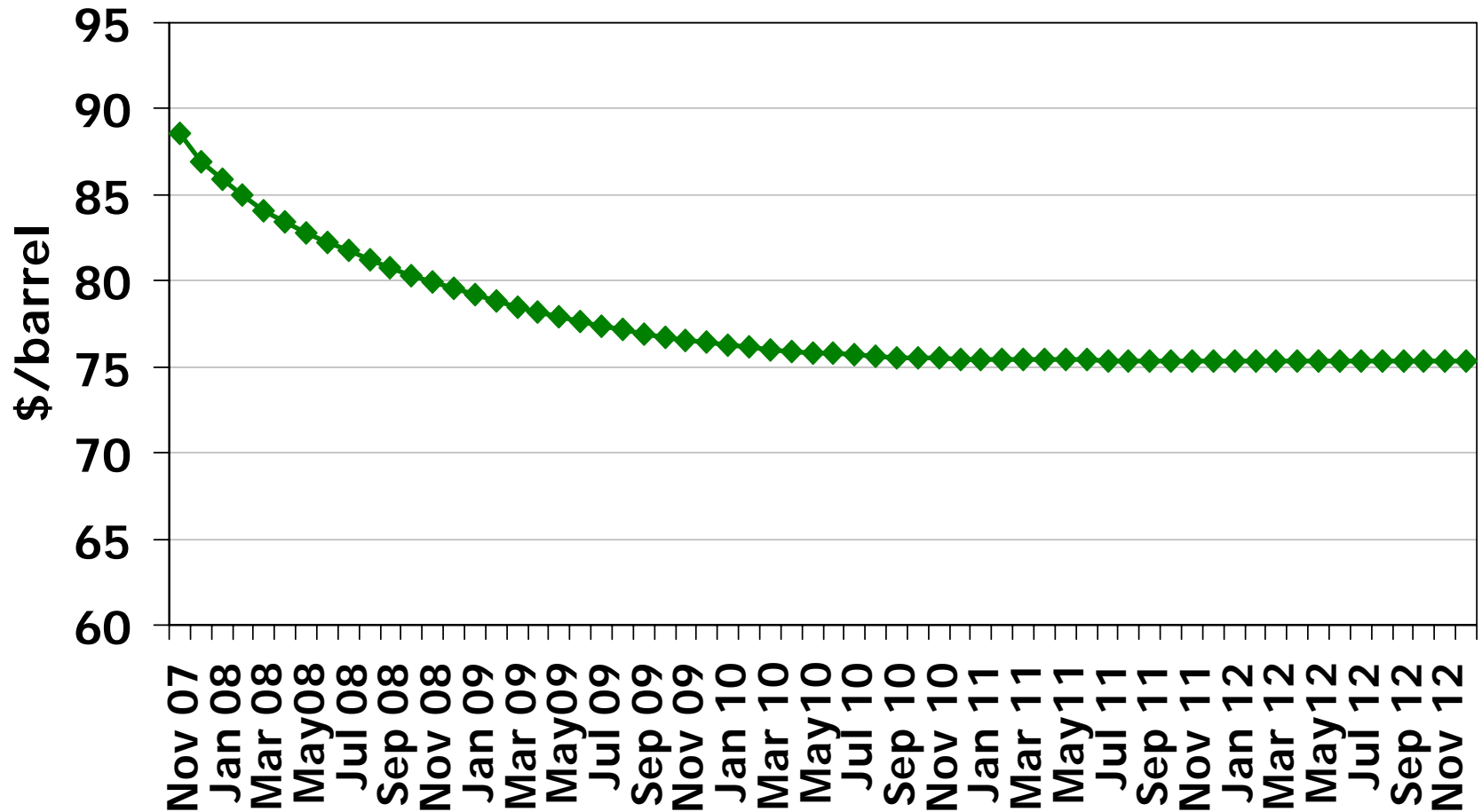
December 2007 Crude Oil Futures



Source: New York Mercantile Exchange

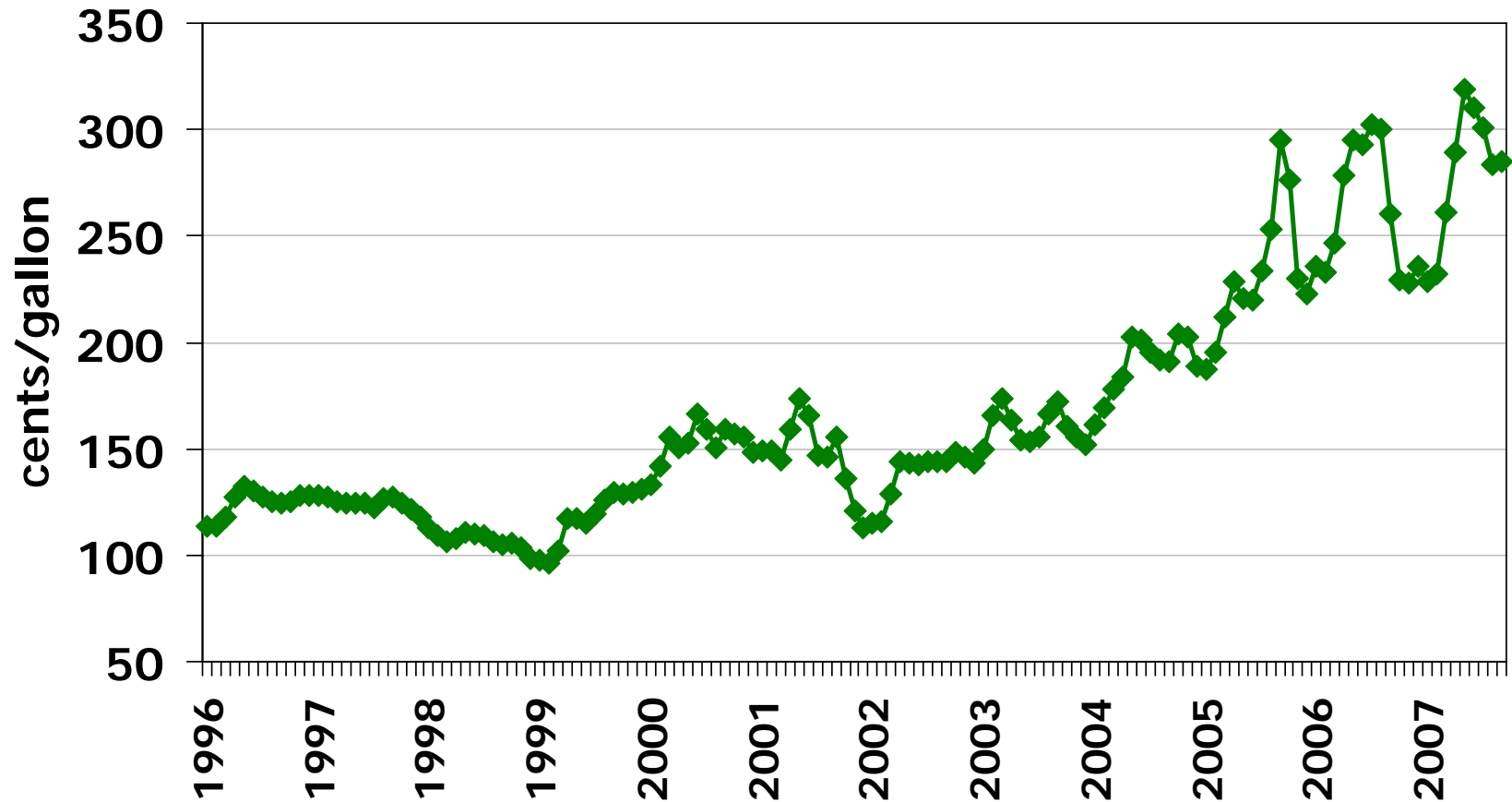
Settled at \$92.82/barrel on 10/29/07

Crude Oil Futures Prices



Source: New York Mercantile Exchange close on 10/19/07

U.S. Retail Gasoline Prices, All Grades, All Formulations, 1996-2007



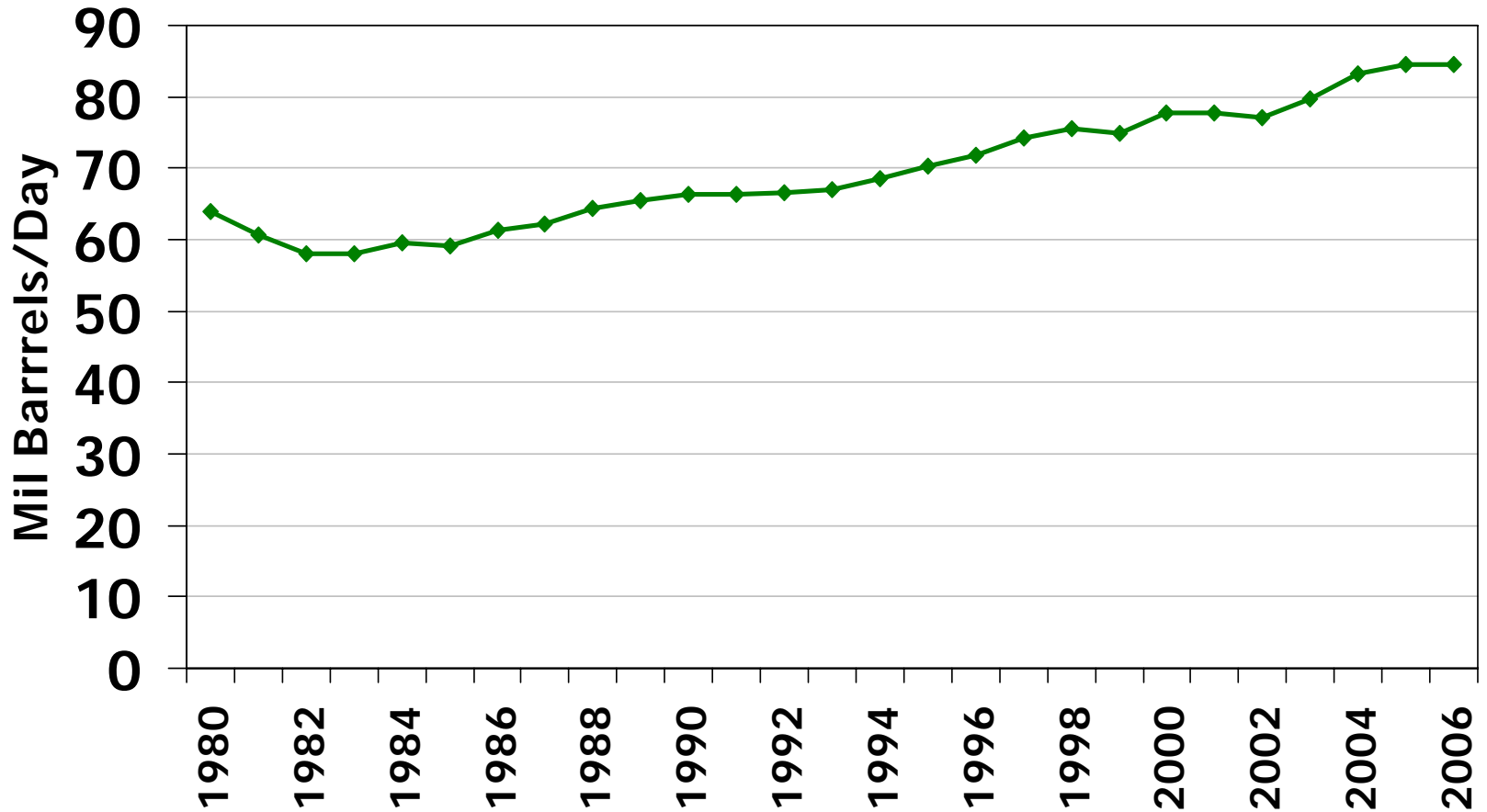
Source: U.S. Energy Information Administration



Oil Production

World Crude Oil Production

Million Barrels Per Day, 1980-2006



Source: U.S. Energy Information Administration

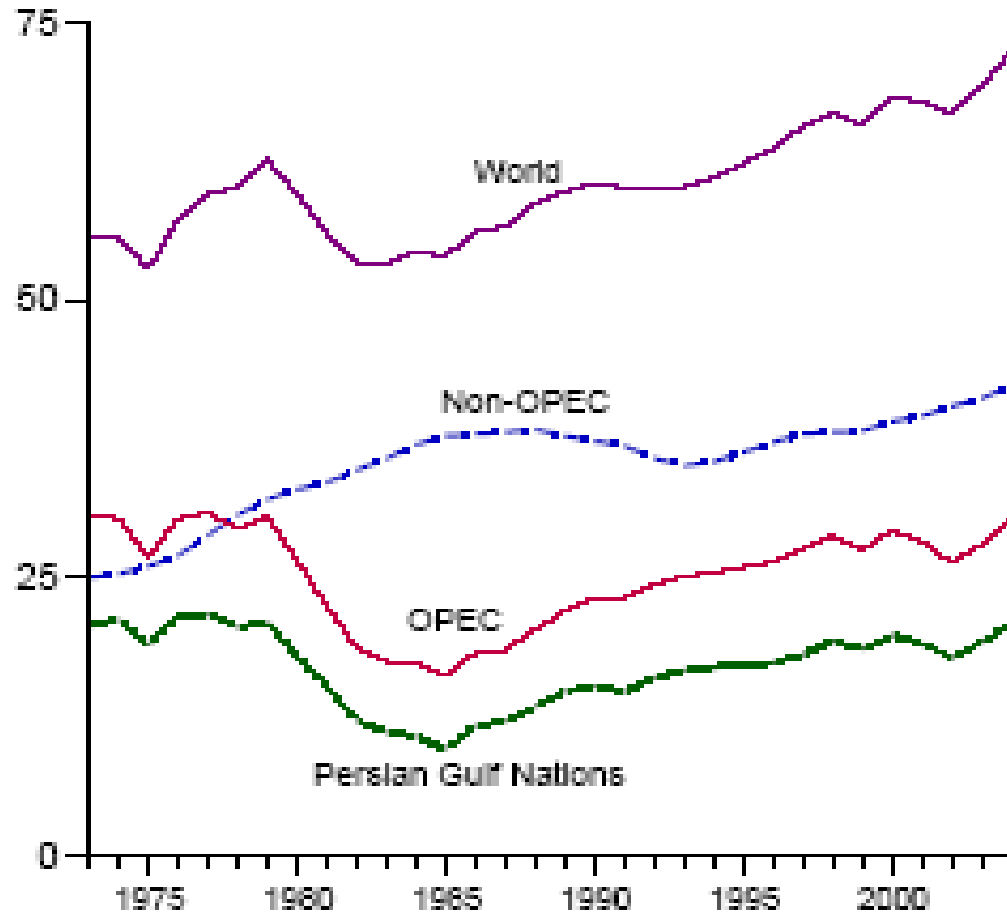
Top 10 Oil Producing Countries, 2006

| | Nation | Million Barrels Per Day | |
|-----|--------------|-------------------------|--|
| 1. | Saudi Arabia | 10.67675 | |
| 2. | Russia | 9.67657 | |
| 3. | U.S.A. | 8.37027 | In 2006, the world produced 84.63213 million barrels of crude oil per day |
| 4. | Iran | 4.14817 | |
| 5. | China | 3.85814 | |
| 6. | Mexico | 3.70718 | |
| 7. | Canada | 3.28803 | |
| 8. | UAE | 2.94508 | |
| 9. | Venezuela | 2.80275 | |
| 10. | Norway | 2.78642 | |

Source: U.S. Energy Information Administration

World Crude Oil Production, 1973-2004

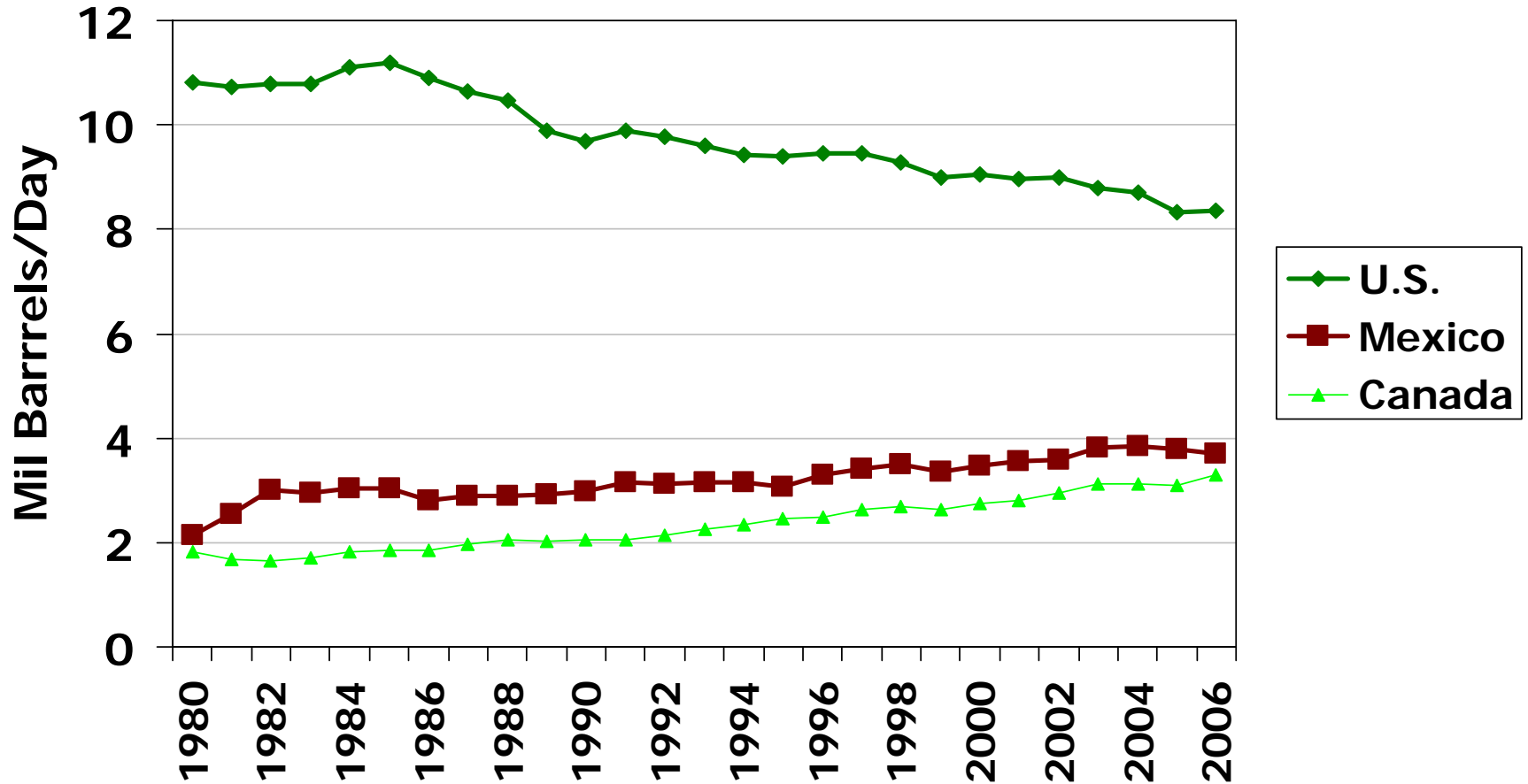
Million Barrels Per Day



Source: U.S. Energy Information Administration

North American Crude Oil Production

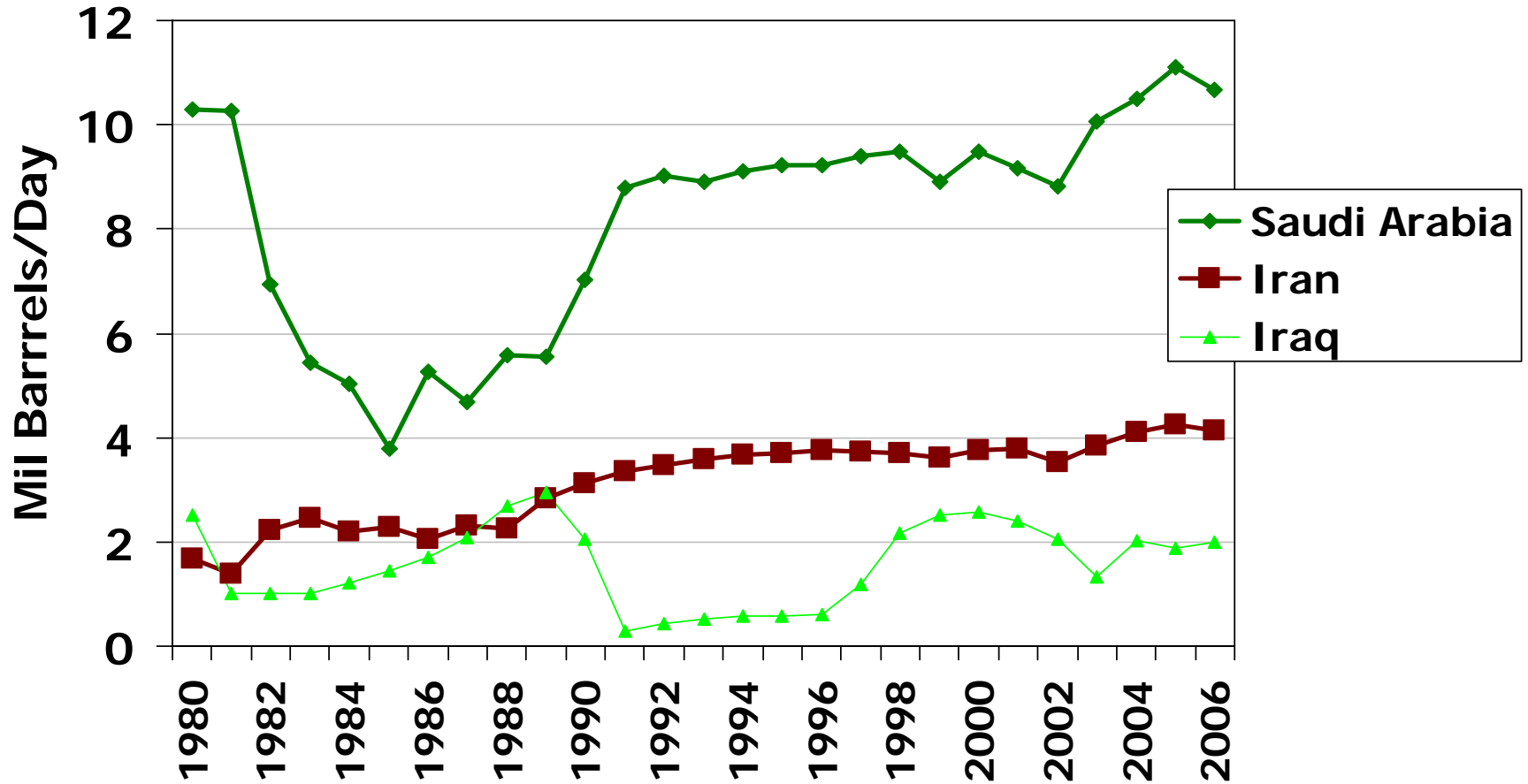
Million Barrels Per Day, 1980-2006



Source: U.S. Energy Information Administration

Middle East Crude Oil Production

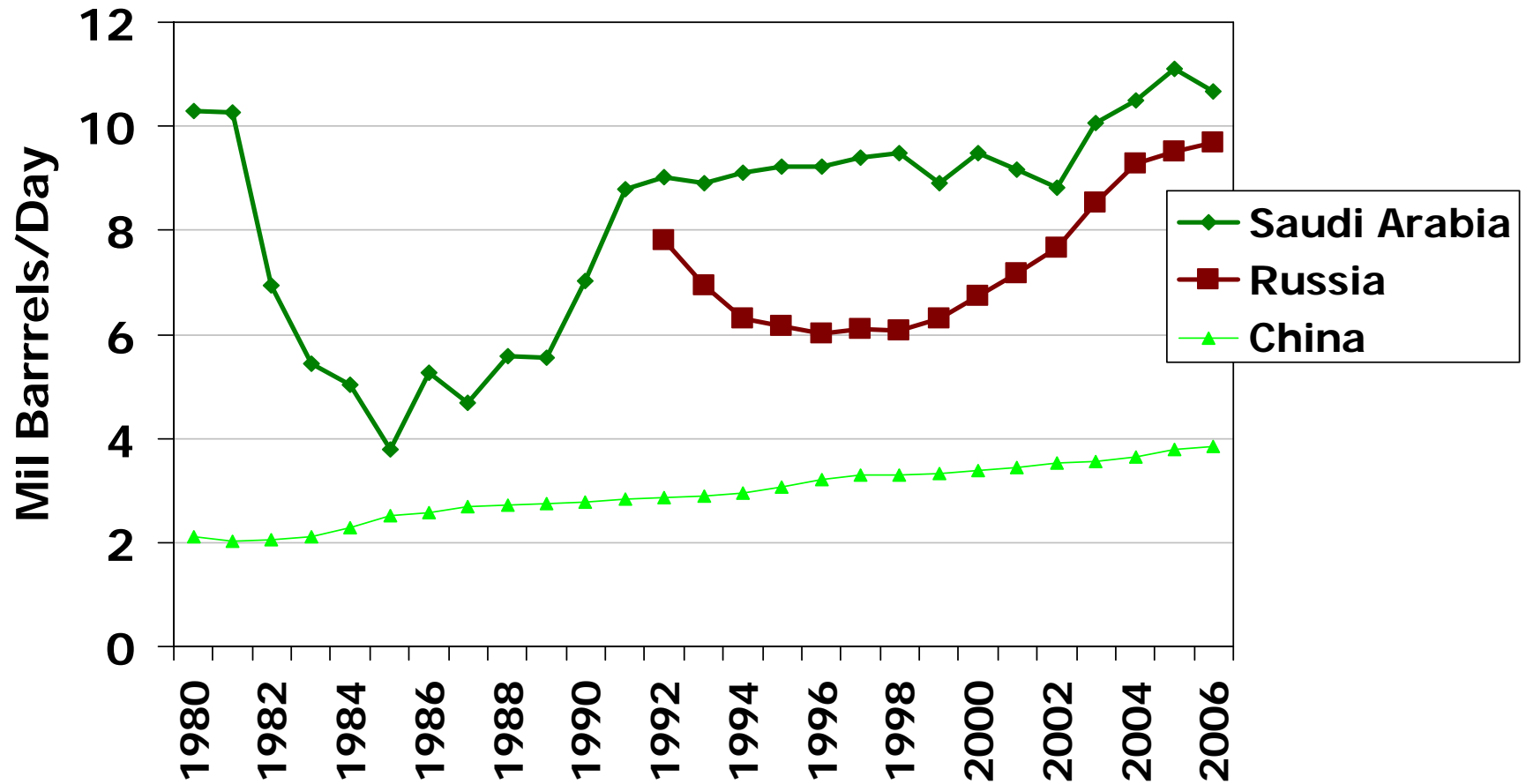
Million Barrels Per Day, 1980-2006



Source: U.S. Energy Information Administration

Crude Oil Production

Million Barrels Per Day, 1980-2006





Oil Consumption

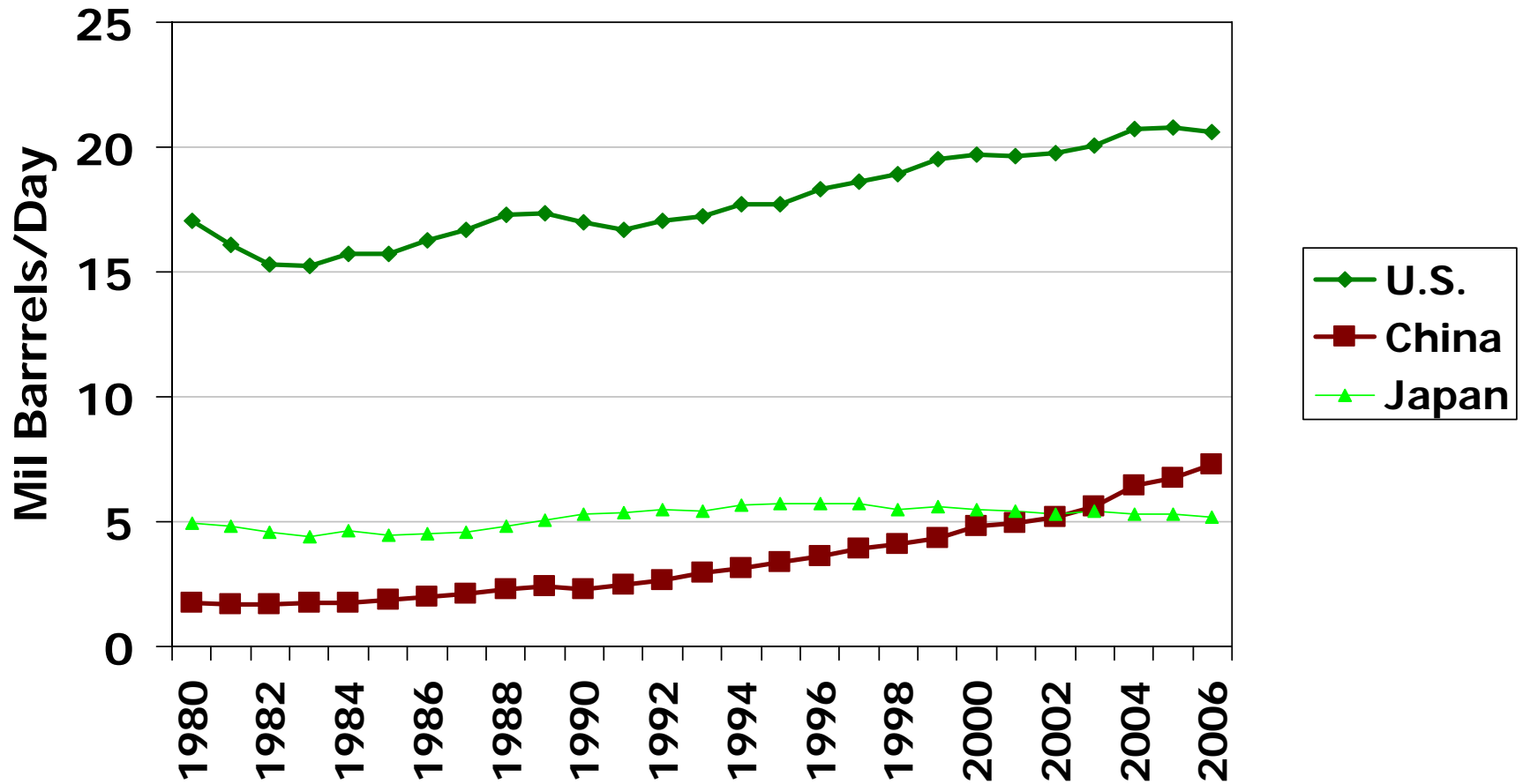
Top 10 Oil Consuming Countries, 2006

| | Nation | Million Barrels Per Day | |
|-----|--------------|-------------------------|--|
| 1. | USA | 20.58756 | |
| 2. | China | 7.27329 | |
| 3. | Japan | 5.15943 | In 2006, the world used 84.45366 million barrels of crude oil per day |
| 4. | Russia | 2.91556 | |
| 5. | Germany | 2.66348 | |
| 6. | India | 2.49891 | |
| 7. | Brazil | 2.25229 | |
| 8. | Canada | 2.22821 | |
| 9. | South Korea | 2.17379 | |
| 10. | Saudi Arabia | 2.11678 | |

Source: U.S. Energy Information Administration

Crude Oil Consumption

Million Barrels Per Day, 1980-2006



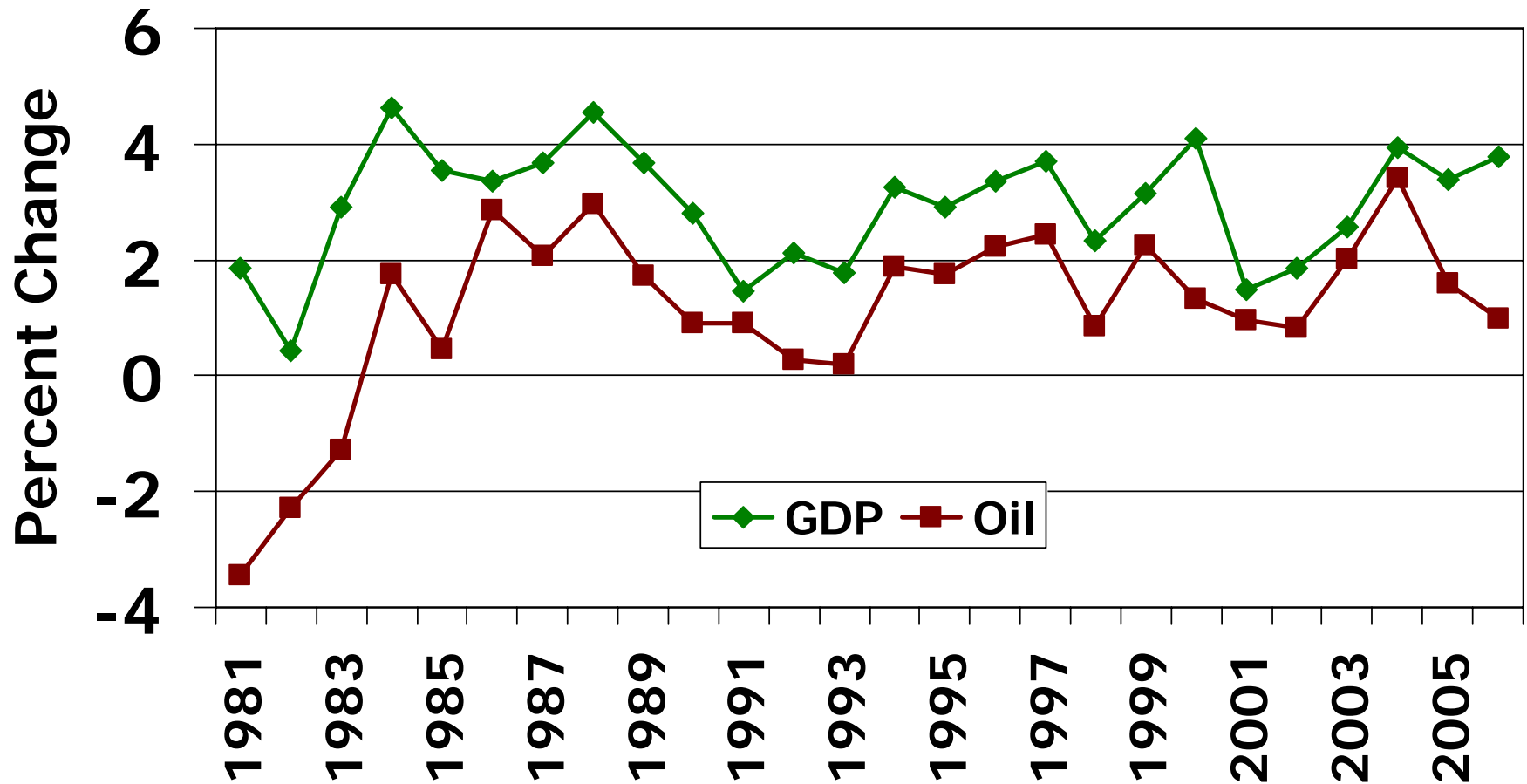
Source: U.S. Energy Information Administration

Change in Oil Consumption, 1996-2006

| | Nation | Million Barrels Per Day | |
|-----|--------------|-------------------------|--|
| 1. | USA | 2.28 | |
| 2. | China | 3.66 | |
| 3. | Japan | -0.58 | From 1996 to 2006 world oil consumption grew by 12.83 million barrels per day |
| 4. | Russia | 0.30 | |
| 5. | Germany | -0.26 | |
| 6. | India | 0.82 | |
| 7. | Brazil | 0.32 | |
| 8. | Canada | 0.36 | |
| 9. | South Korea | 0.07 | |
| 10. | Saudi Arabia | 0.79 | |

Source: U.S. Energy Information Administration

World Real GDP Growth & Oil Consumption, 1981-2006



Source: USDA/ERS

U.S. Energy Source & Use, 2005

| <u>Source</u> | <u>Quad BTUs</u> | <u>Use</u> | <u>Quad BTUs</u> |
|--------------------|------------------|------------------|------------------|
| □ Petroleum | 40.7 | □ Electricity | 39.9 |
| □ Coal | 22.8 | □ Transportation | 28.0 |
| □ Natural gas | 22.9 | □ Industrial | 20.9 |
| □ Nuclear power | 8.2 | □ Resid/com'cial | 11.1 |
| □ Renewable energy | 6.6 | | |

Source: U.S. Energy Information Agency

U.S. Energy Sources, 2005

| <u>Source</u> | | <u>Quad BTUs</u> | |
|--------------------------|------------------|------------------|--|
| <input type="checkbox"/> | Petroleum | 40.7 | |
| <input type="checkbox"/> | Coal | 22.8 | |
| <input type="checkbox"/> | Natural gas | 22.9 | |
| <input type="checkbox"/> | Nuclear power | 8.2 | |
| <input type="checkbox"/> | Renewable energy | 6.6 | |
| <input type="checkbox"/> | Hydroelectric | 2.70 | |
| <input type="checkbox"/> | Wood | 2.13 | |
| <input type="checkbox"/> | Landfill gas | 0.45 | |
| <input type="checkbox"/> | Geothermal | 0.34 | |
| <input type="checkbox"/> | Ethanol | 0.34 | |
| <input type="checkbox"/> | Wind | 0.18 | |
| <input type="checkbox"/> | Solar | 0.06 | |
| <input type="checkbox"/> | Bio diesel | 0.01 | |



Source: U.S. Energy Information Agency



Oil and Ethanol

Basics of Ethanol Production

- Ethanol is an alcohol made by fermenting grain and other carbohydrates
- This is an old process which traditionally has been used to produce ethanol for use as a beverage
- 97% of U.S. ethanol is made from corn
- Rest: milo, wheat, brewery waste, whey, etc

Macon Ethanol Plant



Economics of Ethanol

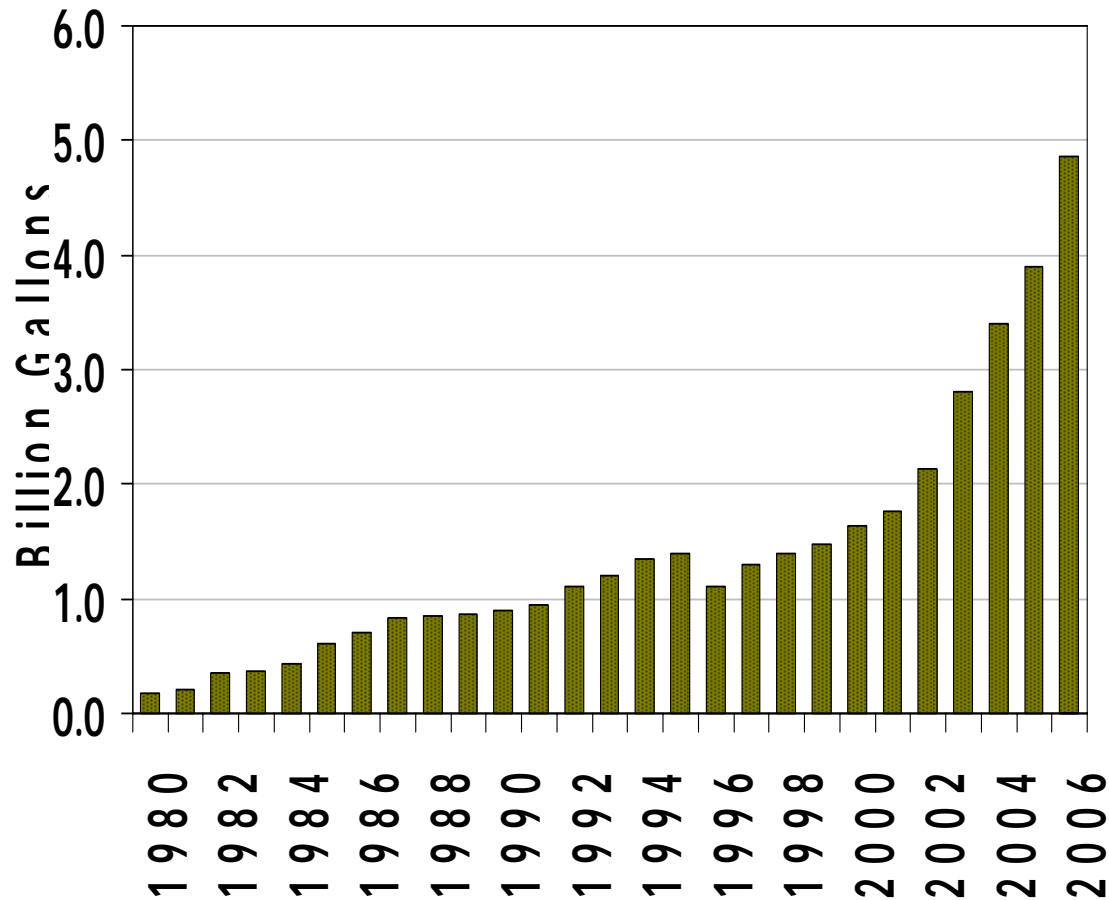
- Corn is worth 6¢ per pound
- Gasoline is worth 27¢ per pound
- DDGS is worth 5.5¢ cents per pound
- The cost of conversion is 3.5¢ per pound
- There is a federal government subsidy of 2.5¢ for each pound of corn converted to ethanol and DGS

Ethanol Plants Have Been Very Profitable

In 2006, U.S. plants produced ethanol for about \$1.34 per gallon. The average price of ethanol was about \$2.58 per gallon.

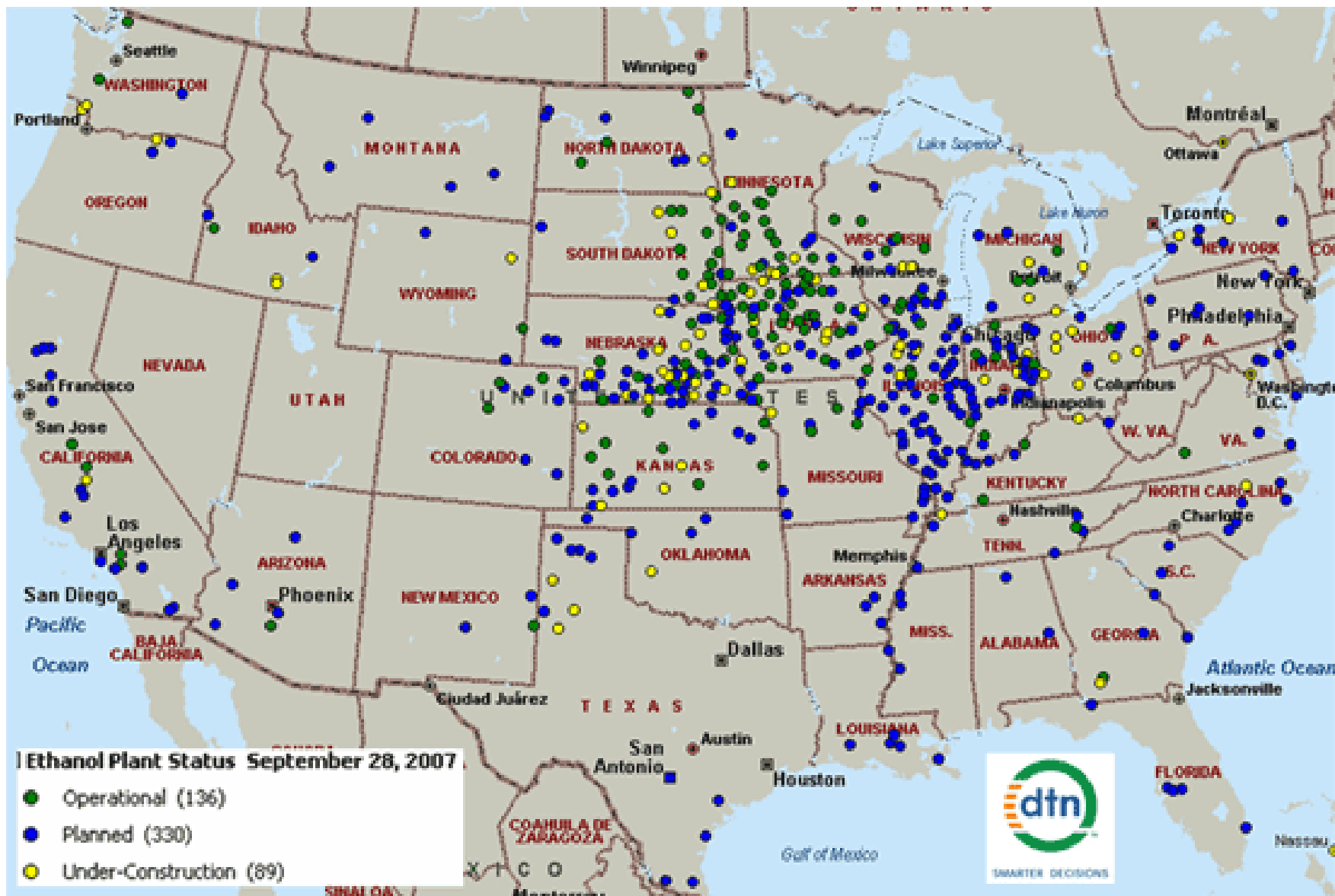


Ethanol Production, 1980-06



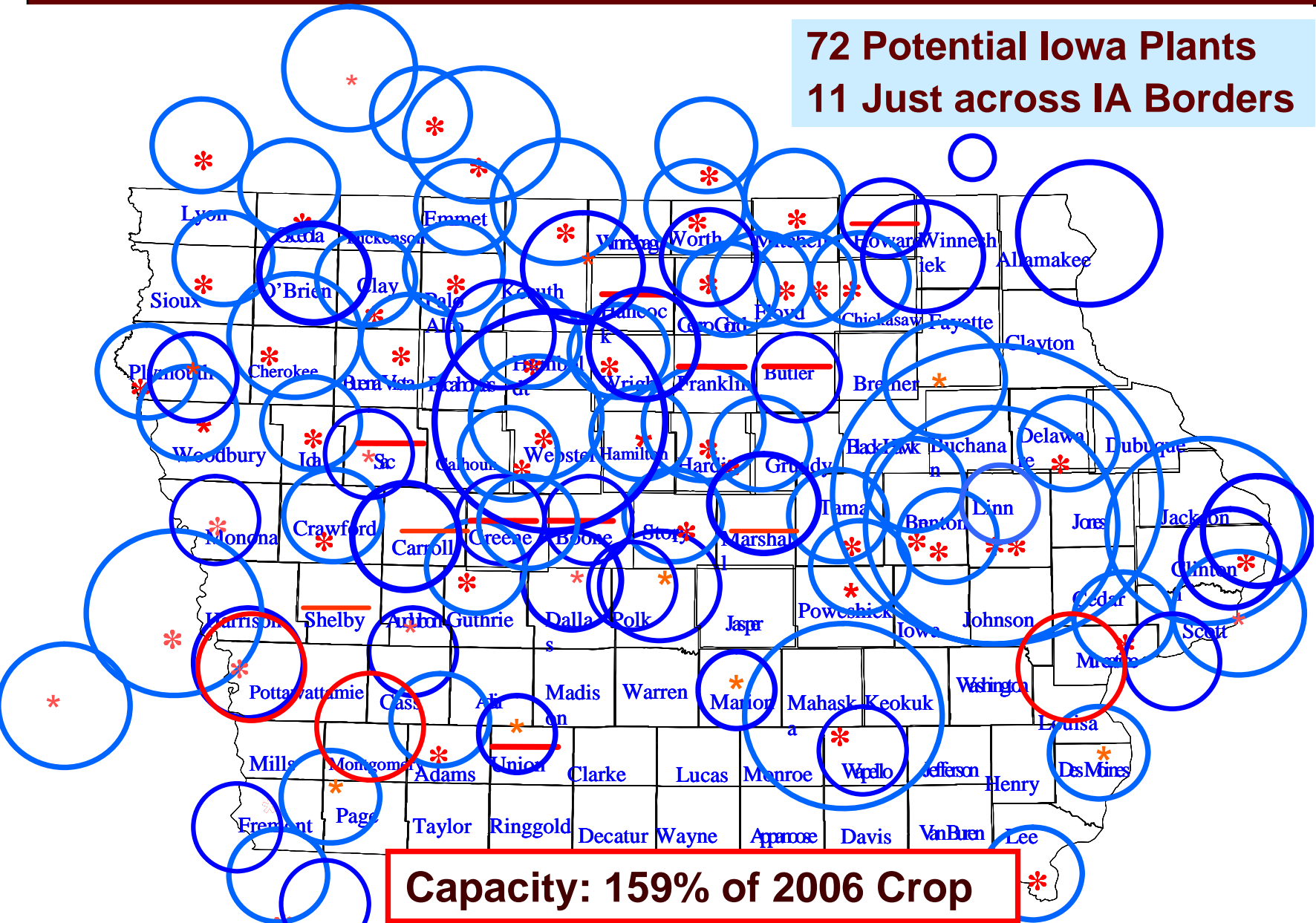
Source: Renewable Fuels Association





*Alaska has one ethanol plant in the planning stage
 *Hawaii has two ethanol plants in the planning stage

**72 Potential Iowa Plants
11 Just across IA Borders**



Capacity: 159% of 2006 Crop

Iowa Corn Processing Plants, Current & Planned, 7/25/07

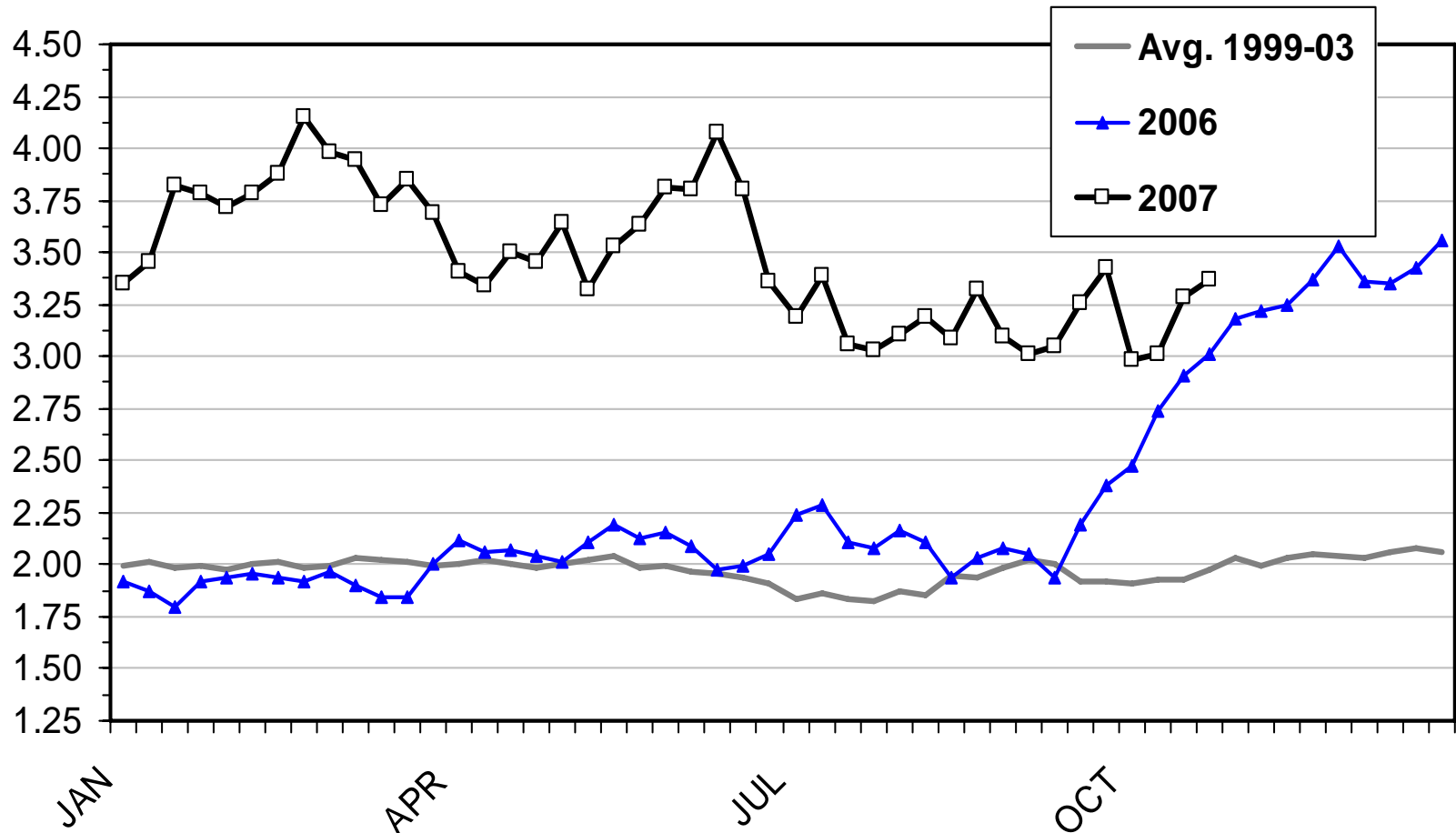
Ethanol Capacity Growth



Source: Renewable Fuel Association website <http://www.ethanolrfa.org/industry/statistics/#B>

Omaha Corn Prices, weekly

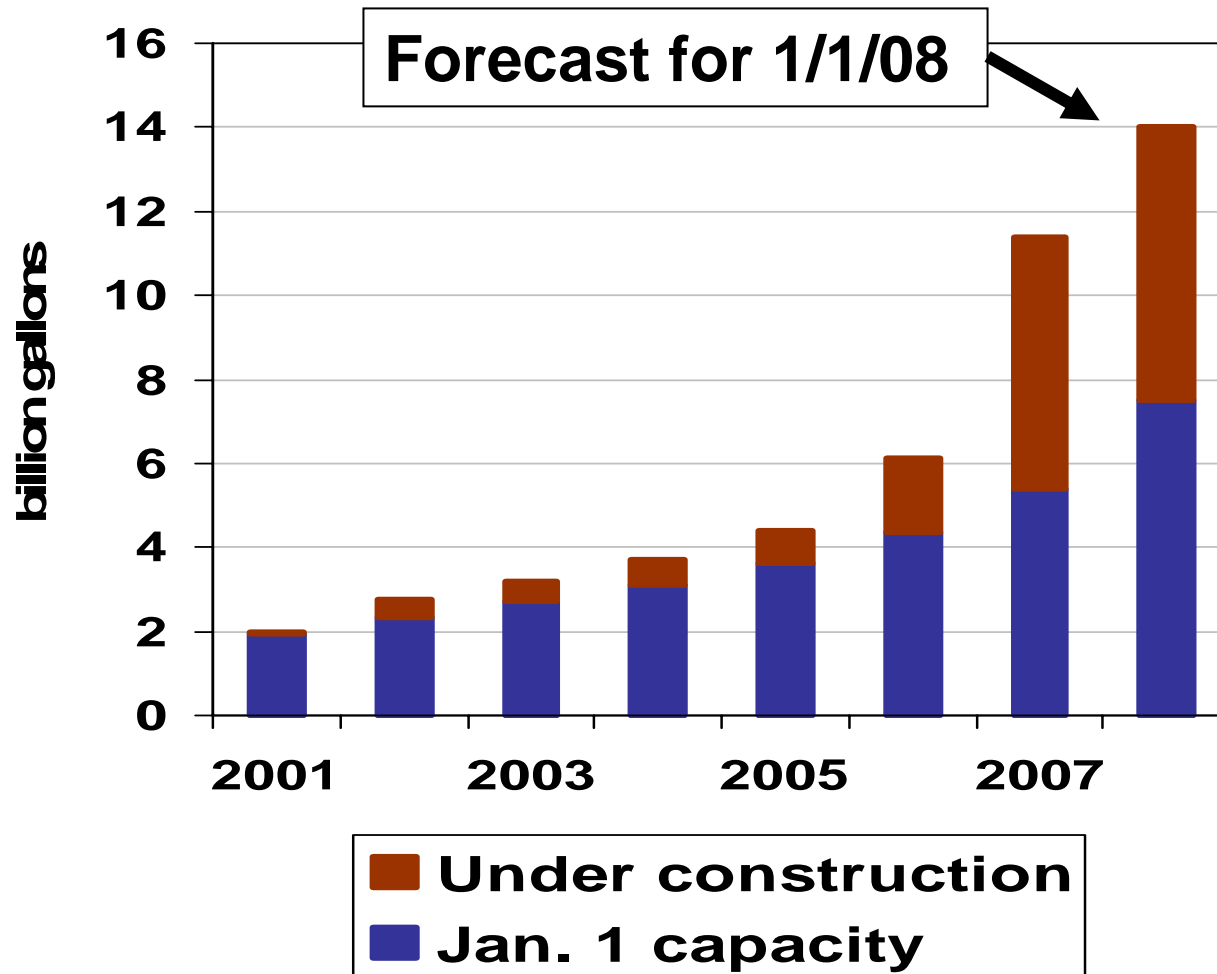
\$ Per Bu.



Ethanol Plant Statistics, 10/09/07

- 131 plants operating in 26 states with capacity to produce 6.9234 billion gallons of ethanol per year (49 plants farmer owned)
- 73 new plants under construction and 10 expansions with capacity to produce 6.5619 billion gallons of ethanol per year
- >100 plants being planned

Ethanol Capacity Growth

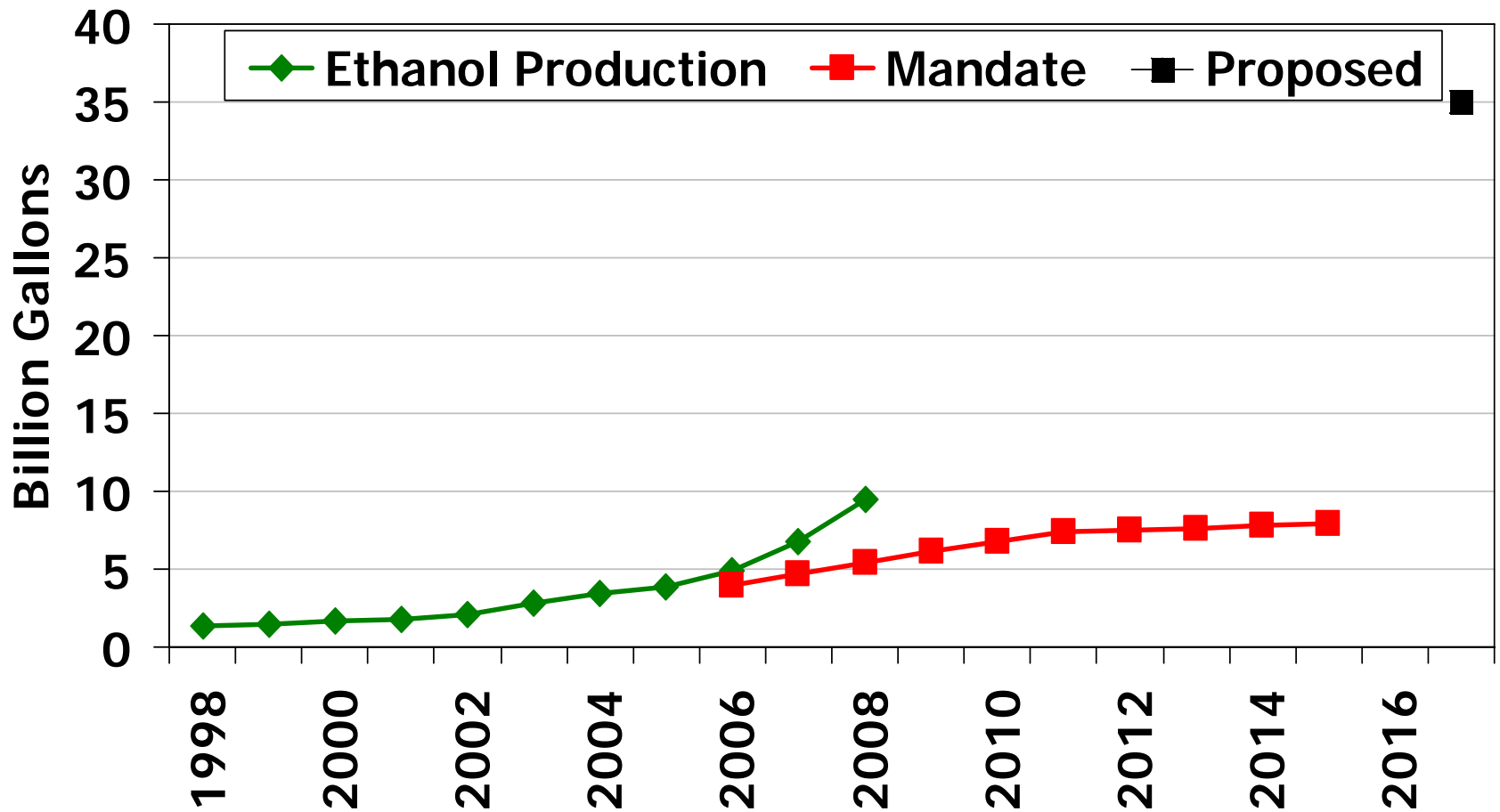




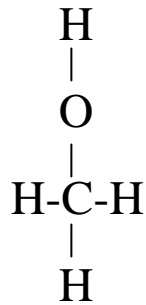
Reasons Ethanol Production Is Increasing

- Legislation
 - Production Subsidies
 - Mandated use
 - Phase-out of MTBE as oxygenate
- Ethanol production is profitable
 - High cost of crude oil
 - Cheap corn

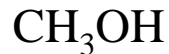
Ethanol Production & Renewable Fuels Mandate



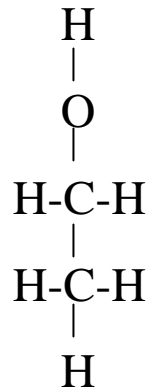
Formulation of Alcohols



Methanol



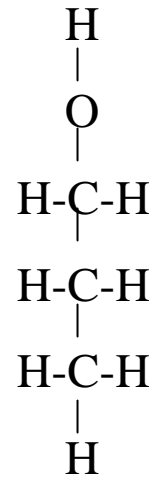
62,800 BTU



Ethanol



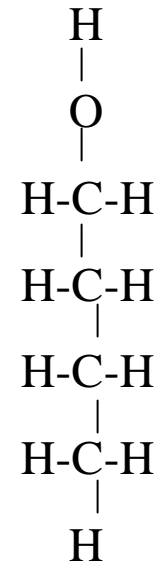
84,400 BTU



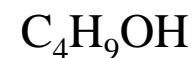
Propanol



100,000 BTU



Butanol



110,000 BTU

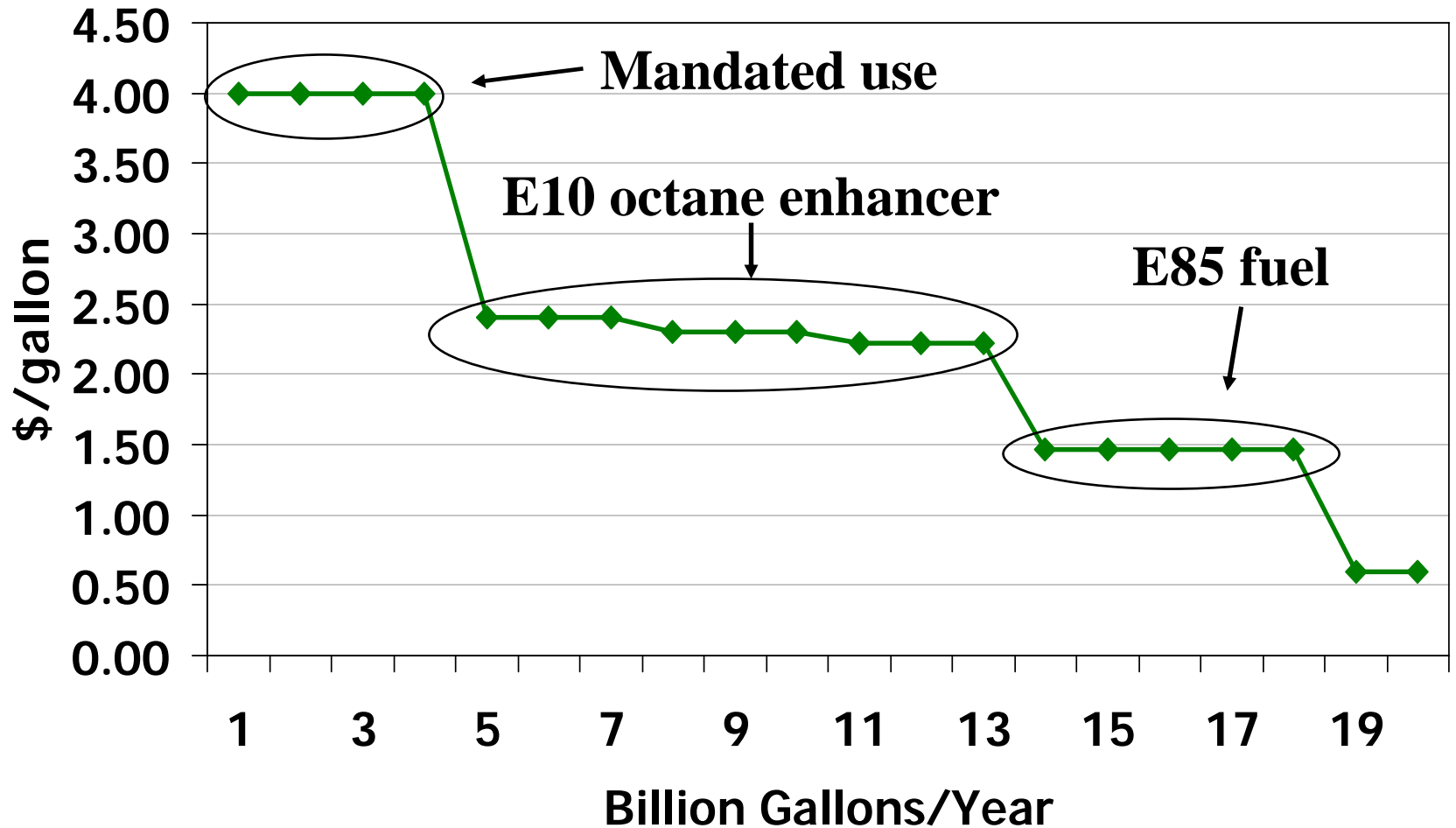
Gasoline is mostly C_8H_{18}

Gasoline has 125,000 BTU/gallon

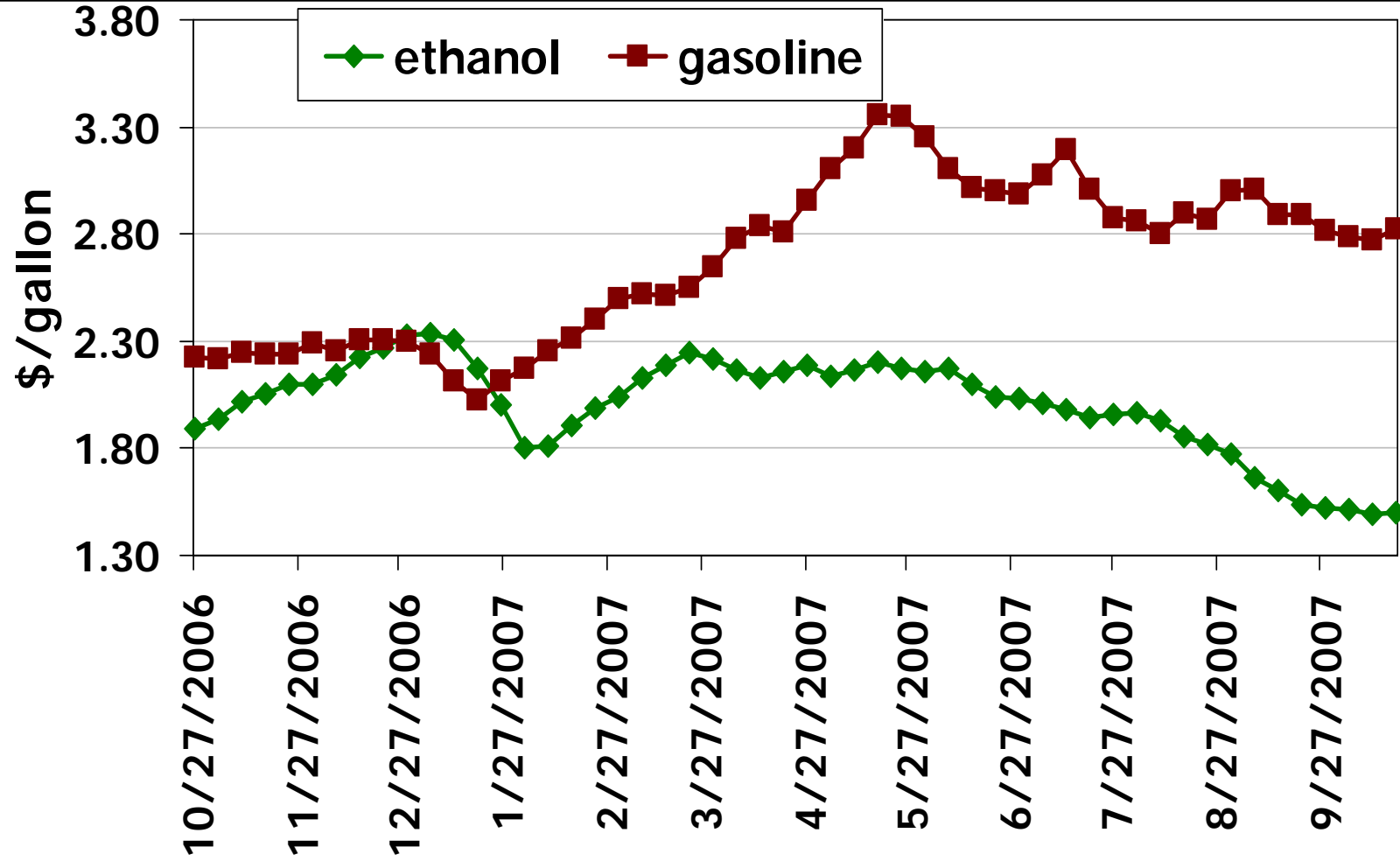
Gasoline-ethanol Price Relationship

- Mandated use
 - Sky's the limit
- Octane enhancer
 - Equal retail prices
 - Slightly higher rack price for ethanol
- Gasoline substitute – miles/dollar
 - Retail price E10 = 97% that of gasoline
 - Retail price E85 = 74% that of gasoline
 - Rack price E100 = 75% that of gasoline

Ethanol Price with \$2 Gasoline Rack Price ~ \$2.70 Retail Gasoline



Iowa Ethanol & Midwest Retail Gasoline Prices

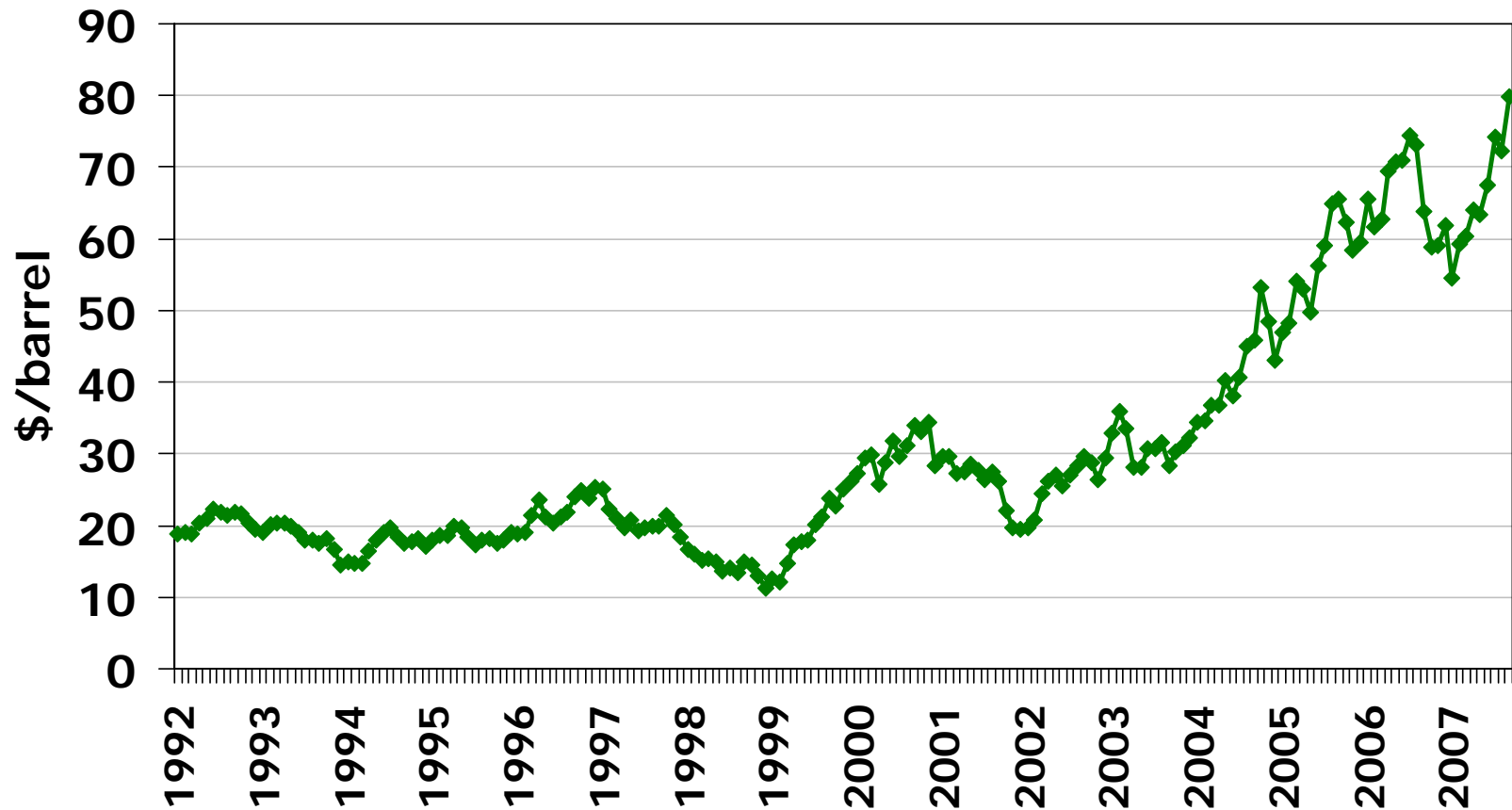




Impact on Gas Prices

Spot Crude Oil Prices 1992-2007

WTI, Monthly Average Price, Cushing, Oklahoma

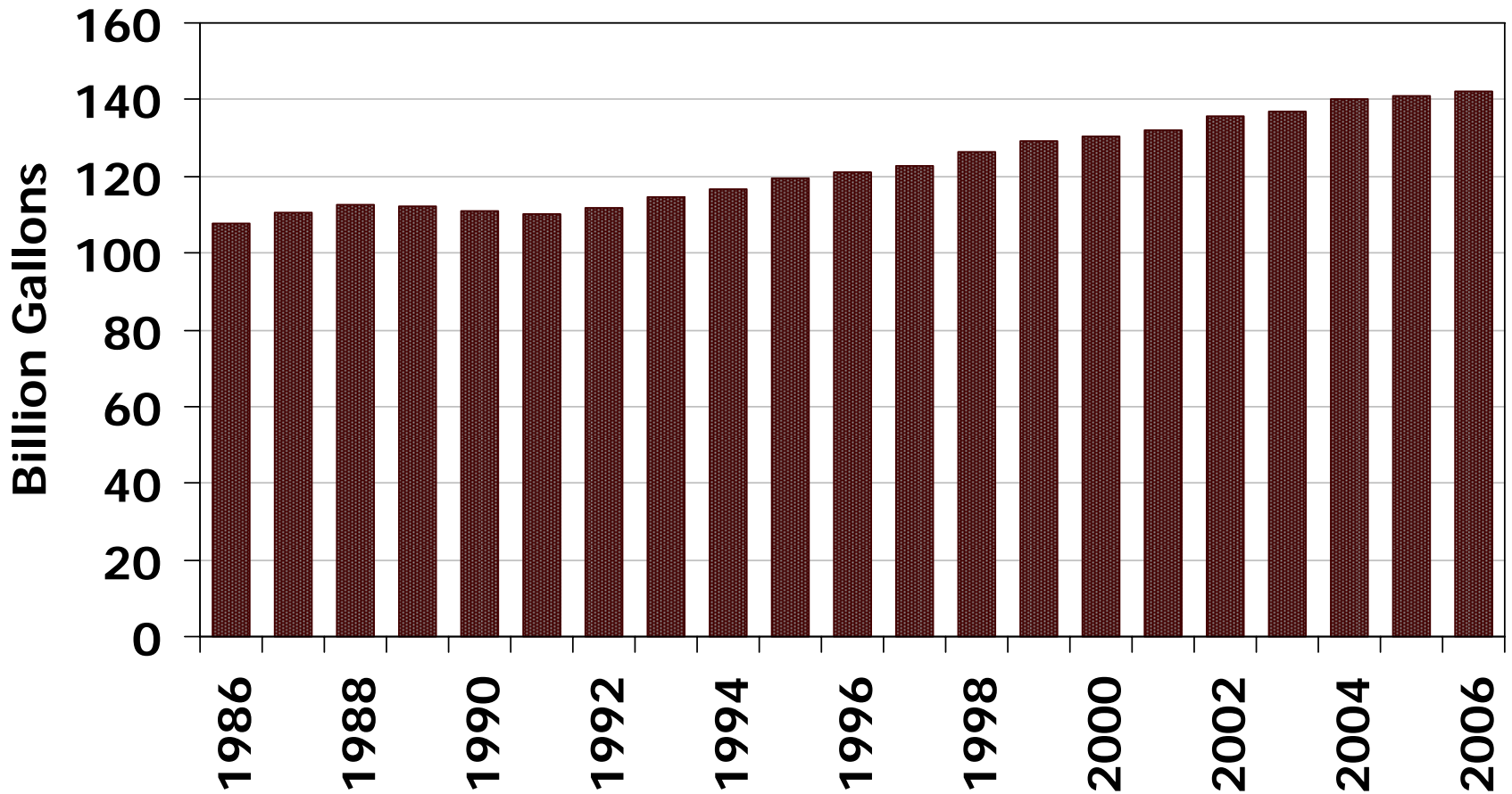


Source: U.S. Energy Information Administration



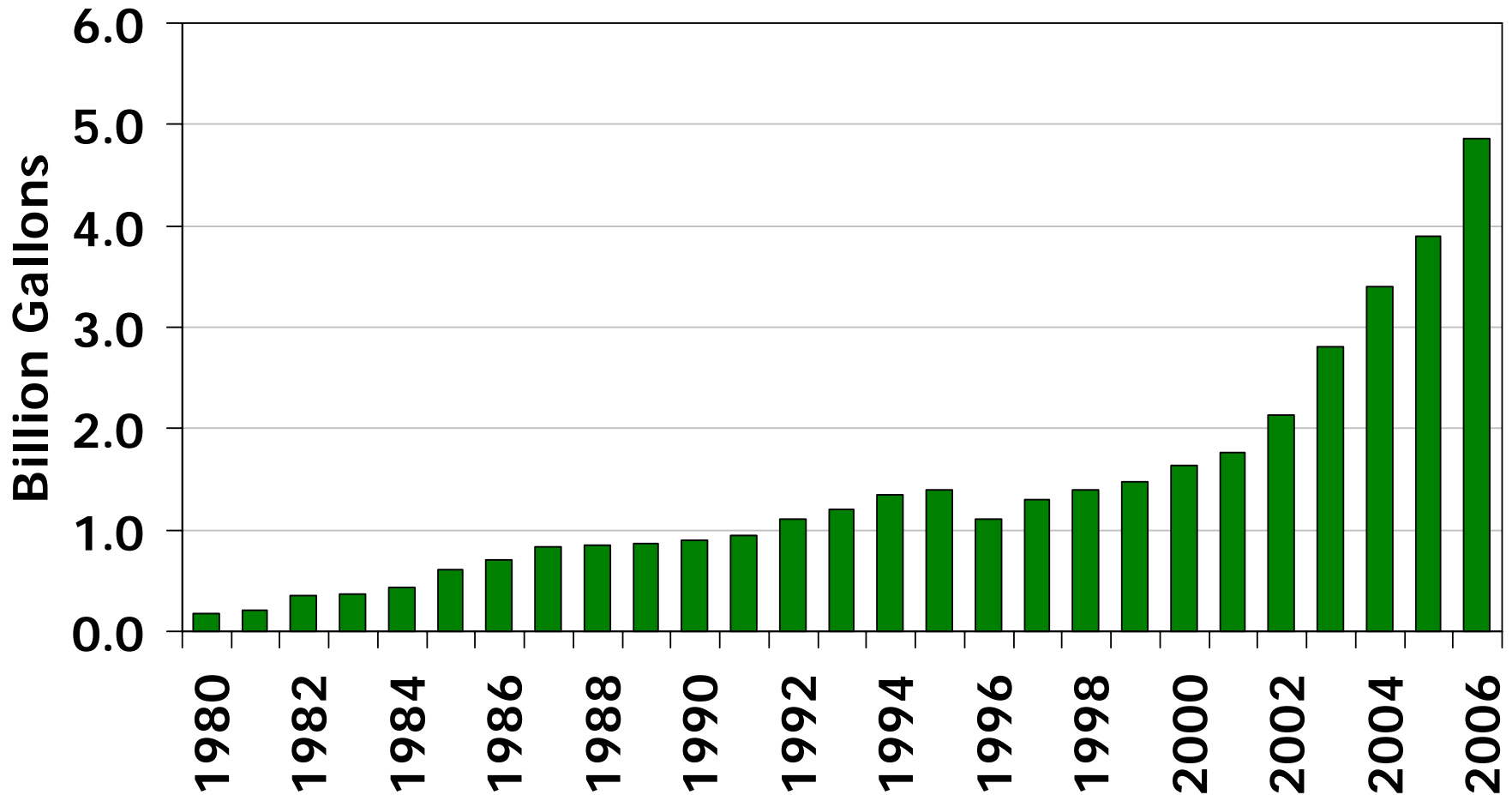
How much gasoline can ethanol replace?

U.S. Gasoline Usage, 1986-06



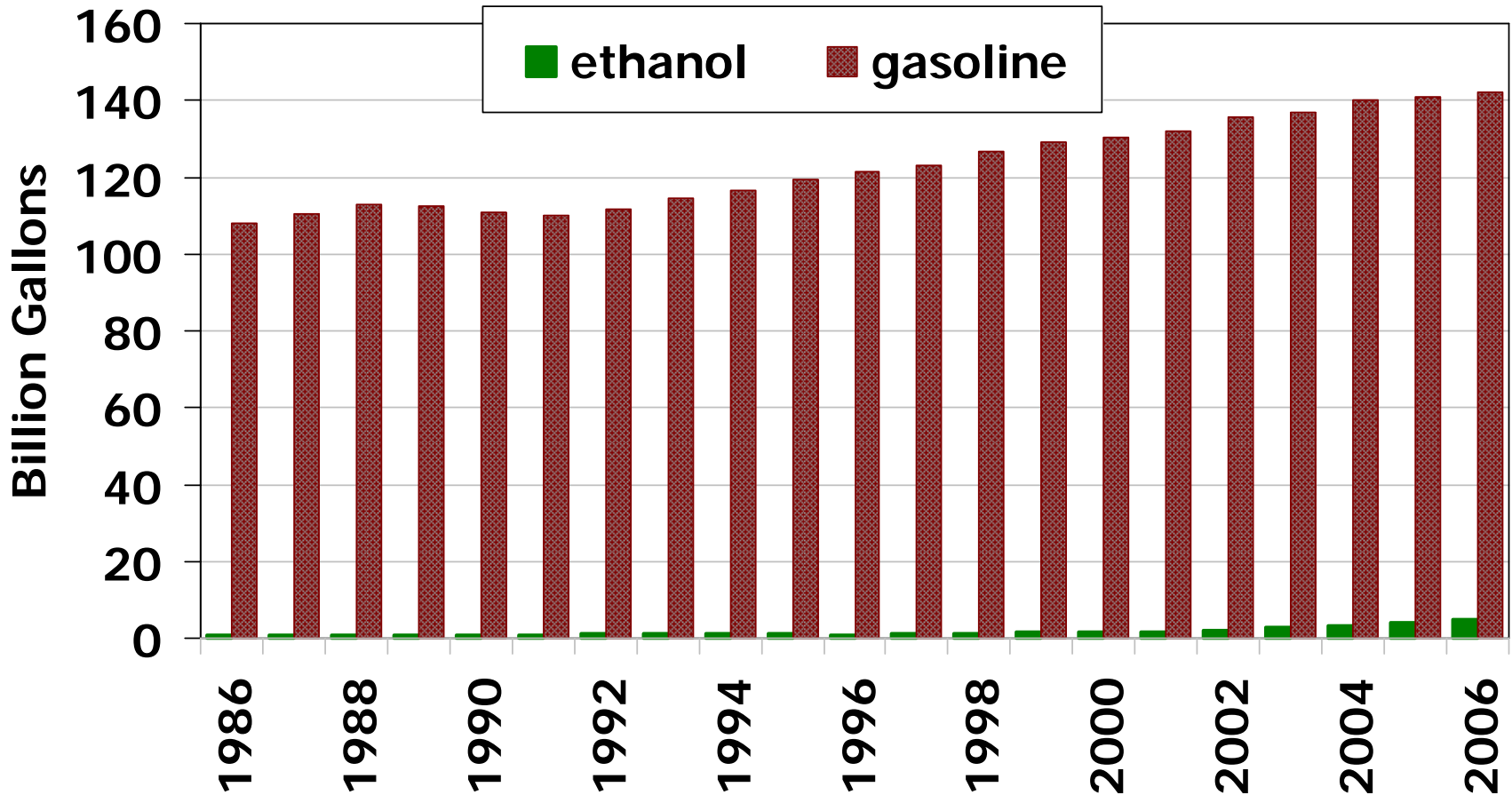
Source: U.S. Energy Information Administration

Ethanol Production, 1980-06



Source: Renewable Fuels Association

Gasoline & Ethanol Production, 1986-06



Source: U.S. Energy Information Administration

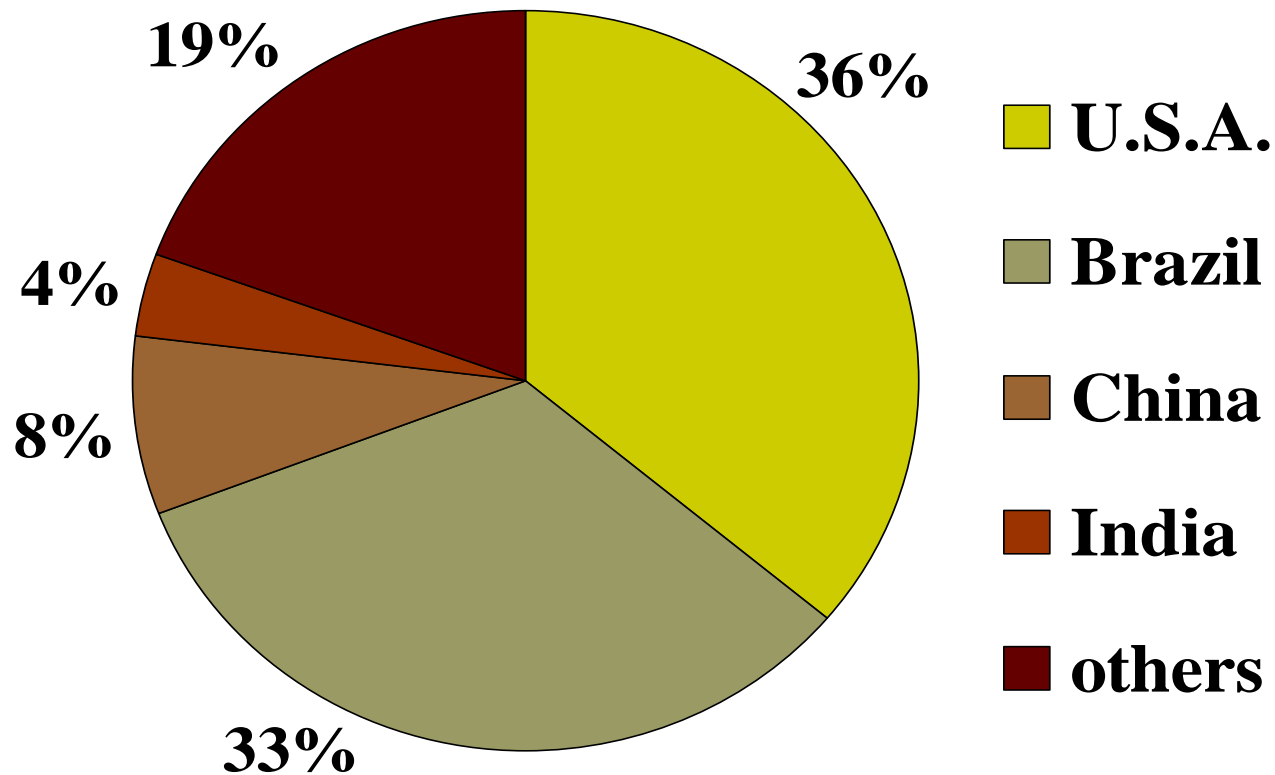
U.S. Gasoline Usage

- 141 billion gallons gasoline used per year
- Mandating 10% ethanol in all gasoline would require that nearly half of the U.S. corn crop be processed into ethanol
- If all U.S. corn were made into ethanol, it would produce 31 billion gallons per year
- To replace all U.S. gasoline would require 78.6 billion bushels of corn annually

78.6 Billion Bushels of Corn

- Record U.S. corn yield is 160 bu/acre
- 78.6 billion bushels at 160 bu/acre would require 491 million harvested acres of corn
- Equals **166%** of 2006 U.S. harvested acreage of corn, soybeans, wheat, sorghum, cotton, rice, sunflowers, barley, oats, rye, peanuts, tobacco, canola, sugar beets, sugarcane, potatoes, dry edible beans, proso millet and hay **combined**.

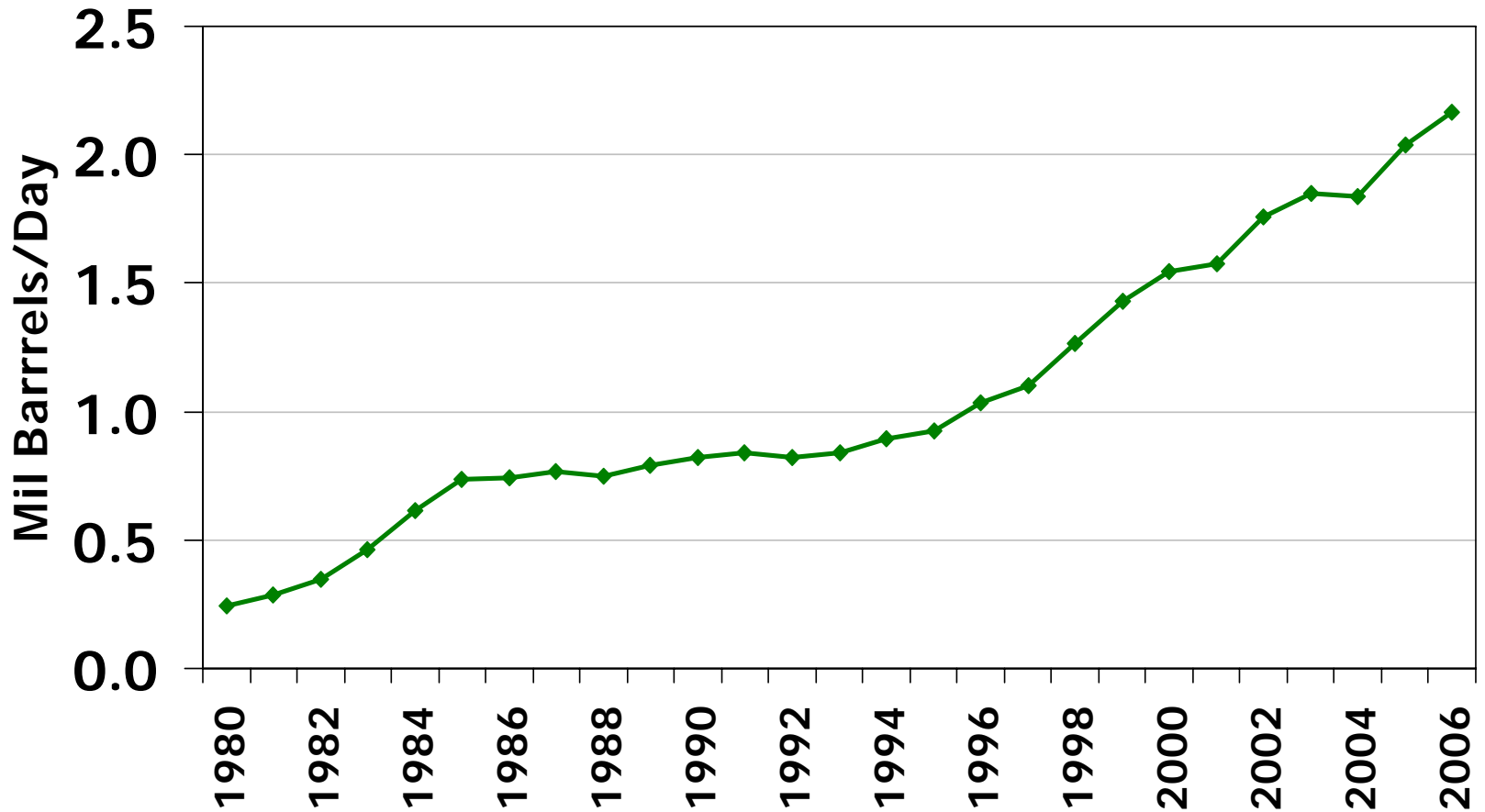
World Ethanol Production, 2006



Source: Renewable Fuels Association

Brazilian Crude Oil Production

Million Barrels Per Day, 1980-2006

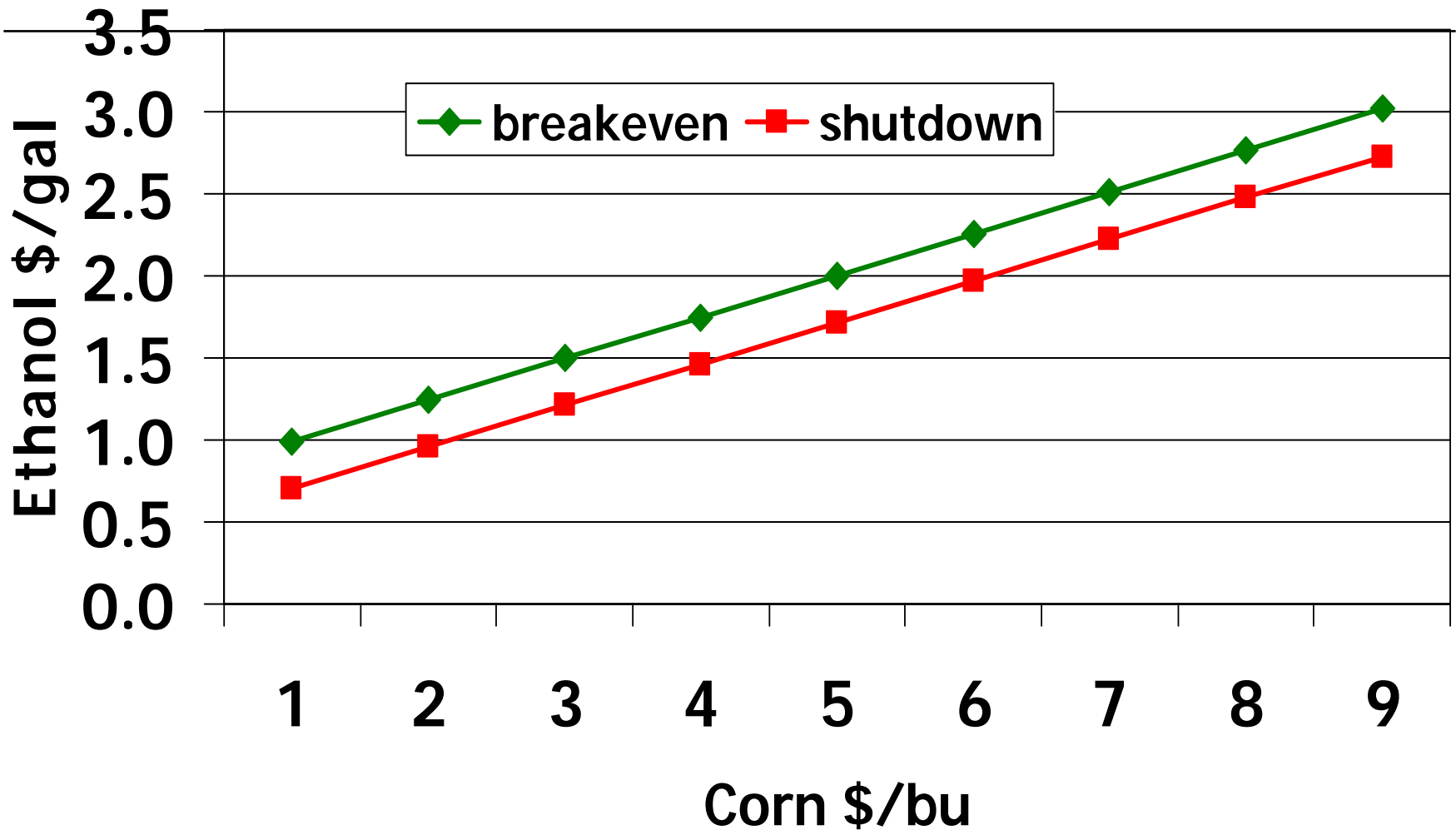


Source: U.S. Energy Information Administration



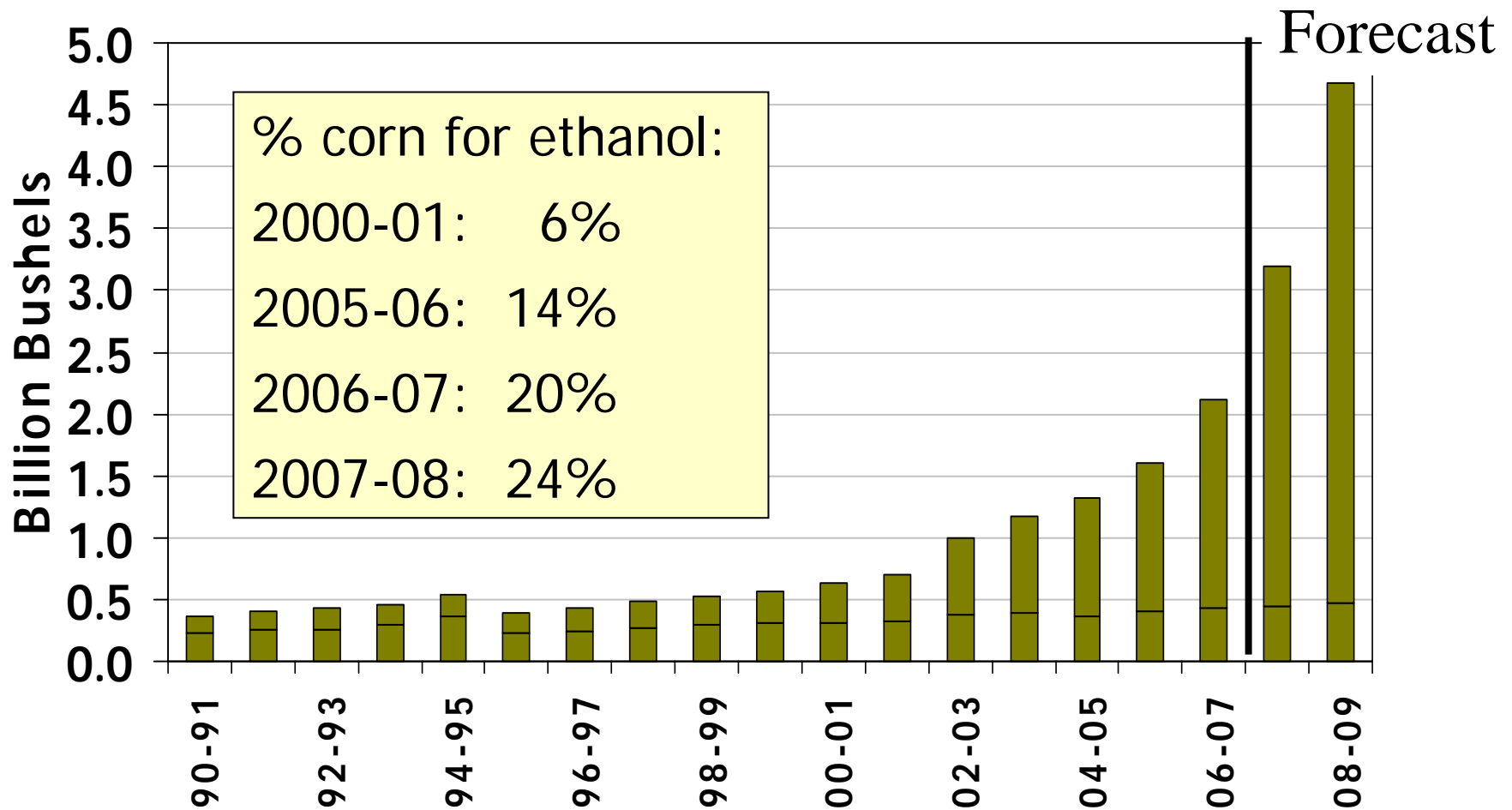
Ethanol and Corn

2007 Ethanol-Corn Price Relationship



Source: Ron Plain

Corn Milled for Ethanol



Forecasted Cost of Ethanol in 2007

U.S. Dollars Per Gallon of Ethanol Produced

| | |
|--|----------|
| □ Corn (\$3.50/bu) | \$1.2727 |
| □ Natural gas | \$0.23 |
| □ Electricity | \$0.06 |
| □ Enzymes & yeast | \$0.05 |
| □ Chemicals & Denaturant | \$0.09 |
| □ Labor & administration | \$0.11 |
| □ Maintenance | \$0.062 |
| □ Fixed costs | \$0.12 |
| □ Other costs | \$0.015 |
| □ Total cost | \$2.0097 |
| □ Less byproduct credit of \$0.38 for DDGS | |
| □ Total cost per gallon of ethanol: | \$1.63 |

If ethanol averages \$1.85, then profit equals \$0.22/gal or \$0.605/bu

Forecasted Cost of Ethanol in 2008

U.S. Dollars Per Gallon of Ethanol Produced

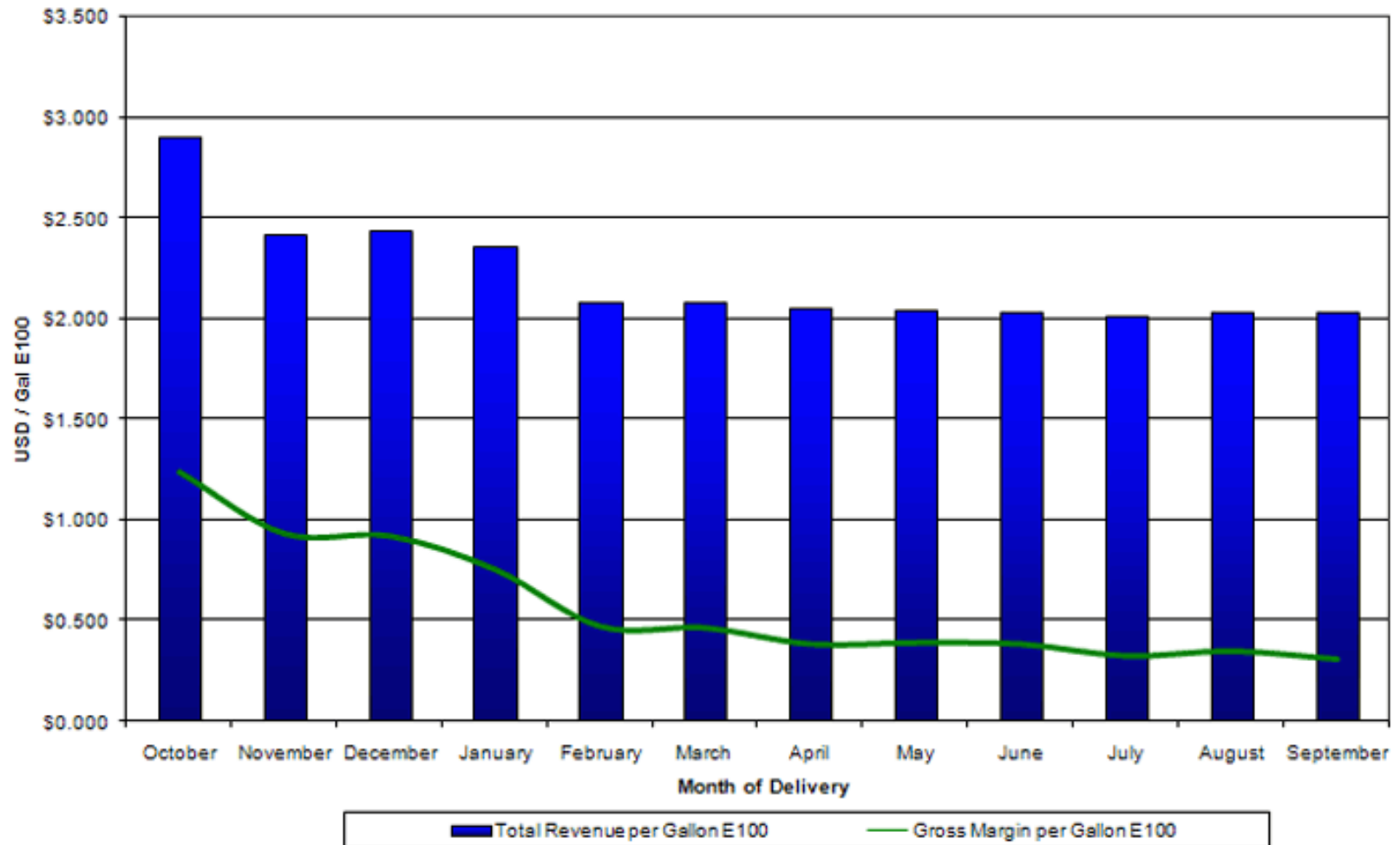
| | |
|--|----------|
| □ Corn (\$4.00/bu) | \$1.4545 |
| □ Natural gas | \$0.24 |
| □ Electricity | \$0.06 |
| □ Enzymes & yeast | \$0.05 |
| □ Chemicals & Denaturant | \$0.09 |
| □ Labor & administration | \$0.12 |
| □ Maintenance | \$0.07 |
| □ Fixed costs | \$0.12 |
| □ Other costs | \$0.02 |
| □ Total cost | \$2.2245 |
| □ Less byproduct credit of \$0.40 for DDGS | |
| □ Total cost per gallon of ethanol: | \$1.8245 |

If ethanol averages \$2.00, then profit equals \$0.175/gal or \$0.48/bu

DTN Ethanol Forecast

E100 Profitability

October 23, 2007



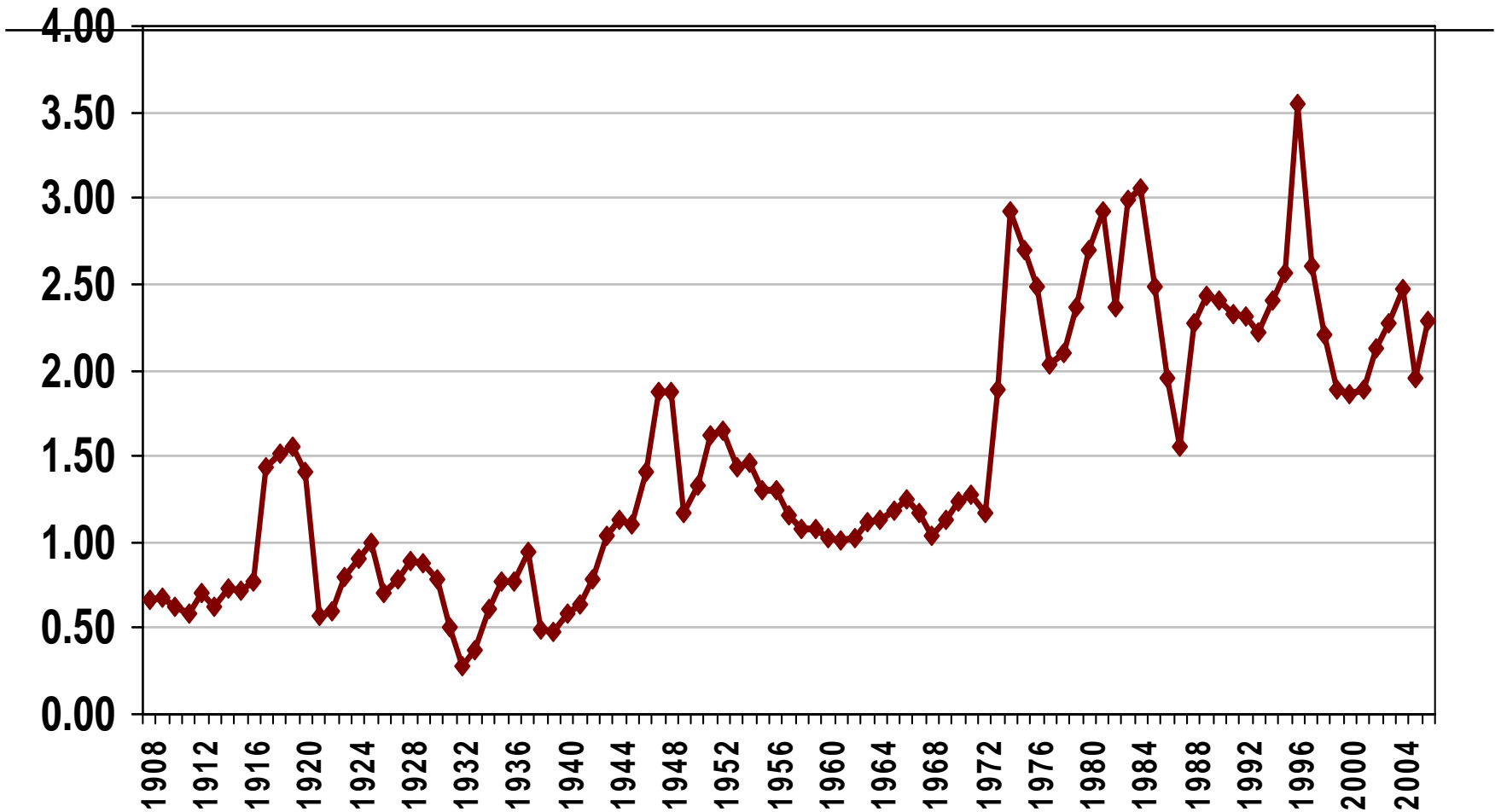
U.S. Corn Supply and Use – October 2007 revision

| | 2004/05 | 2005/06 | Projected | |
|-----------------------------------|---------------|---------------|---------------|---------------|
| | | | 2006/07 | 2007/08 |
| Planted area (mil. ac.) | 80.9 | 81.8 | 78.3 | 93.6 |
| Harvested area (mil. ac.) | 73.6 | 75.1 | 70.6 | 86.1 |
| Yield (bu./ac.) | 160.4 | 148.0 | 149.1 | 154.7 |
| Beginning stocks (mil.bu.) | 958 | 2,114 | 1,967 | 1,304 |
| Production | 11,807 | 11,114 | 10,535 | 13,318 |
| Imports | 11 | 9 | 12 | 15 |
| Total supply | 12,776 | 13,237 | 12,514 | 14,637 |
| Feed | 6,158 | 6,155 | 5,600 | 5,700 |
| Ethanol | 1,323 | 1,603 | 2,115 | 3,200 |
| Food, seed, other | 1,363 | 1,378 | 1,371 | 1,390 |
| Exports | 1,818 | 2,134 | 2,125 | 2,350 |
| Total use | 10,662 | 11,270 | 11,210 | 12,640 |
| Ending stocks | 2,114 | 1,967 | 1,304 | 1,997 |
| Stocks/use ratio | 19.8% | 17.5% | 11.6% | 15.8% |
| Farm price | \$2.06 | \$2.00 | \$3.04 | \$3.20 |
| Loan rate | \$1.98 | \$1.95 | \$1.95 | \$1.95 |

On 10/11/07 December 07 corn futures settled at \$3.44

U.S. Average Corn Price, 1908-2006

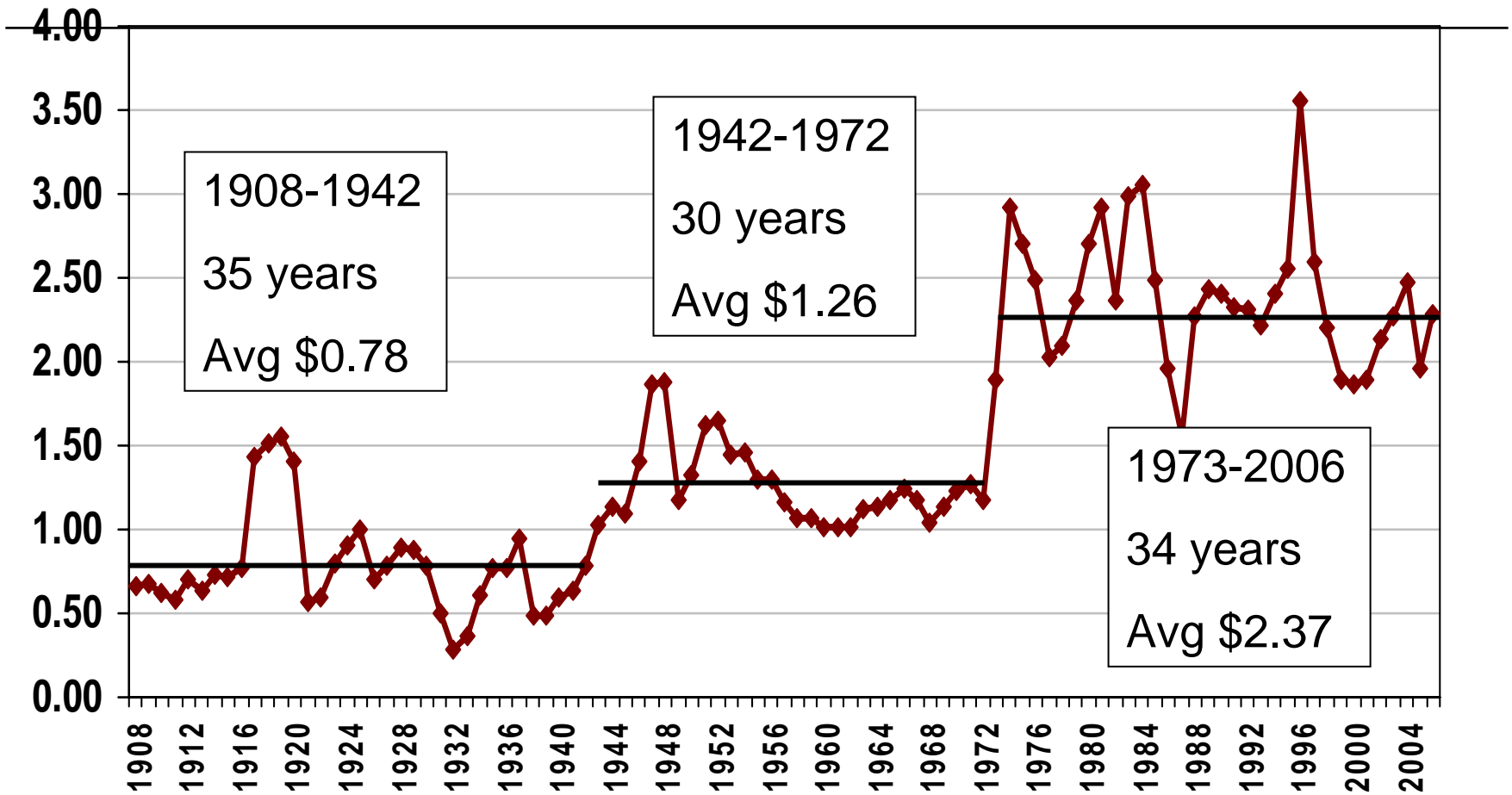
\$ Per Bushel



Source: USDA/NASS

U.S. Average Corn Price, 1908-2006

\$ Per Bushel

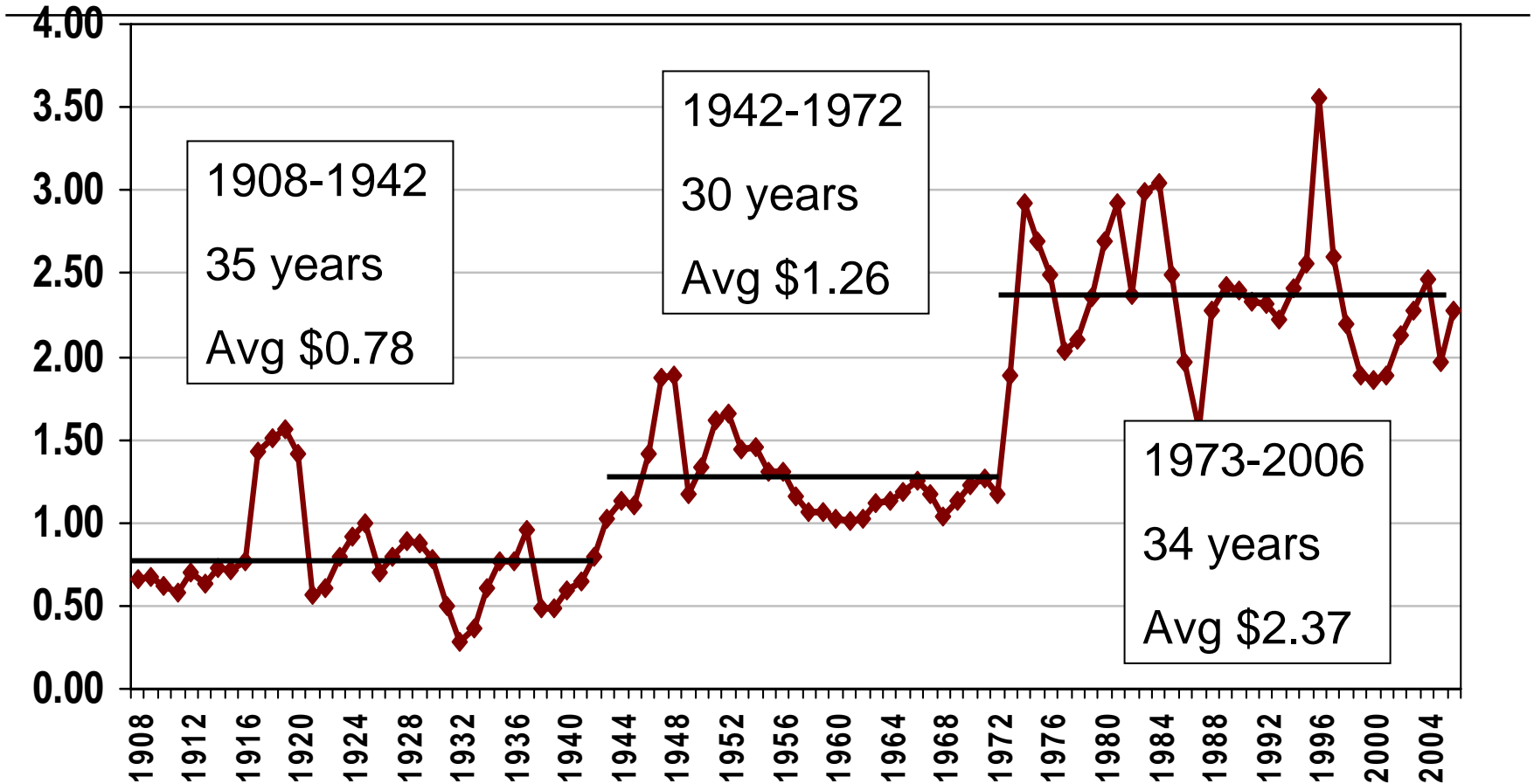


Source: USDA/NASS

U.S. Average Corn Price, 1908-2006

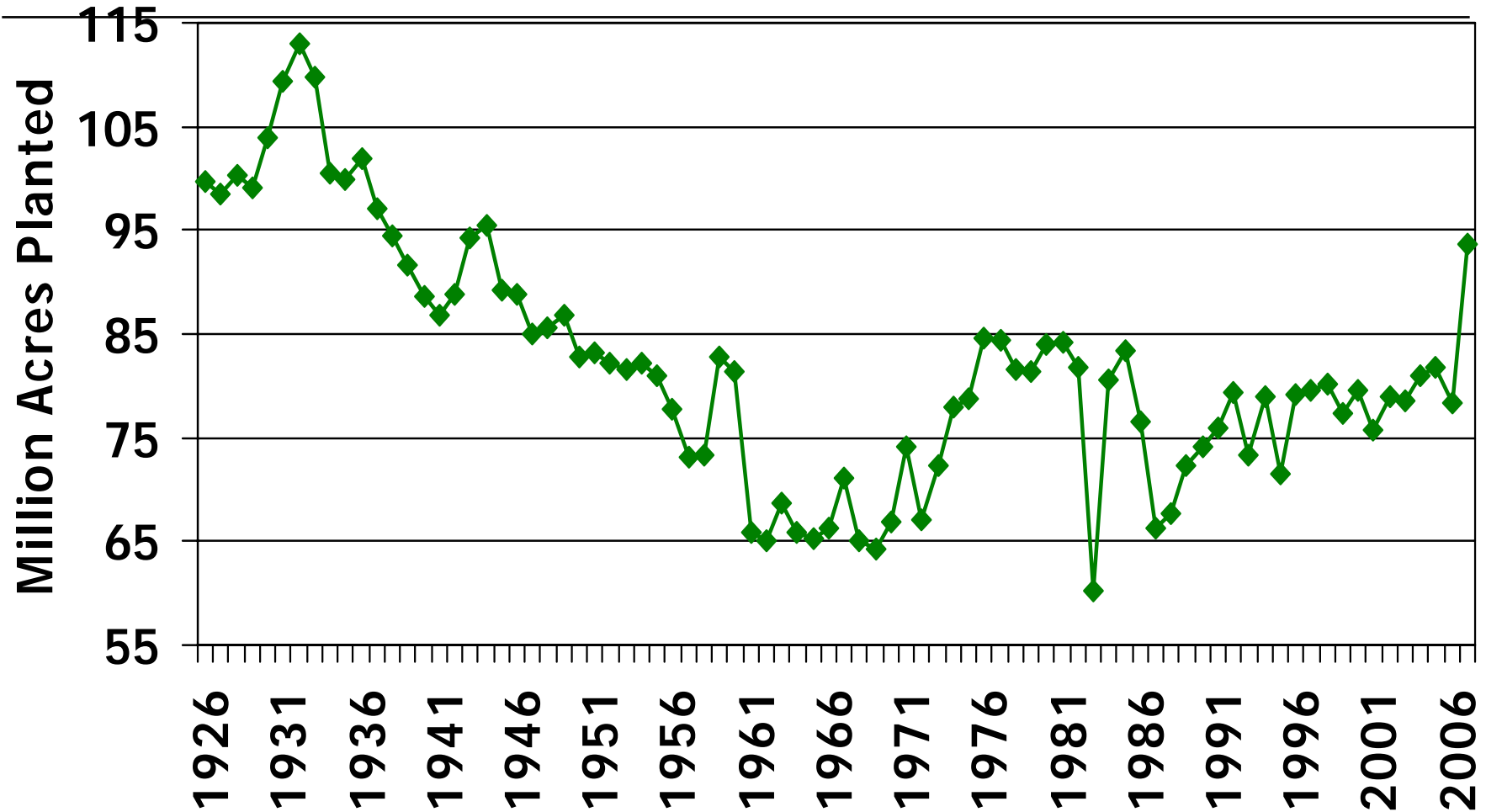
\$ Per Bushel

What's the next level?

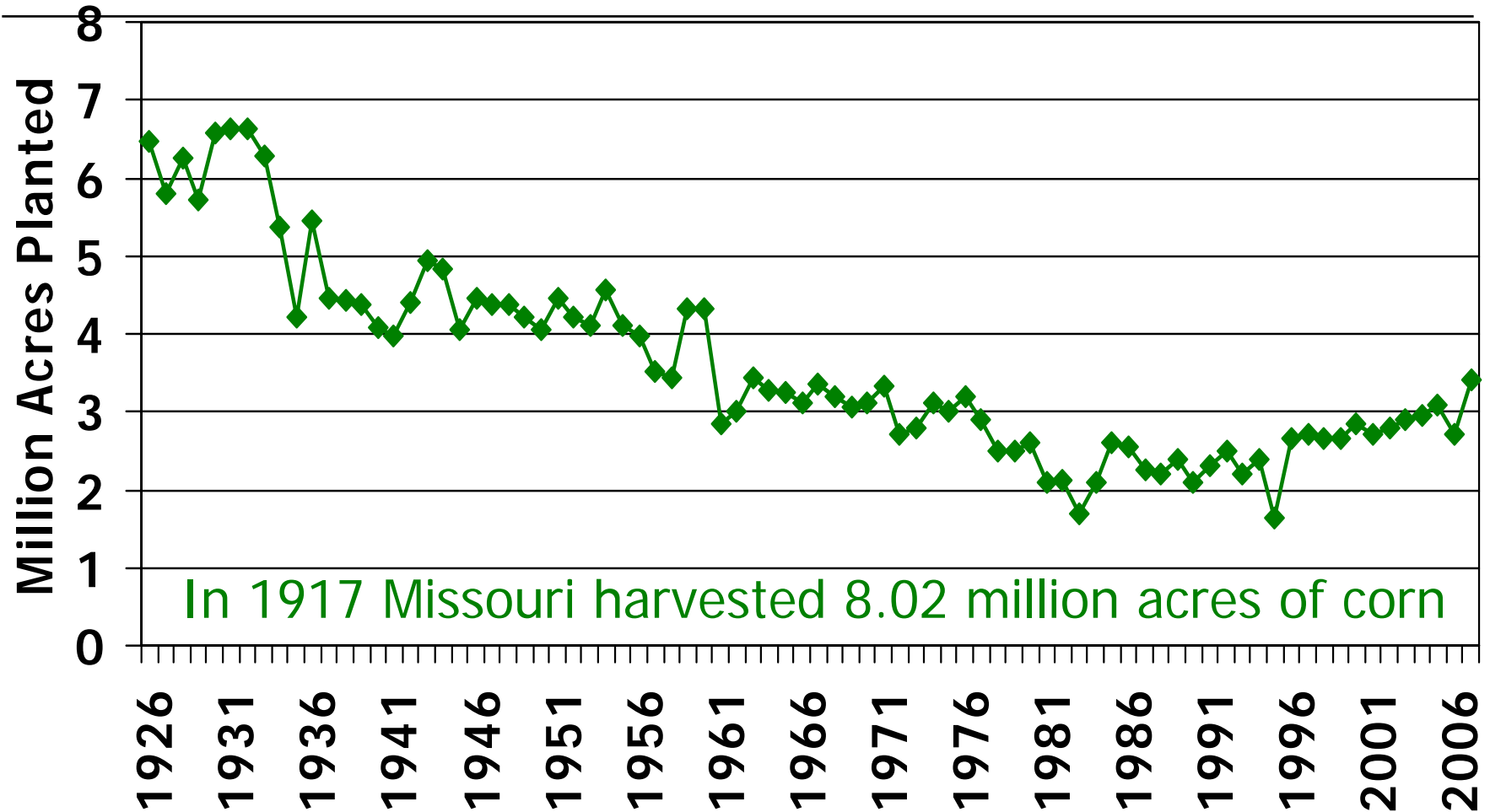


The 1940s step raised corn price 62%, the 70s step: 88%
A 75% step will take corn to \$4.15/bu

U.S. Corn Acres Planted, 1926-07



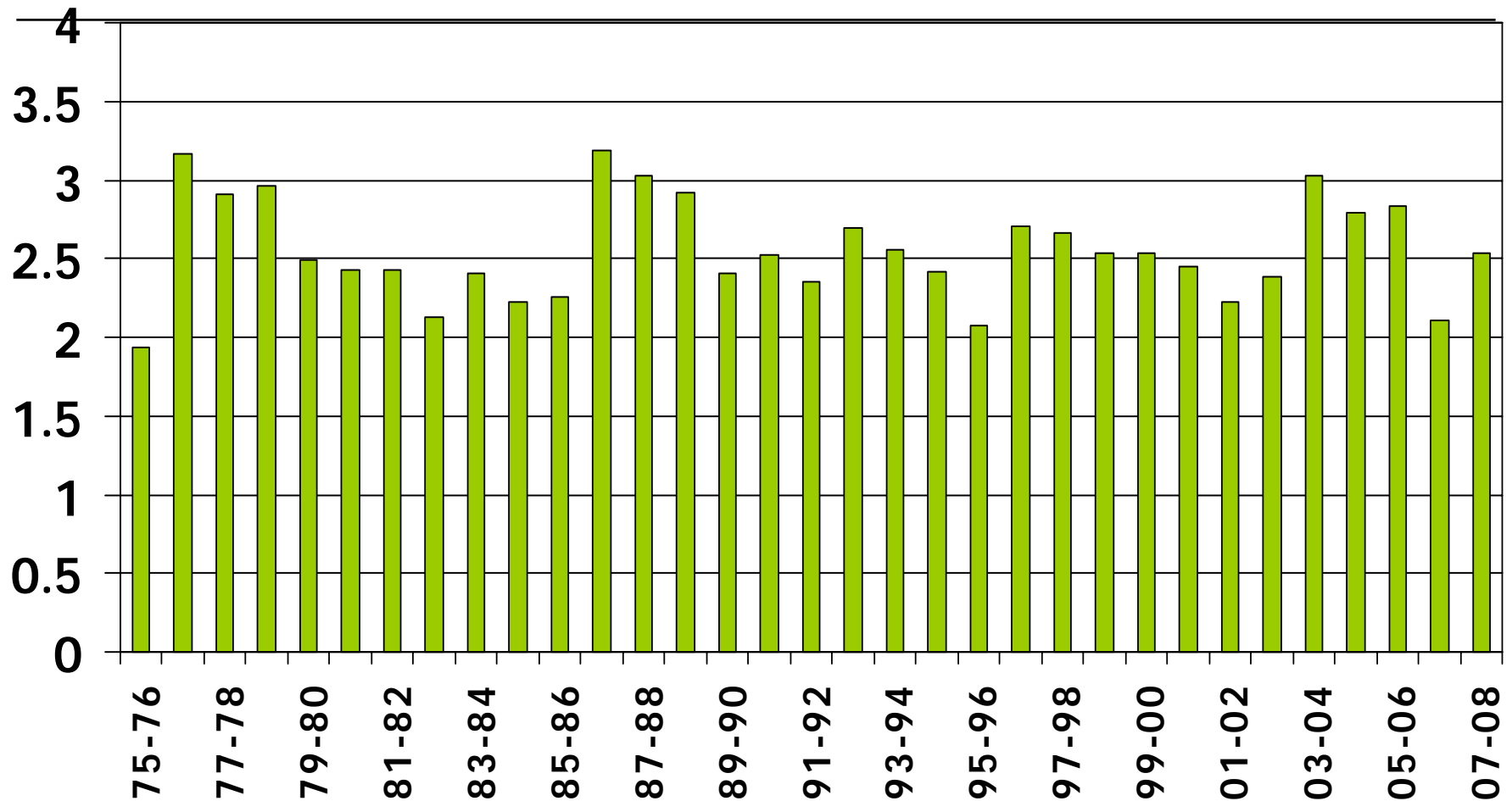
Missouri Corn Acres Planted, 1926-07





Implication of \$4 corn for soybean prices

U.S. Soybean/Corn Price Ratio, 1975-08



Million Acres Planted by Crop

| | 2006 | 2007* | Change |
|----------|---------|---------|----------|
| Corn | 78.327 | 93.616 | + 15.289 |
| Soybeans | 75.522 | 63.669 | - 11.853 |
| Wheat | 57.344 | 60.433 | + 3.089 |
| Cotton | 15.274 | 10.847 | - 4.427 |
| Sorghum | 6.522 | 7.704 | + 1.182 |
| Oats | 4.168 | 3.760 | - 0.408 |
| Barley | 3.452 | 4.020 | + 0.568 |
| 18 crops | 315.835 | 320.052 | + 4.217 |

*October 12 estimate

November 07 Soybean Futures



Soybean Futures, 1988-07



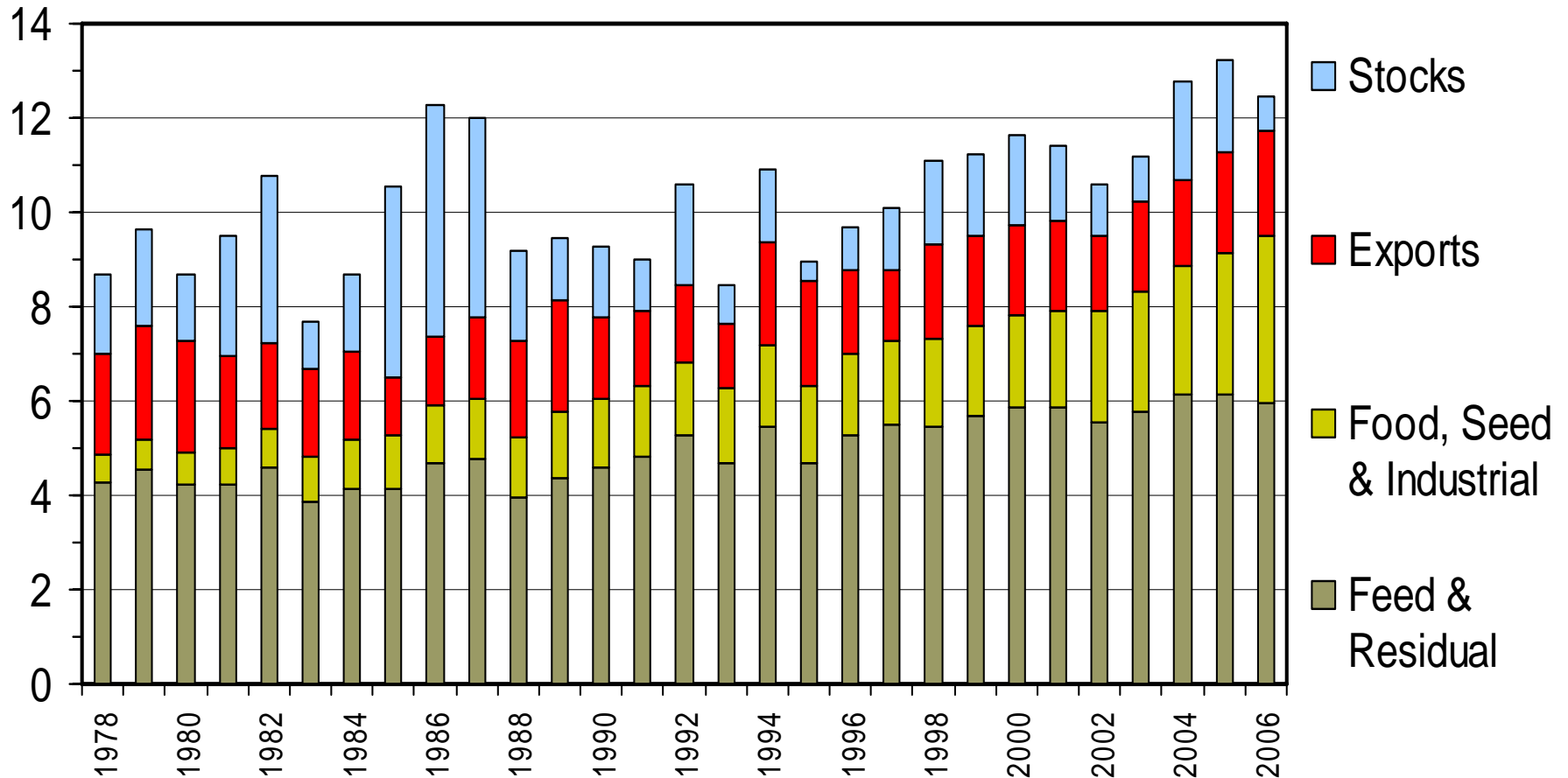
Implications of Increasing Ethanol Production

- Higher corn prices
 - Smaller LDP & CCP payments
- Higher land rent and prices
- New grain storage/shipping patterns
- Acreage shift to corn
 - First from soybeans
 - Then other commodity crops
- Higher production cost for livestock
 - Reduced livestock production
 - Higher meat/milk/egg prices
- Feeding lots of distillers grain

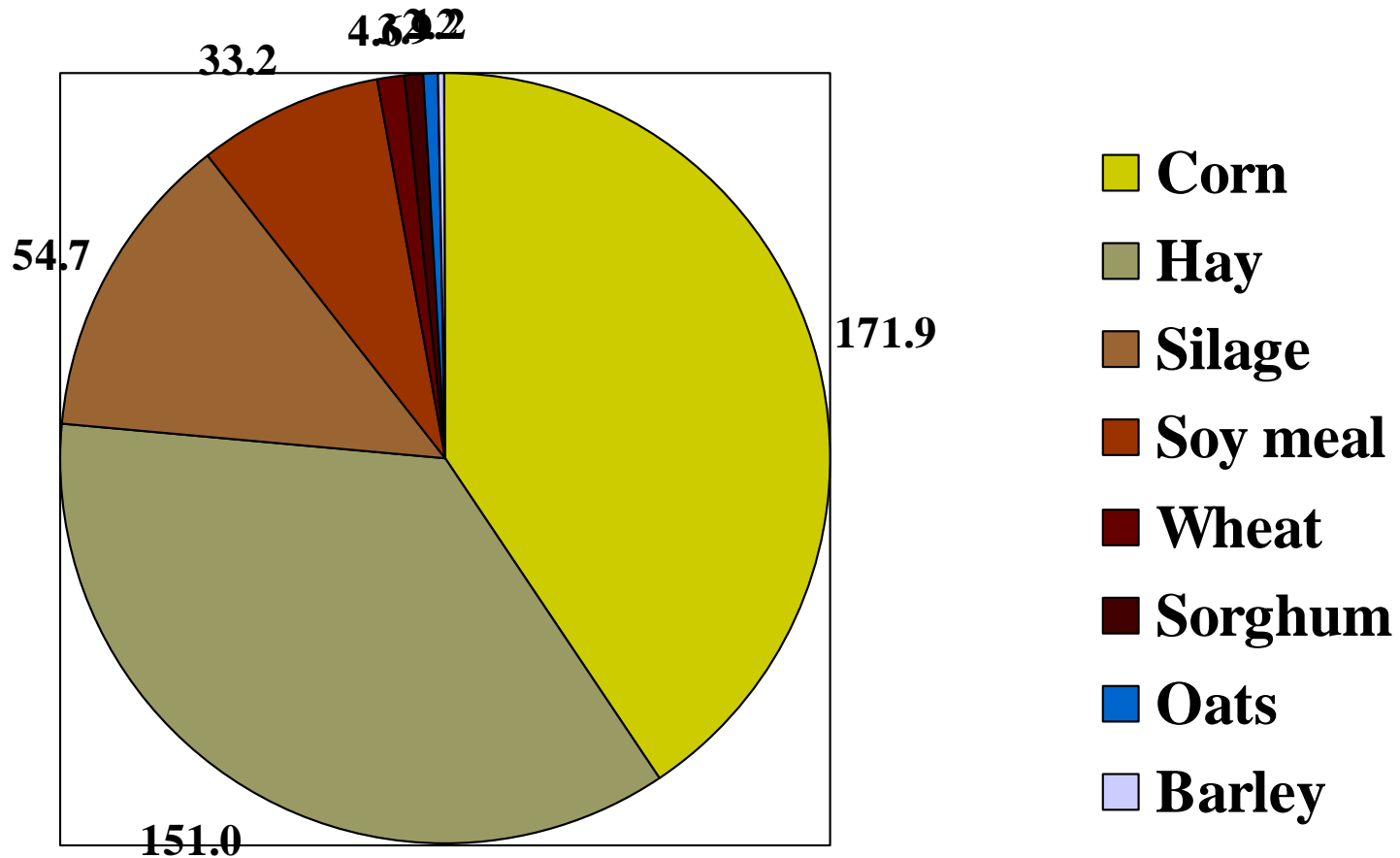
CORN DISAPPEARANCE AND STOCKS

Crop Year

Bil. Bushels

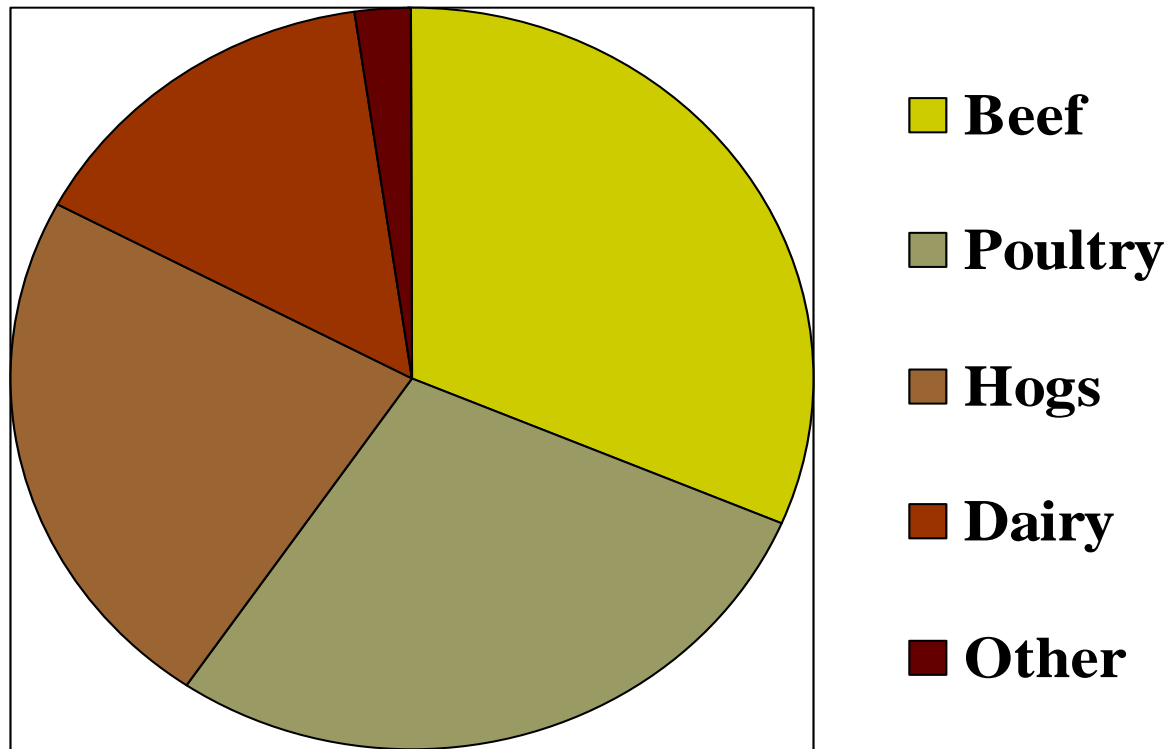


U.S. Feed Sources, 2005-06



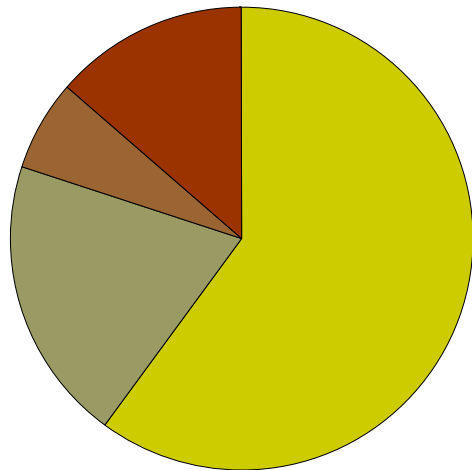
Source: USDA/WASDE

U.S. Feeding of Corn, 2005-06



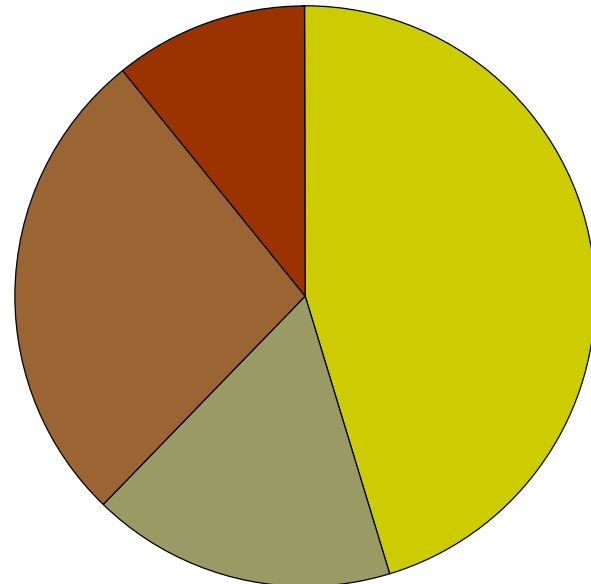
Source: PRX ProExporter Network

U.S. Corn Usage



2000 crop

- Feed
- Exports
- Ethanol
- Other

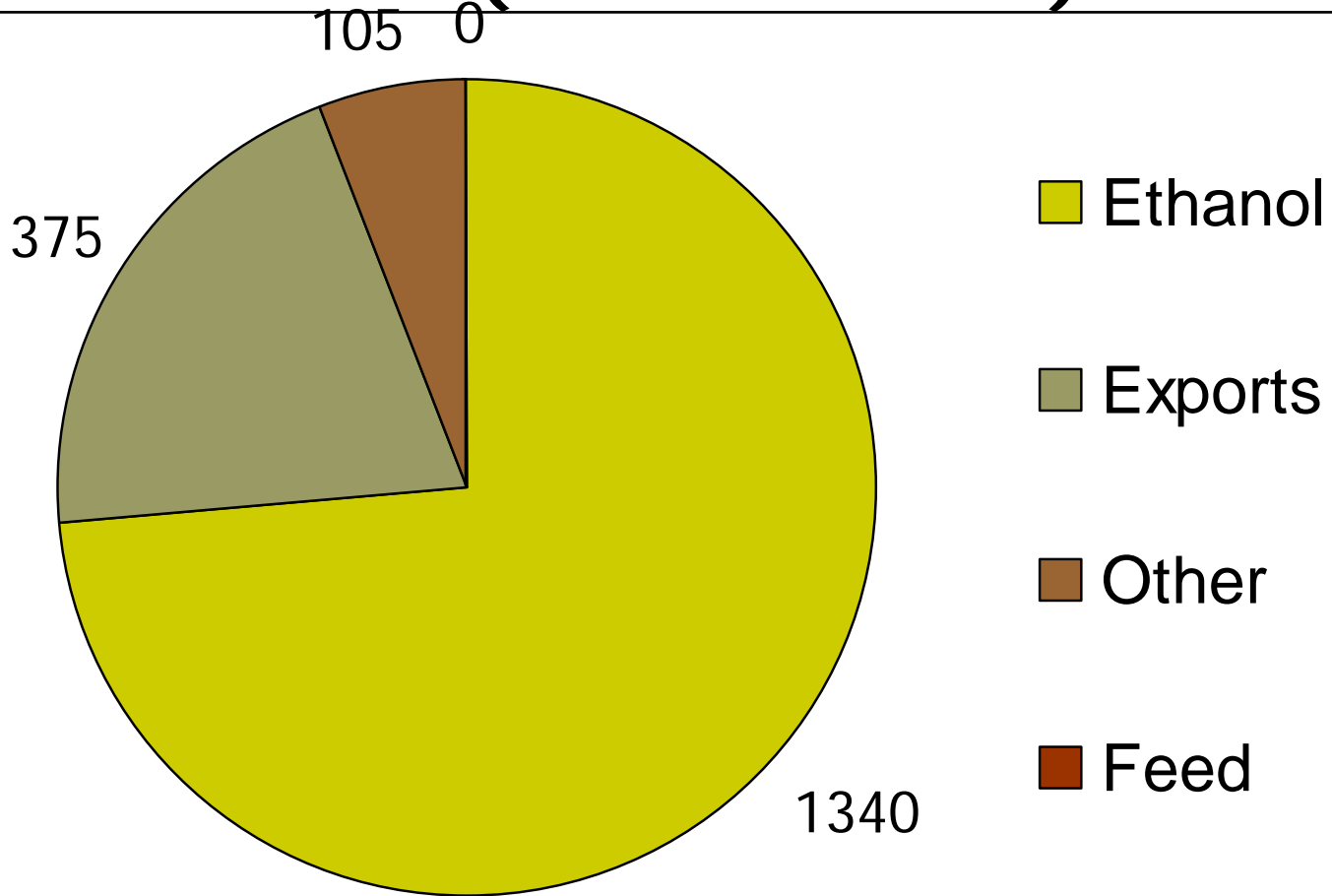


2007 crop

- Feed
- Exports
- Ethanol
- Other

Corn usage is up 30% since 2000

FORECAST CHANGE IN CORN USAGE 2005-15 (million bushels)

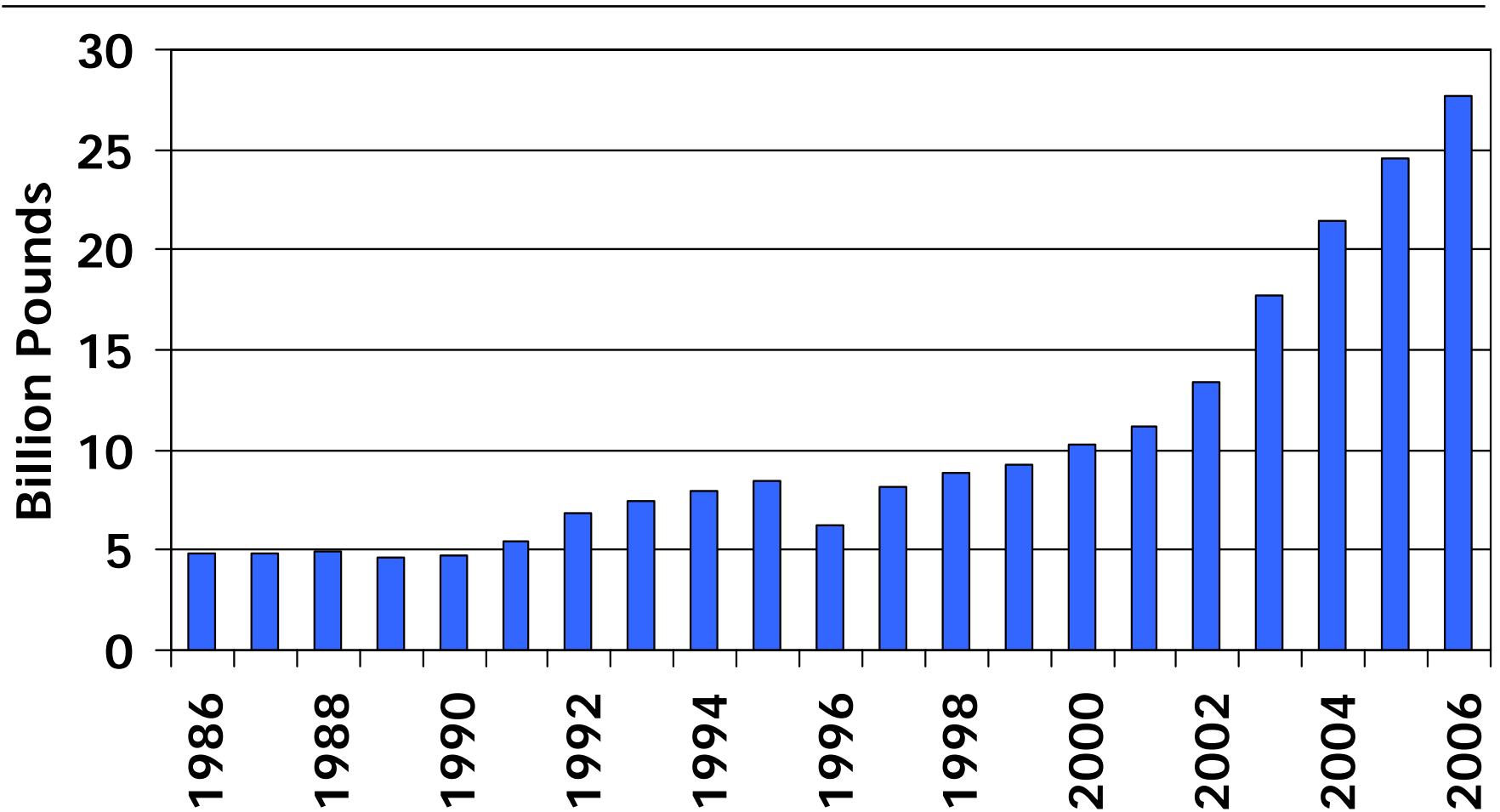


Source: February 2006 USDA Agricultural Baseline Projections



By Product Feed

Ethanol By-Product Feed



Value of DDGS Depends on Use

| | |
|---|----------------|
| Assumptions: | |
| •Corn | \$2.00 / bu |
| •SBM | \$175.00 / ton |
| •Urea | \$360.00 / ton |
| •Non-ruminant diets corn/SBM | |
| •Ruminant diets typical diets with competing by-products. | |

| Feed | Dollars/ton |
|-------------------------|--------------------|
| Dairy Lactation | \$114.24 |
| Beef Feedlot | \$108.00 |
| Layer Diet | \$104.66 |
| Poultry Finisher | \$100.09 |
| Swine G-F Diet | \$ 96.34 |

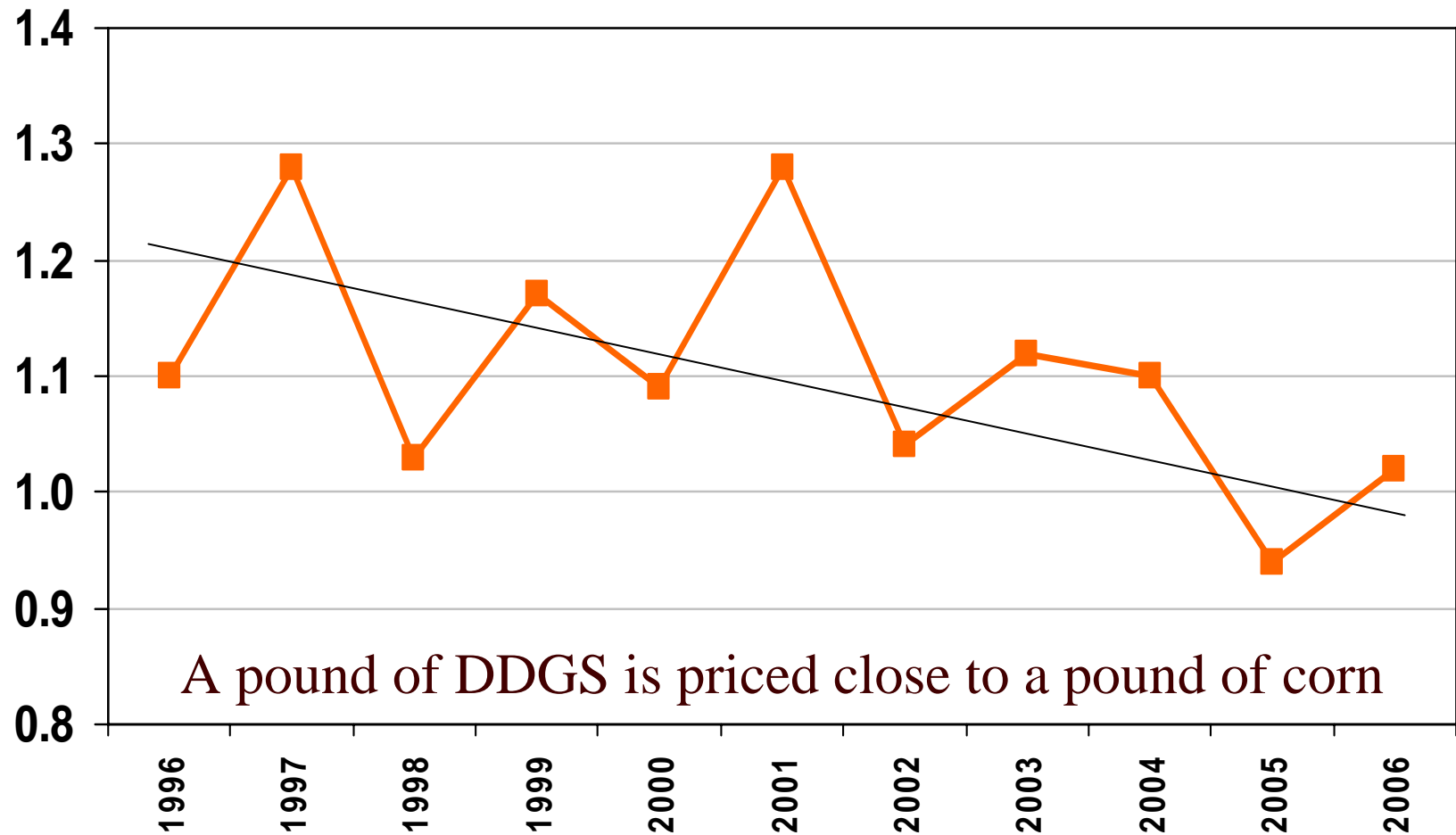
Nutrient Composition (DM)

| Item | Corn | SBM | DDGS |
|------------------|-------------|------------|-------------|
| Crude Protein, % | 8-9 | 47-49 | 29-33 |
| Crude Fat, % | 4 | 3 | 8-12 |
| Crude Fiber, % | 2-3 | 10-11 | 5-10 |
| ADF, % | 3.1 | 10.6 | 17.5 |
| DE, kcal/lb | 1551 | 1782 | 1589-1836 |
| Lysine, % | 0.3 | 3 | 0.6-1.1 |
| Phosphorus, % | 0.3 | 0.7 | 0.4-1.0 |



DDGS-Corn price relationship

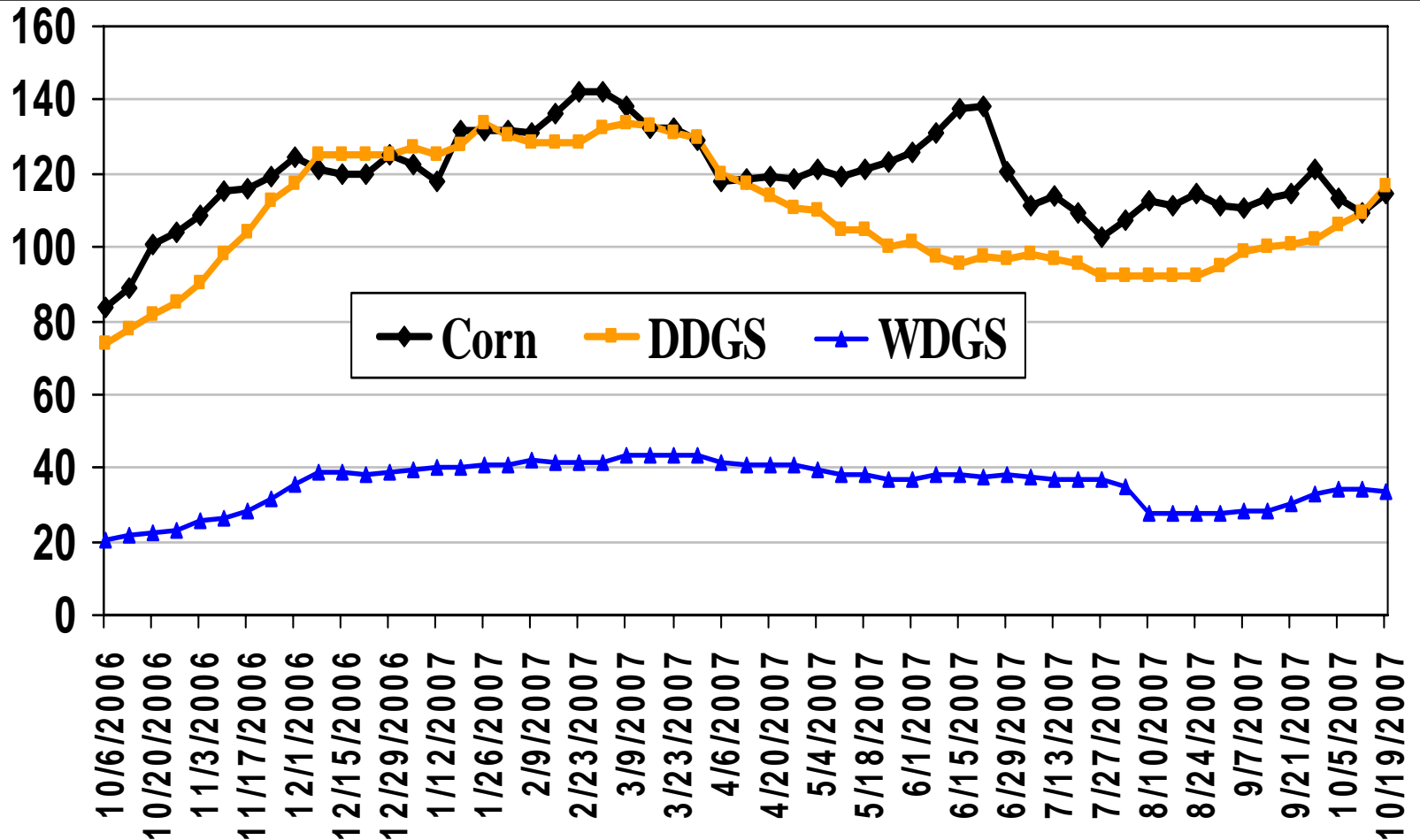
Price Ratio: DDGS/Corn, Illinois, 1996-06



A pound of DDGS is priced close to a pound of corn

Northwest Iowa Prices, 2006-07

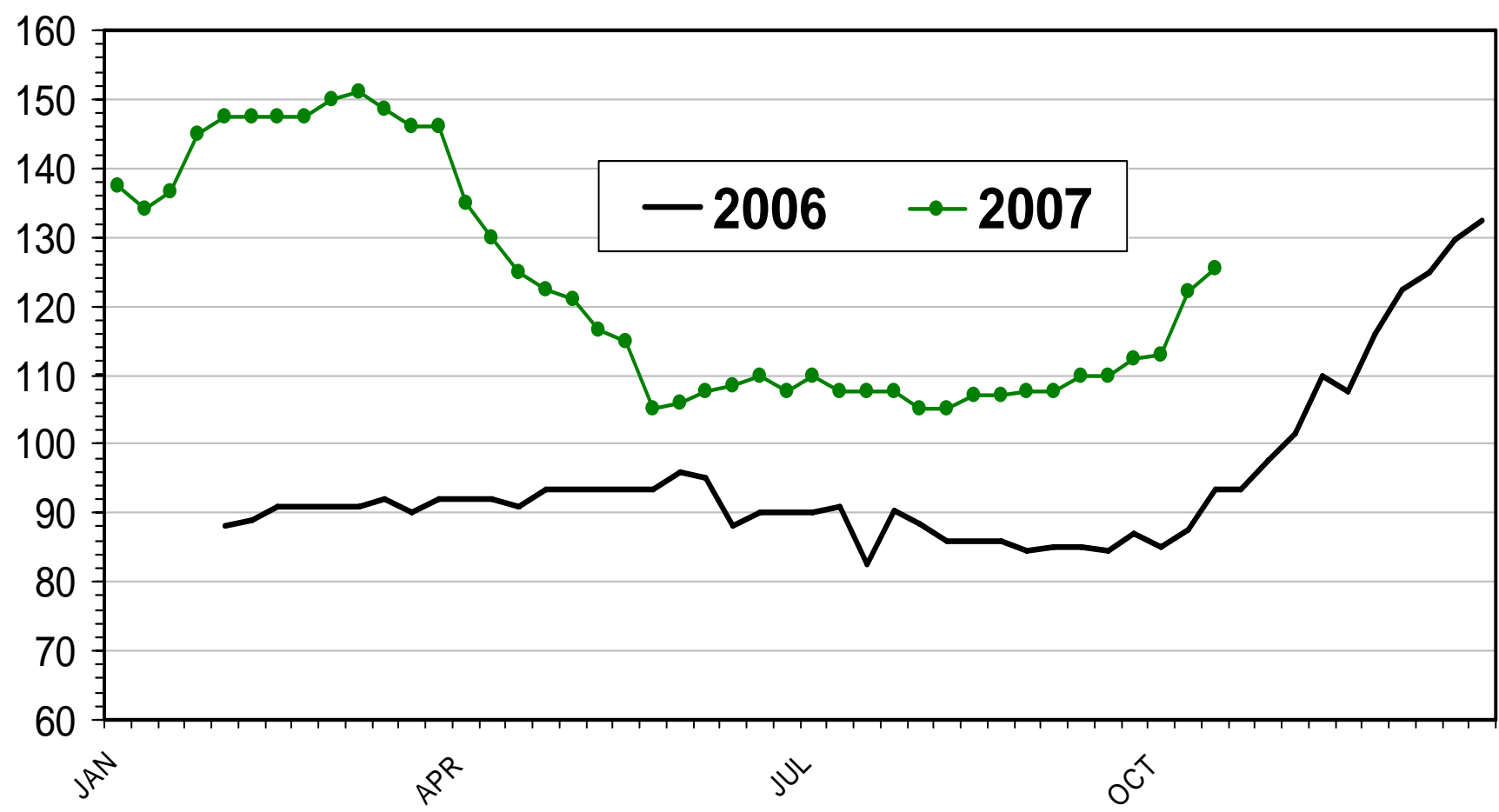
\$ Per Ton



Source: LMIC

North Missouri DDGS Prices

\$ Per Ton



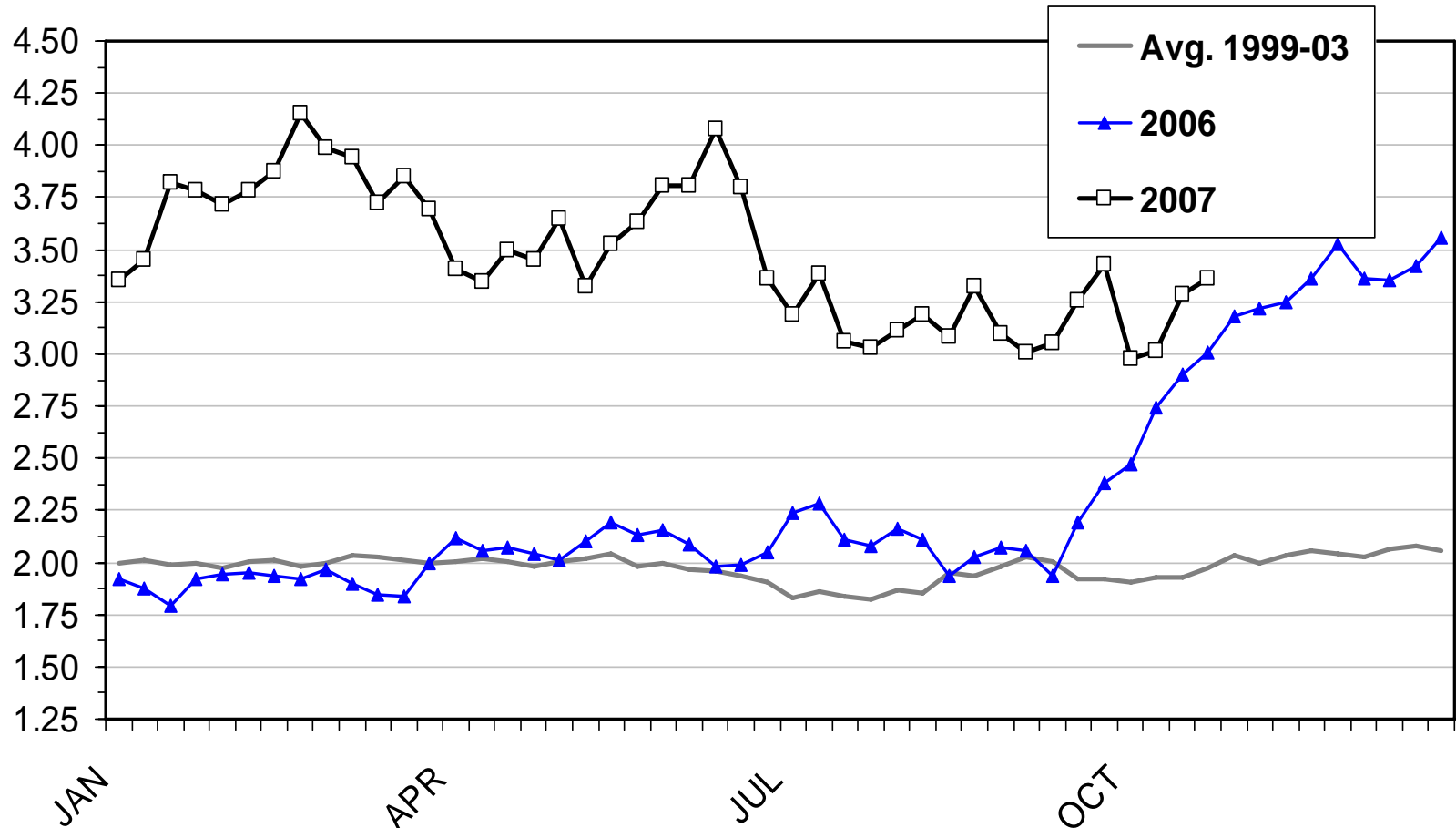
Source: LMIC



Doubling Corn Prices

Omaha Corn Prices, weekly

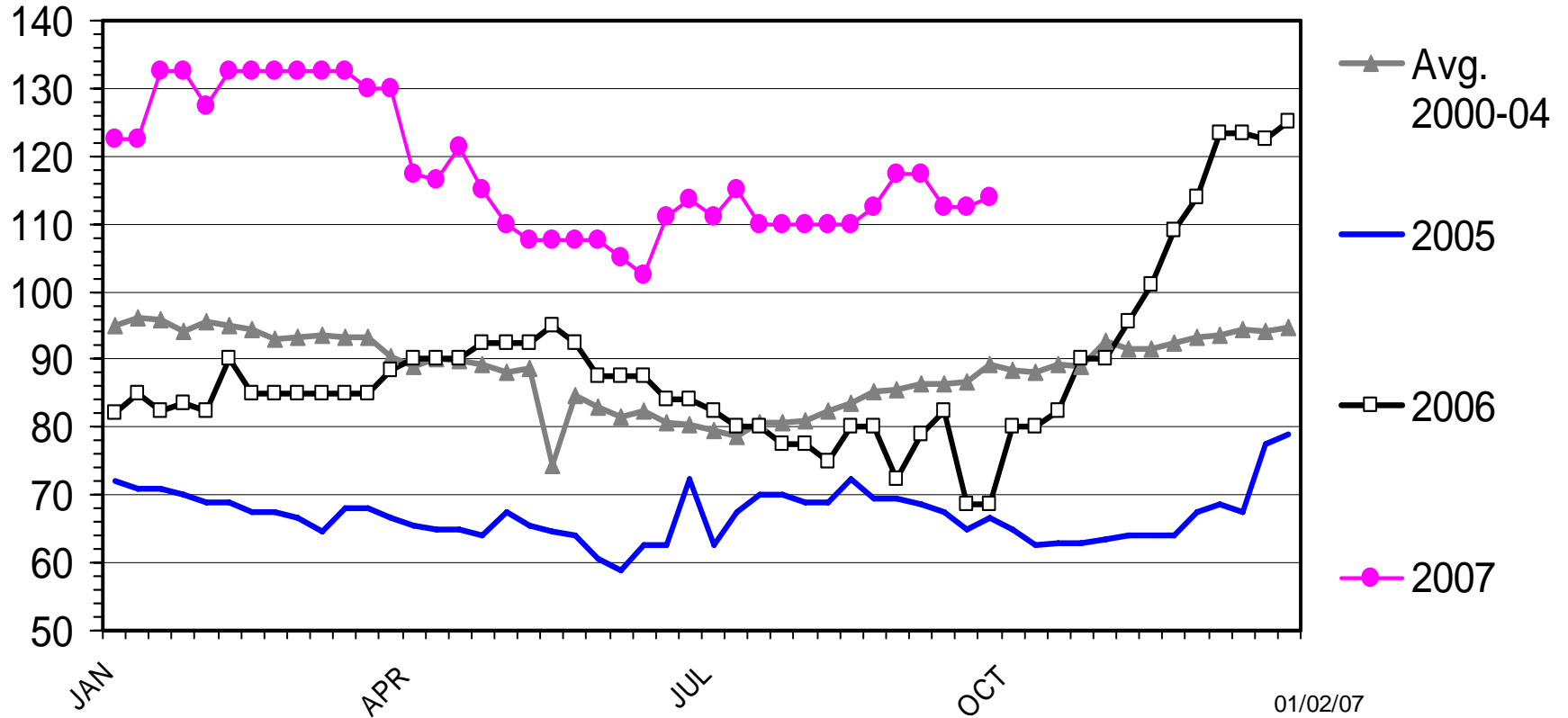
\$ Per Bu.



DISTILLER DRIED GRAIN PRICES

Central Illinois, Weekly

\$ Per Ton



January 2007 CME Feeder Cattle

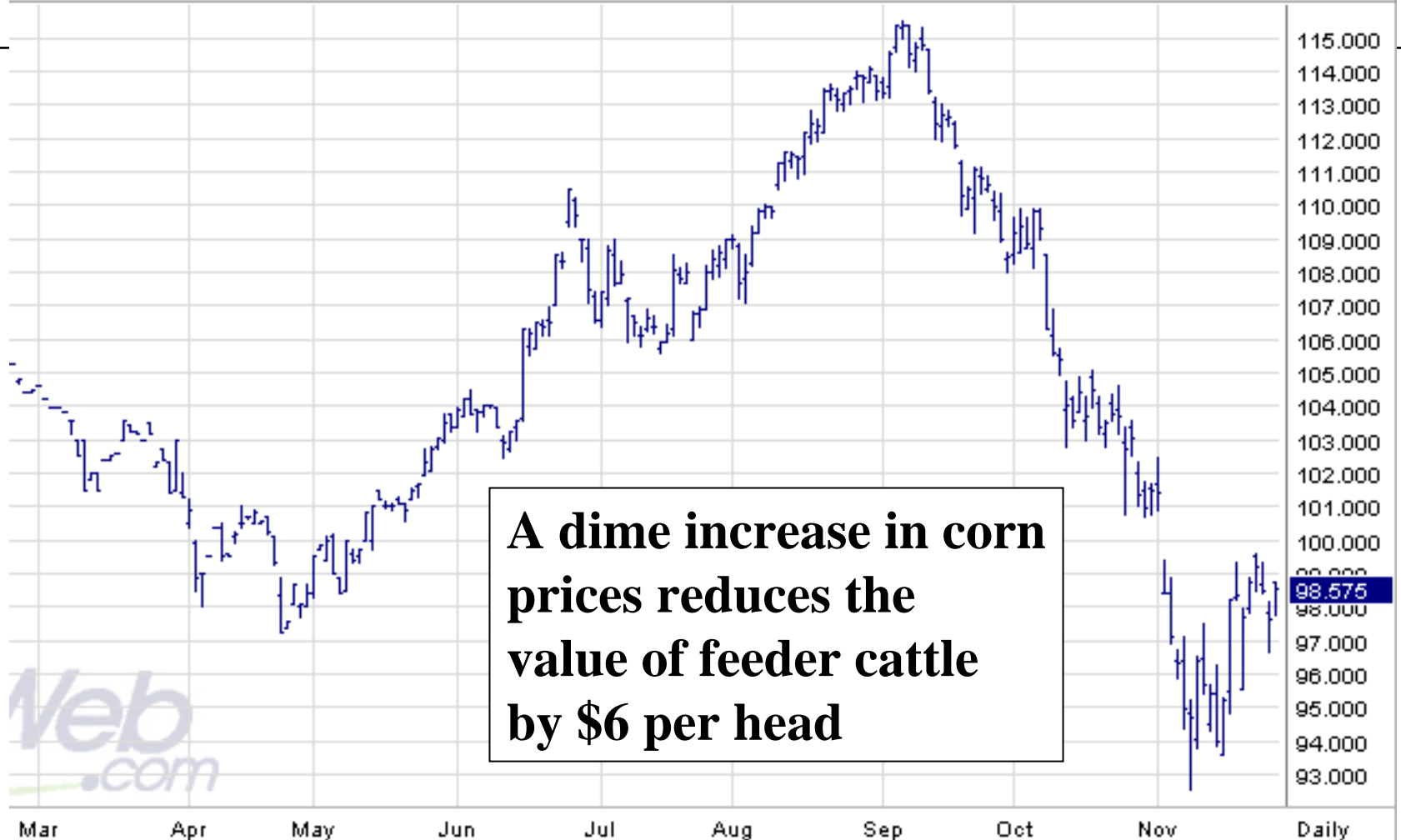
ST: 98.575

CHANGE: ▲ 0.950

HIGH: 98.750

LOW: 97.775

11/28/2006



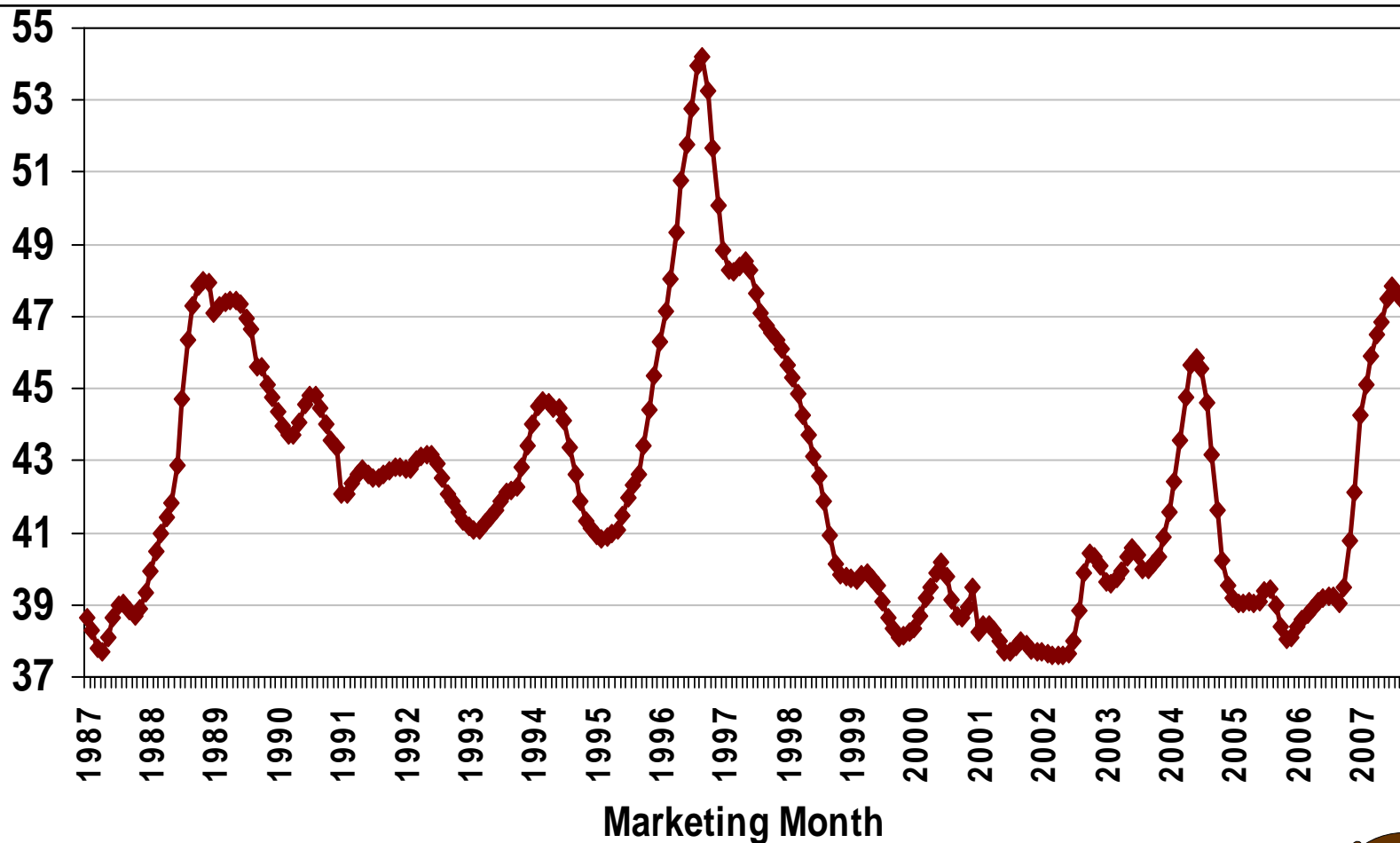
A dime increase in corn prices reduces the value of feeder cattle by \$6 per head

Web.com

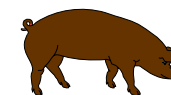
Cost of Slaughter Hog Production

Iowa State University Calculations, 1987-2006

\$ Per Live Cwt



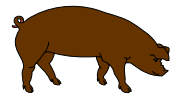
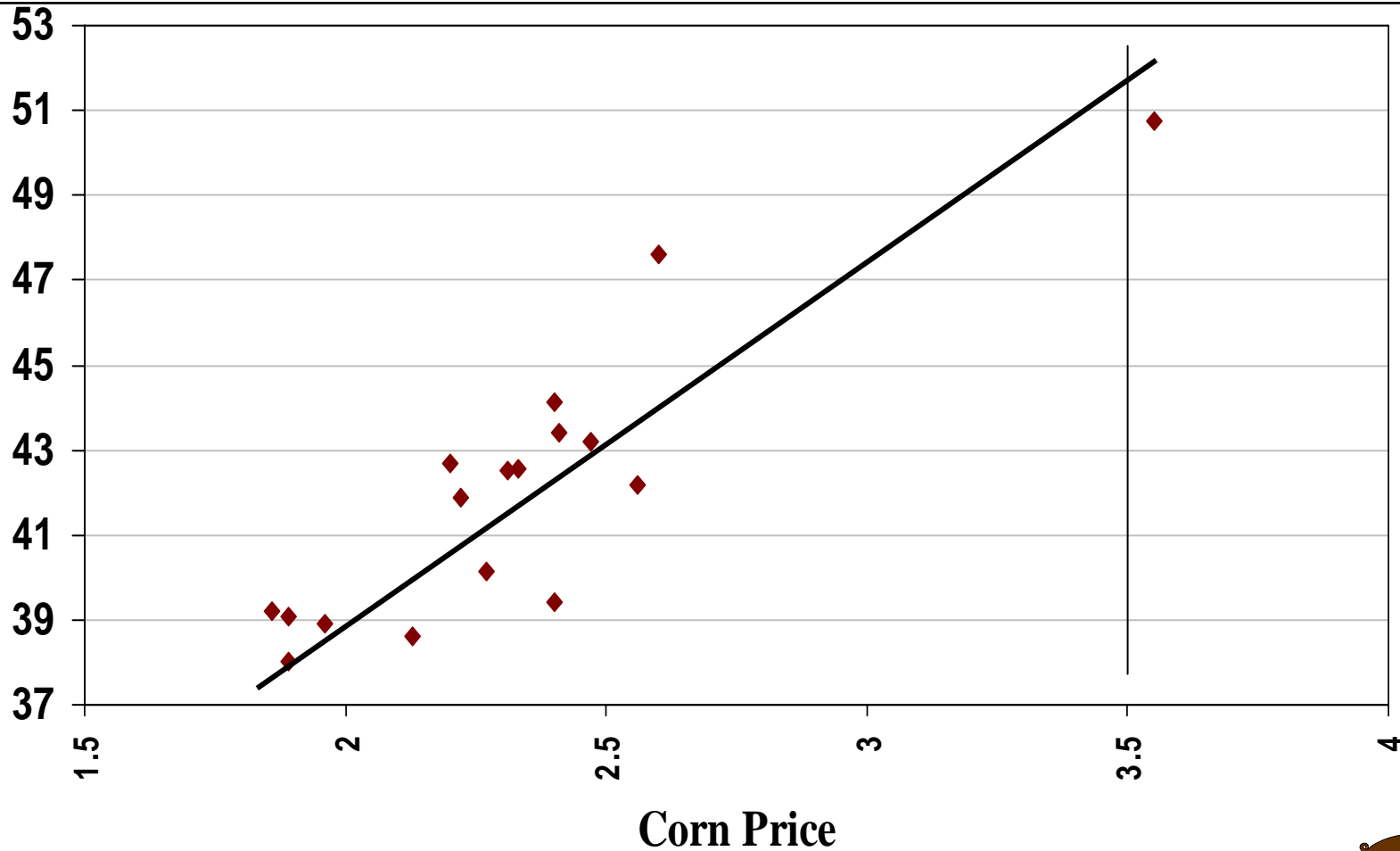
Source: John Lawrence, Iowa State University



Breakeven Hog Price & U.S. Corn Price

Iowa State University Calculations, 1990-2005

\$ Per Live Cwt



Corn Price Impact on Livestock

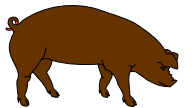
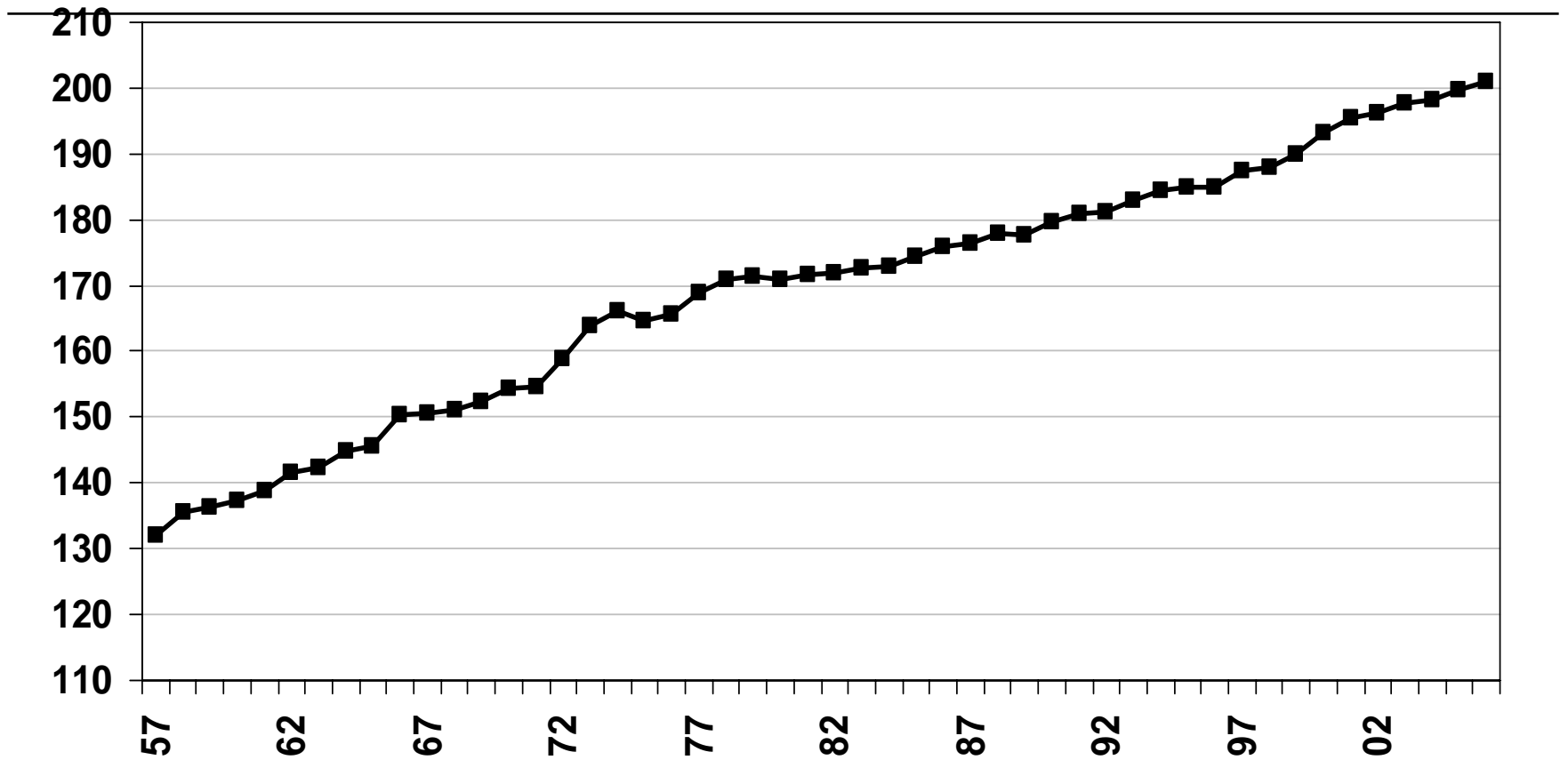
A dime increase in the price of a bushel of corn:

- Reduces the value of feeder cattle by \$6 per head
- Increases the cost of producing a market hog by \$2/head

Hog Weights & Corn Prices, 1957-2006

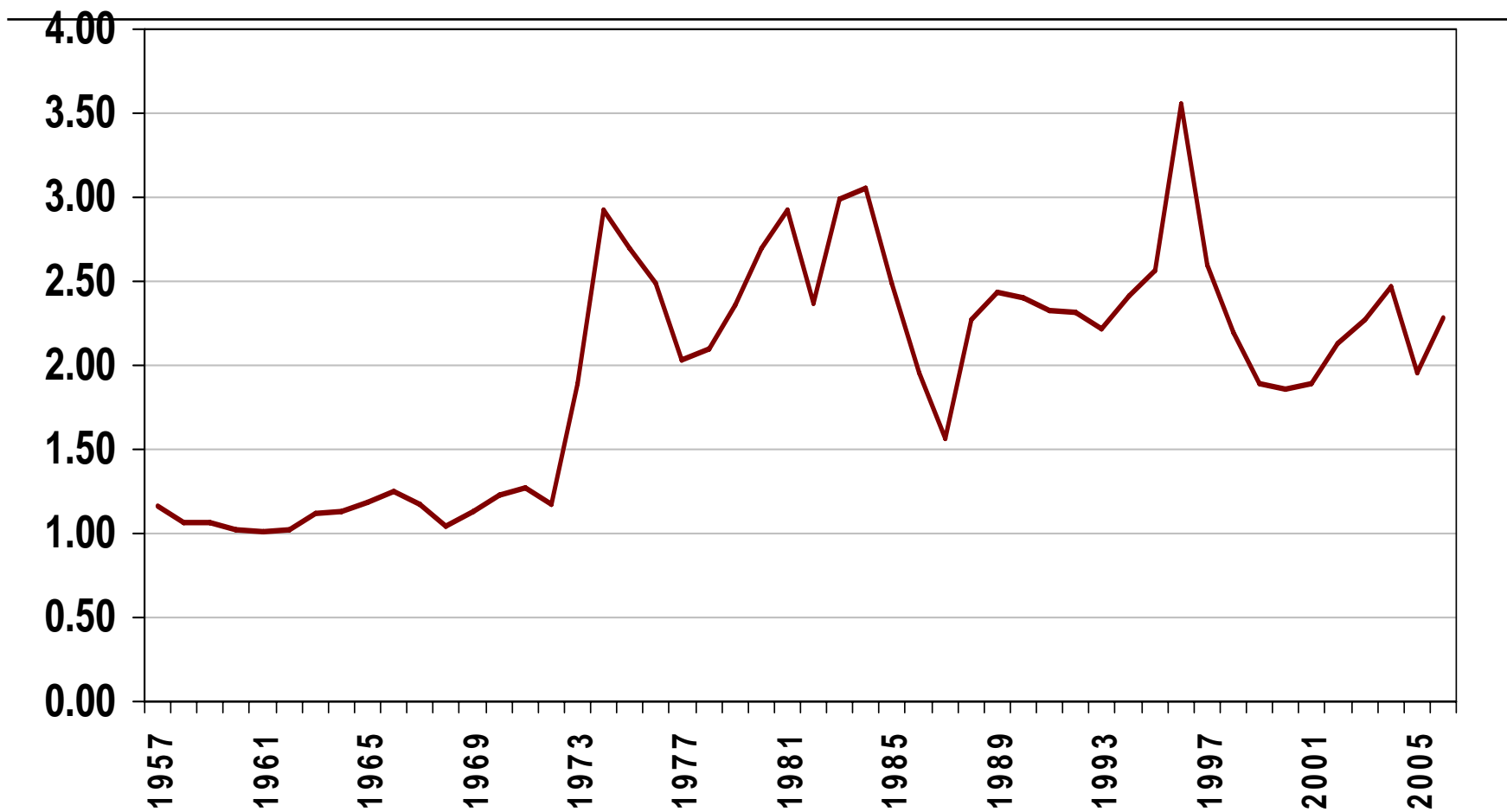
Average U.S. Hog Carcass Weight, 1957-2006

Pounds



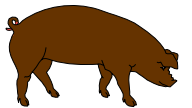
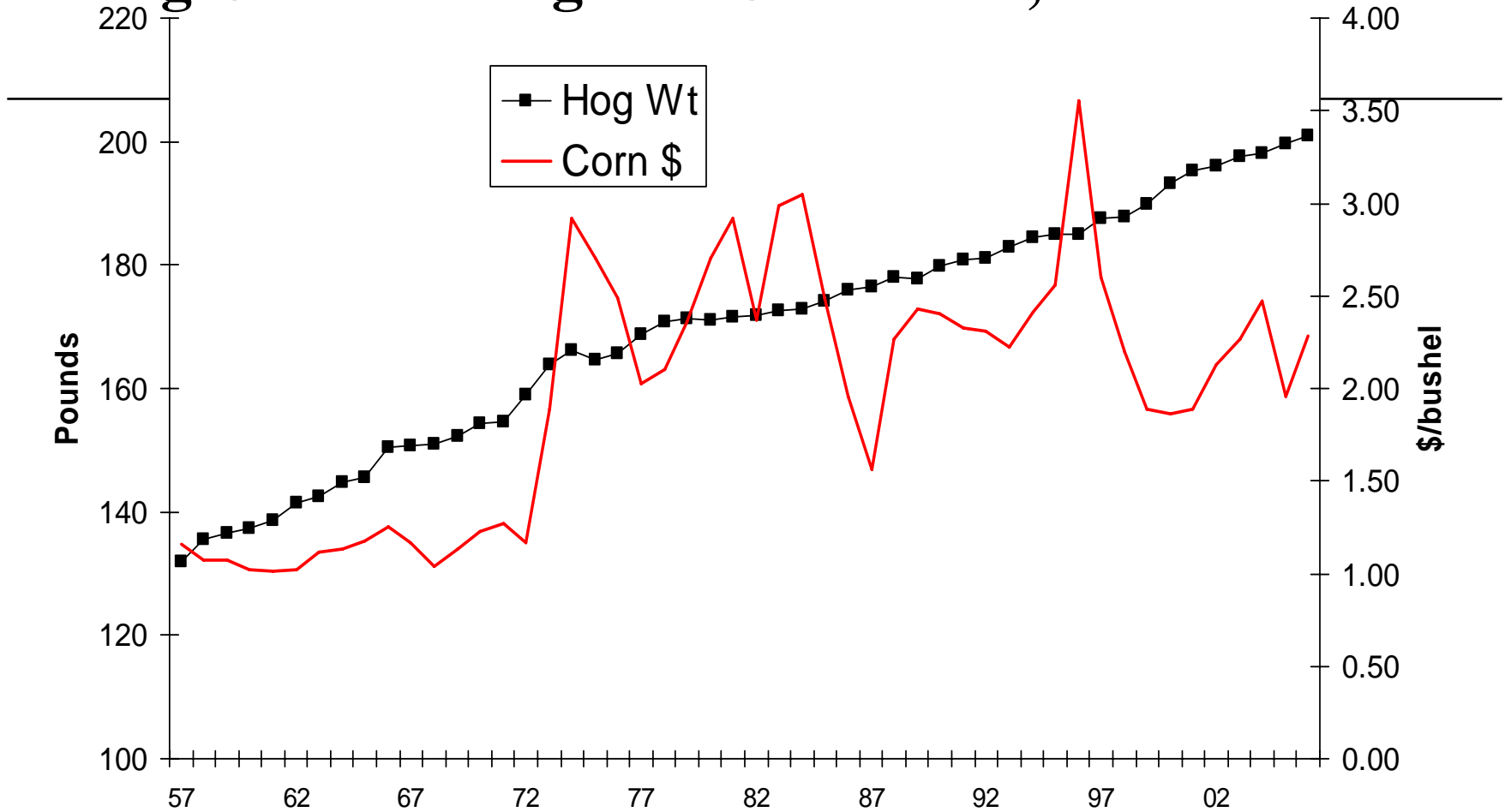
U.S. Average Corn Price, 1957-2006

\$ Per Bushel



Source: USDA/NASS

Hog Carcass Weight & Corn Price, 1957-2006

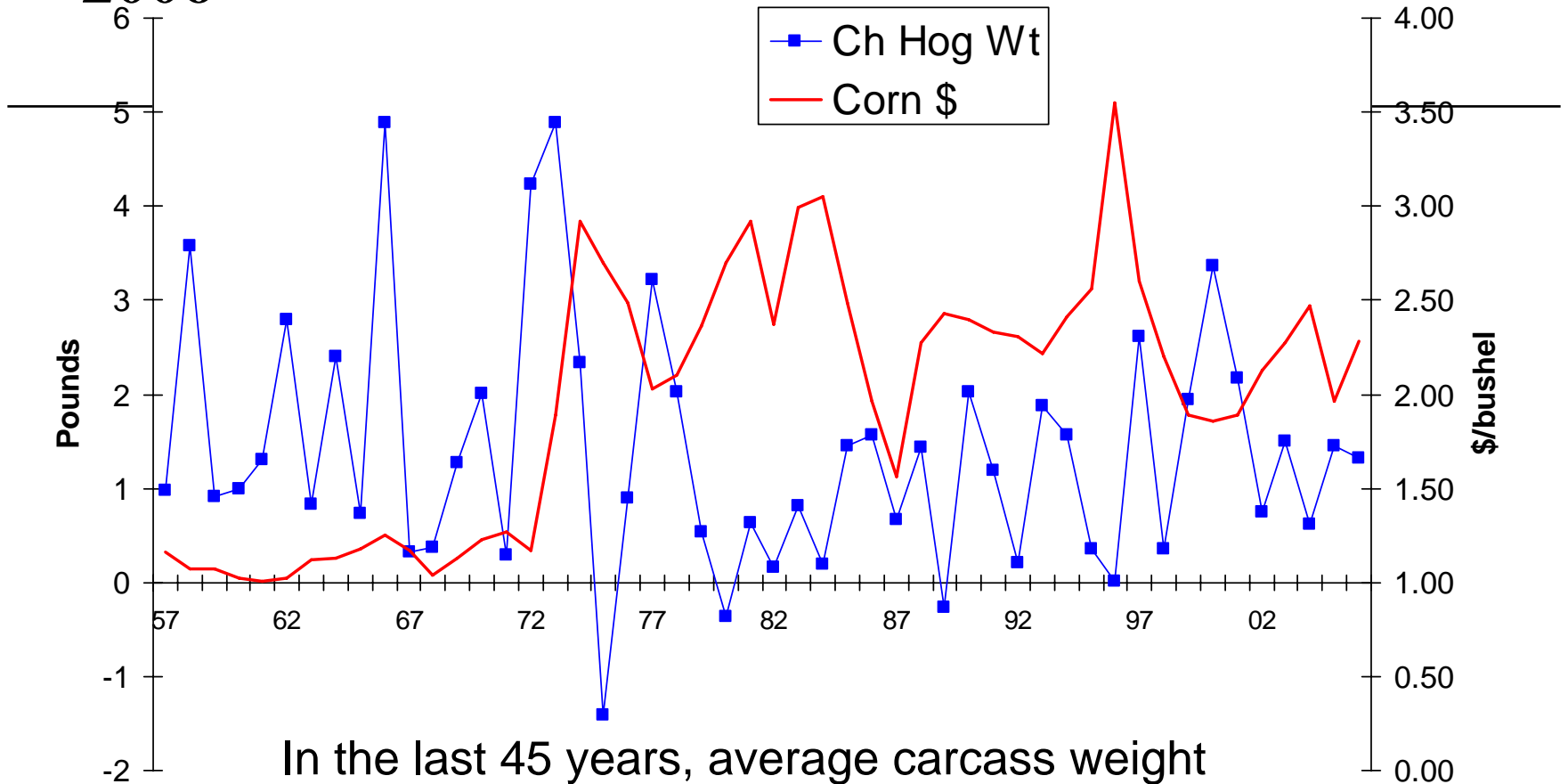




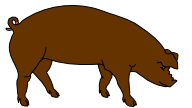
Hog Weights and Corn Prices

- Over time, both corn prices and hog slaughter weights have gone up a great deal.
- The more interesting relationship is what happens to hog weights, relative to their trend, when corn prices go up.

Change in Carcass Weight & Corn Price, 1957-2006



In the last 45 years, average carcass weight have gone up every year except 1975, 1980, 1989 and 1996, each years with relatively expensive corn.

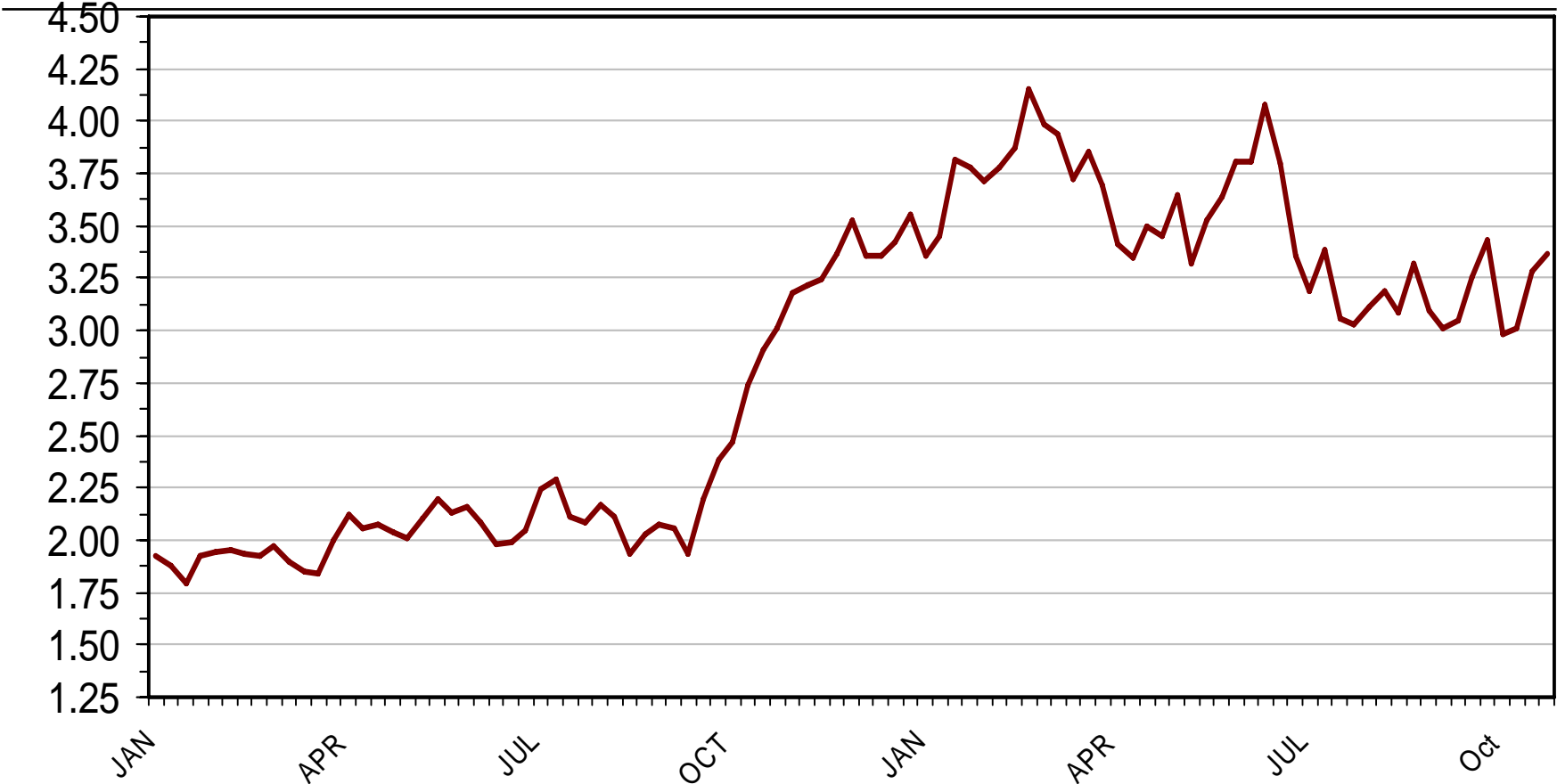


Hog Weights & Corn Prices, 2006-07

OMAHA CORN PRICES

Weekly, 2006-07

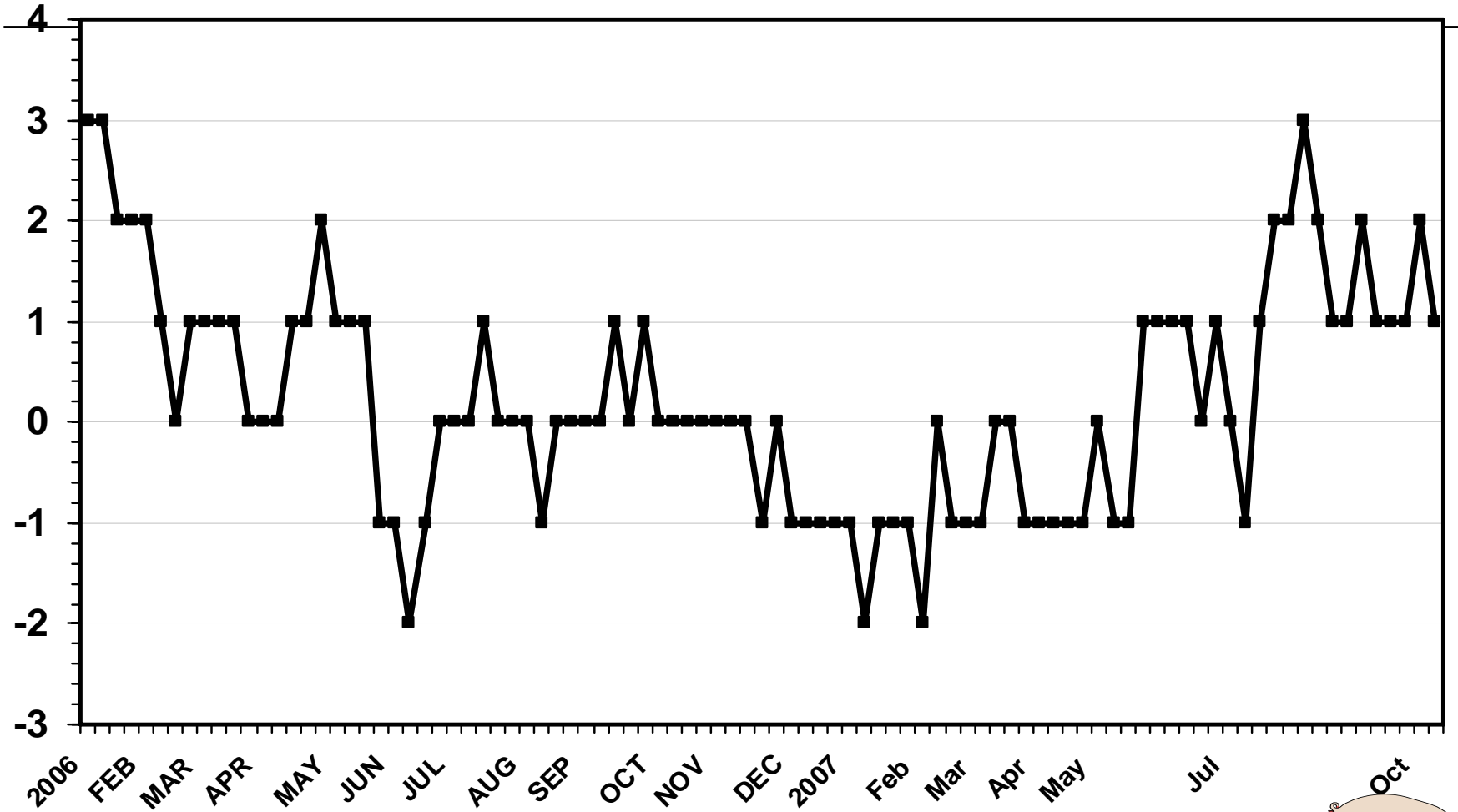
\$ Per Bu.



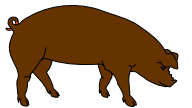
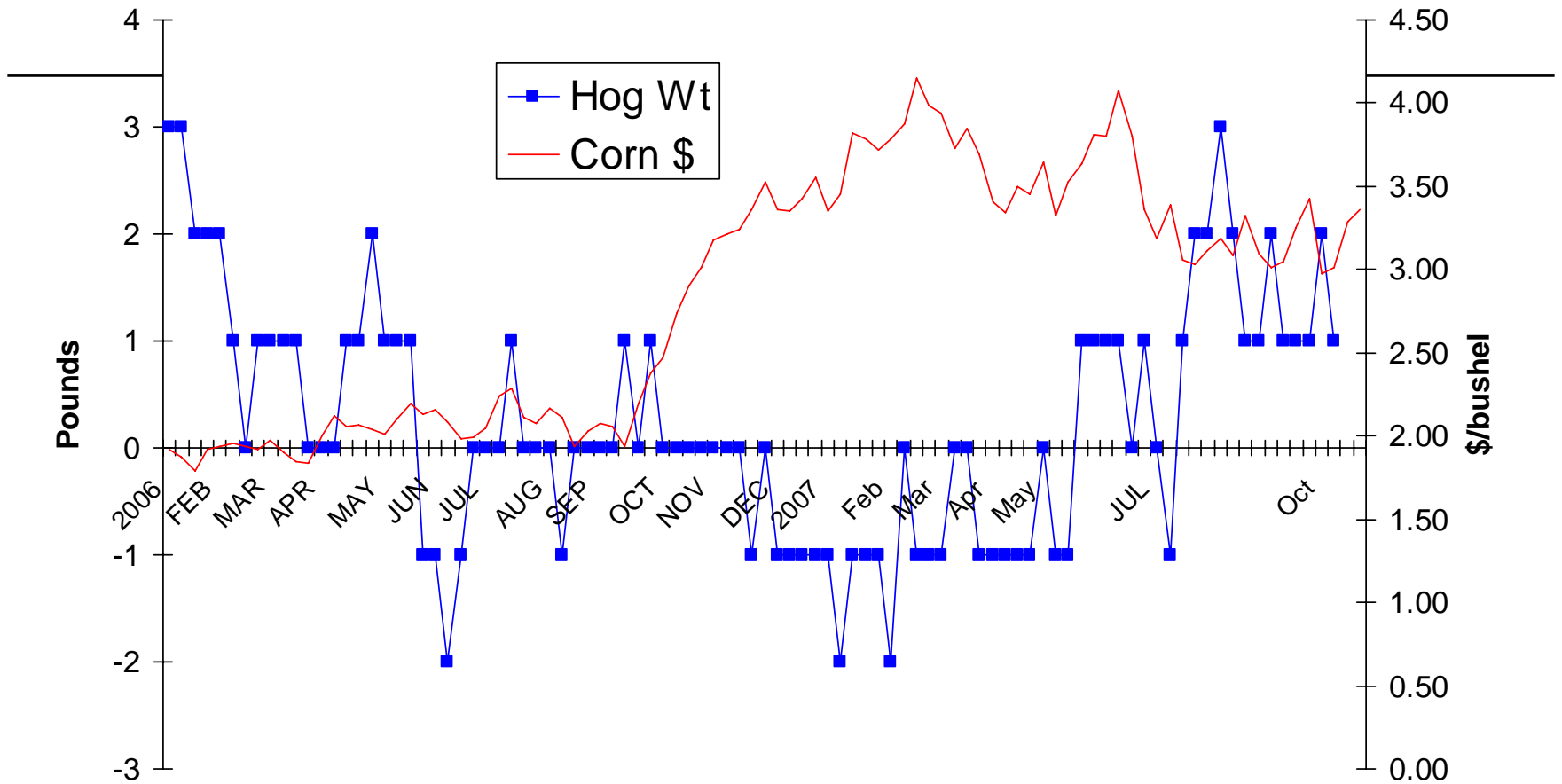
Barrow & Gilt Dressed Weights

Change From Year Ago

Pounds



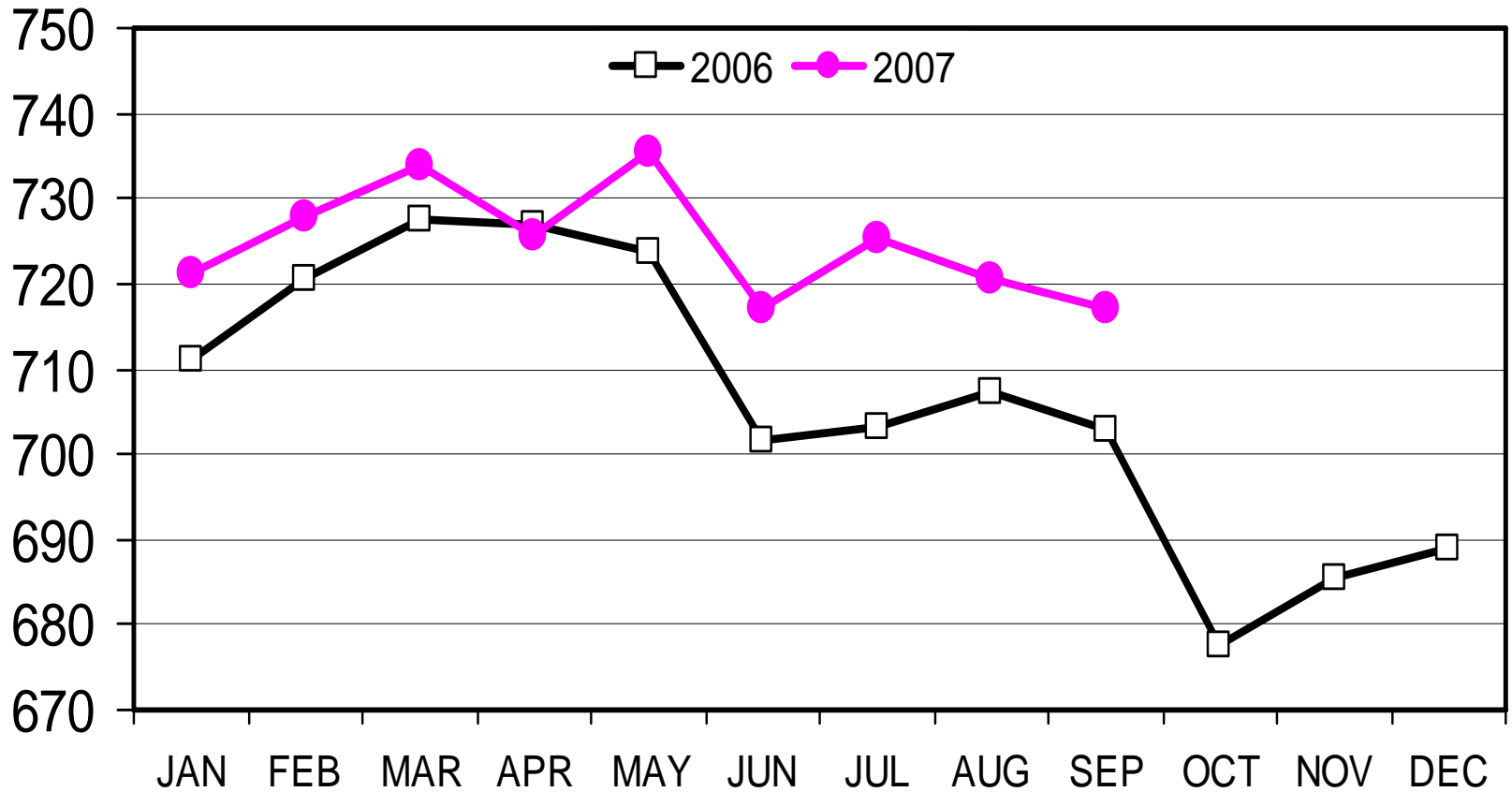
Hog Carcass Weight & Corn Price, 2006-2007



CATTLE ON FEED

Placement Weights, Monthly

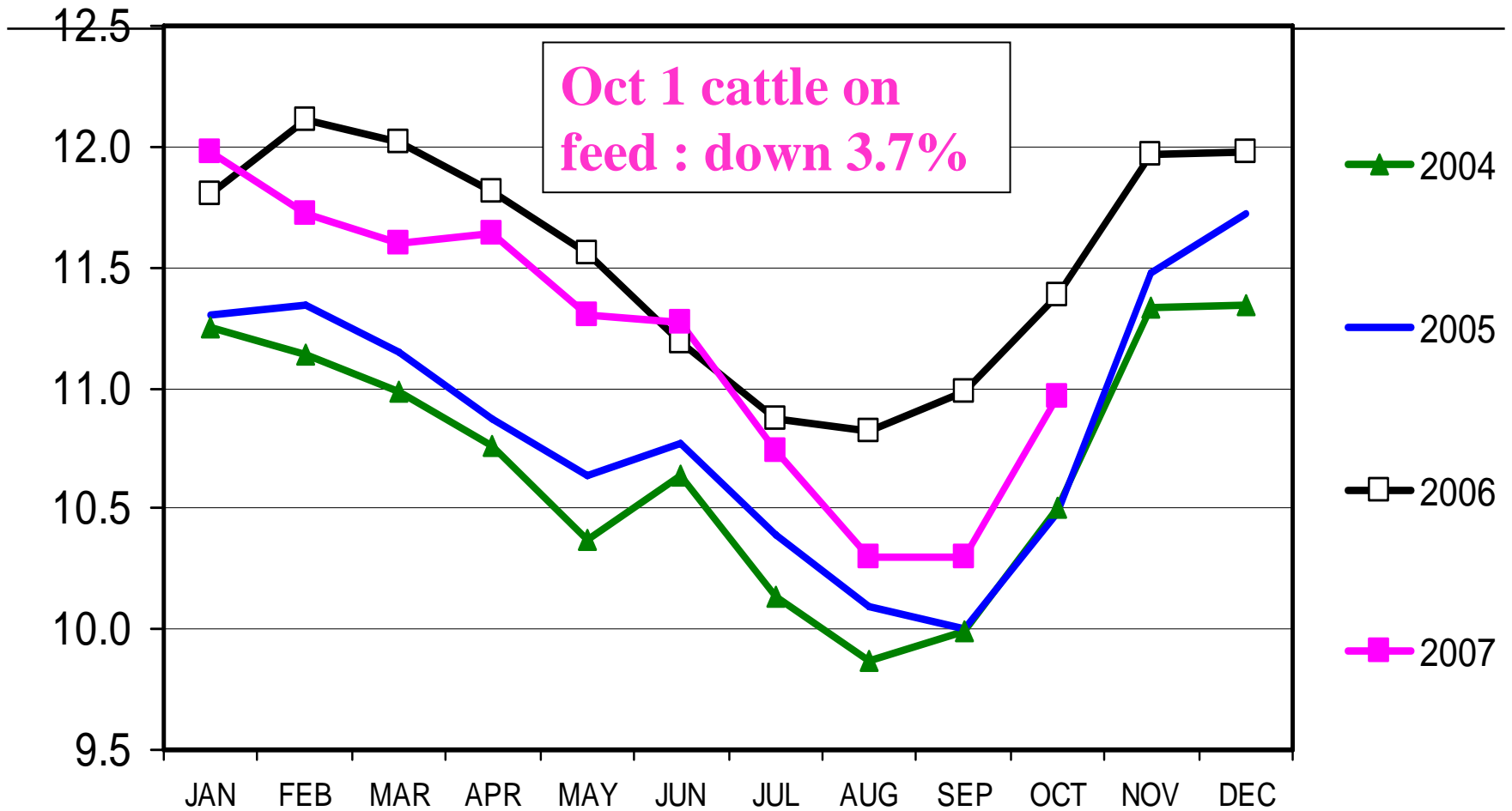
Pounds



CATTLE ON FEED

Large U.S. Feedlots, Monthly

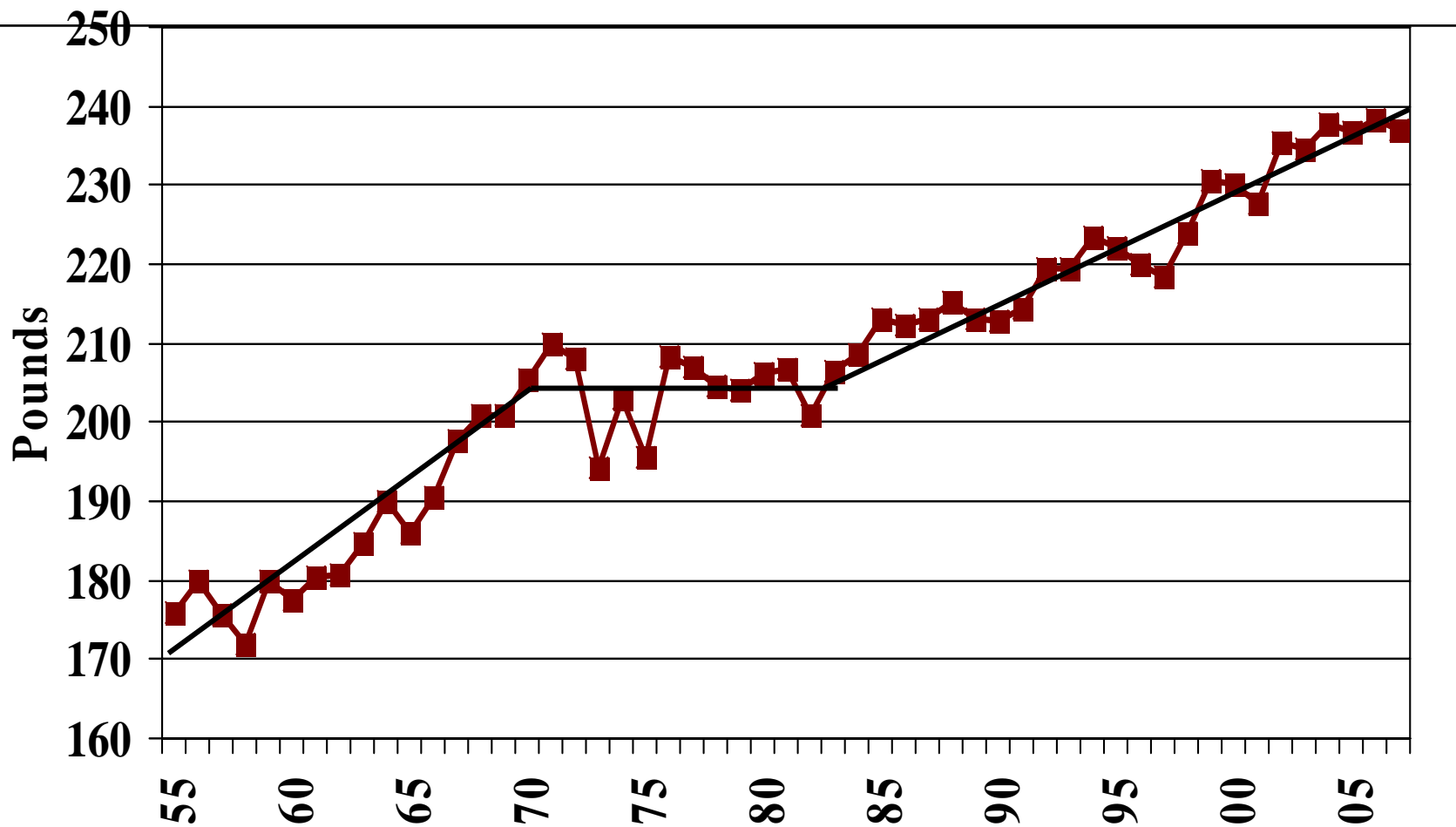
Mil. Head



Meat Consumption

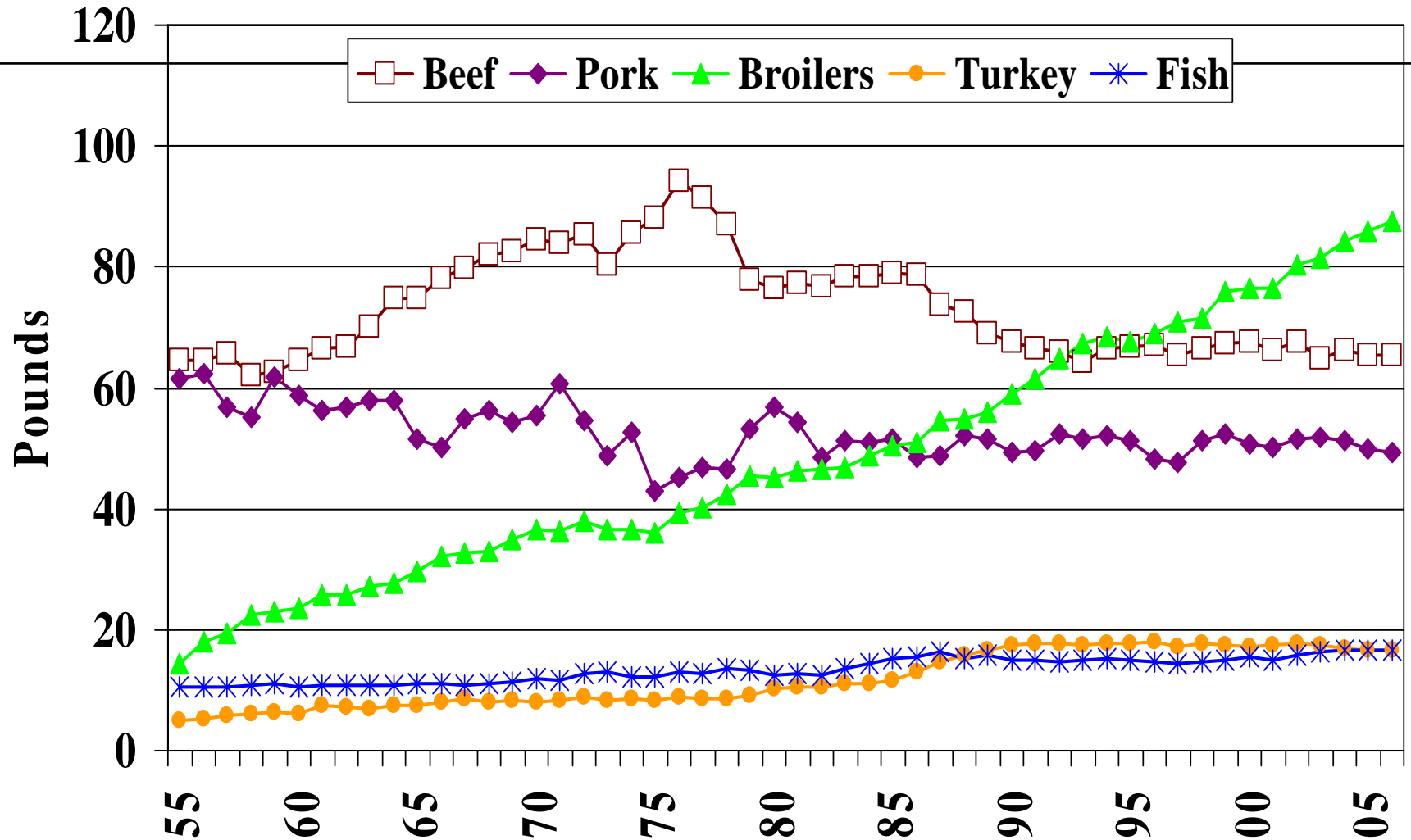
U.S. Per Capita Meat Consumption

Retail Weight, 1955-2007



U.S. Per Capita Meat Consumption

Retail Weight, 1955-2006



International Trade



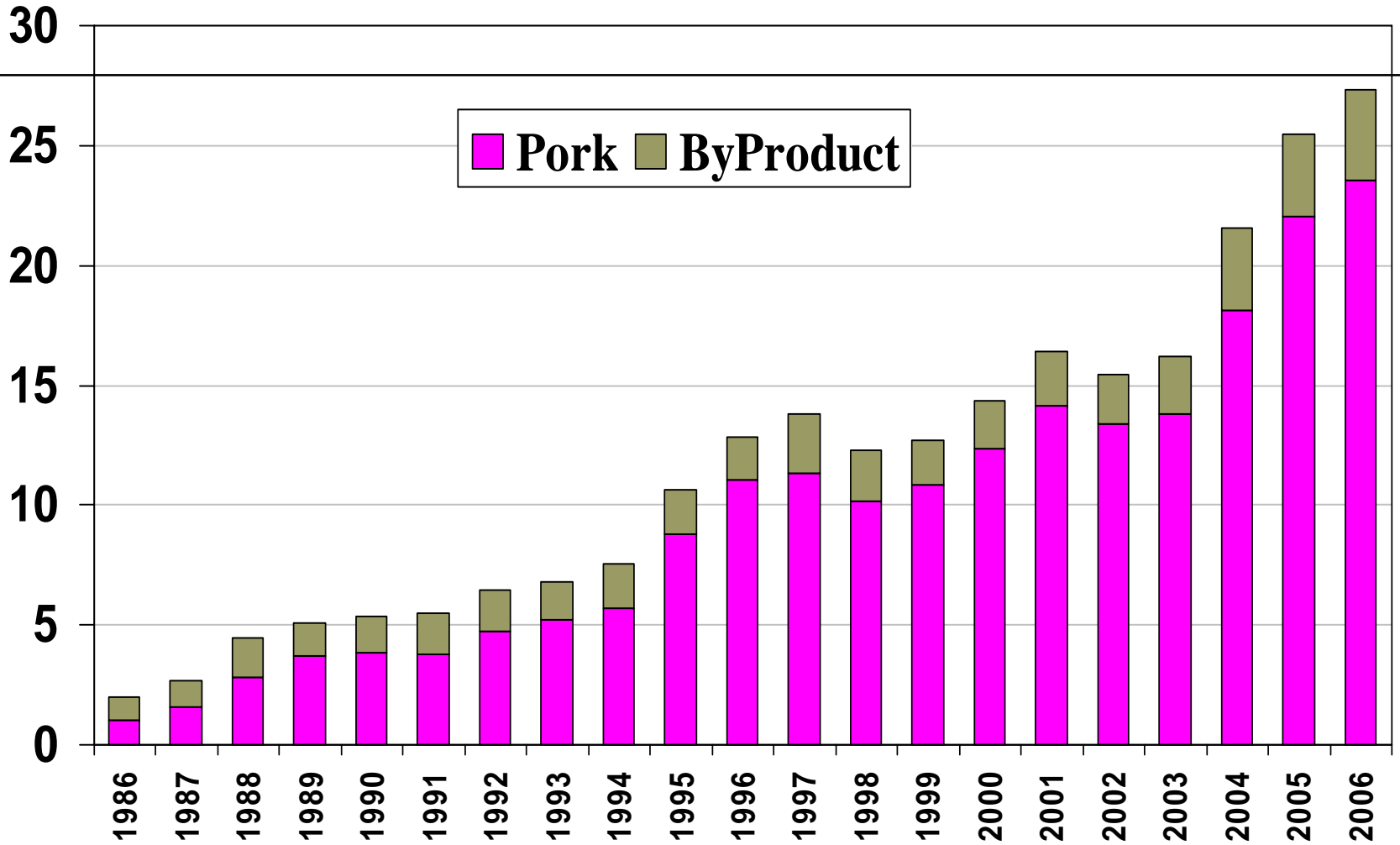
World Corn Production & Price

The U.S. accounts for 40% of world corn production and 60% of world corn exports

The U.S. price of corn is the world price of corn

\$/hog slt

Value of U.S. Pork Exports



U.S. Meat Exports

In 2006, the U.S. exported:

- 4.4% of our beef production
- 9.6% of our turkey production
- 14.3% of our pork production
- 14.8% of our broiler production

Summary

For each gallon of ethanol that is produced, about 20.4 pounds of corn are destroyed and 6.2 pounds of DDGS are created.

U.S. ethanol production is increasing at the rate of roughly 2.8 billion gallons per year.

Thus, ethanol plants are reducing the supply of corn available for feed at the rate of 28.5 million tons/year and increasing the supply DDGS at an annual rate of 8.6 million tons/year.

Summary

The reduced supply of corn available for feed leads to higher corn prices and increased corn production

The increased supply of DDGS leads to lower DDGS/corn price ratio

Summary

Higher corn prices result in higher livestock & poultry production costs leading to:

- Small herds & flocks
- Higher meat prices
- Reduced meat exports



The New Ag Market?

Crude oil drives ethanol prices

Ethanol drives corn prices

Corn drives livestock prices