

# **THE UNITED STATES ETHANOL INDUSTRY**

**World Biofuel Policy Forum**

**Policy Research Institute  
Ministry Of Agriculture, Forestry  
& Fisheries, Japan  
March 20, 2007, Tokyo, Japan**



# Overview

- **U.S. Ethanol Industry**
- **Supply and Use**
- **Policies**
- **Land-base Resources**
- **Economic Impacts and Costs of Production**
- **Life-cycle Analysis**
- **Conclusions**

# Ethanol in the United States

- **Removing tetra lead from gasoline**
- **Arab oil embargo**
- **Iranian revolution**
- **World oil price volatility**
- **Reducing dependency**
- **The Energy Security Act of 1979**
  - **Created a tax credit to reduce national dependency to foreign oil and increased the value of US grains**

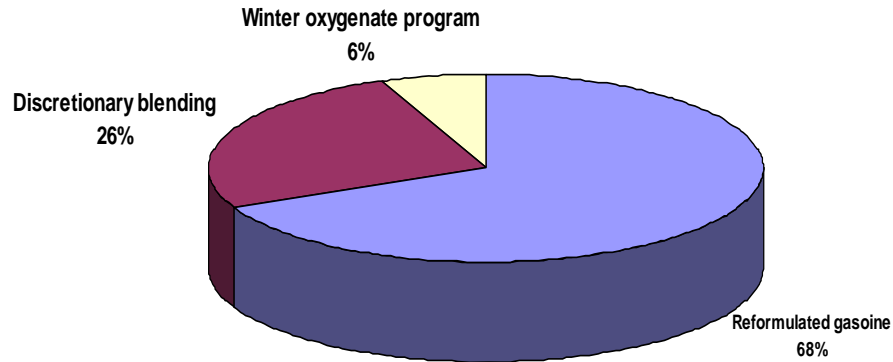
# Fuel Additives vs. Fuels

- **In the United States and the world (except Brazil) biofuels are used as fuel additives**
- **In absence of any policy, biofuels as fuel need to compete unconditionally with fossil fuels**

# Ethanol Use

- **1980s**
  - **Gasoline extender and octane booster**
- **1990s**
  - **Clean Air Act Amendment (CAAA) of 1990, winter oxygenate and reformulated gasoline programs**
- **2000s**
  - **Replacing MTBE, Renewable Fuels Standard (RFS), reformulated gasoline program, Octane, Oxygenate program**

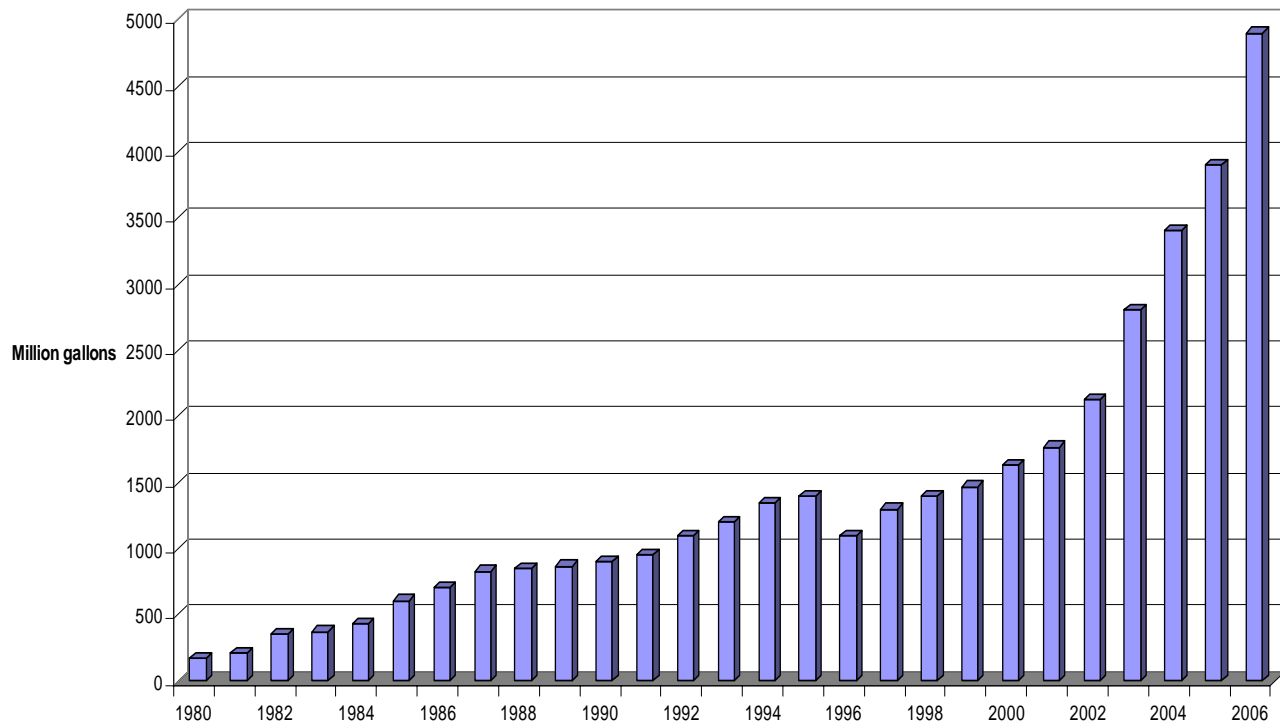
# 2006 Ethanol Use by Market



# Industry at a Glance

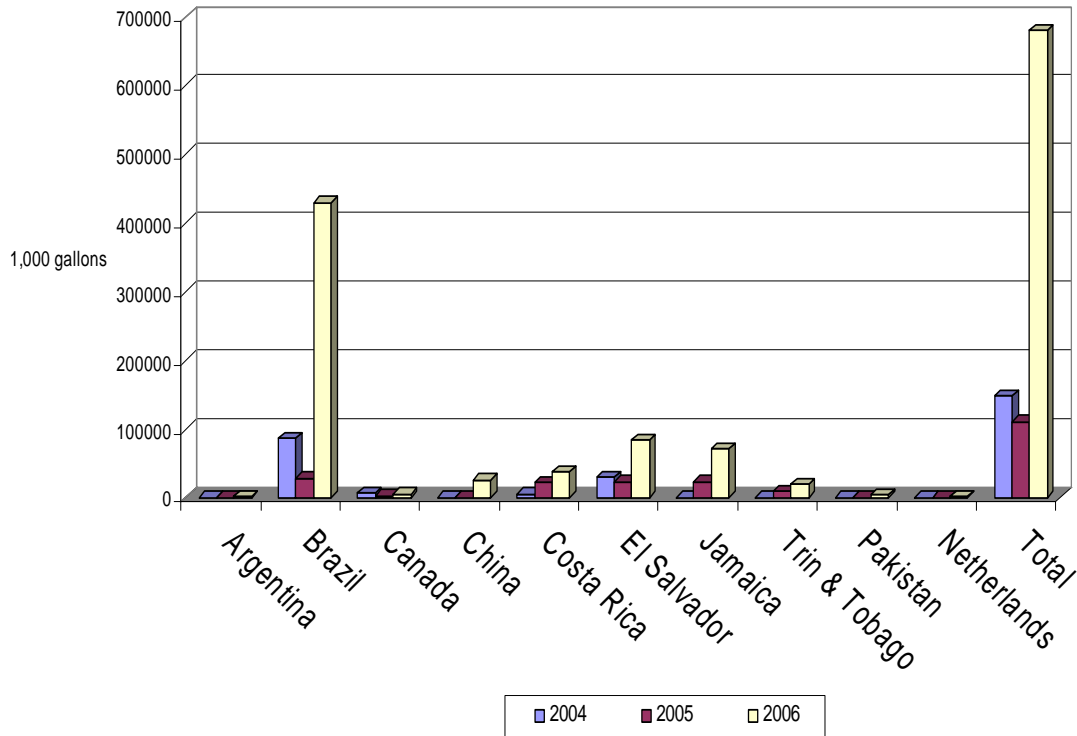
- **Number of operating plants, 114**
- **Total production capacity, 5.6 billion gallons**
- **Plants under construction and expansion, 85**
- **Capacity under construction, 6.2 billion gallons**
- **Total capacity by 2008-09 11.8 billion gallons**

# Fuel Ethanol Production, 1980-2006

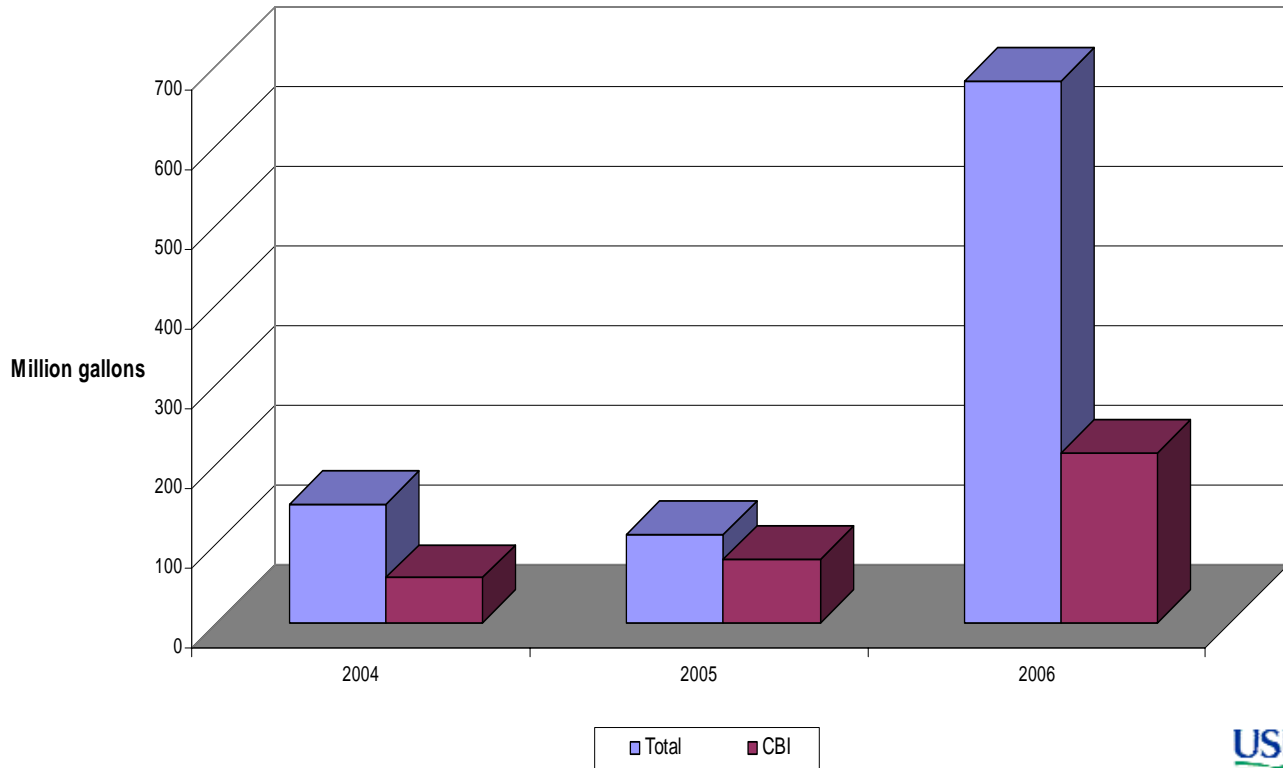




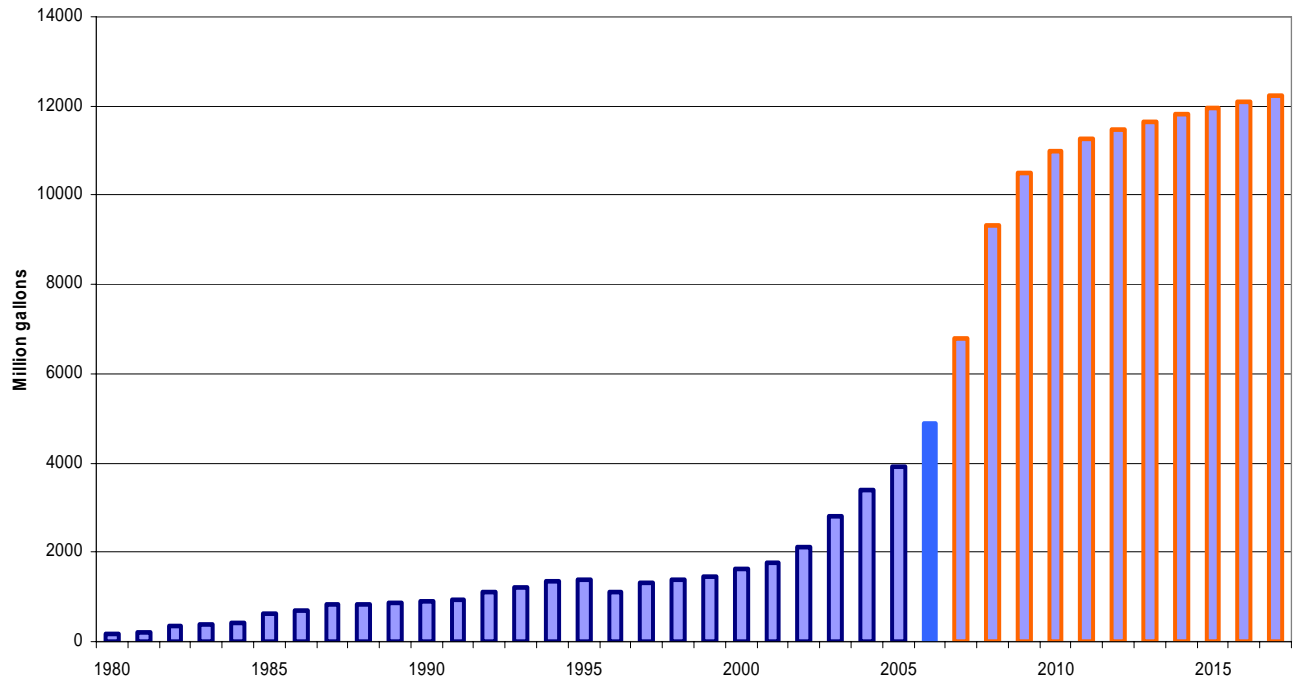
# U.S. Fuel Ethanol Imports



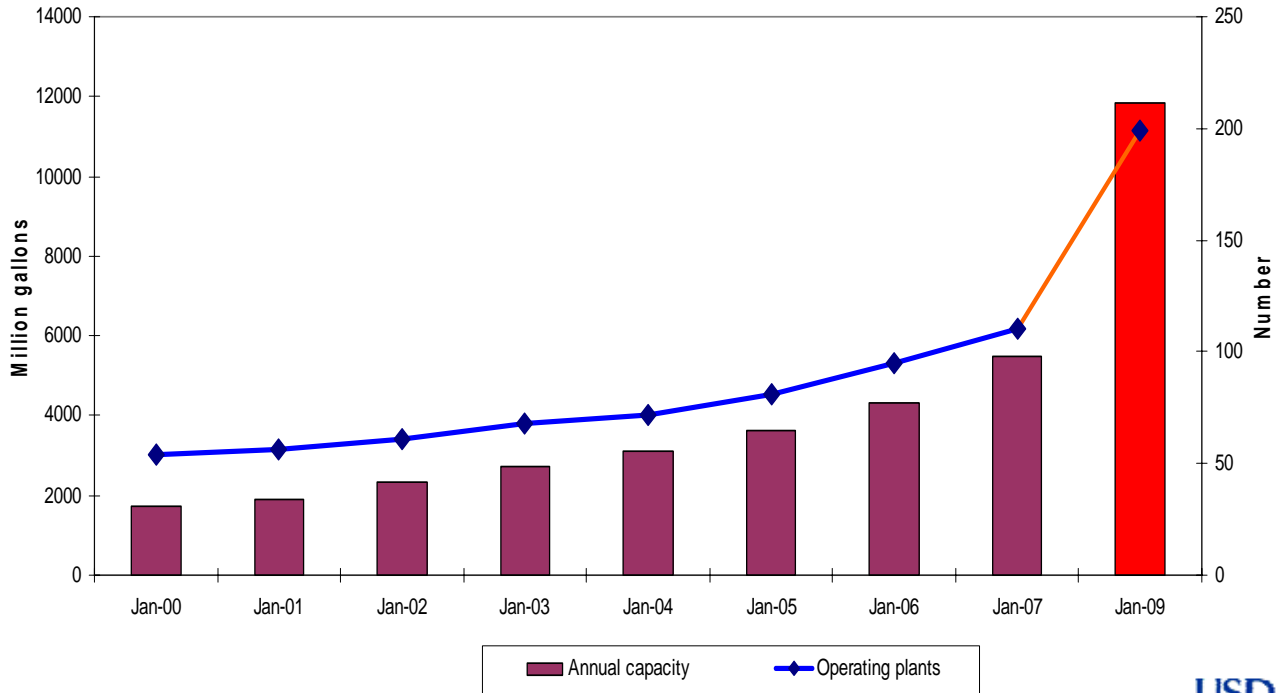
# U.S. Fuel Ethanol Imports



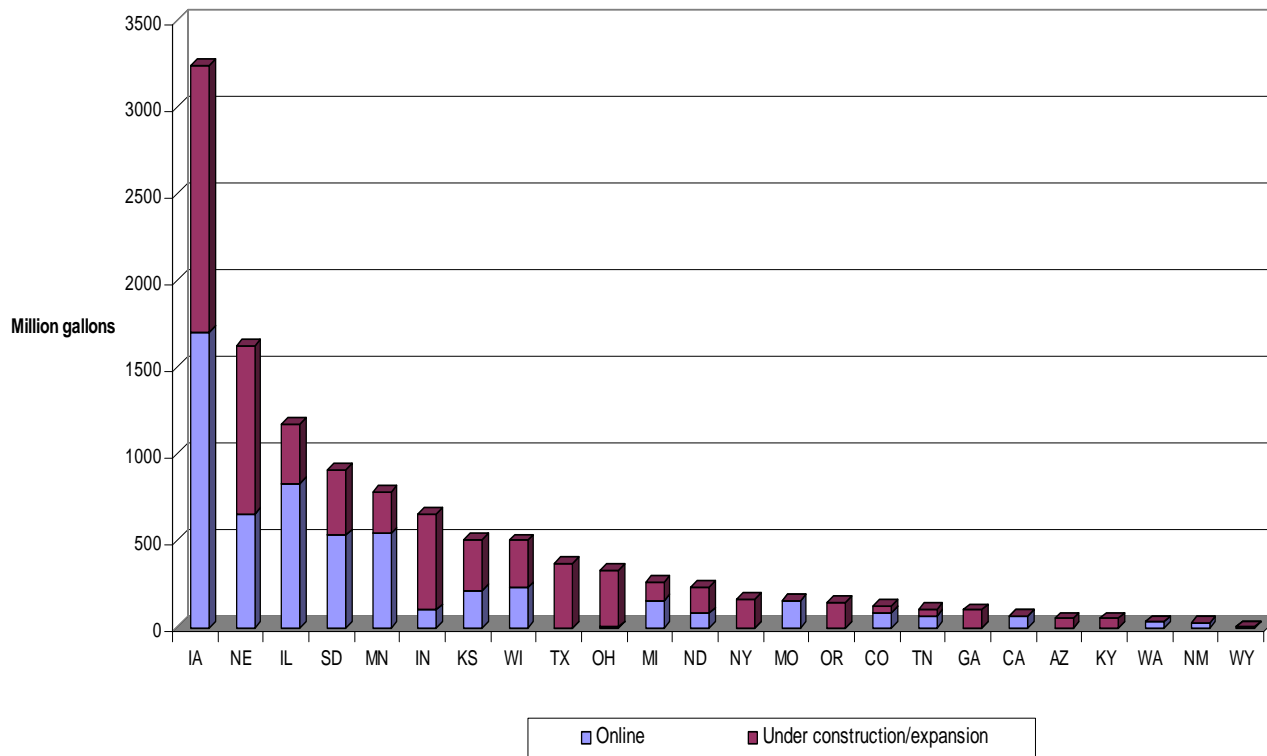
## Projected Ethanol Production, 2007-2017



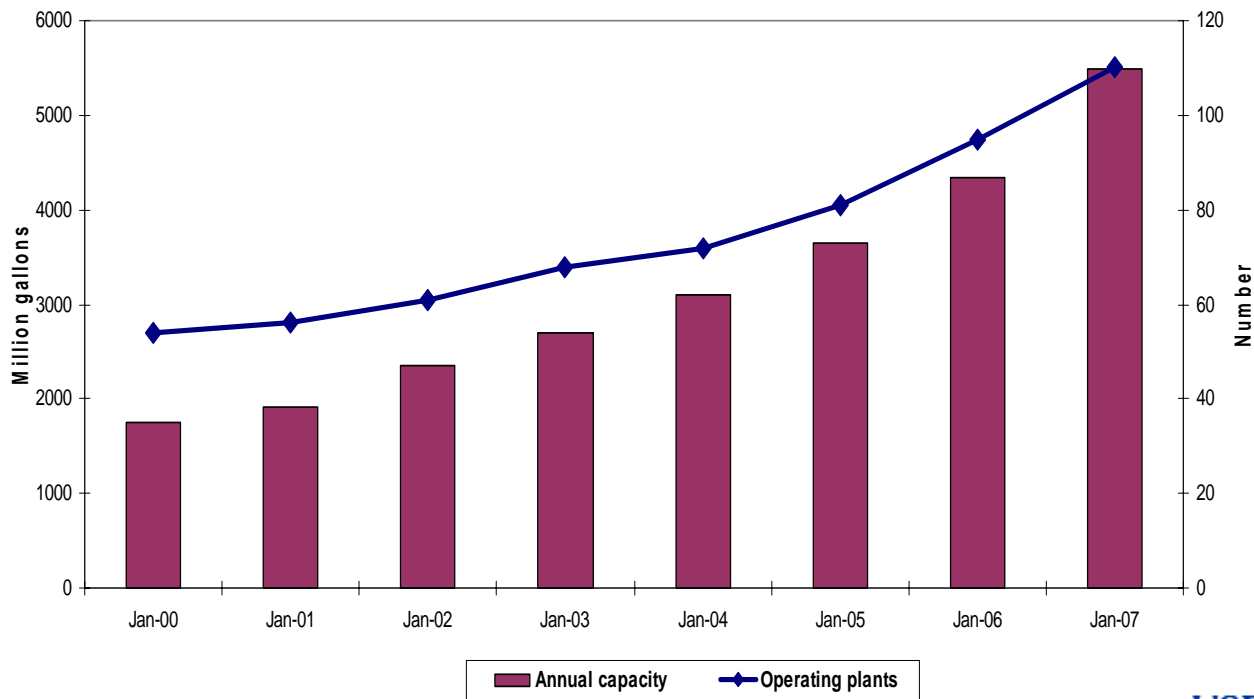
# Projected Ethanol Industry Expansion, Jan. 2000-Jan. 2009



# U.S. Ethanol Production Capacity by State



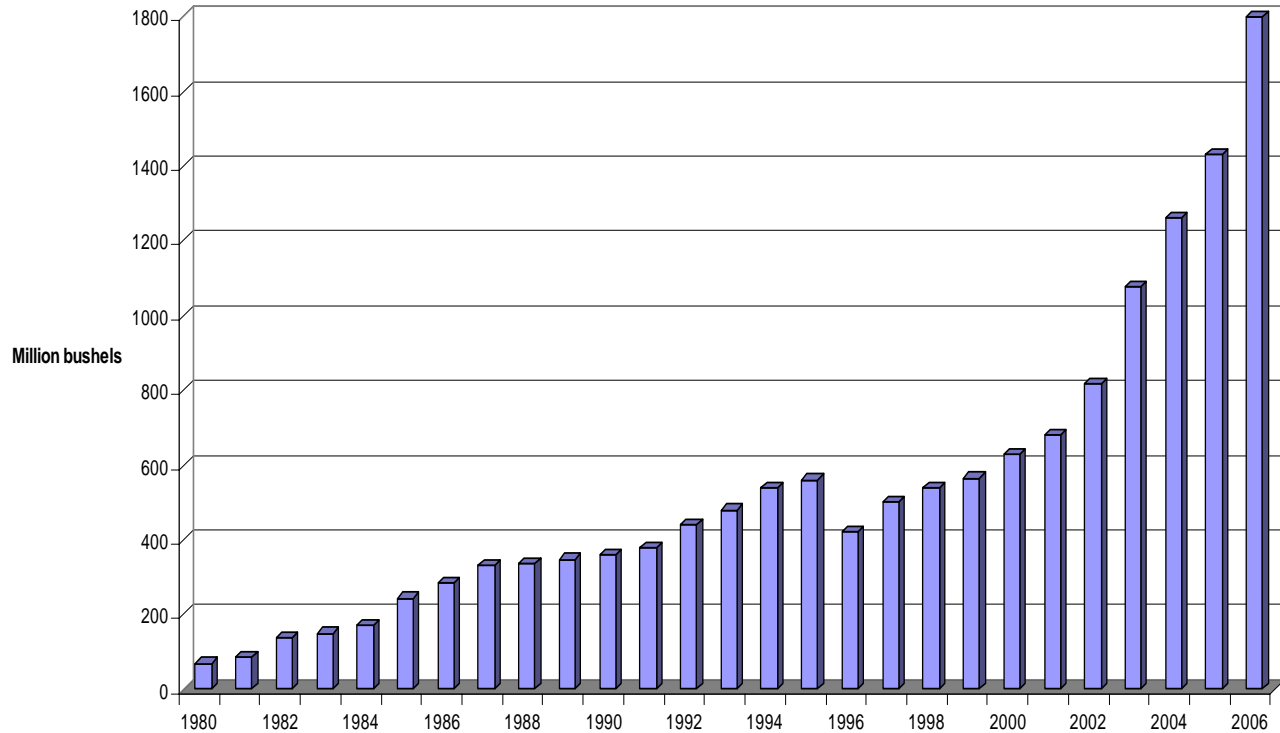
# Ethanol Industry Expansion, January 2000- January 2007



# Feedstock Used in Production of Ethanol

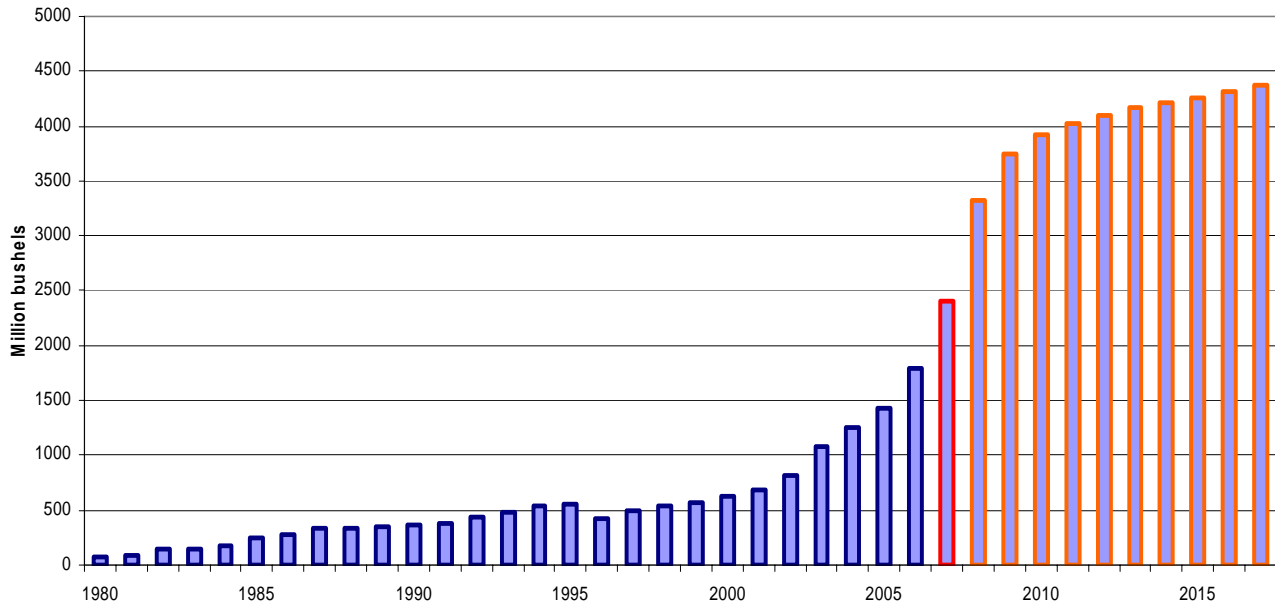
- **Corn, 97%**
- **Sorghum 2%**
- **Others 1%**
- **Sugarcane and sugar beets ?**

# Corn Used in Ethanol Production





# Projected Corn Used for Ethanol, 2007-2017



# Production Process

- **Wet milling process,**
  - current market share, 20%
  - near future, market share, 10%
- **Dry milling process,**
  - market share, 80%
- **Hybrid dry milling**

# Ethanol Byproducts

- **Wet milling process, CO<sup>2</sup>, corn gluten feed, corn gluten meal, corn oil**
- **Dry milling process, distillers dried grains with soluble, CO<sup>2</sup>, condense syrup**
- **Hybrid plants, corn germ, corn fiber, low fiber DDGS, CO<sup>2</sup>**

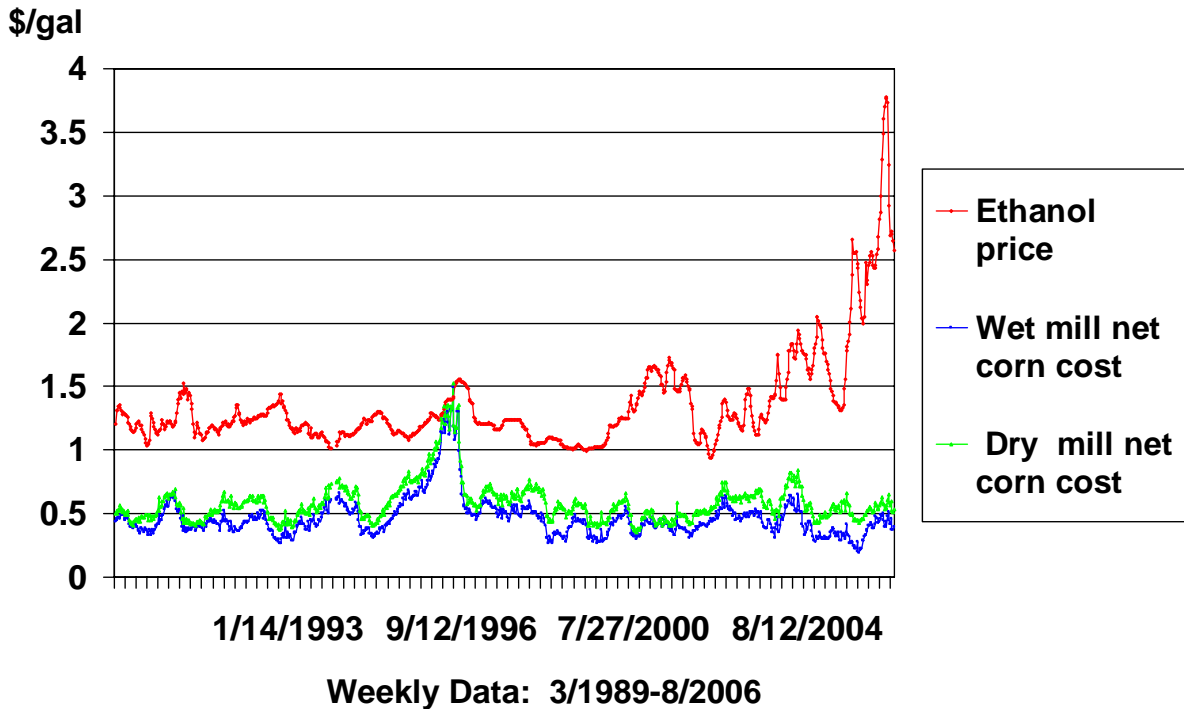
# Demand for Ethanol

- **Agriculture, energy and environmental policies**
  - Federal and state incentives, Mandate, import duties
- **Regulations, Clean Air Act, MTBE ban**
- **Prices**
  - Crude oil and gasoline
  - Corn
  - Ethanol
  - Processing costs
- **Production over capacity**

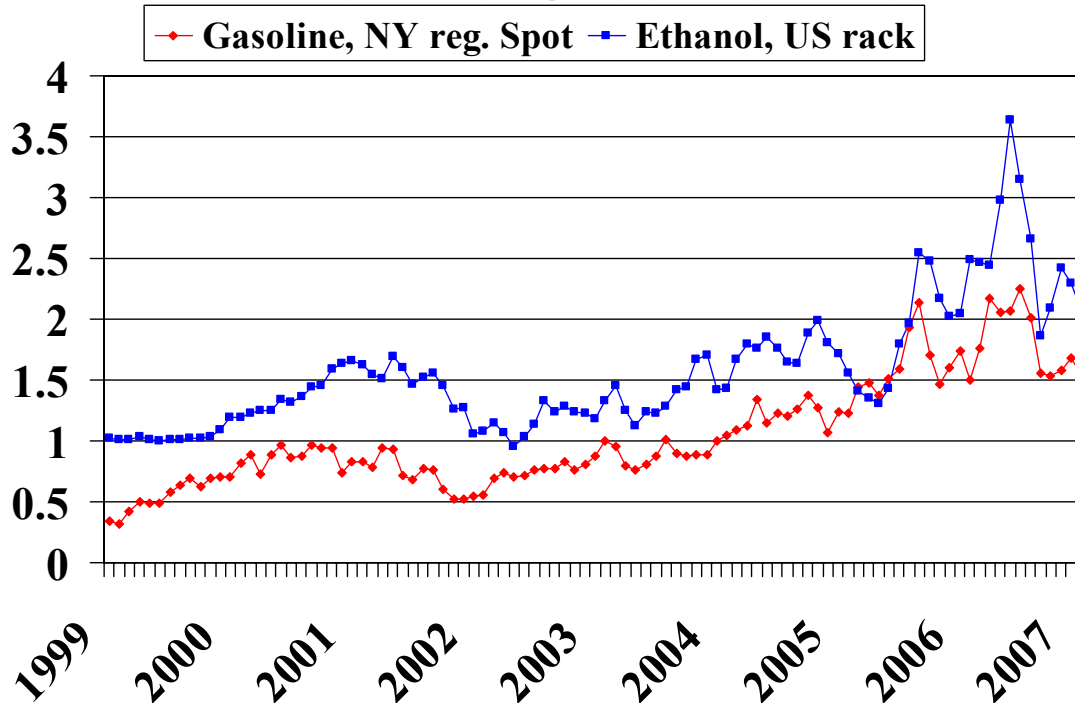
# Price of Ethanol

- **Price of gasoline**
- **Price of corn**
- **Ethanol Excise Tax Credit**
- **Prices of byproducts**

# Ethanol Price and the Net Cost of Corn for Ethanol Plants



# Ethanol and Gasoline Prices



Sources: The Wall Street Journal and Renewable Fuel News

# Supply of Ethanol

- **Federal and state producer incentives, mandate**
- **Price of corn and other raw materials**
- **Capital investment**
- **Processing costs**
- **Risk associated with production of raw materials and investment in processing plants**



# Ethanol Policies

- **Federal Regulations**
- **States Regulations**

# Public Law That Supports Biofuels

- **Clean Air Act Amendment of 1990**
- **Energy Policy Act of 1992**
- **Biomass Research & Development Act of 2000**
- **Energy Provisions in the 2002 Farm Bill**
- **The Healthy Forest Restoration Act of 2003**

# Public Law That Supports Biofuels, (Con't)

- **The American Jobs Creation Act of 2004**
  - Federal Fuel Tax Exemption for Ethanol
  - Federal Fuel Tax Exemption for Biodiesel
- **Energy Policy Act of 2005**
  - National Renewable Fuels Standard
  - Minimum quantity of ethanol from cellulosic biomass
  - Special consideration for cellulosic Biomass or Waste Derived Ethanol
  - Small Ethanol Producer Credit Adjusted

# **Public Law That Supports Biofuels, (Con't)**

- **Energy Policy Act of 2005, (Con't)**
  - **Biodiesel Tax Credit Extension Through 2008**
  - **Small Biodiesel Producer Credit Established**
  - **Funding Support for Research, Development, and Demonstration of alternate Biofuel process**
- **Energy Provisions in the 2002 Farm Bill**

# 2002 Farm Bill, Energy Title, IX

- **Section 9004: Biodiesel Fuel Education Program**
- **Section 9005: Energy Audit and Renewable Energy Development Program**
- **Section 9006: Renewable Energy System and Energy Efficiency Improvement**

# **2002 Farm Bill, Energy Title, IX—(Con't)**

- **Section 9007: Hydrogen and Fuel cell technologies**
- **Section 9008: Biomass Research and Development**
- **Section 9010: Continuation of the Bioenergy Program**
- **Renewable Energy on Conservation Research Program (CRP) Lands**

# Key Federal Regulations

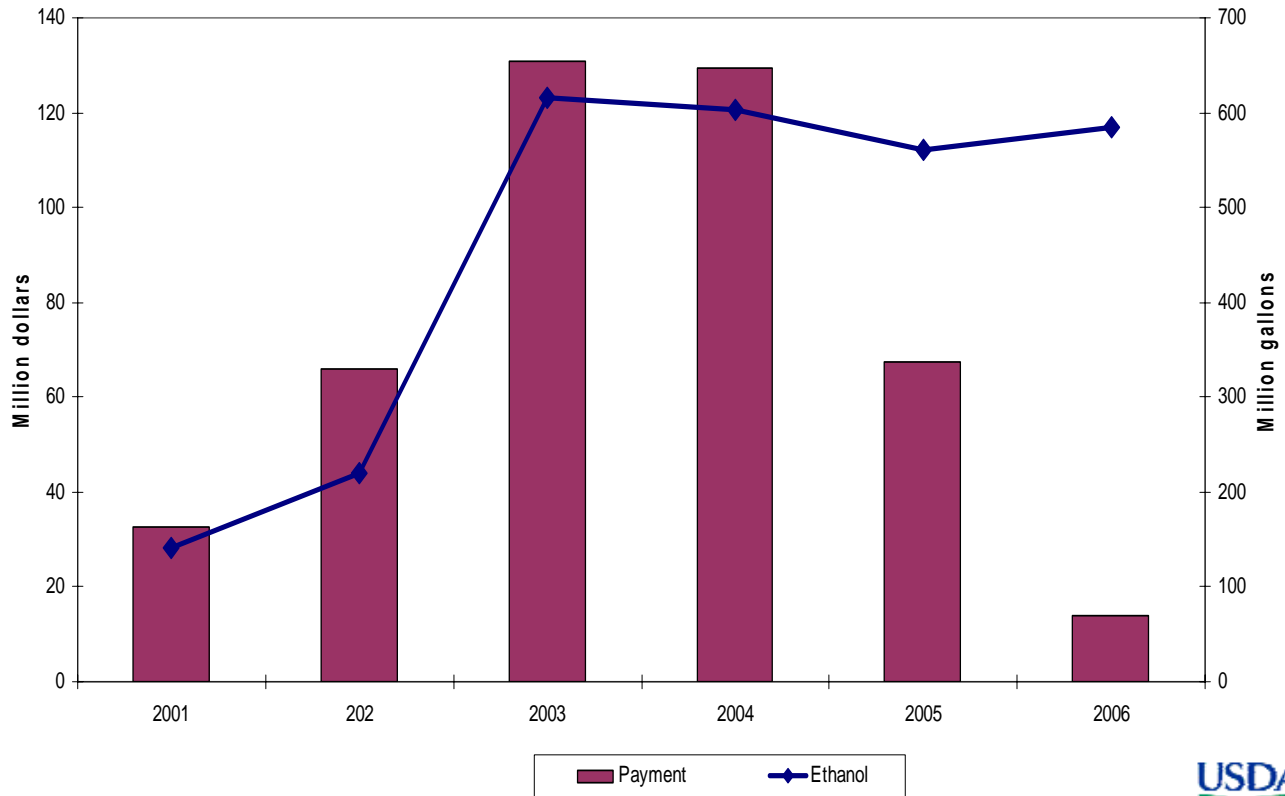
- **Renewable Fuels Standard (RFS)**
- **Volumetric Ethanol Excise Tax Credit (VEETC)**
- **Small ethanol producers tax credit**
- **Biodiesel Tax Credits**
- **Federal Reformulated Gasoline Program (RG)**
- **Winter Oxygenated Fuels**
- **Commodity Credit Cooperation (CCC)  
Bioenergy Program**
- **Import Tariff**

# 2002 Farm Bill, Energy Title, IX—(Con't)

- **Rural Development Loan and Grant Eligibility Expanded to More Renewable Energy**



# CCC Bioenergy Program Impacts, 2001-06



# State Regulations

- **Producer Incentive Program (16)**
- **Retailer Incentive for Ethanol Blends and E-85 (11)**
- **State RFS (4)**
- **MTBE Ban Passed (25)**
- **Retail Pump Label requirement (37)**
- **State Fleet Fuel Purchase Requirement (3)**

# Ethanol Production Costs

- **Actual survey of ethanol plants in 1998 and 2002**
- **Cash variable costs was about 95 cents per gallon in 1998 and 2002**
- **Current cash variable costs are significantly higher due to record price of corn, natural gas and electricity (\$1.60-\$1.80 per gallon)**

# Net Energy Balance and Life-cycle Analysis

- **Net energy balance of corn ethanol is positive and increasing over time due to higher corn yield per acre, higher ethanol yield per bushel of corn, and advanced technologies in corn production and corn processing**
- **Net energy balance of corn ethanol was 1.24 in 1991, 1.34 in 1996 and 1.67 in 2001**

# Life-cycle Results

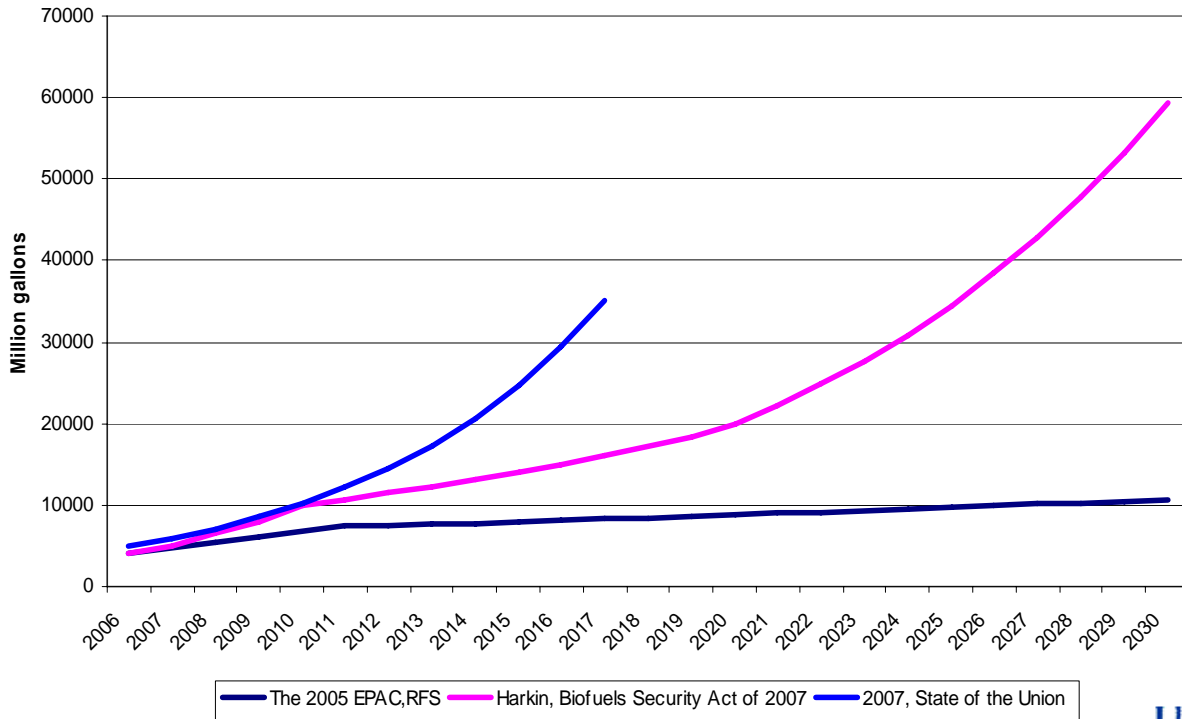
- **Reduction in GHG emissions:**
  - **GREET:**
    - E-10 corn, 2%
    - E-85 corn, 24-26%
    - E-85 cellulose, 68-91%
  - **FASOM:**
    - E-85 corn, 15-20%
    - E-85 cellulose, about 70%

# Economic Impacts of Ethanol Production

- **Reduces agricultural surplus and increases the commodity prices**
- **Lowers government payments to farmers**
- **Increases net farm income**
- **Improves balance of trade**
- **Creates jobs in rural areas**
- **Improves air quality and reduces greenhouse gas (GHG) emissions**
- **Diversifies markets for agricultural and forestry products**

# Cellulosic Ethanol

# Projected Biofuel Production

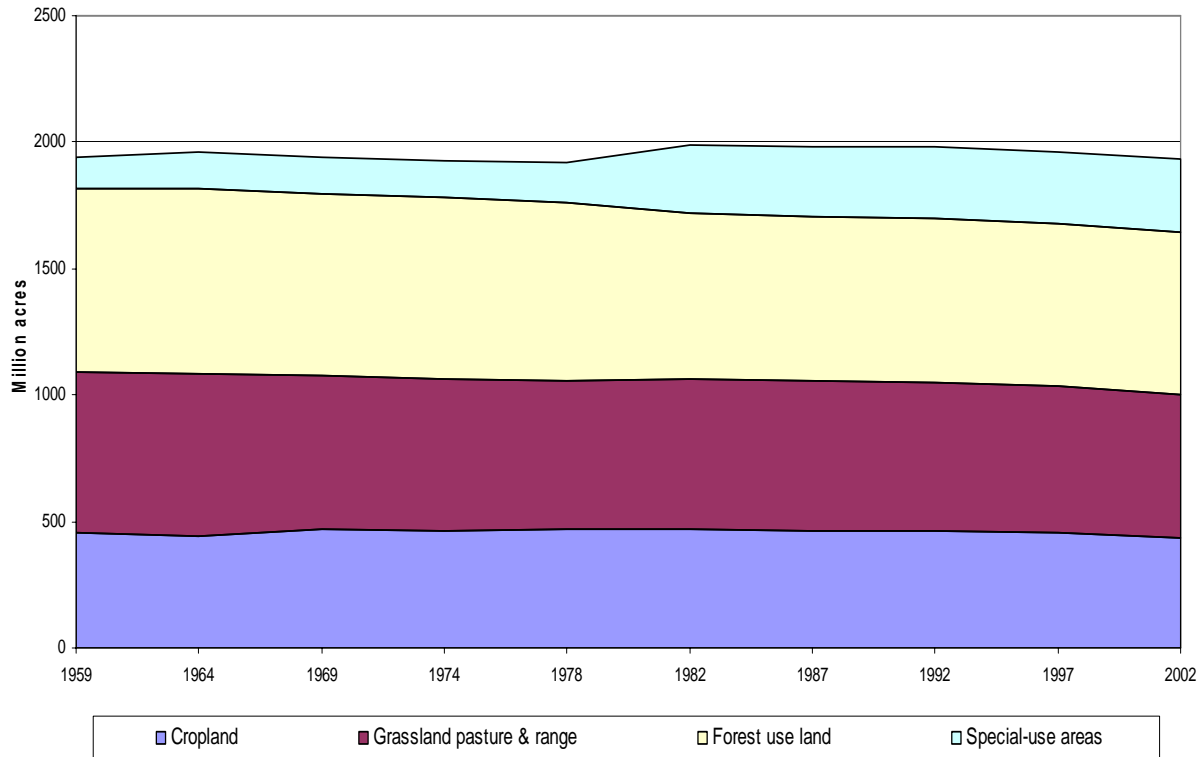




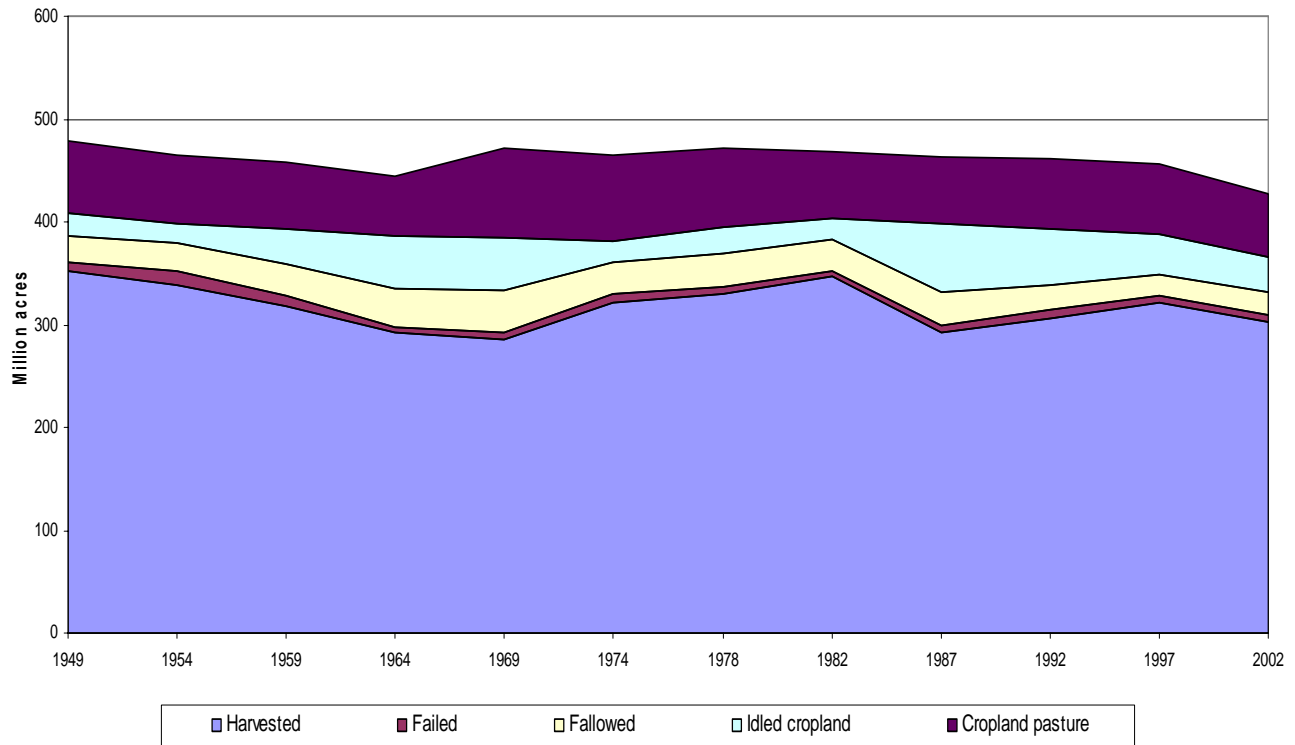
# Land Base Resources

- **Agricultural land**
  - **Crop land**
  - **Land idled by farmers and government program**
  - **Cropland pasture**

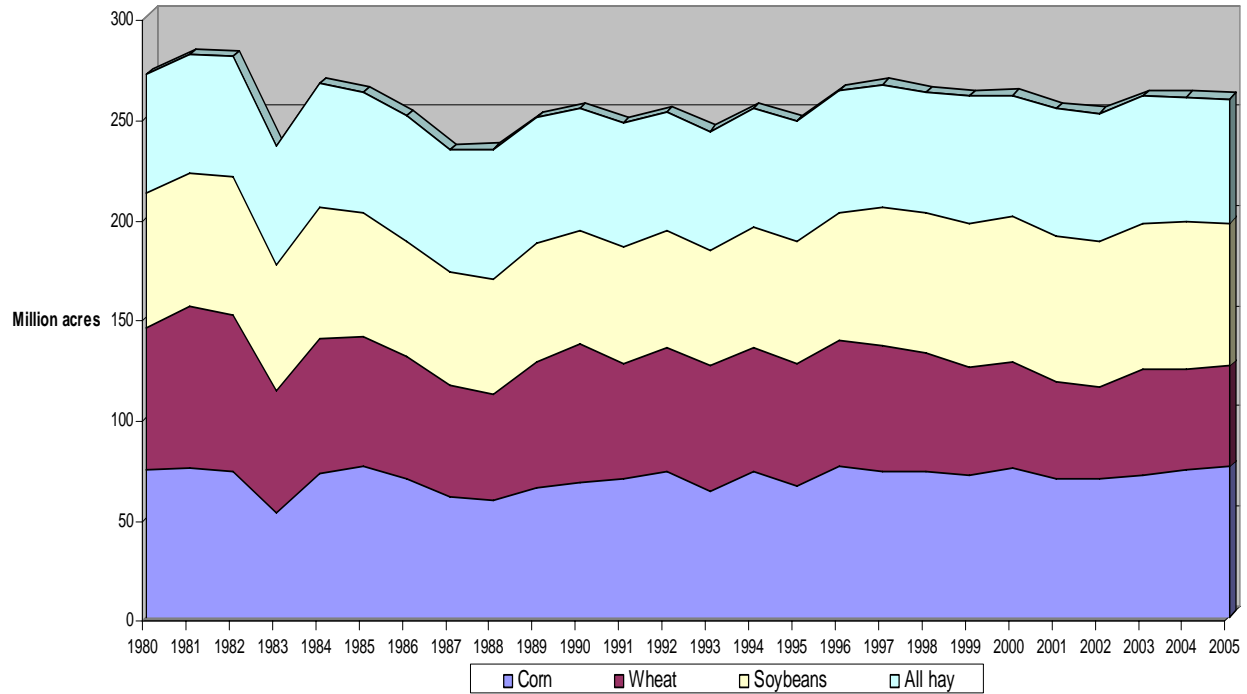
## Major Use of Land, United States, 1959-2002



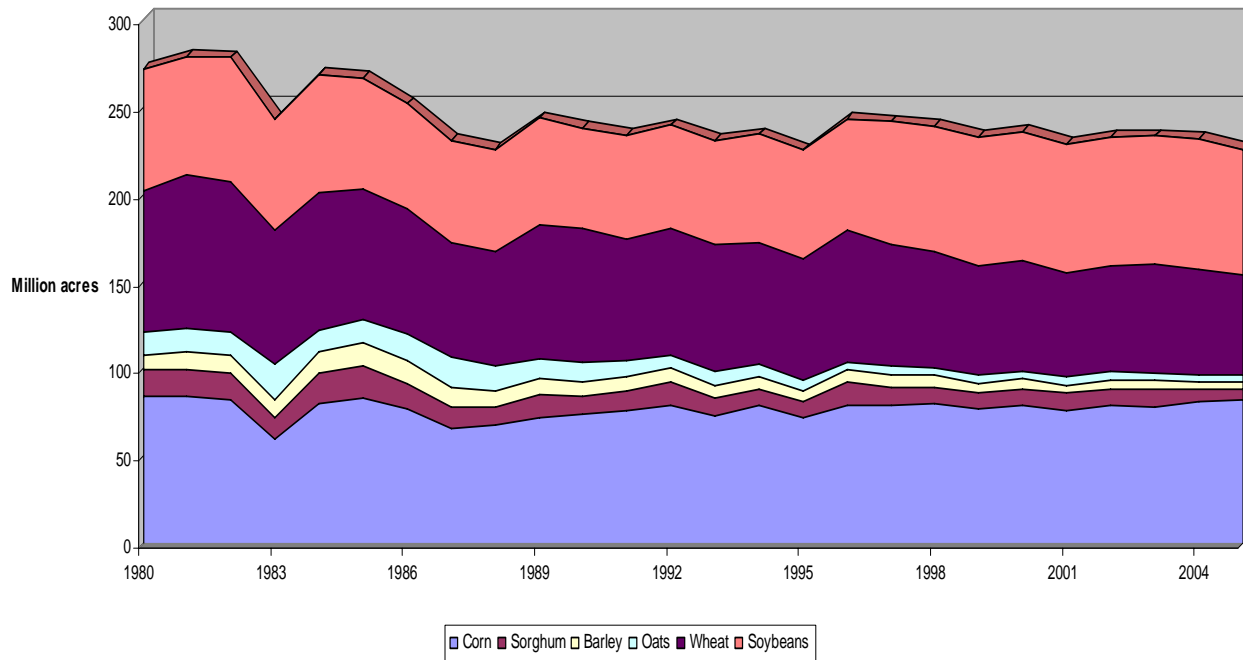
## Major Use of Croplands, 1949-2002



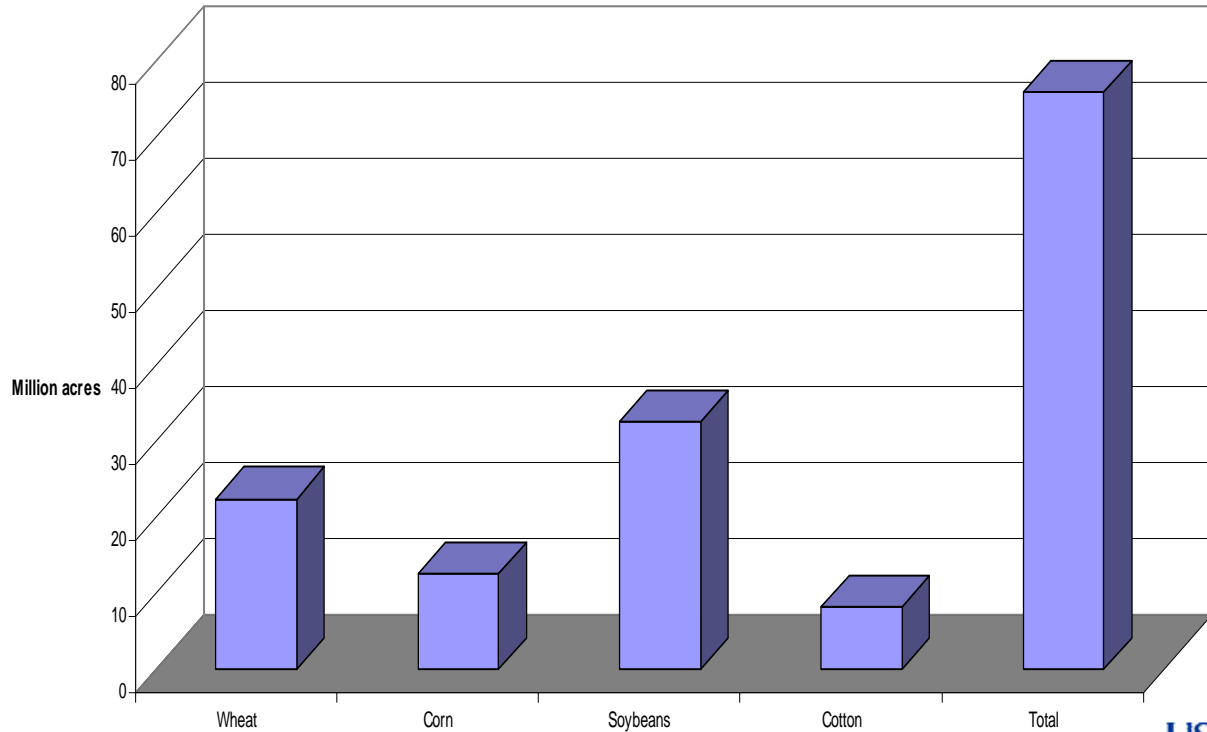
# Major Crops: Area Harvested



## Coarse Grains, Soybeans, and Wheat- Areas Harvested, 1980-2005



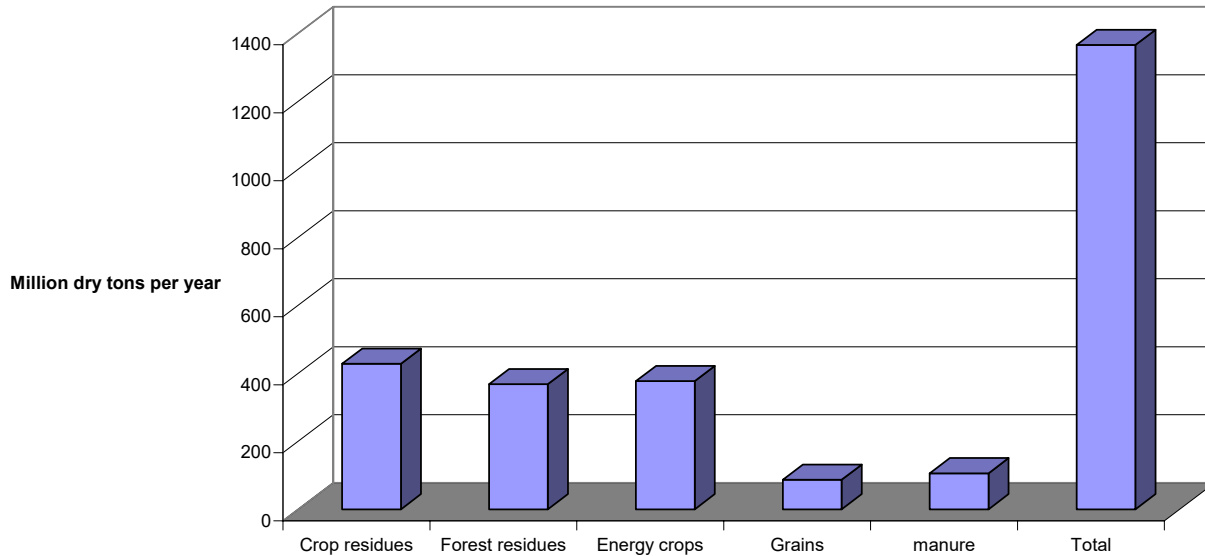
## Area Harvested for Export, 2001/02 - 2005/06 Averages



# Biomass Ethanol

- **Feedstock:**
  - **Sorted municipal solid waste**
  - **Animal waste**
  - **Agriculture and forest residues**
  - **Food and forestry processing plants byproducts**
  - **Dedicated energy crops**

## Annual Biomass Resource Potential from Forest and Agricultural Resources, 2050



Source: DOE/USDA





# Biofuels

- **Ethanol**
- **Bio-methanol**
- **Bio-butanol**
- **Bio-diesel**
- **Synthesis biodiesel**
- **Biocrude, green diesel, green gasoline**
- **Hydrogen**

# Production Process

- **Conventional (first generation)**
  - Ethanol--fermentation
  - Biodiesel—trans-esterification
- **Second generation, cellulose materials**
  - Sugar platform, fermentation
  - Thermo-chemical conversion
    - Gasification- Fischer & Tropsch
    - Gasification- fermentation
    - Gasification-hydrogen
    - Fast pyrolysis- Biocrude
    - Hydrotreating-biodiesel

# Conclusions

- **Federal policies will increase demand for biofuels**
- **Advances in technology will lower the production cost of biofuels**
- **Biofuels could be used as tool to reduce greenhouse gas emissions and improve air quality**

# Thank you

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