



The Intersection of Energy and Agriculture: Biofuel and New Technology

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World Energy Outlook

- World energy consumption will increase 70 percent by 2030.
- Transport accounts for 60% of growth in oil consumption.
- 70 percent of energy demand growth outside OECD countries
 - 1/5 of demand growth will be in China.
 - 18 cars per 1000 persons in China--800 in US
- **Remaining oil resources can sustain 70 years of consumption.**
- Energy prices rise significantly to \$60/Barrel and above



Economic growth in China is creating greater demand for automobiles, creating traffic and air quality problems.

Implications for Agriculture of Higher Energy Prices:

- Higher inputs costs--water, fertilizers, feed, transport
- Adoption of Conservation technologies
- High prices of foods--consumers lose
- Greater instability of food prices
- Research yielding higher ag productivity can reduce impacts.



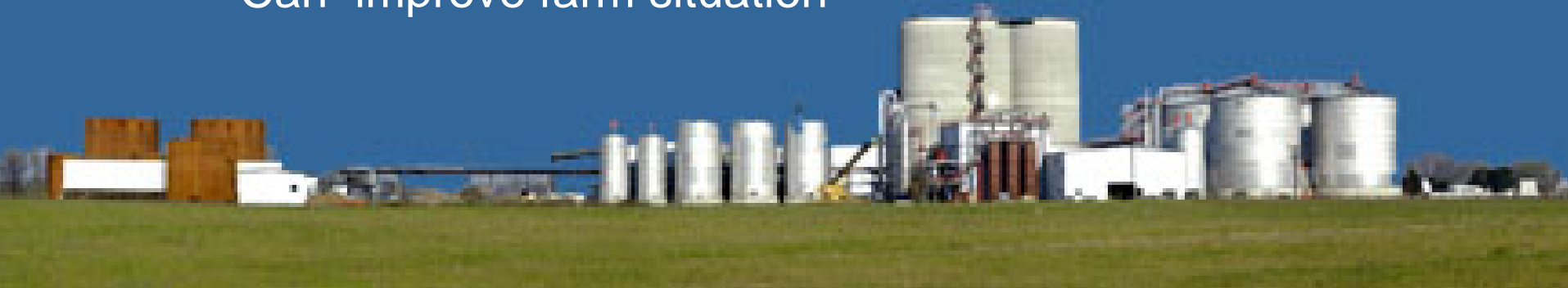
Solutions to Energy Situation

- Conservation and Efficiency
 - CAFE standards
 - Taxation and other incentives (unfortunately unpopular)
- New oil discoveries
 - OPEC would have to spend \$350 billion by 2030 to reach 60 mbd capacity.
- Unconventional Petroleum
 - Tar sands, Gas or coal to Liquids (polluting or expensive)
- New sources of energy
 - Hydrogen fuel cell, electric hybrids (long way to go)
 - **Biofuels**



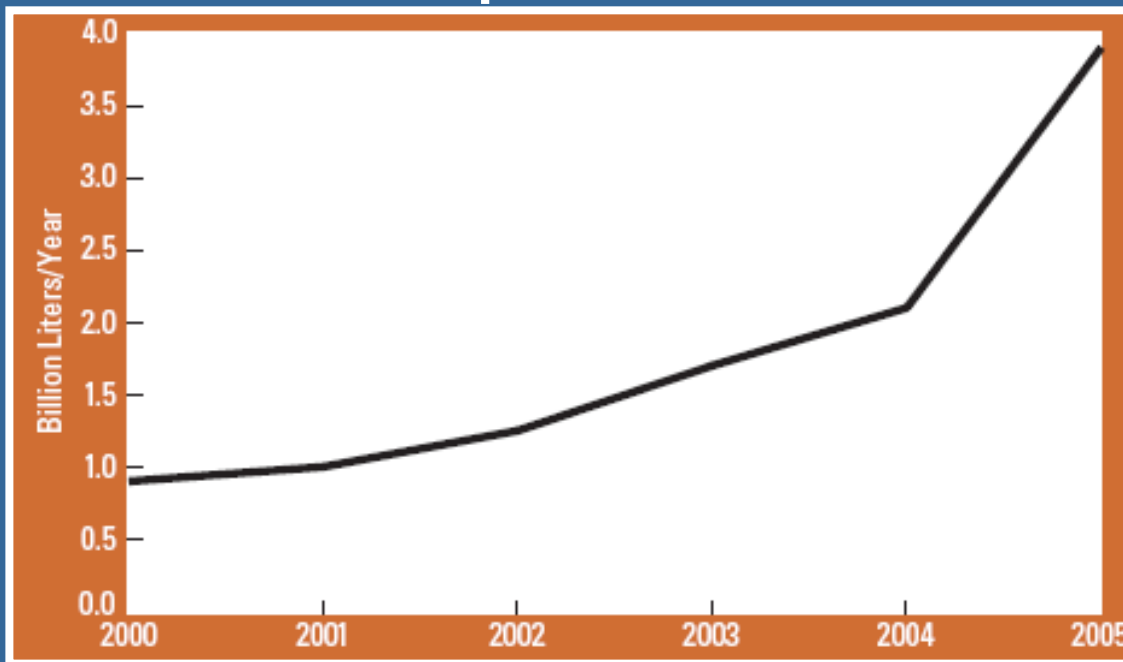
The Emergence of Biofuels

- Biofuels are not new
 - In the 19th century, significant land was devoted to fueling transportation; fossil fuels allowed us to move away from agriculture as a source of transport fuel in the 20th century
- Appeal
 - It is proven technology that needs refinement, not proof of concept
 - Can be adopted easily
 - Can address climate change concerns
 - Can improve farm situation



Current Status of Biofuel Production

World Biodiesel production 2000 to 2005

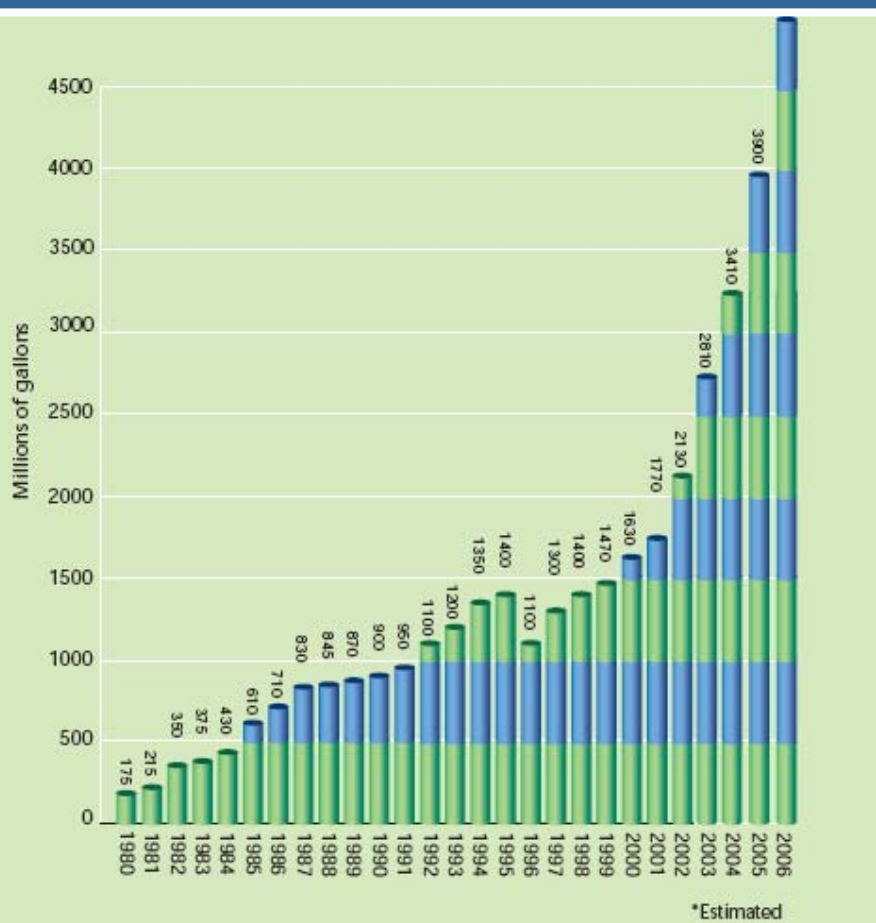


Renewables Global Status Report 2006 Update



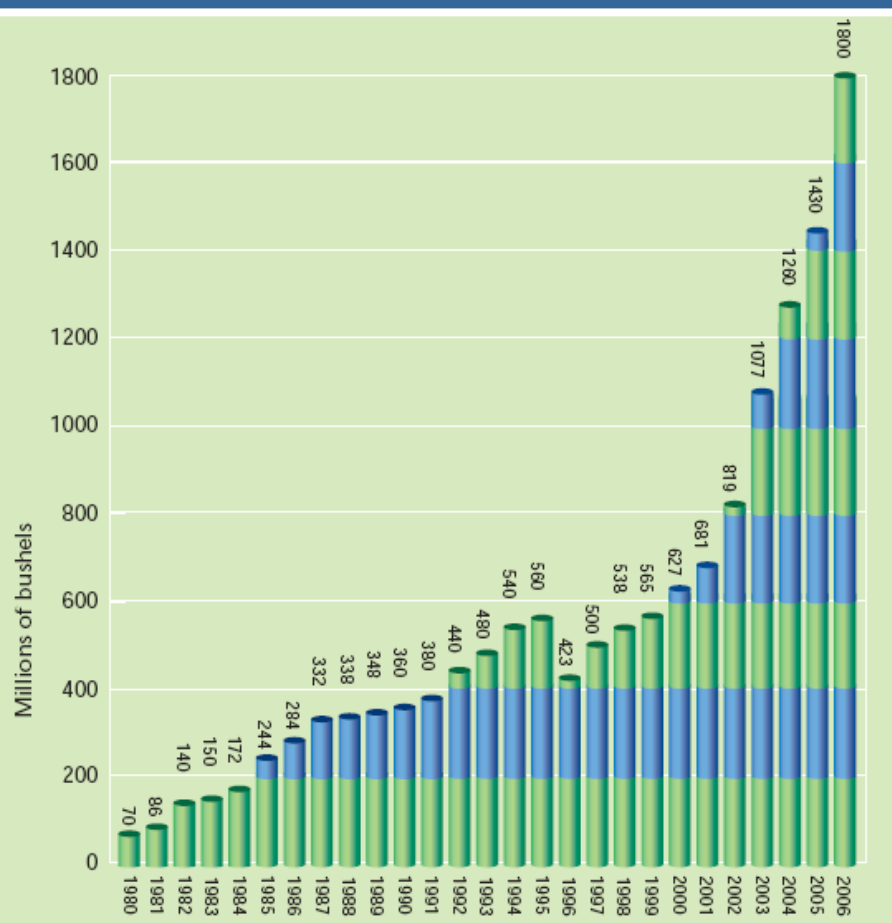
Recent Trends in Biofuels – Ethanol in US

Historic US Ethanol Production



Source: U.S. Energy Information Administration / Renewable Fuels Association

Historic US Corn Production



Source: National Corn Growers Association

Current Status of Biofuel Production

- Global ethanol production 2005: ~33 billion liters (US + Brazil = 90%)
- Global biodiesel production in 2005: ~4 billion liters (Germany + France = 70%)
- Liquid biofuels comprised ~1 percent of crude oil supply



The Evolution of Biofuels

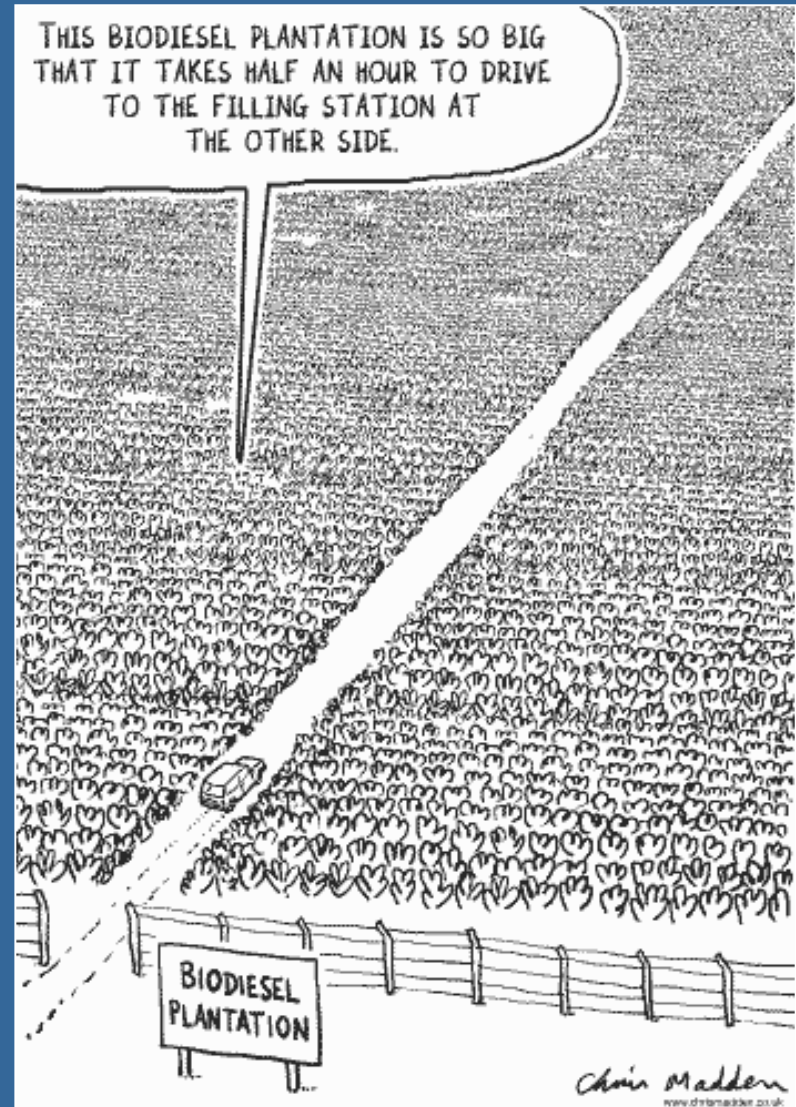
- Technology is in its infancy;
 - U.S. and Brazil can increase energy crop by 4-10 million acres.
- Adoption must occur at processing sector and at the pump.
 - Incentives for investment in capacity and for production of flex-fuel cars.
 - Biofuels are not just an ag problem, but an industrial one.
- Employment opportunities: demand for new skills for researchers, factory workers, experimental groups.
- Research improves performance gradually--but big breakthroughs are needed to make a difference.

The Benefits of Biofuels

- Fewer oil imports
- Fewer GHG emissions
- Lower energy prices
- More sustainable energy supply

The Drawbacks of Current Biofuels

- More land for energy crops
 - => less land for food and less land for environment
 - => pressure on water resources
- Higher food prices
 - May particularly effect the poor
- Increased vulnerability as food stock/flow ratio declines



Current Biofuels in Perspective

- They are a mixed bag
- High energy prices make bad biofuels profitable: Corn in U.S., sugar cane in Brazil, and palm oil in Europe
- Corn is a bad choice for biofuel crop—but it's the best we have in the U.S.
- Sugarcane is better.
- Current biofuel crops are not efficient—we can do better
- Efficiency of crop use is crucial; Cannot afford to waste residue.



Biofuels Challenge

- How to mitigate the negative environmental and social effects of biofuels?



Taking Advantage of New Tools of Science: Molecular and others

- New science can produce new biotech and better varieties of biofuel. They can yield:
 - Higher food and energy crop yields
=> reduce pressure on food prices
=> reduce land in food production (assuming inelastic food demand).
 - Reduced use of inputs (chemicals) on expanded ag land.
 - Improved net energy content and net carbon emissions of biofuels.
 - **May increase land in biofuel production depending on elasticity of demand
=> effect on natural habitat uncertain.

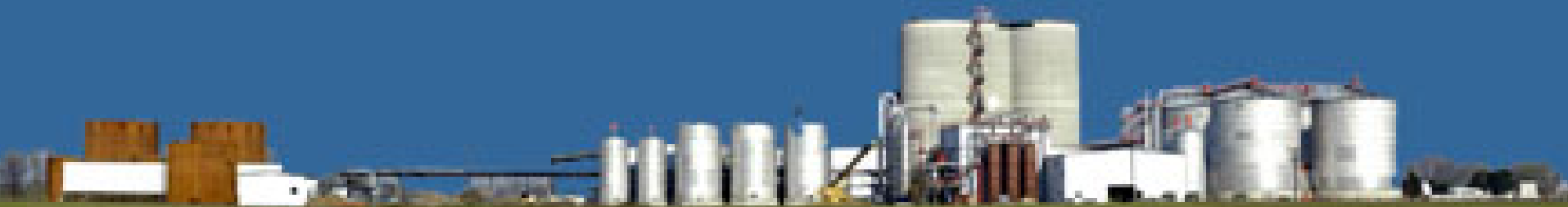
The Future of Biofuels

- Expect a gradual process of technological change
- It will lead to:
 - Improvements in fuel yield per acre from improvement in crop yield and conversion efficiency
 - New feedstock – Cellulosic sources like switch grass
- Continuous increased in fuel produced per unit of land and water
- Increased ease and reduced costs of use of biofuels as fuels



Biofuel, High Energy Prices and Ag Policy

- Ag policy will become energy and environmental policy.
- May be less demand / justification for ag policy.
- BUT, high food prices may warrant government purchases of food to prevent hunger.
- Government should help establish strategic fuel industry, but then it must compete.
- Some CRP (and other) land should be returned to production for economic reasons.
- Public sector support for research to develop better biofuels and assess environmental impacts



Economics and Social Science Research Agenda

- Understand the production economics of biofuels--in the context of technology and market risks
- Develop understanding of integrated energy and agricultural markets
- Understand economic growth in developing world: how it is effected by energy and agriculture.
- Understand how climate change policies will interact with energy policies, and how they will affect agriculture
- The Economics of R&D and regulation of biofuels
- The industrial organization implications of biofuel--how it will affect agribusiness.
- Biofuel impact on land, water, biodiversity.
- Biofuels within a dynamic context: what is the optimal trajectory of renewable and nonrenewable technologies and how can policy affect it?

A New Environmental Paradigm

- Climate change and energy scarcity may lead to a new environmental and humanitarian crisis—but we can act!
- Adapting to population growth, increased incomes, climate change and energy scarcity requires
 - Incentives and policies to **adapt and conserve**
 - Premium on **innovation** of new ways to adjust
 - Promote environmental entrepreneurship
 - Need to quantify and prioritize risks--for reasonable regulations
 - May need to take small risks to avoid big ones
 - Sound experimentation of new technologies
 - Integrated global policies
- Good research can guide the way!



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