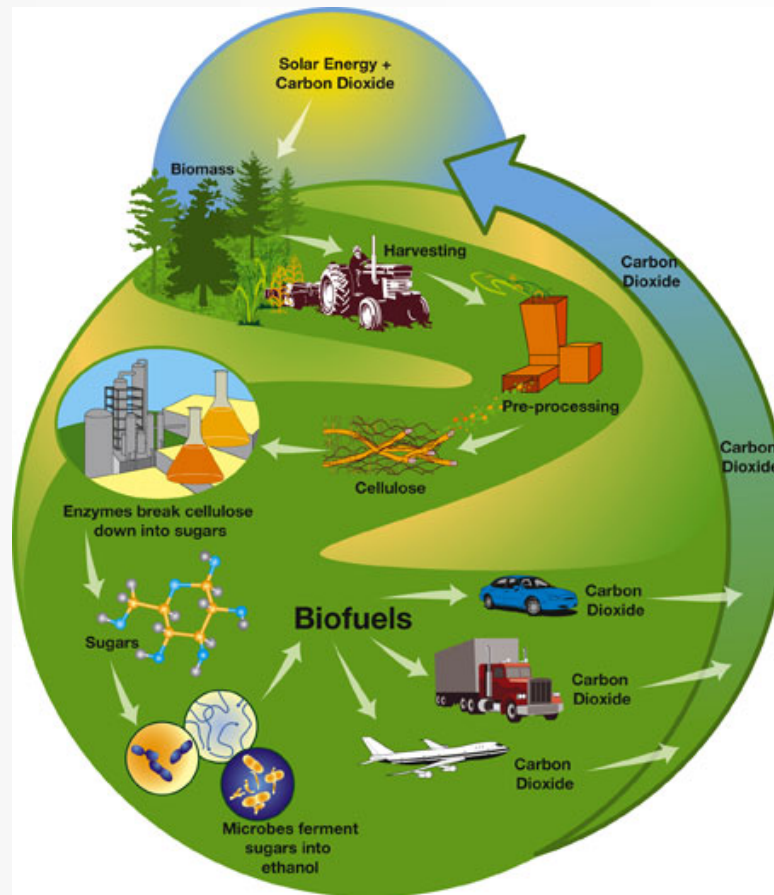


# Biofuels: Ethanol



David Roh  
Bing Liu  
Juan Shishido  
Lisa Garrett

# Oil, Biofuels, and Backstop Technology

## Alternative Resource for Oil.

- Fixed supply of oil remains an issue today
- Alternative: Biofuel, and Hydrogen fuel cells
- These represent a backstop technology for gasoline
- Same objectives as Gasoline

## Backstop Technology.

- We can think of backstop technology as a future technology that acts as a perfect substitute for a current exhaustible resource.
- The cost of providing this alternative technology is seen as a backstop to the price of the exhaustible resource.
- If backstop technology is introduced then, this will increase the extraction in current period.

# Oil, Biofuels, and Backstop Technology

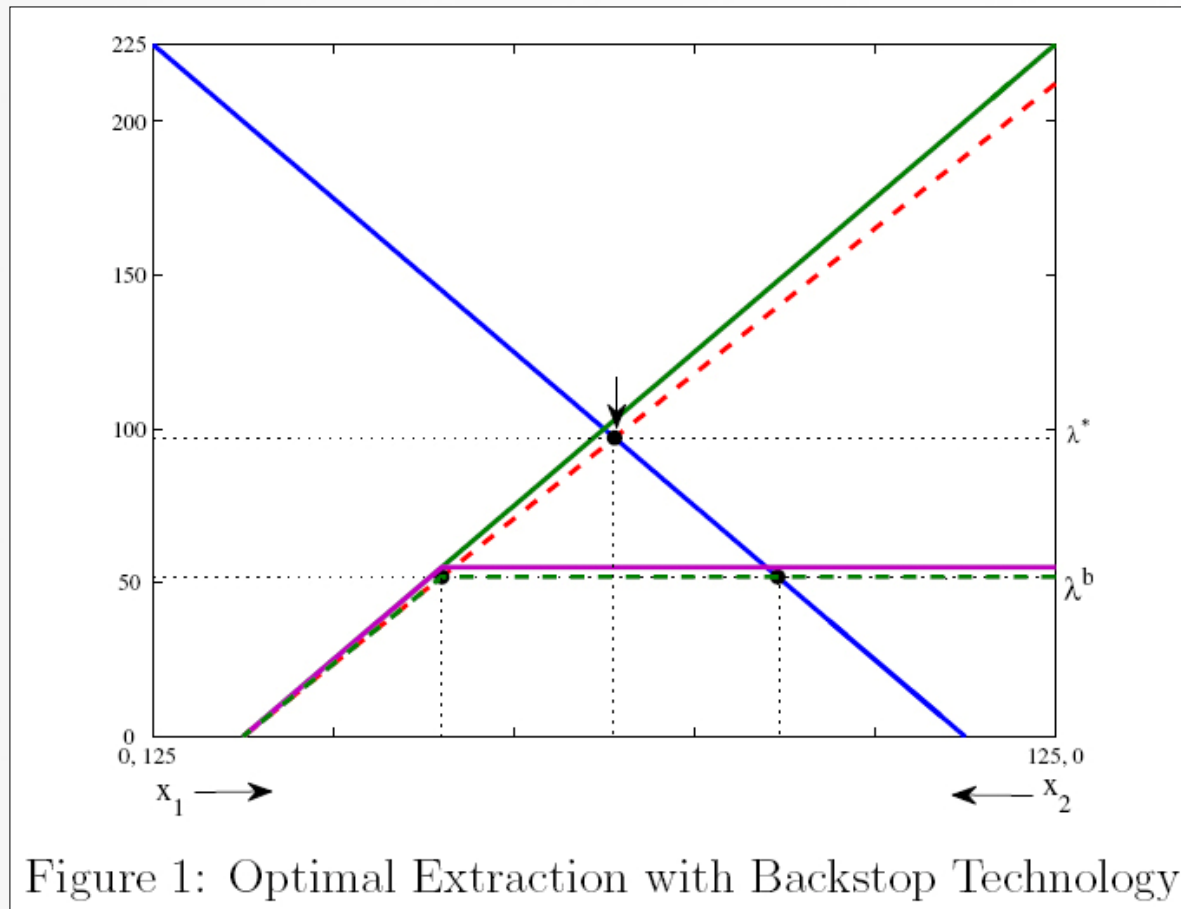
## Two Dynamics to Backstop Technology.

- The cost of providing the backstop technology will typically be decreasing over time.
- The availability of the backstop technology will be increasing over time.

## Basic Concept of a Backstop Technology.

- The more certain that a backstop technology will be available, the more resource owners mine in the present with current technology.
- The less certain the backstop technology, the less it constrains the behavior of the resource owner.
- In this case less is extracted in the current period and the solution approaches the one with no backstop technology on the horizon.

# Oil, Biofuels, and Backstop Technology



# Oil, Biofuels, and Backstop Technology

## Biofuel vs. Gasoline

- More than five million vehicles are already equipped with engines that can run on energy source.
- Thanks to biotech breakthroughs: more feedstocks

*"I'm absolutely convinced that without putting any more land under agriculture and without changing our food production, we can introduce enough ethanol in the U.S. to replace the majority of our petroleum use in cars and light trucks."*



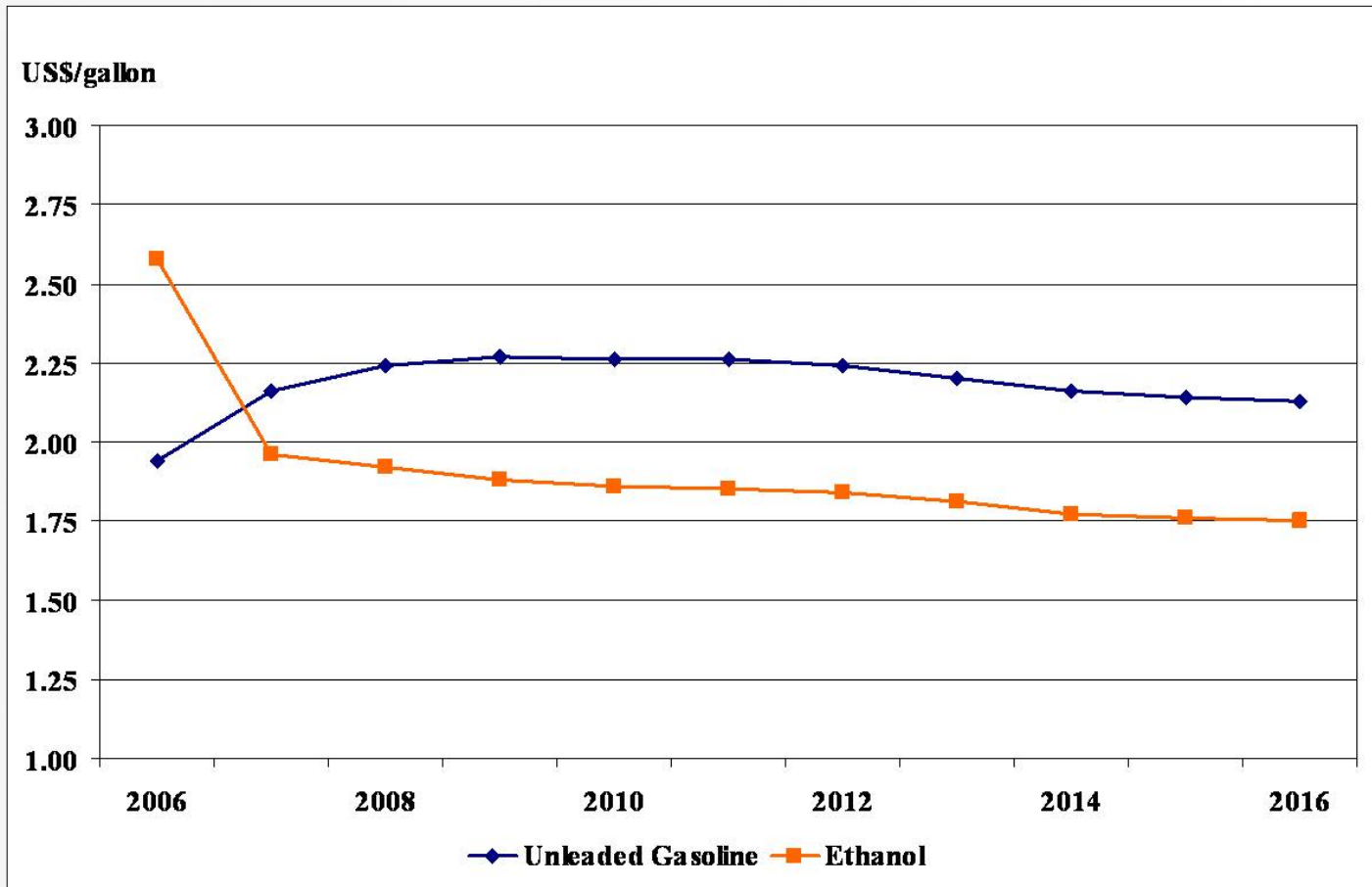
# Oil, Biofuels, and Backstop Technology

## How Brazil beats the U.S.

- Brazil boasts the biggest economy south of Mexico: Annual GDP 2.6%.
- Perfect geography for growing sugar cane
- *“Everyone talks about alternative fuels, but we’re doing it.”*
- *“I hate to see the U.S. ten years behind Brazil, but that’s probably about where we are.”*
- Ethanol: 40% of the fuel Brazilians use in their cars
- Consumers are choosing ethanol rather than being forced to buy it
- Investors now view Rio as the future of fuel.

# Oil, Biofuels, and Backstop Technology

Wholesale Gasoline and Ethanol Prices.



# Oil, Biofuels, and Backstop Technology

## Biofuel always better?

- If they require heavy fertilization or irrigation, are produced in low yield, biofuel may not be an attractive option.
- Bio-diesel can act as a solvent that can loosen up deposits and clog up gas station fuel filters.
- Break down rubber components
- Replace rubber components with synthetic rubber.
- Gas owners: additional cost to convert to bio-diesel.
- Car warranties will be changed.

# Oil, Biofuels, and Backstop Technology

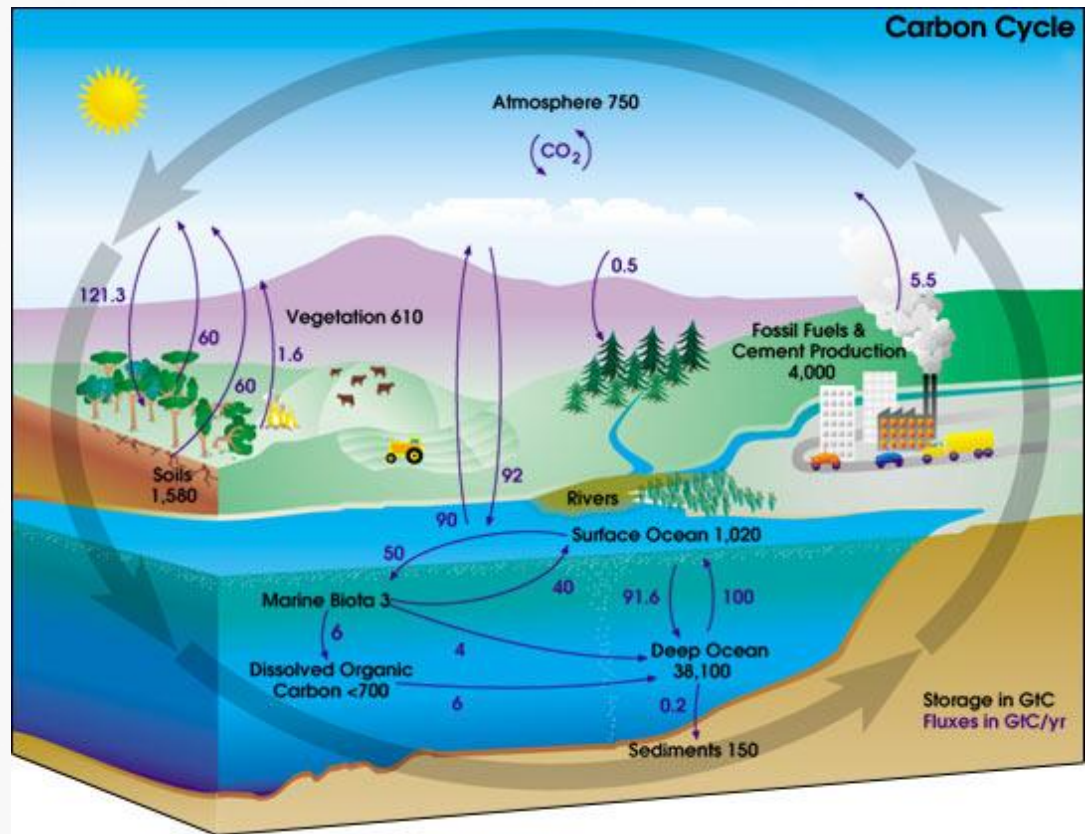
## Policy.

- Incentive and tax credits for producers and users of renewable and alternative fuel.
- More profits for producers, Less profit for consumers
- Some states does not have enough supply to benefit from government incentives
- Mandate is unfair and does not consider the states that are not in a position to compete and convert to bio-diesel.
- Winners and Losers.



# CO<sub>2</sub> & Emissions

- Using biomass to create energy has positive environmental implications.
- Before the anthropomorphic discovery of fossil fuels, the carbon dioxide cycle was stable.
- In the past 150 years, the period since the Industrial Revolution, carbon dioxide levels in the atmosphere have risen from around 150 ppm to 330 ppm.



# CO<sub>2</sub> & Emissions

- Biofuel is far cleaner than fossil fuel.
- Biofuel can emit more nitrous oxide, a smog-forming compound.
- Biofuel's overall smog-creating potential is 50% lower than fossil fuel's.

# CO<sub>2</sub> & Emissions



- Adding ethanol to gasoline decreases emissions of carbon monoxide.
- According to the EPA, a 10% ethanol blend can reduce benzene by 25% compared to gasoline. .
- Ethanol does result in slightly higher emissions of acetaldehyde.
- Ethanol also has a mixed impact on ground-level smog.

# CO<sub>2</sub> & Emissions

- An overwhelming majority of scientists now link carbon dioxide with rising temperatures in the atmosphere.
- Scientists are predicting a rise in average temperature 2-10 degrees Celsius.
- This small shift in average temperature has huge implications for melting ice sheets, which would raise global water levels up to 30 feet.
- More extreme weather patterns are predicted to occur, as well as habitat loss, spread of disease and a whole host of other problems.
- The amount of CO<sub>2</sub> pumped into the atmosphere today will remain for at least a hundred years, since the half life will outlive all of us.

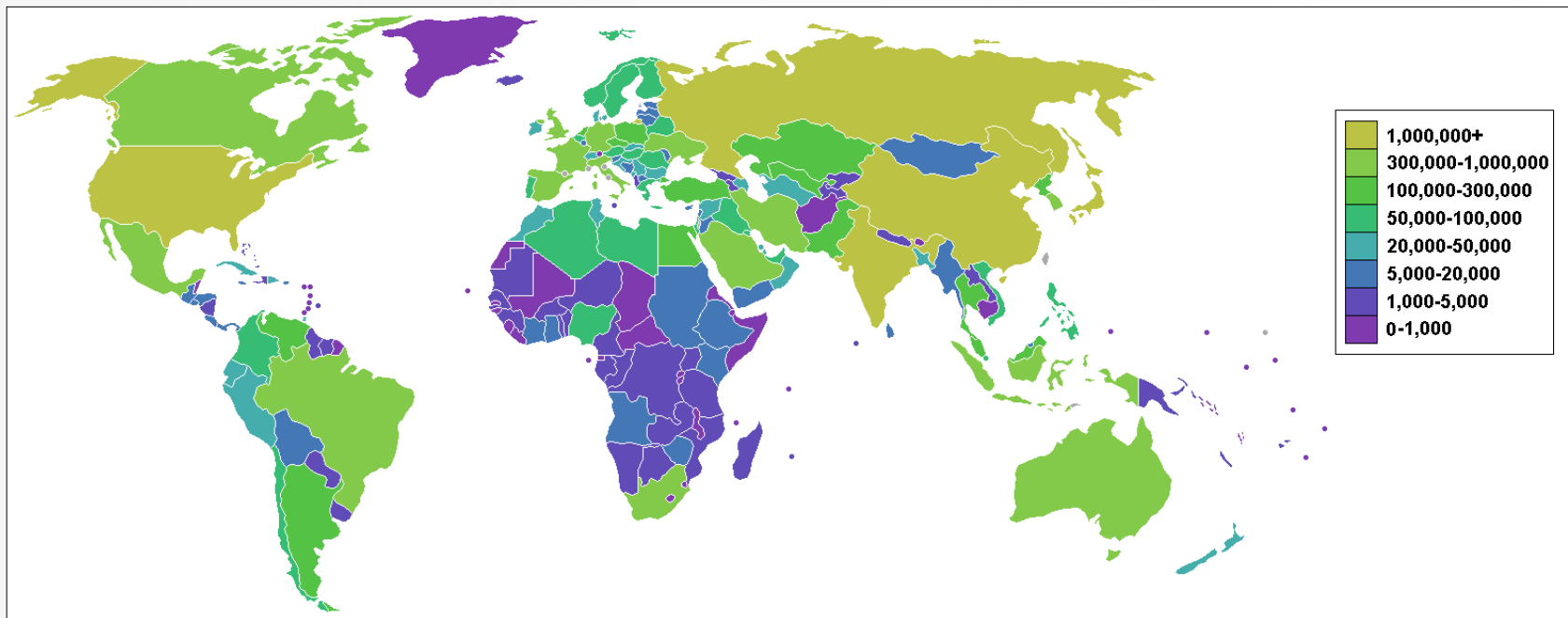


# CO<sub>2</sub> & Emissions

- Plant-based fuels have what's called a "closed carbon cycle".
- In contrast, when fossil fuel is burned, it releases carbon dioxide that has been stored for millions of years.
- Plants are able to recycle some, but not all of the carbon dioxide released by burning fossil.
- On average, lifecycle carbon dioxide emissions from biofuel are 78% less than fossil fuel.
- On average, lifecycle carbon dioxide emissions from corn-based ethanol are 35% less than fossil fuel.

# CO<sub>2</sub> & Emissions

Countries by carbon dioxide emissions via the burning of fossil fuels (2007) in thousands of metric tons



# Biofuels and Land Use

Land is required to grow biomass: corn, soy, sugarcane, switchgrass, etc.

Increased biofuels demand → increased demand for land → ?

**ILUC: Indirect Land-Use Change** is the idea that increased biofuels production, by causing prices to rise, encourages increased planting of biofuel crops.



# Biofuels and Land Use

Land-Use Concerns: why it matters.

Natural ecosystems purify air and water, **sequester carbon**, and provide habitats for plant and animal species.

How do farmers respond to increases in ethanol demand?

- Increasing productivity.
- Substituting corn for relatively less profitable crops: soy and wheat.

How does this affect the environment?

- Farmers may expand corn crops into land not currently in use.

Environmental impact depends on the type of land converted.

# Biofuels and Land Use

ILUC: The beginning.

“Land Clearing and the Biofuel Carbon Debt”

Joseph Fargione, *et al.*

“Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change”

Timothy Searchinger, *et al.*



29 February 2008  
Vol. 319, Issue 5867, Pages 1157-1268

These studies brought the topic of indirect land use changes caused by biofuels to widespread attention.

# Biofuels and Land Use

## “Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change”

Argues that prior studies don't accurately account for biofuel emissions.

- Prior studies only considered sequestered carbon via growth of feedstock; they excluded emissions from land-use change.
- Searchinger, *et al.* consider carbon emissions that result from the conversion of forests and grasslands to new croplands as well.

*“By using a worldwide agricultural model to estimate emissions from land-use change, we found that corn-based ethanol, instead of producing a 20% savings, nearly **doubles greenhouse emissions over 30 years** and increases greenhouse gases for 167 years. Biofuels from switchgrass, if grown on U.S. corn lands, **increase emissions by 50%.**”*

# Biofuels and Land Use

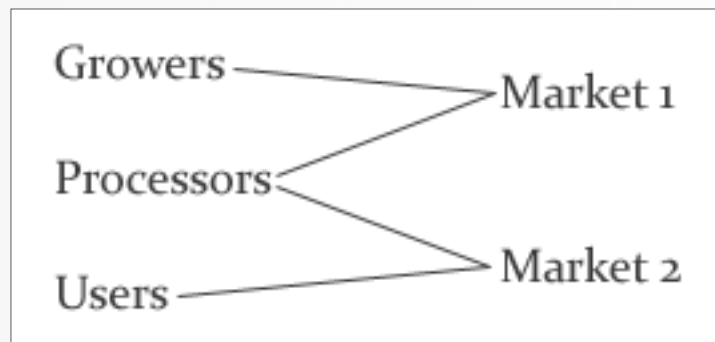
Corn and cellulosic ethanol emissions exceed or match those from fossil fuels and therefore produce no greenhouse benefits.

Source of fuel	Making feedstock	Refining fuel	Vehicle operation (burning fuel)	Net land-use effects		Total GHGs	% Change in net GHGs versus gasoline
				Feedstock carbon uptake from atmosphere (GREET)	Land-use change		
Gasoline	+4	+15	+72	0	–	+92	–
Corn ethanol (GREET)	+24	+40	+71	–62	–	+74	–20%
						+135 without feedstock credit	+47% without feedstock credit
Corn ethanol plus land use change	+24	+40	+71	–62	+104	+177	+93%
Biomass ethanol (GREET)	+10	+9	+71	–62	–	+27	–70%
Biomass ethanol plus land use change	+10	+9	+71	–62	+111	+138	+50%

# Biofuels and Land Use

Tweaking our view: a unified market with two main actors?

More realistically, there are two markets and three actors.



The land-use mix is determined by the **crush spread**: the price differential between the price of ethanol and corn feedstock.

A high crush spread occurs when *refined fuel prices* > *feedstock prices*.

# Biofuels and Land Use

ILUC in California.

## Call to Action on Biofuels and Land-Use Change

On April 21, 2009 more than 170 scientists and economists wrote to the CARB Chairman, Mary Nichols, urging the board to account for biofuel pollution from indirect land-use change under the state's proposed Low Carbon Fuel Standard (LCFS).

*“[C]onventional biofuels can directly or indirectly result in substantial heat-trapping emissions through the conversion of forests and grasslands to croplands to accommodate biofuel production.”*

# Biofuels and Land Use

## Biofuels' Externalities: Far Reaching Effects.




- U.S. corn production displaces soy production.
- Soy production moves elsewhere, responding to higher prevailing prices that result from a decrease in supply.
- Brazil is home to more and more soybean farms.

<http://www.flickr.com/photos/inparadiso/133428648/>

That's not all though...

# Biofuels and Land Use

## Biofuels' Externalities: Far Reaching Effects.

- U.S. corn subsidies, by diverting resources away from other energy crops, indirectly increase the price for those energy crops.
  - The biofuel boom of early 2008 lifted palm oil prices by about half.
  - Palm oil plantations are expanding in Indonesia.
  - Southeast Asia's peat swamps are being replaced and, in the process, emitting about 2 billion tons of carbon dioxide emissions per year, according to Wetland International.
- 
- The wildlife suffers as well.

# Biofuels' Impact on Food Prices

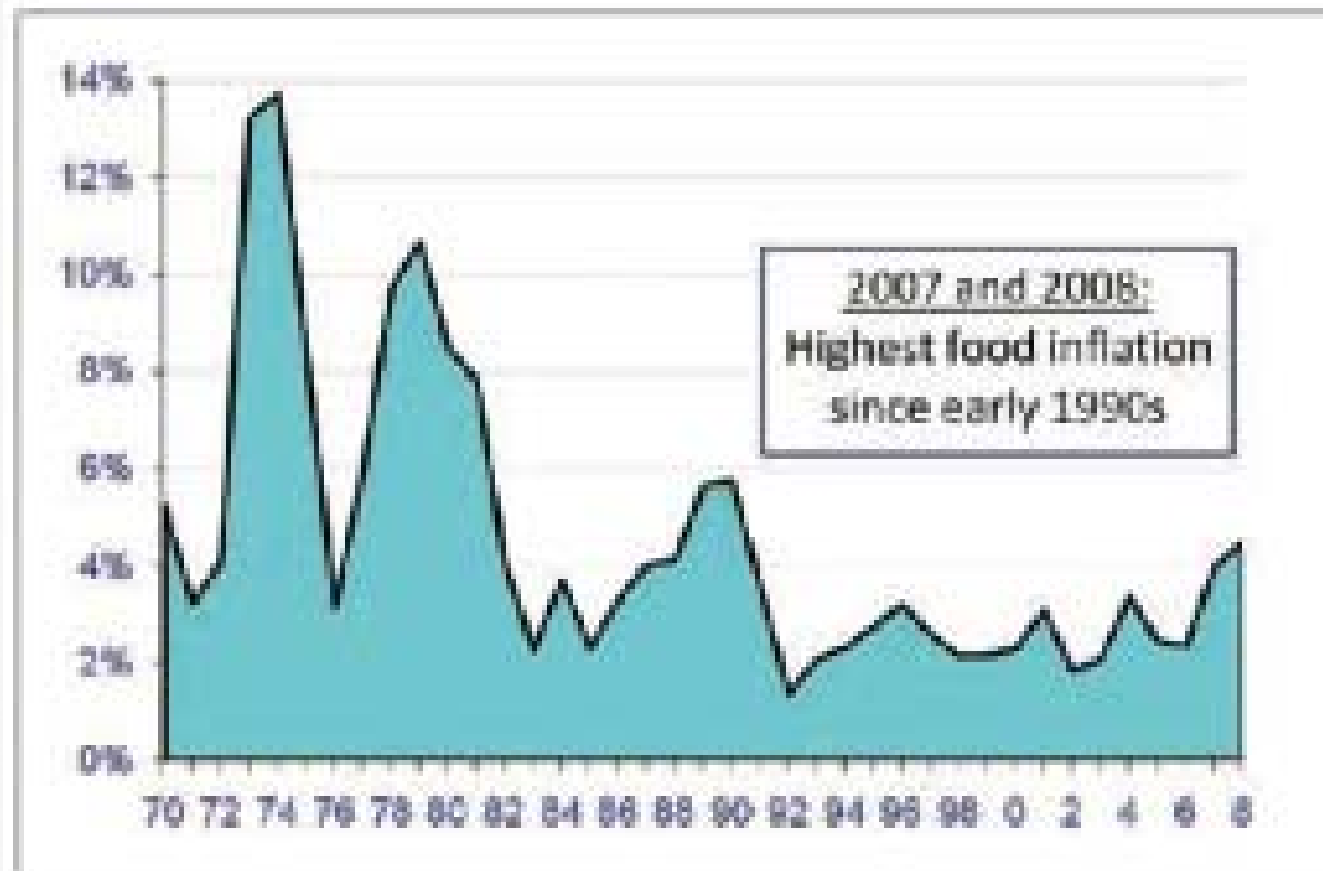


*“The biofuels surge makes things worse by adding high demand on top of already high prices and low stocks,”*

- Don Mitchell, Lead Economist, World Bank

# Biofuels' Impact on Food Prices

Food prices are increasing, but which ones?

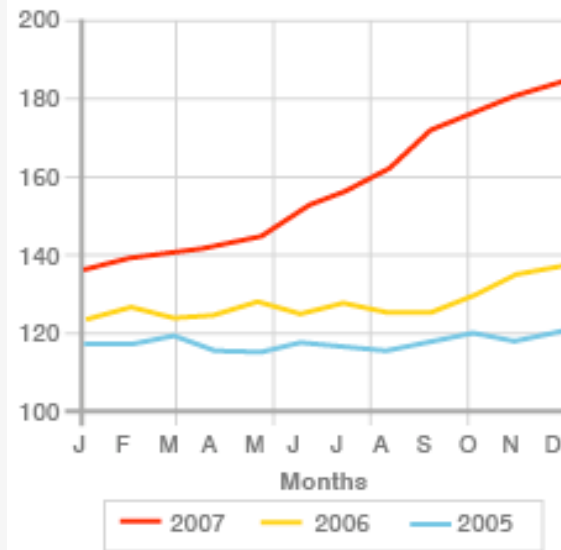


# Biofuels' Impact on Food Prices

Since 2007, the price of food has increased even more!

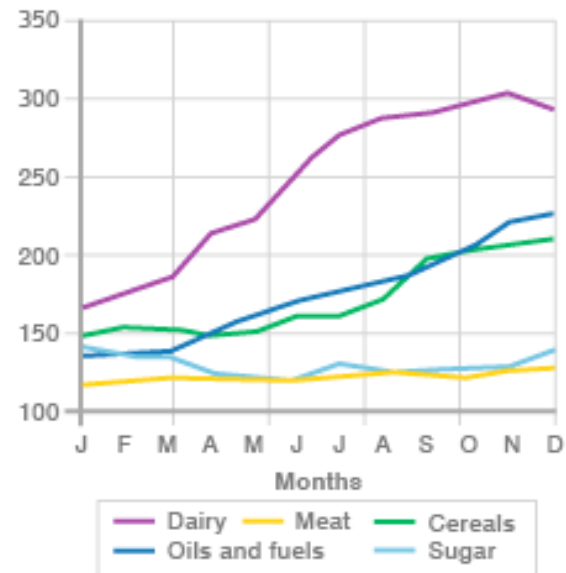
**RISING FOOD PRICES, 2005-2007**

1998-2000 = 100\*



**PRICES RISES BY FOOD TYPE, 2007**

1998-2000 = 100\*



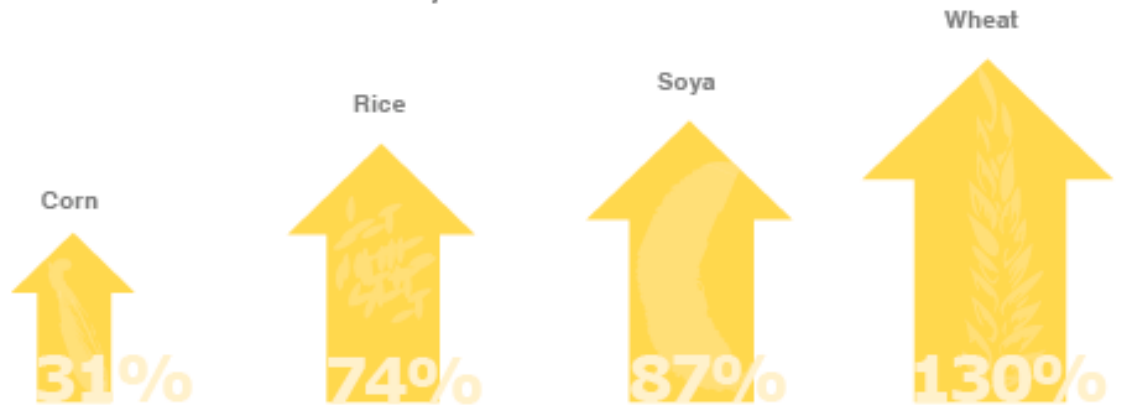
\*Changes in price are indexed against the costs dating from 1998-2000

SOURCE: Source: FAO

# Biofuels' Impact on Food Prices

Staple food prices that contribute to the food supply are increasing.

PRICE RISES IN A SINGLE YEAR, MARCH 2007-MARCH 2008

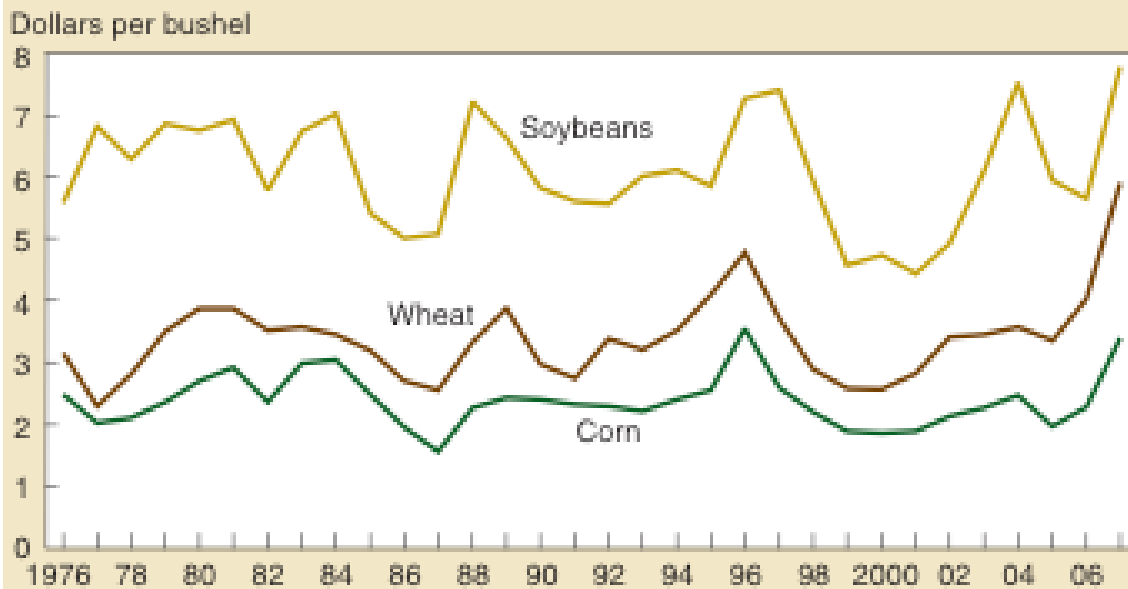


SOURCE: Bloomberg, except rice: FAO/ Jackson Son & Co

# Biofuels' Impact on Food Prices

Corn, Soybeans, and Grains in particular.

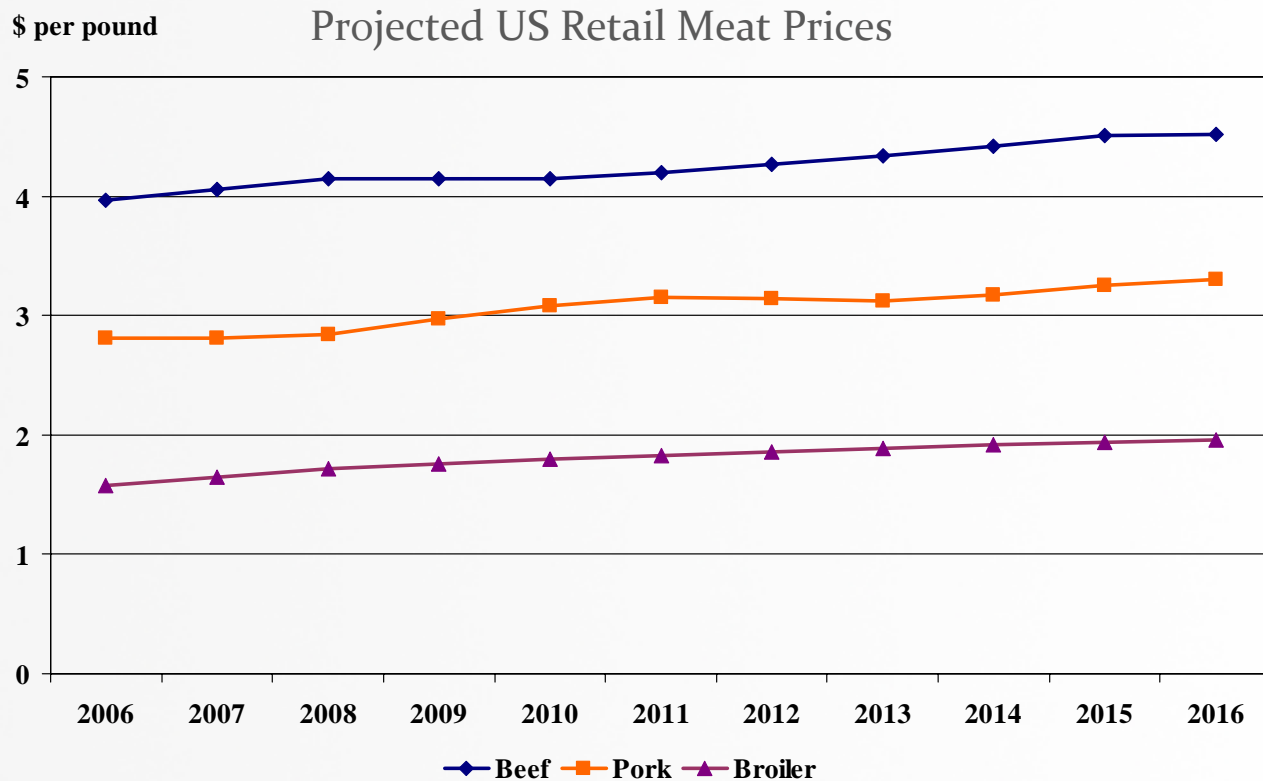
**Corn, wheat, and soybean prices at or near record highs in 2007**



Source: USDA, National Agricultural Statistics Service, Agricultural Price Series, 1976-2007.

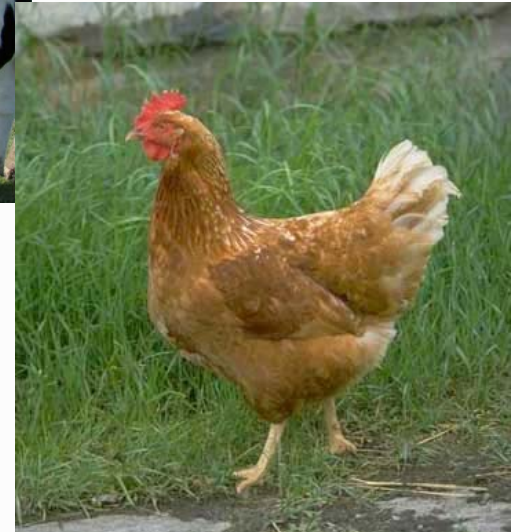
# Biofuels' Impact on Food Prices

Poultry, dairy, and livestock costs are also rising, but why?



# Biofuels' Impact on Food Prices

These guys need to eat too!



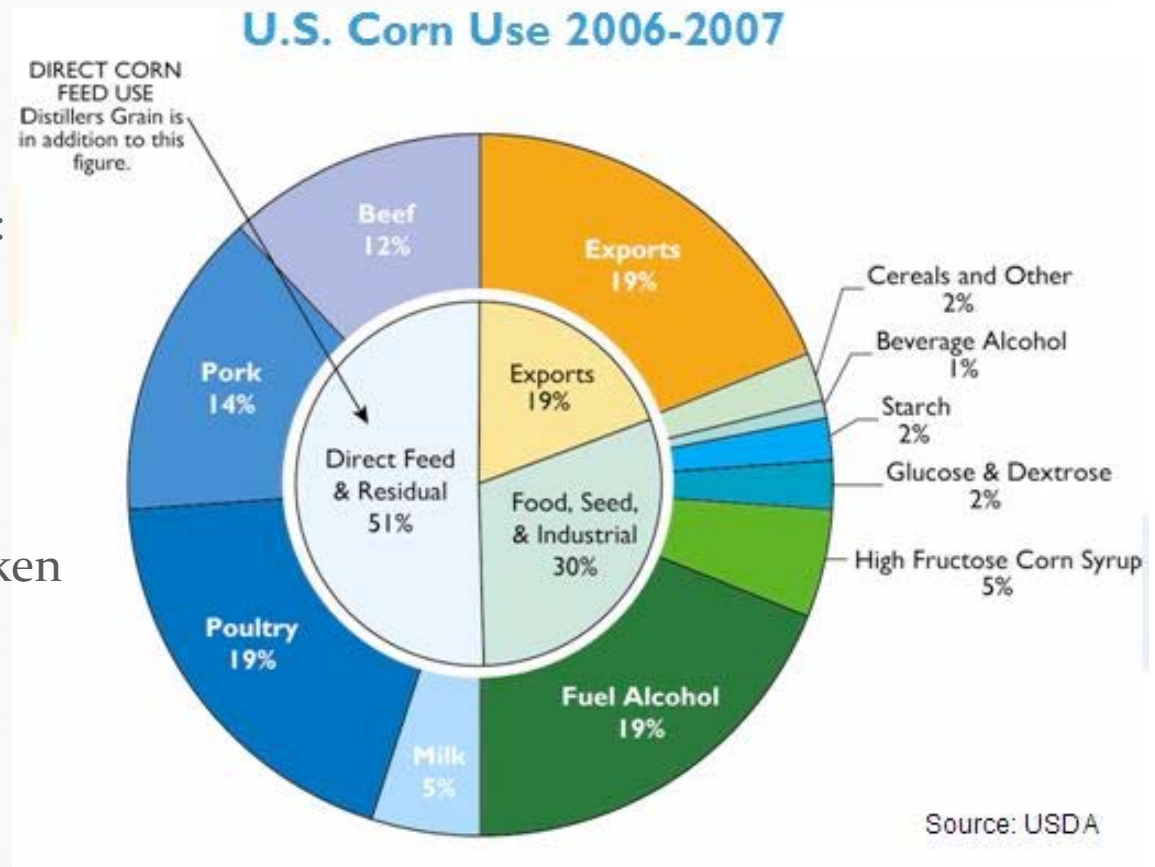
As corn prices increase, farmer's feed costs also increase.

# Biofuels' Impact on Food Prices

Over half of the corn produced in the U.S. is used for animal feed.

Current estimates (2008):

- 7lbs corn = 1lb beef
- 6.5 lbs corn = 1lb pork
- 2.6 lbs corn = 1lb chicken



# Biofuels' Impact on Food Prices

What do Biofuels have to do with all of this?

Increased demand for Biofuels production has increased the demand for food commodities.

- From 2004 – 2007, the use of maize for ethanol increased 36% while the increase for feedstock only 1.5%
- Higher feedcosts → lower production → retail prices increase



# Biofuels' Impact on Food Prices

What do Biofuels have to do with all of this?

Increased Biofuels production has been driven by subsidies and mandates.

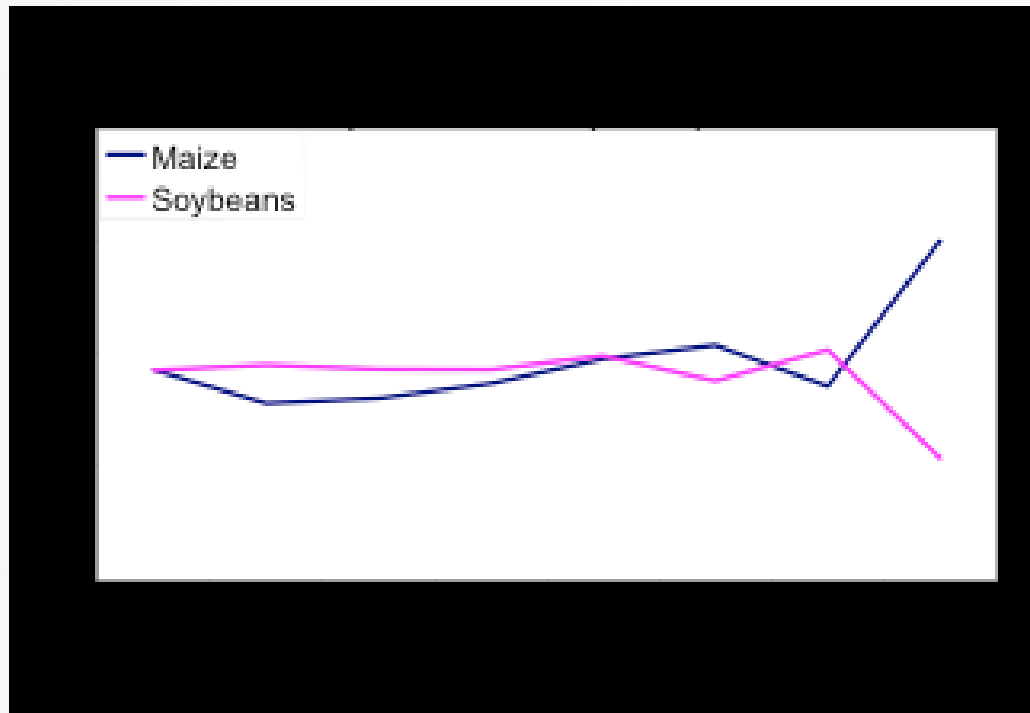
- Energy Act of 2005
- Energy Independence and Security Act of 2007
- 2008 Farm Bill



# Biofuels' Impact on Food Prices

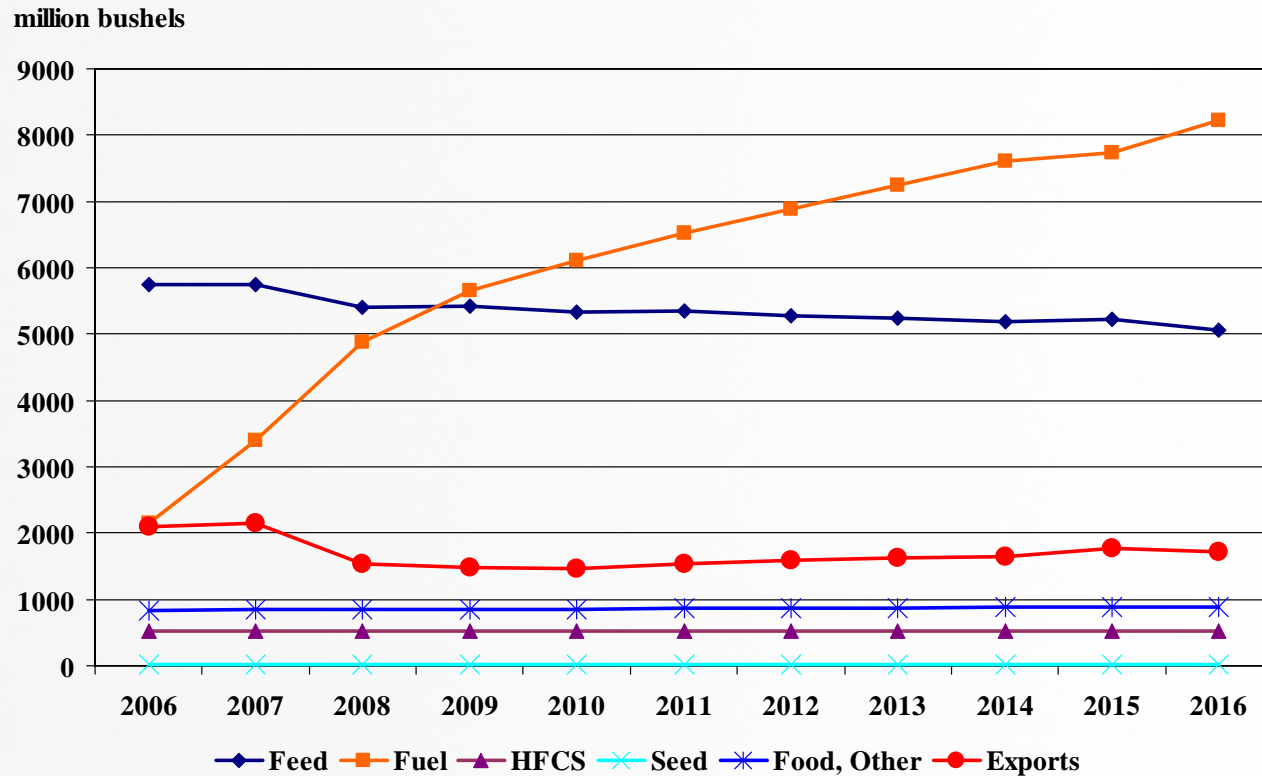
What do Biofuels have to do with all of this?

Land use changes due to expanded Biofuels production have led to reduced productions of other food crops.



# Biofuels' Impact on Food Prices

## Projected Utilization of Corn



# Biofuels' Impact on Food Prices



## Conclusions

- Food producers, in the short run, may feel the effects of increased cost of production, but, in the long run, may become more efficient producers.
- Policy related to biofuel production should be considered in light of their impact on food prices.
- Conditions can change as other alternative energy sources develop.