

# **A Sustainable Biofuels Industry**

Biofuels, Carbon, and Trade Conference

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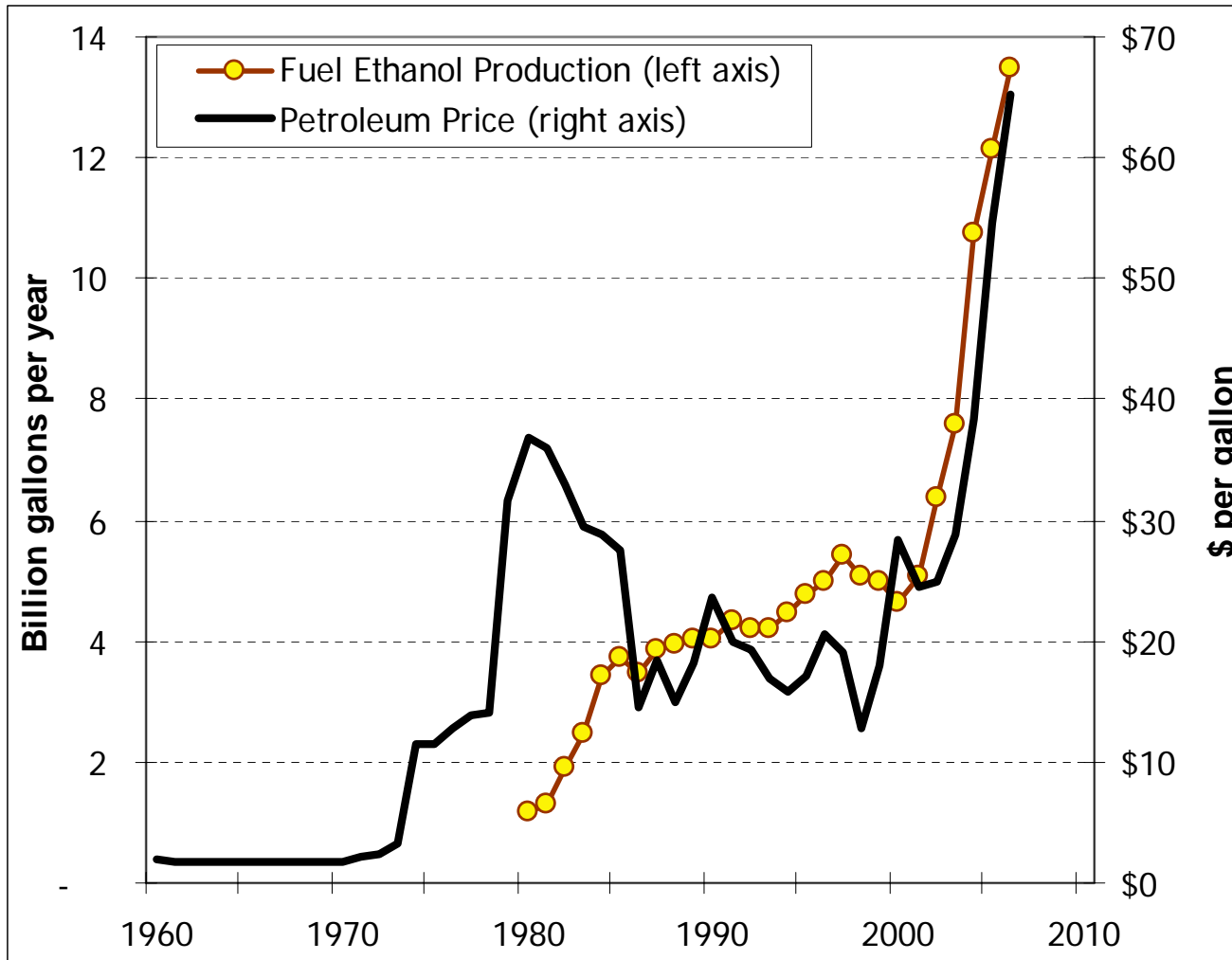
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# Today's Biofuel Industry

- Feedstocks are agricultural commodities
- Fuels are traditional substances
- Success depends on subsidies and mandates
- Small, but profitable and growing rapidly



Sources: US EIA, BP, RFA

# Fundamental research goals for a sustainable biofuels industry

- **Lower costs and enhance economic opportunities**
  - Improve fuel properties
  - Decrease production costs
- **Reduce environmental effects**
  - Greenhouse gases, biodiversity, fertilizer runoff, etc.
- **Promote social goals**
  - Rural livelihoods, oil import reduction, etc.

⇒ **Social objectives and technological progress will reduce the need for arable land**

**Note: This discussion is about liquid fuels only. Biomass energy has its own roles in electricity, in rural areas in developing countries, etc.**

# Far better biofuel properties are feasible

- **Ethanol**
  - $C_2H_5OH$
  - 21 MJ/L
  - Hydrophilic
  - Corrosive
  - Latent heat of vaporization  
694 kJ/kg
  - Easy to manufacture
- **Butanol**
  - $C_4H_9OH$
  - 29 MJ/L
  - Slightly water soluble
  - Non-corrosive
  - Latent heat of vaporization  
463 kJ/kg
  - Difficult to manufacture
- **Hydrocarbons**
  - $C_nH_m$
  - ~32 MJ/L
  - Insoluble in water
  - Non-corrosive
  - Latent heat of vaporization  
330 kJ/kg
  - Very difficult to manufacture
  - Virtually identical to petroleum-based fuels

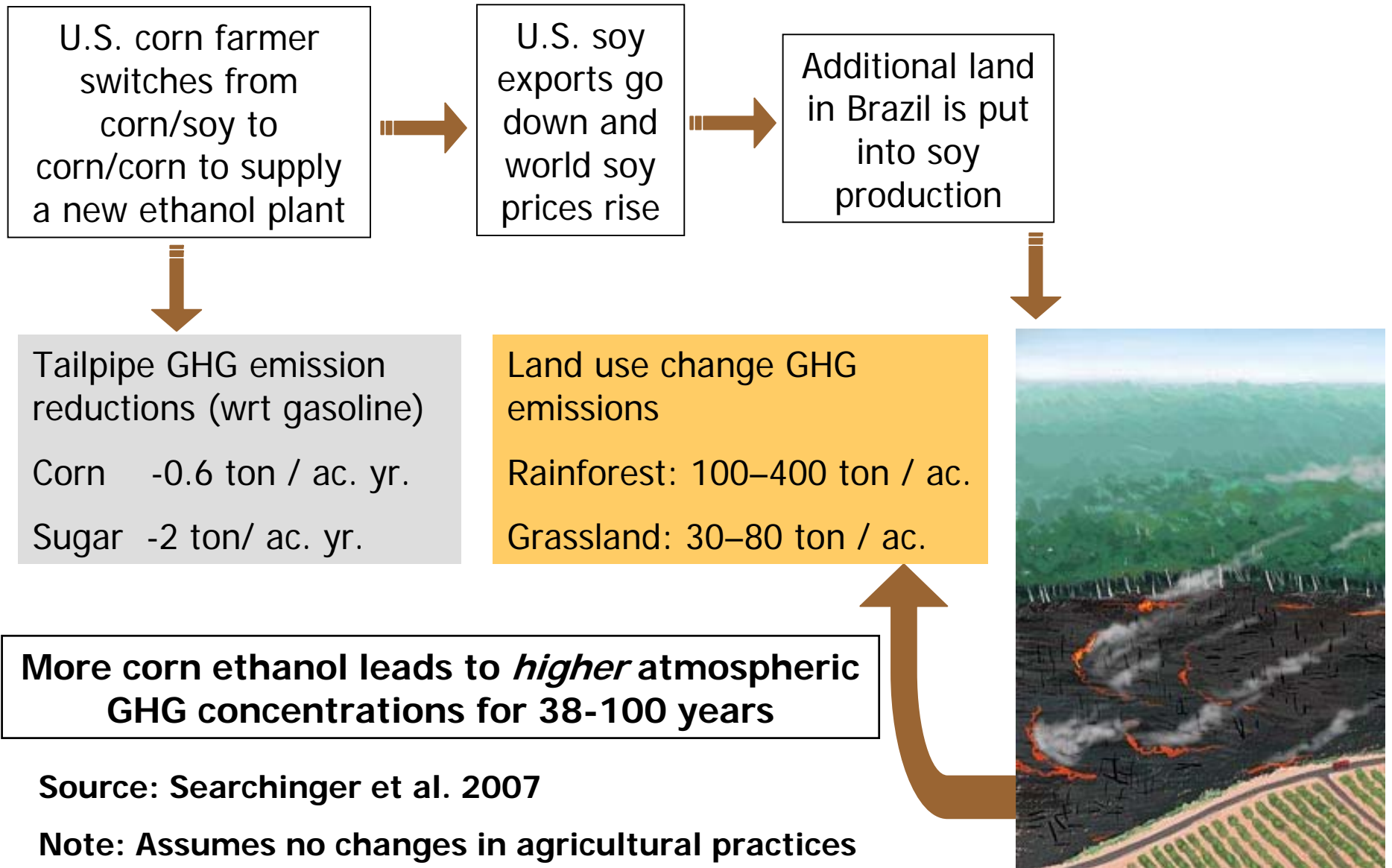
# Land use may be the most important determinant of sustainable biofuels

- **Direct land use**
  - Soil erosion
  - Biodiversity loss
  - Most biofuel income goes to landowners
- **Indirect land use (displacement)**
  - Global markets for energy and food create global competition for land use



# Indirect land use causes large GHG emissions

(One example below)



# The relationship of feedstock to land is the key to sustainability

## 1. Feedstocks grown on arable land

- Corn, Cane, *Miscanthus*, Poplar, etc.
- Soy, Palm, Canola, Jatropha, etc.



## 2. Feedstocks from “degraded” land

- Prairie grasses, *Miscanthus*, etc.
- Jatropha, etc.



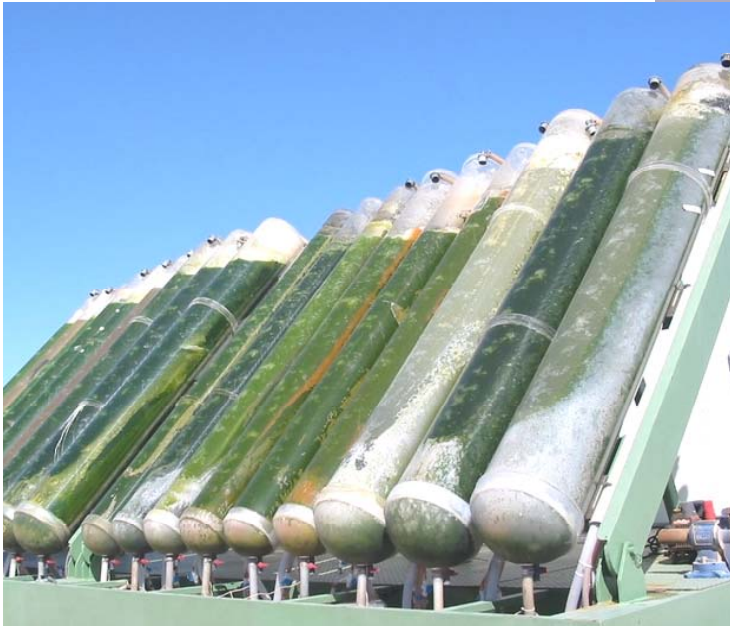
## 3. Feedstocks that require no land

- Wastes and residues
- Algae
- Agricultural integration



# Feedstocks that use degraded land or no land require advanced technologies

- Ligno-cellulosic fermentation
- Gasification & synthesis
- Fast Pyrolysis
- Algae



# What about today's biofuel industry?

- **Investments for incrementally lower GHG emissions**
  - Lower GHG emissions of feedstock production
  - More energy efficient biorefineries
  - Biomass energy supply for biorefineries
    - Chippewa Valley Ethanol Co. in Benson, MN
    - Biomass gasifier
  - Process integration
    - E3 Biofuels in Meade, NB.
    - Feedlot + Manure Digester + Ethanol plant
- **Innovations to dramatically lower GHG emissions**
  - New microbes to produce better fuel molecules
  - Upgrades to use cellulosic processes
  - Carbon capture and sequestration

# Policies

# Biofuel policy goals

- **Current priorities**
  - Agricultural sector income
  - Export income (mostly for landholding elites)
  
- **Planned or hoped for**
  - Rural development and livelihoods
  - Environmental quality
    - Biodiversity
    - Reduce GHG emissions
    - Sustainable energy supply
    - Better air quality
  - Energy security

# Current biofuel policies support agriculture (U.S. example)

- **Mandates**
  - State ethanol percentage requirements
  - Oxygenate requirement (1990-2007)
  - Federal Renewable Fuel Standard (RFS, 2007+)
- **Subsidies**
  - Tax credits (51¢/gallon)
  - Flex-fuel vehicle incentive
- **Tariffs**
  - 54¢/gallon
- **Research and Development**
  - Six Dept. of Energy pilot plants for cellulosic ethanol fermentation

# Prospective policies may focus more on development and environment

- **Sustainable biofuel sourcing requirements**
  - United Kingdom, Germany, Netherlands
- **Multinational best practice evaluations**
  - International Roundtable on Sustainable Biofuels
  - Global Bio-Energy Partnership (GBEP)
- **Low Carbon Fuel Standard (LCFS)**
  - Reduce carbon intensity (gCO<sub>2</sub>e/MJ) by 10% by 2020
  - Applies to all fuels (including petroleum)
  - Applies to refiners and blenders
  - Spreading widely
    - California and Florida
    - European Union
    - U.S. Environmental Protection Agency
    - Multiple bills in Congress

# Conclusions

- **The biofuel industry is likely to become larger and to use technologies much different from today's**
- **Today's biofuel producers have many opportunities to start the transition to a sustainable industry**
- **Sustainable biofuels seem to require that no land (or degraded land) be used**
- **Advanced biofuel research will enable the use of wastes and residues, cellulosic crops suited to degraded land, and factory-produced biofuels (e.g. algae).**
- **Public policies are shifting from agricultural support to environmental performance and rural development**
- **Waste and residue feedstocks, or algae, may or may not provide agricultural support or export income.**
- **Increased value for degraded land may lead to it being taken away from the poor and the powerless**

# Thank you

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