Ecosystem-Level Effects of Ethanol Crop Monoculture in the Americas

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Outline

• Background and introductions to the current bioenergy crops in the U.S. and Brazil
• Primary agricultural regions and brief environmental impact statements
• Potential effects of expanding biofuel production
• Conclusions and policy recommendations
Corn Ethanol Production

Background

• Policy incentives for growth and expansion of corn ethanol

• The need for an examination of the impacts of biofuel crops from an ecological perspective

Sources: Tiffany, 2009
SECO, 2005
Corn Ethanol Production Increases in the U.S.
1980 through 2008

Source: Martinelli et al., 2009
Corn for Grain 2010
Production by County
for Selected States

Bushels
- Not Estimated
- < 1,000,000
- 1,000,000 - 4,999,999
- 5,000,000 - 9,999,999
- 10,000,000 - 14,999,999
- 15,000,000 - 19,999,999
- 20,000,000 +

U.S. Department of Agriculture, National Agricultural Statistics Service
Sugarcane Ethanol Production

Background

• History of large-scale biofuel production
• Virtually unrestrained use of natural resources and subsequently large levels of environmental degradation

Sources: Martinelli et. al, 2008
Oliviera et. al, 2002
Sugarcane Production in Brazil

1960 to 2007

Source: Martinelli et. al, 2008

Fig. 1. Increase of planted area and productivity of sugar cane in Brazil from 1960 to 2007 (FAOSTAT 2007).
Sugarcane-producing areas

“Sensitive” biomes as characterized by the Brazilian government

Source: Brazilian Ministry of Agriculture
PESTICIDES

GALLON OIL PER BUSHEL OF CORN

ETHANOL PLANT ADM

MORE FUEL FOR PROCESSING

CHEMICAL FERTILIZER

ETHANOL SAVES OIL AND REDUCES POLLUTION!
Impacts Overview

- Water Inputs
- Landuse change
- CO₂
- Soil Erosion and Depletion

From Kucera, 2012
SOIL

Soil Degradation

- BRAZIL
  - Erosion and compaction
  - Net erosional soil loss of 10 Mg/ha (up to 30 Mg/ha in some areas of So Paulo), with an erosional rate of 5.2

- USA
  - 22.2 Mg/ha average erosional loss, 18x faster than the rate of soil formation
  - Monoculture’s impact on the soil

WATER

Deterioration of Aquatic Systems

■ BRAZIL
  • Sediment transport
  • Inputs
    • Vinasse/Fertilizer application
    • Pesticides

■ USA
  • Irrigation needs and groundwater depletion
    • Groundwater mining, 25% faster than the natural rate of recharge in some states. (1 ha of corn requires ~4 millions liters of water during the growing season, with an additional 2 million liters/ha evaporating from the soil
  • “Agrichemicals”
ECOSYSTEM EFFECTS

Land-Use Change

- BRAZIL
  - Conversion of land from cerrado grasslands to biofuel production: requires 37 years of biofuel production in order to offset land conversion

- USA
  - Conversion of central grasslands to biofuel production: 93 years.

Biodiversity loss

- BRAZIL
  - Destruction of Riparian Ecosystems
  - Governmental measures (?)

Source: Tiffany, 2009
Predictions for the United States

Ecosystem effects in the wake of growing demand for corn as a biofuel feedstock

Source: USDA, 2009
Personal Opinions and Policy Recommendations

UNITED STATES:
Converting to more sustainable biofuel crops, researching means of increasing input and output efficiencies

BRAZIL
Drawing attention to sustainability issues associated with large-scale biofuel production, establishing new policies to protect natural resources, investing in new harvesting technologies.
Links

http://www.msnbc.msn.com/id/22301669/ns/us_news-environment/t/corn-boom-could-expand-dead-zone-gulf/#.T8umeplYv2g
http://www.scientificamerican.com/article.cfm?id=grass-makes-better-ethanol-than-corn&