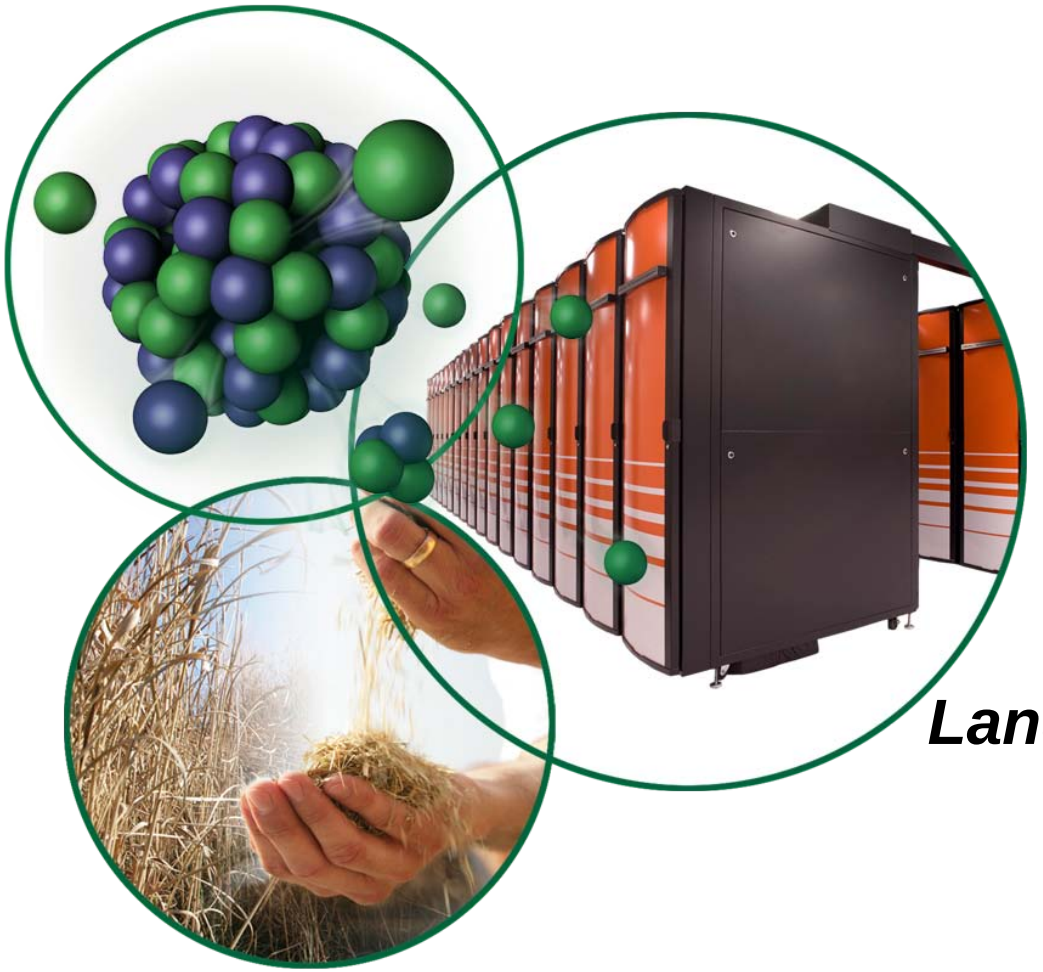
Outstanding Issues in General Equilibrium Modeling of the Land Use Impacts of U.S. Biofuels Policy



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A '3x5' presentation for

Land-Use Change & Bioenergy Workshop

May 2009

Role for Computable General Equilibrium (CGE) Models

- **Market-mediated land-use effects**
  - **International trade in agriculture and fuels**
  - **Wide range of linkages between energy and the rest of the economy**
  - **Need for explicit modeling of economic behavior requires a structural approach**
  - **Models readily available for agricultural commodities, trade and energy**
- **GTAP is currently a prominent framework**
  - **Dual database/model for the global economy**
  - **Public access**
  - **GTAP-BIO efforts - bioenergy crops**

Outstanding Issues

- **Data limitations, uncertainties**
  - **Significant problem in land use analysis**
  - **Historic data, land cover change, has huge uncertainty**
  - **Land “use” often conjecture**
- **Land use modeling**
  - **All models have limitations**
  - **Current models do not reflect complex nature of land-use change**
  - **CGE models are particularly limited**
  - **Crop production and yield issues**
- **Implementation of Biofuel Drivers and Policies**
  - **Baseline and treatment of dynamics**
  - **Many ways to model biofuel policies in CGE models**
  - **Need to represent intended policies/technologies accurately**

Land Change: Two GTAP Simulations

- Direct Increase in Fixed Proportion of Ethanol in Petroleum Products
- Price-based Yield Change
- Non Price-based Yield Change

Region	Forest	Agricultural Land	Shrub/ Grass Land	Other Land Cover	Shrub/Grass/ Agricultural Land	Total Land
United States	-0.01	0.02	-0.05	-0.01	0.01	0.00
Canada	0.00	-0.01	0.02	0.01	0.00	0.00
Brazil	-0.01	0.03	-0.02	0.00	0.01	0.00
Oceania	0.00	-0.02	0.01	0.00	0.00	0.00
EU-27	0.01	-0.01	0.04	0.01	-0.01	0.00
Russia	0.00	-0.01	0.01	0.00	0.00	0.00
Rest of Europe	0.00	0.00	0.01	0.00	0.00	0.00
Mid East/N. Africa	0.02	-0.03	0.05	0.02	0.00	0.00
Sub Saharan Africa	0.00	-0.02	0.02	0.01	0.00	0.00
Rest of SE Asia	0.00	0.00	0.01	0.00	0.00	0.00
Rest of S. Asia	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.00	0.00	0.00	0.00	0.00	0.00
China-Hong Kong	0.00	0.00	0.01	0.00	0.00	0.00
India	0.00	0.00	-0.01	0.00	0.00	0.00
Central America	0.01	-0.02	0.04	0.02	-0.01	0.00
South America	0.00	0.00	0.00	0.00	0.00	0.00
East Asia	0.00	0.01	-0.01	0.00	0.00	0.00
Malaysia/Indonesia	0.00	0.00	0.01	0.00	0.00	0.00

- 136% Oil Price Increase
- MTBE Replacement
- Price-based Household Substitution of Ethanol and Petroleum Products
- Only Price-based Yield Change

Region	Forest	Agricultural Land	Shrub/ Grass Land	Other Land Cover	Shrub/Grass/ Agricultural Land	Total Land
United States	-0.12	0.26	-0.55	-0.07	0.09	0.00
Canada	-0.01	0.10	-0.27	-0.05	0.07	0.00
Brazil	-0.35	1.85	-1.63	-0.47	0.40	0.00
Oceania	-0.04	0.73	-0.49	-0.19	0.00	0.00
EU-27	-0.49	0.90	-2.24	-0.62	0.41	0.00
Russia	-0.01	0.19	-0.24	-0.02	0.05	0.00
Rest of Europe	-0.02	0.04	-0.12	-0.02	0.00	0.00
Mid East/N. Africa	-1.30	1.74	-2.85	-1.07	0.01	0.00
Sub Saharan Africa	-0.19	0.87	-1.10	-0.55	0.05	0.00
Rest of SE Asia	0.02	-0.07	0.10	0.10	-0.04	0.00
Rest of S. Asia	0.13	-0.32	0.58	0.24	-0.02	0.00
Japan	-0.01	0.05	-0.11	-0.01	0.05	0.00
China-Hong Kong	0.11	-0.15	0.49	0.26	-0.04	0.00
India	0.58	-0.53	1.87	0.62	-0.23	0.00
Central America	-0.16	0.29	-0.51	-0.17	0.07	0.00
South America	0.04	-0.17	0.19	0.00	-0.03	0.00
East Asia	0.20	-0.46	0.79	0.27	-0.02	0.00
Malaysia/Indonesia	-0.03	0.08	-0.17	-0.04	0.05	0.00

Land Cover Change: Two Simulations

- **Percentage Change in US Agricultural and Forest land differs by a factor of more than 10 between the two cases; and differs by factor of 35 for Brazil forests**
- **There is a need for careful application of economic models to land use analysis**
- **Factors behind land use change cannot be completely captured in an economic model**
- **Complementary and detailed land use data/ modeling needed for analysis of the indirect land use effects of biofuels**