EPA Renewable Fuel Lifecycle GHG Assessment

Argonne / Purdue Workshop

January 26, 2009

Overview

- Overview of approach
- Land use change methodology
- Land use change issues
- Time impacts

Methodology

- EISA definition requires the use of a number of models and tools to capture *all* indirect emissions
  - Including direct and indirect impacts such as land use change requires analysis of markets
    - Typical life cycle analysis tools are based on process modeling
    - To capture market impacts need to use economic models
  - Conducting our own process and emissions modeling as part of rulemaking

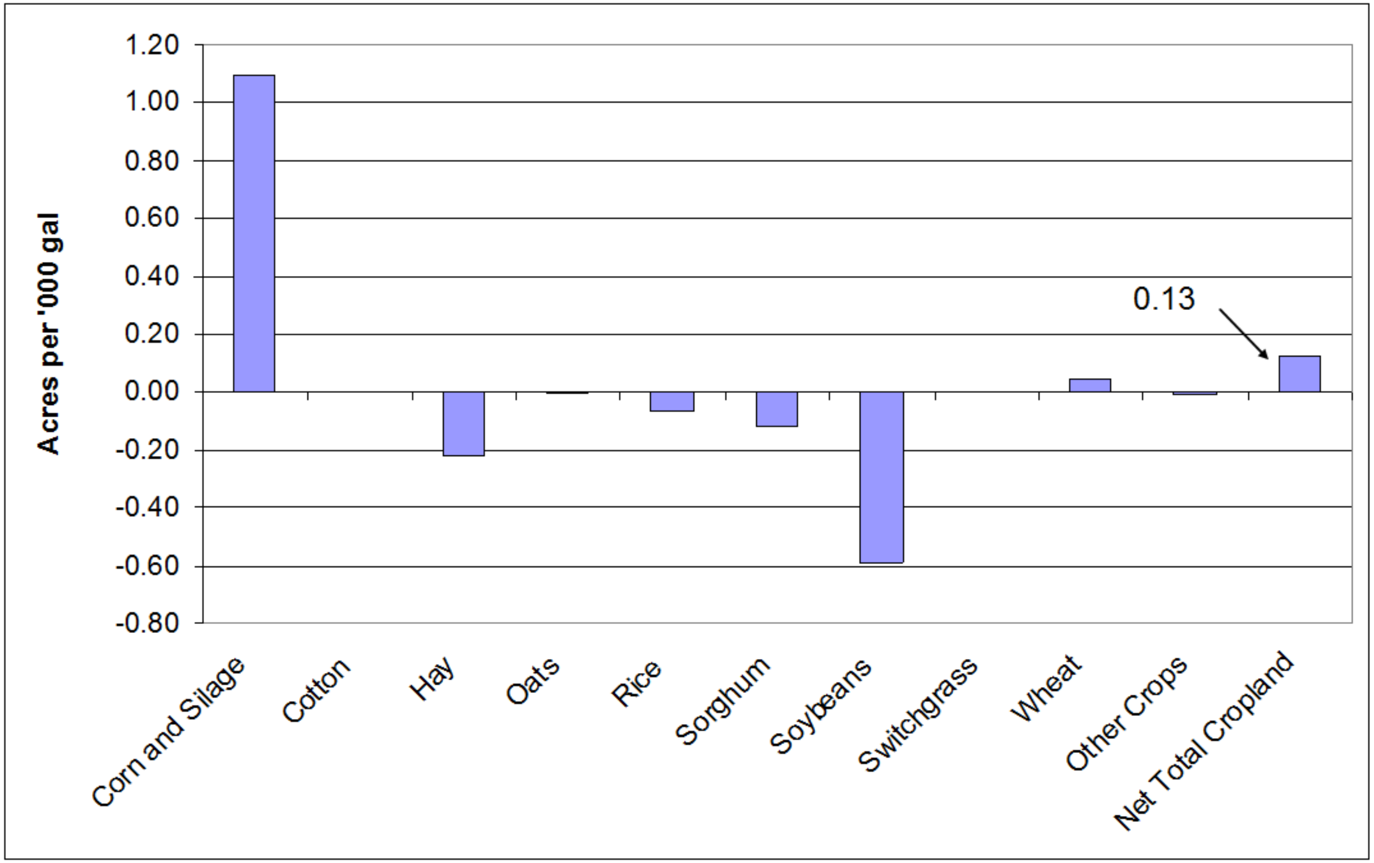
- Scenario Comparison: Run models with different volume scenarios to isolate the impact of specific fuel
  - Consider change between baseline projected fuel volume in 2022 (i.e., without RFS2) and projected RFS2 mandated volume.
  - Held volumes of other fuels constant at RFS2 mandated levels

Land Use Change Methodology

Key Question	Domestic	International
Amount, or area, of land converted?	FASOM	CARD
Location of land use changes?	FASOM (region-level)	CARD (region-level) MODIS (sub-region)
Land types, or biomes, converted?	FASOM (modeled interactions with cropland, pasture, CRP, and forest)	MODIS (recent trends of land conversion between, cropland, savanna, grassland, shrub land, and forest)
GHG emissions from land conversion?	FASOM (e.g., DAYCENT for soil carbon changes)	Winrock / IPCC

Domestic Crop Expansion
FASOM – Acres per Thousand Gal, 2022

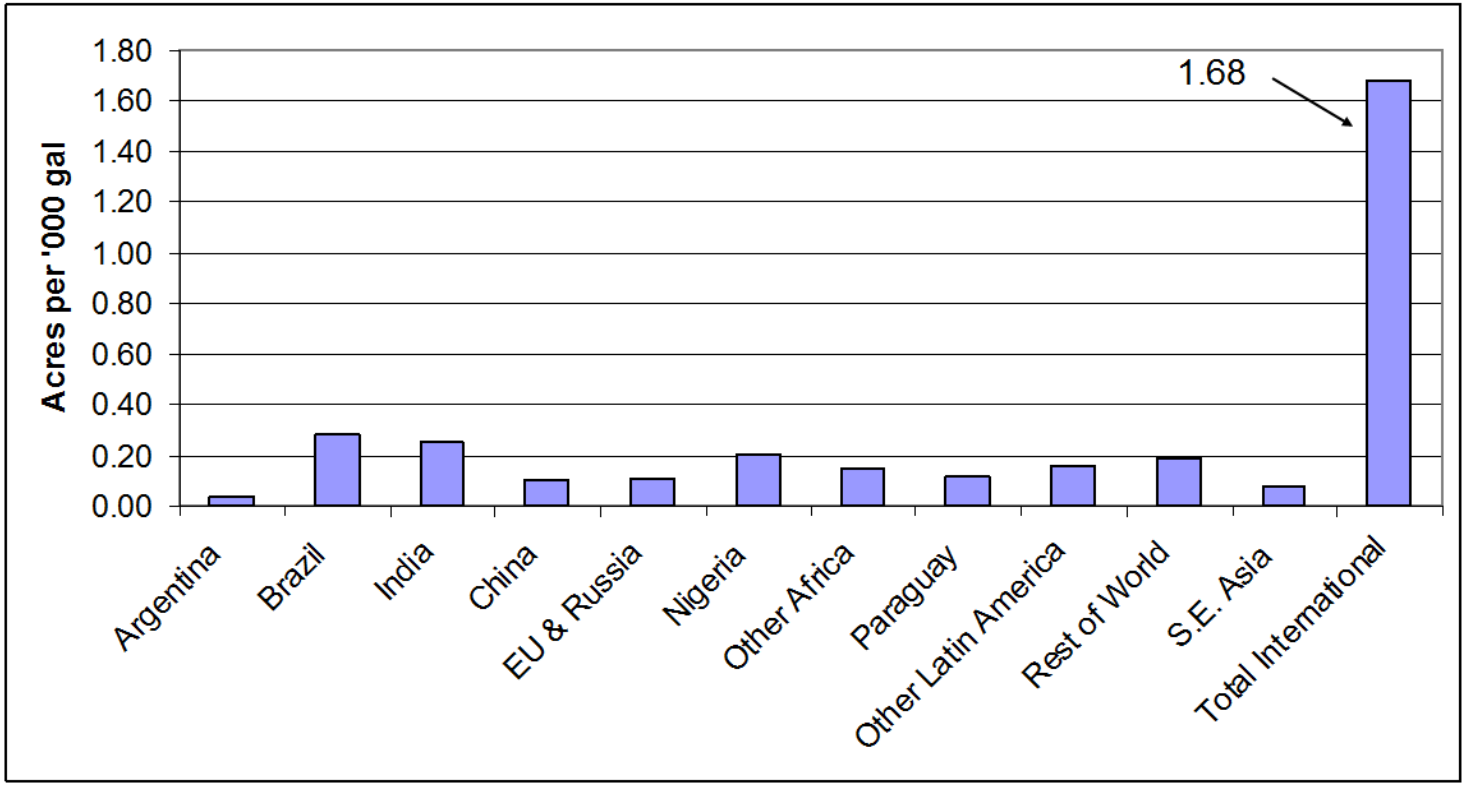
ILLUSTRATIVE EXAMPLE



- No forest sector yet
- Soil carbon changes from crop shifting not just conversion to crops

International Crop Expansion
CARD – Acres per Thousand Gal, 2022

ILLUSTRATIVE EXAMPLE



Types of Land Converted to Cropland, MODIS Satellite Data 2001-2004

ILLUSTRATIVE EXAMPLE

Country	Forest	Grassland	Savanna	Shrub
Argentina	8%	40%	45%	8%
Brazil	4%	18%	74%	4%
China	17%	38%	23%	21%
E.U.	27%	16%	36%	21%
India	7%	7%	33%	53%
Indonesia	34%	5%	58%	4%
Malaysia	74%	3%	19%	3%
Nigeria	4%	56%	36%	4%
Philippines	49%	5%	44%	3%
South Africa	10%	22%	53%	15%

Type of Land Converted

- Pasture replacement
  - Pasture loss would have to be offset by intensification or substitution
  - We assume that pasture converted to cropland would be “replaced” by conversion of forest or shrub to pasture
    - Pasture intensification?
    - Decline in livestock herd?
    - Potential to “replace” pasture
- Timber markets
  - Converting managed forests would have different impact from unmanaged forests
  - GHG emission factors are different for managed vs. unmanaged forests
  - If managed forests are converted need to account for timber markets
    - Increased forests elsewhere
    - Demand changes
  - GHG credits for harvested wood products or other use of biomass cut down

GHG Releases from Land Conversion

- State-specific emissions factors were calculated using 2006 IPCC AFOLU Guidelines
- Accounts for immediate emissions
  - Biomass C stocks
    - Account for different C stocks in annual versus perennial crops
  - Soil C stock change
    - Immediate release and ongoing releases (annual emissions over 20 years)
    - Carbon stocks in top 30cm estimated using FAO soil map of the world
  - Non-CO2 Emissions
    - Clearing with fire was assumed for all conversions to cropland for all countries except China and Argentina. For other conversion types, no fire was assumed.
- Lost forest sequestration
  - Foregone sequestration from forests over time (what would have been sequestered if forest was not converted) – over 80 years

Example Detail of Land Use Change GHG Emission Factors

EMISSIONS FACTORS DATA INPUTS						
Country	State	Forest C stock (MT C/ha)	Soil C stock (top 30 cm) (MT C/ha)	Grassland C stock (MT C/ha)	Savanna (campo sujo) C stocks (MT C/ha)	Shrubland (cerrado) C stocks (MT C/ha)
Brazil	Acre	98.48	58.51	10.90	19.7	37.30
Brazil	Alagoas	20.20	24.01	10.90	19.7	37.30
Brazil	Amapa	123.50	56.47	10.90	19.7	37.30
Brazil	Amazonas	133.01	58.37	10.90	19.7	37.30
Brazil	Bahia	50.76	35.85	10.90	19.7	37.30
Brazil	Ceara	18.10	22.40	10.90	19.7	37.30
Brazil	Distrito Federal	9.10	42.50	10.90	19.7	37.30
Brazil	Espirito Santo	37.97	49.96	10.90	19.7	37.30
Brazil	Goias	13.28	49.29	10.90	19.7	37.30
Brazil	Maranhao	50.39	35.93	10.90	19.7	37.30
Brazil	Mato Grosso	72.59	47.91	10.90	19.7	37.30
Brazil	Mato Grosso Do Sul	27.79	52.36	10.90	19.7	37.30
Brazil	Minas Gerais	29.24	43.95	10.90	19.7	37.30
Brazil	Para	109.12	53.38	10.90	19.7	37.30
Brazil	Paraiba	9.26	20.00	10.90	19.7	37.30
Brazil	Parana	19.93	71.01	10.90	19.7	37.30
Brazil	Pernambuco	15.43	23.60	10.90	19.7	37.30
Brazil	Piaui	34.58	26.52	10.90	19.7	37.30
Brazil	Rio De Janeiro	10.59	46.18	10.90	19.7	37.30
Brazil	Rio Grande Do Norte	12.09	20.00	10.90	19.7	37.30
Brazil	Rio Grande Do Sul	19.93	52.39	10.90	19.7	37.30
Brazil	Rondonia	97.78	49.86	10.90	19.7	37.30
Brazil	Roraima	103.30	58.64	10.90	19.7	37.30
Brazil	Santa Catarina	19.93	75.37	10.90	19.7	37.30
Brazil	Sao Paulo	12.07	43.94	10.90	19.7	37.30
Brazil	Sergipe	36.47	23.18	10.90	19.7	37.30
Brazil	Tocantins	35.24	44.80	10.90	19.7	37.30

Land Use Change GHG Emission Factors Used in Analysis (MT CO_2-eq. / Acre)

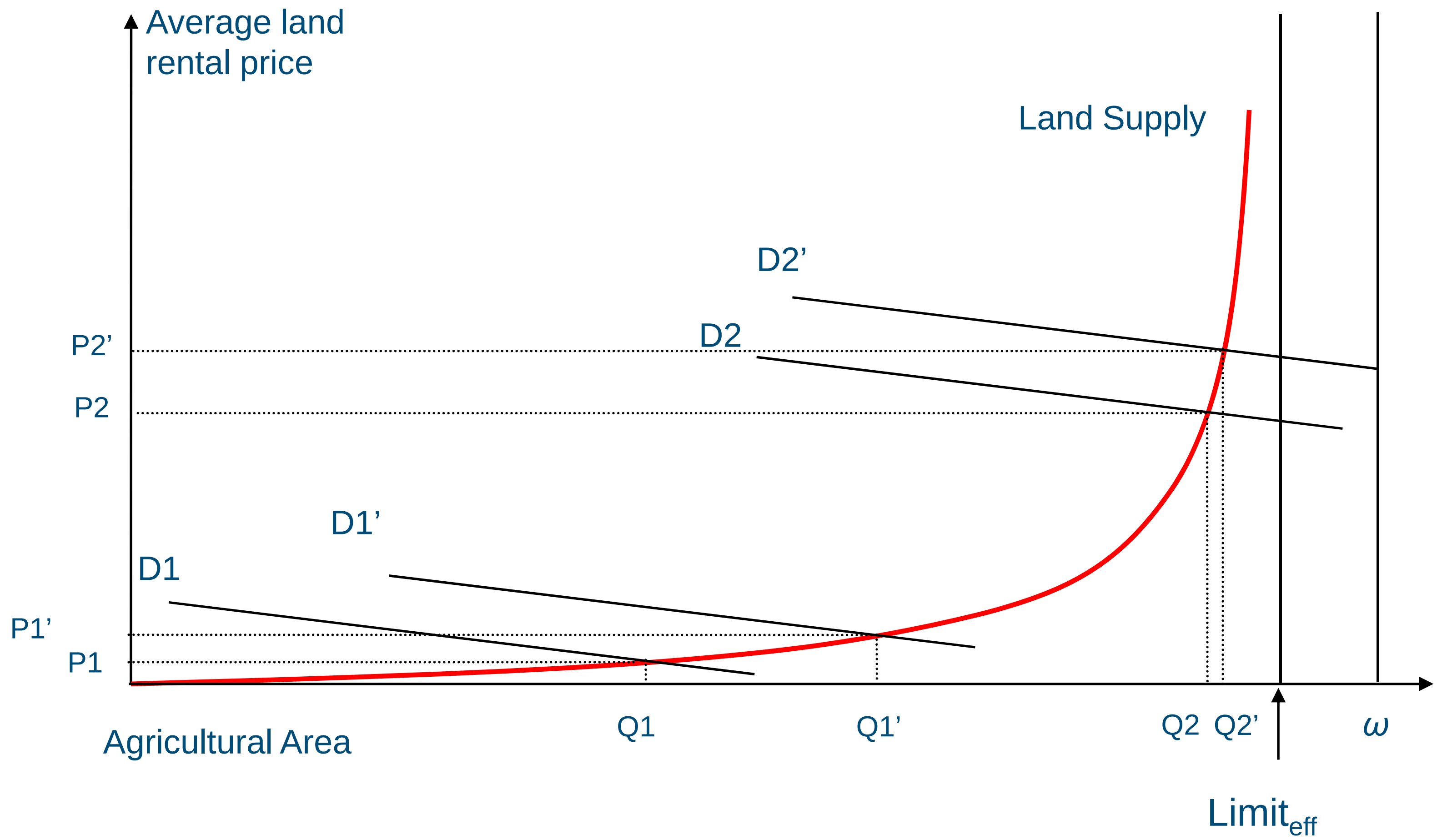
- Continuing to develop factors for other countries
- Current analysis represents ~60% of total international land use change predicted

Country / Region	To	From			
		Forest	Grassland	Savanna	Shrub
Argentina	Crop	115	16	17	33
	Grassland	136			15
	Savanna	129			9
Brazil	Crop	258	45	60	82
	Grassland	257			39
	Savanna	240			26
China	Crop	237	23	34	49
	Grassland	186			27
	Savanna	240			27
European Union	Crop	318	28	38	47
	Grassland	216			22
	Savanna	181			14
India	Crop	247	26	26	38
	Grassland	249			249
	Savanna	236			12
Indonesia	Crop	432	43	51	94
	Grassland	455			51
	Savanna	415			42
Malaysia	Crop	473	50	57	103
	Grassland	457			51
	Savanna	438			42
Nigeria	Crop	96	18	23	78
	Grassland	92			58
	Savanna	112			28
Philippines	Crop	402	34	44	88
	Grassland	371			51
	Savanna	359			42
South Africa	Crop	111	18	36	79
	Grassland	109			58
	Savanna	86			47

Issues Impacting Land Use Change

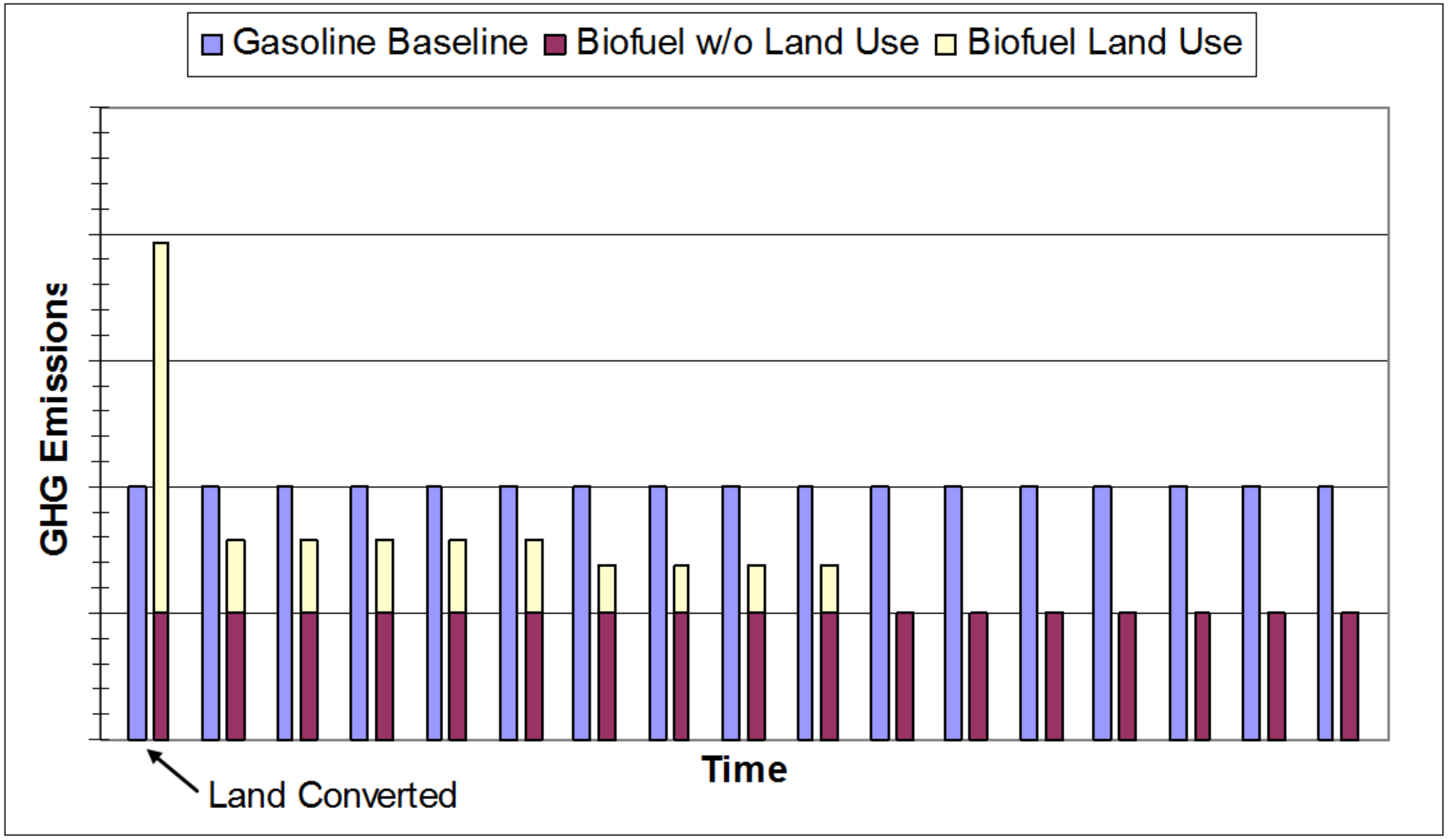
- Yields
  - Baseline improvements over time vs. price induced
- Demand response / shifting
  - Feed and food use
- Export response
  - Domestic shifts in production vs. shifts internationally
- International trade response
  - Where will crop production grow (now vs. future)
- Land supply base
  - How is land constrained

Land Supply Issues



Time Dimension of LCA

ILLUSTRATIVE EXAMPLE



- We take the snapshot in 2022 to determine agricultural sector impacts including land use change – project these changes out into future
- The value is used to represent biofuels GHG impacts across different volumes and timeframes

Time Dimension Issues

- What timeframe(s) to consider
- Land reversion
  - There are a number of reasons why land converted to cropland as a result of biofuel production could revert back to its prior use or change to a different use
    - Continuing crop yield improvements
    - Biofuel production ends
    - Changes in population or food demand
- Cumulative impacts as opposed to annual projected impacts
  - Take cumulative change in GHG emissions over cumulative increase in biofuels use
  - Captures dynamic impacts of soil carbon change, crop rotations, yield changes, etc.