

EPA Fuel Life Cycle GHG Estimates Update

2nd GBEP Taskforce Meeting on
GHG Methodologies

EPA OTAQ Biofuel Life Cycle GHG Work

- May 2007 Renewable Fuel Standard (RFS) Published mandated 7.5 billion gallons of renewable fuels by 2012
- EPA conducted an analysis to determine GHG impact of rule
 - Based on life cycle GHG factors for renewable fuels (corn ethanol, biodiesel, cellulosic ethanol, imported ethanol) compared to petroleum fuels they replace
- Primarily based on the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model developed by Argonne National Laboratory

Updates to RFS Life Cycle Work

- President Bush's Executive Order of May 14, 2007
 - Cut gasoline consumption and greenhouse gas emissions from motor vehicles
 - “20 in 10” goal (35 billion gallons renewable and alternative fuel by 2017)
- Address some of the concerns with the RFS life cycle analysis
 - Did not fully account for agricultural sector secondary impacts
 - Increased biofuels production changes agricultural commodity prices (e.g., corn) this has impacts on agricultural sector e.g., crop patterns change, livestock production changes
 - These changes have associated GHG impacts
 - Did not adequately account for land use change
 - Land converted into crop production where crops are directly used for biofuels
 - Use of crops that would have gone into other markets, including exports, that cause more crops to be produced internationally for other uses results in indirect land use change from biofuel use

Energy Independence and Security Act

Year	Advanced Biofuel			Total Renewable Fuel
	Biomass-Based Diesel	Cellulosic Biofuel	Total Advanced Biofuel	
2006				4.0
2007				4.7
2008				9.0
2009	0.5		0.6	11.1
2010	0.65	0.1	0.95	12.95
2011	0.80	0.25	1.35	13.95
2012	1.0	0.5	2.0	15.2
2013	1.0	1.0	2.75	16.55
2014	1.0	1.75	3.75	18.15
2015	1.0	3.0	5.5	20.5
2016	1.0	4.25	7.25	22.25
2017	1.0	5.5	9.0	24.0
2018	1.0	7.0	11.0	26.0
2019	1.0	8.5	13.0	28.0
2020	1.0	10.5	15.0	30.0
2021	1.0	13.5	18.0	33.0
2022	1.0	16.0	21.0	36.0

Energy Independence and Security Act Requires Life Cycle Assessment

- Life cycle assessment required to determine which fuels meet mandated GHG performance thresholds (reduction compared to baseline petroleum fuel replaced)
 - Conventional Biofuel (ethanol derived from corn starch) – 20% (only applies to fuel produced in new facilities)
 - Cellulosic Biofuel (renewable fuel derived from "cellulosic feedstocks") – 60%
 - Biomass-Based Diesel (biodiesel) – 50%
 - Other Advanced Biofuels (e.g., imported sugarcane ethanol, renewable diesel, CNG/LNG made from biogas) – 50%
- Baseline fuel for comparison is gasoline and diesel fuel in 2005 (implies level of desulfurization and tar sand use)

Definition of Life Cycle GHG Emissions

“(H) LIFECYCLE GREENHOUSE GAS EMISSIONS.—The term ‘lifecycle greenhouse gas emissions’ means the aggregate quantity of greenhouse gas emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes), as determined by the Administrator, related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer, where the mass values for all greenhouse gases are adjusted to account for their relative global warming potential.

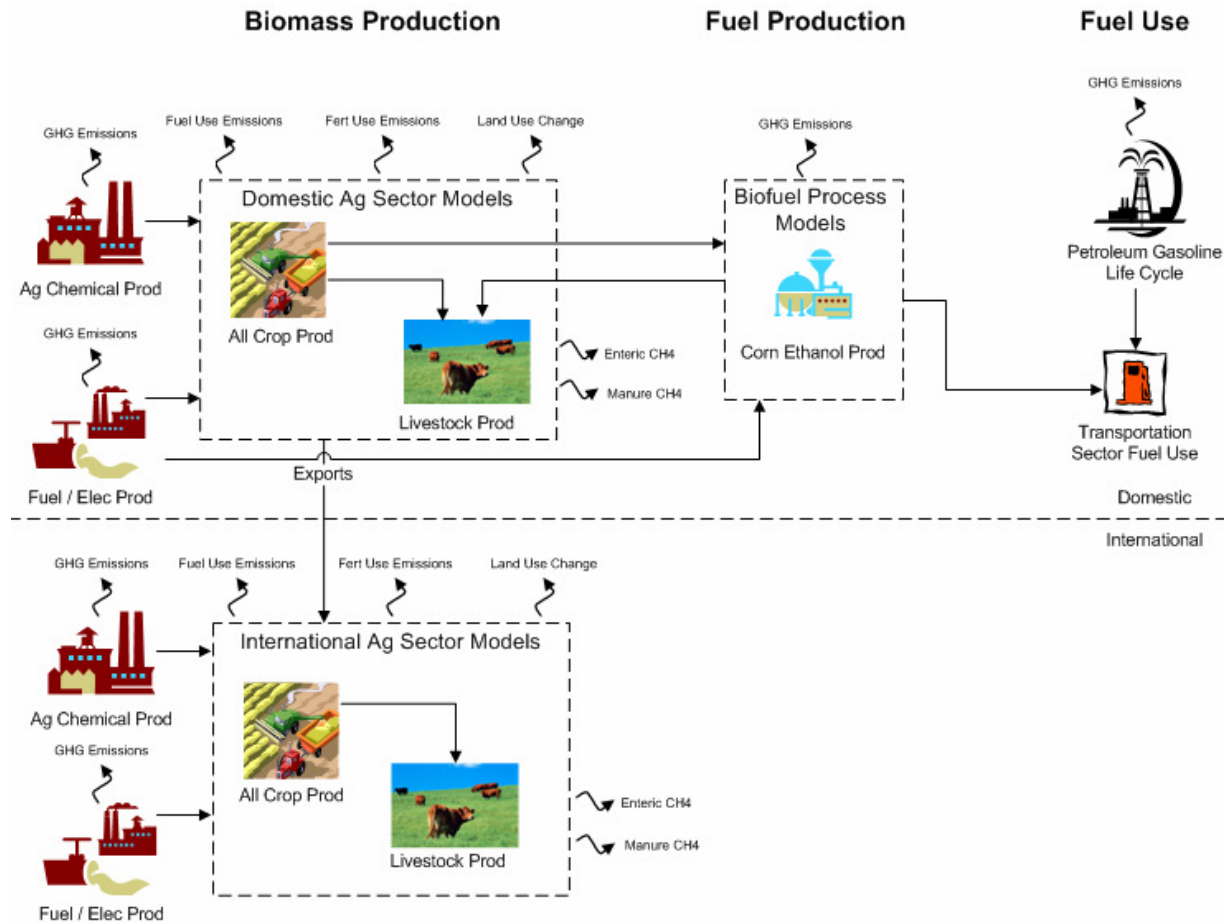
Overview of Updated Approach

- Domestic Agricultural Sector: use comprehensive agricultural sector model (FASOM) to determine sector-wide impacts of increase biofuel production
- International Agricultural Sector: use comprehensive models for worldwide agricultural sector (FAPRI) for a reference case and policy case to determine:
 - Changes in U.S. exports due to increased domestic biofuel production
 - International increased corn production, decreases in other crops, changes in total crop acres
- GHG emissions included in FASOM, FAPRI results converted to GHG emissions based on GREET defaults and IPCC emission factors
- Ethanol process emissions based on process models
- Feedstock and ethanol transportation based on GREET
- Gasoline baseline based on GREET defaults

Agricultural Sector Modeling and Allocation

- ISO 14044 Environmental Management – Life Cycle Assessment – Requirements and Guidelines
 - Section 4.3.4.2 Allocation Procedure: Whenever possible, allocation should be avoided by expanding the product system to include the additional functions related to the co-products
- Agricultural sector economic modeling factors in use of ethanol co-product animal feed in the livestock market – no further allocation at ethanol plant
- Other co-products not captured in the same way, e.g., excess electricity production, refinery co-products

Corn Ethanol Scenarios Modeled

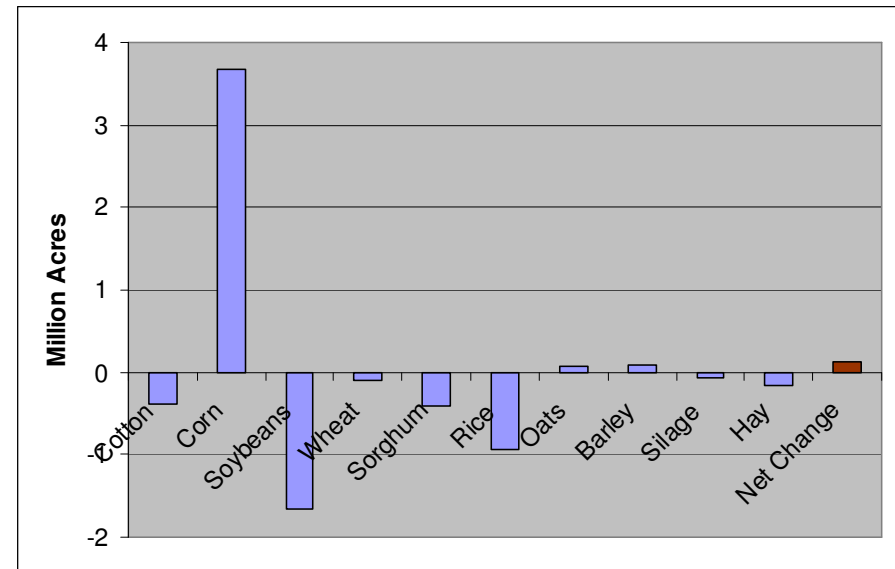


- Compared two similar corn ethanol volumes in both agricultural sector models
- Other fuel volumes held constant to isolate impacts of corn ethanol
- **Results represent per mmBtu “average marginal” impact of going from ~12 to 18 Bgal**

Domestic Agricultural Sector Impact

- Looking at domestic impacts only of increased ethanol production results in a net decrease in total GHG emissions

- Shift in crop production results in no net crop acreage increase (small increase in agricultural sector inputs)
- Decrease in rice acres and livestock production (due to increased feed prices) results in GHG emission reductions



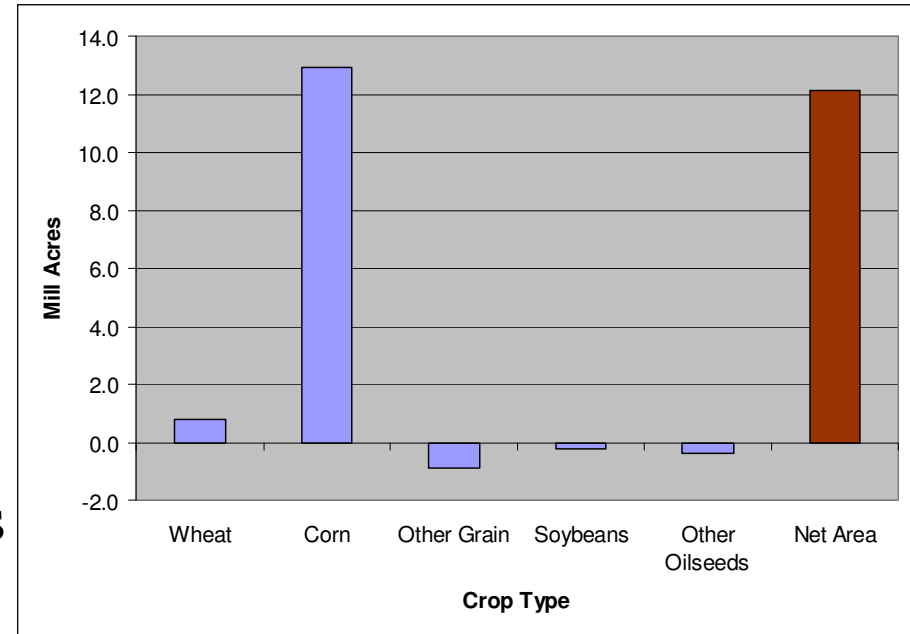
- 40% of corn used for ethanol comes from reductions in exports (highlighting need to include international impacts)

International Agriculture: Land Use Change

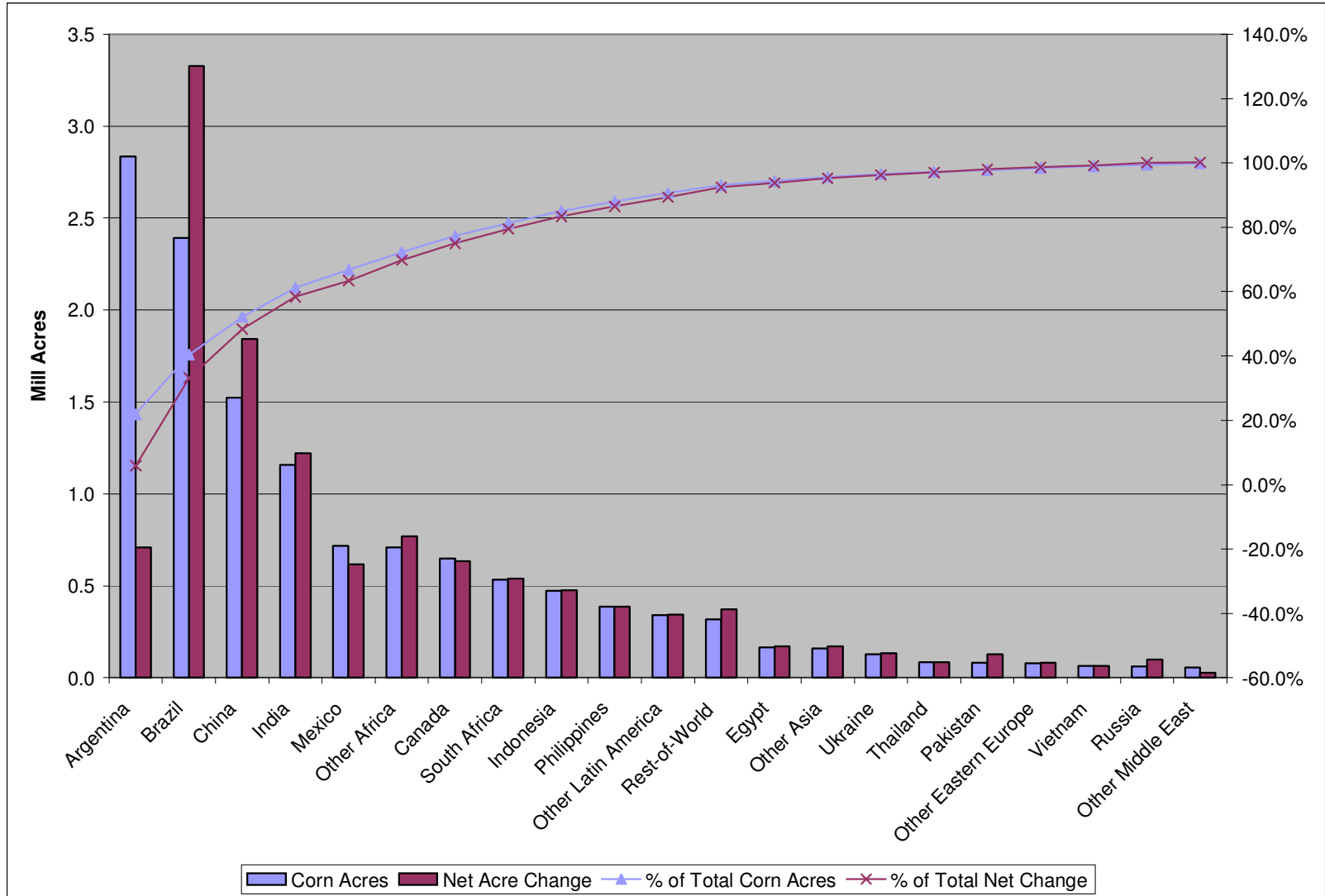
- Issue: What are the impacts associated with land use change from increased crop production internationally (e.g., increased crop production due to reduced U.S. exports)
 - Total acres of land impacted (and where)
 - What types of land are converted
 - What are the GHG factors from that land conversion
 - Timing impact of release (i.e., annualization)

International Agricultural Sector Impact

- Decrease in U.S. exports results in increased crop production internationally
 - Not all export losses are made up with production – shifts in crops and decrease in demand (e.g., less livestock)
- Changes in crop acres based on yields in different countries
- Assumed net increase in all crop acres results in land use change



International Land Use Change

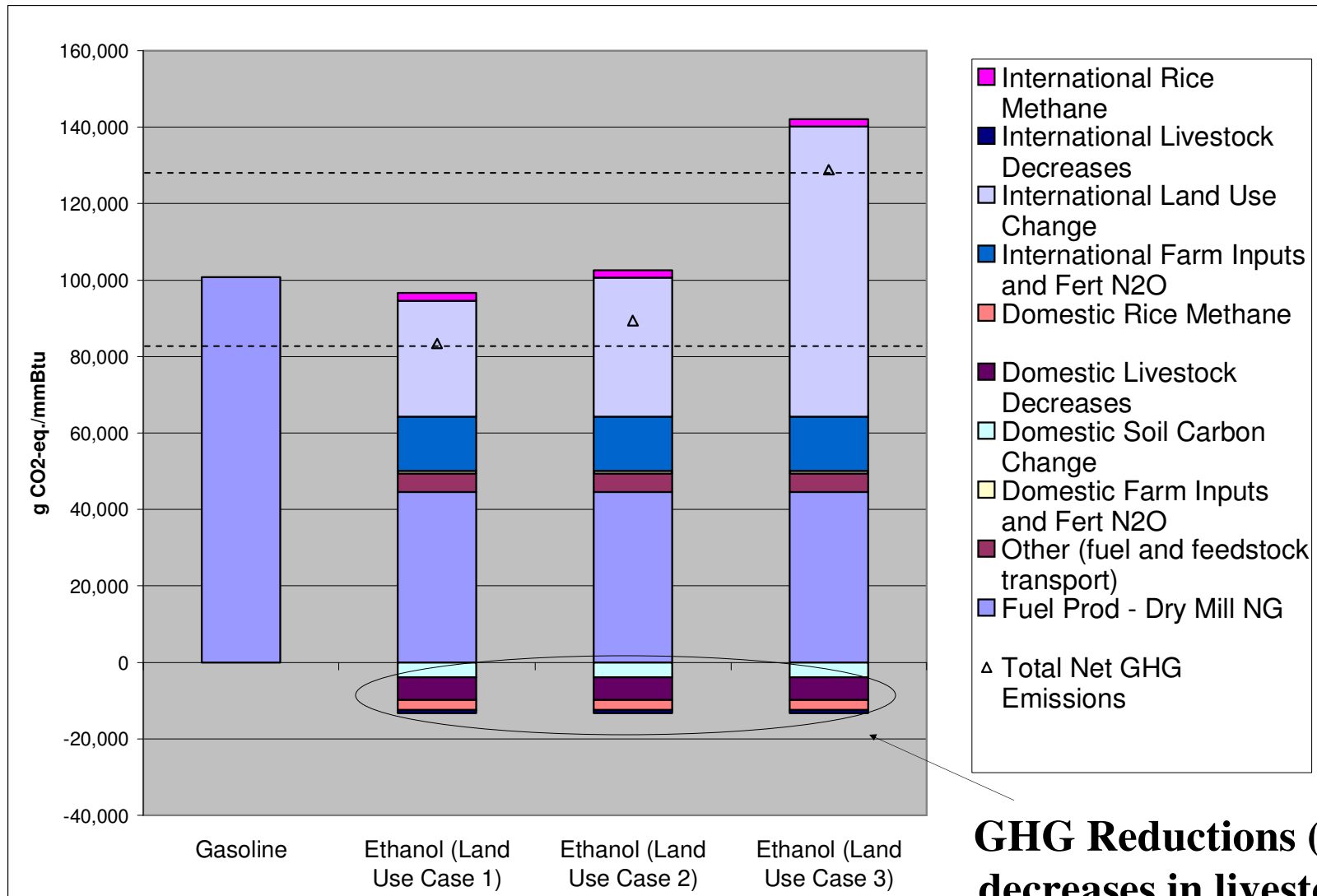


Land Use Change Assumptions

- Land use change is occurring regardless of U.S. biofuel production, need incremental land use change associated with increased biofuel production in U.S.
 - Where are crops planted
 - Price induced changes (higher crop / land values)
- Assumed representative land types for different countries, performed sensitivity analysis on type of land converted
- We need to develop a specific GHG life cycle reduction value for each fuel (based on a snapshot in time) - need to annualize land use change factors
 - We considered an annualization rate of 30 years

Impact of Land Use Change Assumptions

(Dry Mill, Natural Gas, Dry and Pelletized DDGS)



GHG Reductions (e.g., decreases in livestock)

Impact of Ethanol Plant Energy Use

