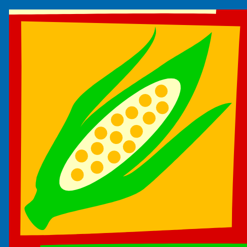
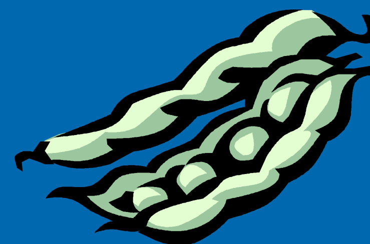
Lifecycle Assessment Under EPA's Proposed Regulation of Biofuels





February 2008

National Biodiesel Board Annual Meeting

Robert Larson, USEPA

Recent Events

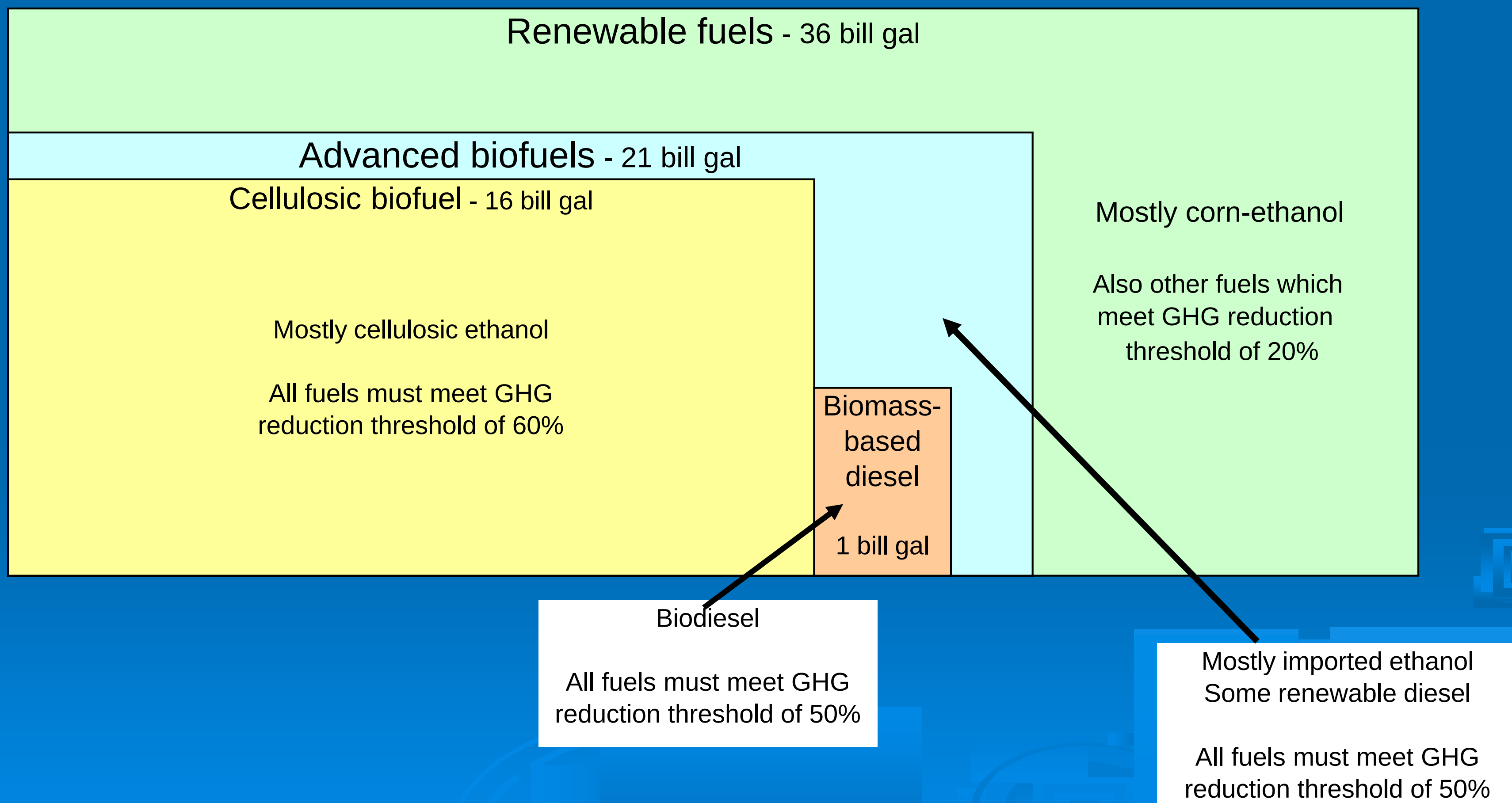
- January 2007 — State of the Union Address—20-in-10 goal
- March 2007 — Administration proposes Alternative Fuel Standard legislation
- April 2007 — Supreme Court Decision
- May 2007 — President's Announcement and Executive Order (35 billion gallons renewable and alternative fuel)
- December 2007 — Energy Independence and Security Act (H.R. 6) was passed by Congress and signed by President Bush on December 19, including a 36 billion gallon renewable fuel mandate

4 Separate Standards

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

The Standards are Nested

Shown with 2022 volumes



Importance of Lifecycle Assessment

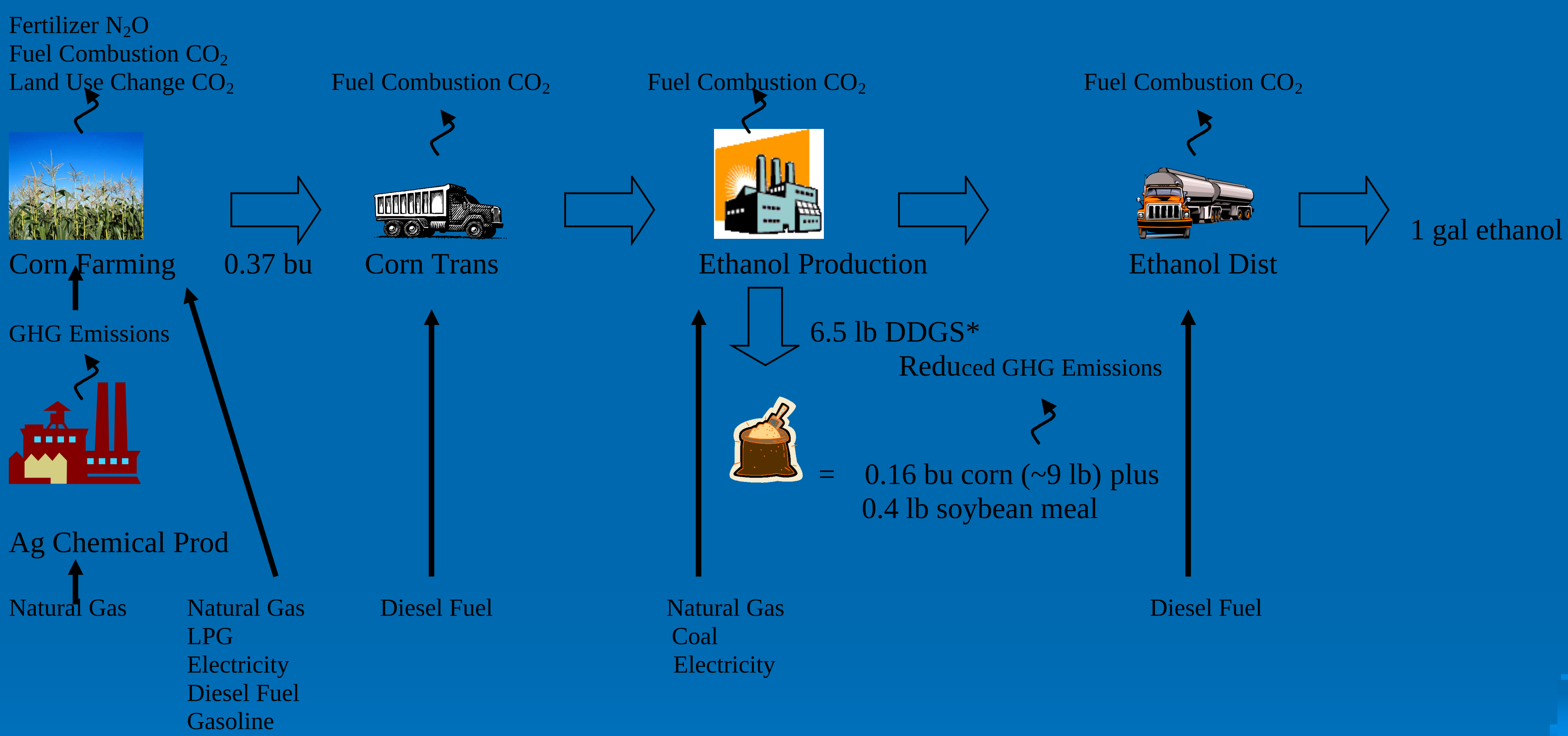
Energy Independence and Security Act Requires Lifecycle Assessment

- Lifecycle assessment required to determine which fuels meet mandated GHG performance thresholds
  - 20% reduction for new facility renewable fuel
  - 50% reduction for biomass-based diesel
  - 60% reduction for cellulosic biofuel
- Lifecycle assessment must include impacts on land use

Fuel Life Cycle GHG Assessment

- Also called fuel cycle or well-to-wheel analysis, compilation of the GHG impacts of a fuel throughout its life cycle
  - Production / extraction of feedstock
  - Feedstock transportation
  - Fuel production
  - Fuel distribution
  - Tailpipe emissions
- Can be used to compare one or more fuels performing the same function (e.g., miles driven)

Corn Ethanol Example



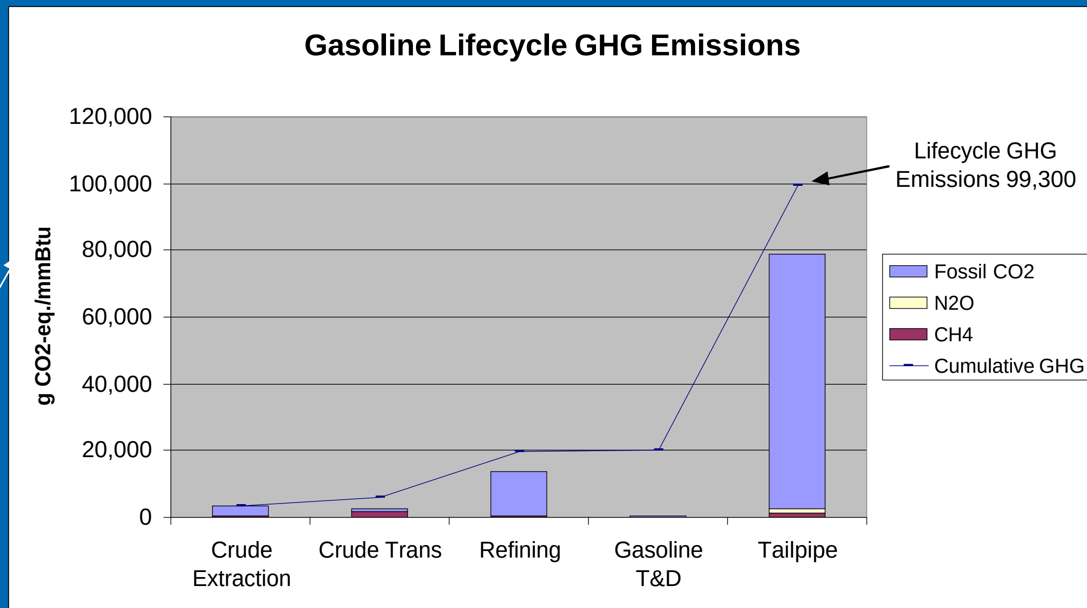
* Displacement allocation used, so for entire system new corn production = 0.21 bu and results in 0.4 less soybean meal produced

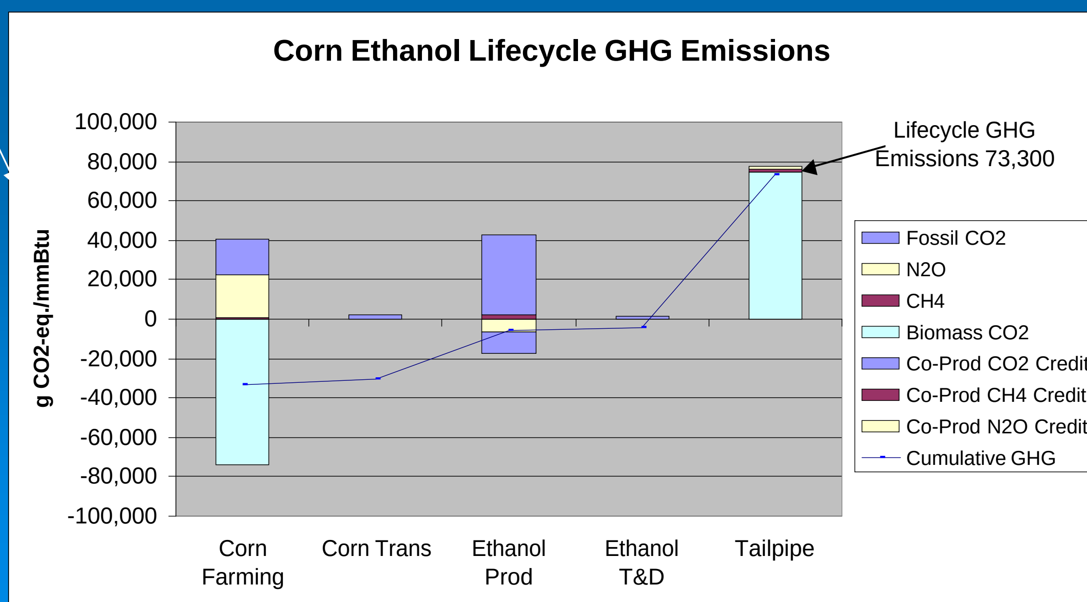
DDGS = Distiller Dried Grains, substitute animal feed

Can compare to producing an equivalent amount of petroleum gasoline

Example: Gasoline vs. Corn Ethanol Lifecycle Comparison From RFS 1

Comparing energy equivalent amounts of fuel

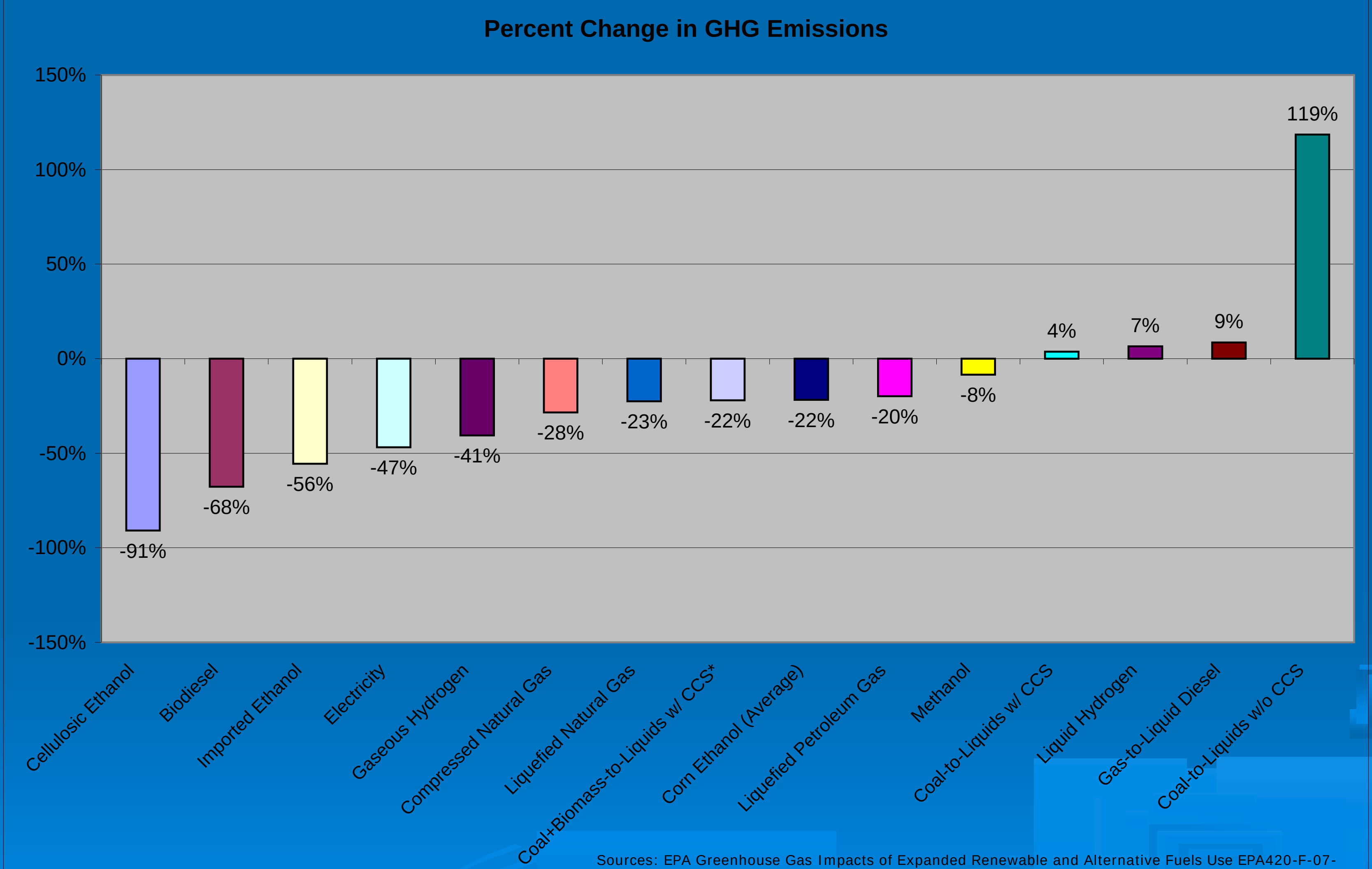




26% reduction in GHG emissions

Assumptions: 7.5 Bgal scenario used in the Renewable Fuel Standard Rulemaking, corn ethanol dry milling using natural gas

Important Method to Distinguish Between Fuels



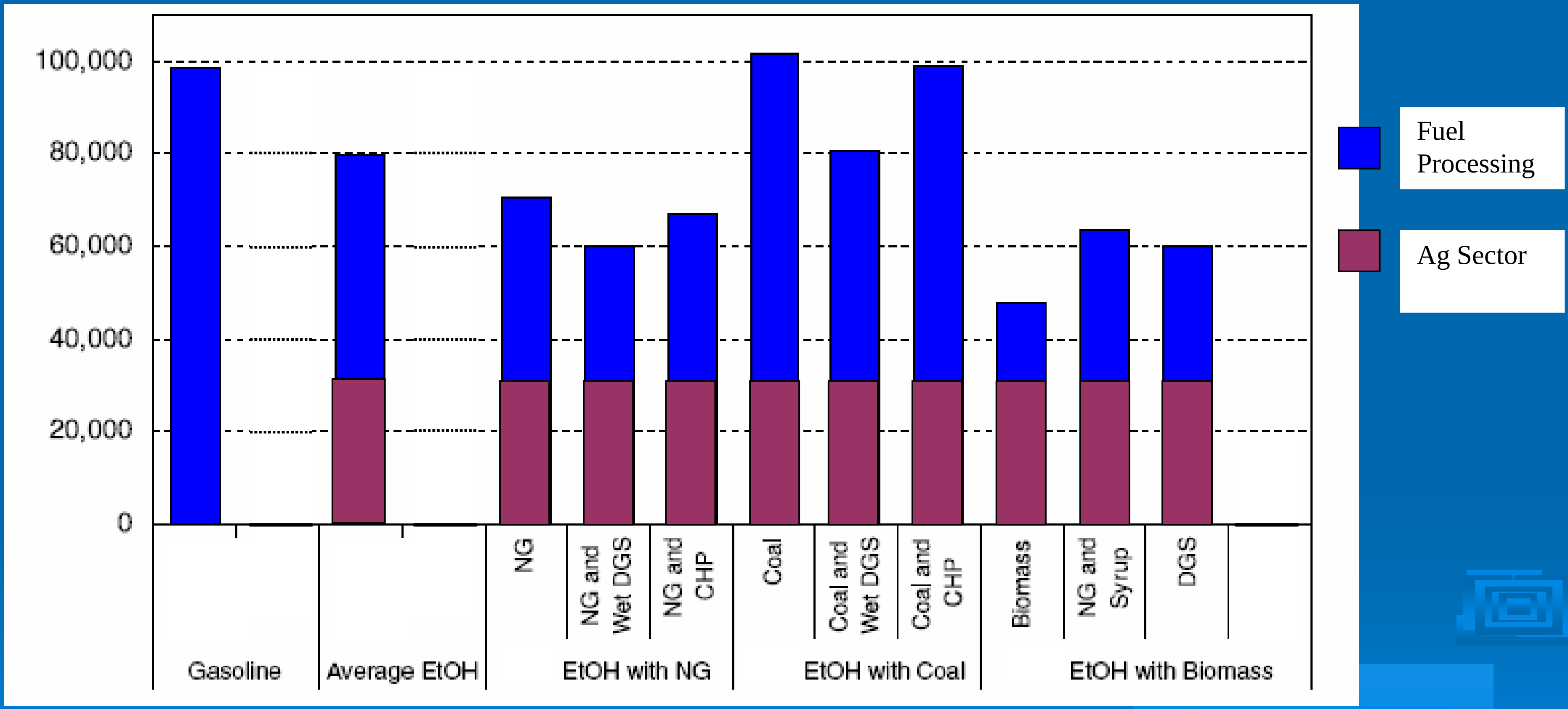
Sources: EPA Greenhouse Gas Impacts of Expanded Renewable and Alternative Fuels Use EPA420-F-07-035, April 2007

*Preliminary results from National Energy Technology Laboratory (NETL) 10% biomass by energy

Values were developed as part of the Renewable Fuels Standard analysis and are in the process of being updated. Values as well as types of fuels considered are subject to change.

Fuel Production Variation

- Range of results for different corn ethanol pathways

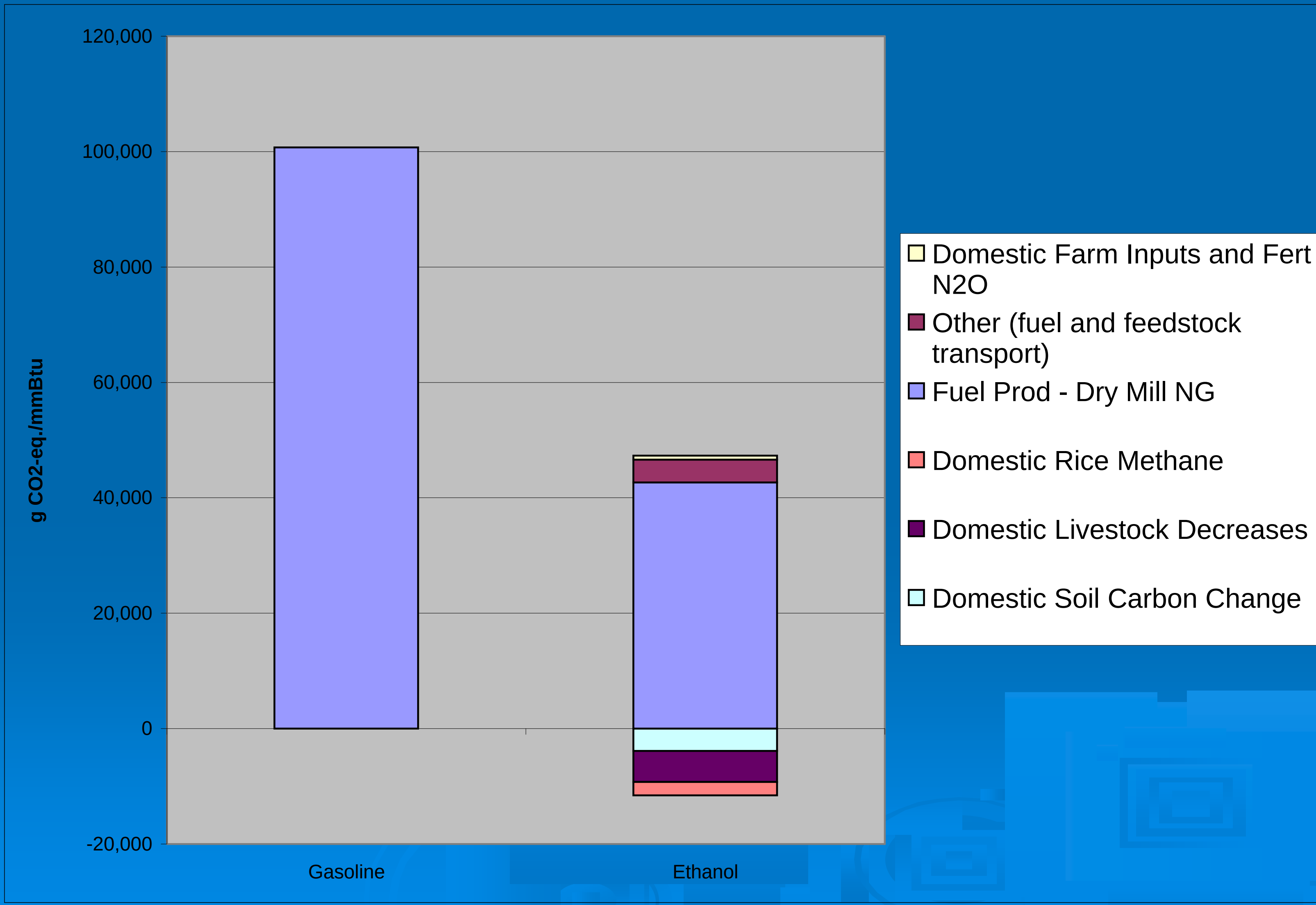


Source: Life-Cycle Energy and Greenhouse Gas Emission Impacts of Different Corn Ethanol Plant Types, Michael Wang, May Wu and Hong Huo, Environmental Research Letters, May 2007

Example Lifecycle Analysis

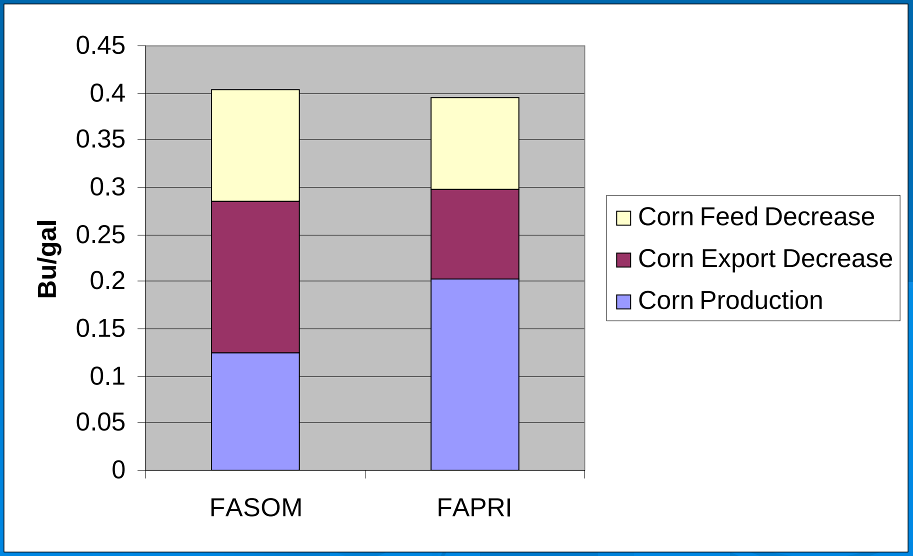
- RFS analysis assessed first order impacts
  - GHG impacts of corn and soybean acres in US
- New analysis more complete assessment of domestic impacts and added international
  - Corn and soybeans plus other crops
  - Land use changes
  - International impact of decreased US exports
    - Increased crop production in other countries adds GHG
    - Land use impacts critical

Domestic Emissions Only



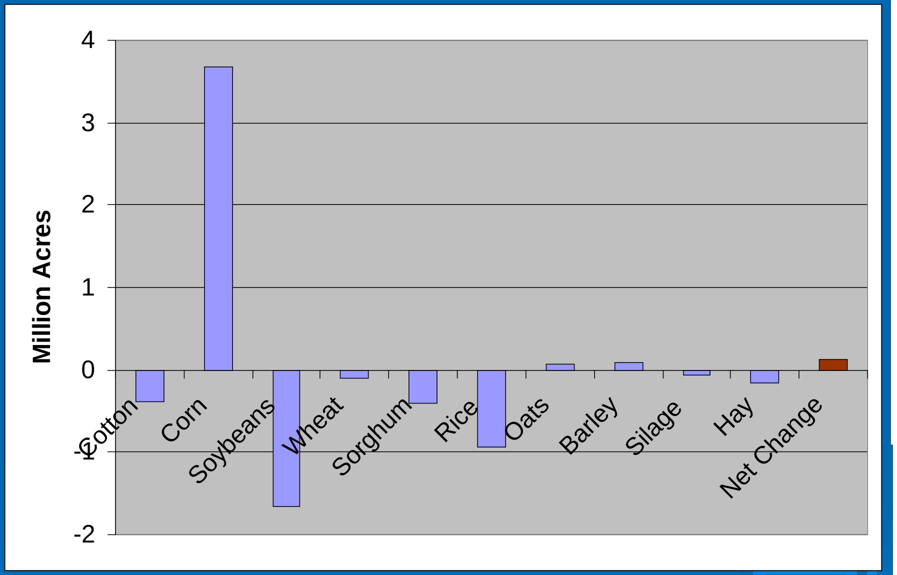
Modeled Export Changes

- International impacts are dependent on domestic modeling of export changes
- FASOM and FAPRI predict different export response (not just corn but other crops as well)
- Inconsistent to compare FASOM domestic impacts with FAPRI international impacts as is



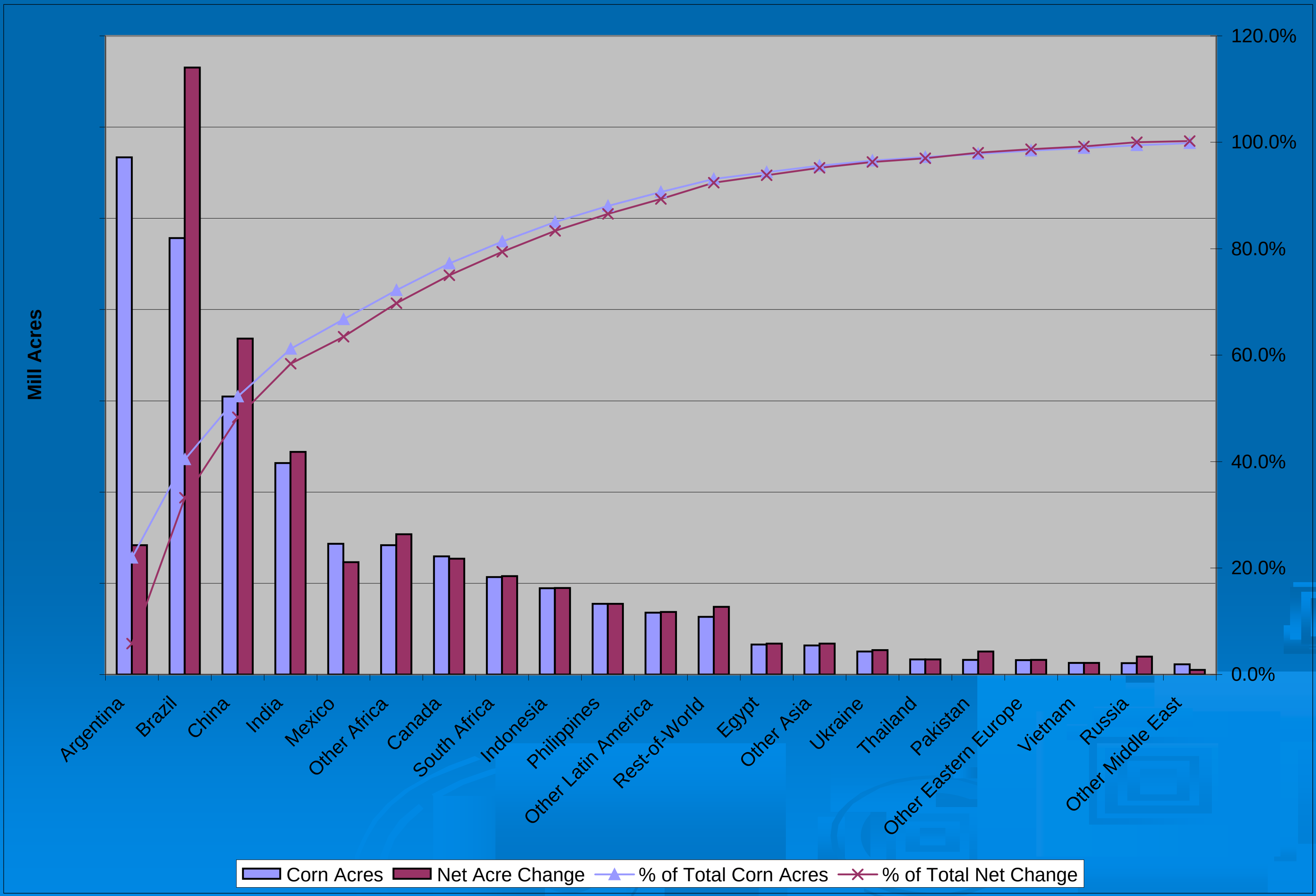
Domestic Impact Discussion

- 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



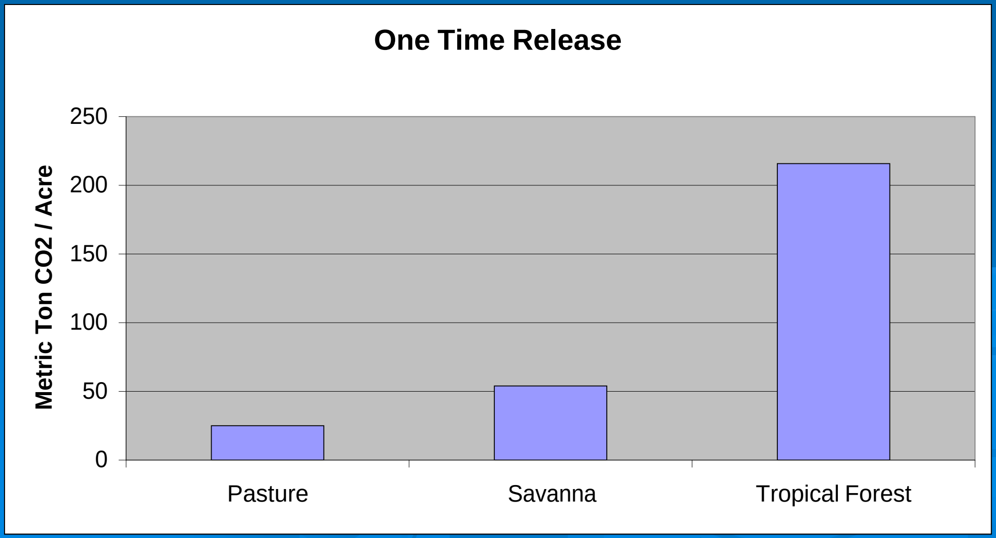
- 40% of corn used for ethanol comes from reductions in exports (highlighting need to include international impacts)

Adjusted Land Use Change



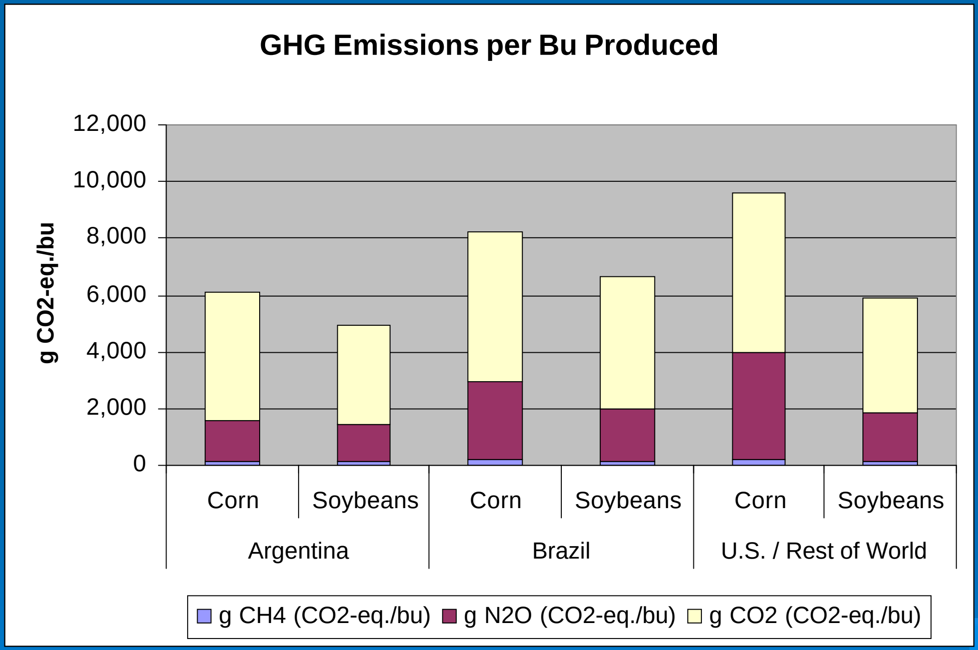
Land Use Change Assumptions

- Need to consider carbon per acre for different land types
- What type of land is converted in different countries, for example:
  - Argentina (Savanna)
  - Brazil Case 1 (Pasture)
  - Brazil Case 2 (Savanna)
  - Brazil Case 3 (Pasture + Tropical Forest)
  - Indonesia (Tropical Forest)



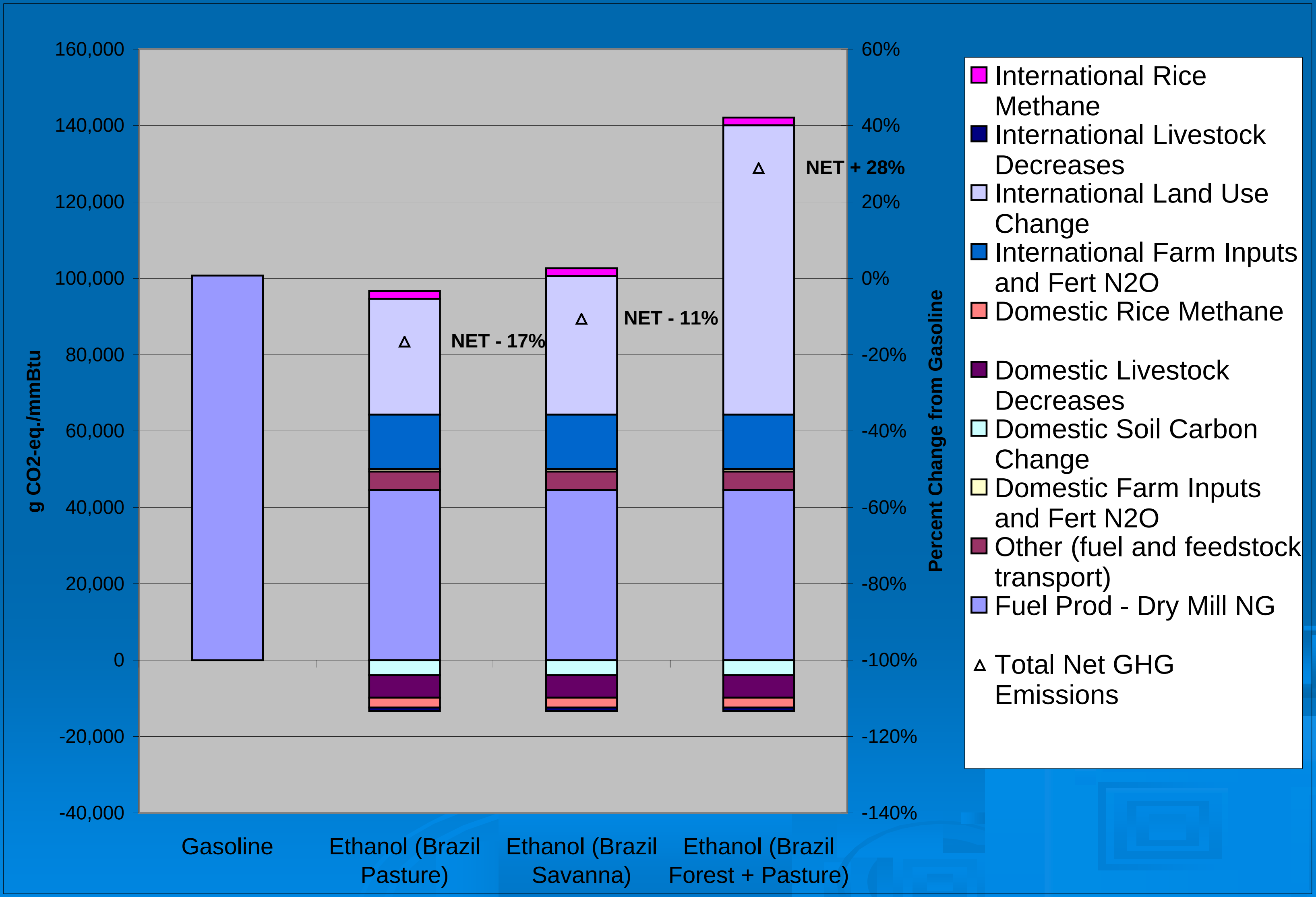
International Agricultural Sector GHG Impacts

- Corn & soybean production emissions based on GREET defaults
  - Brazil and Argentina fertilizer use adjusted



- Also included impacts on livestock internationally
  - Enteric fermentation and manure management

Impact of Land Use Change Assumptions
(Dry Mill, Natural Gas, Dry and Pelletized DDGS)



Further Work on Life Cycle Modeling

- **Specific areas of improvement that we are working on include:**
  - Building a consistent modeling framework that captures both domestic and international agricultural sector changes and GHG impacts
  - Working with experts to improve understanding of agricultural N2O emissions
  - Developing country specific GHG emissions factors associated with land use change and agricultural practices
  - Updating petroleum baseline
- **Updating other biofuel life cycle GHG factors with this approach**
  - Biodiesel
  - Imported ethanol
  - Cellulosic ethanol
- **We continue to have discussions with**
  - Industry groups
  - Academics and other experts
  - CA and EU regulators