



Implications of US & EU Biofuels for Global Land Use

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Outline

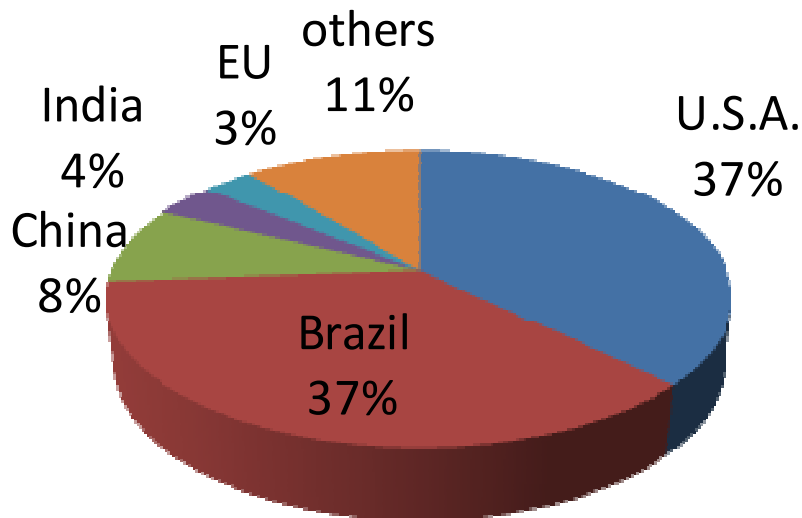
- Analytical framework and model validation
- Implications of taking US corn-based ethanol from 5 billion to 15 billion gallons
- Interactions with other mandates: Add to US, the EU mandate at 6.25%
- Qualifications: Very much preliminary analysis
- Conclusions

Introduction

- Biofuels from agricultural sources have contributed to higher commodity prices, affecting food, feed, and livestock markets worldwide
- While previously viewed as potentially reducing GHG emissions through displacement of petroleum, recent work has called these findings into question
- Searchinger et al. identify land use change in the rest of the world as a key driver of increased GHG emissions
- However, analysis to date has lacked a comprehensive global land use modeling approach; supplying such an analysis is our goal

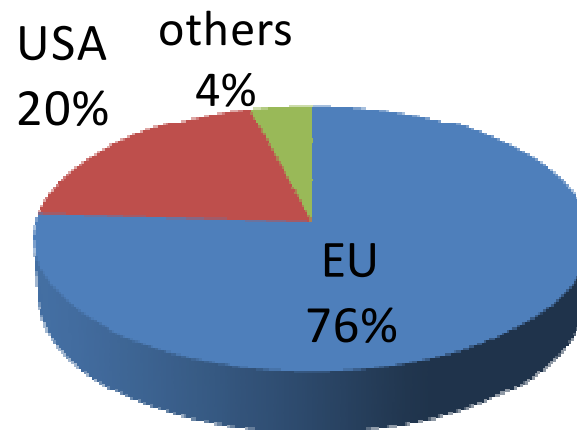
In 2006, the EU dominated biodiesel production, while USA/Brazil for Ethanol

Ethanol



World Ethanol Production:
49.3 billion liters

Biodiesel



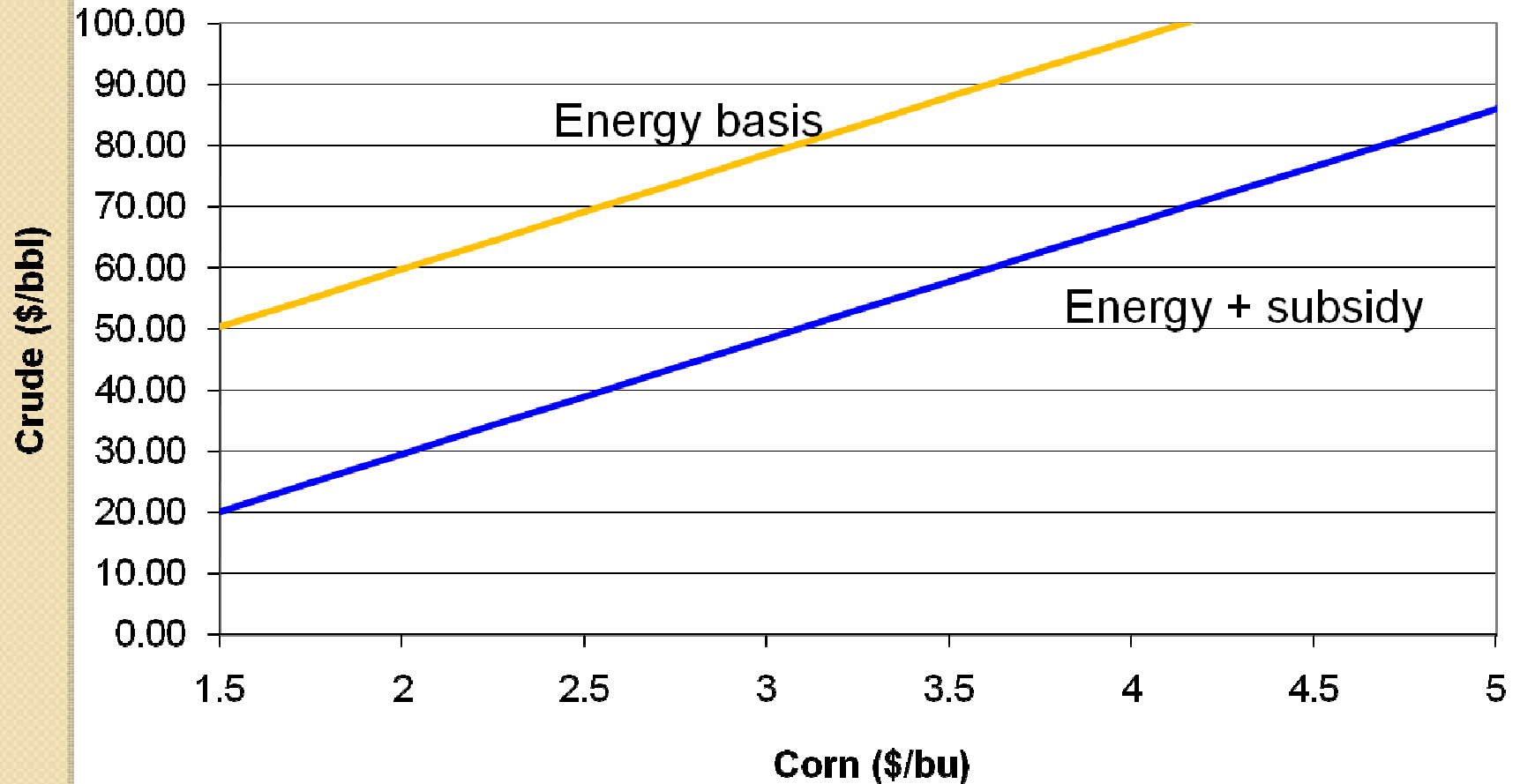
World Biodiesel Production:
5.6 billion liters



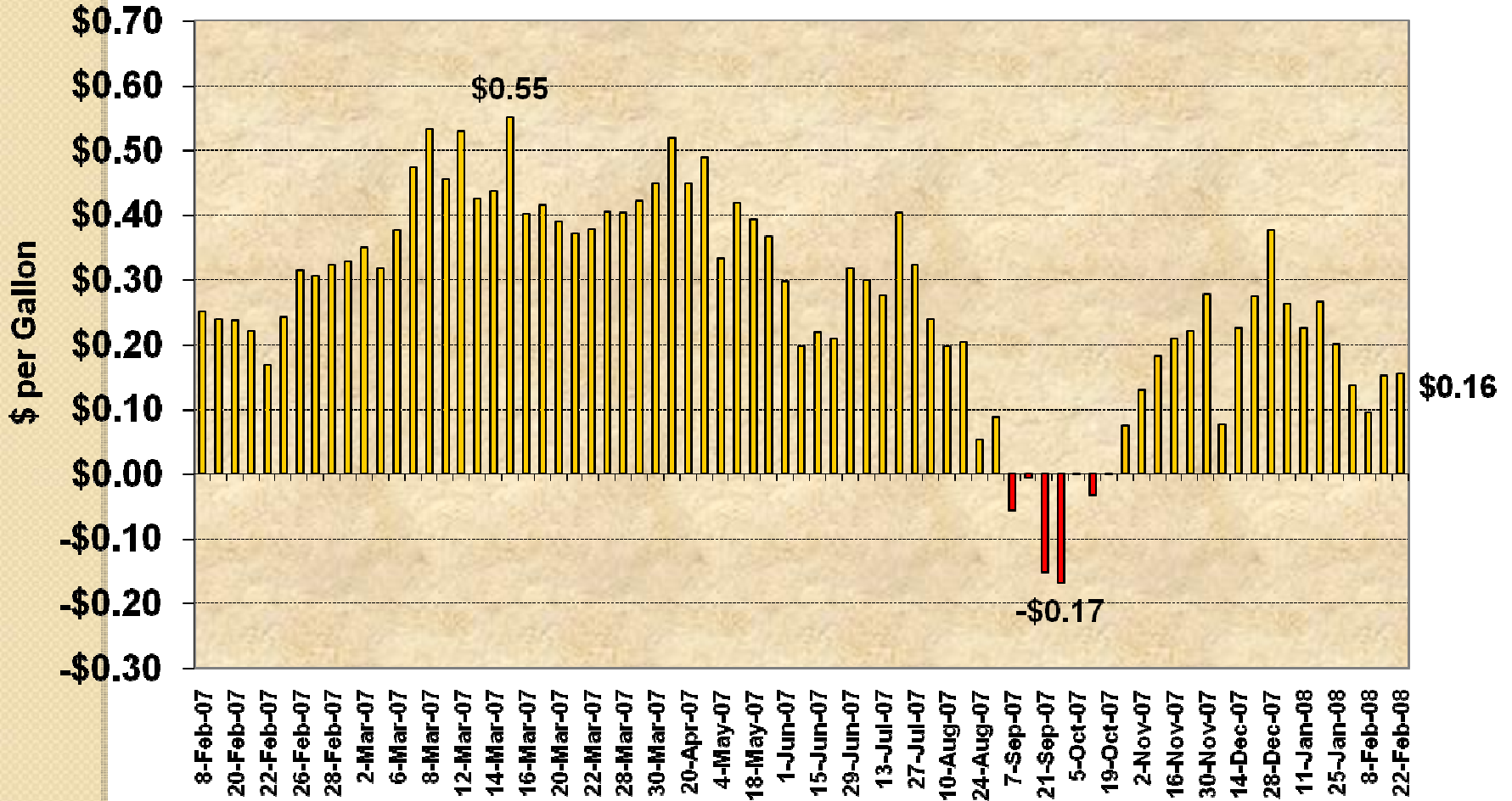
Analysis of US ethanol boom: Will it last?

- For our analysis, we envision a zero pure profits equilibrium in which the industry expands until new entrants just “breakeven”
- Tyner and Taheripour (2007) use breakeven charts to determine the price of corn that ethanol producers can pay for their feedstock and still breakeven selling into the market for gasoline
- Future growth depends on the crude oil prices, feedstock prices, subsidies, tax credits and, most recently the Energy Policy Act

Breakeven Corn and Crude Prices with Ethanol Priced on Energy Bases with and without Federal Subsidy



Net Returns per Gallon, Dry Mill Ethanol Plant (Based on Near Term Futures Prices)



*Net Returns = Value of Ethanol + DDGS - Corn Cost - Operating Costs - Capital Costs

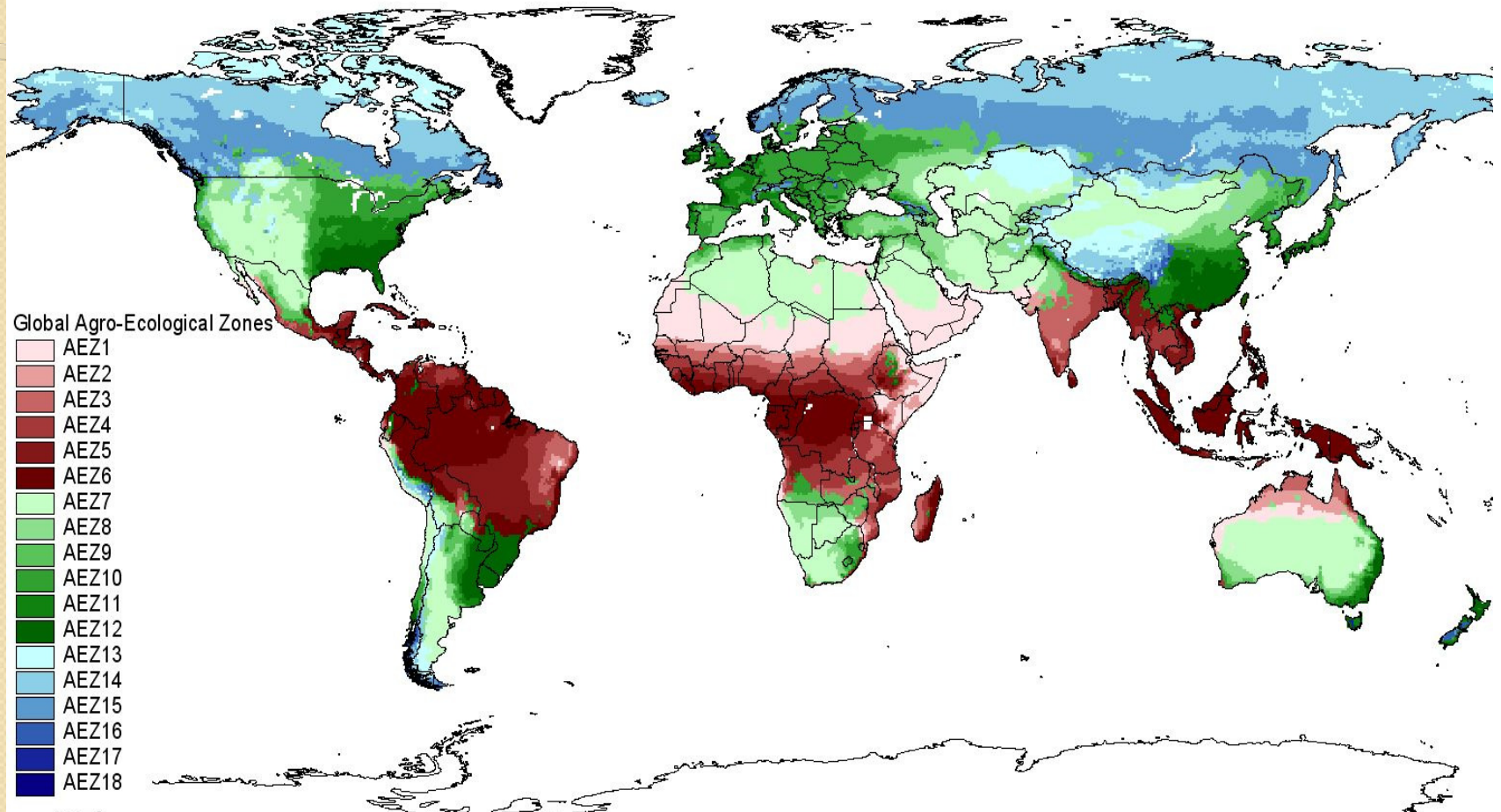
Focus of this study

- US (and EU) mandates are contingent on GHG impacts of biofuels. Therefore explore land use impacts of US 15 billion gallon target for corn-based ethanol in 2015
- This large scale increase in biofuels production will have substantial implications on global agricultural output, land use, and international trade, particularly if the EU aggressively pursues its renewable fuel goals
- Impact also depends on openness to biofuel imports (from Brazil and elsewhere)

Study Approach: Analytical Tool

- We implement the US mandates on a global CGE model which has following key features:
 - Incorporation of biofuels into the GTAP-E global energy data base and model: ethanol from corn, ethanol from sugarcane, biodiesel
 - Extension of the above model to a broader set of regions and agricultural commodities, and addition of Agro-ecological Zones (AEZs) for each of the land using sectors: built up from 1/2 degree grid cell level
 - Consider *commercially employed land*, including: commercial forestry, cropland and pastureland (*do not yet incorporate virgin forest and other unmanaged land*)

Global Distribution of AEZs



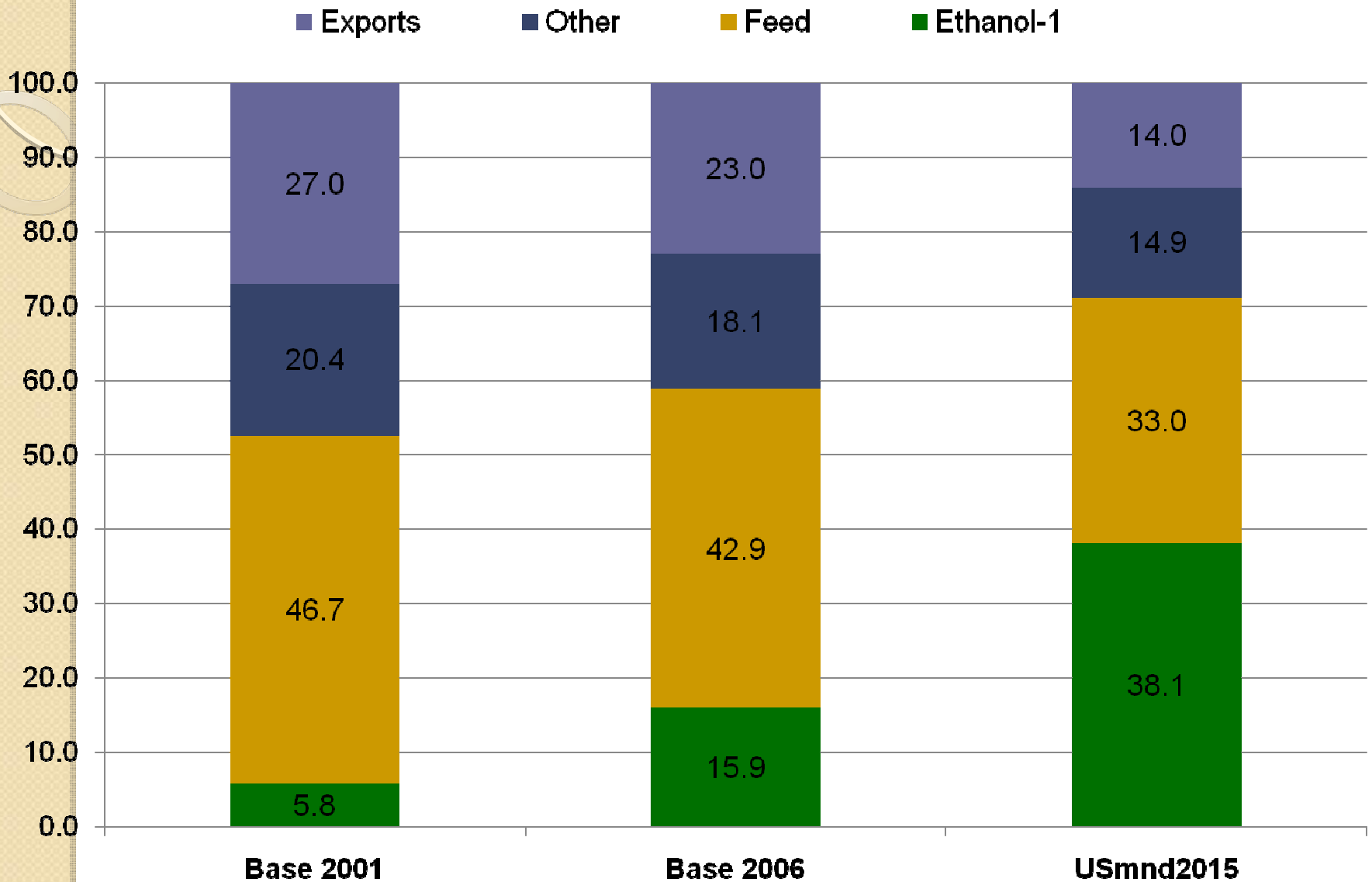
Study Approach: Experimental Design

- The initial data base pertains to year 2001; hence, we perform an historic simulation to project biofuel economy in 2006, by:
 - Increasing petroleum prices
 - Replacing MTBE with ethanol in gasoline additives
 - Adjusting AVE of ethanol subsidy
- This historical simulation is used to estimate the critical elasticity of substitution between biofuels and petroleum products
- We start from this 2006 baseline and shock ethanol use and in the US to meet the usage target – allowing imports to grow in the same proportion
- Then add EU mandates (as 6.25% renewables in 2015)

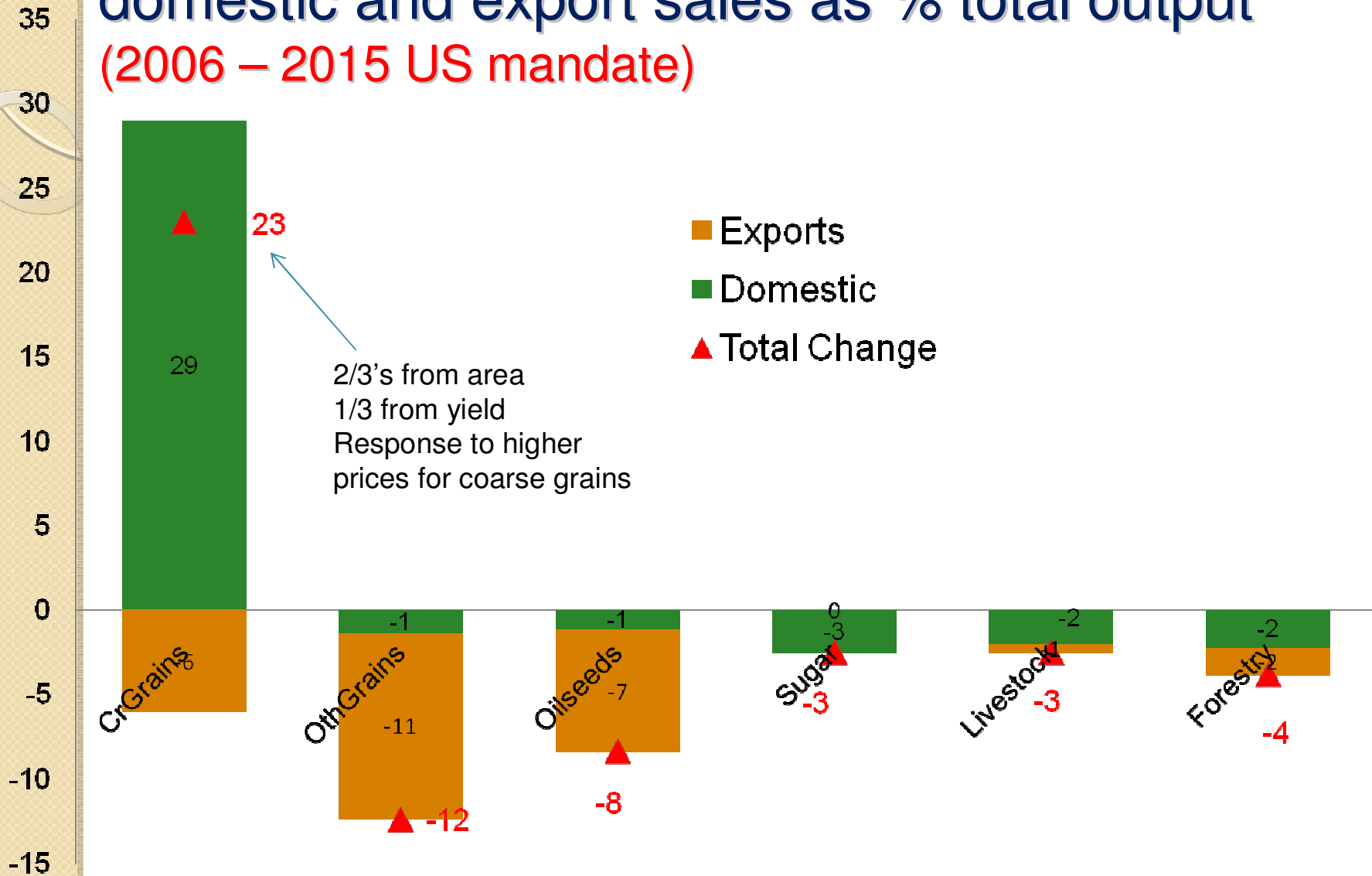


Implications of US Ethanol Growth to 15 billion gallons: 2006 - 2015

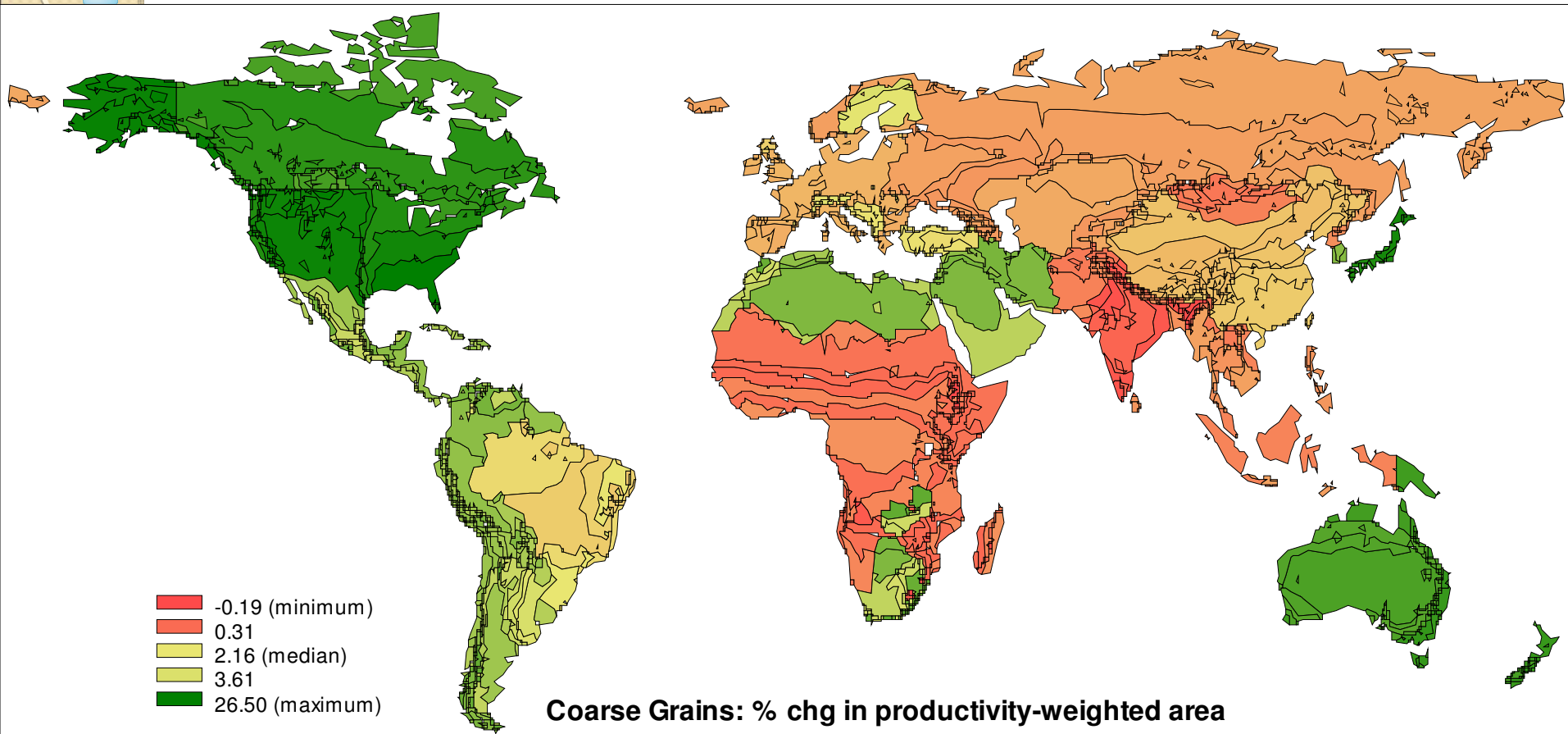
Disposition of Coarse grains in US (% output)



Change in US production: Contributions of domestic and export sales as % total output (2006 – 2015 US mandate)



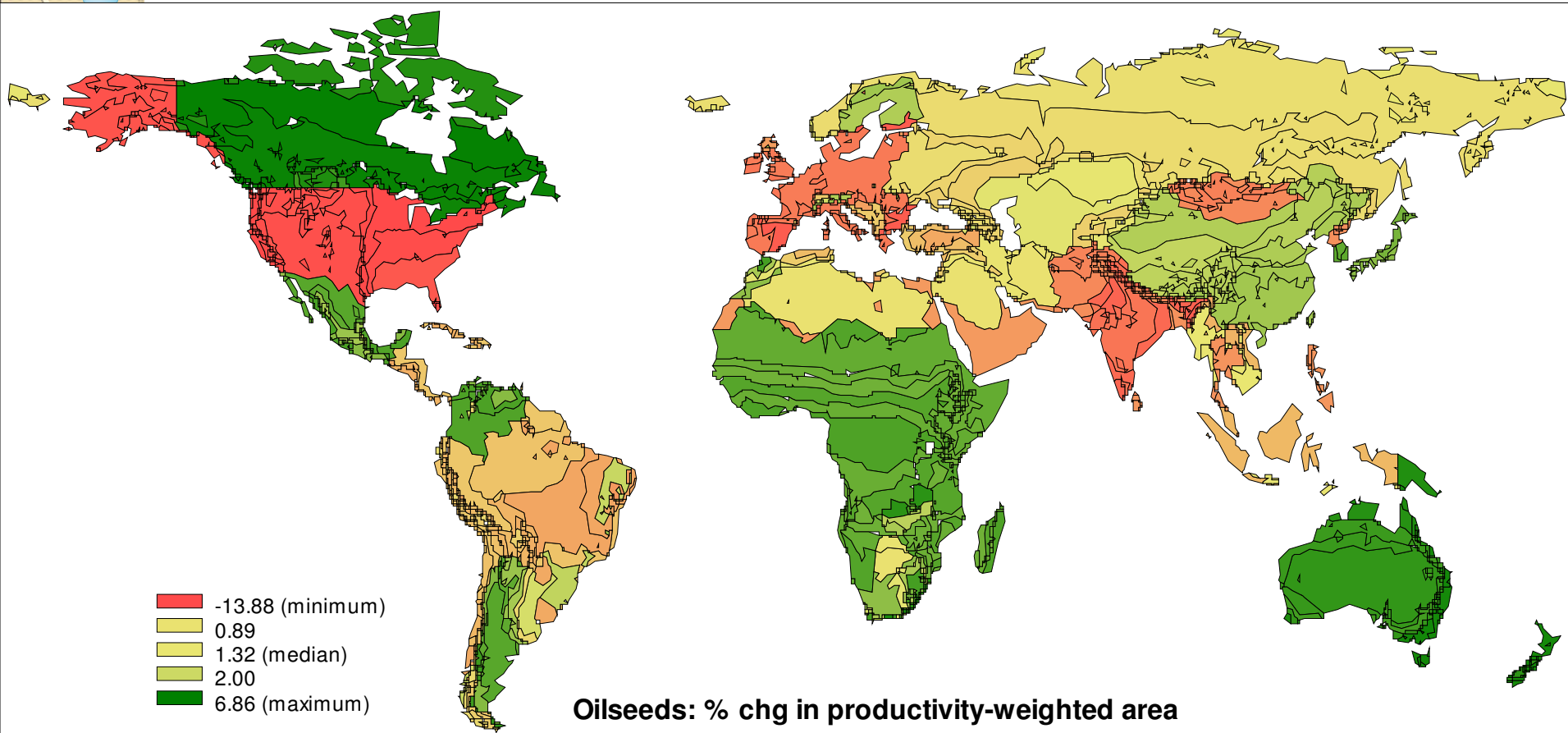
Change in Harvested Area **Coarse Grains: US 15 bill.**



Coarse Grains	USA	Canada	EU	Brazil
Harvested Land change (%)	14.3	6.6	0.8	1.9

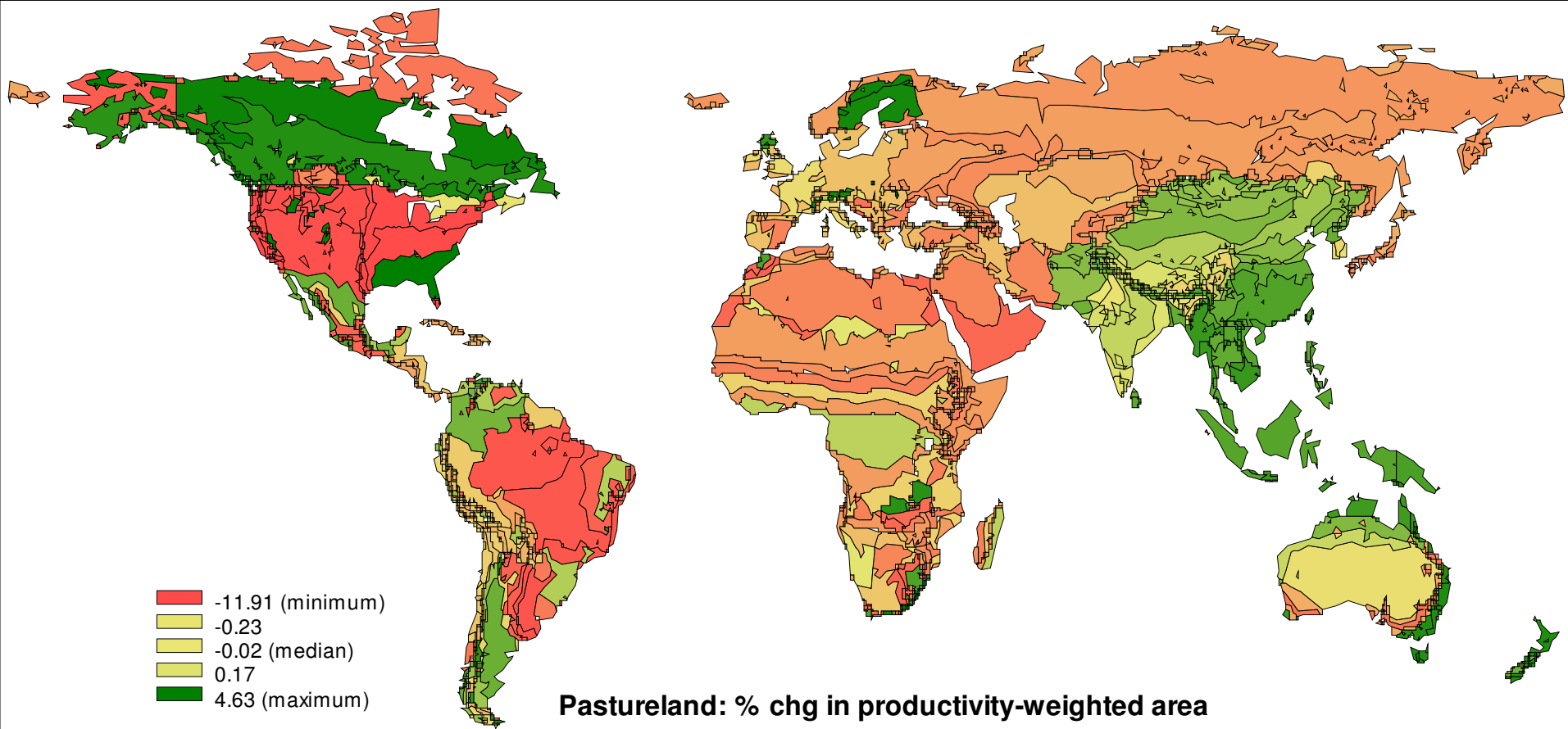
Change in Harvested Area Oilseeds : US

15bill



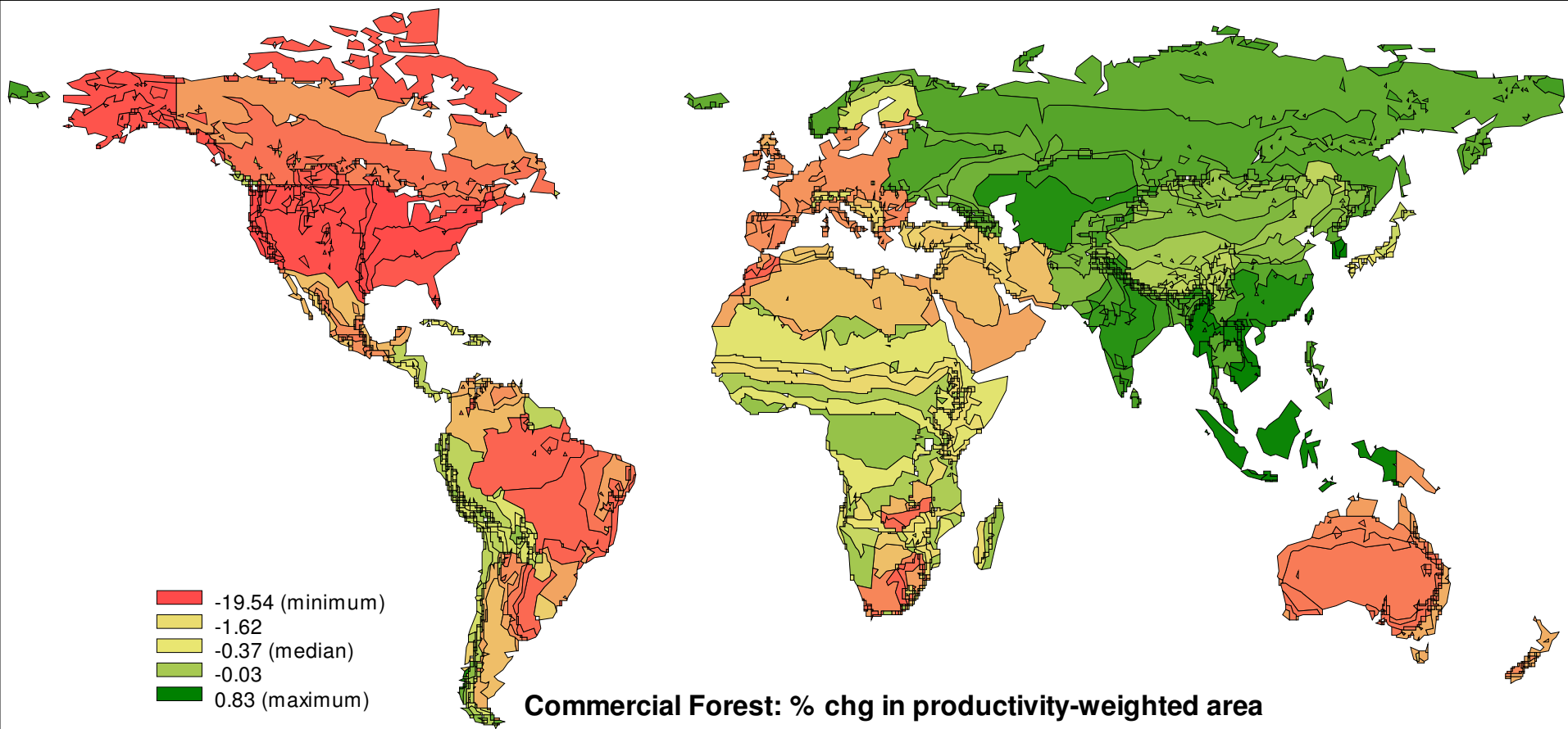
Oilseeds	USA	Canada	EU	Brazil
Harvested Land change (%)	-11.3	4.4	0.1	1.2

Change in Land Area under Pasture: US 15 bill



Pastureland	USA	Canada	EU	Brazil
Land cover change (%)	-3.6	0.4	-0.0	-1.1

Change in Land Area under Commercial forest: US 15bill



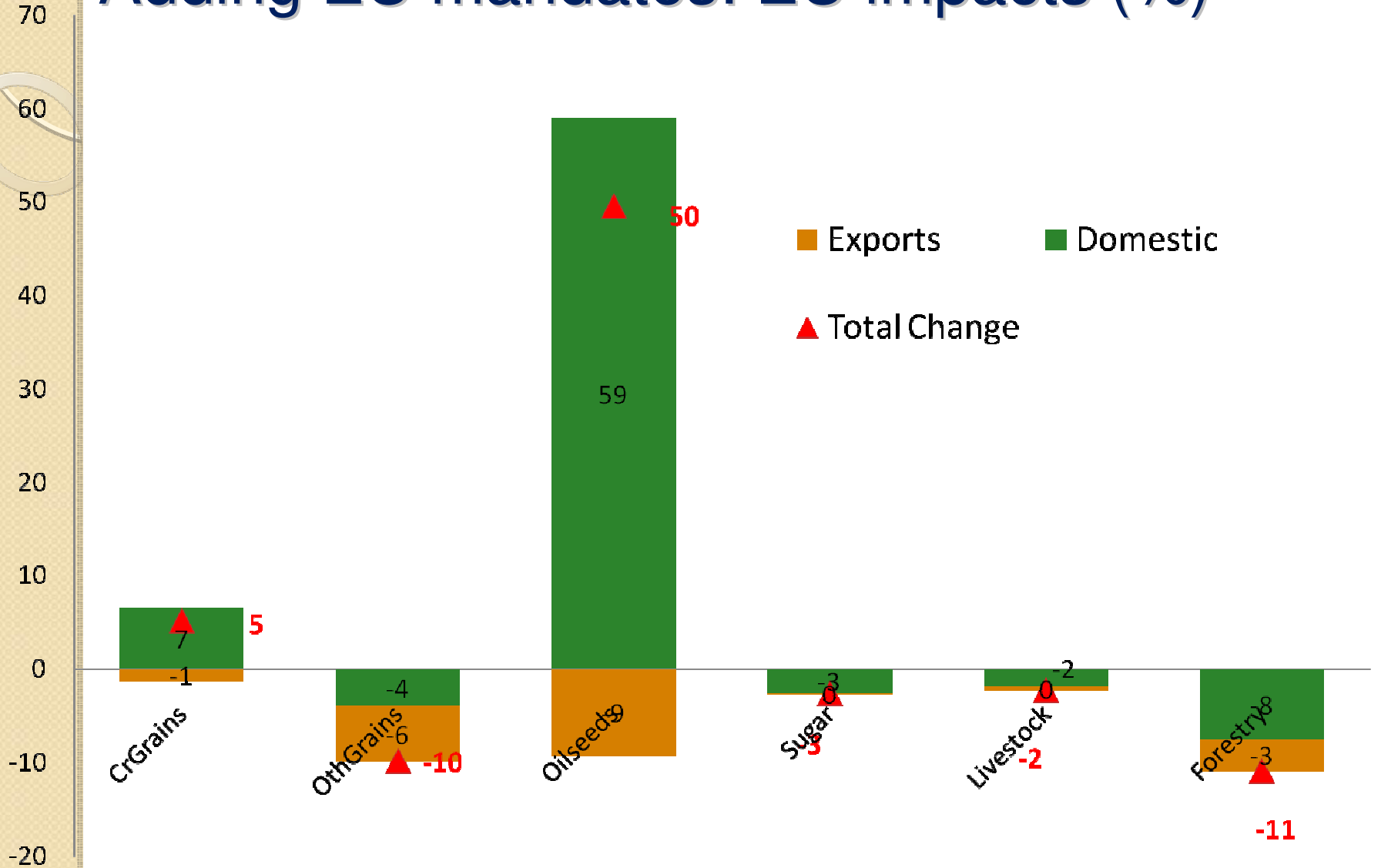
Commercial forest	USA	Canada	EU	Brazil
Land cover change (%)	-6.4	-1.9	-1.4	-2.7

Disposition of Oilseeds in the EU when EU mandates are added (% of output)

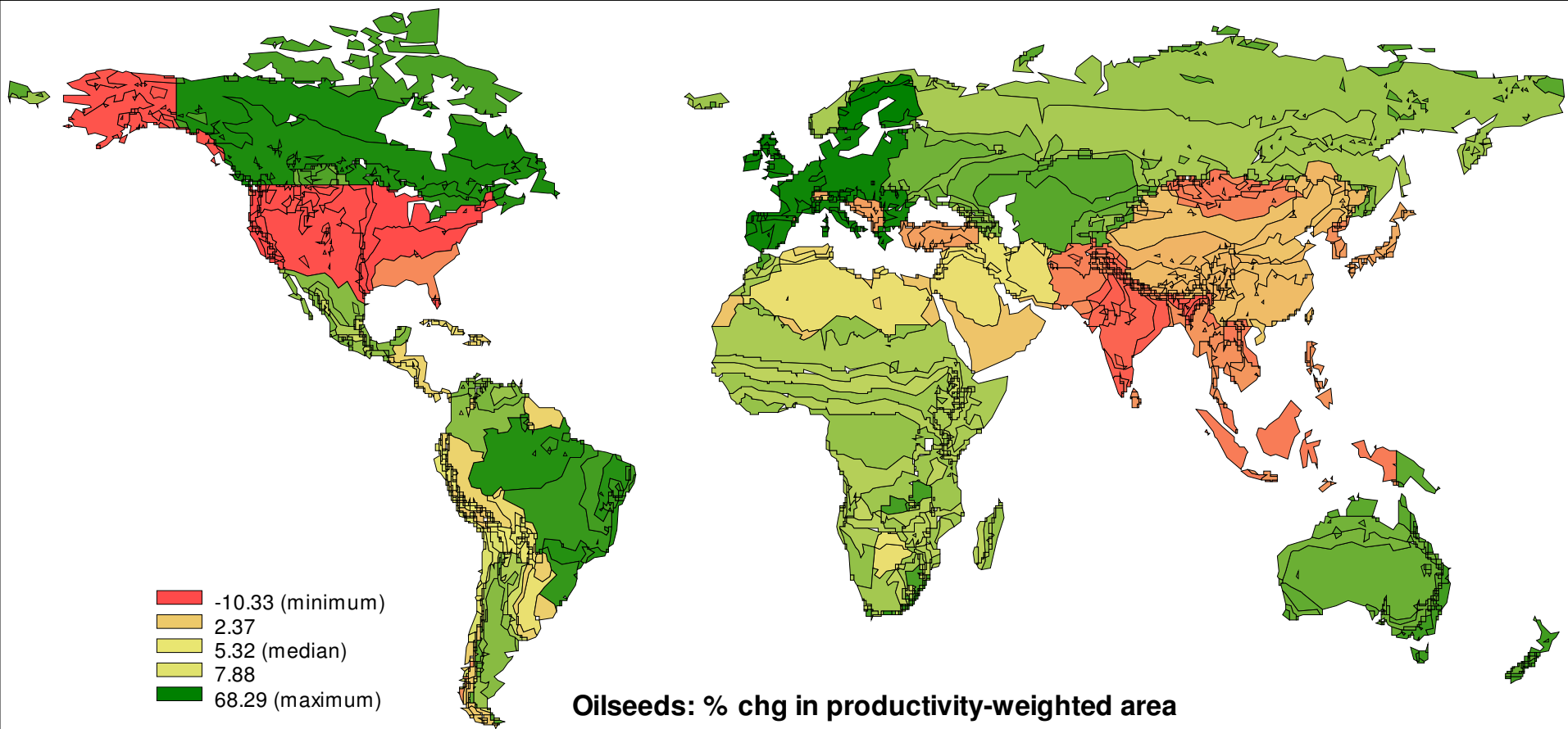
■ Exports ■ Feed etc ■ Other food products ■ Biodiesel



Adding EU mandates: EU impacts (%)

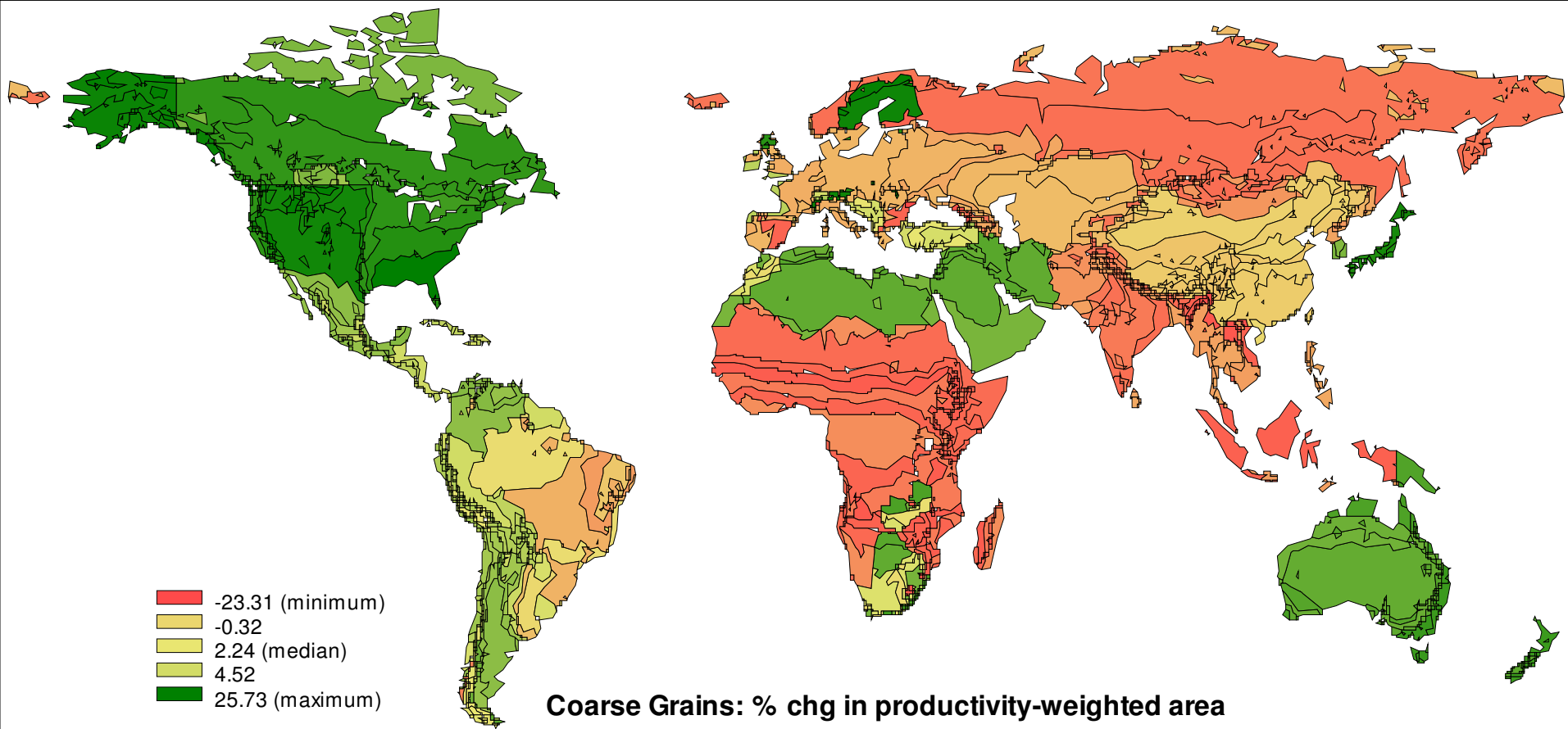


Change in Harvested Area Oilseeds : US-EU



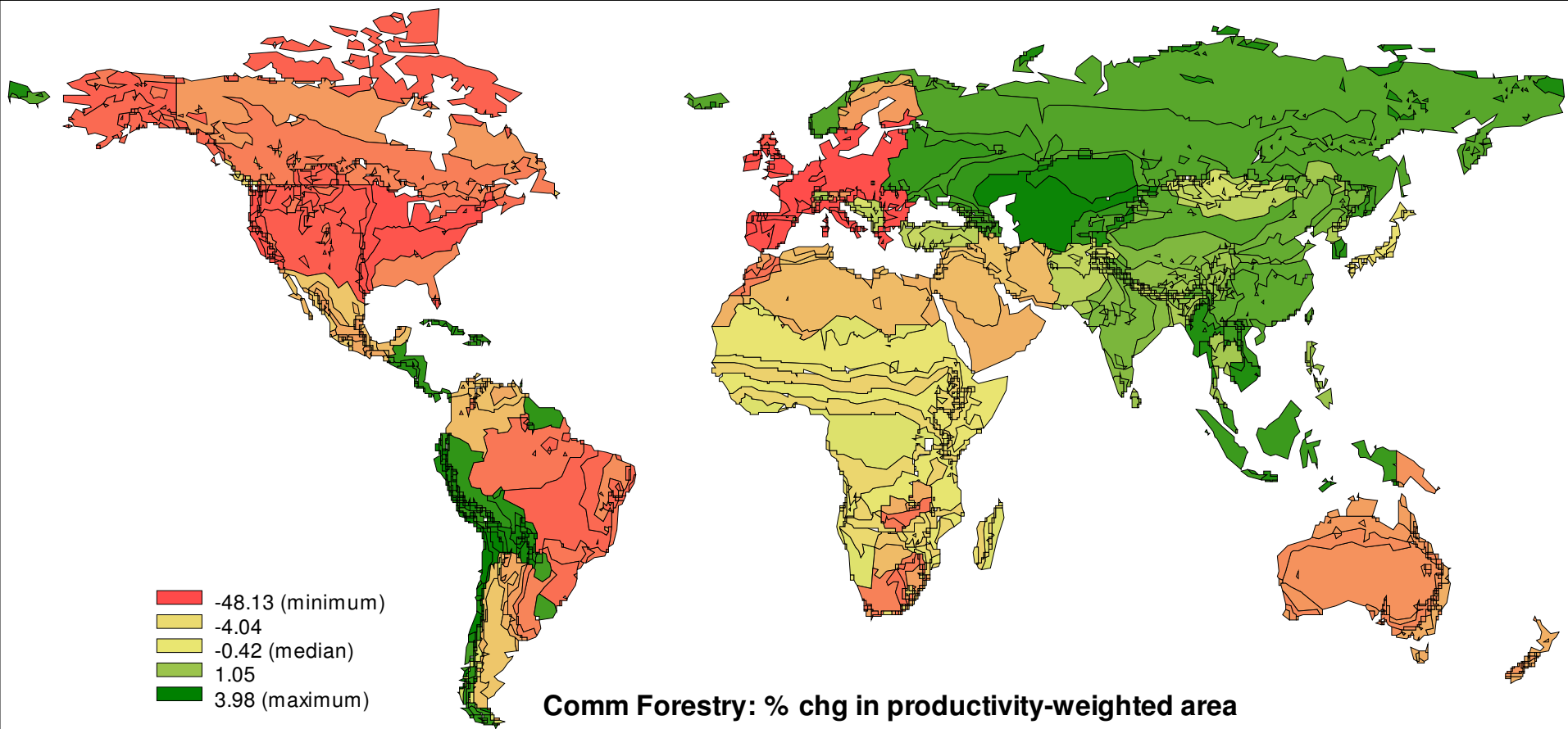
Oilseeds	USA	Canada	EU	Brazil
Harvested Land change (%)	-7.7	12.0	38.5	10.8

Change in Harvested Area **Coarse Grains: US-EU**



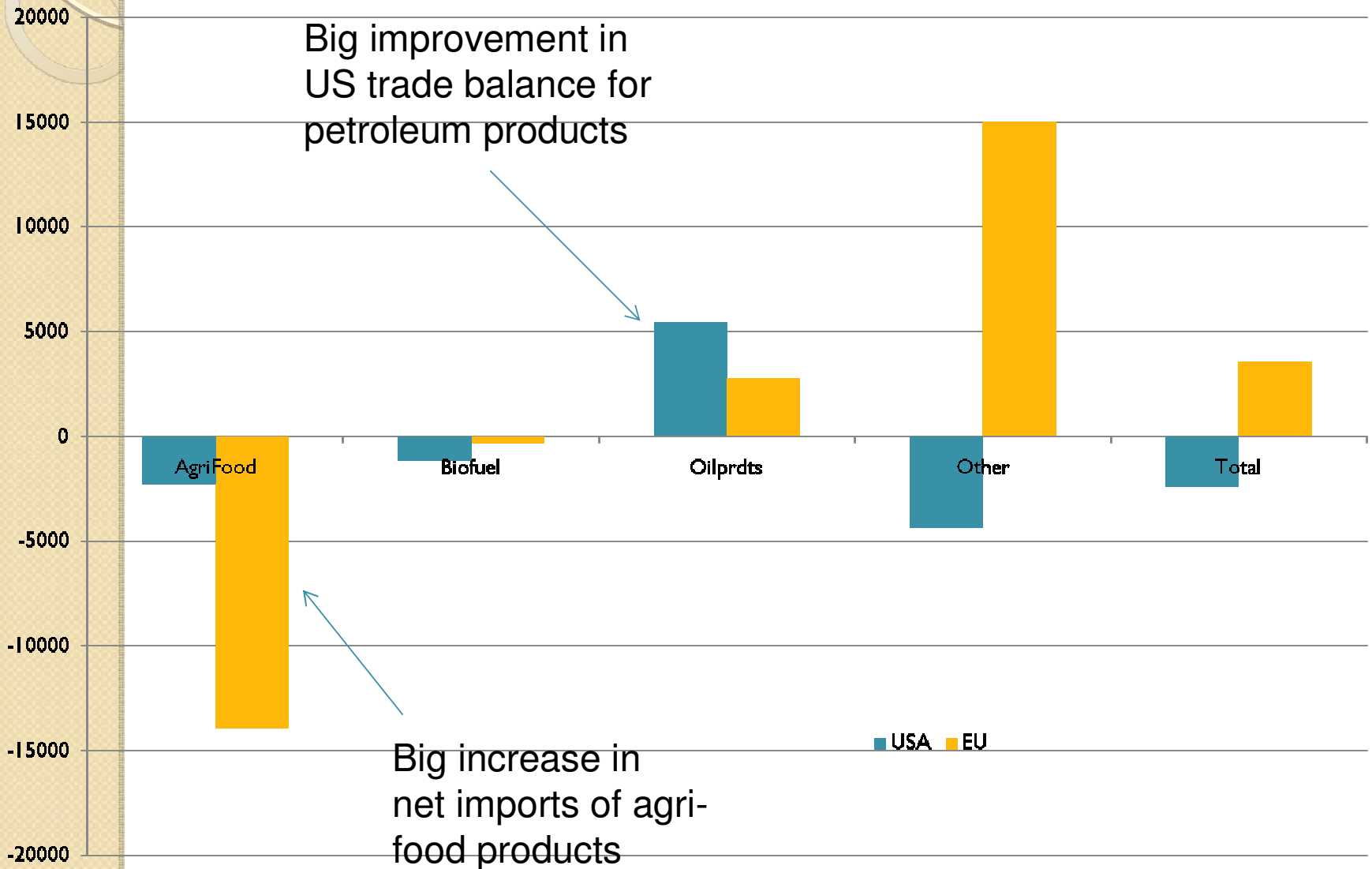
Coarse Grains	USA	Canada	EU	Brazil
Harvested Land change (%)	13.6	6.9	0.3	0.5

Change in Land Area under Commercial forest: US-EU



Commercial forest	USA	Canada	EU	Brazil
Land cover change (%)	-6.6	-4.2	-16.0	-6.2

Change in Trade Balance: 2006-2015 due to US and EU Mandates (\$ million)



Qualifications

- Have not incorporated unmanaged land: *particularly important for Brazil*
- We have not yet captured the link from EU biodiesel to palm oil production: *we understate the impact on Southeast Asia, overstate impacts on Brazil*
- Have not taken account of ethanol by-products; so *overstate impact on livestock feed costs*
- Need to pay close attention to key parameters: yield response, mobility of land between forestry and agriculture, substitution amongst biofuels and petrol: Present results as confidence intervals

Conclusions – impact on EU, US

- Strong expansion of ethanol in the US leads to a 23% increase in corn production: 2/3's from area, 1/3 from yield (long run effects)
- Ethanol industry uses 38% of output (2015), sharp reductions in corn to feed/exports
- Massive increase in biofuel demand in the EU generates strong demand for oilseeds. Domestic oilseed output increases by 50% from 2006-2015, with shortage met by massive imports of oilseeds, oils and biofuel
- By-products from ethanol and biodiesel production: What will be the impact of massive increases in soymeal and DDGS available for livestock feed?

Next Steps

- Add unmanaged land and by-products
- Collaborating with EPA/DOE/CARB to bring in emissions associated with changing land use and eventually tie in with broader emissions story: non-CO2 and CO2 emissions associated with economy-wide activities
- Examine poverty impacts:
 - Higher food prices hurt poor consumers
 - But majority of poor still rely on agriculture for earnings, so there is a positive income effect
 - Need a formal economic model to sort out net impacts



Thank You

Questions / Comments?