PURDUE UNIVERSITY

PURDUE AGRICULTURE

BioEnergy

Fueling America Through Renewable Resources

Policy Options for Integrated Energy and Agricultural Markets and Global Biofuels Impacts

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Main Topics

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- Energy and agricultural markets are becoming integrated, and they have not been in the past
- Developed country biofuels policies have huge impacts on national biofuels programs, but also on production and trade globally
- We will explore these topics using both partial equilibrium and general equilibrium analysis on a national and global scale

Market Integration

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- In the past, agricultural markets have been well integrated.
- Markets for different energy commodities, especially liquid energy products, also have been tightly linked.
- But agricultural markets and energy markets have not been closely correlated.

Agricultural and Energy Historic Price Correlations

Data Pair	Correlation Coefficient
Crude-gasoline	0.98
Crude-ethanol	0.88
Gasoline-ethanol	0.86
Ethanol-corn	0.25
Crude-corn	0.16
Crude-soybeans	0.13
Corn-soybeans	0.72

Policy Alternatives

- Fixed subsidy of 51 cents per gallon of ethanol
- No subsidy
- Variable subsidy – subsidy that varies with the price of crude oil with no subsidy when crude is over $75/bbl.
- Renewable fuel standard – 15 billion gallons of corn based ethanol

Model Integrating Corn and Energy Markets

- Partial equilibrium model encompassing corn, ethanol and by-products, crude oil and gasoline
- Endogenous variables:
  - Gasoline supply, demand, and price
  - Ethanol supply, demand, and price
  - Corn supply and price
  - Corn use for ethanol, domestic use, and exports
  - DDGS supply and price
  - Operating costs of corn production

Model Description

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- The model is driven and solved by market clearing conditions that corn supply equal the sum of corn demands and that ethanol production expands to the point of zero profit
- Exogenous variables include crude oil price, corn yield, ethanol conversion rate, ethanol subsidy rate and mechanism, and gasoline demand shock

Model Simulations

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- The model is simulated over a range of oil prices with no demand shock and a 10% demand shock (due to increases in incomes and population)
  - No demand shock assumes higher CAFE standard
  - 10% demand shock is DOE base case out to 2015 and essentially assumes that crude oil supply cannot keep up with rising gasoline demand as it has in the past

Ethanol Production

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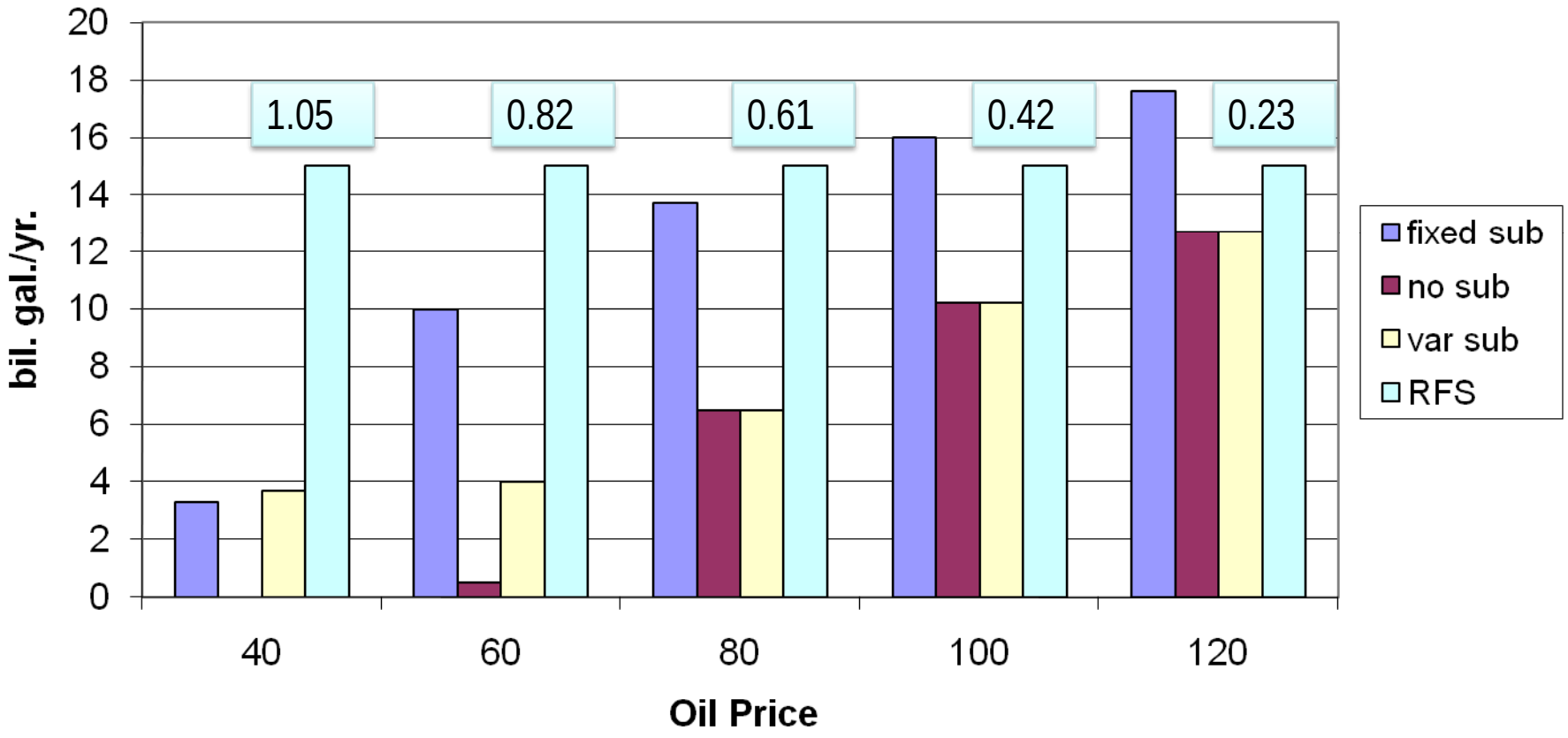
no demand shock



Ethanol Production

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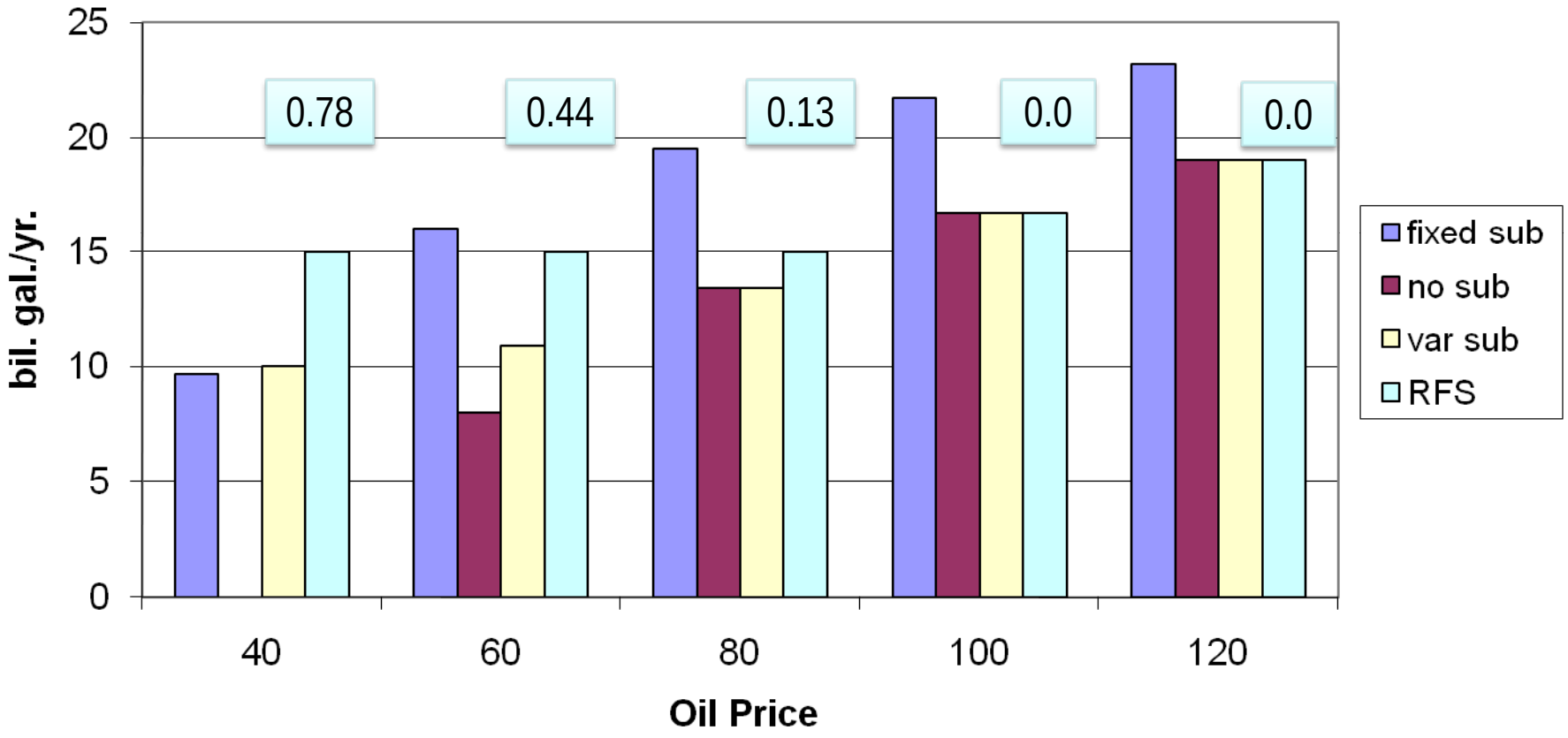
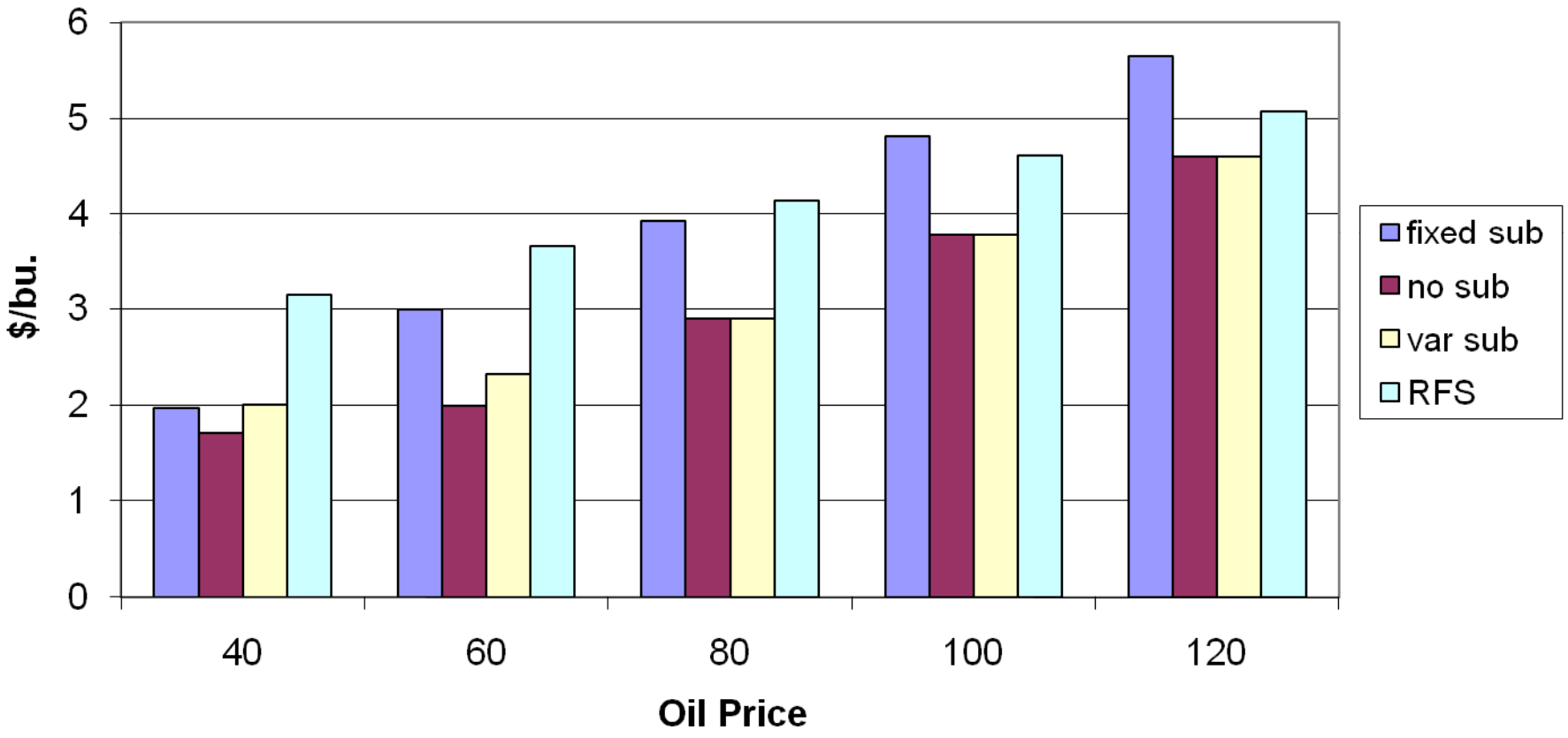
10% demand shock



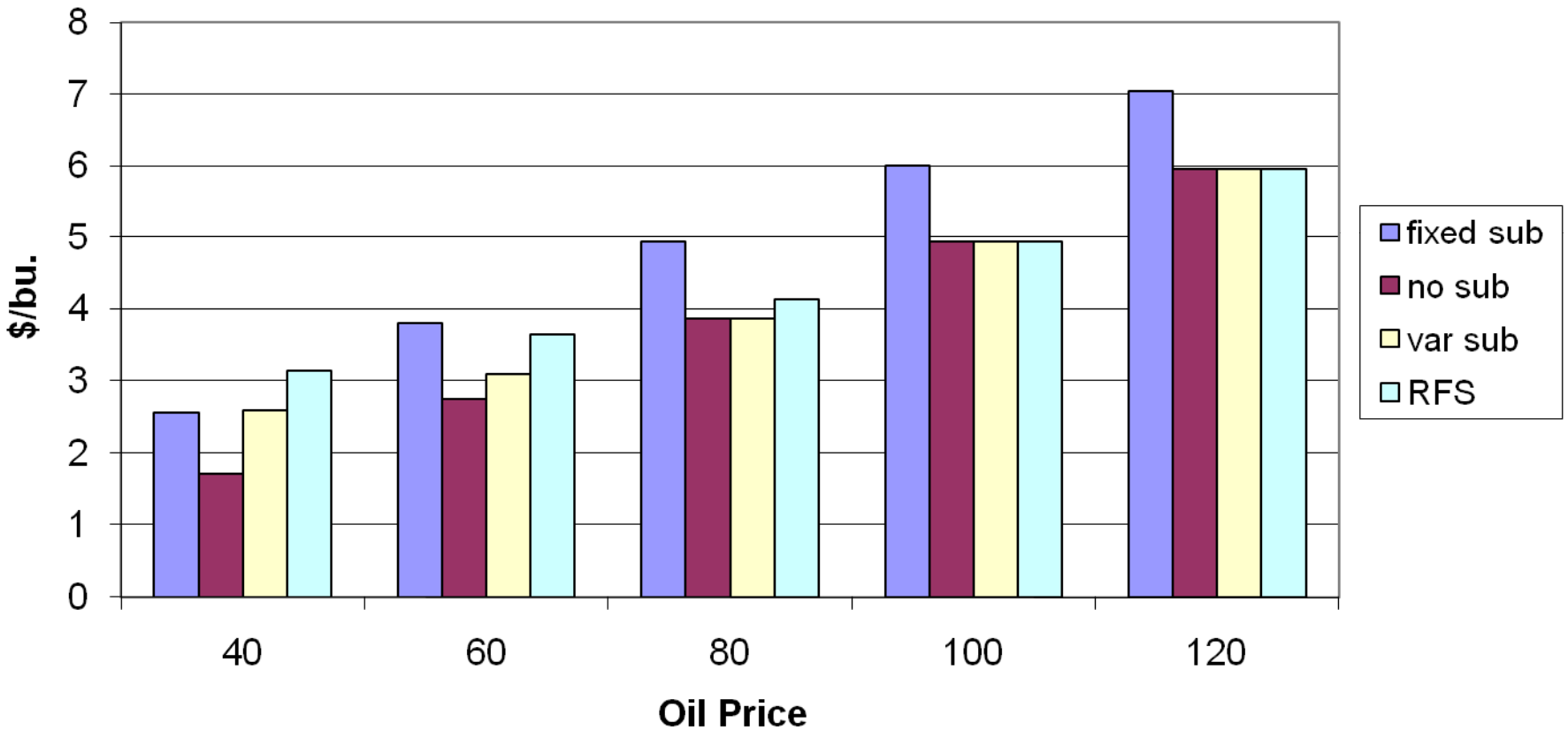
Corn Price

no demand shock



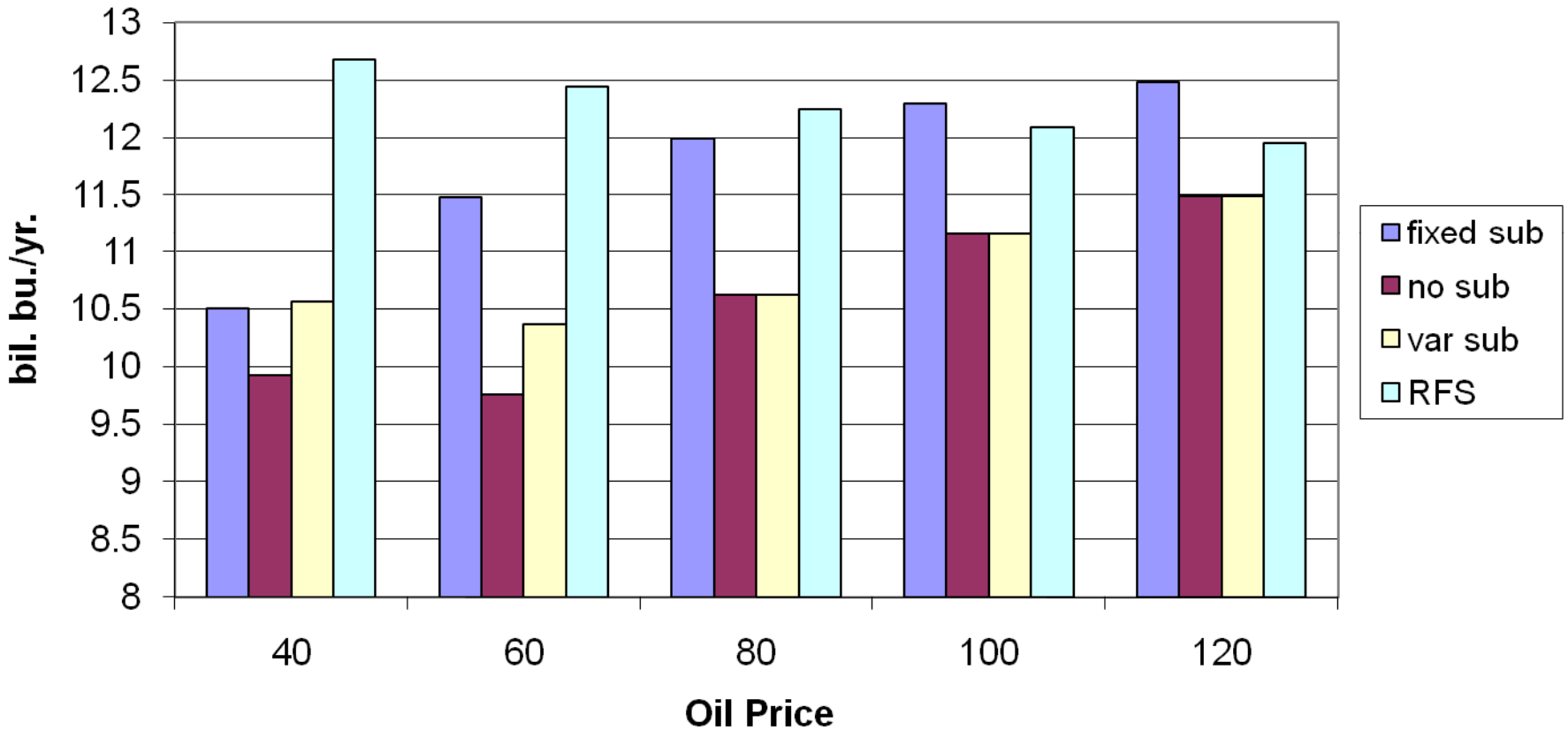
Corn Price

10% demand shock



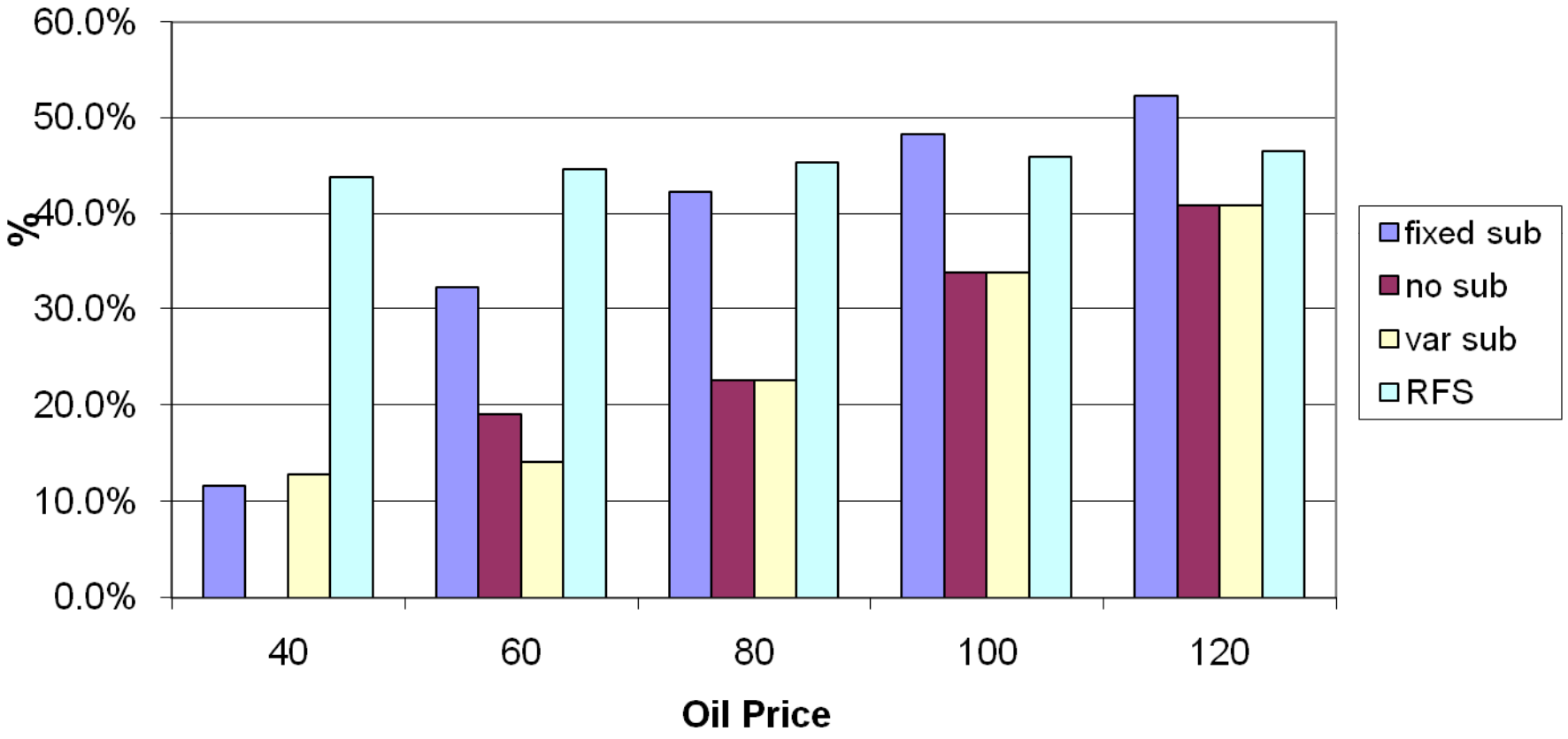
Corn Production

no demand shock



Fraction of Corn for Ethanol

no demand shock



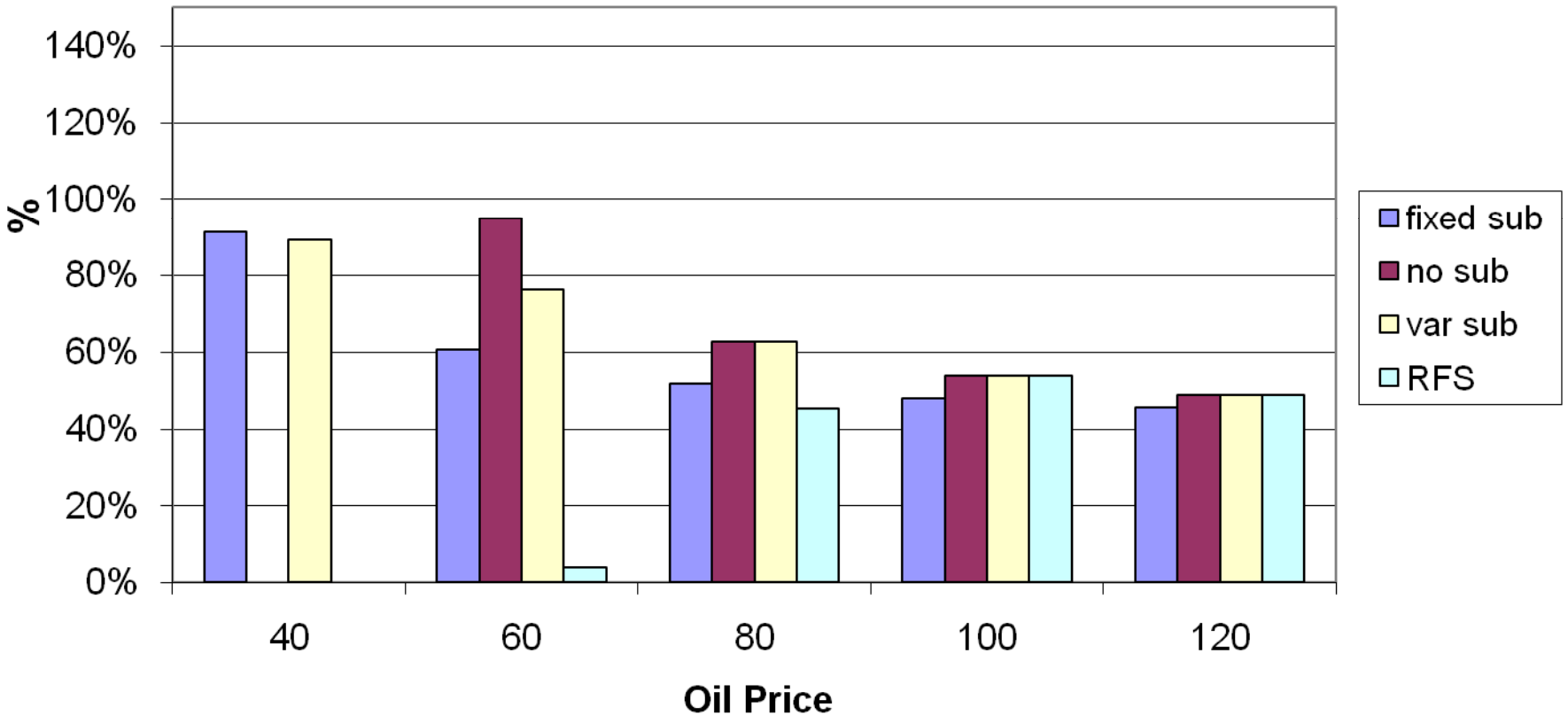
Sensitivity to 30% Corn Yield Increase

(compared with the base cases)

- Ethanol production up substantially
- Corn price down 15-39% depending on the case
- Corn production up 7-22% depending on the case
- Larger share of corn used for ethanol in all cases except RFS at lower oil prices
- Sensitivity results conform to expectations – yield increase means lower corn price, more corn produced, more profitable ethanol, and more ethanol production

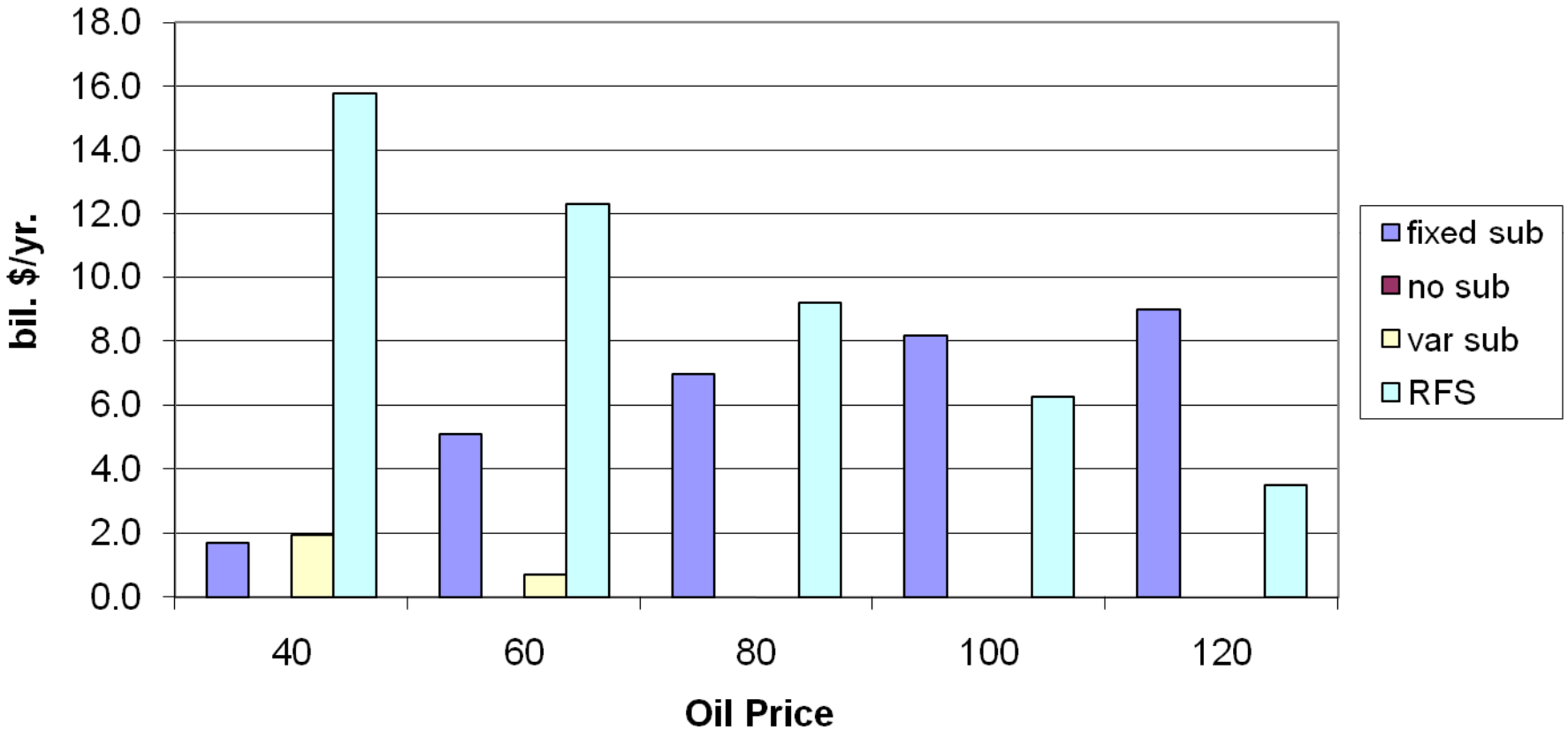
% Change in Ethanol Production with 30% Corn Yield Increase

10% demand shock



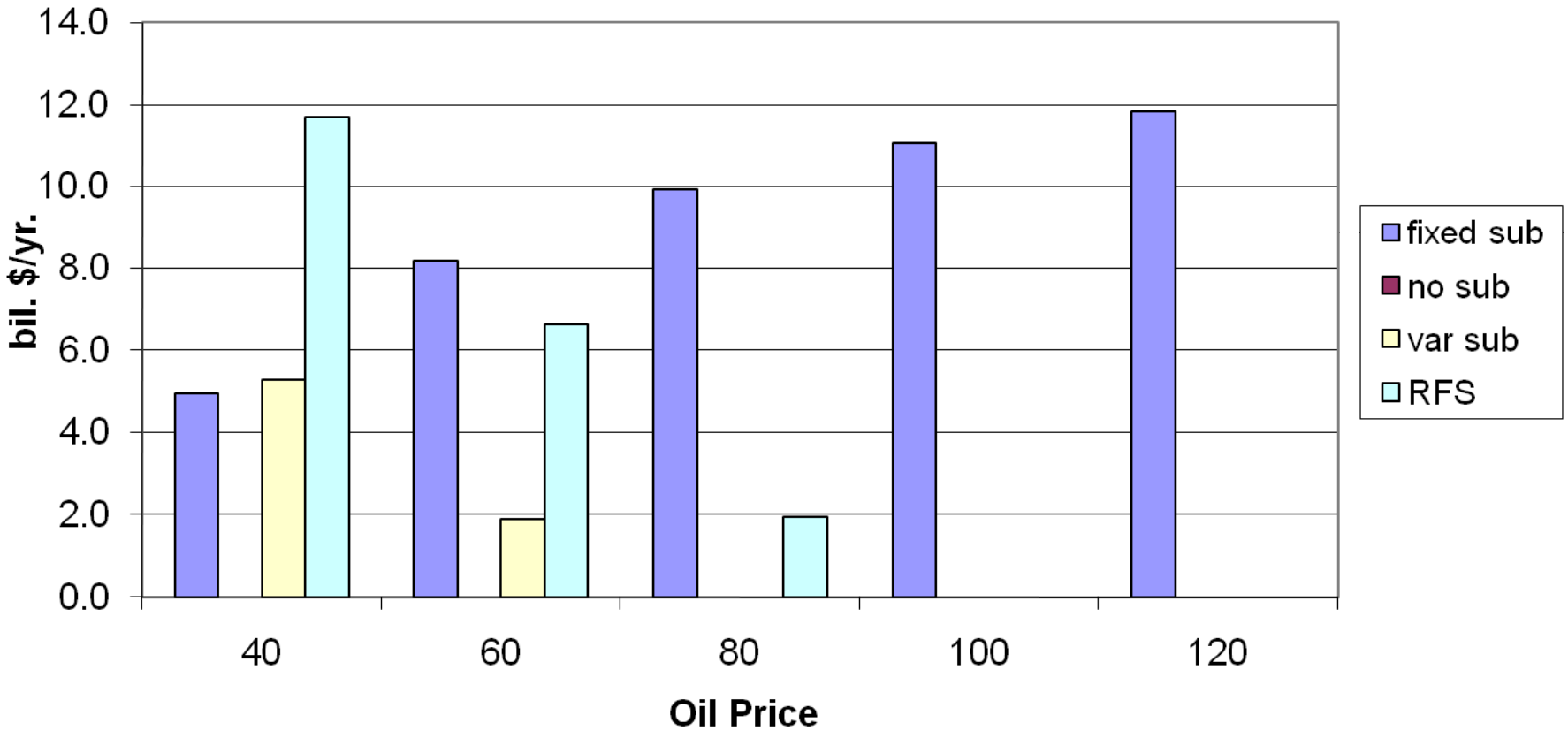
Policy Costs

no demand shock



Policy Costs

10% demand shock



Conclusions

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- Model results clearly illustrate the linkage between crude oil prices and corn prices and therefore with most agricultural commodities
- There are substantial differences among the policy alternatives evaluated. Fixed subsidy cost is on the government budget. RFS cost is paid directly by consumers. Variable subsidy cost is very low.
- These model results are consistent with the firm level results from our earlier work

Biofuels in a CGE Framework

Biofuels in GTAP Database

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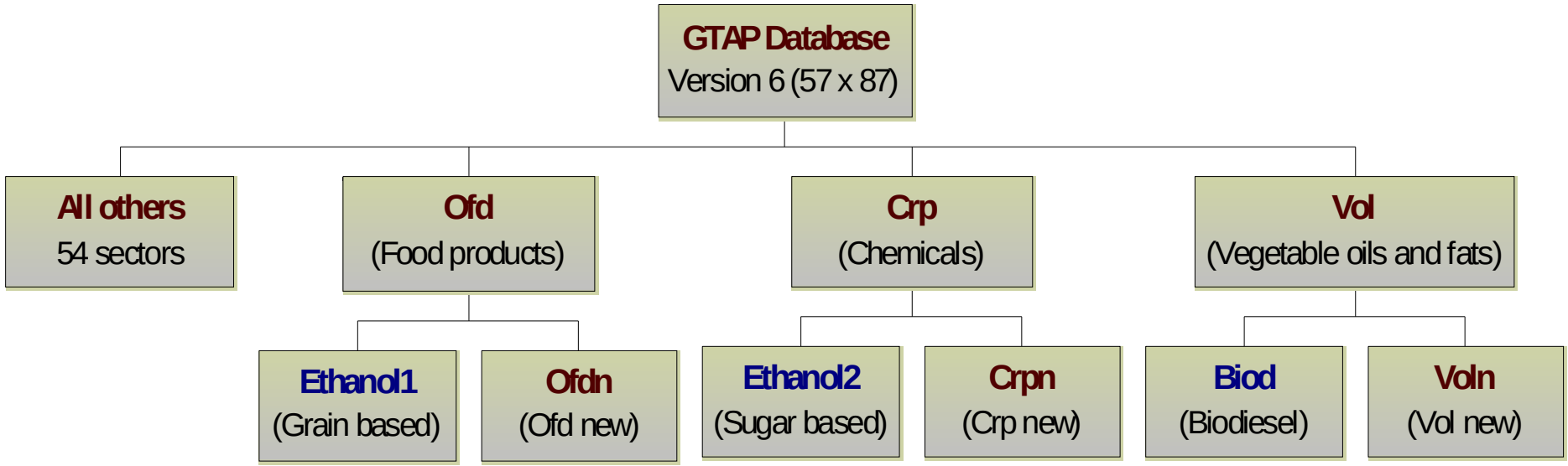
Splitting the three types of Biofuels:



GTAP Database with Biofuels
(60 sectors x 87 regions)

*For details please refer to Taheripour et al., (2007)

Global Distribution of AEZs

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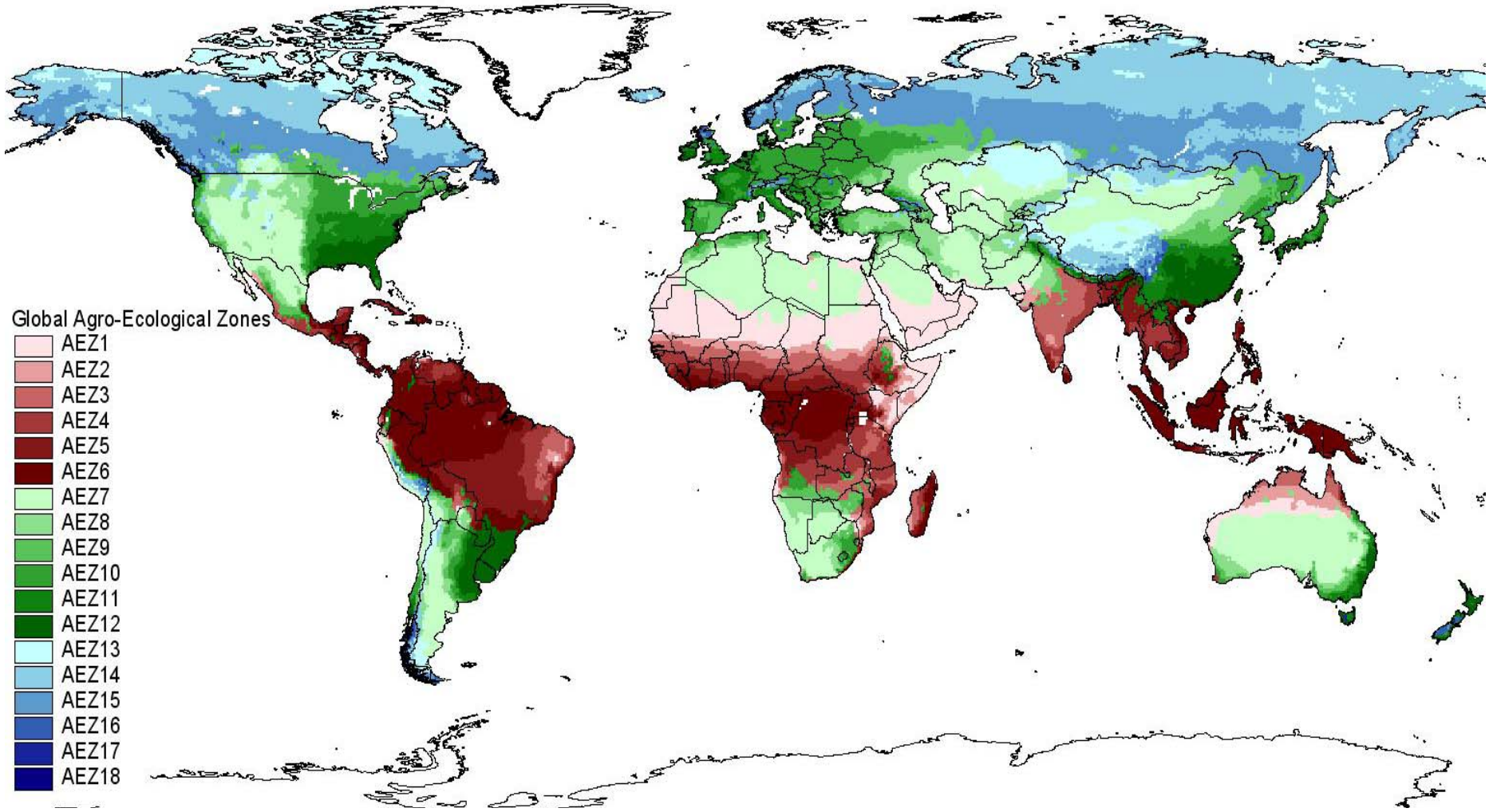

(Lee, Hertel, Sohngen, and Ramankutty, 2005)

An Illustrative Scenario

EU/US Biofuel Mandates: 2006 – 2010

Focus of this study

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- EU and US have set mandates for biofuels for 2010, which require substantial increase in share of feedstock used for biofuels
- This large scale increase in biofuels production could have profound implications on global agricultural output, land use, and international trade
- We explore these linkages between biofuels production and agricultural markets in 2010, focusing mainly on US, EU, and Brazil.

Biofuel Mandates in the US and EU

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	US		EU	
	(million gallons)		*(million gallons)*	
2006	Ethanol	Biodiesel	Ethanol	Biodiesel
Current Production	4855	385	420	1467
Share in Biofuels Market	92.7%	7.4%	22.3%	77.7%
Current Production Capacity	6843	541	752	1821
2010				
Total Biofuels – Mandates for 2010	13429		7200	
Mandates - keeping the composition same as in 2006	13429	-	1604	5596
% Ch 2006-2010	176.6		281.4	281.4

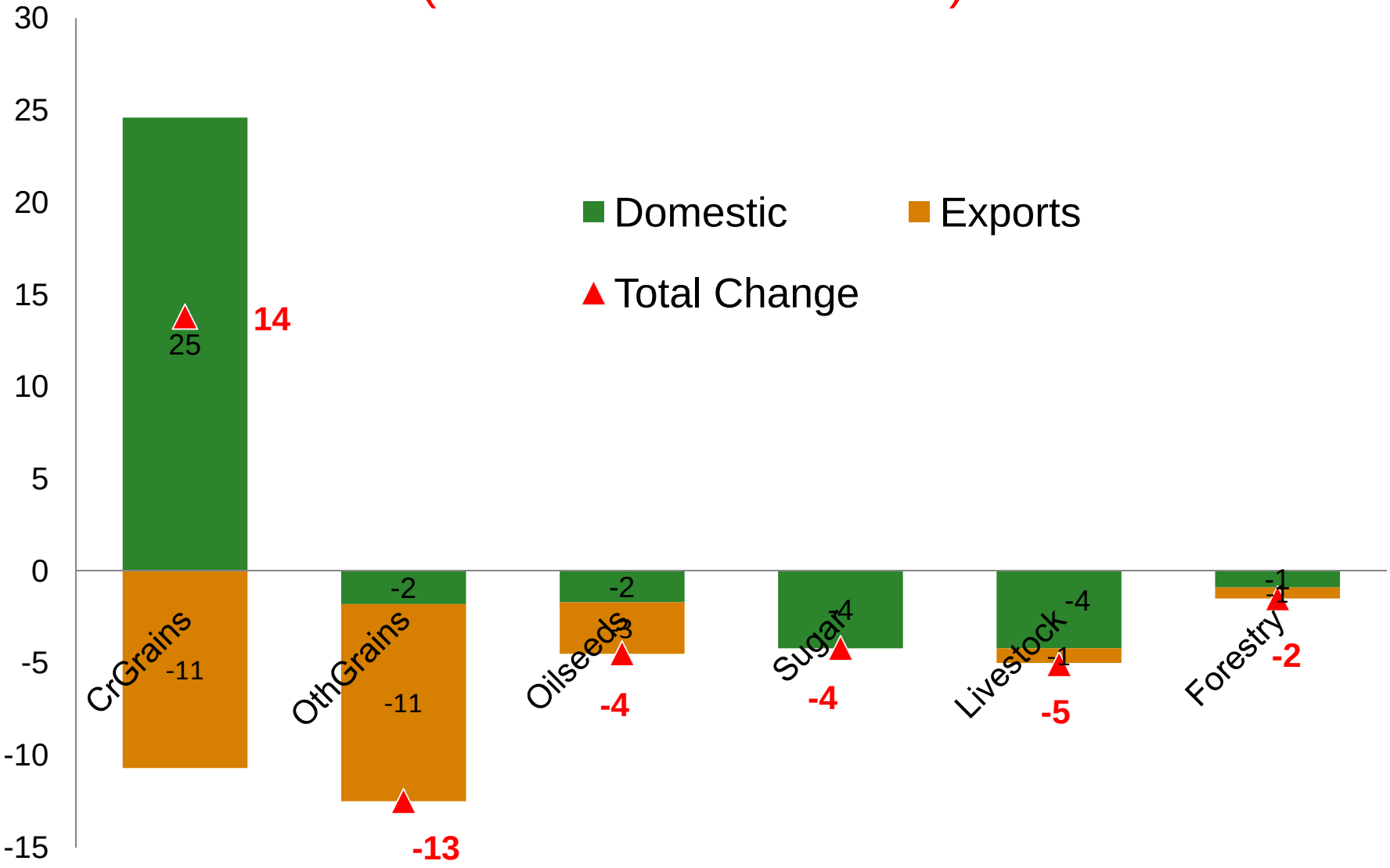
Study Approach: Experimental Design

- From the initial data base which pertains to year 2001, we perform historic simulation to project the biofuel economy in 2006.
  - Increasing petroleum prices
  - Replacing MTBE with ethanol in gasoline additives
  - Adjusting AVE of ethanol subsidy
- We start from this hypothetical 2006 baseline and shock ethanol output by 177% in the US and biofuels output by 281% in the EU, to generate the 2010 biofuels scenario

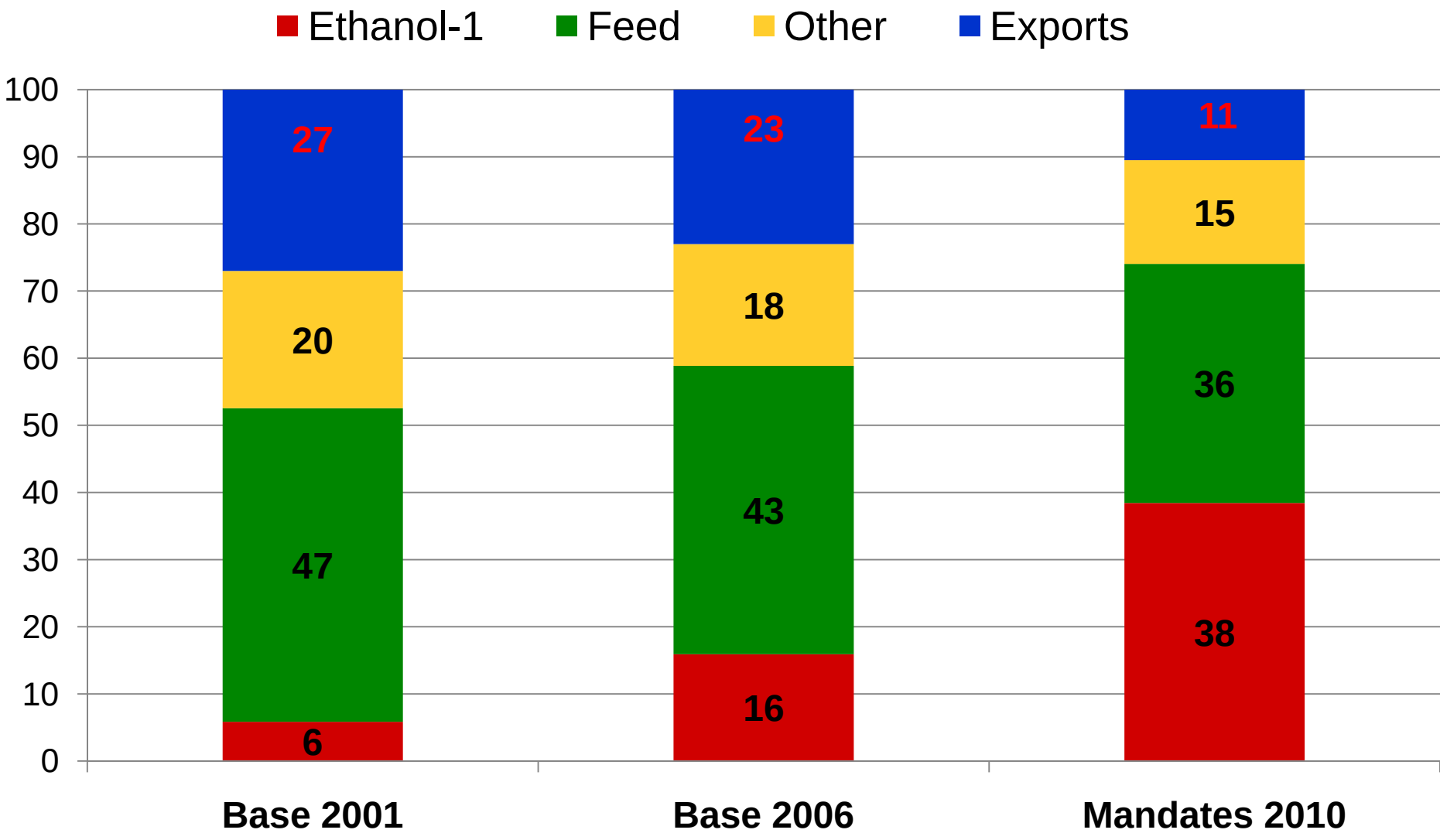
Implications of EU/US Biofuel Mandates: 2006 – 2010

Change in US Supply: Contributions of domestic and exports as % of total output

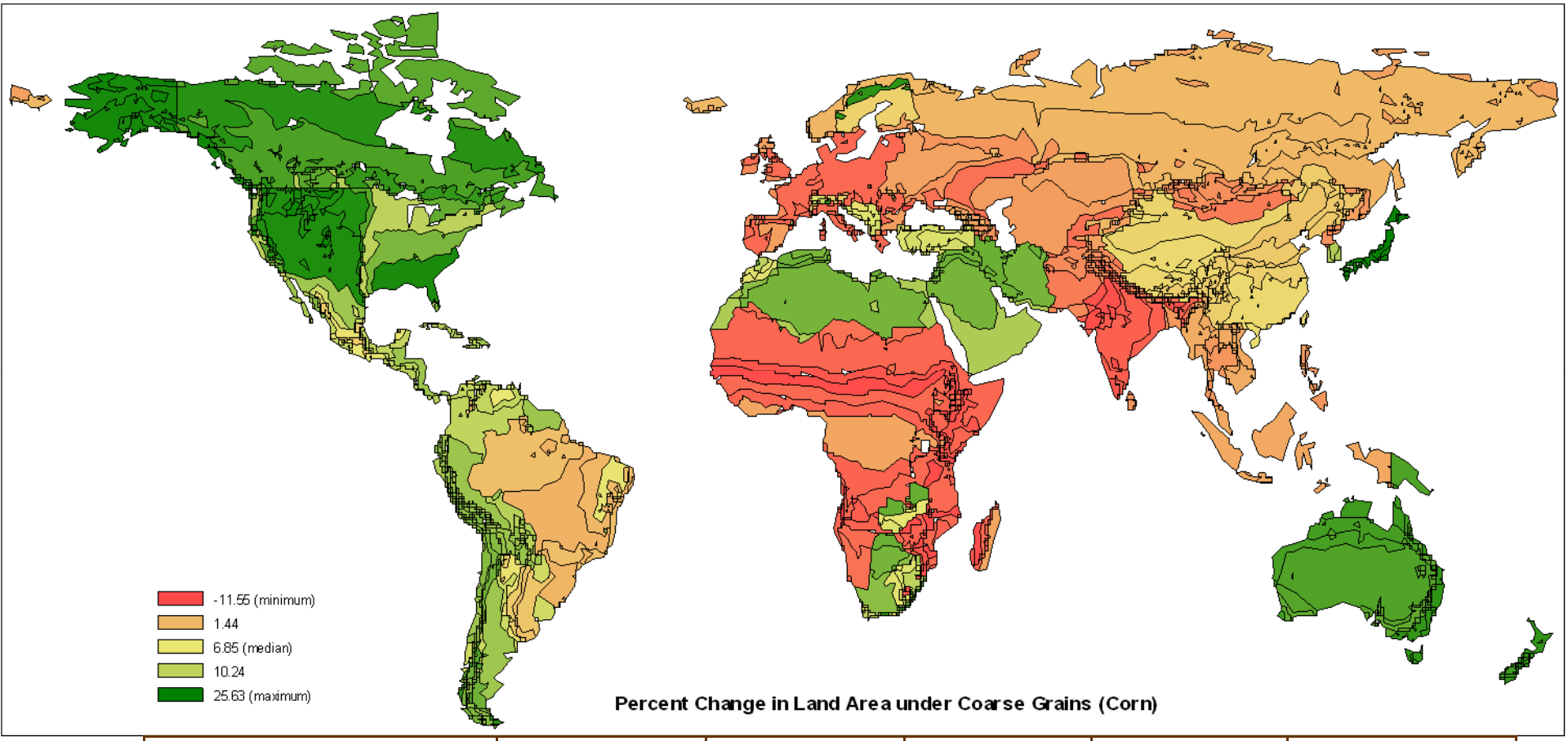
(2006 – 2010 mandates)



Disposition of Coarse grains in US (%)

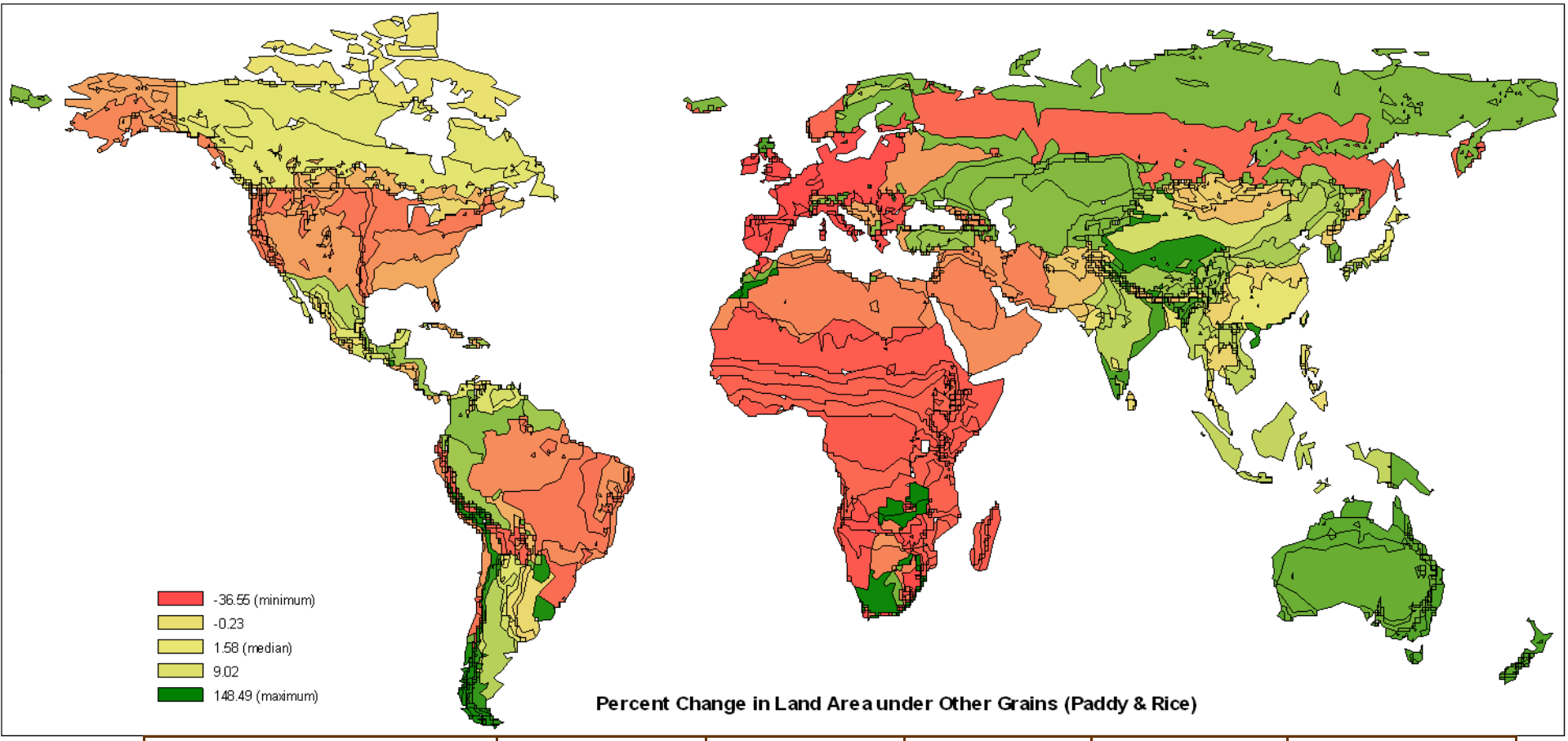


Change in Land Area under Coarse Grains



Coarse Grains	USA	Canada	EU	Brazil	All Others
Aggregated Land use change (%)	11.2	11.7	0.5	3.7	4.7

Change in Land Area under Paddy & Wheat



Paddy & Wheat	USA	Canada	EU	Brazil	All Others
Aggregated Land use change (%)	-13.5	-2.4	-12.9	-7.8	0.1

Change in Output in the EU (%)

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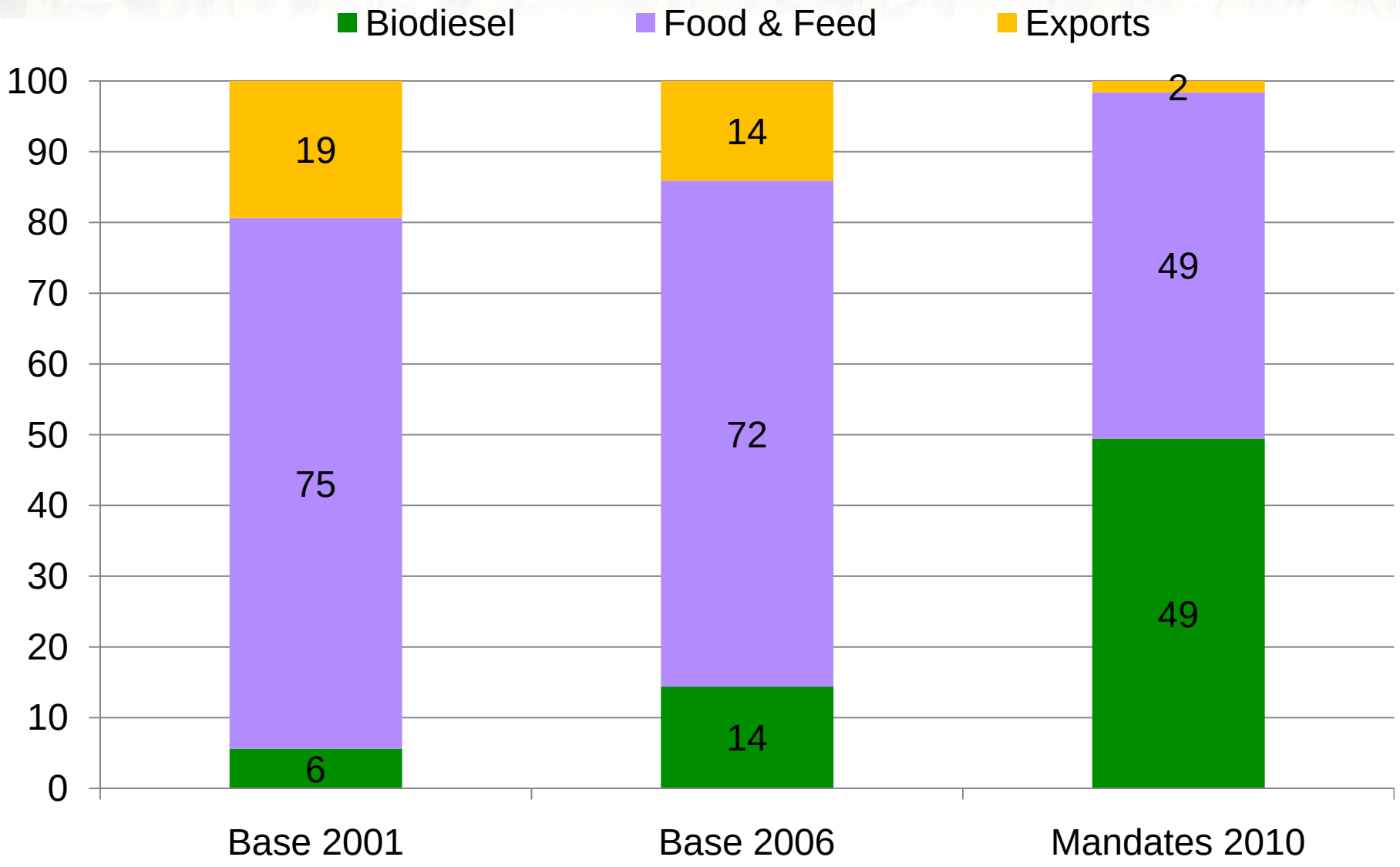
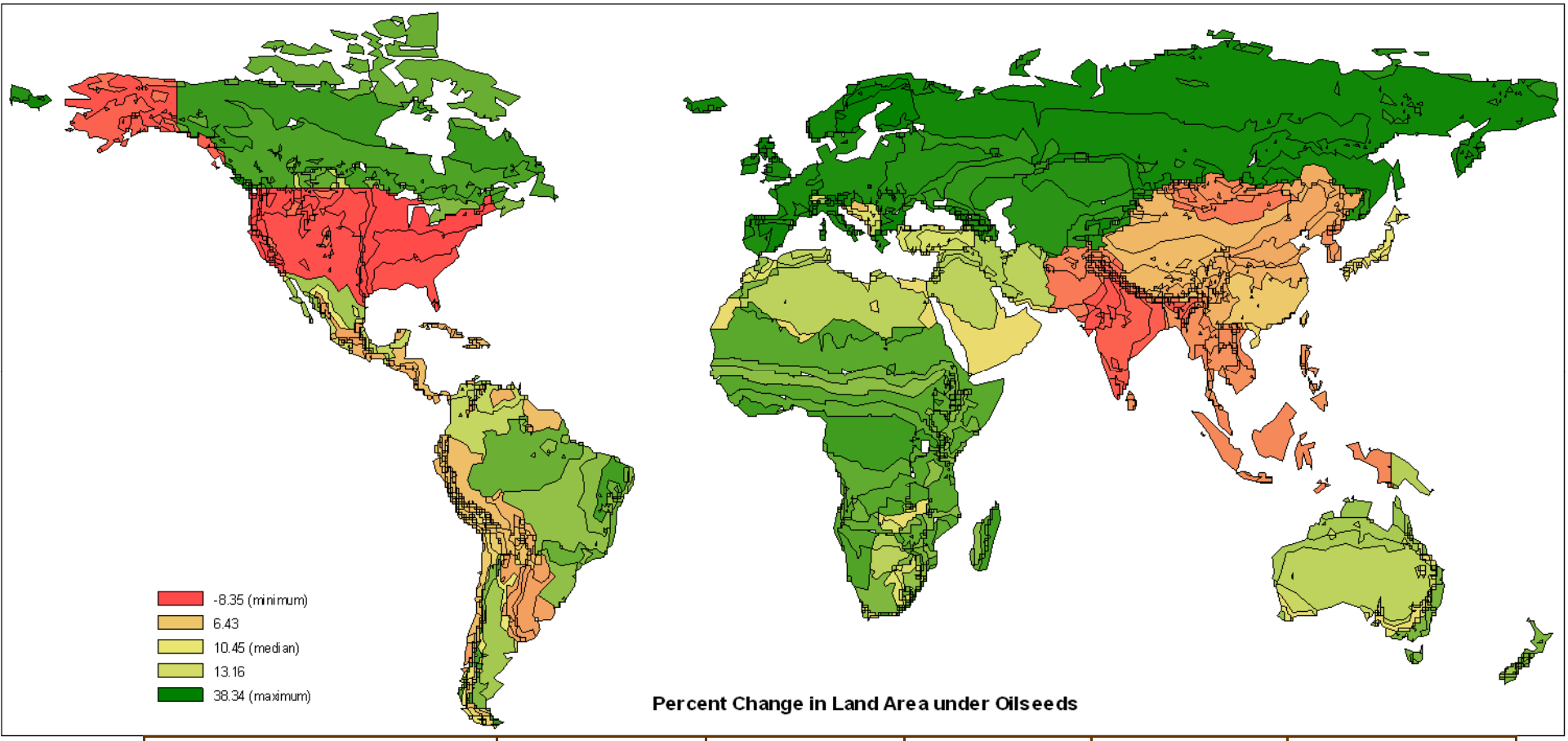
Disposition of Oilseeds in the EU(%)

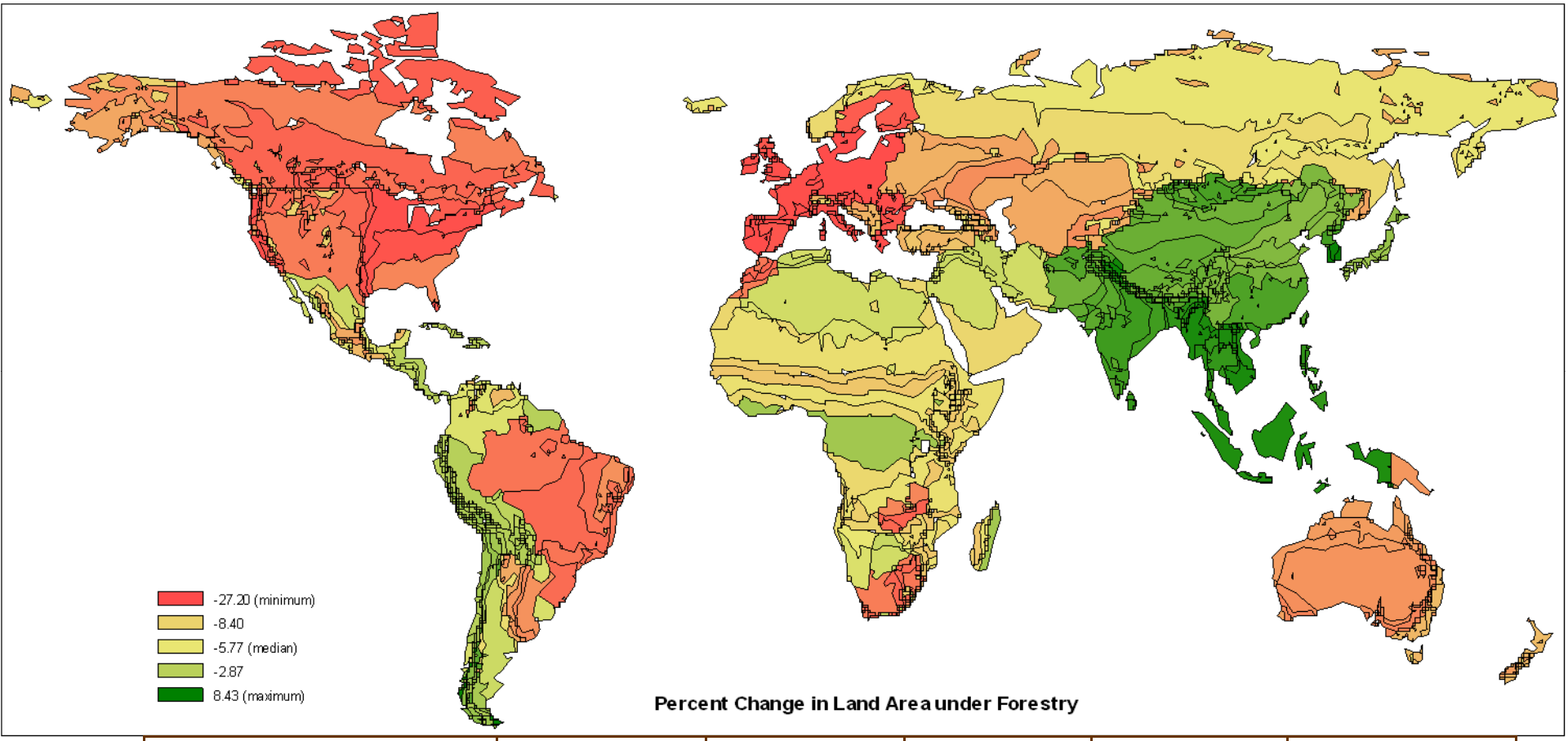


Change in Land Area under Oilseeds



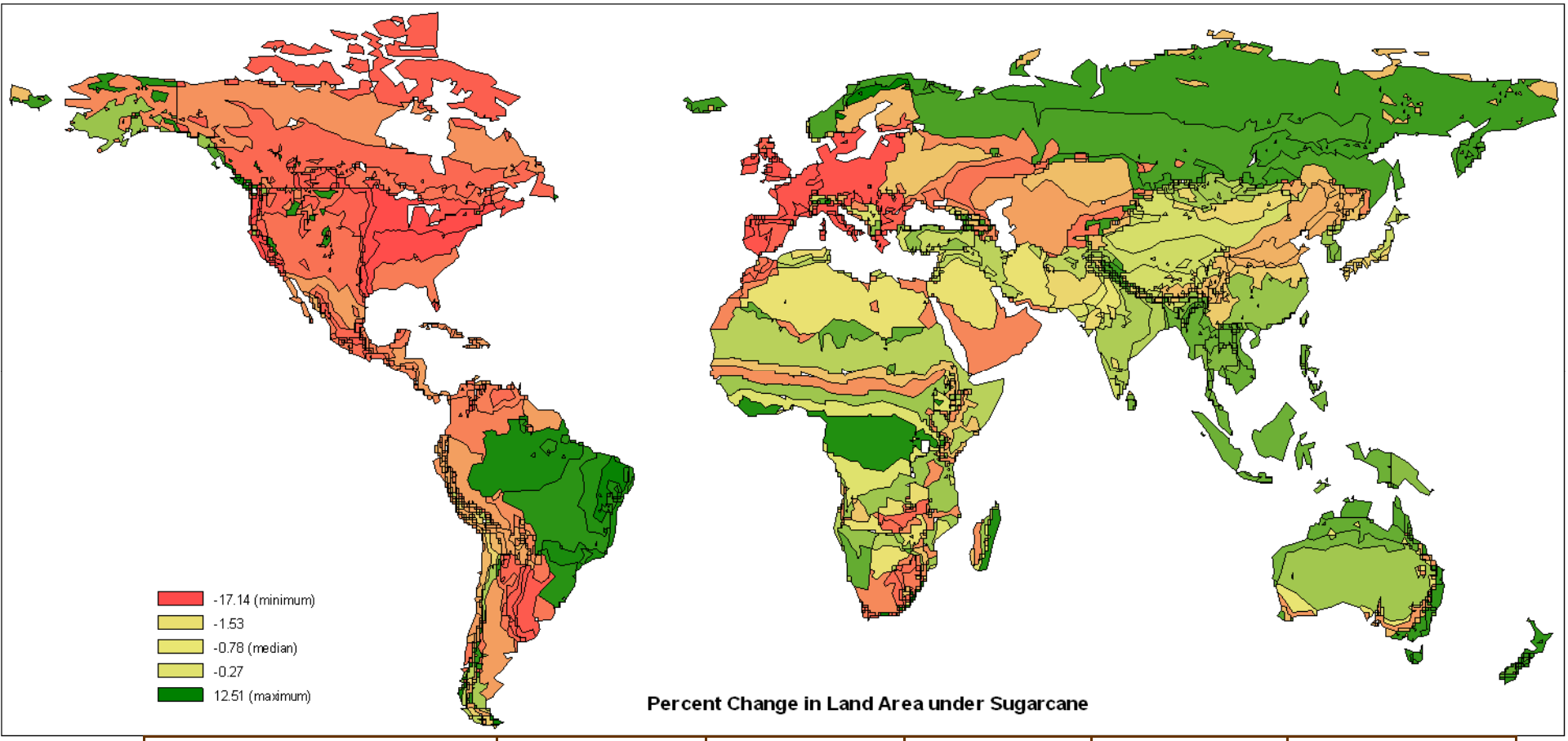
Oilseeds	USA	Canada	EU	Brazil	All Others
Aggregated Land use change (%)	-6.2	13.9	21.4	12.4	5.4

Change in Land Area under Forestry



Forestry	USA	Canada	EU	Brazil	All Others
Aggregated Land use change (%)	-11.6	-11.1	-16.1	-11.1	-4.3

Change in Land Area under Sugar



Sugar	USA	Canada	EU	Brazil	All Others
Aggregated Land use change (%)	-5.8	-3.5	-6.1	1.7	-0.9

Change in Output in Brazil (%)

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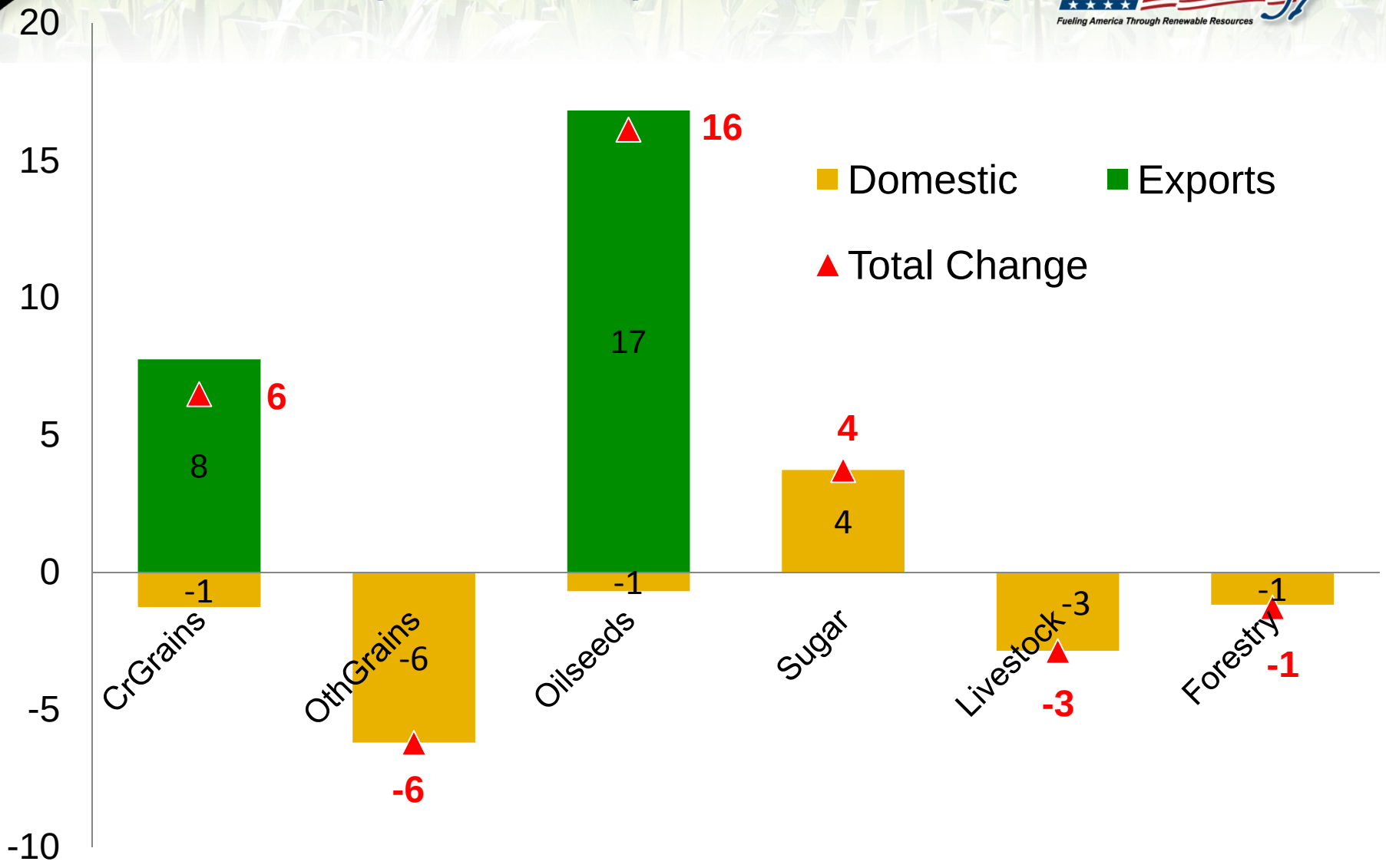
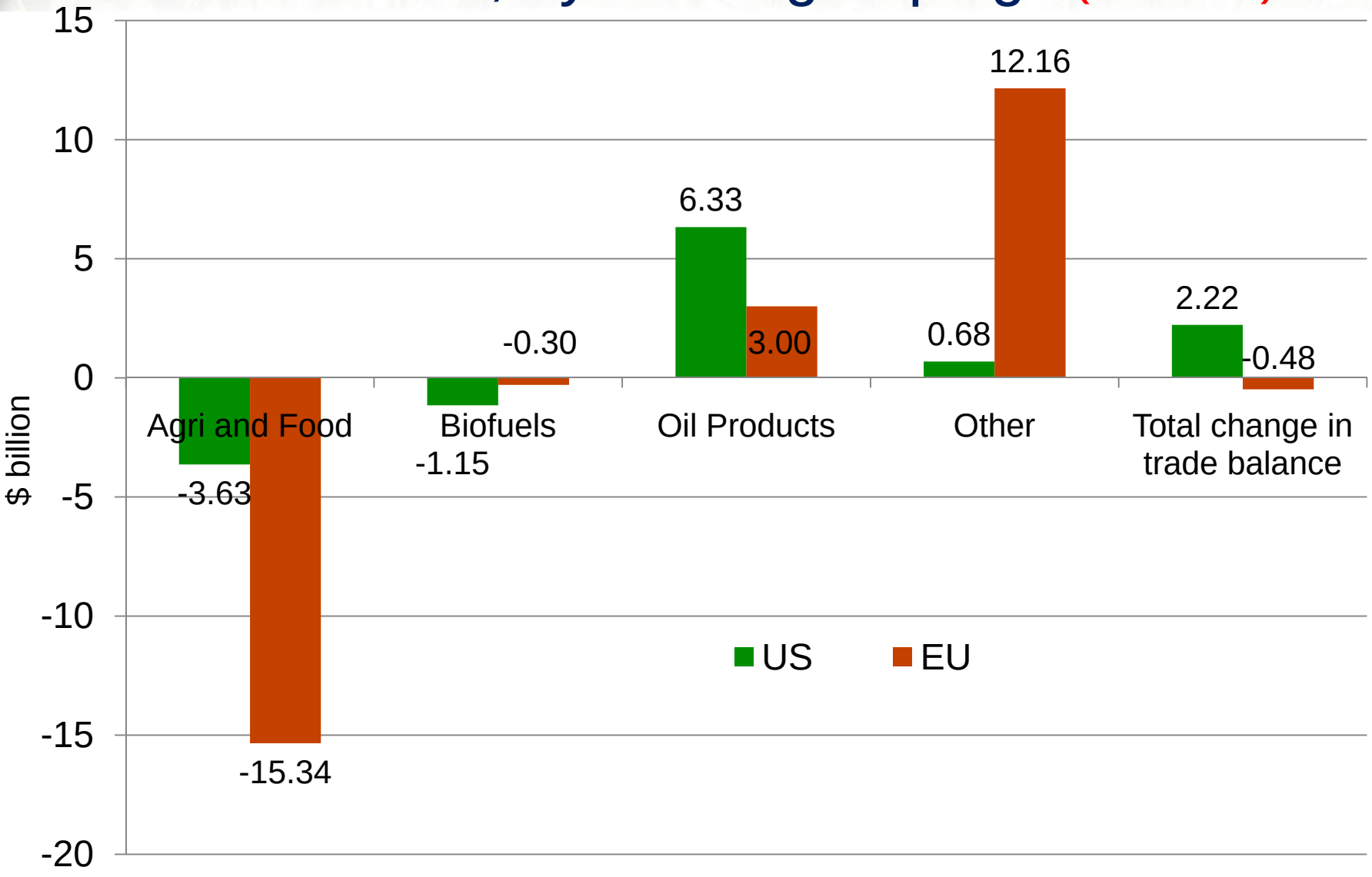


Change in Trade Balance due to Mandates: US and EU, by broad groupings ($ billion)



Qualifications

- Have not taken account of ethanol by-products; so overstate impact on livestock feed costs
- Need improved estimation of substitution between biofuels and petroleum – and extend detailed analysis beyond the US (e.g., distinguishing additive demand from energy substitution) to other regions
- We have not yet captured the link from EU biodiesel to palm oil production. As a result, we understate the impact on Southeast Asia and overstate impacts on oilseed production and prices.
- Need better treatment of non-US biofuel subsidies

Impact on EU, US

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- US mandate feasible; EU mandate very ambitious
- Strong expansion of ethanol in the US leads to a 14% increase in corn production, ethanol industry uses 38% of output (2010), 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 26% from 2006-2010, with shortage met by increased imports of oilseeds: EU imports rise by $4 billion
- By-products from ethanol and biodiesel production: What will be the impact of massive increases in soymeal and DDGS available for livestock feed?

Impact on Trade Balances

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- Biofuels programs have a substantial impact on the global pattern of trade – for agriculture, energy, and manufactured goods
- US trade balance for petroleum products improves by $6 billion. This is partly offset by deterioration in the food and agriculture trade balance
- EU agricultural trade balance deteriorates by much more; this is offset by an increase in net exports of manufactures and services
- Falling oil prices and rising agricultural prices generate substantial terms of trade gain for the US

Land Use Changes and GHG Emissions

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- It is becoming clearer that understanding land use changes are absolutely critical to getting the story right with respect to GHG changes
- GHG emission reductions claimed for biofuels can be substantially reduced or eliminated depending on how we handle and estimate the impacts of land use changes.

Thanks very much!

Questions and Comments

For more information:

http://www.ces.purdue.edu/bioenergy

http://www.agecon.purdue.edu/papers/

http://www.gtap.agecon.purdue.edu/