INTERNATIONAL FOOD

Land Use Change and European Biofuel Policies

David Laborde Debucquet -
d.laborde@cgiar.org

September 2012

The views expressed by the author are not those of IFPRI or the European Commission

INTRODUCTION

Why Biofuels?

- Energy policy?
  - Energy “Security”
  - Energy prices
  - Current account concerns
- Farm policy?
  - A silver bullet vs the WTO discipline
- An environmental policy?
  - Road transportation produces emissions…

If the latter, then Land Use Changes **matter**!

The Burden of Proof?

- Should we prove that iLUC effects exist or that does not exist?
- Working in a Farm or Working in Brussels teach you two things: Level of agricultural production is tied to the amount of land
- Increased demand of agricultural commodities HAS land use effects
- The debate should be about their magnitude, not their existence

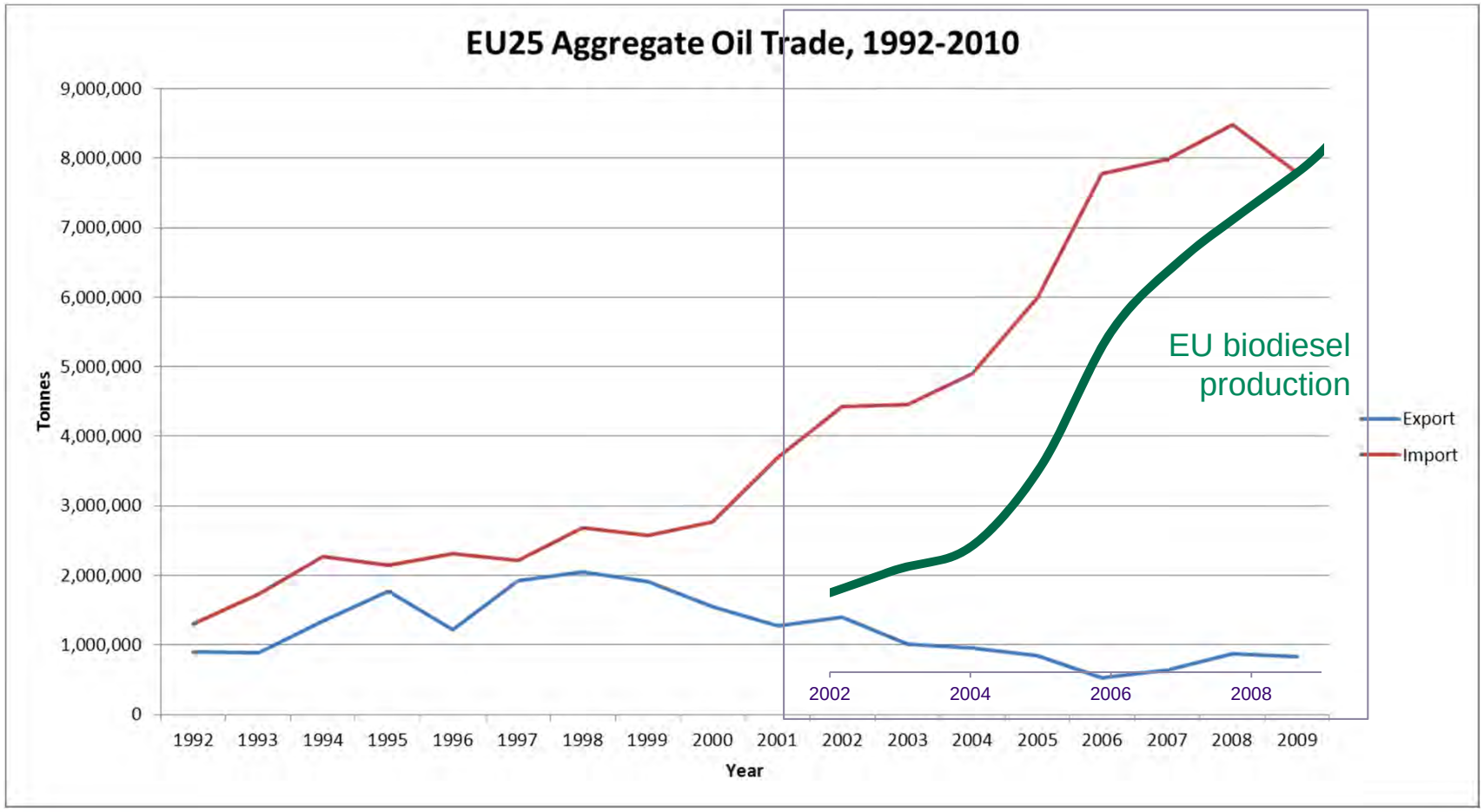
Preamble: iLUC or LUC

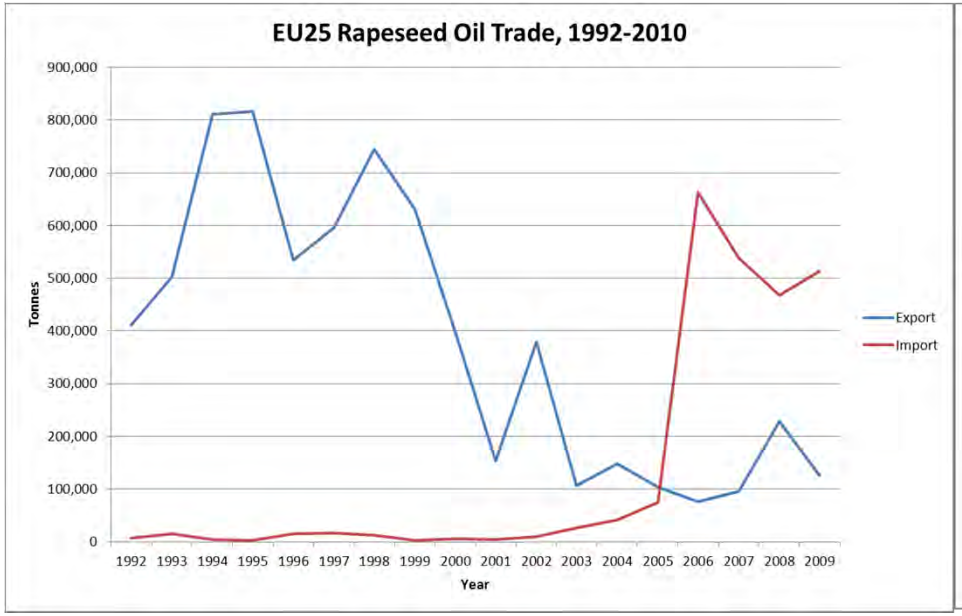
- An important and sensitive “policy” issue
- An issue that most models will never address: the spatial dimension
- Few empirical evidences about the relevance of the discrimination
- What matters is the net effects

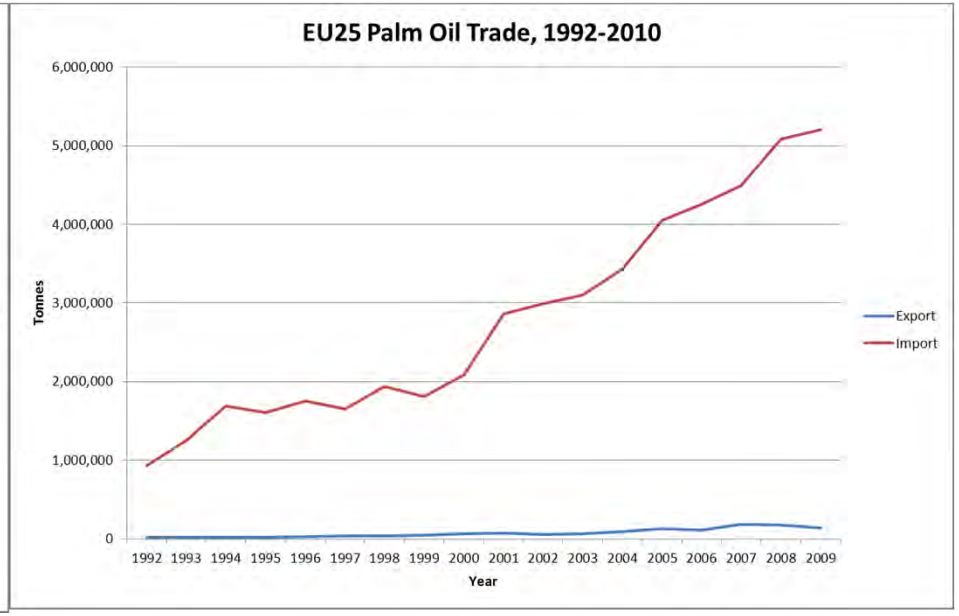
EU BIODIESEL [84% OF EU MARKET] AND THE VEGETABLE OIL MARKETS: SOME FACTS

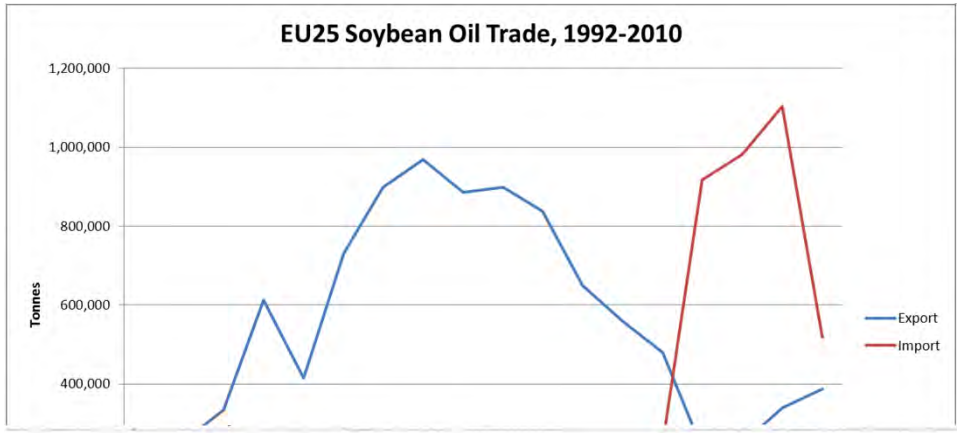
To put in perspective the modeling exercise, the complexity of the world and why LUC is important and why international trade is the key

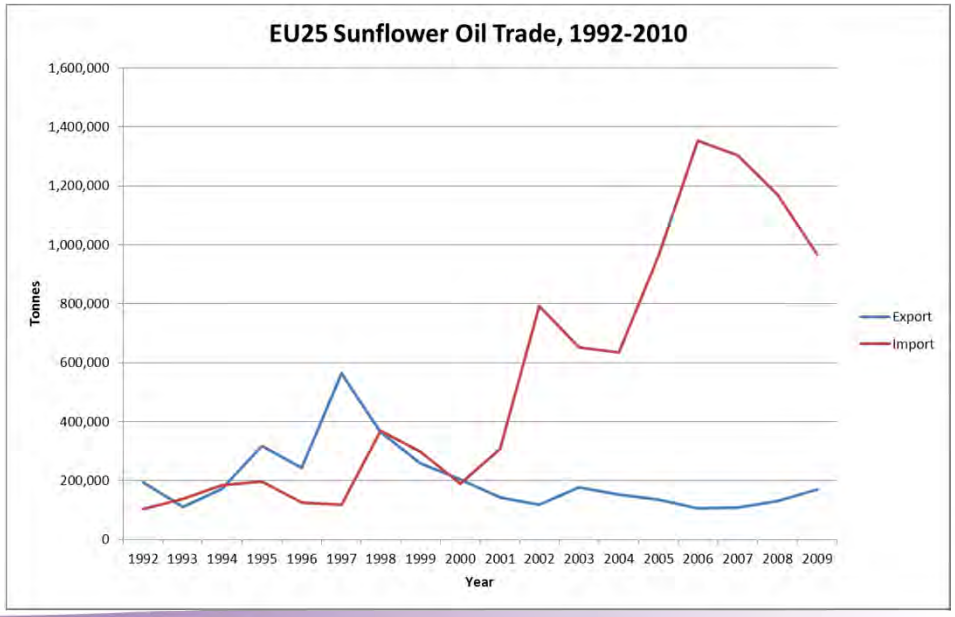
EU Total Veg Oil trade



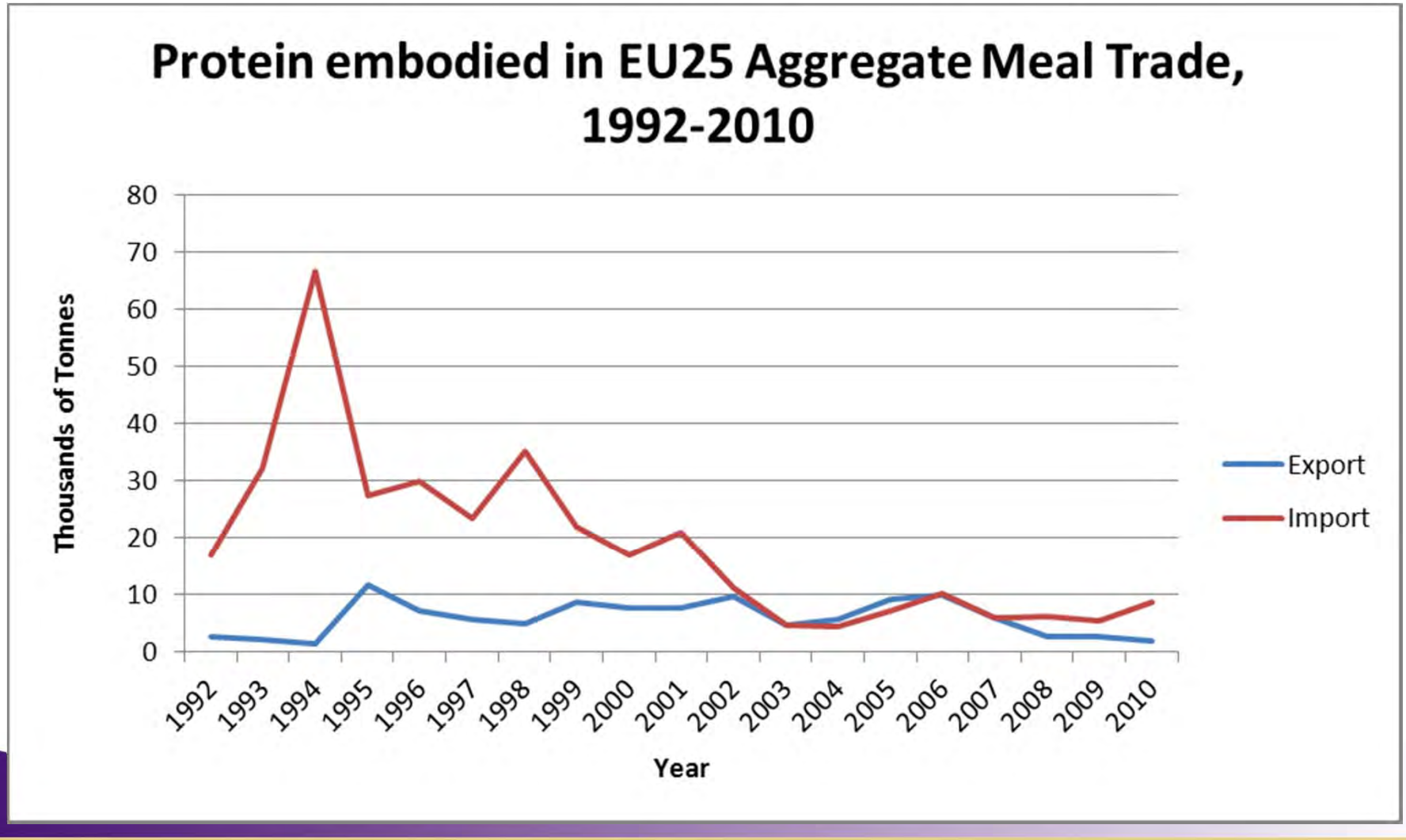

EU25 Rapeseed Oil Trade, 1992-2010
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Tonnes
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Year
Export
Import


EU25 Palm Oil Trade, 1992-2010
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Tonnes
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Year
Export
Import

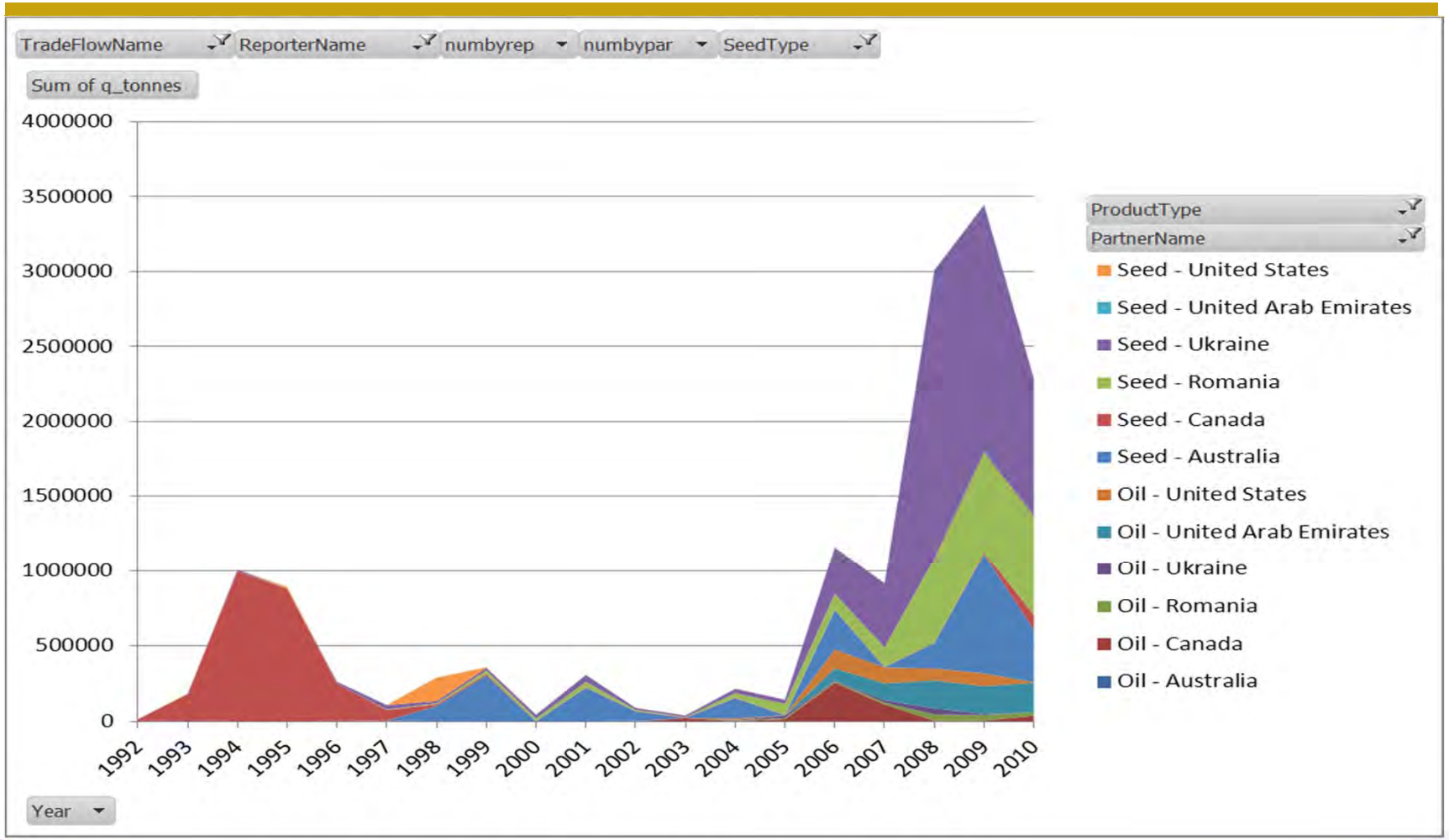

EU25 Soybean Oil Trade, 1992-2010
1,200,000
1,000,000
800,000
600,000
400,000
Tonnes
Export
Import


EU25 Sunflower Oil Trade, 1992-2010
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Tonnes
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Year
Export
Import

EU Meal trade



EU Suppliers of Rapeseed: **Seed** and Oil



A CGE MODEL: MIRAGE-BIOF

The MIRAGE-BIOF

- The MIRAGE model has started to be developed in 2001 in CEPII, Paris. Focusing on EU Integration and Trade Policy analysis of the beginning
- Now used by several institutions around the World, numerous versions (trade policy focused, FDI, Services, Climate Change etc.)
- Biofuels assessment started in 2008
- On land use:
  - First study for the DG Trade in 2009 (limited to ethanol)
  - Second study for DG Trade in 2010 (part of the public consultation)
  - This new study for: DG Trade in 2011
- But other applications: mandates of other countries, comparison of “traditional” ag policies and biofuels etc., food prices and price stability consequences

Modeling Biofuels in MIRAGE

- MIRAGE model
  - Multi country, Multi sectoral, and global
  - Recursive dynamic set-up
- Modified model and data components
  - Improvement in demand system (food and energy)
  - Improved sector disaggregation
  - New modeling of ethanol sectors
  - Co-products of ethanols and vegetable oils
  - New modeling of fertilizers
  - New modeling of livestocks (extensification/intensification)
  - Land market and land extensions at the AEZ level

Sectoral Disaggregation (43)

Sector	Description	Sector	Description	Sector	Description
Rice	Rice	**SoybnOil**	Soy Oil	**EthanolW**	Ethanol - Wheat
Wheat	Wheat	**SunOil**	Sunflower Oil	**Biodiesel**	Biodiesel
Maize	Maize	**OthFood**	Other Food sectors	**Manuf**	Other Manufacturing activities
PalmFruit	Palm Fruit	**MeatDairy**	Meat and Dairy products	**WoodPaper**	Wood and Paper
Rapeseed	Rapeseed	**Sugar**	Sugar	**Fuel**	Fuel
Soybeans	Soybeans	**Forestry**	Forestry	**PetrNoFuel**	Petroleum products, except fuel
Sunflower	Sunflower	**Fishing**	Fishing	**Fertiliz**	Fertilizers
OthOilSds	Other oilseeds	**Coal**	Coal	**ElecGas**	Electricity and Gas
VegFruits	Vegetable & Fruits	**Oil**	Oil	**Construction**	Construction
OthCrop	Other crops	**Gas**	Gas	**PrivServ**	Private services
Sugar_cb	Sugar beet or cane	**OthMin**	Other minerals	**RoadTrans**	Road Transportation
Cattle	Cattle	**Ethanol**	Ethanol - Main sector	**AirSeaTran**	Air & Sea transportation
OthAnim	Other animals (inc. hogs and poultry)	**EthanolC**	Ethanol - Sugar Cane	**PubServ**	Public services
PalmOil	Palm Oil	**EthanolB**	Ethanol - Sugar Beet		
RpSdOil	Rapeseed Oil	**EthanolM**	Ethanol - Maize		

Modifications in Modelling for this new report

- Dynamic baseline and food demand
  - Dynamic recalibration to maintain price elasticity in the CES LES. Standard of living evolution
- Co-products substitution: one level
  - Two type of effects:
    - Displacement of other crops
    - Intensification
- Modification of central values for elasticities
- Marginal shock simulations
  - From a marginal 1 to 60 Mios GJ
  - But still, concept to manipulation with precaution:
    - Substitution effects vs expansion effects
- Peat emissions and Indonesia land availability

SIMULATION DESIGN

Baseline

- Sugar reform (still a source of numerical problems)
- End of the Land Set Aside
- EU trade measures vs US Biodiesel
- No change in trade policy for Ethanol
- Some restrictions on Brazilian exports to the US in the baseline:
  - Partially capture the change in the real exchange rate real/USD
  - Avoid too much confusion between corn and sugar cane ethanol for the central scenario
- Stronger Brazilian domestic consumption: but still large export supply response
- Modification of initial profitability in Argentina
- New yield changes: Aglink Cosimo
  - VERY IMPORTANT EFFECTS but no SENSITIVITY ANALYSIS on this assumption
  - ISSUE ON EU WHEAT → New Members catch up

Scenarios

- Biofuel mandate:
  - Member states Action Plan

- Trade policy options:
  - Status Quo
  - Full Liberalization in the EU of Ethanol and Biodiesel

Sensitivity Analysis

- On linearity/non linearity issue
  - Estimation of crop LUC at a “half mandate”, at a full mandate
    - But still weak on Ethanol: no saturation effects
- On food consumption
  - Endogenous vs Fixed to Baseline level
- On Co-products: with or without
- Monte Carlo simulations on selected parameters
- But in reality, much more uncertainties (see **Box 2**, 25 items related to LUC, but even more regarding net emissions…)
  - About the land (amount, location, carbon values)
  - About future technologies
  - Both behavioral and technical uncertainties

Monte Carlo Simulations

- 1000 runs = 240 days of computations time
- Some restrictions for the model version
  - Iterative process during the earlier stage
  - Any modification of the model or data has to be done of the core version and for the sensitivity analysis
- Log Uniform distribution
  - Wide uncertainty
  - We focus mainly on elasticities
  - We do not have distribution estimates

RESULTS

Scenario Design
(Table 3) EU consumption pattern by feedstock. Percent

	Palm Oil	Rapeseed	Soya	Sun-flower	All Biodiesel	Maize	Sugar Beet	Sugar Cane	Wheat	All Ethanol
Structure of consumption in 2008 – Total =11.7 MTOE										
Baseline	4	57	20	2	**83**	3	3	5	5	**17**
Structure of consumption in 2020 – Total =27.2 MTOE										
Baseline	11	60	10	3	**83**	3	3	7	4	**17**
No Trade liberalization	17	41	11	4	**72**	4	5	13	6	**28**
Full Trade Liberalization	17	41	11	4	**72**	1	1	25	1	**28**
Additional Mandate Composition					**+10 Mtoe**					**+5Mtoe**
No Trade liberalization	22	26	12	5	**65**	4	6	18	7	**35**
Full Trade Liberalization	22	26	12	5	**65**	-1	-1	38	-1	**35**

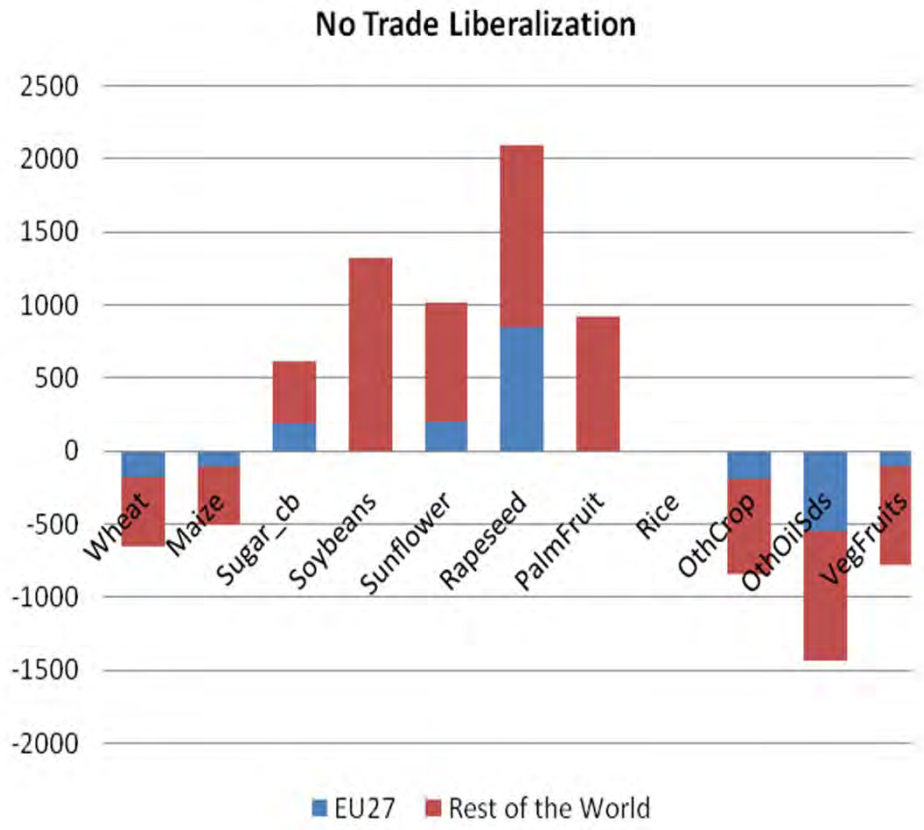
(Table 5) EU biofuel production in 2020 by feedstock. Energy content. Percent.

	Baseline	No Trade Liberalization	Trade Liberalization
Biodiesel	**79.29**	**69.25**	**92.54**
PalmFruit	7.55	12.87	16.96
Rapeseed	62.04	44.37	59.58
Soybeans	6.52	7.45	9.90
Sunflower	3.17	4.56	6.09
Ethanol	**20.71**	**30.75**	**7.46**
Maize	5.83	7.59	2.16
Sugar_cb	6.53	10.96	2.17
Wheat	8.35	12.20	3.12

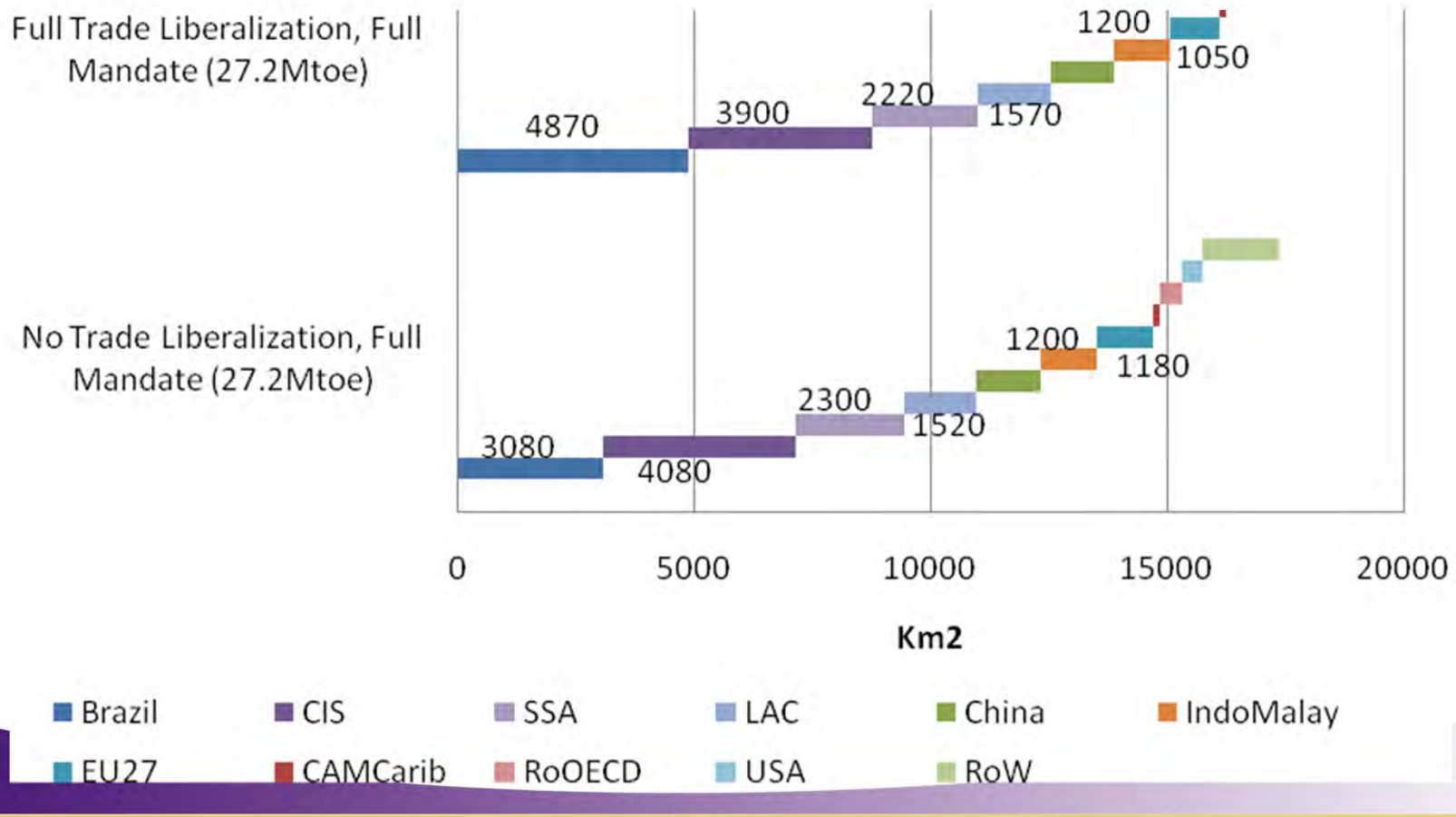
(Table 6) Commodity balance sheet - World - Full mandate - No trade liberalization. 1000 tons

	Biofuel demand	Additional Supply	Total Demand displacement	Livestock demand displacement	Ratio Additional Supply / Biofuel demand	Share of livestock demand displacement in total demand displacement
Wheat	5,366.6	-1,595.9	-6,962.5	-6,326.6	**-30**	90.9
Maize	4,353.0	-2,986.3	-7,339.3	-6,471.7	**-69**	88.2
Sugar Cane & Beet	76,616	69,574	-7,042	-6.6	**91**	0.1
Soybeans		4,677.6	4,677.6*	-1,889.9		-40.4
Sunflower		2,676.0	2,676.0*	-344.2		-12.9
Rapeseed		7,135.4	7,135.4*	-544.2		-7.6
PalmFruit		22,207.0	22,207.0*	-208		-0.9
Rice		-101.9	-101.9	418.1		-410.4
OthCrop		-765.9	-765.9	-363.4		47.5
OthOilSds		-395.4	-395.4	-322.4		81.5
VegFruits		-3,372.2	-3,372.2	25.6		-0.8
OilPalm	3,850.6	5,342.0	1,491.4		**139**	0.0
OilRape	4,456.9	2,474.4	-1,982.5		**56**	0.0
OilSoyb	2,063.5	1,270.8	-792.8		**62**	0.0
OilSunf	933.3	1,172.4	239.1		**126**	0.0

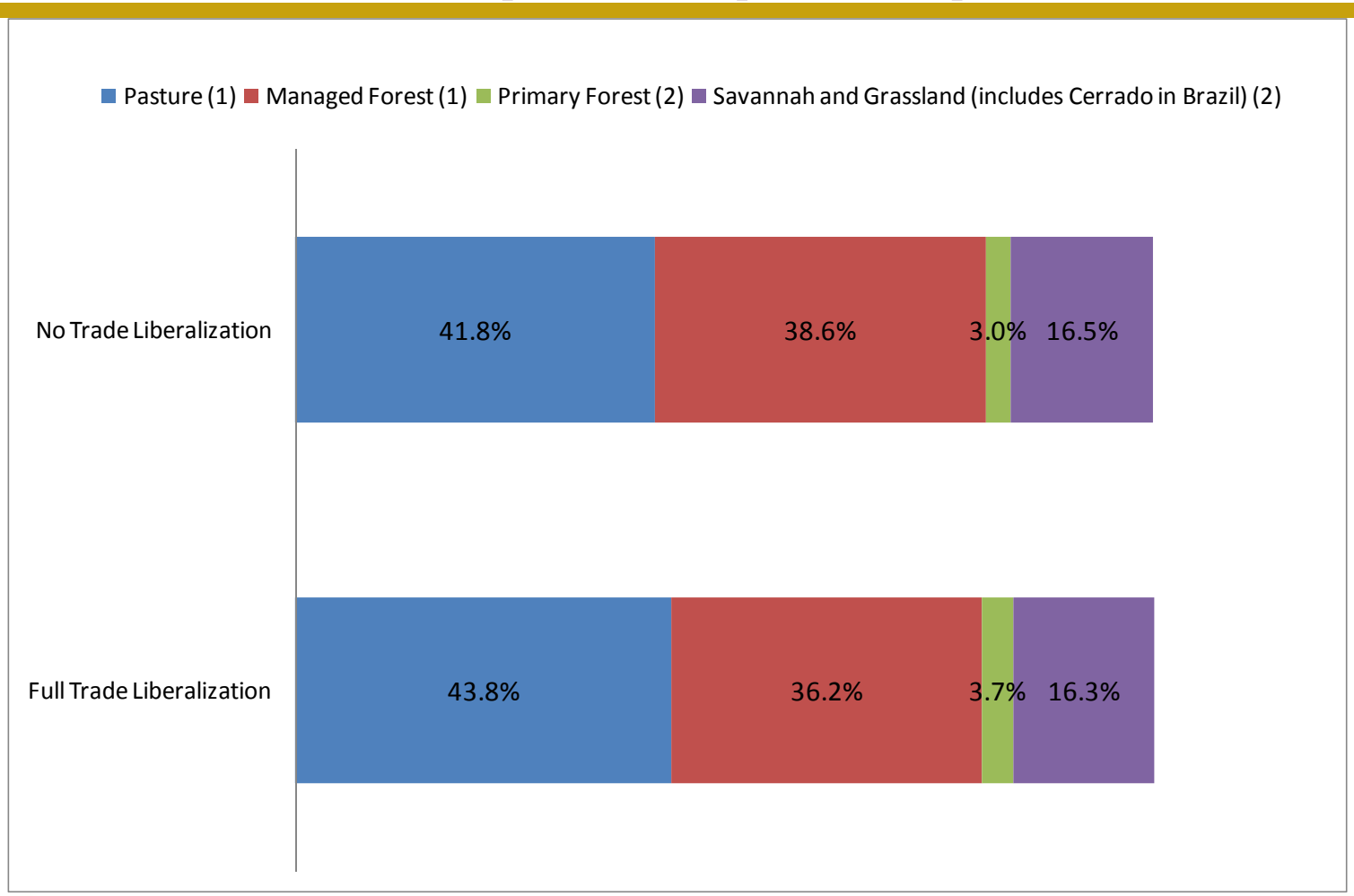
(Figure 5) Land use changes for main crops, 1000 Ha



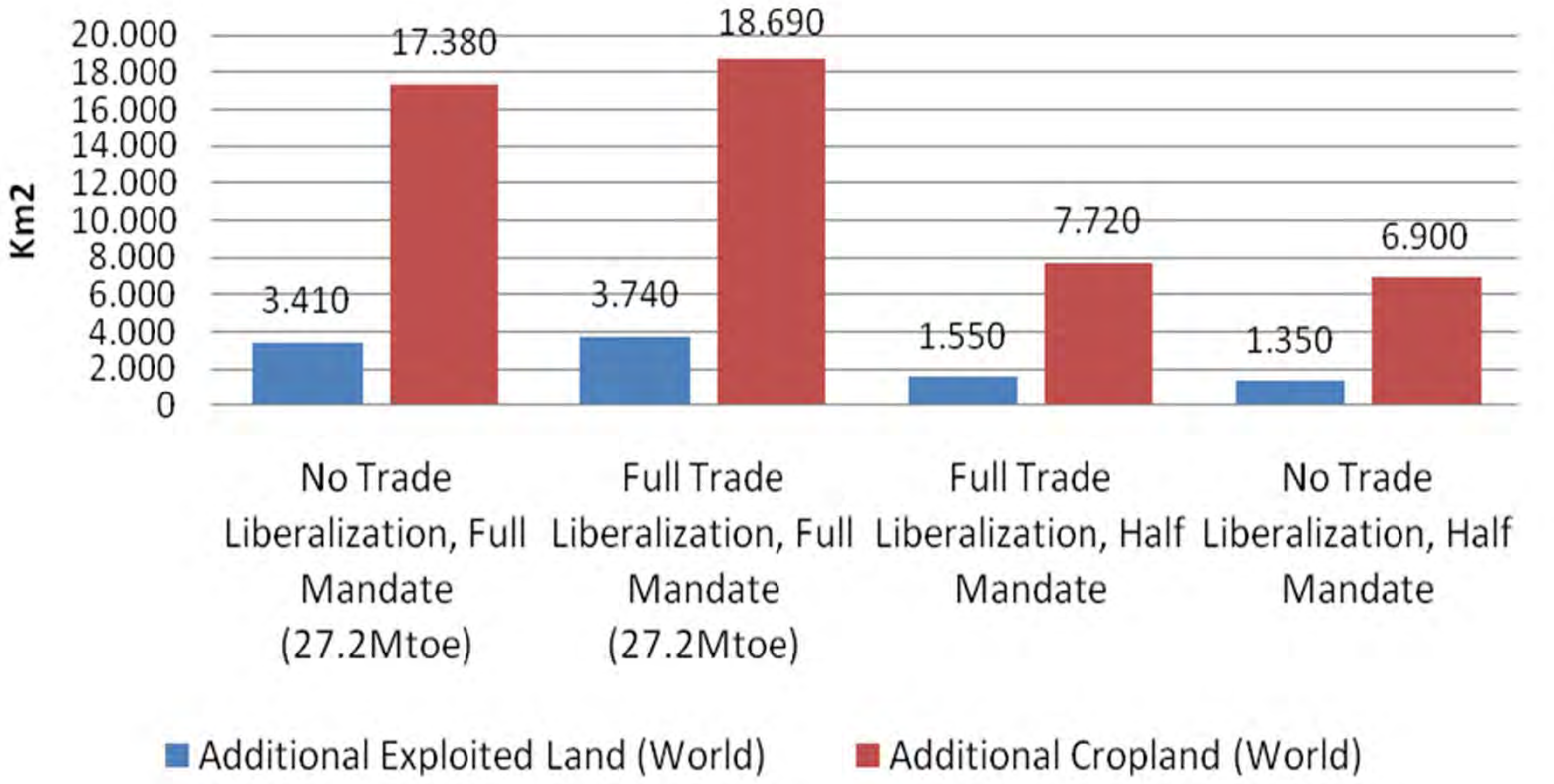
(Figure 6) Location of cropland extension. Changes compared to the baseline. Km2



(Figure 7) Distribution of source of cropland (world)



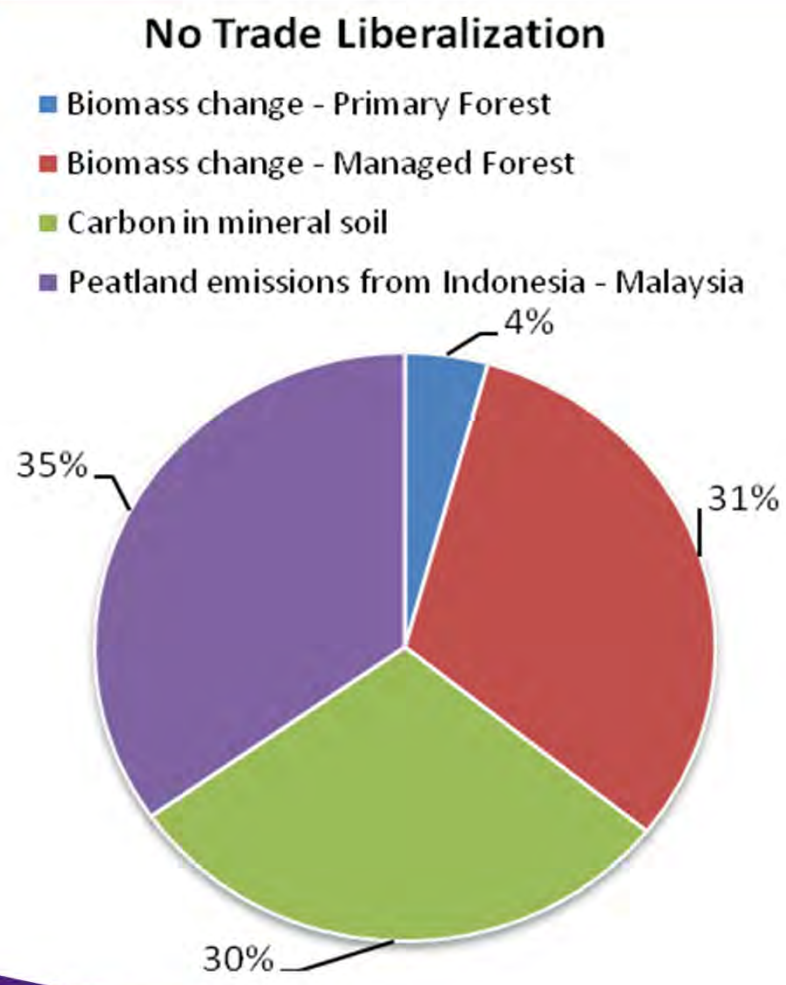
(Figure 8) Cropland extension vs. Exploited land extension. Km2

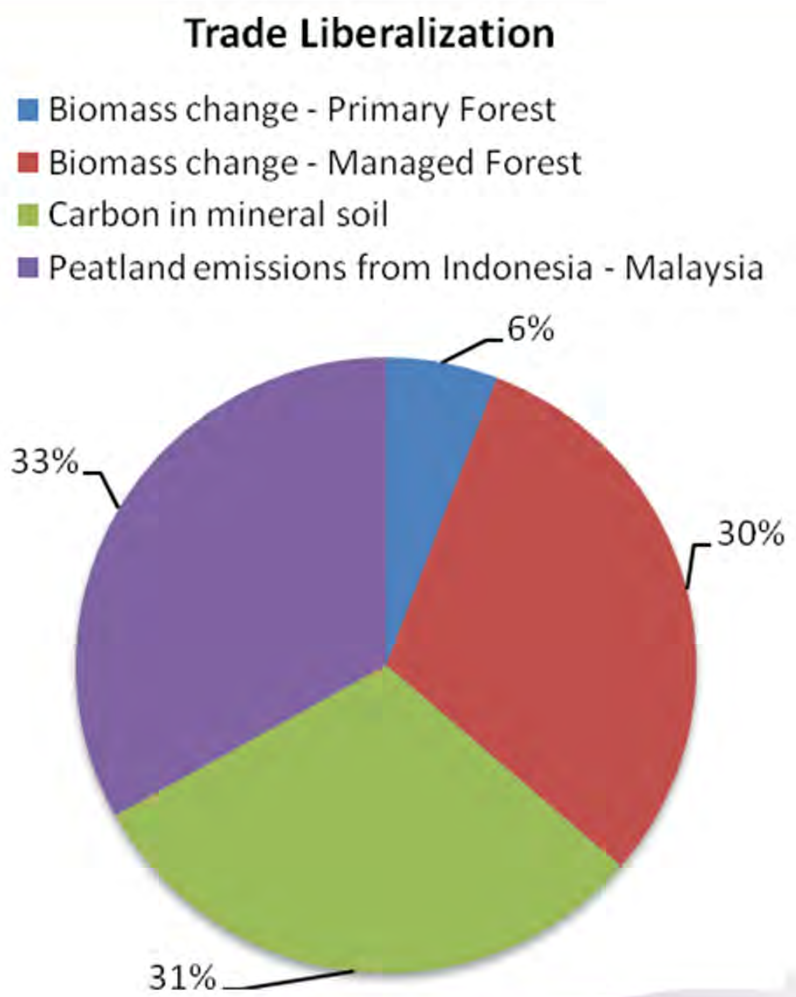


LUC coefficient (grCO2/MJ)

495 MtCo2 for 15.5 MToe

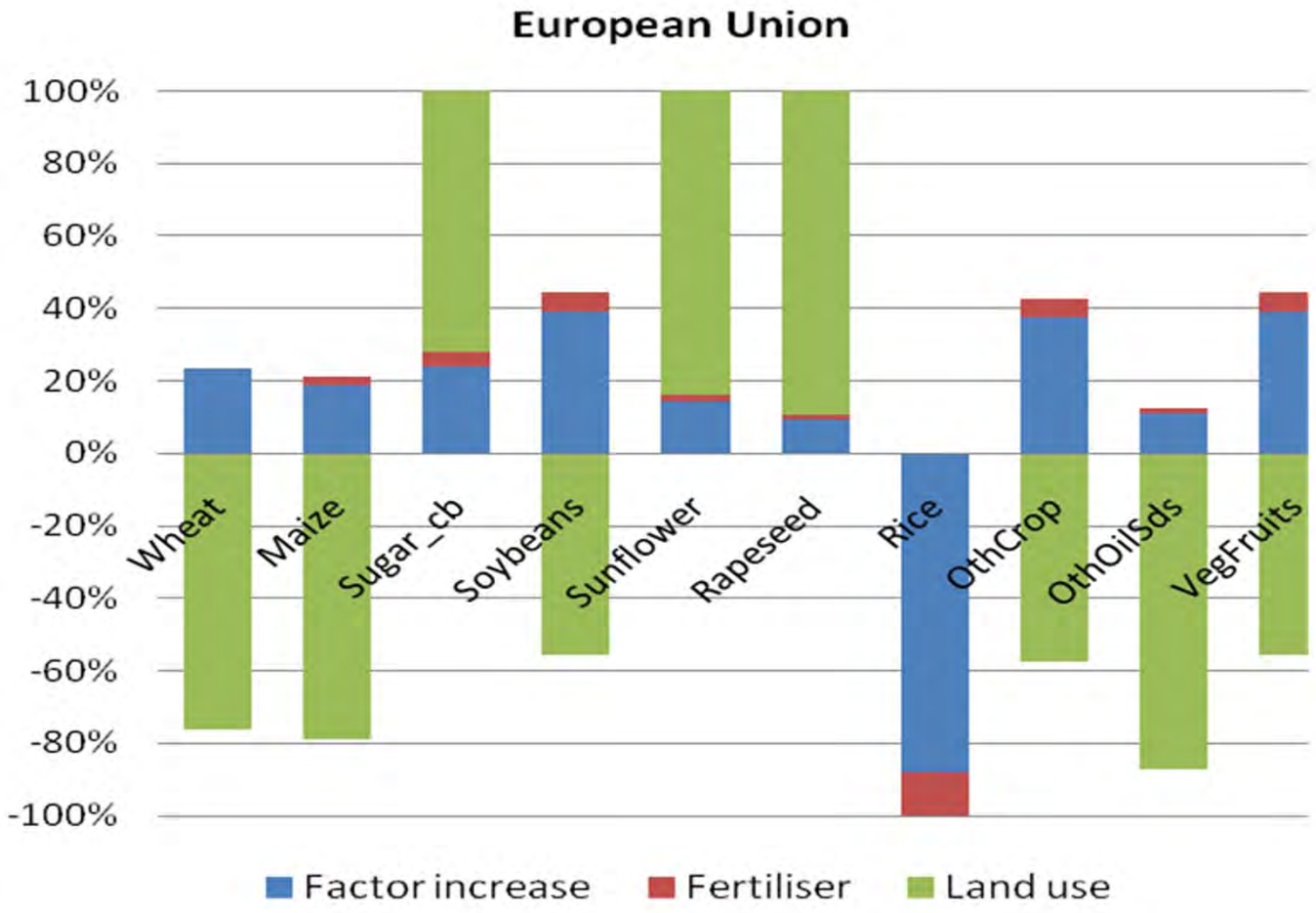
(Figure 10) Source of emissions



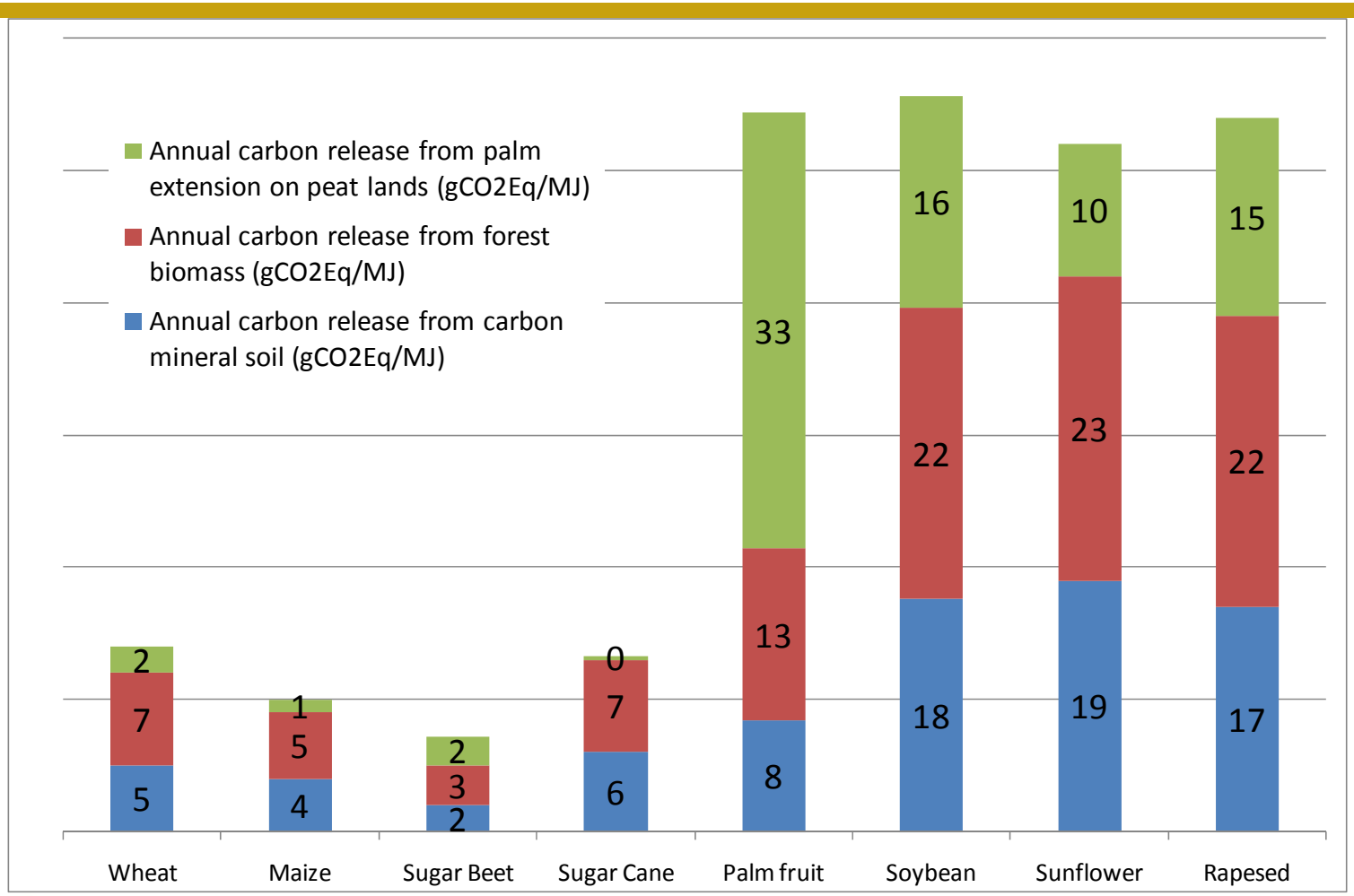


with a value of peatland emissions of 55gTCO2 HA/an

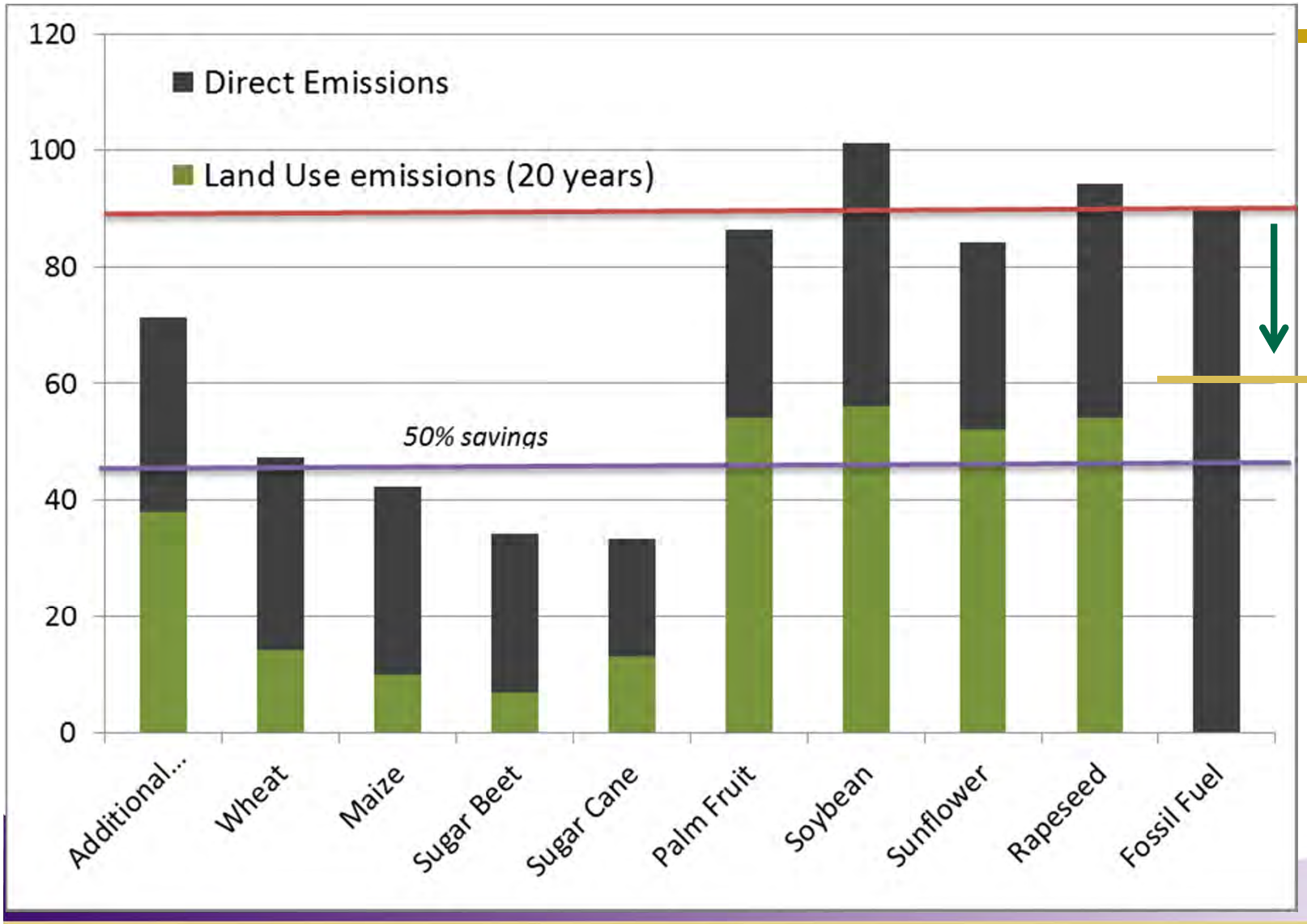
(Figure 11) Intensification and Extensification drivers. Normalized effects: Additional Mandate, Trade Policy Status Quo



(Figure 14) Crop specific LUC. Source of emissions



Emissions grCO2/MJ



If considering oil leakage effects

Differences? DEMAND effect

Table 10 Ratio Additional Supply/Biofuel demand. Percent.	
Sugar Beet	94.40
Sugar Cane	98.30
Maize	56.69
Wheat	51.38
Palm Fruit	96.6
Rapeseed	78.2
Soybeans	40.3
Sunflower	71.0

mandate

Table 10 Evolution of Livestock consumption of feedstocks. Selected Crop specific scenarios (60GJ incremental demand of biofuel in the EU). Tons.

	Ethanol Maize	Ethanol Wheat	Biodiesel Rapeseed	Biodiesel Soybean
Maize	-2693	-213	-2000	-4431
Wheat	-333	-2799	-2228	-1740
Palm Fruit	-1	-2	-81	-110
Rapeseed	-4	-5	-465	-126
Soybeans	11	12	-810	-2747
Sunflower	-6	-6	-126	-131
DDGS	3485	2419	1	-32
Meal-Palm	1	1	23	29
Meal-Rape	-37	-78	3841	813
Meal-Soyb	-187	-105	2431	8954
Meal-Sunf	-1	-5	253	272
Other Crops	174	411	-154	-834

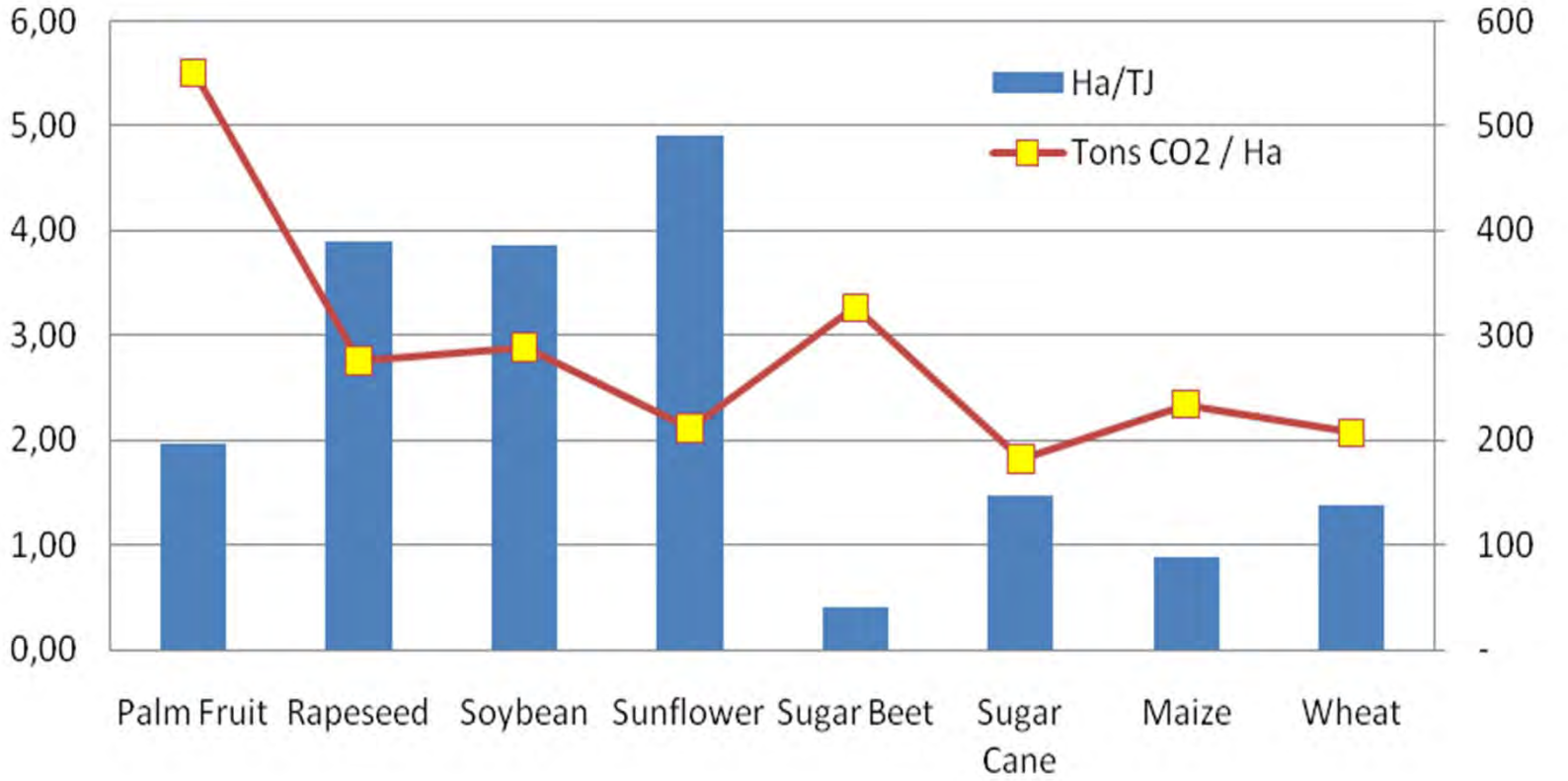
Differences? Supply effect

- Yield reactivity
- Land displacement

Table 14 Land Use displacement Summary. Value by feedstock. Ha by Tj	Scenario Feedstock	Net Energy Crops	Net Cropland	Pasture	Net Exploited Land
Biodiesel_Rapeseed					
EU27	4.42	2.94	0.51	-0.10	0.14
World	10.91	11.72	3.90	-1.39	0.64
Biodiesel_Soybean					
EU27	0.14	0.77	0.10	-0.02	0.03
World	11.61	11.41	3.86	-1.50	0.76
Ethanol_Maize					
EU27	2.40	1.13	0.08	-0.02	0.01
World	6.52	3.69	0.88	-0.40	0.00
Ethanol_Wheat					
EU27	3.27	1.77	0.17	-0.04	0.03
World	7.64	4.99	1.39	-0.54	0.10

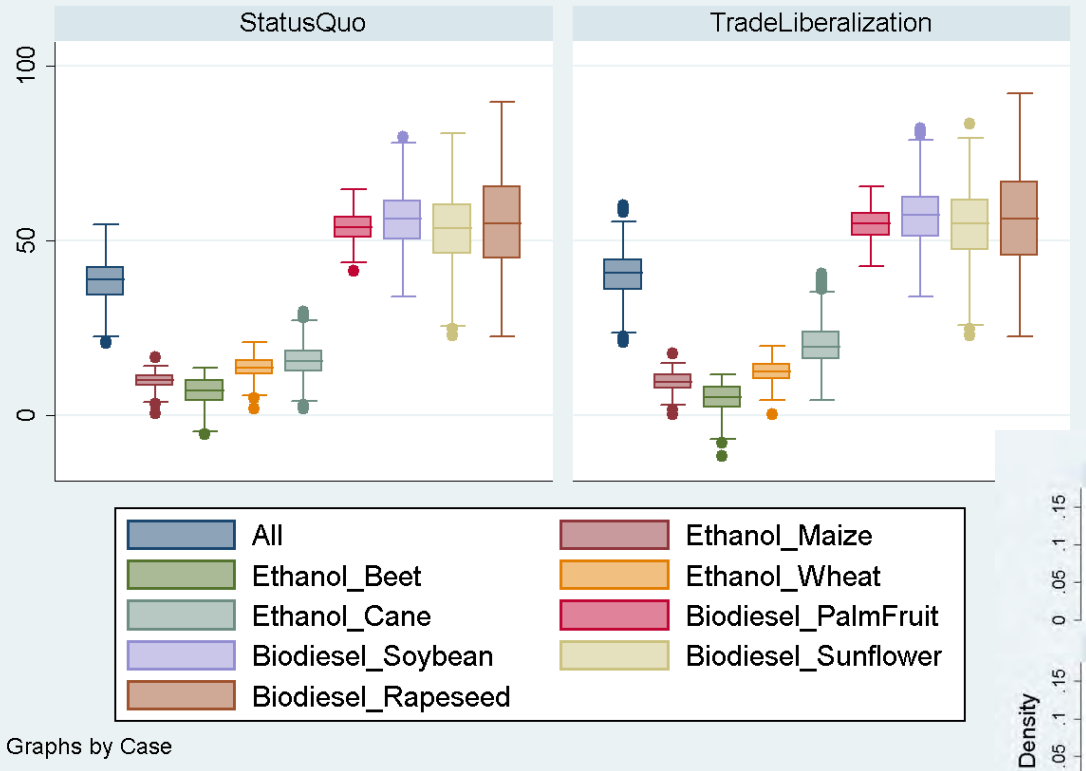
Differences: Carbon stocks

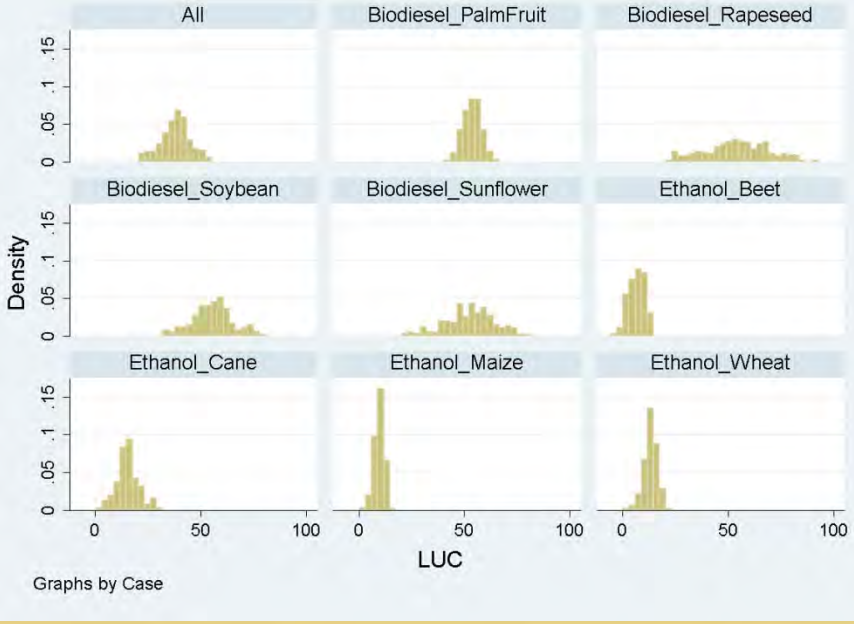
(Figure 16) More cropland or More Carbon (Ha by TJ and Tons CO2 eq by Ha of cropland)



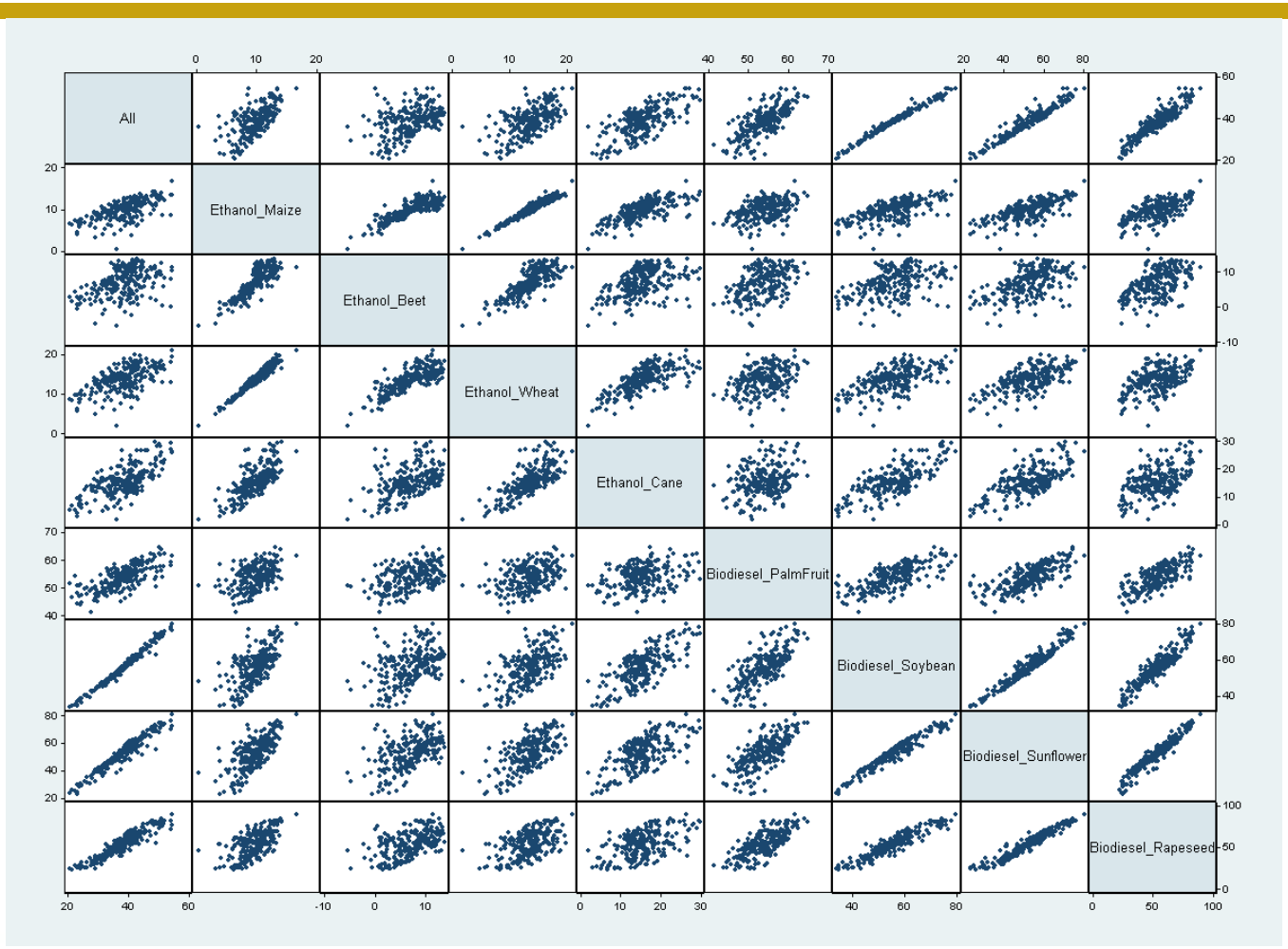
Note : The bars (left y-axis) show the amount of additional net cropland by TJ of biofuel produced for one feedstock. The line (right x-axis) shows the average tons of CO2 equivalent by net Ha of cropland.

Sensitivity Analysis

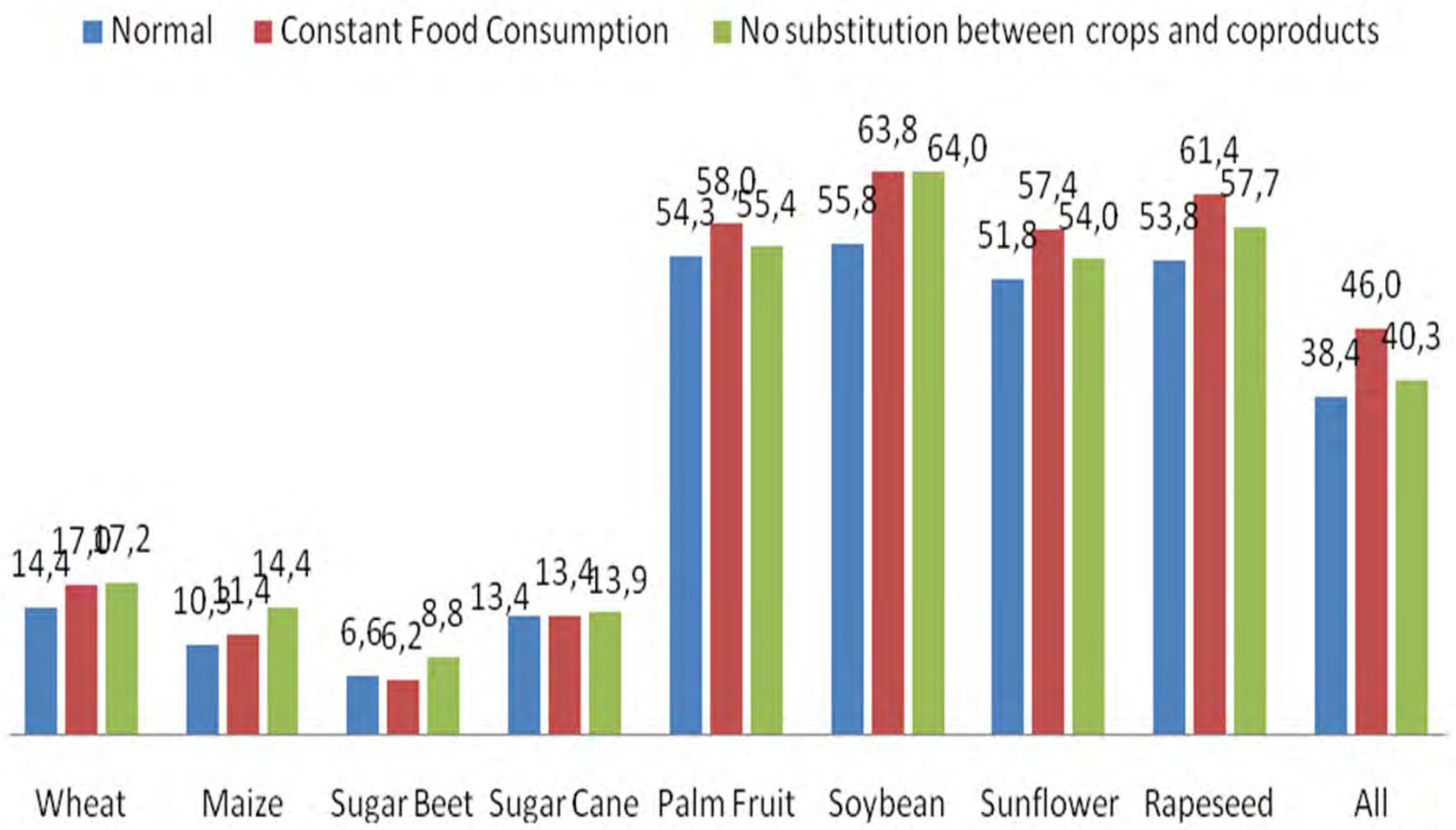




(Figure 21) Correlation matrix of LUC factor, grCO2eg/MJ. Trade policy Status quo.



(Figure 22) Consequences of alternative closures on LUC (grCO2e/MJ)



Worst case (all demand fixed, no coproducts) can x3 total LUC

From model results to the policy space

POLICY RECOMMENDATIONS

General considerations

1. Land use changes driven by biofuel policies are a **serious** concern. This finding is robust as more than 99 percent of crop LUC coefficients in the Monte Carlo analysis are positive.
2. LUC regulation and the Pandora Box: LUC for all, LUC for none? The real challenge is to promote better land use practices for agriculture widely.
3. Reducing the biofuel ambition is still the most direct way to limit additional land use emissions (evolution of political economy due to supply constraint in the EU)

Targeted measures

1. Crop specific LUC *can* be difficult to implement. Increasing the minimal requirements of direct savings *can* be a better solution and will provide incentives for the sector to adopt the most efficient pathway.
2. Despite all uncertainties, our findings show the hierarchy between ethanol and biodiesel in terms of LUC. Additional breakdown can be considered. Therefore, promoting a larger share of ethanol than the current projection will be meaningful. Role of trade liberalization

Broader measures

1. Alternative trade policy options may be developed to promote good practices in terms of land conservation at a national level by trade partners (sustainability criteria, TRQ);
2. Using available technologies to increase yield e.g. **biotech**, and low carbon agricultural practices to reduce emissions;
3. Health check for biofuel policies and needs to have a flexible framework.