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Impacts of biofuels on world agricultural markets

Les conséquences du développement des biocarburants
sur les marchés mondiaux de produits agricoles



Fabrice Levert

Le Havre – RIH 2013- 13/09/13

Context

- ❖ In general :
 - ❖ Demography expansion, higher revenues in developing countries...
 - ❖ Higher food prices, higher volatility
 - ❖ Ressources scarcity (Energy, land...)
 - ❖ Climate change concerns
- ❖ Biofuels compete with food for land and feedstocks. : “Food versus Fuel debate”
- ❖ Biofuel expansion in the world driven by policy : tax reduction, consumption mandates, targets...
 - ❖ In the EU : RED 2003/30/EC, RED 2009/28/EC, Energy taxation directive 2003/96/EC, FQD 2009/30/EC + FQD et RED 2009 amendments 2012/10/17
- ❖ Motivation for promoting biofuels :
 - ❖ Reducing greenhouse-gas emissions
 - ❖ Reducing energy dependency
 - ❖ Providing opportunities for employment and regional development

Landmarks

❖ Ethanol:

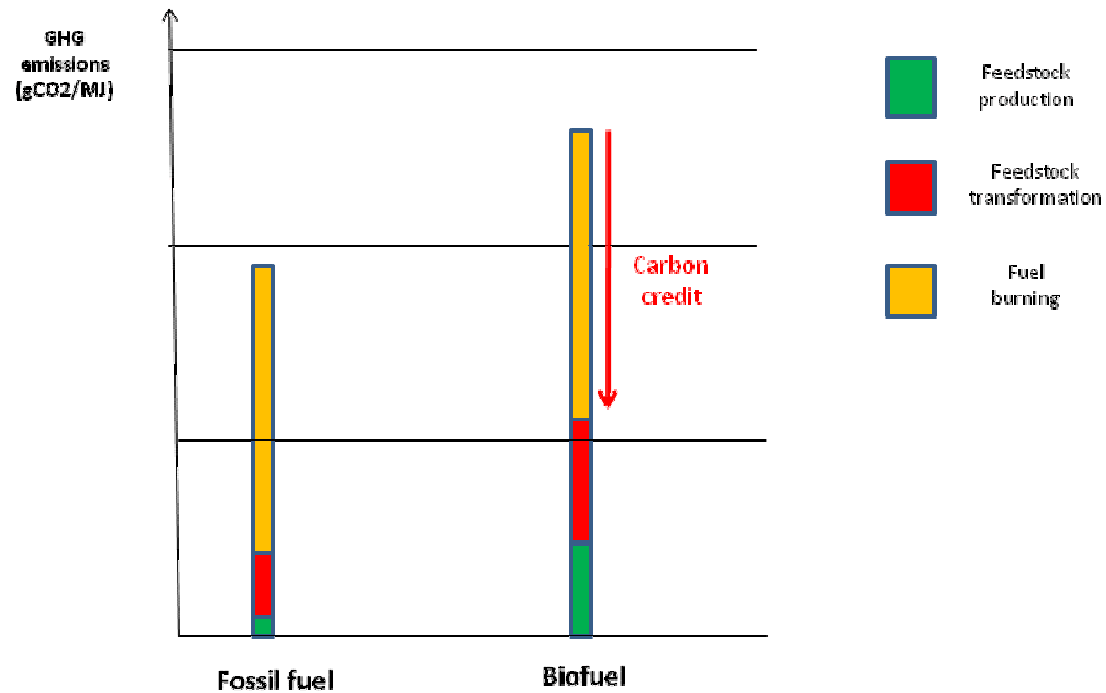
- ❖ World production (2012): 84 MT, (50% in North-America, 3MT in EU)
- ❖ Use 150 MT of cereals, 280 MT of sugar cane, 6 MT of sugarbeet :
 - ❖ Equiv. to 6% of the world cereal production (2.5 GT in 2013)
 - ❖ 40% of the US maize production for biofuels

❖ Biodiesel:

- ❖ World production (2013): 22 MT
 - ❖ EU supply = 9 MT for a consumption of 10,6 MT
- ❖ Use 17MT of vegetal oil (soya oil 7MT, rape oil 6MT, palm oil 4MT) and 2.8 MT of waste feedstock.
 - ❖ Equiv. to 11% of the world veg. oil production or 1.2 x the EU veg. oil production

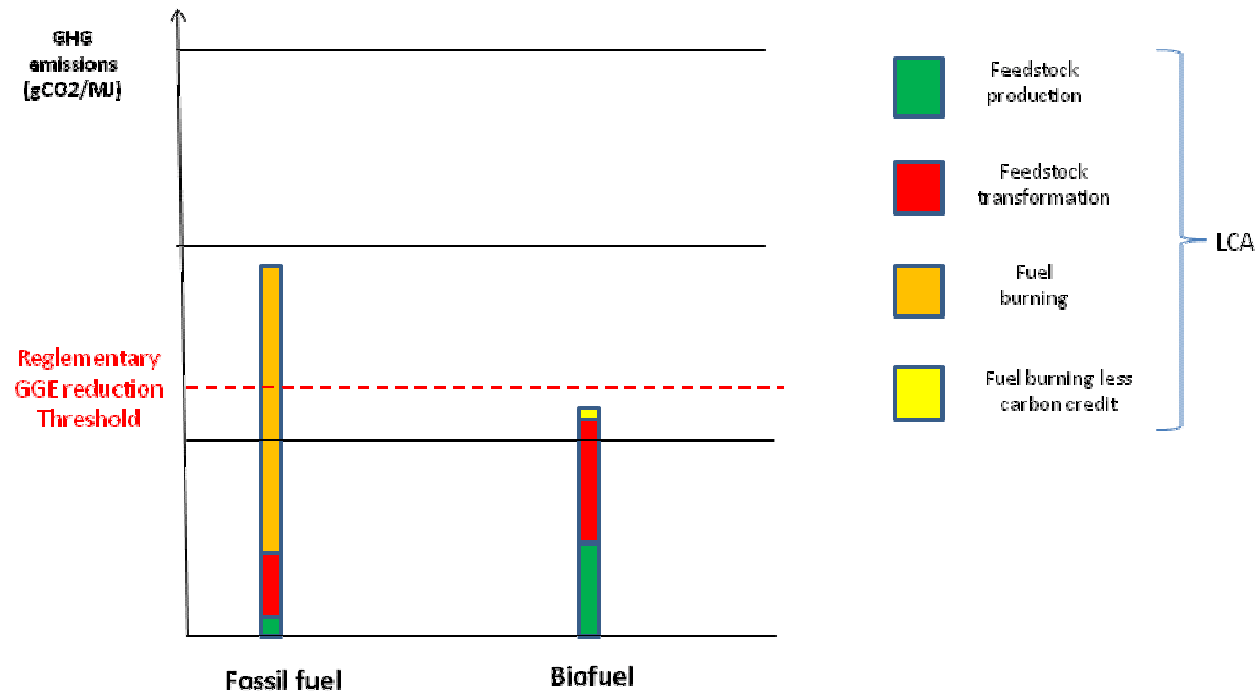
Does Biofuels mitigate GHG ?

- ❖ Biofuels produce less GHG than fossil fuels with LCA analyses but a huge uncertainty remains about the amount of the ILUC effect (ADEME, 2010):



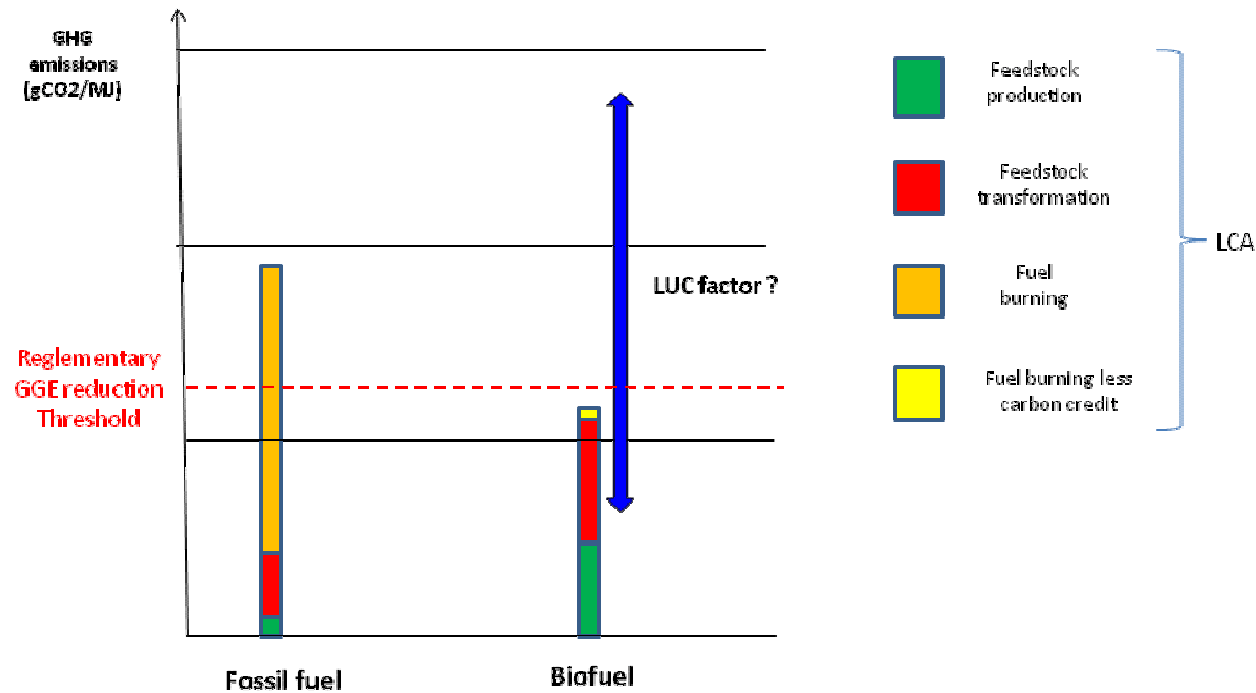
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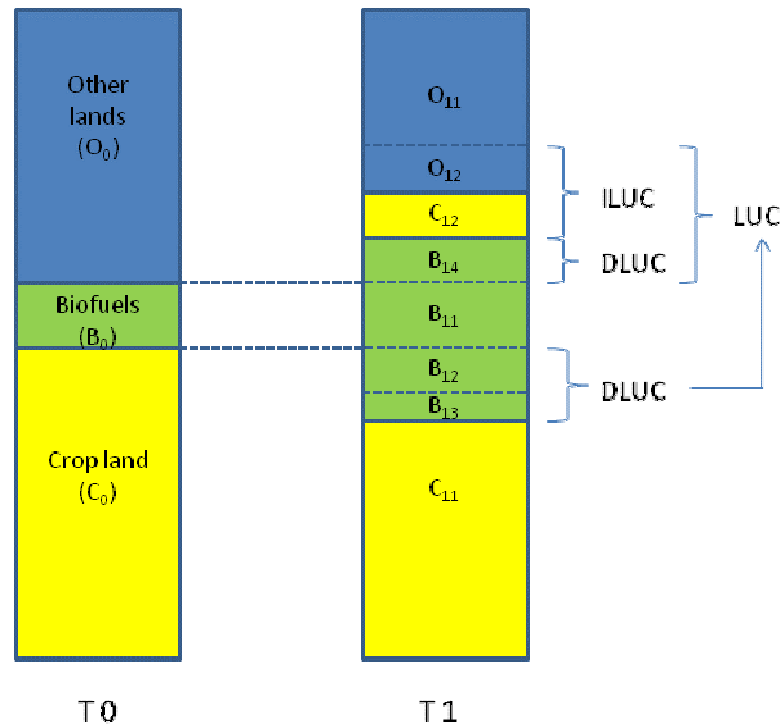
- ❖ Biofuels produce less GHG than fossil fuels with LCA analyses but a huge uncertainty remains about the amount of the ILUC effect (ADEME, 2010):



- ❖ Searchinger (2008) emit the hypothesis that taking into account the ILUC effects, biofuels produce more GHG than oil, and a huge carbon debt.

LUC definitions

- ❖ DLUC : Land required to grow biofuel feedstocks
- ❖ ILUC : Land displaced in response to reallocation of crop (market effect)
 - ❖ “ILUC emissions occur when grassland and forest are converted to cropland somewhere on the globe to meet the demand for commodities displaced by the production of biofuel feedstocks” (Plevin et al., 2010)



How to evaluate LUC?

- ❖ **Attributional approach:**
 - ❖ Classical LCA on a limited system (from seed to wheel)
 - ❖ No valuation of ILUC but DLUC possible

- ❖ **Consequential LCA / Causal descriptive approaches:**
 - ❖ LCA trying to take into account indirect effects without explicit modeling of market equilibrium, through simplifying hypotheses of these mechanisms

- ❖ **Economic modeling approaches:**
 - ❖ Partial Equilibrium Models (PE)
 - ❖ General Equilibrium Models (GE)

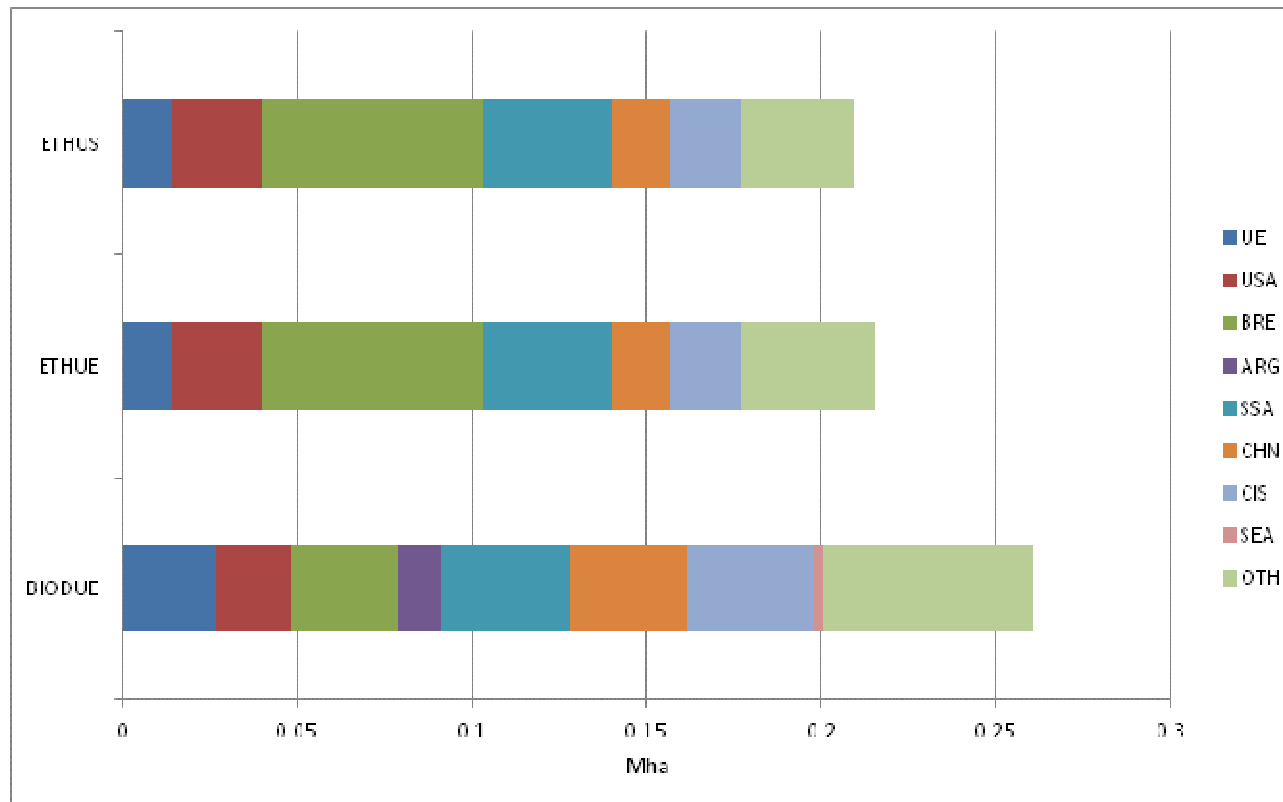
→Challenge: isolate the own effect of biofuel

Impacts of biofuels in term of LUC

LUC Biodiesel			LUC Ethanol	
Study/Model	ha/toe	Feedstock/origin	ha/toe	Feedstock/origin
<i>Our simulations :</i>				
MATSIM-LUCA	0.25	Mix	0.22	Mix
<i>Laborde 2011 :</i>				
Mirage	0.08	Palm	0.02	Betterave
Mirage	0.16	Rape-Soya	0.04	Maïs
Mirage	0.21	Sunflower	0.06	Canne-blé
<i>Edwards et al. 2010 :</i>				
LEITAP	1.93	Biod EU	0.73	Eth France
LEITAP	0.43	Biod Indonesia	0.86	Maize US
FAPRI	0.44	Biod EU	0.39	Eth EU
AGLINK	0.23	Biod EU	0.57	Eth EU
AGLINK	0.24	Biod US	0.51	Eth maize US
			0.13	Cane Brazil
GTAP	0.38	Biod EU	0.79	Eth EU
GTAP	0.08	Biod Indo/Mal	0.17	Eth maize US

Impacts of biofuels in term of LUC

Land use change in the world for a choc of 1Mtoe of Biodiesel (EU demand) or Ethanol (EU or US demand)

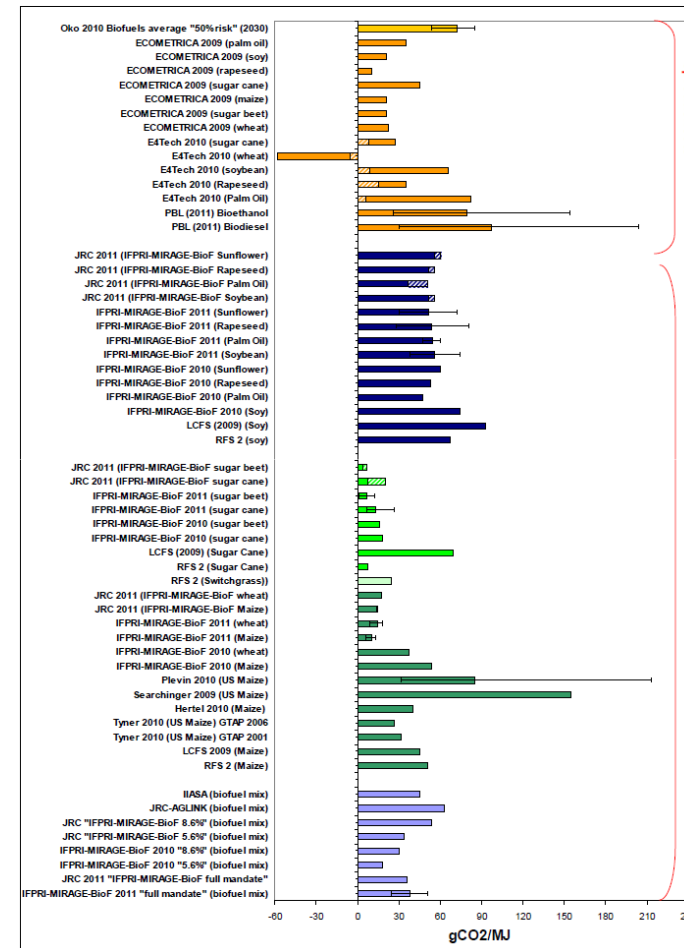


Source : Our simulations with MATSIM LUCA

Impacts of biofuels in term of GHG emissions

$$LUC \text{ factor} = \frac{(\text{CroplandAreaExpansion} * \text{AverageEmissionFactor})}{(\text{BiofuelProduction} * \text{ProdPeriod})}$$

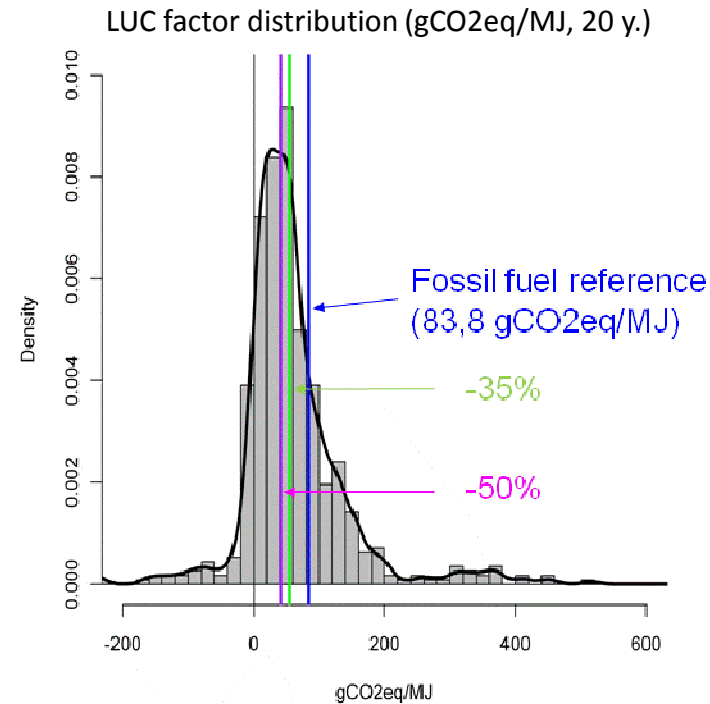
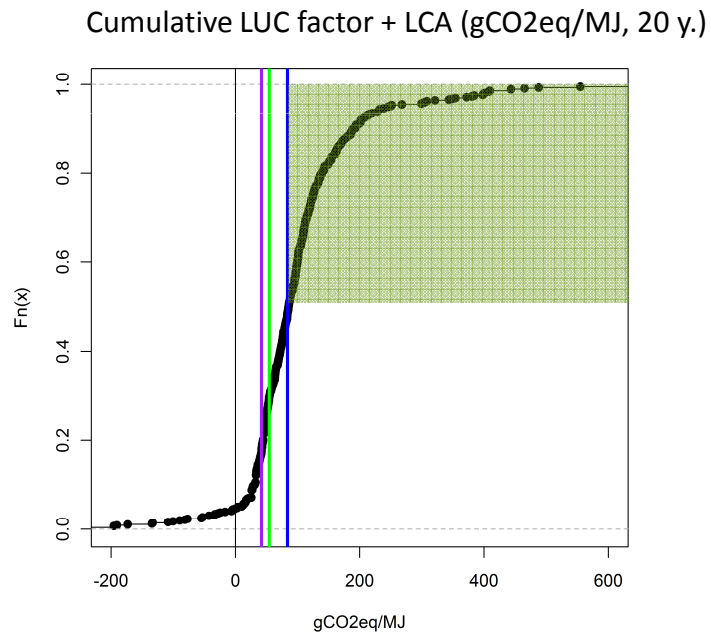
- ❖ Unit : gCO₂eq/MJ
- ❖ Posterior to the phase of economic modeling: new source of uncertainties.
- ❖ Biodiesel generates more GHG than Ethanol
- ❖ Some feedstocks are more efficient than others
- ❖ Large variability between model/studies



Source : EC (2012)

Impacts of biofuels in term of GHG emissions. Litterature review (De Cara et al. 2012)

- ❖ 71 references, 561 obs.
- ❖ LUC factor :
 - ❖ Mean : 71 gCO₂/MJ
 - ❖ Mediane : 48 gCO₂/MJ
 - ❖ 50% between 18 and 87 gCO₂/MJ



- ❖ Including LCA + LUC :
 - ❖ 52% > fossil reference
 - ❖ 71% > reduction mandate of 35%

Source : De Cara et al (2012)

Sources of variabilities

- ❖ Type of approach:
 - ❖ Economic model (+) vs. Consequential studies (-)
- ❖ Type of biofuel:
 - ❖ Ethanol (-) vs. Biodiesel (+), 2nd generation (-)
- ❖ Type of land converted:
 - ❖ Supply region for feedstocks (Lat. Amer. (+))
 - ❖ Peatland/Wetland effect (+)
- ❖ Market mechanisms
 - ❖ Price endogeneity of yields (-) and demand (-)
- ❖ Taking account of coproducts (-)

Sources of uncertainties

- ❖ Supply side :
 - ❖ Yields adjustment vs. Land expansion :
 - ❖ Ability to improve yields (\Leftrightarrow disponibility or access to factors, technological improvement...) \rightarrow *substitution elasticities*
 - ❖ Ability to cultivate biofuel crops on previous cultivated area \rightarrow *Land transformation elasticities*
 - ❖ Ability to expand crop land (stock and disponibility of land in different countries) \rightarrow *Crop land expansion elasticity*
- ❖ Demand side :
 - ❖ Reduction in food and feed demand with increasing prices \rightarrow *Demand elasticities*
 - ❖ Ability for biofuel coproducts to replace other feedingstuffs in feed rations \rightarrow *substitution elasticities*

Sources of uncertainties

- ❖ Trades:
 - ❖ Openness of the global market (price transmission, local vs. imported product differentiation...) → depend on trade policy assumptions or *Armington elasticities*

- ❖ GHG emissions:
 - ❖ Type of land converted (pasture/forest/fallow land...)
 - ❖ Assumption on soil carbon stocks

Conclusion

- ❖ Biofuels has an impact on food products markets
- ❖ There is a huge suspicion that they don't mitigate GHG emissions.
- ❖ The variability existing among results about GHG mitigation of biofuel doesn't legitimate policy inaction.

- ❖ Vote of the EU Parliament on Wednesday 11th september 2013 :
 - ❖ Integration of LUC in biofuel GHG performance
 - ❖ Limitation of Food based Biofuel to 6 pc.

- ❖ But the debate is unfair: LUC evaluations should be apply to other activities (urbanization, extensive agricultural production systems...)

Thank you for your attention

<http://www6.rennes.inra.fr/smart>