iLUC impacts of biofuels

Literature review of most influential and most recent scientific papers

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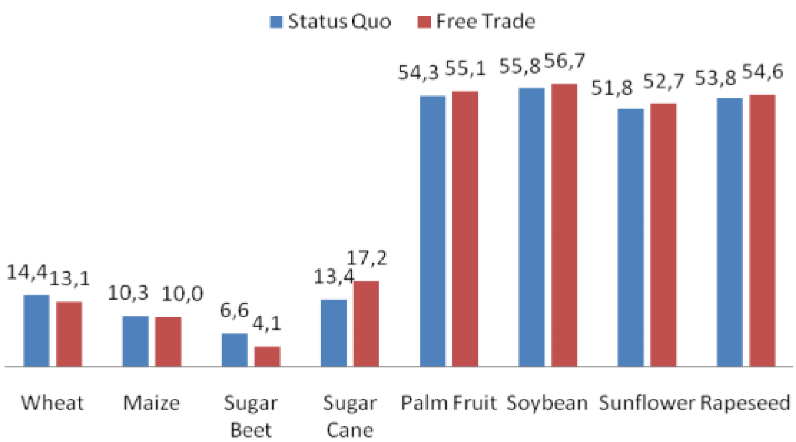
Fossil fuel comparator

The fossil fuel comparator (RED, 2009): "actual average emissions from the fossil part of petrol and diesel consumed in the Community, … the value used shall be 83,8 gCO2eq/MJ". This value may serve as a point of reference for putting indirect land use change (iLUC) factors into perspective.

IFPRI (2011 and 2014)

Although not a peer-reviewed paper, due to its influence in policy making IFPRI (2011) is important to consider. Authors present robust findings with regard to differences between the performance of bioethanol and biodiesel. IFPRI (2011) finds that all ethanol feedstocks have a much lower LUC emission than biodiesel feedstocks. The study clearly shows that corn is the best realistically available option with regard to LUC emission coefficients (around 10 gCO2eq/MJ). (Note that the economics of sugar beet is questionable.)

1. Graph LUC emission coefficients (grCO2eq/MJ) by feedstock estimated at the mandate level and alternative trade policy options



Source: IFPRI, 2011, p.59

In 2014 the report was updated to address concerns with some of its previous assumptions. The new results show that annualised iLUC emissions of corn ethanol is estimated at 13gCO2eq/MJ.

Searchinger et al. (2008)

One of the most influential papers on land use change impacts was (Searchinger *et al.*, 2008). It was published in Science so it has been cited widely. The authors found that corn-based ethanol, instead of producing a 20% savings, nearly doubles greenhouse gas emissions over 30 years and increases greenhouse gases for 167 years (+93% change in net GHG emissions versus gasoline). This finding is based on the logic that farmers worldwide respond to higher prices and convert forest and grassland to new cropland to replace the grain (or cropland) diverted to biofuels, thereby leading to carbon emissions from land-use change unaccounted for in prior studies.

Kløverpris and Mueller (2013)

To illustrate the influence of baseline time accounting on existing ILUC factor results, Kløverpris and Mueller (2013) apply the concept on the studies by Searchinger et al. (2008) and Hertel et al. (2010), both relating to corn-based ethanol. The authors derive emissions data directly from these studies. Above- and below-ground emissions in the developing world are estimated at 2,240 and 110 g CO2e/MJ for the Searchinger and Hertel study, respectively. The authors find that with current trends in global agricultural land use, the method significantly reduces the estimated climate impact in the previous ILUC studies.

1. Table Estimated ILUC factors

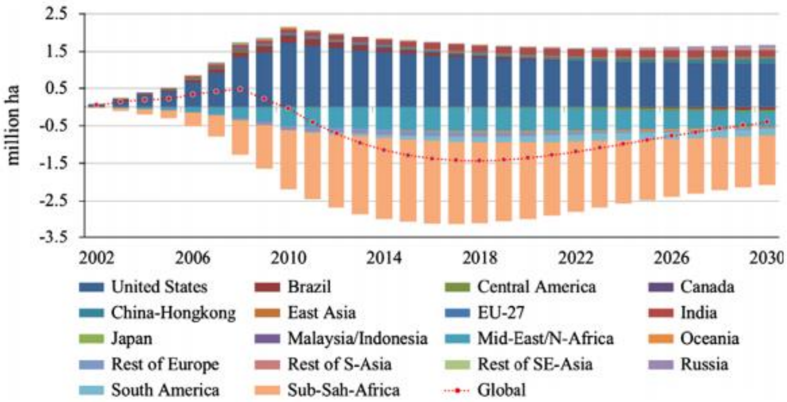
	30 years annualization, (g CO2e/MJ)	Baseline time accounting (g CO2e/MJ)
Searchinger et al. (2008)		
Developing world	78	24
Developed world	26	6
Total	104	30
Hertel et al. (2010)		
Developing world	3	1
Developed world	24	10
Total	27	11

Source: Kløverpris and Mueller (2013)

Oladosu and Kline (2013)

Oladosu and Kline (2013) evaluated the global ILUC implications of biofuel use in the USA from 2001 to 2010 with a dynamic general equilibrium model and their results suggest that the global LUC implications may be lower than prior estimates found in the literature. The authors find that the effects of biofuels production on agricultural land area vary by year; in some of the cases they investigated from a net expansion of 0.17 ha per 1000 gallons produced (2002) to a net contraction of 0.13 ha per 1000 gallons (2018). The reason behind this, as the authors suggest is that “agricultural land use is estimated to decline in some regions because of the income effects of reductions in oil imports by the USA under biofuel policy. This negative LUC is driven by a similar economic mechanism that produces positive LUC in other regions” (p.1137).

1. Figure . Changes in agricultural land area under Case 1 relative to the baseline



Source: Oladosu and Kline (2013)

Dunn et al. (2013)

Dunn et al. (2013) estimated LUC GHG emissions for ethanol from four feedstocks: corn, corn stover, switchgrass, and miscanthus. The authors's results for corn ethanol are lower than corresponding results from previous studies. Results showed a low value for corn ethanol; LUC GHG emission for corn ethanol was found to be 7.6 g CO2e/MJ.

2. Table Range of LUC GHG emissions (g CO2e/MJ)

	Switchgrass	Miscanthus	Corn stover	Corn
Minimum U.S. LUC GHG emissions	−3.9	−12	−0.24	1.2
Maximum U.S. LUC GHG emissions	13	−3.8	−0.19	7.4
International LUC GHG emissions	6.7	1.7	−0.97	3.5
LUC GHG emissions range	2.7 to 19	−10 to −2.1	−1.21	4.7 to 11
Lifecycle GHG emissions range[b]	10 to 26	−8.5 to −0.20	0.97 to 1.0	62 to 68

[a] Values presented represent range of results generated at all combinations of surrogate CENTURY (Table 4) and CCLUB modelling parameter settings discussed.
[b] Using default GREET parameters [10] and varying only LUC GHG emissions.

Source: Dunn et al. (2013)

Conclusion

Indirect land use change impacts are real. There are strong reasons to include iLUC impacts in EU policy making.

iLUC factors appear to be smaller than previously thought. Although there is much uncertainty and variability in modeling ILUC (see Finkbeiner, 2014), recent scientific papers show a relatively low value for land-use change impacts of bioethanol. As Broch et al. (2013) note, since Searchinger (2008) utilization of updated databases in agro-economic models to better predict the iLUC response to biofuels policy resulted in a decreased overall estimates of iLUC-induced GHG emissions. Most recent scientific papers estimate iLUC to be around 10 gCO2e/MJ for corn ethanol. That is found not to be a decisive figure compared to an overall emission of around 40 gCO2e/MJ for the corn ethanol pathway. It is also worth to bear in mind that the fossil fuel comparator is 83.8 gCO2eq/MJ, so including latest iLUC factors in the GHG calculations will still result in a substantial net GHG savings for bioethanol. As shown earlier, other bioethanol pathways are also associated with relatively low iLUC impacts.

Note that estimated iLUC impacts of most biodiesel pathways tend to be larger than those of bioethanol. From a policy perspective it is therefore necessary to differentiate between bioethanol and biodiesel with regard to their land-use change impacts.

References

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