



Counting the Carbon Emissions from Agricultural Products: Technical Complexities and Trade Implications

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Carbon footprints

1. The production, processing, transport and storage of agricultural products, like most human activities, gives rise to emissions of greenhouse gases (GHGs). These GHG emissions include carbon dioxide (CO₂) emitted through the combustion of fossil energy at various stages in the life-cycle of a product: in the production of agri-chemicals and soil amendments; by farm machinery during field preparation, planting, cultivation and harvesting; by vehicles used to transport the intermediate and final products; by the factories that process the products; and in the production of electricity used to keep the products refrigerated, if necessary. They also include nitric oxide (N₂O) released from the soil as a result of applying nitrogenous fertilizer; and changes in soil carbon resulting from farm practices that result in either a net release to the atmosphere (through oxidation) of carbon, or its sequestration (e.g., through storage by root biomass). Products of livestock, especially from ruminant animals, also release methane (CH₄) from enteric digestion, and N₂O from decomposing manure.

2. In 1994, a British researcher, Andrea Paxton, wrote a paper highlighting the emissions associated with transporting food ingredients, tracing the distance that they typically travel from the farm gate to the dinner

plate.¹ This kind of accounting for “food miles” led eventually to the labeling of food products on that basis by one of the U.K.’s largest retailers. This practice soon came under sharp criticism, however, from researchers and food-exporting countries, who pointed out that the bulk of GHG emissions created along the food-supply chain have their origins in the production phases, and much of the rest by processing. Moreover, *how* the products are transported – i.e., by what mode (road, rail, water or air) – can matter more than the actual distances over which they travel.

3. The result of such criticisms was not the cessation of attempts to differentiate food products by their carbon emissions, but quite the opposite: the flourishing of new, more sophisticated ways of doing the accounting. Today there are dozens of private and public organizations around the world trying to measure the life-cycle impacts of consumer products, particularly foods and beverages, and particularly their GHG emissions. These carbon accountants draw to varying degrees on their own measured data and on data stored in life-cycle inventories. The data are then run through spreadsheet-based life-cycle assessment (LCA) models, to generate an estimated “carbon footprint”, usually expressed in grams of CO₂-equivalent per functional unit (e.g., kilograms or liters) of the product.

¹ Paxton, A. *The Food Miles Report: the Dangers of Long Distance Food Transport*, Safe Alliance: London, 1994.

4. Initially, it was mainly the private sector that sponsored these life-cycle assessments. Many companies found they could use LCA to help identify points in their supply chains, or “hot spots”, where reductions in energy consumption, and hence in GHG emissions, could be realized easily. LCAs provide information to companies, which enables them to trim costs, and helps them to improve their corporate image. Those retailers who have gone the extra step of labeling the carbon footprints of the products they sell (sometimes only for own-label products) have done so to promote a “green” identity or in response to consumers’ demands for such information. Other companies may have been motivated to establish an emissions baseline for their operations, in anticipation of the introduction of carbon-reduction requirements or to earn salable carbon credits.

5. Lately, governments have also taken an interest in carbon-footprint labeling. The trail-blazer in this area was The Carbon Trust, a not-for-profit company created in 2001 by the UK government to accelerate the transition to a low-carbon economy. In 2007 the corporation formed a subsidiary, The Carbon Trust Footprinting Company, to help firms measure the carbon emissions associated with their products and to provide them with a label, The Carbon Reduction Label, for displaying those products’ carbon footprints. (The label also demonstrates a commitment by the product owner to reduce that footprint every two years.) The standards behind the Carbon Reduction Label, set out in Publicly Available Specification 2050 (PAS 2050), launched in October 2008, were developed by the Carbon Trust in conjunction with two government bodies, the British Standards Institute and the UK Department for Environment, Food and Rural Affairs (Defra). PAS 2050 has since gained international recognition in a number of countries, and has influenced the development of similar publicly supported standards and schemes in Japan, France and at the International Organization for Standardization (ISO).

6. The proposed scheme in France is the most ambitious considered to date. Originally planned to come into force on 1 January 2011, Article 85 of the

Grenelle 2 Law would have required retailers to display information on the environmental footprint — generally, the life-cycle GHG emissions of a product and some other environmental impacts, such as water use — of a wide array of consumer products, including food, beverages and apparel. Due to recent amendments, the scheme will now start in July 2011 with a voluntary trial phase of at least one year, after which a final decision on how to implement the environmental display framework will be taken.

Biofuel sustainability standards and low-carbon fuel standards

7. In parallel with the emergence of product carbon footprints, similar attempts have been undertaken to estimate the life-cycle GHG emissions of a particular subset of products of agriculture: liquid biofuels. These are fuels that, for the moment, are produced largely from the fermentation of sugars or starches derived from food crops (ethanol), or from plant oils, animal fats, and waste food grease (biodiesel and bio-jet).

8. The history of LCAs for biofuels can be traced back to the 1990s, when life-cycle assessments were used to answer questions relating to the net energy balances of biofuels. Analysts subsequently found that, by tracking energy flows through the production cycle, they could also produce estimates of the associated CO₂ emissions. These emissions were then compared with estimates of emissions generated over the life-cycles of competing petroleum products.

9. Initially, the results of the LCAs for biofuels mainly fed into debates over the merits of government support for biofuel production and use. Since biofuels were generally more expensive to produce than petroleum fuels, their markets were dependent on government intervention, typically in the form of reductions in fuel-excite taxes and, over time, through regulations requiring minimum volumes used in road-transport fuels. Although a strong rationale for government support for biofuels was to provide an additional income source for farmers, or rural communities more generally, policy makers were also keen to promote

biofuels as a means of reducing petroleum imports, urban air pollution or GHG emissions.

10. In the late 2000s, LCAs of biofuels were elevated from the realm of academia to become the core basis of public policy. This change came about as a result of growing concern by environmentalists over the potential adverse effects — from direct land-use change in particular — associated with the production of biofuel feedstock. While some advocated eliminating the subsidies and regulations driving demand for biofuels, many others (including a number of leading environmental groups) suggested that sustainability standards for biofuels, based in part on their life-cycle environmental impact, would adequately address these problems.

11. Anticipating the development of multiple, mandatory government regulations around the world, in 2007 a group of interested individuals and organizations formed the Round Table on Sustainable Biofuels, to develop an international reference standard for biofuels that addresses their life-cycle greenhouse-gas emissions, other environmental impacts and social impacts. Meanwhile, several governments, starting in Europe, began developing draft sustainability standards for biofuels expected to be consumed in their countries. Switzerland was the first to implement such a standard, which went into effect officially in July 2008. The following year, the European Union adopted its “Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources”, which establishes, among other sustainability criteria, standards relating to the life-cycle emissions of renewable fuels (to be enforced from 5 December 2010 onwards). And in February 2010 the U.S. Environmental Protection Agency established standards relating to the life-cycle emissions of renewable fuels that can qualify against federal blending mandates (to be implemented from 2011 onwards).

12. These sustainability standards usually aim to: increase the probability that the life-cycle GHG emissions of biofuels are significantly lower than the petroleum fuels they displace; protect tropical forests and other areas of high biodiversity; and discourage

the conversion of high-carbon soils for growing biofuel feedstocks. Unlike food-safety standards, however, sustainability standards do not determine whether or not biofuels can be imported, but only whether they can count towards mandatory-use quotas and can qualify for tax-reductions or subsidies.

13. Instead of, and in some cases in addition to, biofuel sustainability standards, several jurisdictions in OECD countries have adopted so-called “low-carbon fuel standards” (LCFSs). This idea was developed by academics in California who proposed the LCFS as a more cost-effective, and flexible, alternative to mandated and subsidized biofuels use. On 23 January 2007 California’s Governor Arnold Schwarzenegger signed an Executive Order that “require[d] fuel providers to ensure that the mix of fuel they sell into the California market meets, on average, a declining standard for GHG emissions measured in CO₂-equivalent” grams per unit of fuel energy sold. Regulations to implement California’s LCFS were developed over the course of the following two years, and will start to go into effect in 2011. They require that the carbon intensity of road transport fuels used in California must be reduced by an average of 10% by the year 2020. Other U.S. jurisdictions are also contemplating adopting a LCFS. Meanwhile, Canada’s Province of British Columbia’s LCFS went into effect at the beginning of 2010. And, under the EU’s Fuel Quality Directive, fuel suppliers are required to report the life-cycle GHG emissions of the fuel that they supply, and to reduce those emissions from 2011 onwards, achieving a 10% reduction in life-cycle GHG emissions by the end of 2020.

Possible trade implications

14. Carbon-footprint standards, biofuel-sustainability standards and low-carbon fuel standards all pertain to the consequences of processes and production methods that do not affect the characteristics of the product (non-product-related PPMs for short). Non-product-related PPMs have been an issue in international trade law for more than two decades. The concern here is not with the consistency of such standards with WTO rules — which cannot be assessed generically and

would depend on the particulars of an individual case — but their trade implications, which hinge on how the standards are designed and implemented. Simply put, when regulations or their implementation are arbitrary or insufficiently predictable and transparent, they are likely to cause substantial problems for exporters. The OECD 2005 Guiding Principles for Regulatory Quality and Performance emphasize the importance of transparent regulations, systematic assessments to ensure the effectiveness and continuing relevance of regulations, and of the reduction of regulatory barriers to trade and investment arising from divergent and duplicative requirements.

15. Carbon standards included in public and private schemes differ significantly in terms of their coverage of environmental and social impacts, as well as the criteria and thresholds used to assess sustainability. Servicing multiple markets becomes very difficult as a result of these differences, in particular for developing country suppliers. In the case of fuel regulation, the required levels of life-cycle GHG reductions for transport fuels generally (in the case of LCFSs), or biofuels in particular, can vary considerably. Qualifying biofuels in Switzerland, for example, must be able to demonstrate a minimum 40% reduction in life-cycle GHG emissions compared with fossil fuels, whereas the EU threshold is a 35% reduction, and in the United States it is a 20% reduction². Moreover, in Switzerland and the United States existing domestic producers are automatically assumed to meet the minimum standards, regardless of their actual GHG emissions. Countries of course enjoy the sovereign right to establish their own domestic environmental standards. The issue for trade is that heterogeneity among standards can narrow options or increase costs for exporters otherwise capable of supplying several markets at once.

16. The larger concerns relate to what trade experts call “conformity assessment”: the steps involved in determining, directly or indirectly, that a process, product, or service meets the relevant standard and fulfills its requirements.³ If the life-cycle emissions

of products could be measured with a precise device, or by direct observation, then meeting GHG-related product standards would be a relatively simple process, leading to few disagreements. But estimating life-cycle emissions is as much art as science. Consider:

- As is intrinsic to all LCA models, those used by importers to estimate the life-cycle emissions of different products, including imported products not produced domestically, involve the application of expert judgment, not always entirely scientifically based. In the case of LCAs for biofuels, the life-cycle assessment (LCA) models are typically run by government staff, and data inputs to the models approved by the government applying the regulations. It is not uncommon for the officially approved LCA models of different countries to yield different results for the same feedstock-biofuel combination produced under the same conditions. This can result from differences in system boundaries (i.e., what stages in the life-cycle are counted), parameter assumptions, and data.⁴
- As with all computable models, the results of LCA models are sensitive to their data inputs. Generally, those data are much better elaborated for developed countries and temperate crops.⁵ Data for some regions of the world, notably Africa, are very limited, forcing analysts to make broad and often inappropriate generalizations, or to fall back on “default” values. This is problematic since variables affecting actual farm-level emissions can vary greatly over short differences, and crop yields and fertilizer application rates can vary from one year to

⁴ More recently, one of the researchers who first drew attention to the problem of iLUC, has extended his analysis to argue that *all* GHG changes associated with the substitution of biofuels for fossil fuels are indirect. If his argument proves correct, then the logic intrinsic in the application of LCA to biofuels — which ignores emissions from combustion on the argument that they are recycled in the growth of the feedstock biomass is itself flawed. See T.D. Searchinger “Biofuels and the need for additional carbon”, *Environ. Res. Lett.* 5, 024007, 2010 (doi: 10.1088/1748-9326/5/2/024007).

⁵ See P. Brenton, G. Edwards-Jones, and M.F. Jensen, “Can Carbon Labeling Be Development Friendly? Recommendations on How to Improve Emerging Schemes”, *Economic Premise* (World Bank), No. 27, August 2010.

² Higher threshold apply to “advanced biofuels” (50%) and cellulosic ethanol (60%).

³ ISO/IEC Guide 2:2004.

the next. A further complication is that estimates of key parameters are dependent on the overall context of relative prices of inputs and outputs, which can change in response to new market conditions. And very different results can be obtained depending on whether the analyst assumes that the agricultural products (or biofuel feedstocks) are produced under marginal or average conditions prevalent in the geographic area for which the emissions are being estimated. Thus, even with identical system boundaries, results may still vary significantly.

- The cost of providing the data for complying may be high for small and medium-size enterprises (SMEs). In a recent conference of France's National Association for Foreign Trade in Frozen Food Products, for example, trade associations for SMEs expressed concerns about France's proposed environmental indications scheme, noting that they "may not have the resources to carry out detailed environmental impact analyses themselves and would therefore be allocated reference data based on conservative levels which may be penalising in a competitive environment."⁶ Similar concerns have been expressed by exporters of biofuels to countries with biofuels sustainability or low-carbon fuel standards.

17. The imprecision intrinsic to LCA-model results is likely one reason why retailers who have adopted product carbon footprint labeling, such as Casino and Leclerc in France, have been reluctant to compare footprints of similar products produced by competing brands. Casino has so far only labeled the carbon footprint of its own house brands, and Leclerc displays a generic carbon-footprint number on all the shelf (price) tags for a given product, such as milk or canned beans.

18. In the case of biofuels, an additional factor has been introduced in some countries' policies that creates even more imprecision in the life-cycle GHG estimates. In February 2008, two papers published in the prestigious journal, *Science*, pointed out that the

⁶ www.bordbia.ie/industry/services/alerts/Pages/ConcernsoverenvironmentalimpactlabellinginFrance.aspx.

diversion of existing crops to biofuels in one area could raise crop prices, thus encouraging the expansion of agriculture elsewhere (Searchinger et al., 2008; Fargione et al., 2008). If that expansion took place through the clearing of forests or the plowing up of carbon-rich soils, a huge carbon "debt" would be created that could take decades or even centuries to pay off through the substitution of biofuels for fossil fuels. Accounting for such indirect land-use change (iLUC) effects is now required in California's low-carbon fuel standard and in the U.S. EPA's Renewable Fuels Standard, and is being considered in the context of the EU's biofuels standard.

19. Importantly, the policy interest in the indirect land-use effects of biofuels is closely linked with the fact that biofuel use is being stimulated by public policies, generally in the name of reducing carbon emissions from transport. (Apart from the influence of good-nutrition campaigns, and food subsidies aimed at people on low incomes, the demand for non-biofuel agricultural commodities is largely market-driven.) Yet, at the margin, the indirect land-use effects of consuming a product derived from a given quantity of grain or oilseeds should be the same for, say, corn whiskey as for corn-derived fuel ethanol.⁷ But iLUC factors are being applied only to the latter and not to the former. On the other hand, GHG emissions (i.e., changes in carbon stocks) caused by land-use change are often accounted for differently in biofuel LCAs than for food LCAs. The PAS 2050 methodology, for example, requires that emissions from all land-use changes that occurred after 1990 be included in the carbon footprint of an agricultural product; in the EU's sustainability standard for biofuels, by contrast, emissions caused by direct land-use change are not counted if the land-use change occurred before January 2008.

20. These data and computational uncertainties cannot but affect the market prospects of concerned products. If consumers respond to carbon footprint labels, then an under-estimated carbon footprint may erroneously give the suppliers of that product a

⁷ Harry de Gorter and David R. Just, "Why Sustainability Standards for Biofuel Production Make Little Economic Sense", *Policy Analysis* (Cato Institute), No. 647 October 7, 2009.

small market advantage and actually lead to greater GHG emissions. Over-estimating emissions will have the opposite effect. To avoid misleading consumer information, retailers could be more explicit about the uncertainty of LCA results by displaying the range of values for each generic item, and explaining separately (e.g., in brochures) what factors give rise to that uncertainty. Alternatively, consumer information about the differences in life-cycle emissions among products, could be indicated by broad (color-coded) bands — for example, green for the lowest values, yellow and orange for in-between, and red for the worst — just as is done to indicate the energy efficiency of electrical appliances. Whether consumer comprehension of the information would thereby be improved has yet to be tested.

21. Impacts arising from uncertainties in LCA calculations' are even more significant in the case of biofuels, where a small difference in the estimated life-cycle emissions — if that difference would put it on either side of the minimum threshold value — can decide whether the supplier is able to benefit from a price premium or subsidies, or not. In the case of a low-carbon fuel standard, the assigned emissions determine a market premium that is proportional to how much lower its determined life-cycle GHG emissions are compared with its corresponding petroleum fuel — that is to say, every percentage-point improvement is worth real money.

22. Sustainability standards are likely here to stay. How can standard setters minimize potential trade conflicts while ensuring that carbon emissions reductions are real? Continuing international efforts towards developing comparable approaches to life-cycle assessment, and improving data, particularly relevant to developing countries, is clearly vital. Research aimed at better understanding the effects of agriculture on GHG emissions, and the effects of climate-change motivated policies on agricultural production patterns and practices, is also needed.

23. In the case of biofuels, some environmental groups have suggested radical changes in policies, including — e.g., requiring that only biofuels made from true waste products, or produced from land of low biodiversity value that will not support the growing of food crops, should be certified as “sustainably produced”. Such an approach would buy time — time to improve analytical tools and databases. Ultimately, however, as more and more countries adopt limits on GHG emissions, their governments will be compelled to address emissions from agriculture, and that will mean that some form of accounting will be required. The precedents created, and the lessons learned, from these initial forays into carbon-related standards, will thus be of utmost importance in shaping future policies aimed at reducing agriculture's carbon footprint.

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