Union of Concerned Scientists

The Equation

a blog on independent science + practical solutions

The Latest on Biofuels and Land Use: Progress to Report, but Challenges Remain

January 23, 2015 ***Jeremy Martin, senior scientist, Clean Vehicles***

Carbon pollution caused indirectly by the increasing use of crops to produce biofuels has been a contentious topic for the last 7 years. In this post I look back at what we have learned since then about indirect land use change (ILUC) emissions, as this phenomena is generally called. The headline 7 years ago – that crop-based biofuels are far worse than fossil fuels – no longer holds.

Both the studies and the world have changed. Agricultural markets are more flexible, deforestation has fallen in some key areas (Brazil in particular) and biofuels production is getting more efficient. The overall result is that biofuels are getting cleaner over time, and most biofuels are cleaner than gasoline. But the central importance of reducing biofuels impact on food and forests has been reaffirmed. Expanding the production of food-based fuels will not deliver the low carbon fuels we need to cut projected oil use in half and address climate change, and will cause many other problems. Fortunately we have better options.

What are indirect land use change emissions and why do they matter?

Prior to 2008, biofuels were considered a guilt-free energy source: cleaner than gasoline, good for farmers that produced the feedstocks, and available domestically at seemingly limitless scale. In February 2008 that changed when important papers in Science Magazine, particularly one by Searchinger and coauthors, raised the specter that as US corn ethanol consumed an ever greater share of U.S. crop production, cropland overseas was expanding to fill the void in food markets. Most concerning was the conversion of tropical forests to farmland. Since deforestation is itself a major source of carbon emissions, this shift undermines the potential climate benefits of crop-based biofuels. Searchinger and coauthors estimated that emissions from ILUC for corn ethanol were higher than the total emissions of using gasoline, leaving no potential for corn ethanol or other crop based biofuels in a low carbon transportation future. This concept resonated powerfully, reinforced by the related concern that using food for fuel could make food more expensive and aggravate food insecurity. Since then ILUC emissions have become an important and contentious part of the lifecycle analysis of biofuels and in the administration of fuel regulations that are based on such analyses.

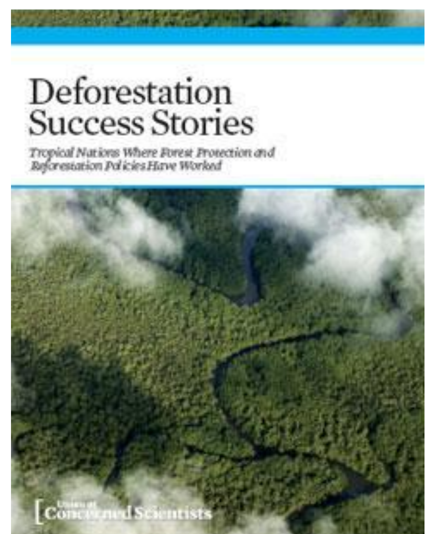
Experts across the country have been hard at work on this topic for the last 7 years, and have learned a great deal about ILUC. The headline conclusion of the 2008 paper, that corn ethanol's emissions are much higher than gasoline, has not survived careful scrutiny. Subsequent analyses found more flexibility in the agricultural system to expand production without large increases in deforestation, and deforestation in Brazil has slowed. California's most recent analysis finds ILUC emissions of about 20 grams of CO_2equivalent carbon pollution per megajoule of energy for the fuel produced (g /MJ), about 80% lower than the Searchinger's result. Nailing these numbers down remains challenging, and an uncertainty analysis finds plausible estimates range from 11 g/MJ to 37 g/MJ. However, these revised values mean that – when ILUC emissions are combined with all other emissions – corn ethanol produced at an average Midwestern facility using natural gas as a source of process heat is 20% cleaner than gasoline, and the cleanest facilities are better still.

Expanding agriculture to make more biofuels has real costs

However, the underlying notion that biofuels expansion is profoundly impacting agriculture has only gotten clearer. Numerous studies have looked at how biofuels expansion impacts land use, crop prices, food consumption, livestock, and the use of irrigation. The global food and agricultural system is complex, to say the least, and incorporating these modelling approaches into a regulatory framework is and will remain a major challenge. But every credible study finds that biofuels are a major player in global agricultural markets. It is clear that, going forward, sustainable biofuels must not only cut oil use and reduce emissions, but also protect food security and complement the agricultural system. For reasons ranging from climate change to water pollution to food price stability, expanding biofuels by moving more and more grain and vegetable oil into fuel markets is not smart transportation policy or smart food and agricultural policy.

Biofuels don't need to drive deforestation

Much of the analysis of ILUC has focused on corn ethanol and soybean biodiesel produced in the US and its link to deforestation in Brazil. This makes sense since the US and Brazil are the largest producers of ethanol and soy biodiesel and the largest producers of corn and soybeans, and Brazil is historically among the largest sources of carbon emissions from deforestation. But what was just starting to come into focus in 2008 was how much of an improvement Brazil was making in reducing deforestation. As my colleagues have described in their recent report, Deforestation Success Stories, Brazil has cut the rate of deforestation by three quarters and they have done this even as soybean and cattle production continue to grow.



Strategies for reducing deforestation are working in a variety of places. Understanding these success stories can help us turn them into a global success story.

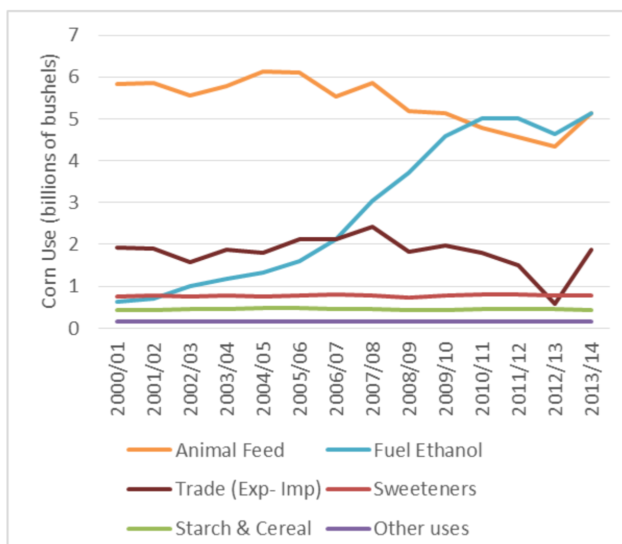
California's latest ILUC analysis suggests that most Brazilian cropland expansion is likely to come from pasture land , as cattle producers raise more cattle on fewer acres. Another important shift is *where*expansion is occurring, with cropland and pasture expansion occurring on previously cleared land in response to more robust forest protection. And recent analysis from Iowa State has shown that much of the increased production in Brazil from 2004 to 2012 came from farmers growing two or more crops per season, or harvesting more of what they plant. The progress in protecting forests together with these opportunities for intensification mean that the magnitude of deforestation associated with corn, soybeans and beef expansion is going down, which is great news.

The bad news is that deforestation in Southeast Asia is still a major concern, particularly driven by the expansion of palm oil production.Because of this, California's recent analysis found that palm oil biodiesel has ILUC emissions of 71 g/MJ, more than twice as high as soybean biodiesel and more than three times as high as corn ethanol. This means that palm oil-based biodiesel is more polluting than petroleum diesel. In the U.S. we don't use a lot of palm oil for biodiesel, but my colleagues are putting pressure on the major companies that use palm oil in household products and foods to stop the expansion of palm oil onto forests. And they are succeeding in getting important commitments from major U.S. companies (for example Hershey, General Mills and Proctor & Gamble) and global agricultural traders (for example Wilmar and Bunge).

Increasing biofuels production and supply chain efficiency

When assessing the performance and potential of a biofuel, it's important to look at ILUC alongside other factors. In 2008 when the ILUC debate got going, the general understanding (based on a model called GREET from Argonne National Lab) was that corn ethanol from a typical Midwestern facility would reduce emissions by about 20% compared to gasoline. Adding 103 g/MJ as Searchinger and coauthors suggested made corn ethanol far worse than gasoline, and even the 30 g/MJ (~30%) California's 2010 analysis found, was enough to make corn ethanol from a typical facility equal to or a little worse than gasoline. But corn ethanol production has been getting more efficient, and an updated version of GREET that reflects these efficiency gains finds that the direct emissions for Midwestern corn ethanol produced using natural gas are about 60 g/MJ or 40% cleaner than gasoline. Adding 20 g/MJ to account for ILUC emissions still leaves typical corn ethanol about 20% cleaner than gasoline. And for corn ethanol producers that adopt the most efficient technology in their production process, for example installing efficient combined heat and power systems, the emissions can come down even further.

Just because corn ethanol can be cleaner than gasoline doesn't mean we need more



While ILUC is just one factor of the lifecycle, the lifecycle itself is still just part of the story for biofuel impacts. And where corn ethanol is concerned, we have to talk about scale. U.S. corn ethanol production expanded rapidly over the last decade, as ethanol changed its role from a minor blending component (an oxygenate required to address air quality problems in some key regions) to its present role as a source of octane in E10 (a 10% ethanol gasoline blend) that is the main type of gasoline sold in the U.S. today. As consumption of corn for ethanol increased by 400 percent in just a decade, ethanol went from being a relatively minor use of corn to being the single largest use worldwide.

Continuing this expansion will make things worse, starting with the harm corn ethanol expansion has caused to water quality, but also the damage to the long term productivity of our agricultural system. My colleagues have outlined the need for a more balanced approach to farming, and for both dietary and environmental reasons, doubling down on corn won't help us get there.

The future of clean transportation is fueled by better biofuels (and electricity)

While more corn won't get us where we need to go, the good news is that we have a lot of biomass resources that are a better choice. These are waste materials from our cities andagricultural residues like corn stalks, as well as environmentally friendly perennial grasses. With these materials we can make enough cellulosic biofuel to easily double or triple biofuels production in the next twenty years, and these non-food based cellulosic biofuels can cut emissions up to 90% compared to gasoline. Just as important, these cellulosic biofuels can scale up while moving our agricultural system in a healthy and sustainable direction. Cellulosic biofuel production is coming on line now, and with policies that support the best biofuels, as well as more electric vehicles and continued efficiency improvements across the transportation sector, we can keep moving towards our goal ofcutting oil use in half in the next twenty years.
My conclusion after working in this area for 7 years is that we need to focus on three distinct areas

- **Make biofuels cleaner:** Move to more efficient and lower carbon production processes to reduce direct emissions along the whole supply chain.
- **Make biofuels out of better biomass:** Make a transition from food crops to sustainable sources of biomass.
- **Scale matters for food and forests:** Sources of waste fats and oils are available to produce a billion gallons of biodiesel a year but cause problems at 2 billion. Corn ethanol is already problematic at its current scale of more than 10 billion gallons a year, but would be catastrophic at 20 billion. And as biomass based fuels scale to more than 10 billion gallons a year, which will take a decade of steady growth, we'll need to calibrate their scale to not just meet our fuel needs, but to protect land for food, forests, and other needs as well.

About the author: Jeremy Martin is a scientist with expertise in the technology, lifecycle accounting, and water use of biofuels. He is working on policies to help commercialize the next generation of clean biofuels (made from waste and biomass rather than food) that can cut U.S. oil dependence and curb global warming. He holds a Ph.D. in chemistry with a minor in chemical engineering.