Growing Sustainable Biofuels: Common Sense on Biofuels – Part 1

Posted by Patrick Mazza on 03 March 08, 02:36 PM

By Patrick Mazza

Biofuels received a fresh surge of bad publicity with recent publication of two studies in *Science* that looked at the greenhouse gas releases caused by land use changes connected to biofuels production.

The studies make complex and nuanced statements that were predictably mangled by the press, with headlines easily interpreted as a general condemnation of biofuels. Typical was the *New York Times*, "Biofuels Deemed a Greenhouse Threat," The studies were creating new uncertainties even among biofuels supporters and tipping others toward a skeptical position. At very least the studies add to substantial public perception problems facing biofuels.

So it is crucial to line out exactly what the studies say, what they do not say, and what the critics are saying about the studies.

THE SEARCHINGER STUDY

The two studies appeared in the Feb. 7, 2008 of *Sciencexpress*. The first is by Timothy Searchinger et al, "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change." Here is what it says:

- Prior studies "have failed to count the carbon emissions that occur as farmers worldwide respond to higher prices and convert forest and grassland to new cropland to replace the grain (or cropland) diverted to biofuels."
- The study models an increase in U.S. corn ethanol of 56 billion liters above projected 2016 production levels. This would divert 12.8 million hectares of U.S. corn production to ethanol, bringing 10.8 million hectares of new cropland into cultivation, primarily in Brazil, China, India and the U.S.
- The study assumes that land converted to farming will release 25 percent of its soil carbon, an average of 351 metric tones per hectare.
- Employing a standard GREET model lifecycle analysis which assigns a 20 percent greenhouse gas reduction to corn ethanol compared to gasoline before indirect land use changes, researchers calculated that it would take 167 years to pay back soil carbon losses. Based on this researchers calculate that corn-ethanol would emit double the greenhouse gases of gasoline over the first 30 years after 2016.
- Cellulosic ethanol has far lower net emissions of greenhouse gases. But if switchgrass feedstock crops replace corn, the displacement effect would still require a 52-year carbon payback period.

- The study assumes average corn yields will stay the same. Researchers constructed a more positive scenario in which corn yields increase 20 percent, soil carbon emissions are only half of their estimates, and corn ethanol before land use changes reduces emissions 40 percent compared to gasoline. That scenario would reduce carbon payback time to 34 years.

It is important to specify that the Searchinger study does not say that current corn ethanol production increases greenhouse gases (GHGs). Its findings reflect land use changes tied to an increase in U.S. corn ethanol production approximately six times that of today.

THE FARGIONE STUDY

The second study, "Land Clearing and Biofuel Carbon Debt," by Joseph Fargione et al examines direct impacts of land clearing for biofuels crops. In other words, this is not about displacing food production, but about opening entirely new lands for biofuels feedstock growing. It gives carbon payback times for the following land conversions:

- Southeast Asian tropical rainforest to palm biodiesel – 86 years.
- Southeast Asian peatland rainforest to palm biodiesel – 423 years.
- Brazilian tropical rainforest to soy biodiesel – 319 years.
- Brazilian wooded Cerrado to sugarcane ethanol – 17 years.
- Brazilian grassland Cerrado to soy biodiesel – 37 years.
- US Midwest grassland to corn ethanol – 93 years.
- US Midwest conservation reserve lands to corn ethanol – 48 years.
- US Midwest conservation reserves to cellulosic ethanol – 1 year.
- US marginal croplands to cellulosic ethanol – no carbon payback time.

WHAT THE CRITICS SAY ABOUT THE STUDIES

Key U.S. biofuels lifecycle researchers weighed in with a series of critiques of Searchinger et al. Michael Wang of Argonne National Laboratory, developer of the GREET model, and Zia Haq of the US Department of Energy Biomass Program, gave these responses:

- Searchinger et al "correctly stated that the GREET model includes GHG emissions from direct land use changes associated with corn ethanol production."
- Argonne and other organizations are already updating their models to reflect indirect land use conversions.
- The corn ethanol growth figures used by Searchinger correlate to 30 billion gallons a year of production by 2015. However, the new federal renewable fuel standard caps corn ethanol production at 15 billion annual gallons. The Searchinger study "examined a corn production case that is not relevant to U.S. corn ethanol production in the next seven years."

- It is incorrect to assume no growth in corn yields. Yields have increased 800 percent over the past 100 years, and 1.6 percent annually since 1980. They could well gain two percent annually through 2020 and beyond.
- Searchinger does recognize that corn ethanol production also yields Distillers Grain and Solubles (DGS) animal feed byproducts but underestimates their protein value. Thus the study lowballs the contribution of coproducts by at least 23 percent, which drives up their estimates of farmland needed to replace feed corn.
- "There has also been no indication that U.S. corn ethanol production has so far caused indirect land use changes in other countries because U.S. corn exports have been maintained at around two billion bushels a year and because U.S. DGS exports have steadily increased in the past 10 years… It remains to be seen whether and how much direct and indirect land use changes will occur as a result of U.S. corn ethanol production."
- Wang and Haq cite a 2005 Oak Ridge National Laboratory on cellulosic potentials. "With no conversion for cropland in the United States, the study concludes that more than one billion tons of biomass resources are available each year from forest growth an byproducts, crop residues and perennial energy crops on marginal land. In fact, in the same issue of Sciencexpress as the Searchinger at al study is published, Fargione et al show beneficial GHG results for cellulosic ethanol."

Another critique comes from David Morris of the Institute for Local Self-Reliance:

- "The vast majority of corn that will be grown in 2008 will be on land that has been in corn production for many years, perhaps for generations."
- Future corn ethanol plants will achieve 2-4 times greater GHG emissions reductions than the GREET model estimates by converting to renewable energy, while future gasoline from unconventional sources such as tar sands will produce 30-70 percent more GHGs.
- No-till cultivation of corn adds 0.4-0.6 tons of soil carbon annually, which "would offset at least part of the carbon losses from bringing new land into production."
- Of 14 million new acres of U.S. corn cultivation in 2008, 60 percent came from soybeans, 97 percent of which goes into animal feed. Because of the DGS coproduct, only a fraction of an acre of soybeans are needed to replace an acre of corn.
- Even with 14 million acres of increased U.S. corn production in 2008, "the likely overall conclusion is that as of early 2008, ethanol production continues to reduce greenhouse gases."
- Most U.S. land conversion is due to urban and suburban development, with 2.2 million acres per year lost to farming.

SYNTHESIS: TOWARD LOW CARBON FUELS

Searchinger et al is a scenario of future ethanol growth rather than an assessment of biofuels use today. The researchers base their scenarios on an assumption virtually all observers believe is unlikely, 30 billion gallons per year of corn ethanol – 15 billion annual gallons is generally regarded as the peak, and that is why it is embodied in the federal fuels standard. The Searchinger study does seem to tend toward more pessimistic conclusions about ethanol efficiency and farm productivity, and is built on modeling assumptions about land use conversion for biofuels rather than observed real world experience. Nonetheless, both Searchinger and Fargione send a strong signal that we must take into account of the whole system by which a new economic sector is created – bioenergy. That has to account for indirect as well as direct land use impacts.

This understanding is already being developed. In fact, while the new studies came as a shock to many, they were no surprise to people who have been working in the sustainable biofuels arena. As a result of advocacy by Natural Resources Defense Council and other green groups, the new federal Renewable Fuels Standard contains greenhouse gas criteria. Corn ethanol must yield a 20 percent reduction. Cellulosic ethanol must reduce emissions 60 percent and other advanced biofuels 50 percent. The latter two represent 21 billion of the annual 36 billion gallon by 2022 standard. The lifecycle studies that measure emissions are mandated by law to include both direct and indirect land use impacts. The Environmental Protection Agency is now conducting those studies, which will be used in rulemaking to adopt the standard. (EPA can reduce goals 10 percent, for instance, corn ethanol to a net 10 percent GHG reduction.)

BOTH STUDIES POINT TO SUSTAINABLE BIOFUELS PATHWAYS

Contrary to the tone of much of the media coverage, neither of the studies counts out the potential environmental value of biofuels. Fargione's results for cellulosic ethanol points to highly sustainable biofuels production pathways, though other considerations such as wildlife and water use must be taken into account.

"Degraded and abandoned agricultural lands could be used to grow native perennials for biofuel production which could spare the destruction of native ecosystems and reduce GHG emissions," they write. "Diverse mixtures of native grasslands perennials growing on degraded soils, particularly mixtures containing both warm season grasses and legumes, have yield advantages over monocultures, provide GHG advantages from high rates of carbon storage in degraded soils, and offer wildlife benefits."

One of the coauthors, David Tilman of the University of Minnesota, was lead author on a previous *Science* study ("Carbon-Negative Biofuels from Low-Input High-Diversity Grassland Biomass," Dec. 8, 2006) which documented the environmental and productivity advantages of diverse perennials. They found that the gain in soil carbon as grasses sink deep roots more than makes up for all greenhouse gas releases in the full bioenergy lifecycle.

Fargione et al found other sustainable feedstock options: "Monocultures of perennial grass and woody species monocultures also offer GHG advantages over food-based crops, especially if sufficiently productive on degraded soils, as can slash and thinnings from sustainable forestry, animal and municipal wastes, and corn stover."

The Searchinger study also points to sustainable options: "This study highlights the value of biofuels from waste products because they can avoid land use change and its emissions. To avoid land use change altogether, biofuels must use carbon that would reenter the atmosphere without doing useful work that needs to be replaced, for example, municipal waste, crop wastes and fall grass harvests from reserve lands. Algae grown in the desert or feedstock produced on lands that generate little carbon today might also keep land us change emissions low, but the ability to produce biofuels feedstocks abundantly on unproductive lands remains questionable."

That last point does raise a prospective dilemma – Marginal farmland is marginal typically because it sustains lower productivity, and whether such lands can produce enough biomass per acre to be economically feasible is indeed questionable. But if farmers are financially rewarded for growing soil carbon as well as bioenergy feedstocks, biomass production could be lower. This combined growing of bioenergy and biocarbon might well be what it takes to provide incentives for both.

Today U.S. biofuel production centers on the Midwest, where well above 90 percent of all U.S. biofuels feedstocks are grown in corn fields. The Searchinger study focuses on the impacts of corn ethanol. It would be ironic if the new studies were taken as a signal to shut down biofuels development, since biofuels feedstocks in other U.S. regions will primarily come from sustainable feedstocks identified in the Searchinger and Fargione studies – waste streams, cellulose crops and algaes. For areas that have limited corn production capacity, such as the Northwest, these represent the prime biofuels opportunities. If anything, the new studies indicate a need for accelerated development of these new feedstocks and production technologies to take advantage of them.

Part 2 of "Common Sense on Biofuels" will cover the larger contexts of oil, food, carbon and politics that are shaping biofuels growth.

This is part of a series of articles on Growing Sustainable Biofuels by Climate Solutions Research Director Patrick Mazza, . Send comments to patrick@climatesolutions.org.