Biodiesel as a Greenhouse Gas Reduction Option[1]

A research report written by Michael Delucchi of the University of California – Davis suggests that the use of biofuels would increase greenhouse gas emissions as land is converted from forests, wetland and conservation reserve acres to grow more corn and soybeans. Some of these research results were also reported in a 2/18/04 Oxy-fuel News article written by Jack Peckham.

Land Use

Delucchi's greenhouse gas emissions evaluation of biofuels (biodiesel and ethanol) is largely based on the assumption that increases in feedstocks for ethanol and biodiesel will occur on "new" (not-otherwise-cultivated) land. In the United States, Delucchi assumes that the displaced land will be a mix mainly of CRP, pasture, fallow, and crops.

However, information in the latest USDA land use survey would indicate otherwise. From 1982 through 1997 there was a decline in cropland, while conservation reserve program (CRP) and forest land increased. That is at a time when total rural land declined; it became urban land instead. In the United States, it appears that we are not losing those carbon sinks to crops; we are losing them to urban development instead.

Land Cover/Use on Nonfederal Rural Land, by Land Capability Class and Subclass, and by Year

Land Class & Subclass	1982	1987	1992	1997
		(thousand acres)		
Cropland	420,954	406,639	382,315	376,998
CRP land	0	13,801	34,042	32,696
Pastureland	132,006	128,114	126,048	119,992
Rangeland	416,739	411,104	407,380	405,977
Forest land	403,338	405,256	405,207	406,955
Other rural land	49,648	49,931	50,626	51,142
Total rural land	1,422,686	1,414,846	1,405,617	1,393,760

Source: Table 4 of Summary Report, 1997 National Resources Inventory, Revised December 2000

With cropland acres decreasing from 1982-1997, where will the corn and soybeans come from that will be used for biofuels? The fact is the feedstock is already available. American farmers grow more corn and soybeans than can be used in this country. In fact over 12.8% of the soybean oil produced in this country during the 2001/02 and 2002/03 crop years was exported,

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the equivalent of about 320 million gallons of neat biodiesel annually. In addition to the exports of soybean oil, over 37% of soybeans produced were exported during this same time frame, providing additional oil if those soybeans were processed in the US. Since biodiesel can be made from any vegetable oil or animal fat, increases in biodiesel demand can be met from other feedstocks such as yellow grease, animal fats, and other vegetable oils.

Secondly, technology advances will continue to increase yields per acre. From 1990 to 2001, average soybean yields increased by 19.5% per acre, from 31.06 bushels/acre to 37.12 bushels/acre. Technology can do that again in the next decade, if there is demand and prices that will justify ever increasing efficiency.

The American Soybean Association and the National Biodiesel Board do not support reductions in CRP acres and support a zero net loss policy towards wetlands. We believe that continued increases in soybean yields per acre coupled with the normal ebb and flow of cropland between various crops can provide a readily available supply of soybean oil to meet expected demand for biodiesel and at the same time foster and encourage the growth and development of a biodiesel industry that will help to lessen our dependence on foreign oil.

Greenhouse Gas Emissions

N_2O Emissions

Delucchi concludes in his study that the use of biofuels actually increases the lifecycle greenhouse gas emissions. His conclusions are based upon models that estimate N_20 emission from nitrogen fertilizer application, releases of N_20 due to leaching and erosion and the deposition of atmospheric nitrogen to the soil. Much of the assumptions for soybeans are based on studies making global agronomic assessments. He also assumes that the potential emissions from the nitrogen fixed in the plants are a major contributor to biodiesel lifecycle greenhouse gas emissions. Unfortunately, the studies that are cited produce no definitive conclusions about N_20 emissions from the soybean plant and are unable to scientifically substantiate this hypothesis.

The average soybean acre receives only 2.5 pounds of nitrogen fertilizer and 3.6 lbs of phosphate fertilizer annually. Annual nitrogen leaching and runoff was estimated to be 142.5 grams (five ounces), while phosphate runoff from soybean fields was estimated to be 21 grams (or about three quarters of an ounce) per acre posing an insignificant contribution to surface water eutrophication.

CO_2 Emissions

Delucchi also doubts the existence of CO_2 benefits from corn and soybean production when he refers to them as a “supposed benefit”.

They are not “supposed.” It is a fact that soybean oil contains 75% carbon by weight and that carbon came from the plant taking up CO_2 from the atmosphere. If you convert carbon back to CO_2 then every pound of soybean oil contains the equivalent of 2.77 lbs of CO_2 that was taken out of the atmosphere. Petroleum or natural gas used as fuel cannot make the same claim. The net effect on greenhouse gases (total emissions from production and use, less GHG removed by the crop) are much lower for ethanol or biodiesel than they are for gasoline or petro-diesel.

A recent life cycle inventory produced by the National Institute of Science and Technology published in April 2003, showed that

- when all of the carbon dioxide emissions associated with soybean production were totaled, including all fuel burned not only in the field but also in the production and transportation of all inputs such as seed, fertilizer and electricity, that the growing plants still *reduced* total atmospheric CO_2 by 1.56 million grams or 1.75 tons per acre.
- It also showed that total nitrous oxide emissions for soybean agriculture, based on an earlier EPA Inventory of Greenhouse gas Emissions and Sinks 1990-2000 were only 2.469 grams (less than one tenth of an ounce) per acre. That is roughly equivalent to the amount of nitrous oxide found in a can of whipped cream.
- The study also found no reportable methane emissions (the third major greenhouse gas) associated with soybean production.

Deluchhi's model also appears to completely ignore the Life Cycle Inventory Study of Biodiesel and Diesel Fuel completed in May 1998 by the U.S. Department of Agriculture and the U.S. Department of Energy. This study concluded that biodiesel reduces net emissions of CO_2 by 78% compared to petroleum diesel.

Summary

While Delucchi tries to take a comprehensive approach to analyzing the life cycle emissions from various fuels, his models calculating greenhouse gas emissions from biodiesel and ethanol are based on many unproven assumptions that can significantly over report greenhouse gases emissions from biofuels. Delucchi, himself, concedes that there is significant uncertainty in several key variables in the emissions models. A few of these are taken directly from Delucchi's report:

> *The CO_2-equivalency factors (CEFs) for all Non-CO_2 greenhouse gases.* The uncertainty in the CEFs for CH_4, N_20, N (as NOx, or nitrogen in fertilizer), $S0_2$, and PM can have a significant effect on the overall results. The uncertainty in the CEFs for CO and NMOCs is less important: varying these CEFs over their likely range of values does not significantly affect the results. In any case, the uncertainty in the CEFs runs deep: most of the existing estimates do not incorporate several important effects, and in many cases the effects considered are not well characterized.
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> *Emissions related to changes in cultivation and land use.* In the biomass fuel cycles, the most uncertain and important parameters, aside from those mentioned above, are those that represent which land uses (e.g., forests, pasture land, or agricultural land) are replaced by which energy crop systems (corn, soybeans, switchgrass, or SRIC trees), and those pertaining to N_20 emissions related to nitrogen fertilizer inputs. In some cases (e.g, the biodiesel fuel cycle), uncertainty regarding N inputs can have an enormous impact on fuel cycle CO_2-equivalent emissions.

The effect of quantity changes on prices and hence demand and ultimately, supply in other markets. In a few instances I account, crudely, for economic effects in the markets for products related to the co-products of fuel cycles (e.g., in markets for electricity affected by the generation of power from excess lignin in biomass-to-ethanol plants). The values of these parameters are uncertain and can significantly affect fuel cycle CO_2- equivalent emissions.

The fact is American soybean farmers have made great strides in improving production practices and reducing their environmental footprint. Conservation tillage is practiced on over 75% of soybean acres today. One result is that fuel use declined significantly during the 1990s to an average of only 17 liters or less than 4.5 gallons of diesel fuel per acre for an entire season from planting through harvest. Put another way, about one-twelfth of a gallon of diesel is used to grow the soybeans to make one gallon of biodiesel, plus an additional 50 pounds of soybean meal used to feed humans and animals.

Biodiesel vs. Petroleum Diesel

- Neat biodiesel reduces the net gain in CO_2 emissions by 78% compared to petroleum fuel.
- Biodiesel also reduces tailpipe emissions of particulate matter (soot or black carbon) by 47% which is fast becoming recognized as a major contributor to global warming as well as a critical air pollutant associated with reduced human health, particularly among children and asthmatics.
- Soybean oil and biodiesel contain no sulfur and generate no sulfur emissions, a major source of acidification in rain and surface water. The EPA has moved to limit sulfur content in diesel fuels for this reason.
- Biodiesel reduces this country's dependence upon fossil fuels and upon foreign sources of oil.