

Biofuels Are an Environmental Dead End

By Tom Philpott, Grist Magazine. Posted December 13, 2006.

Tom Philpott questions biofuels skeptic extraordinaire David Pimentel about why crop-based energy won't work.

Any worthy idea can withstand and even be improved by naysayers; scolds and skeptics play the useful role of pointing out obvious flaws. The biofuels industry has no more persistent, articulate, and scathing critic than David Pimentel, professor emeritus of entomology at Cornell University.

In 1979, with the price of oil surging and a politically connected company called Archer Daniels Midland investing heavily in ethanol production, the U.S. Department of Energy invited Pimentel to chair an advisory committee to look at ethanol as a gasoline alternative. The committee's conclusion: ethanol requires more energy to produce than it delivers.

That assessment didn't stop the government from enacting a variety of subsidies for ethanol, which has since developed into a multibillion-dollar industry. Nor has Pimentel refrained from issuing a series of scholarly articles claiming to show that, after decades of steady government support, ethanol remains an energy bust.

Over the years, Pimentel has become an increasingly controversial figure. The U.S. Department of Agriculture now claims that corn ethanol delivers a modestly positive net energy balance [PDF], a conclusion recently endorsed by a study from University of Minnesota researchers. Yet Pimentel's provocations continue. Not only is corn-based ethanol a net energy consumer, he says, but cellulosic ethanol -- simultaneously biofuel's holy grail and sacred cow -- is "worse."

Pimentel thinks biofuels are an environmental dead end and enthusiasts for crop-based energy would do well to at least examine his analysis.

Philpott: You claim corn ethanol's energy balance is negative, and there's a growing consensus that it's positive. Why the difference?

Pimentel: Pro-ethanol people make it out to be positive by omitting many of the inputs that go into corn production. For example, they omit the farm labor -- I'm not talking about the farm family, I'm talking about the farm labor. They omit the farm machinery. They omit the energy to produce the hybrid corn. They omit the irrigation. I could go on and on. Anyway, if I did all of those manipulations, I could achieve also a positive return.

However, that's not the way these assessments are made. You can go check the noted agricultural economists who have looked at corn as well as other crops, and they do include the labor, they include the farm machinery, they include repair of the farm machinery, and so forth and so on. And so, those are all inputs that the ag economists include. Why are the pro-ethanol people leaving them out?

Philpott: When you say that the ethanol crowd fails to include the farm machinery, are you talking about the energy that's needed to manufacture a tractor, for example?

Pimentel: That's right. Or an automobile used by the farmer.

Philpott: From your experience, how do these researchers justify that omission?

Pimentel: They don't. They just omit it.

Philpott: I also see that in your studies, your calculation of how much energy goes into producing synthetic fertilizer is higher than the USDA's assessment. Why that difference?

Pimentel: Our data come from the U.N. Food and Agriculture Organization. We're actually using a lower number than [the FAO's]. We're using 16,000 kilocalories per kilogram [of fertilizer], and I say the FAO is using 18,000. So again, we're using the most accurate data that are available, and not trying to manipulate these numbers.

Philpott: Another place where you clash with other researchers is over the byproducts of ethanol: stuff like

distillers grains that go into animal feed, etc. For those researchers, byproducts are what push ethanol's energy balance solidly onto positive ground.

Pimentel: We do account for it. Distillers grains, incidentally, are being used as a substitute for soybean meal. So we went back to the soybean meal, and examined how it's produced, and the energy that is required to produce it. Instead of giving [distillers grains] a 40 to 60 percent credit as the pro-ethanol people do, we found that the credit should be more like 9 percent. They [pro-ethanol researchers] are manipulating the data again.

Philpott: All of that is very controversial, but let's get to the really provocative part of your work. You claim cellulosic ethanol's energy balance is "worse" than that of conventional ethanol. How can that be?

Pimentel: It's quite easy. Number one, if you have a handful of sawdust, and a handful of corn, which one has the most starches and sugars? That's easy. It takes almost twice as much sawdust to make the same gross energy as [corn] from cellulose, or wood.

Number two, it takes two additional treatments to release the starches and sugars [from cellulose]. That is, you're going to treat the cellulose. It's held by the lignin, and the lignin is the stuff that holds the trees up straight. And the cellulose is trapped inside that lignin. And you've got to release it, and that requires an acid or an enzyme. And so that's one treatment, and then you've got to use an alkali to stop the acidity at some stage. And now you can introduce the bugs for the fermentation. But No. 1, it takes more cellulose, and No. 2, you've got two additional treatments.

Philpott: But wouldn't the response to that be that it's a lot less energy intensive to grow material for cellulosic ethanol because you don't need to focus on plants that have high sugar concentrations?

Pimentel: That's right. And we did that [in a recent study (PDF)]. But we found negative energy balances for both wood and switchgrass.

Philpott: Don't you figure that after 35 years the industry will figure out how to make cellulosic ethanol work? We're always hearing about a big breakthrough that's about to happen.

Pimentel: Well, we know how to make it work. The question is, can you do it energetically, with small amounts of energy? That I seriously doubt.

Philpott: You recently wrote that "green plants in the United States collect about 53 exajoules of energy per year from sunlight. Americans consume slightly more than twice that amount, however." How did you arrive at these figures?

Pimentel: All you do is sit down with a pencil and paper, total up all the crops being produced, along with any of the additional biomass that goes with it. Like with corn, you not only total up the corn, but the corn stalks. You total up all the crops, and then with the wood material, you total up all the annual production in forests, and we use a rather optimistic number, three tons per hectare per year, under a range of conditions. So you can make this calculation yourself.

Philpott: So if we converted 100 percent of a year's worth of solar energy stored in plant matter to fuel, we'd only supply half of our current energy consumption. What's that telling us?

Pimentel: It's telling us we're using too goddamn much fossil energy! And another thing it tells us is that you're not going to be self-sufficient, or even produce half of our energy from biomass in the U.S., if we want to eat. And that's using an optimistic figure for ethanol production. I don't know why [biofuel proponents] don't sit down with pencil and paper and make these calculations instead of spouting off on all the wonderful things we can achieve.

Philpott: One of your critics, David Morris, has written [PDF] that the basic thrust of your work is that "the world's population has vastly exceeded its biological carrying capacity." Is that an accurate characterization?

Pimentel: Yes. The World Health Organization is reporting now that we've got 3.7 billion people who are malnourished on Earth. That's about 60 percent of the world population, and that problem has been getting worse each year.

Now look at the production of cereal grains per capita. That's an important number, because it is per capita that we

eat and utilize resources. And you will note that since 1983, per capita grain production has been declining continuously. Declining for more than 20 years. Now why?

Philpott: Population growth, right? Because overall production has actually risen over that same time.

Pimentel: That's right. But it's not increasing as fast as the population.

Philpott: What do you think about the prospects for sustainable or organic agriculture to meet these increasing population demands?

Pimentel: I don't want to say that organic can supply all the food in the world, but it can be much more sustainable than conventional ag and just as productive. I recently coauthored a 22-year study of organic agriculture utilizing corn and soybeans, which are certainly two dominant crops in the United States. Yes, we can produce these crops organically, with less energy, while improving the sustainability of the soil. [The study involved] rotating corn with soybeans in conjunction with cover crops. We had one field that was dependent on legume cover crops [for fertility], and one dependent on manure.

Philpott: Which came out better?

Pimentel: Well, the manure was slightly better in terms of increasing soil organic matter. Slightly ... I think the yields were about the same. In both cases, the yields equaled those in conventional corn.

Philpott: Now let me ask you a trick question. What if we took some of that organic corn and soy and turned it into ethanol and biodiesel? Would that achieve a positive energy balance?

Pimentel: No! It's not going to do it. It certainly would improve [the energy balance], because we were able to reduce the energy inputs for corn by about 30 percent.

Philpott: Is it theoretically possible to turn biomass into a fuel with a positive net balance?

Pimentel: The difficulty is that plants do not collect very much solar energy. On average, plants collect one-tenth of one percent of the solar energy available. Photovoltaic solar cells collect at least 10 percent, which means 100 times the energy collected by plants. But you can get a positive energy balance by simply burning biomass.

Philpott: But not by converting it into a liquid fuel?

Pimentel: No. I don't care what kind of imagination you have, it won't work.

Philpott: A lot of earnest people support biofuels as a way to reduce greenhouse-gas emissions and displace fossil fuels. What do you tell them?

Pimentel: Conserve! One word. And no one talks about it, including the environmentalists. When these people talk about biofuels providing us with our energy, they need to look at the facts right now. Eighteen percent of all corn is going into ethanol production. We're getting 4.5 million gallons of ethanol. That's 1 percent of U.S. petroleum use. It's 1 percent.

If we use 100 percent of U.S. corn, and we won't do that, but if we used 100 percent, what would that do for us? Six percent. And ethanol is being subsidized at 45 times the rate of gasoline.

Grist staff writer Tom Philpott farms and cooks at Maverick Farms, a sustainable-agriculture nonprofit and small farm in the Blue Ridge Mountains of North Carolina.

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