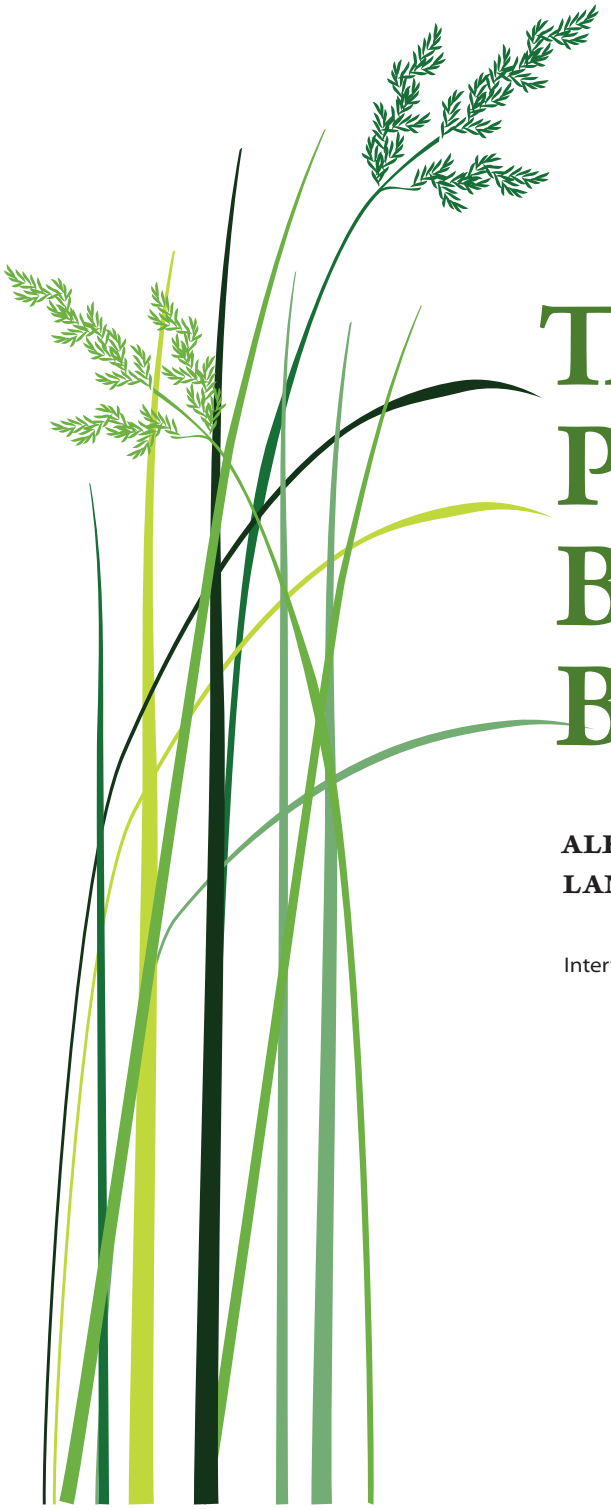

The Path to Better Biofuels

ALEX FARRELL ON THE LATEST LAND USE STUDIES

Interview by Andrew Plemmons Pratt

TWO STUDIES indicating that biofuel production may emit more greenhouse gases than the gasoline the fuels displace appeared this February in *Science*. Mainstream media headlines were quick to declare biofuels a threat to the planet. But a knee-jerk response to the latest research could obscure the fruitful guidance the new studies provide and confuse the policies that reduce emissions with those that pump more carbon into the air. Biofuels are not necessarily bad, but growing feedstocks on land that competes for food or wilderness is counterproductive. The studies focus on this land use issue and the carbon released when farmers in the United States convert forests or grasslands to cropland to make up for the grain diverted to biofuel production. The new calculations indicate that while many promising feedstocks do absorb carbon as they grow and do offset emissions from the gasoline they replace, it can take decades or centuries for absorption and displacement to balance out the carbon released from converting the land and sacrificing the previous ecosystems.

To better understand the policy implications of the new work and how it can steer farmers and policy makers towards better biofuels, *Science Progress* spoke with the late Alex Farrell, who was an associate professor in the Energy and Resources Group at the University of California, Berkeley. Farrell died in April. As his colleague Dan Kammen, a professor in the Energy and Resources Group and of public policy, said at the time, he was "one of the leading lights in the area of low-carbon fuels and energy systems." Kammen added that, "The trajectory of his career and his contributions were both impressive."

ANDREW PLEMMONS PRATT, *SCIENCE PROGRESS*: These latest papers, from the Searchinger group and the Nature Conservancy/University of Minnesota group, claim that previous studies of carbon life-cycle emissions of biofuels ignored land use. This seems like a substantial oversight. How did previous researchers miss this, and how significant are these revisions to previous emissions estimates?

FARRELL: The Searchinger paper is a very important paper. They have made the first effort to quantify the effects of producing biofuels as they ripple through the global economy. Other people have looked at this in the past, but not in the same kind of way. Mark Delucchi from the University of California-Davis has looked at this, and you can find research papers on his website. But the reason it has tended not to be evaluated very much in the past is that it's a difficult thing to do. You need to use a model of the global economy, and no one's really tried before.

The most important thing is to think about land. Using land to produce biofuels essentially competes with using land for food production or keeping land in wilderness. We have three possible ways to use land: wilderness, fuel production, and food production. The way we produce biofuels today, if you do one, you don't really get a chance to do the other. You have to account for wilderness—rainforests, or even grasslands here in the United States—because these lands have a lot of stored carbon in them. So when you convert the wilderness—weather it's grassland or rainforest—into an agricultural operation of some sort, you release a lot of this carbon. Usually, you're burning the material on the surface, and turning over the soil so it gets oxidized. It's the release of carbon dioxide from the conversion of the wilderness to agricultural production that is the problem.

I'll give you a quick example to understand why it is a little complicated to understand how you might calculate this value. Imagine that I am a corn farmer and that I am in a corn/soy rotation. One year I plant corn; next year I plant soy, and back and forth. You build an ethanol plant near me and I decide I'm going to continuous corn. What that means is that the soy production is now less in the United States than it would have been otherwise. And so U.S. exports for soy go down a little bit compared to what they would have been without this ethanol plant. The price of soy internationally goes up just a little bit, and now farmers all over the world have an incentive to either farm a little more intensively—to use a little more pesticide, for instance—or to accelerate the expansion of wilderness land for agricultural production. This is in the context of expanding populations and people eating more meat, etc. But it is an effect that exists because we have a global economy.

This expansion—because we've got more ethanol production that is now placing land in competition for food and for wilderness—yields these greenhouse gas emissions. That's the basic effect. Other people have not looked at it partially because it's a very challenging to simulate all those market interactions, and partially because the other part of the calculation, a direct process emission, is also relatively challenging, and so people have just been working on the direct emissions part for the last several years.

***SP*:** Are biofuels bad? A lot of headlines over the past few days suggest just that.

FARRELL: The answer is "not necessarily." Biofuels are not necessarily bad. What really matters to answer that question is how the material for the biofuel is produced. If the material for the biofuel is produced on land so that it competes with wilderness and food, that's a problem. But if it's produced in a way that does not compete for land with other uses like wilderness and food, then you probably avoid most or all of the problems. And there are ways to do this. There are at least three strategies to make what I call "better biofuels."

The first strategy is to use waste and residues—things that really are waste that are not otherwise

used. Many of them are things that we can turn into biofuels.

The second strategy is to use land that does not compete for wilderness or food. This could be severely degraded land or marginal land that you can't get a crop on. There's a proposal to grow mixed prairie grasses on degraded land in the Midwest and to harvest it a couple of times a year, allowing the carbon in the soil to continue to build up and produce a very healthy soil bank. But you could also restore degraded land to natural ecosystems and you should consider that option, too.

The third strategy would be to integrate the production of biofuel feedstocks with food production. We don't do that very much right now. It's a little bit more subtle, so let me give you an example. In California, there are some farmers who cannot make a profit on a crop in the wintertime, but they could grow a cover crop—alfalfa, or mustard, or clover—if they wanted to, but they can't really make enough money doing it. But if they could take this cover crop and sell it for biofuel production, they could actually make a profit and not effect food yields whatsoever.

So there are three strategies that can help solve this problem and that can help develop these better biofuels. An important feature of these three strategies is that they all require advanced technologies, whether it's cellulosic ethanol production, or growing algae in the desert. The desert does not compete for the use of land for food or for wilderness because there's not very much carbon in desert wilderness. There are several different strategies, but they all require advanced technologies, and that's the way out of this problem.

***SP*:** Could these new reports damage the policy making process with regard to clean fuels? What should policymakers take away from the reports?

FARRELL: I think the most important lesson to take away from these newest reports is that not all biofuels are created equal. If we want clean biofuels, then we need to demand or incentivize clean biofuels. And recent policy decisions are moving in that direction. Let me mention just two.

One is in California. We have the low carbon fuel standard here in California. Also, in the Lieberman-Warner bill, there is an emission cap that would include transportation. So those types of policies that actually measure what we're interested in—which is low greenhouse gas emissions, among other things—those are the right kind of policies, and they provide the correct incentives to allow companies to bring these advanced technologies to the market, and for farmers to figure out how to grow better biofuels and produce them.

The second one that I would mention is the recent energy bill, which includes some provisions for advanced biofuels that require a standard of performance for low greenhouse gases, with different types of performance standards for different types of fuels. Those parts of the provision are very important. They will help move the biofuels industry in the right direction. In fact they're essential to the biofuel industry, because those kinds of incentives will enable to biofuel industry to develop and sell the products that will have a market in the future. The way out is to create markets for these greener biofuels, as well as providing research and development support. We have some of that already, but we could certainly use more.

***SP*:** Will current renewable fuel standards push biofuels in the right direction?

FARRELL: I think it's important to say that the current renewable fuel standard also has provisions that grandfather in the current corn ethanol industry, and over time we need to think of a strategy to help transform that industry, giving it a much cleaner approach. It might be possible, for instance, to retrofit the existing biorefineries. Attending to that is correct, but we need to get these technologies in place first, and I do think there is some urgency to do this because the climate problem is an important one; it's getting worse as time goes on.

SP: The Searchinger paper in particular seems to conclude that biofuel production will necessarily increase food prices. What's the effect on food prices of increasing biofuel production both domestically and internationally? You were saying this is a complicated issue that we're only beginning to understand. Is this going to be harder on developing nations than it's going to be on the U.S.?

FARRELL: Unfortunately, I think the answer to that question is probably yes. I think it's important to say that the Searchinger paper is the first attempt to calculate these effects. This calculation of how biofuel production ripples through the global economy is difficult, and I would hope to see other individuals and groups attempt do these calculations and come up with these sorts of estimates, because it's an important thing to look at. The magnitude of the effect is not at all clear, but I think it is clear that there is an effect. That said, the people who will individually be hurt the most will be very low income people in developing counties who have to buy their food. The reason is that in the United States food prices will not change very much because the actual cost of the raw material that goes into food, like the corn that goes into the corn products that we eat, is pretty small compared to the processing and the packaging. But for people who are relatively low income in developing countries, the actual price of the commodity itself is a very high portion of the actual price that they pay, and they can barely afford to buy some of these food products. Because the basic mechanism is that increased demand and competition increases the price for the basic product—whether it's corn or vegetable oil—that is going to lead to some people being less able to afford food. But we can get away from that problem by getting away from biofuels that compete for food production and that compete for wilderness.

SP: How do these current reports influence thinking about the transition that biofuels offer as a bridge to solutions that will get us to the greenhouse gas emissions targets? Are biofuels a bridge technology to other better solutions, or are they a useful end in and of themselves?

One of the questions will be, "What is the mix between biofuels, electricity, hydrogen, and other things that we might imagine?"

FARRELL: I think that these "better biofuels" that I have in mind, and that people are working on right now, could be part of the solution in the end if they're done right. Let's be clear that there are pilot plants that are funded by the U.S. Department of Energy that are being built right now. One of the questions will be, "What is the mix between biofuels, electricity, hydrogen, and other things that we might imagine?" So I do think there is almost certainly a role for biofuels in the long future. A combination of innovative technologies and policies that get the industry to move in the right direction will get us there.

SP: What is the final lesson?

FARRELL: This will be a very important economic issue for developing countries that have planned to export biofuels. Understanding how to help them develop their economies while preserving their forests and their ecosystems is a very important task. To some degree, this points to the problem that we are undervaluing forests and grasslands and wilderness for their carbon storage. If we were to fix that problem—which was discussed at some length at the Bali climate convention a few months ago—we would go a long way to fixing this overall problem. sp