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BELATED EARTH DAY STATE OF THE POTTY DIALECTIC: WASTEWATER-BASED FERTILIZATION OF BIOENERGY CROPS

Preface

***General Jack D. Ripper**: Mandrake, do you recall what Clemenceau once said about war?*
***Group Capt. Lionel Mandrake**: No, I don't think I do, sir, no.*
***General Jack D. Ripper**: He said war was too important to be left to the generals. When he said that, 50 years ago, he might have been right. But today, war is too important to be left to politicians. They have neither the time, the training, nor the inclination for strategic thought. I can no longer sit back and allow Communist infiltration, Communist indoctrination, Communist subversion and the international Communist conspiracy to sap and impurify all of our precious bodily fluids.*

Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb (1964)

"Little did we know as we repeatedly desecrated the sign of [a neighboring] fraternity house in the late 1970's that we were literally pissing away our futures."

Unattributed quote by a member of the class of 1980 at a small southern university.

It is my distinct and indelicate privilege on behalf of the class of 1980 to discuss with you, almost fifty years after General Ripper's memorable line, the state of Americans' precious bodily fluids. I can't speak to all of his concerns, but it does seem like some things have gotten much better. We have done a fairly good job under the Clean Water Act of cleaning up the dumping into our waterways, although more work still needs to be done. But it does seem to me that we have a way to go before we are reaching the full potential for at least some of our fluids, if not our solids as well. Fortunately, it is not too late. The future is still …

Introduction

Anyone who wants to talk to you about urine—especially urine in relation to emerging bioenergy crops, some of which may not need much phosphorus, and in a state or region that is currently struggling with too much P from chicken litter—is probably justifiably viewed rather like General Ripper. But I come in peace. I am also utterly serious about this topic (although no one doubted General Ripper's sincerity either). At least listen to what my possibly paranoid pointy head has to say.

Americans undoubtedly do have a variety of conflicting views toward many things, including agriculture and corollary subjects like bioenergy, crop programs, and sustainability. As discussed in this essay, in some ways this polarization only intensifies when one examines questions from an international perspective. One does not have to be a conspiracy theorist to recognize that, at the international level, real or perceived issues of food security, land use, and, increasingly, agricultural input use, are sometimes seen to be in conflict with bioenergy production, particularly intensive biofuel crop production by industrialized nations.

I will not ask you to succumb to the fear that "we," either nationally or internationally, experience this polarization at our or our grandchildren's peril. Unlike General Ripper, I don't have that much clarity on these issues. By all means, feel free to disagree with me on the need to focus on cooperation and sustainability as a moral or utilitarian imperative.

But please realize that the very fact that there will likely be serious disagreements concerning agricultural topics means that those working in industrialized agriculture in developed nations, not least those working in bioenergy production: (1) may be affected by the outcome of these disagreements, and (2) therefore should try to be aware of the ramifications of, and possibilities for addressing, these disagreements.

By way of disclosure, this is not a purely academic discussion to me, although I am admittedly more detached than many who care about American and international agriculture. I don't live or work on a farm or in an agricultural occupation at the present time, unless you want to call my organic garden (which admittedly is an occasional recipient of wastewater-derived fertilizer blended from tap water and you know what) a suburban subsistence farm. My paternal grandfather came to America from tiny La Gomera in the Canary Islands, where much of the populace still lives off water-starved terrace farms that have existed for centuries or longer. Meanwhile, on the other side of the Atlantic, my cousin Johnny is an American farmer struggling to keep land that has been in the hands of my mother's extended family for generations.

I am going to refer quite a bit to Johnnie in this introduction. Because he is a modest fellow, and because this essay would further confirm to him that I am a fool, I hope he never reads this. He knows what works in his real southeastern agricultural world of uncertain weather, markets, and pestilence. He is an extremely honest and good man who goes to church where our kinfolk are buried. He violates only one commandment, and that one only arguably, because I think there is a farmer exemption to the commandment to take off all of the Sabbath day.

Currently, he intensively grows corn for ethanol in clay soil that once grew corn for bootleg liquor and a variety of other crops to varying degrees of success, allowing my mother's family to survive but never thrive. He rarely leaves the county or sees a doctor. By necessity, he uses a pick-up or a tractor until he can use it no more. He missed the coming of the flat screen television but does have a cell phone and keeps up on every detail of his crops. He does not talk much and politely gets back to work when I try to converse with him for more than two minutes. He will eat a piece of fried chicken at the annual June family reunion then get back in the truck before I can ask him about his views on the Millennium Development Goals. In part because Johnny is too busy surviving to join me in this search for truth, I am going to ask you to join me.

My wife rolled her eyes when I told her at breakfast the other day that the World Health Organization's "Guidelines for the Safe Use of Wastewater, Excreta and Greywater" was possibly the most exciting book I have ever read. Published in 2006, this four volume set is a masterful balanced view of the actual and potential use of domestic wastewater in agriculture. I say masterful because it covers much of the topic so methodically, and balanced because, starting with its first paragraph, it reflects the nuanced tension of two competing needs that weigh heavy on the do-gooder's heart:

> The United Nations General Assembly (2000) adopted the Millennium Development Goals (MDGs) on 8 September 2000. The MDGs that are most directly related to the safe use of wastewater, excreta and greywater in agriculture and aquaculture are "Goal 1: Eliminate extreme poverty and hunger" and "Goal 7: Ensure environmental sustainability." *The use of wastewater, excreta and greywater in agriculture and aquaculture can help communities to grow more food and make use of precious water and nutrient resources. However, it should be done safely to maximize public health gains and environmental benefits.*

(WHO 2006, 1.vii; emphasis added.)

Thus, from the outset the report recognizes that protection of health and the environment must be balanced with real world choices, including the fact that people in much of the world have few options and struggle for food security. This report is the treatise on the health-perspective in relation to human wastewater usage. Despite its breadth, however, it is not definitive on all issues relating to wastewater.

For instance, it does not even mention the word struvite, a promising wastewater-derived fertilizer input (discussed below) that may be needed for wastewater to make a nutrient-recovery impact on much of the developed world. Likewise, one of the shortcomings of the WHO study is that by focusing on the whole world, including the developing world, it understandably cannot focus on the particular circumstances that influence decision-making in each specific place, particularly those in the developed world. It tries to account for this by generally recognizing that unless an idea can work in a particular locale for a particular cousin Johnny it is not going to be relevant in that locale. Hence, for example:

> It is important that planners and designers of restricted irrigation schemes engage with local farmers early in the planning process to consult them and determine what "restricted crops" can be grown at a reasonable profit. They must clearly understand the difference between restricted and unrestricted irrigation (including the different wastewater qualities used for each), and they must be aware of the health consequences that will occur if they irrigate food crops that are eaten uncooked with wastewater treated only to the level for restricted irrigation.
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> Examples of successful crop restriction schemes are found in India, Mexico, Peru and Chile (Blumenthal et al., 2000b; Buechler & Devi, 2003). In Chile, the use of crop restriction, when implemented with a general hygiene education programme, reduced the transmission of cholera from the consumption of raw wastewater–irrigated vegetables by 90% (Monreal, 1993). Experience from Hyderabad, India, indicates that restricted irrigation is not synonymous with restricted farmer income: two of the most profitable wastewater-irrigated crops are para grass (used to feed water buffalo) and jasmine flowers (used for flavouring tea) (Buechler & Devi, 2003).

(WHO 2006, 2.76; *see also* 2.75, 4.132)

Suffice it to say that my cousin does not have the luxury of focusing on para grass for water buffalo in India or jasmine flowers for flavoring tea. Neither I, nor even the WHO, is going to tell Johnny anything he does not already know about growing his crops. But I can try to set out on paper why I think it might be a good idea for the influence-makers in American bioenergy to consider wastewater-based nutrients for meeting crop fertilizer needs.

The reasons I think this might be a good idea have to do with the potential *suitability*, *availability*, and *sustainability* of wastewater-based nutrients. I say “potential” because, as with much having to do with second generation biofuels, there is a lot to be researched, developed and brought to scale before wastewater-based fertilizer will become a reality in American agriculture. We do not know its actual suitability or potential availability to the American farmer, and we likely will not come near to agreeing on the need for fertilizer sustainability anytime soon.

This latter point, the lack of agreement about the need for fertilizer sustainability, I will put aside for the moment. One might find it ironic that an industry whose existence is largely driven by the quest for sustainability is itself ambivalent about the merit of the quest when it comes to its inputs. Personally, I am fairly confident that one day *necessity* will dictate the use of sustainable inputs. However, this no doubt would sound like a dreamer notion to many, if not most, in the bioenergy field at present.

I am not talking about the fact that many, if not most, in all walks of American society generally believe that the market will dictate reality when it is good and ready to, and that American farmers will then spontaneously supply the market (although this may run counter to the rationale for bioenergy research and development and crop programs in the first place). Nor am I talking about the fact that we always seem to have many good people who always try to believe the rosy corporate scenario. Perhaps I go too much the other way, but it does perplex me that some: doubted that smoking causes cancer; doubt that humans cause global warming; doubt that we will ever reach peak oil; and (if they learned that phosphorus is a critical macronutrient mined from a handful of places on earth) would reflexively doubt that we will ever reach peak P. I am certainly not going to say, particularly on this Easter Weekend, that faith is a bad idea, even if it is a faith in unlimited supplies of needed resources that I find nowhere in the Bible.

No, without being in the least snarky, I recognize that factors of prioritization and immediacy dictate that many in the bioenergy community not only might question some of these phenomena in their own right but more importantly do not have the luxury of caring at the present time. While sustainability is a cited justification for bioenergy, it might be considered a waste of critical time, when bioenergy is struggling to gain a foothold, for its opinion-leaders to think about the long term supply of inputs like nitrogen and phosphorus. This makes a lot of sense.

To further the dialectical process, I am going to put the sustainability issue off until last. As I will explain, I believe that the question of sustainability does not have to be answered per se, but only recognized to exist as a serious question, to merit those in bioenergy taking a critical look at the questions of suitability and availability.

Suitability

We know that wastewater can successfully provide the nutrients for growth of a variety of traditional crops, including such first generation biofuels as corn. (WHO 2006, 4.10) It has done this for thousands of years and still does this successfully around the world.

The WHO report recognizes urine's value as a nitrogen source:

Use of urine as fertilizer

Urine is rich in nitrogen and can be used for fertilizing most non-nitrogen-fixing crops after proper treatment to reduce potential microbial contamination. Crops with a high nitrogen content that respond well to nitrogen fertilization include spinach, cauliflower and maize. Direct use of urine as a plant fertilizer will entail the most efficient use of nutrients, but addition of urine to improve composting of carbon-rich substrates is another possibility (although it may result in large ammonia losses). The nutrients in urine are in ionic form, and their plant availability and fertilizing effect compare well with those of chemical (ammonium- and urea-based) fertilizers (Kirchmann & Petterson, 1995; Johansson et al., 2001). When the nitrogen content of collected urine is unknown, a concentration of 3–7 g of nitrogen per litre at excretion can be used as a default value (Jönsson & Vinnerås, 2004). On a yearly basis, the amount of nitrogen produced per person equals 30–70 kg, supporting one crop on 300–400 m^2, but up to 3–4 times this level may be an optimal application strategy.

(WHO 2006, 4.10; *see also* 4.12) The report also notes the value of urine as a source of phosphorus:

Phosphorus is an essential element for plant growth, and mined phosphates are a common input into agricultural production in order to increase crop productivity. Soil phosphorus content varies with parent material, texture and management factors, such as rate of application, type of phosphorus applied and soil cultivation (Sharpley, 1995). It is usually present in soils in relatively important quantities. World supplies of accessible mined phosphate are diminishing. It is predicted that phosphate-carrying rocks/mineral reserves will run out in 60–130 years. The mining of phosphate causes environmental damage because it is often removed close to the surface in large open mines, leaving behind scarred land. Moreover, phosphate-carrying rocks/minerals also contain varying amounts of non-desired elements, such as cadmium. Approximately 25% of the mined phosphorus ends up in aquatic environments or buried in landfills or other sinks (Tiessen, 1995). The discharge into aquatic environments causes eutrophication of water bodies, leading to more environmental damage. To reduce the phenomenon of eutrophication, wastewater treatment plants require additional phosphorus removal treatment capacity, which adds to the costs and complexity of the treatment process.

Urine alone contains more than 50% of the phosphorus excreted by humans. Thus, the diversion of urine and its use in agriculture can aid crop production and reduce the need for costly, advanced wastewater treatment processes to remove phosphorus from the effluents (EcoSanRes, 2005).

(WHO 2006 4.122)

In addition, urine is relatively sterile, gaining pathogens mainly from incidental contamination by fecal material. It can be separated at the source through at-home toilets and related technology that is far cheaper for developing countries to implement than conventional wastewater treatment systems. And, through simple storage for a period of months, it can be rendered safe for unlimited use on all food crops, including root and low-growing crops consumed in raw form. (WHO 2006, 1.24, 1.29, 1.54-.59, 2.xiv-xvii, 4.77, 4.80-.87)

Moreover, even without storage or any measures to control pathogens, wastewater, including fecal material, is used in many developing countries in food production. For example in Pakistan, some farmers pay a huge premium for untreated wastewater over the fees for fresh water because the nutrients in the wastewater allow them to get three crops a year rather than one. (WHO 2006, 2.5)

These wastewater-derived nutrients are, at least in theory, potentially useful in growing biofuels of many types, in part because consumer exposure to pathogens is not an issue.[1] (WHO 2006, 2.76, 4.15, 4.73, 4.77, 4.149) However, one thing we don't know is how well wastewater or products derived from it could support second generation biofuels in America, assuming availability. In fact, much work needs to be done to determine fertilizer needs and overall fertility management for second generation biofuels such as switchgrass (known for its ability to grow in poor soils) even using conventional fertilizer. (Brown 2010) Moreover, this is not a one-place fits all concept, again even with conventional fertilizer. Crops such as switchgrass may have different fertilizer needs in different places.

Availability

Availability of wastewater-based fertilizer to American farmers may be the most significant challenge to its intensive use. Even as we learn about the potential suitability of wastewater-based fertilizer for bioenergy and other crops, this will have little practical value in the world of American agriculture if the nutrients cannot make it to the farmer in a useable form.

Availability can be influenced by many factors, and obviously, every place in the world has differences that must be taken into account. For instance, intensive American agricultural practices are vastly different from subsistence agricultural practices, and often so are American expectations for environmental and health protection. America's vast geographical expanse and mechanized production systems also present challenges. In America, many of our major population centers, and potential major fertilizer production centers, are far separated from much of America's farmland. Similarly, to the extent livestock, and more specifically, livestock wastewater or solid waste, can play a growing role in fertilizer production, it is also far separated from many farms.

In addition, it must be recognized that often the benefits of human wastewater for crops extend beyond the realm of nutrient management into the realm of water management. Israel uses over 80% of its treated water in agriculture and is moving toward 100% reuse. (WHO 2006, 2.141) As even those places in America long considered "fresh water rich" face major water shortages and hard allocation decisions, this may yet play a role in shifting views of wastewater reuse in America. For now though, much of American agriculture does not use irrigation. Therefore, for this sector, the water component of wastewater may not be attractive, at least assuming current rainfall patterns. Further, even for irrigated fields and where the wastewater is treated to high U.S. standards, it may be unaffordable to transport the wastewater to the fields. The transportation economics will have to work. For instance, the WHO recognizes that even in developing countries where wastewater is highly valued for its nutrients, excreta treatment facilities may need to be located where minimal transportation is needed. (WHO 2006, 4.124-.126)

[1] The fecal component of human excreta not used in crop production, as well as associated oil and grease, can also be used for production of biogas and biodiesel. (WHO 2006, 3.51, 4.15, 4.79, 4.92-.93, 4.124, 4.132)

The intensive American biofuels farmer will have to be given a reliable fertilizer product in a form that can be readily used based on crop needs as they are determined. Particularly where the fields are located far away from population centers, piping or trucking wastewater will be impracticable. Wastewater nutrients likely will have to be converted into a conventional form, much like some in the bioenergy industry are exploring the conversion of biofuels to drop-in replacement fuels like gasoline.

The early stages of drop-in replacement fertilizer production derived from both human and livestock wastewater appears to be already occurring. This production is centered upon wastewater precipitates, including struvite, a crystalline compound composed mainly of magnesium ammonium phosphate. Its formation in humans and animals sometimes causes kidney and gall stones, and it can be a problem in both domestic and animal wastewater systems and lagoons. (Manel; Ohlinger 1999; Ohlinger 2000; Wierzbicki) Now wastewater engineers are beginning to create purposefully the conditions for maximum struvite production from both domestic and in some cases animal wastewater, both to lower the nutrients going into advanced treatment plants and ultimately to reduce nutrient levels released into water bodies. (*See, e.g.,* "Phosphorus Removal in Oregon, Recovered nutrient from wastewater becomes high value fertilizer," Government Engineering, September-October 2010; *see also* Owen; Ericson; Fattah; Barak; Mohan; Westerman; Burns; Nelson) A Netherlands company has even recently claimed to have gone into production with a factory using source-separated human urine for conventional fertilizer production. (*See* collection of articles on GMB Watertechnologie BV)

Chemists have long been aware of a potential for struvite production from wastewater. It may simply be the case that given the dramatically rising price of conventional fertilizer and more stringent government environmental policies, critical mass is finally approaching in going to scale. Again, however, the challenge is in producing a competitively priced and fungible fertilizer commodity that can be carefully managed with minimal unpredictability and inconvenience to the farmer, and with acceptable risk to the environment and health.

Of potential special interest in the state of Alabama and other major poultry producing states, nutrients apparently can be recovered in the form of struvite from poultry manure. However, this may not present the degree of nutrient recovery obtainable from human wastewater and the wastewater of other livestock. Interest in poultry-related struvite production seems to be more a reflection of concern over the *surplus* of phosphorus in chicken litter that can cause water quality problems. (Yilmazel; *see also* Hunger, Whang) Obviously, Alabama and other major livestock producing states have long known about the need to have P out of the waterbodies where it can do harm. This is illustrated by the long Clean Water Act lists of impaired waters attributable to P overloading in these jurisdictions.

In summary, it is likely that in much of intensive agricultural America not reliant upon irrigation, direct application of treated wastewater may be economically unfeasible for the foreseeable future. In addition, broad availability of economical uniform wastewater-derived crop nutrients may have to await the large scale availability of struvite-based fertilizer products. This may ultimately constitute a feasible form of wastewater-related nutrients of great practical value. At the present time, however, it is easy to see that in many American watersheds the problems with N and P are usually *too much* rather than *too little*.

Therefore, at least for now, the timing may not be right for commercial farming usage. Nevertheless, in the longer term, the fertilizer market could change, and other pressures relating to sustainability may predominate, as discussed below. American farmers in general, and bioenergy producers in particular, may need to be ready for this change.

Sustainability

Sustainability may be the mother of all controversial subjects to many American farmers, including, ironically, many bioenergy crop producers. Before getting to what may be the salient point of key relevance to bioenergy, let's briefly consider the arguments about peak oil and peak phosphorus in a direct way.

Here in a nutshell is the oil industry point of view about peak oil, according to Jack Gerard of the American Petroleum Institute:

> We take warnings about "peak oil" and "running out of oil" with a pinch of salt. Nevertheless, the world does need to be making significant investments in new oil development to ensure that supplies keep pace with demand. Governments' energy development policies should be aligned with this reality.
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(Financial Times, 1/14/2011) This is obviously not an outright dismissal of the possibility. Meanwhile, many academics focused on energy and food security take a more dire view of fossil fuel supplies. (Kerr, R. A., 3/25/2011, "Peak Oil Production May Already Be Here"; Dawson) Some even recommend that in light of its importance to N production, methane from natural gas be carefully managed to ensure the long term ability to produce commercial N in a cost-effective manner. (Dawson)

Moving on to peak phosphorus, here is the nutshell industry viewpoint, according to the International Fertilizer Industry Association:

> In response to a lack of up-to-date information, the International Fertilizer Development Center (IFDC) carried out a study, World Phosphate Rock Reserves and Resources, that reassessed the phosphate rock reserves and resources of important phosphate-producing countries. This study, released in September 2010, concluded that **global phosphate rock resources suitable for phosphate-based products, including phosphate fertilizers, were far more extensive than previously estimated. At current extraction rates, these resources would be available for several centuries**. A few months later, in January 2011, partly based on information in the IFDC report, the United States Geological Survey (USGS) updated its widely used estimate of world phosphate rock reserves from 16 billion tonnes (the 2010 estimate) to 65 billion tonnes. This estimate is in line with the IFDC report's world phosphate rock reserves estimate of 60 billion tonnes.
>
> IFA supports the conclusions of the IFDC report that the world is not facing a peak phosphate event. The 2011 USGS estimate of world phosphate rock reserves also supports the conclusions of the IFDC report.

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> Based on these recent assessments by IFDC and the USGS of world phosphate rock reserves (and of current phosphate consumption), **IFA does not believe that peak phosphorus is a pressing issue, or that phosphate rock depletion is imminent**. Nevertheless, it believes that efforts to minimize phosphorus losses to the environment and optimize phosphorus use should be encouraged.
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> It is important to note that research so far has focused on a possible peak in phosphorus supply. However, **a potential peak in phosphorus demand should also be investigated**. Since phosphorus accumulates in agricultural soils, phosphorus requirements do not increase linearly with agricultural production. There is a need to increase phosphorus levels to a critical level that optimizes phosphorus availability to plants while maintaining soil fertility. The steady improvement of soil phosphorus levels in Asian and Latin American countries, possibly leading to a peak in world phosphate fertilizer demand by 2050, is a scenario that has so far been overlooked. IFA has established an industry-wide task force on Phosphate fertilizer demand looking at different consumption scenarios.

(emphasis in original; http://www.fertilizer.org/ifa/HomePage/SUSTAINABILITY/Phosphorus-peak-phosphate) While seemingly more reassuring than the oil industry position, this also is not an outright denial, but rather expressly includes a call for more careful agronomy and soils research. Meanwhile, again, many experts focused on food security take a more dire viewpoint. (Cordell; Childers; Harvey)

So we have opposing viewpoints on two factors affecting agriculture's most important manufactured input, modern fertilizer. On the one hand, the fossil fuel and mineral fertilizer industries and others seem to say one thing. On the other hand, academics and others seem to say another. Normally, this might be cause for blithe dithering by third parties. After all, it *may* be decades or longer before peak oil or peak phosphorus disasters hit the fan, if they ever will.

But here is the catch, and while it may strike of a General Ripper fantasy, there be hundreds of millions of persons with their own perceived reasons to mistrust America, and things American, including American bioenergy. And existing worldwide foes of bioenergy (and there seem to be more at every turn) may not simply sit back and patiently watch as food, conventional fossil fuel, and conventional fertilizer prices go up yet again and again. When fertilizer prices went through the roof just a few years ago, people looked for a culprit. Some of these people may be highly misinformed. Some may be highly informed. It really does not matter. It matters that they might again come looking for a culprit, and the culprit could be bioenergy, particularly U.S. bioenergy. This may be the only target consistent with a world view fearing peak oil and peak phosphorus. For if and when fossil fuel or mineral P production peaks, presumably the guardians of these industries will be perceived as somewhat powerless discredited puffers. The "bad guy" label may go on the competing users of land and resources that could otherwise go to food production.

As it stands, when food and fertilizer price shocks occur, as they surely will, the U.S. bioenergy sector cannot do much more than parrot the "we've got plenty" arguments of its major competitor sector, the fossil fuel industry, and those of the fossil mineral fertilizer industry. The bioenergy sector may be both unnecessarily setting itself up for criticism and missing out on a robust opportunity to differentiate itself as a truly sustainable industry. Bioenergy sector research and use of waste-derived fertilizer, even on a pilot level, could help demonstrate to the world that the sector takes its own justifying message of sustainability seriously.

The WHO 2006 report could be read to implicitly call on non-food crop producers, including those in developing countries, to consider accepting even untreated wastewater as a fertilizer source, because any pathogens that might be present will be less likely to affect consumer health. If in some developing countries people are without food, fuel, and fertilizer, not to mention water, while over in the United States, the bioenergy industry is not even willing to use highly treated wastewater and wastewater-derived products to fertilize non-food crops, developing countries and international organizations could raise legitimate hard questions. Similarly, if the published positions of bioenergy spokespersons appear to be head-in-the-sands insistence on business as usual dependency on conventional fertilizer supplies in perpetuity, food sector be damned, this may not play very well around the world. These questions may dovetail with the growing questions already being asked about land competition. (Harvey)

Fortunately, recently the bioenergy sector has begun to demonstrate that it is aware of this sensitivity. Last month, in a biofuels industry publication, the editor expressly recognized the seriousness with which the industry needs to take peak P. (Biofuels Digest, 3/4/2011. "Peak Phosphorus: Is there enough for biofuels at scale.") The importance of bioenergy opinion leaders taking such a public position should not be under-estimated. This could allow others to come out of the closet, so to speak, and look for ways to coalesce sustainable energy production with sustainable fertilizer usage. It wouldn't just be the work of General Ripper types, crying in the Wilderness about an imminent threat that ever seems to be at hand.

Of course, in polarized American society, and in a still more polarized and resource-starved world, no matter what the bioenergy sector does, it could still be criticized. As the new kid on the energy block still in need of nurturing, as its entrenched fossil fuel competitor receives large government subsidies, bioenergy is easy to pick on or assail on editorial pages in this day and age of budget cuts. (Once things go to scale in second generation biofuels, bioenergy may have broader shoulders.) Further, if the young bioenergy upstart begins seeming like it takes the threatened fossil fuel and P peaks too seriously, it may invite new foes in the mineral fertilizer industry to go with its existing foes in fossil fuel.

But at the same time, it may be addressing if not allaying one of the sincere concerns of those on the world hunger and environmental sides of things—that the bioenergy sector may not truly mean what it says about the need for a sustainable future for humanity. Sometimes it is best to just do the right-seeming thing, and take the chance that the rosy scenario will not come true.

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