INDUSTRIAL WASTE AS FERTILIZER: WHAT'S WRONG? WHAT'S RIGHT?

Seattle newspaper article raises critical issues on fertilizer regulations for reuse of industrial residuals. Researchers stress the need for "product specific" data to get protection and desired results.

Jerome Goldstein

QUINCY, Washington is a small town in the central region of the state with a good number of farms and food processors. Last month the town received national publicity when the *Seattle Times* used it to lead off a series of articles carrying the headline: "Fear In The Fields: How hazardous wastes become fertilizer."

The main point of the articles is that some heavy industrial companies have found a way to dispose of hazardous wastes by highlighting or adding fertilizer elements. "The use of industrial toxic waste as a fertilizer ingredient is a growing national phenomenon," wrote Duff Wilson, *Seattle Times* staff writer, adding: "*The Times* found examples of wastes laden with heavy metals being recycled into fertilizer to be spread across crop fields. ... Officials rely on fertilizer producers to document that their products are safe, and never check back for toxic components. There is not even a requirement that toxins be listed on ingredient labels. ... There is no national regulation of fertilizers in this country, unlike many other industrialized nations. The laws in most states, including Washington, are far from stringent. The lack of national regulation makes it virtually impossible to measure the volume of fertilizers produced by recycling hazardous wastes. Some industries dispose of tons of toxic waste by giving it free to fertilizer manufacturers, or even paying them to take it."

Are the charges factual, or are they an example of journalistic sensationalism? Are some companies exploiting a loophole in existing regulations to save money on waste treatment costs? Are some fertilizer companies endangering farmland by using untested wastes in products they sell to the growers? The articles began appearing in newspapers around the country during the first week of July. In the few days prior to this issue going to press, *BioCycle* editors interviewed regulatory officials in state agricultural and environmental agencies to get objective answers to the extent of the abuses cited. We also talked to researchers who have evaluated the use of industrial wastes in agriculture — some initial findings follow:

ANALYZING "DERIVATIVES" IN IOWA

According to John Whipple, Fertilizer Bureau Chief in the Iowa Department of Agriculture, the state's policy is to require a "derivative" analysis for all materials that seek to be registered as a fertilizer. "That analysis lists what materials in the fertilizer are derived from," explains Whipple. If the list includes industrial wastes or biosolids, it is required that a complete analysis of heavy metals be done and results submitted to the Bureau. Then that information is shared with staff at the Iowa Department of Natural Resources, which has jurisdiction over heavy metals.

"There are a lot of beneficial industrial materials out there that are useful in agriculture," Whipple adds. "We want to assure the public that materials containing them are consistent with environmental statutes in the state. To the best of my knowledge, I cannot think of any products from heavy industries (such as smelting, etc.) that sought registration as a fertilizer."

TESTING FERTILIZERS FOR HEAVY METALS IN WASHINGTON STATE

In Washington, the Quincy situation led the state to set up an intergovernmental task force to test for heavy metals in fertilizer. Because the State Department of Agriculture's laboratory wasn't equipped to test for relatively low levels of heavy metals, it asked for assistance from the Department of Ecology (DOE). According to the DOE's Chris Chapman, the task force —which includes the DOE, Department of Agriculture, Department of Health and Washington State University — is testing 35 different fertilizer products. The fertilizers being tested include the most frequently used fertilizer products in the state, some known to include industrial by-products, and what Chapman describes as "problem" fertilizers.

The task force had its first meeting in April and recently completed testing on the 35 products. According to Chapman, the task force plans to release a final report in the fall.

Under Washington's fertilizer regulations, the Department of Agriculture is the primary agency and although testing for heavy metals isn't performed routinely, it does work informally with DOE, if Agricul-

BASE OF KNOWLEDGE

THERE has been significant research over the years on the use of industrial by-products as soil amendment products. A recent conference in Beltsville, Maryland — Beneficial Co-Utilization of Agricultural, Municipal and Industrial By-Products — highlighted some of the current research in this area. Technical papers presented data on use of materials such as coal combustion residues, deinked sludge, fly ash and phosphogypsum. Other speakers took a broader perspective, addressing concerns that are raised when considering use of these residuals. The symposium, sponsored in May, 1997 by the Agricultural Research Service of the U.S. Department of Agriculture, also covered utilization of municipal wastewater solids and manures. A proceedings of the meeting will be published. For more information, contact Ronald Korcak, USDA-ARS, Plant Sciences Institute, B-003, Rm.232, BARC-W, Beltsville, MD 20705; 301-504-6591; rkorcak@asrr.arsusda.gov.

ture Department staff suspect that an ingredient may cause a problem.

REGULATING INDUSTRIAL "COPRODUCTS" IN PENNSYLVANIA

In Pennsylvania, the Department of Agriculture (PDA) licenses the producers of fertilizer and fertilizer ingredients. Several years ago, PDA became concerned about the use of waste materials in the manufacture of fertilizer and worked with the Department of Environmental Protection (DEP) to set up a procedure to analyze the waste prior to allowing it to be used as an ingredient in fertilizer. According to John Breitzman of PDA's Bureau of Plant Industry, if a firm is interested in producing a fertilizer for sale in Pennsylvania, the Bureau queries them about the product and its ingredients. If the company plans to use a waste product, it is directed to DEP for the appropriate approvals.

Pennsylvania's regulation of residual waste is atypical. While most states' residual (industrial) waste only comes under regulation when it is disposed, Pennsylvania begins its regulation with the generators of residuals. Using a waste as a coproduct requires the approval of DEP. To receive that approval, an applicant has to submit an analysis of the waste. "We make a determination based on whether the material will do more harm to the environment than what it's replacing," says Bill Pounds of DEP.

Since the early 1990s, several companies have applied to DEP to classify a waste material as a coproduct for use as a fertilizer or soil amendment. Included in that group are several tanneries that received approval to use sludges as soil conditioners. One company, East Penn Manufacturing of Berks County, was approved to use a nitrogen-sulfur scrubber solution as a liquid fertilizer.

> "You have to know what's in the particular waste being considered for use in horticultural and agricultural applications."

PLANT FOOD CONTROL OFFICERS

According to David Terry, who serves as secretary of the American Association of Plant Food Control Officers (AAPFCO) — members of state agencies that regulate fertilizers — a By-Products and Recycled Materials Subcommittee was formed about two years ago. (Dr. Terry is head of the Division of Regulatory Service in Kentucky.) The Subcommittee has been discussing the need to set limits on heavy metals in fertilizer products. While the AAPFCO has no official standing when it sets guidelines, many states do use them as a standard.

In Kentucky, Terry's office does work with the state DEP, but that relationship is built primarily around biosolids. If a company came in to register a biosolids related fertilizer, it would have to pass the EPA standard of Class A biosolids before it would be registered. However, if it is an inorganic waste, Terry's office doesn't go through the same procedure. Last year, Kentucky did start to look into the issue of free riders, but hasn't set any standards to date.

RESEARCH CONNECTION TO WASTES AND AGRICULTURE

"You have to know what's in the particular waste being considered for use in horticultural and agricultural applications," stresses Frank Gouin, Professor Emeritus at the University of Maryland. "You must also understand the role of stability of the product, and look for the right applications." Throughout his career, Gouin has stressed quality of the waste stream, whether residuals come from the municipal or industrial sector.

Two years ago, the United States Agricultural Research Service (ARS) drafted a list of research needs to be addressed in order to "ensure efficient and environmentally safe utilization of readily available waste materials." Following is a summary of the ARS list:

A national data base listing the amounts produced and agronomic characteristics of major wastes generated; Analytical methods to estimate the levels of nutrients and toxic components in wastes and amended soils; and Assessment of the fate and effects of trace elements, synthetic organics and pathogens in wastes on soils, plants, animals and humans. (A risk assessment pathway approach similar to the one used to develop regulations for land application of biosolids will be needed, note the ARS scientists.) Approximately 75 percent of the nitrogen in animal wastes is lost before it is available for crop use. Appropriate research would improve the understanding of basic chemical and biological processes in wastes and waste mixtures, resulting in designs for

storage and surface application to minimize losses of objectionable gases and bioaerosols. A clearer understanding is needed of such factors as aeration, temperature, water content, inoculation and mixing on levels of pathogens, beneficial organisms and viable weed seeds in compost.

Research is needed to blend, mix or cocompost different wastes to yield final products with desirable characteristics for agricultural or horticultural users. According to ARS staff, information on the concentrations, chemical reactions and bioavailabilty of beneficial and potentially hazardous components of wastes will be needed to develop mixing and composting procedures which can eliminate pathogens and toxins, reduce availability of toxic trace elements and enhance nutrient availability in "designer waste" end products.

IDENTIFYING USABLE INDUSTRIAL FEEDSTOCKS FOR FARM UTILIZATION

When asked about the abuses cited in the *Seattle Times'* series on toxic industrial wastes being used in chemical fertilizers, several staff members at the EPA and university experiment stations agreed with there being too many regulatory loopholes that allow such abuses to occur. Interestingly, these same individuals are very much involved with sustainable agriculture development and are deeply committed to the recycling of organic residuals from cities and industries into agriculture. In this context, they strongly believe in the role of composting — and other forms of organics recycling — as a sound conservation policy.

One logical solution to preventing shady dealings by companies who get into the "recycling business" as a pretext for finding a cheap-'n-quick disposal route is for state officials and independent farm groups to compile regional inventories of residuals that have potential crop and soil benefits. There are good precedents for such inventories.

Eleven years ago, for example, the Maine Department of Agriculture, Food and Rural Resources conducted an inventory and review of waste products generated in Maine which have potential for use as agricultural soil amendments. Of the waste materials examined, pulp and paper mill sludge was by far the greatest quantity. Other large volume wastes, in order of amounts, were wood residues, manure, municipal sludge, potato processing waste, ash and kiln dust.

In 1990, the Maine Department of Agriculture issued an updated report of the state inventory following passage by the Maine State Legislature of a solid waste management act calling for a 50 percent reduction in the waste stream by 1994. The update indicated that paper sludges had risen to 1.13 million tons annually, representing a 23.7 percent increase. The major disposal option for paper mill sludges was landfilling. By that time, municipal sludge, poultry manure, wood ash and wood by-products all were over 100,000 tons. Food processing wastes, cull potatoes, and incinerator process residue were estimated at just under 100,000 tons per year.

In the August, 1996 issue of *BioCycle*, Bill Seekins of the Maine Department of Agriculture wrote an article on "Industrial By-Products As Compost Feedstocks." Included is a description of the methods used by the Bowater Paper Company which owns and operates three paper mills in Maine. Bowater officials decided to explore beneficial use of part of its sludge to preserve landfill capacity. Extensive testing showed that sludges fell well within the regulatory limits for heavy metals and other substances. Primary sludge was high in organic matter, while the secondary sludge was high in nitrogen and phosphorus. Composting trials demonstrated that the sludges, amended only with a small quantity of wood ash to help decrease moisture content, were able to reach and sustain sufficient temperatures to meet PFRP requirements (Process for Future Reduction of Pathogens).

"We need a better process to determine what is in the waste, and what an appropriate land application, if any, might be."

COAL ASH AND WOOD ASH

The Washington State University (WSU) power plant generates approximately 1,000 tons of coal ash annually. The university also has an active composting project on campus, which uses manure from the dairy herd and food residuals from the cafeterias. In 1993, a pilot project determined the feasibility of including coal ash in the composting mixture. According to Theresa Beaver of the WSU Center for Sustaining Agriculture and Natural Resources, the study's objectives were to determine how much coal ash could be added to compost piles "without compromising biological activity, and to monitor the chemical composition of compost with additions of coal ash." The results of the metal analysis showed that all metals in the compost, even in the 31.8 percent coal ash compost, are below the limits set by the proposed Washington State Department of Ecology Compost Quality Guidelines and the EPA Sewage Sludge Regulations. "Our results conclude that the addition of coal ash to our composting process will not inhibit biological activity," Beaver explains."We also concluded that adding coal ash will enhance the nutrient value of the final product and subsequently enhance crop growth and soil fertility of field grown crops."

At the University of Idaho, Alton Campbell and colleagues researched the use of wood ash as an amendment in municipal biosolids and yard trimmings composting processes. The wood fly ash — from a wood-fired, electrical generating plant — turned out to be an effective substitute for lime, which is commonly used to stabilize municipal biosolids prior to landfilling or land application.

In tests with coal ash conducted by Herb Brodie, Lew Carr and colleagues at the University of Maryland with the Delmarva Power Station in Delaware, the following observations were made about previous coal ash studies as well as their own:

Investigations with natural soils have shown that the addition of coal ash can result in changes in soil physical and chemical structure. Coal ash has been applied to soils to adjust soil pH (liming material), add plant micronutrients, increase porosity in fine textured soils (bottom ash) and increase the percent fines in a coarse textured soil (fly ash). The degree of success of these efforts has been mixed because of the different ash products used, the soil types amended, application practices, and the type of analyses made. Of particular interest is the environmental impact of coal ash on the soil and plant system. Positive impacts are the possible improvements in soil structure and addition of plant needed nutrients. Negative impacts are the migration of unwanted heavy metal elements into the crop and into soil water systems.

"Soil and soil water studies," they pointed out, indicate that metal migration from alkaline fly ash was insignificant after three years of weathering. However, warm water soluble arsenic, boron, selenium and chromium were mobile. Metal adsorption on coal fly ash was temperature and pH dependent with different optimum conditions for different elements. Column leachate studies defined rapid release of adsorbed metals but could not define long-term release through particle decay. Many elements that were expected to be released were below detectable limits. Leachate quality was directly related to coal ash quality."

The University of Maryland researchers summarized their findings in the Autumn, 1996 issue of *Compost Science & Utilization*: "The coal ash compost trials conducted at Indian River Power Station showed that mixtures of poultry litter, pinebark, sawdust and coal ash can be composted under difficult winter conditions. Recipes with up to 40 percent fly ash by volume (67 percent dry mass) and 25 percent bottom ash by volume (45 percent dry mass) in piles mixed with a bucket loader produced finished compost in 8.5 months. High ash content reduced the maximum temperature attained by the compost mass as compared to low ash content compost. High ash composts had greater levels of heavy metal concentrations than low ash composts. High proportions of poultry litter also resulted in higher levels of metals in the compost. Toxic effects of ash in the compost mix were indicated but could not be substantiated with the Microtox process, which suggests that toxicity may abate with time. Composts were given mixed reviews by a panel based on physical properties. Additional studies of ash compost quality are necessary to allow assessment of potential uses, to determine to what extent the ash enters into the reaction, and if the reaction binds chemical elements which might leach from the ash."

"A KEY COMPONENT OF SUSTAINABILITY"

For a closing statement about blending industrial by-products into fertilizers, we asked David Granatstein of Washington State University — who has been actively involved with sustainable agriculture practices — for his views. Here's his statement:

"As a society, we are constantly looking for ways to utilize waste products from one sector in a beneficial manner elsewhere in the economy. This is a key component of sustainability. The recent publicity regarding the mixing of hazardous wastes into fertilizers will lead to improved oversight of this practice that is obviously needed. The practice itself should not be indicted as many waste products can be beneficially used in agriculture. This is especially true of organic residuals. We need a better process that will scrutinize this practice on a case-by-case basis to determine what is in the waste, and what an appropriate land application, if any, might be. The difference between a toxic heavy metal and a trace element needed for plant growth is often a matter of amount — elements such as zinc and copper fit both categories depending on the situation." ■