Scientific American Is Coal Ash in Soil a Good Idea?

Tons of coal ash are recycled in soil, raising questions about a buildup of arsenic and other toxic substances in food crops

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Crops across the country are grown in soil amended with coal fly ash—the same substance that caused a massive environmental emergency in December when it gushed from a holding pond at a Tennessee power plant.

Tons of fly ash are routinely added to soil to nourish vegetables, peanuts and other crops, primarily in the Midwest and Southeast. But now the spill has raised questions about whether this longstanding agricultural practice is environmentally sound.

Fly ash is a fine powder recovered from gases created by the burning of coal. It is the largest component of coal combustion waste, totaling around 70 million tons annually in the United States.

Adding moderate amounts increases crop yields and stabilizes soils while reducing the need to throw huge quantities in landfills or holding ponds, said Yuncong Li, University of Florida professor of soil and water sciences.

However, fly ash contains various amounts of toxic metals. And studies have shown that food crops grown in large amounts can soak up hazardous concentrations of arsenic.

Because it is not classified as hazardous waste under Environmental Protection Agency standards, there is no federal supervision of its use in agriculture. Some states regulate it but their guidelines vary and often require no monitoring of how it is used, said Jeffrey Stant, director of the Coal Combustion Waste Initiative for the Environmental Integrity Project.

"For soil amendment, most cases are left to the industry itself to monitor where they put fly ash and how much they use of it," said Stant.

For more than a decade, companies have mixed fly ash with other waste to produce soil and compost. About 50,000 tons are used annually for agriculture nationwide.

One example is N-Viro, an international corporation that specializes in turning waste material into products. The company uses 250 tons of fly ash per day to mix with bio-solids, said Raymond Mayo, Florida N-Viro plant manager. The mixture is then heated to kill bacteria and monitored before it is distributed to farms, added Mayo.

The volume of fly ash created by power plants is increasing, due to more coal burning coupled with more stringent air pollution rules. "Currently the U.S. produces 130 million tons of coal combustion waste every year. In another 10 years it will be 150 million," said Stant.

As a result, researchers are studying whether larger amounts can be used safely in agriculture.

Fly ash mixtures provide phosphorus, calcium and other nutrients that crops need to grow while increasing soils' capacity to hold water, said Li. "The material is practically free and coal companies will pay people to dispose of it," he said.

But arsenic, lead and mercury in fly ash raise concerns about cancer or neurological damage.

Crops grown in quantities of fly ash ranging from 5 to 20 percent of soil weight absorbed toxic metals, according to a study by Indiana State University researchers.

When the amount of fly ash increased, the crops absorbed higher concentrations of arsenic and titanium. Basil and zucchini contained potentially toxic amounts of arsenic exceeding 6 parts per million. Concentrations of greater than 2 ppm had severe effects on vegetables, damaging the plants and decreasing production, wrote the scientists in a 2004 paper published in *Environmental Geology*.

Although the potential human health effects are unknown, fly ash fertilization can lead to possible toxic accumulation in crops if not monitored properly, concluded the scientists.

Plants grown with smaller amounts of fly ash have fared much better. In a three-year study, University of Florida researchers applied 22,000 pounds of fly ash per acre (1.1 percent of soil weight).

Mixed with yard waste compost, the fly ash increased tomato yields by up to 70 percent. The study found no groundwater contamination or soil-fertility decline after three years, while the presence of trace metals remained low.

A six-year study at the Indian Institute of Technology in Khargpur, India also indicated that a moderate amount of fly ash (9,200 pounds per acre), along with organic sources like farm manure and crop residue, improves crop yields.

This assortment of wastes increased rice and peanut yields by 31 and 24 percent respectively when compared to using chemical fertilizers alone. Accumulation of trace elements once again remained small.

Nonetheless, agriculture's use of ash has been limited over fears of heavy metal accumulation with repeated use, especially with ash that can contain higher amounts of toxic substances such as arsenic, wrote Li and other researchers in a paper to be published in the journal *HortTechnology*.

Of the coal ash produced, less than .02 percent is recycled for agriculture production, Li said, making it one of the least used byproducts of coal combustion.

"As long as we work carefully with regulators we can apply larger amounts safely," said Li. "I think fly ash has a big potential to improve soil and increase plant growth."

For nearly 50 years, coal combustion products have been used to fertilize peanuts. Air pollution control devices called scrubbers use a sprayed slurry of ground limestone and water to remove sulfur dioxide from gases formed in coal combustion, said Tom Schmaltz, environmental director for Headwaters Resources, a world leader in coal combustion products.

This practice leaves behind gypsum or "scrubber material," which can be processed and transformed into drywall or added to cement and soils.

Bob Sutter, chief executive officer of the North Carolina Peanut Farmers Association, said the gypsum provides "much needed calcium and sulfur to the peanuts."

Toxic metals are still found in the slurry, but in lower concentrations than fly ash, according to EPA studies.

"Gypsum is well established," said Schmaltz. "We are also turning an underutilized resource into a valuable product that prevents (our) having to mine for minerals."

For some communities, using more coal waste on farms may reduce health risks associated with coal waste ponds. Occasionally, toxic substances from waste ponds leach through soil into groundwater or breach impoundment ponds to pollute watersheds and soil.

This happened in December, when a holding pond at the Tennessee Valley Authority's Kingston Fossil Plant spilled over its banks. The sludge, which engulfed hundreds of acres, damaged lakeside homes and polluted drinking water in Tennessee contained high levels of arsenic and elevated levels of radioactive radium, reported Duke University scientists. Three weeks later a second spill occurred in Alabama, further focusing the nation's attention on the potential dangers of coal waste disposal.

A recent report released by the environmental law firm Earthjustice says 25 million tons of coal ash are dumped into American mines every year, threatening ground water.

As coal waste grows, large reuse projects are taking place throughout the country, some with toxic consequences. Battlefield Golf Club in Chesapeake, Virginia, is one of the largest so far, built with 1.5 million tons of fly ash. It was considered a model of successful recycling of coal combustion waste until tests of nearby groundwater wells discovered arsenic and lead levels exceeding drinking water standards, according to city water tests.

Stant said coal waste should be under federal oversight and listed as a hazardous waste.

But businesses say they already adhere to rules and laws when obtaining permits from state and local government before processing and reusing coal waste.

"N-Viro operates under a wastewater permit through the Florida Department of Environmental Protection in order to process bulk amounts of waste," said Mayo.

Although guidelines remain unclear and vary between states, Li said that does not mean it is easy to obtain state permits for using fly ash in agriculture, especially with fears about possible threats to people and the environment.

"I myself have been denied permits from the state of Florida to even conduct research," Li said.

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