calcium phosphate compounds. Most of the biosolid-amended soils also had higher levels of plant-available cadmium, copper, and zinc than the nonamended soils, and soil mineral levels generally increased as amendment levels increased.

Crop Response

Codling then conducted a study in which wheat was planted in pots filled with each type of amended soil. The researcher observed that yields from wheat grown in three of the five biosolid-amended soils were higher than from wheat grown in control soils. The highest yields were recorded for wheat grown in soils amended with biosolids created via anaerobic digestion, and yields in these experimental soils increased as amendment levels increased. But yields from wheat grown in lime-treated biosolids were severely reduced, probably as a result of manganese deficiency.

Codling also measured mineral levels that had accumulated in the above-ground biomass of the experimental crops. He observed that wheat grown in any of the biosolid-amended soils had higher phosphorus concentrations than wheat grown in the control soils. This coincided with the soil's elevated levels of plant-available phosphorus and provided additional indications that phosphorus was readily available for crop uptake 16 years after test soils were amended with biosolids.

Overall wheat tissue levels of lead were low, because most plants typically do not bioaccumulate lead to any significant degree. But tissue cadmium levels ranged from 1.2 parts per million (ppm) to more than 20 ppm in wheat cropped in the biosolid-amended soils. (Cadmium levels in the control soils averaged around 1.4 ppm.)

In addition, all the soil mineral levels were reduced after one cropping of wheat. Since Codling had collected leachate from each pot after watering and returned it to the pots, he surmised that the lower levels of extractable metals and phosphorus in the soils most likely resulted from plant uptake.

Taken together, these results, which are scheduled for publication in the *Journal of Plant Nutrition,* confirmed to Codling that minerals in biosolids can linger in soils long after the soils are amended. In addition, the way biosolids are processed before they are applied to soils may affect soil mineral levels to some degree.

"Even though I was evaluating mineral levels in vegetative tissue, not grain, the results still show that food and feed crops can take up minerals left over from biosolids years after the soils have been amended," Codling says. "Since sewage treatment facilities have different processes for treating biosolids, this information could help us manage biosolid amendments more effectively."—By **Ann Perry,** ARS.

This research is part of Food Safety, an ARS national program (#108) described at www.nps.ars.usda.gov.

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With Hot Air Treatment, Bacteria Fly the Coop

ANNA BATES (K9516-1)

While being transported in hauling coops on trucks, poultry that have been colonized with bacteria such as *Campylobacter* can contaminate, through fecal shedding, pathogen-free poultry. Those pathogens can also be passed on to the next group of birds during the next trip, and so forth, unless the cycle is broken.

That's where Agricultural Research Service microbiologists Mark Berrang and Richard Meinersmann and colleague Charles Hofacre at the University of Georgia in Athens come in. The team has reported a treatment that reduces poultry cross-contamination from transport-cage flooring.

Campylobacter are foodborne pathogens that can be present in raw or undercooked poultry. Since the bacteria are commonly found in the digestive tracts of poultry, they're readily deposited, through fecal shedding, onto coops and trucks when contaminated animals are transported to processing plants.

Berrang and Meinersmann are in ARS's Bacterial Epidemiology and Antimicrobial Resistance Research Unit in Athens.

Earlier work has shown that drying soiled or washed cages for 24 to 48 hours could lower or eliminate detectable *Campylobacter* on cage flooring. But extended drying times are impractical, so the researchers tested the use of hot flowing air to speed the process.

To determine whether the effect was due to heat alone or flowing air alone, hot flowing air was compared with unheated flowing air and static hot air as well as with a control. The numbers of *Campylobacter, Escherichia coli,* and coliforms on small squares of washed or unwashed fecally soiled transport cage flooring were measured after drying treatments.

When applied after a water-spray wash treatment, flowing hot air for 15 minutes lowered the numbers of *Campylobacter* to an undetectable level. The authors reported that the treatment could provide significant savings in drying time if used by industry, suggesting a potential commercial application. Static heat at similar temperatures was not nearly as effective, and unheated flowing air was moderately effective, but less so than hot flowing air.

The authors concluded that processors may be able to use a forced-hot-air treatment to dry cages between transporting flocks, lessening the number of *Campylobacter* on cage flooring, thereby decreasing the potential for cross-contamination during live haul.

More findings are reported in the *Journal of Applied Poultry Research,* December 2011.—By **Rosalie Marion Bliss,** ARS.

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