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Composted Swine Manure for Vegetable Crop Application

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Swine waste or crop fertilizer?

One way to manage swine waste is to spread it on agricultural land, but few swine producers have enough land to which to apply all the waste generated by their operation. Crop producers wishing to use swine waste on their land must address issues such as the cost of transporting liquid waste and the limits on waste use imposed by food safety certification requirements. Composting can help address these concerns. Processing the liquid waste by composting it eliminates the need to transport and apply liquids. Food safety certification for vegetable crops does not allow use of raw manure but does allow the use of properly composted livestock waste. Composting thus has the potential to allow the recycling of swine waste nutrients in a sustainable and environmentally friendly manner.

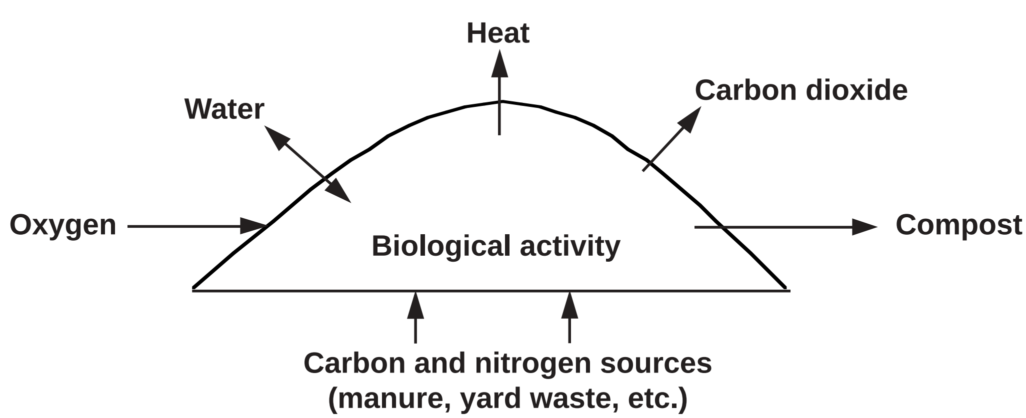
What is composting?

Composting is the biological breakdown of organic matter. It starts with a mixture of materials such as manure, food processing or yard wastes, or waste silage, which decompose in the presence of oxygen. Properly done, with a suitable mixture of carbon and nitrogen source materials and adequate moisture and aeration, composting forms a rich, humus-like material valued for its soil-conditioning qualities. Temperatures in the pile above 130˚F, generated by microbiological activity, will kill many disease organisms.

Compost is known to increase nutrient retention and soil water-holding capacity and improve soil structure. Compost added to the soil provides organic matter, macronutrients (N, P, and K), and micronutrients.

A demonstration of composting in Hawai‘i

The development and implementation of best nutrient management practices appropriate to Hawai‘i farms is important to protect our waters. Our swine waste composting project was designed to demonstrate this alternative livestock waste management practice, using the facilities of the largest swine production operation in the Waimanalo Stream watershed, by diverting some waste from their anaerobic lagoon to composting.



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Composting was followed by a demonstration of land application of compost at agronomic rates on an adjoining vegetable farm using radishes and corn as test crops. The location for the project was selected because Waimanalo Stream on O'ahu, among others in Hawai'i, has been identified as an impaired water body.

Making compost

Two composting piles were made at the Waimanalo swine farm. A sheet of high-density polyethylene was used to line the composting area, and the edges of the liner were raised over a 3-inch diameter PVC pipe to create a berm. Leachate and excess runoff drained from the liner through a screen and were collected in a 45-gallon plastic drum set in the ground below the level of the composting area. Leachate collected in the drum was pumped back to the existing waste collection system.

About 2.7 tons of coarse (drum-chipped) tree trimmings formed each pile (11 ft long x 10 ft wide). We calculated that adding enough nitrogen to obtain a carbon to nitrogen (C:N) ratio of 30:1 would require 2700 gallons of the swine waste effluent. To avoid applying excessive liquid resulting in runoff, we applied approximately 750 gallons of swine effluent to each pile.

The piles differed in the manner of aeration. The static (unturned) pile was aerated through a perforated 4-inch pipe under the pile; a household vacuum cleaner was used to push air through the pipe. A front-end loader was used to mix and aerate the active (turned) pile.

Composting results

Five essential components are needed for composting: the proper decomposing organisms, and the water, carbon, nitrogen, and oxygen needed by the organisms. We assessed our experiment in relation to these components.

Decomposing organisms produce heat by their activity. This heat in turn energizes them, and the whole process goes faster if adequate food sources are present. Using a thermometer to take pile temperature, the level of composting activity was easily determined.

Water should keep a compost pile moist but not too wet. During the first two months of composting, the piles tended to be too dry. This was followed by a very rainy period, which resulted in wet piles, cooler than optimal temperatures, and a slower composting process.

Carbon (C) is abundant in most organic materials and is used as food by decomposing organisms to create energy. The coarsely chopped tree trimmings were high in carbon but had little nitrogen compared with grass clippings, green leaves, or animal manure. The coarseness (up to 8 inches long) of the material kept the piles fluffy and allowed natural air flow through the compost but necessitated longer composting times.

Nitrogen (N) is required by decomposers. The low nitrogen content of the swine effluent made it impossible to apply nitrogen in the amounts needed by decomposers. The low amount of effluent (nitrogen source) increased the C:N ratio well above the optimum 20–30 parts carbon for each part nitrogen and slowed the composting process.

Oxygen is essential to most decomposers. After turning, the turned pile's temperature increased dramatically due to the increased aeration. With the unturned, blower-aerated pile, the anticipated composting process was limited, as indicated by low pile temperatures. When the blower was turned off, the pile temperature greatly increased, suggesting that the added air might be cooling and drying the pile too much.

Safety

Safety of the composted product is important when applying it to vegetables, such as radishes, that are normally eaten raw. Both compost piles reached a temperature higher than 130˚F for more than the 3 days needed to destroy disease organisms. Compost from both piles was negative when tested for salmonella bacteria, confirming its suitability for application on land used to grow vegetables.

Turning the compost pile.

Applying compost to cropland

Frequent rains delayed land application of the compost and crop planting. Compost and soil samples were analyzed for nutrients at the UH-CTAHR Agricultural Diagnostic Service Center. Because soil phosphorus was adequate, compost application rates were based on estimated crop phosphorus removal. Compost was applied at 10 tons of compost per acre, or about ½ pound per square foot, and tilled into the soil. Compost application was compared with the farmer's standard commercial fertilizer application. The field was made into beds with each bed planted with two rows of radishes and one row of corn between them. The crops were irrigated following normal farm practice.

The test planting.

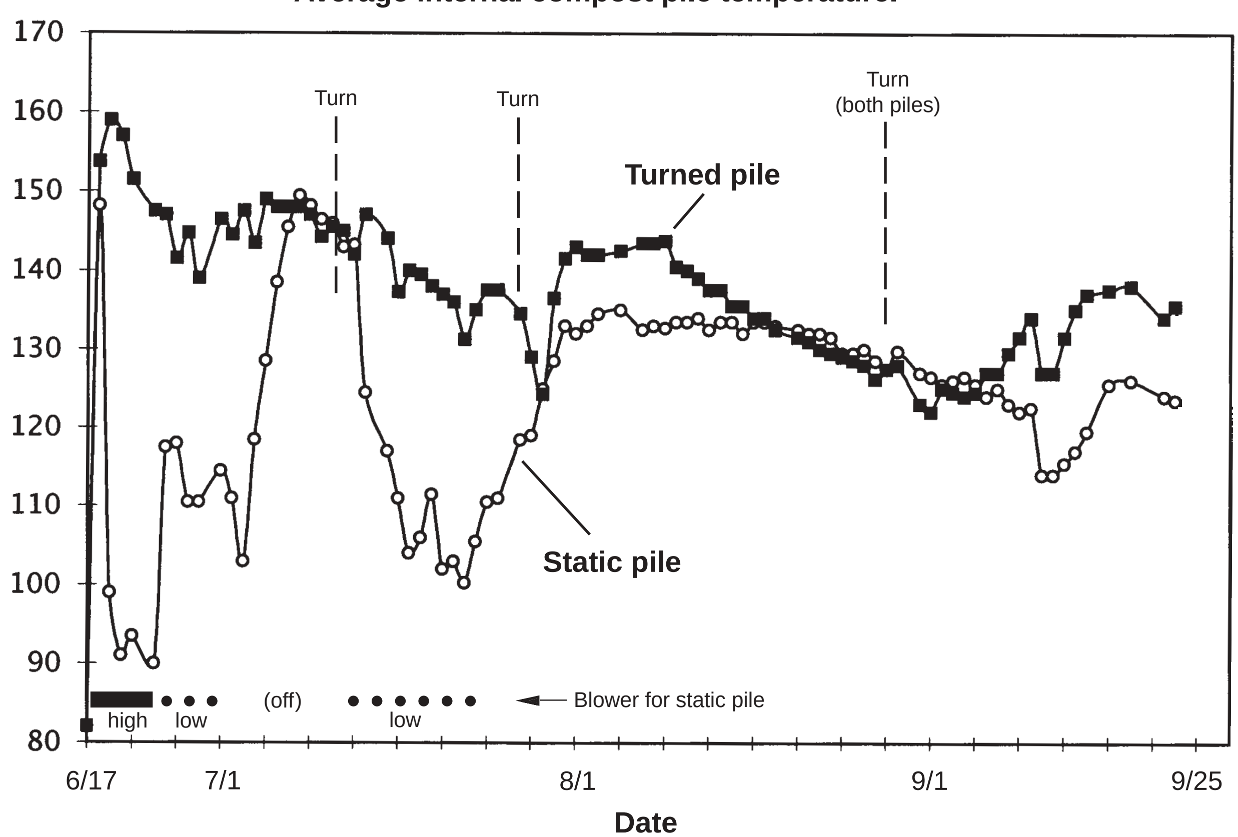
Cropping results

Soil nutrients and the yield response of radishes and corn to the compost were evaluated.

Pre-plant soil tests showed sufficient soil phosphorus for the crops to be grown. By having the soil test results, the farmer was able to save money by not applying inorganic phosphorus.

Radishes grown with compost had a greater total yield but a lower saleable yield because of cracking. High

Average internal compost pile temperature.



rainfall and planting of a susceptible variety contributed to the cracking problem.

Corn grown with compost had 20% higher mean cob weight and total yield per acre than corn without compost.

Postharvest soil tests showed final soil nutrient levels (except magnesium) were lower in composted rows than in rows treated with inorganic fertilizer, possibly due to increased plant nutrient uptake.

Summary and recommendations

- Turned-windrow composting performed much better than static piles.
- The compost was easy to handle and did not require specialized equipment. Operating costs were low, making composting affordable for a small-scale swine producer.
- Assessing moisture with a hay moisture tester in addition to measuring temperature would provide better monitoring of the composting process.
- Composting time could be reduced by using finer tree trimmings and by applying more swine effluent to the compost pile.
- Composting under a roof or cover would protect the piles from rainfall but would greatly increase start-up costs, so composting may be better suited for leeward-area swine farms receiving less rainfall.
- Where the soil is suitable, making the compost pile on compacted soil would reduce costs compared to using a plastic liner.
- There was very little unpleasant odor except during effluent addition. The compost produced had an earthy odor and texture and was judged to be a marketable product.
- Ensuring three days of internal pile temperature over 130°F destroyed disease-causing organisms such as salmonella.
- Soil testing can assist farmers in reducing fertilizer costs.
- Applying compost is recommended for farmers growing corn.
- When designing livestock waste management systems, the products should be tested to ensure suitability for land application and to determine crop response.