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Livestock solution

Composting pig manure in Hong Kong

Correlation of pile temperature, pH and concentrations of various forms of nitrogen point to the cheapest, simplest and most efficient methods for composting litter.

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Photos courtesy of S. Tiquia

A one-foot thick layer of sawdust mixed with bacterial inoculum is used as bedding material in the pig-on-litter system. After 10 to 13 weeks, litter is removed and can be composted further.

LIKE MANY other large cities, Hong Kong is facing a dilemma in terms of urban infringement on agricultural lands where production of crops and livestock is threatened. This problem is further aggravated by the fact that Hong Kong is a small territory with only approximately 100 square kilometers of arable land. Competing economic forces and demand for land continue to put pressure on agriculture to be an efficient and nonpolluting industry. Agricultural residuals, particularly pig manure, have been shown to be the major contributor to stream pollution in the New Territories and in parts of urban Hong Kong, as most animal manures are discharged into the water courses without any treatment. Pollution from pig manure accounts for 70 percent of all stream pollution in the New Territories and 50 percent of organic matter entering the sea. Because of the lack of sufficient land, the problem of livestock wastes in Hong Kong has been mostly concerned with disposal rather than with utilization.

Pig-on-litter system

As a solution to the pig manure problem, the Agriculture and Fisheries Department of Hong Kong initiated the pig-on-litter system of pig raising in 1987. Also known as *in-situ* composting, pigs in this system are raised in pens, the floor of which is covered with a 30 cm thick layer of sawdust (bedding material), mixed with a commercially available bacterial inoculum to aid decomposition. The manure is partially decomposed in the pen, and the pig manure sawdust litter remains in the pen during the entire period of pig raising (about 10 to 13 weeks). The discharge of effluent is unnecessary, and spent litter is the only material that needs to be removed.

Previous investigations showed that a very high density of indigenous bacteria establishes rapidly within the bedding material, which partially decomposes and mineralizes the organic matter and the nitrogenous compounds of the pig manures deposited on it. Because of this, the offensive odor of ammonia and the unpleasant appearance of the feces disappear rapidly within the bedding material.

In 1995 and 1996, studies also were carried out to investigate the specific role of commercially available bacterial inoculum on *in-situ* composting under the pig-on-litter system. Tam and other researchers at the City University of Hong Kong found that with proper management of the pig pens, the addition of commercially available bacterial inoculum had little effect on system performance,

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and that the pig-on-litter system can be operated on a more economic basis without those additions.

Further composting

The spent litter removed from the pig-on-litter system contains high concentrations of organic matter, N, P, K, and trace elements. With further composting in windrows to reach maturity, it can be utilized as a soil fertilizer, conditioner, or for both purposes. Various operating strategies for efficient composting of spent litter and evaluation of compost maturity were investigated in 1996 and 1997. These showed that operating strategies employed for windrow composting of spent litter significantly affect the speed of composting and time of maturation. Turning frequency, moisture content and ambient temperature are the most important factors relating to composting efficiency. If the moisture content of the spent litter was maintained at 60 percent and it was turned every four days, spent litter reached maturity in 56 days. Spent litter piles with less frequent turning (every seven days) and with initial moisture content of 50 percent took 126 days to reach maturity, while piles with 70 percent moisture that were turned more frequently (every four days) took 91 days to reach maturity.

Seasonal variations in Hong Kong also significantly affected the speed of composting. Decomposition of the spent litter during winter — without bacterial inoculum or moisture adjustment — was slow and the spent litter did not reach maturity at the end of a 91-day composting period as it did in summer. Moreover, the addition of bacterial inoculum during the initial pig-on-litter *in-situ* composting process was of no value if the moisture content was adjusted to 60 percent during further composting of spent litter in windrows. Such a finding is significant as it indicates that the process could be run on a much more economical basis.

Evaluation of maturity

The evaluation of compost maturity is one of the most important problems in the composting process and subsequent application of the final product to land. Lack of knowledge concerning the complex processes involved in stabilization and lack of standard indices to measure the degree of stability of a compost material contributes to the difficulties. Our studies demonstrated that the composting process was mediated by active groups of microorganisms and the microbial activities were reflected in the changes in temperature values and physicochemical parameters of the compost piles. Maturation of the spent litter was accompanied by changes in: humification parameters [humic acid (HA), fulvic acid (FA) and HA:FA ratio]; various forms of N [total Kjeldahl N, NH_4^+-N and (NO_3^-+NO_2^-)-N]; and pH. These changes were directly related to the microbial activities and bacterial population sizes in the spent litter.

A total of 17 parameters were measured, and changes monitored during composting. Correlations among these factors enabled us to point out the cheapest, simplest and most rapid parameters to provide reliable information on the degree of composting and the suitability of the spent litter for recycling. Four parameters — pile temperature, pH, concentrations of (NH_4^+-N) and (NO_3^-+NO_2^-)-N — satisfied the above criteria. ■

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