Poultry Manure Management

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The recent demand for low-cholesterol meat products has led to tremendous expansion in the poultry industry. In several states this rapid and concentrated growth of the industry has caused increasing concern about the disposal of poultry wastes with respect to nonpoint source pollution. Although poultry litter is one of the best organic fertilizer sources available, excessive applications of litter (as with any fertilizer source) can cause environmental problems. Nitrate leaching into the groundwater, nonpoint source P runoff into surface water bodies, and release of pathogenic microorganisms are three of the main problems encountered with improper management of this resource. The objective of this chapter is to give an overview of the current state of knowledge on the agricultural use of poultry litter and the options available to integrate litter into economically and environmentally sound management systems.

Manure Production and Composition

Poultry production in the United States is concentrated in the midsouth region. Arkansas, Georgia, North Carolina, and Alabama account for over 40 percent of national cash receipts derived from the sale of poultry products; Arkansas leads all states in both quantity and cash value of poultry products. As midsouth states are crucial to national poultry production, levels of poultry production are similarly important to the economic well-being of these midsouth states. Cash receipts from poultry and eggs constituted 45 percent and 51 percent of total 1989 farm income for the states of Arkansas and Alabama, respectively.

Litter associated with broiler production, manure generated from laying operations (hens and pullets), and dead birds are the three wastes of primary concern in poultry production (Edwards and Daniel 1992). Approximately 13 million Mg of litter and manure were produced on U.S. poultry farms in 1990, much of which (45 percent) was generated in Arkansas, North Carolina, Georgia, and Alabama (table 13). Broiler litter accounted for 68 percent of the total fecal wastes generated by the poultry industry in 1990. Although data on amounts of dead birds generated in poultry production are scarce, a 4-percent mortality rate over a production cycle is considered normal for most poultry operations (Edwards and Daniel 1992). Using this rate combined with the data in table 13 and live weights of 0.9 kg bird^{-1} for broilers, 0.9 kg bird^{-1} for layers, 0.7 kg bird^{-1} for pullets, and 5.0 kg bird^{-1} for turkeys (one-half of the live market weights, Sims et al. 1989), we calculated the weight of dead birds requiring disposal on U.S. poultry farms in 1990 to be approximately 270,000 Mg. Commonly used, approved methods of dead-bird disposal include burying in pits, incinerating, and rendering. However, co-composting dead birds with poultry litter (Cummins et al. 1992), an acceptable and desirable disposal method that produces a material amenable to land application, has become popular.

Land application offers the best solution to management of the enormous amounts of manures generated on U.S. poultry farms each year. Depending on the composition of individual poultry manures, these materials can enhance crop production via their capacity to supply nutrients and increase soil quality.

Broiler litter is a mixture of manure, bedding material, wasted feed, feathers, and soil (picked up during recovery). Bedding materials are used to absorb liquid fractions of excreta. The type of material used depends on locality, but typically includes wood chips, sawdust, wheat straw, peanut hulls, rice hulls, and recycled paper products. Owing to its relatively low moisture and high macronutrient content (table 14), broiler litter is generally considered to be the most valuable animal manure for fertilizer purposes (Wilkinson 1979). Broiler litter also contains significant amounts of secondary plant nutrients and micronutrients (table 14). Chicken manure without bedding typically has an N content similar to that of broiler litter, but has higher concentrations of water, P, Ca, Mg, and Zn (table 14). It also has a higher proportion of N as ammoniacal-N, which is subject to loss via ammonia volatilization. Turkey litter typically contains similar amounts of N and P compared to the amounts in chicken litter, but has lower concentrations of K (Sims et al. 1989). Dead-bird compost is similar to broiler litter in its nutrient composition, except for its lower N content; N losses are inherent to the composting process (table 14).

Spreading equipment

The type of spreading equipment used depends on the method of storing and handling poultry manure. Traditionally, poultry litter is broadcast directly from the house, using a variety of spreaders. Manure stored in deep pits is removed by scraping and is applied with a spreader. In a few cases, manure stored in shallow pits is removed by flushing and, after large solids have been removed by sedimentation and/or filtration, is applied with an irrigation system. Spreading equipment can vary among contractors. In many locations where the poultry industry has recently expanded, existing farm equipment is used to apply the manure. There has been less progress in improving spreading equipment for solid manure than for liquid manure. Equipment development should involve better control of the application rate and provide even distribution of manure.

Available land base

In states where the poultry industry and/or confined animal operations are concentrated, the land base available for manure application is often limited. This limitation mainly arises from the cost of manure transportation. Consequently, poultry manure is usually applied in the immediate vicinity of the production site, with little regard to the geology, soils, or topography. This inflexibility may result in the application of litter to areas with elevated soil N and P contents from previous applications or with high runoff or leaching potentials. Consequently, in the future, recommended manure application rates should be flexible and account for differing geology, soil, and topography of potential application sites.

Proliferation of the poultry industry has been economically driven. Numerous farmers with limited resources have turned to poultry production as a ready source of income with limited cash outlay. In many areas of the southern United States, intensive poultry production has developed on agricultural land unable to maintain high crop yields due to such factors as erratic weather, sloping topography, or soils that are rocky, shallow, coarse textured, or highly permeable. Local need for N and P in such regions would be lower than in areas of intensive crop production.

The current land base for manure application is dwindling. High transportation costs for manures have led to repeated applications on fields immediately surrounding poultry farms, resulting in a buildup of N and P in soils, particularly P. Manure applications to these soils may be based on soil test P requirements rather than on crop N requirements. Currently, most manure application rates are based primarily on the management of N to minimize nitrate losses by leaching. In most cases this has led to an increase in soil P levels after successive poultry manure applications because most crops require a higher N:P ratio than that supplied in poultry manure. For example, poultry litter has an average N:P ratio of 3 (table 14), while the N:P requirement of major grain and hay crops is 8 (White and Collins 1982). Soils receiving repeated applications of poultry litter for several years accumulate more P then N and have more P than the crop can use (Sharpley et al. 1991a, Sims 1992, Wood 1992).

Basing litter application rates on soil P levels rather than on crop N requirements may mitigate the excessive buildup of soil P and at the same time lower the risk for nitrate leaching to groundwater. However, such a strategy for determining proper litter rate would eliminate much of the land area with a history of continual litter applications, since many years are required to lower soil P levels once they reach excessive levels (Kamprath 1967, Wood 1992). In addition, farmers relying on poultry litter to supply most of their crop N requirements will have to purchase commercial fertilizer N instead of using their own manure N. Although basing rates on soil test P may resolve potential environmental issues, it places unacceptable economic burdens on farmers, that is, the cost associated with transporting the manure and buying additional fertilizer N are too high.

Hydrology of the available land base will also be important in determining whether manure application rates should be based on N or P. If the potential for leaching of soluble chemicals from an application site exists, one could argue that N should be a priority management consideration. Conversely, if runoff and erosion potential far exceed leaching potential, then P would be the main element governing application rates.

As the poultry industry continues to grow in areas where poultry production is already high and where the land base suitable for agronomically and environmentally sustainable manure applications continues to decline, manure will, by necessity, be moved outside of these intense poultry producing areas. Research in Alabama, Arkansas, and Oklahoma is evaluating appropriate application rates and cultural practices for poultry litter as a nutrient source for field crops (corn, cotton, rice, sorghum, and wheat) and bermudagrass (coastal and midland). The major obstacle to using this manure on these crops in non-poultry-producing areas continues to be the cost of transport.