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POULTRY MANURE MANAGEMENT AND UTILIZATION

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POULTRY MANURE MANAGEMENT AND UTILIZATION
PROBLEMS AND OPPORTUNITIES

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Introduction

There has been an increased concentration of poultry enterprises on relatively small land areas resulting in the production of large amounts of poultry manure and used litter. This represents a problem to the poultry producer and to the public sector. In the long run, the success of many large poultry production operations may depend on how well the waste is managed and utilized. What has been regarded as a disposal problem must now be regarded as a challenge for appropriate management and utilization. Management of manure for satisfactory disposal requires suitable storage, transport and use to minimize odors, insect problems and contamination of ground or surface water. Utilization of manure implies providing an economic return from manure by use of its nutrient elements as a fertilizer or by converting it to biogas or compost that may increase its value, or by combustion to convert it to heat. This publication has two purposes:

- to summarize the alternatives in poultry manure management and utilization.
- to suggest guidelines for the appropriate management of manure in the poultry house and for the utilization of poultry manure as a fertilizer in crop production.

Alternatives in Poultry Manure Management and Utilization

The major route for the disposal and/or utilization of poultry manure has been its application to cropland. Disposal is when large amounts of manure are applied to the land without regard to soil fertility and projected crop-fertilization needs. Utilization is when the manure applied is calculated to meet the needs for soil fertilizer elements used in crop production. This alternative will remain as a major method of dealing with poultry manure, but increasing emphasis must be placed on utilization for crop production and not on disposal.

Pullet rearing facility with manure collection belt.

Over-application of poultry manure to cropland can lead to problems such as surface and ground water pollution and esthetic problems with odors and insects. Reduced crop yields could also result from over-application due to soil accumulation of both macro and trace minerals. The most serious problem generated by excessive manure application is surface and ground water pollution with nitrates that originate from oxidation of nitrogen contributed by the manure. Also, important ecological problems can result from the discharge of ammonia, phosphates and organic matter that results in increased biological oxygen demand in waterways. A significant increase in biological oxygen demand will cause low levels of oxygen in the water which will cause the death of fish and other aquatic lifeforms. Thus, excessive manure application has the potential for damaging the environment in lakes and streams.

As a crop fertilizer, poultry manure should be limited to amounts needed for crop production so not to contribute significantly to ground or surface water pollution. This means that some concentrated poultry production units need to find additional land area for utilization of their poultry manure output or consider other alternatives for poultry manure utilization that will permit recycling of manure products and their transport for use in other locations.

Poultry Manure Production and Composition

The total output of poultry manure from a given farm or complex can be estimated. From this information, the amount of manure that needs to be moved or used can be determined. Table 1 outlines the fresh manure output of several types of poultry. The total manure that will likely be produced can be calculated from this data. Keep in mind that cage layer manure in well-ventilated houses will lose moisture and the actual output of manure may be one third of that shown in the table. On the other hand, the total amount of used litter to be removed from the floor in a broiler or turkey growing house after the flock is sent to market is the manure output shown in Table 1 plus the original litter material adjusted for moisture changes. In either case, the amount of manure or used litter accumulated over a year's time is quite surprising. While the total amount of manure represents a material handling problem, the composition of manure determines where and how much of it can be utilized.

Another way to estimate manure output from the flock is to calculate it from the flock's feed intake. The relationship of feed intake to fresh manure output is shown in Table 1. The weight of fresh manure output is about 115 percent of the total dry feed intake. Total the flock's feed consumption records, and multiply it by 1.15 to get an estimate of fresh manure output. If the accumulated manure represents more than one flock, the feed records of all flocks must be added together before the calculation is made.

Remember that fresh manure is 75 percent water and the moisture will evaporate from the accumulating manure while it is in the poultry house. Hence, if drying conditions in the house have been very good, only about one third of the calculated weight of the fresh manure will remain, reducing both the amount of manure to be spread on the cropland and the amount spread per acre.

The content of major fertilizer elements in fresh manure is shown in Table 2. These elements are concentrated in the manure when it dries and are diluted when the manure is mixed with litter in floor pen operations. The nitrogen content of the manure behaves differently. The nitrogen is lost as it becomes ammonia gas over time. These losses of nitrogen take place at different rates depending on temperature, mois-

Table 1
How much manure does a poultry flock produce?

Type of Poultry	Daily Feed Intake (per 100 birds)	Daily Fresh Manure Output* (per 100 birds)
Laying Chicken	20-26 pounds	20-34 pounds
Growing Broiler at 6 weeks of age	26-30 pounds	30-35 pounds
Growing Large Tom Turkey at 16 weeks of age	93-115 pounds	108-132 pounds

*Fresh manure will contain 70 percent to 80 percent moisture.

ture, pH, and bacterial activity. For these reasons, fresh manure or manure treated to avoid large nitrogen losses has a higher fertilization value. Rapid drying of fresh manure does help to preserve its nitrogen content. The use of superphosphate in manure to prevent nitrogen losses by reducing pH is not usually recommended because the added phosphorus is not necessary or desirable when poultry manure is used as a fertilizer.

The calcium content of poultry manure is also shown in Table 2. Manure from egg laying chickens is higher in calcium than manures resulting from growing broilers or turkeys. The higher calcium levels of manure from laying chickens used as fertilizer may interact with "liming" practices since both supply substantial amounts of calcium to the soil.

Converting Poultry Manure to Other Products

Microbial conversion of poultry manure to partly oxidized products that have more desirable characteristics has been undertaken in recent years with methods that exert some control over the biological processes involved. Such products may be more desirable because they have greater stability, contain more organic nitrogen, have fewer odors, and may have wider usage than plant fertilizer. These products are produced by controlled composting but require poultry manure to be mixed with a carbon source which provides energy for the microorganisms and a physical matrix for oxygen penetration into the fermenting mixture. The composition and usefulness of such composts varies with the fermentation, the freshness of the manure and the nature/amount of the carbon source employed. In addition to the manure, a readily available carbon source is required to make this process feasible. Crop residues would be the most likely materials to be used as sources of carbon; however, food processing plant wastes might also be used. The potential uses for stabilized composts made from poultry manure include animal feedstuffs, specialized plant fertilizers and soil conditioners. While these products might be recycled on the poultry farm, the greatest benefit would be from transport to other areas not involved in concentrated animal production.

Table 2

What does freshly voided poultry manure contain?

Component or Element	Laying Chicken	Growing Broiler	Growing Turkey
Total nitrogen*	1.0-1.8%	1.4-2.2%	1.2-2.5%
Phosphorus as P_2O_5	0.8-1.2%	0.9-1.2%	1.0-1.4%
Potassium as K_2O	0.5-0.7%	0.5-0.8%	0.5-0.8%
Calcium	3.3-4.8%	1.2-2.5%	1.0-2.3%

*Nitrogen is lost from poultry manure as ammonia (with time). Storage of manure will therefore result in loss of some nitrogen content.

The technology for anaerobic conversion of poultry manure to biogas and sludge in liquid systems as well as high solids anaerobic fermentation to produce methane has also been developed. Sustaining the microbial reaction, storage and reuse of the biogas as a fuel have all received research effort. Major problems with biogas production include maintaining adequate reaction temperatures, keeping the microbial gasification and liquification reactions in balance and utilization or storage of the gas as it is produced. Outputs of 1.5 to 2.0 cubic feet of gas per day per pound of manure in the digester have been reported.

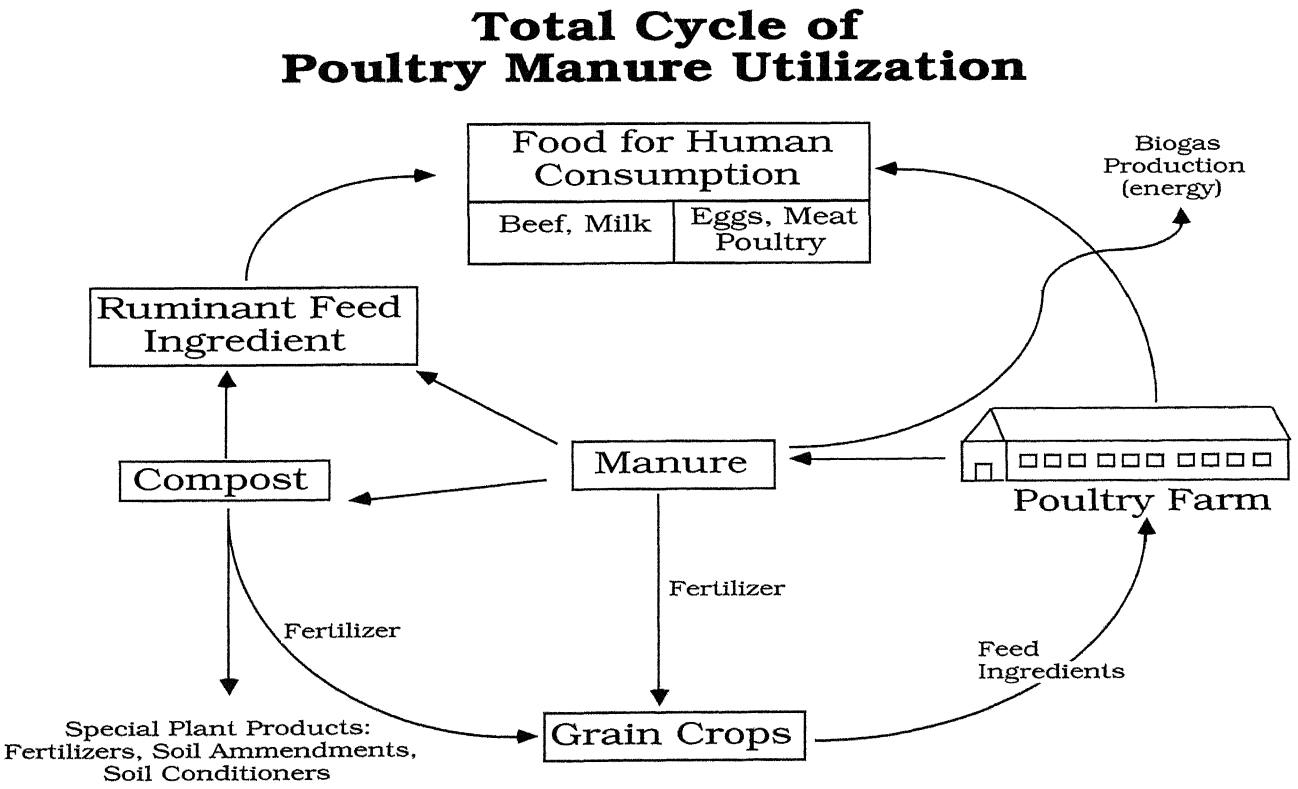
Both aerobic and anaerobic fermentation of poultry manure have the potential for generating new useful products that are more stable and have market potential, as well as potential for reuse on the poultry farm. Clearly, any system for converting poultry manure to other products must be biologically sound, of appropriate engineering design, economically feasible and socially acceptable to succeed. There is a great need to improve the fermentation process, to determine the economic feasibility of fermentation systems, and for pilot plant testing to improve design before investments in commercial scale systems are made.

In addition to broad opportunities for converting poultry manure through specialized fermentation processes, limited opportunity also exists for using poultry manure for ruminant feeding by direct incorporation into diets or indirectly by ensiling it with crop residue where cattle or sheep are grown near to or as part of large poultry enterprises. This is a common practice on some farms. Research has shown that corn silage stability is improved by the addition of cage layer manure.

General Guidelines for Manure Management in Cage Layer Houses

The objectives for manure management in the cage layer house are to minimize odor and insect problems, eliminate water pollution potential, and maximize the potential value of the manure. These objectives can be achieved by limiting the length of time that manure is stored and keeping it as dry as possible. The following guidelines are offered to achieve these two objectives.

1. Manure should accumulate in water-tight areas of poultry houses that cannot be infiltrated by ground or surface water runoff.



2. Flushing of manure with water or other additions of water is to be avoided except in liquid manure handling systems.

3. Water leakage from drinking systems or cleaning systems should be prevented by maintenance and repair.

4. Ventilation system should be of adequate capacity and design to maximize water loss by evaporation from manure when environmental conditions permit.

5. Adequate insulation should be present in the roof and walls of poultry houses to maximize the air temperature during winter months and thereby increase its moisture carrying capacity.

6. Salt and other mineral levels in drinking water and poultry rations should be restricted to those actually required for maximum growth and/or egg production performance.

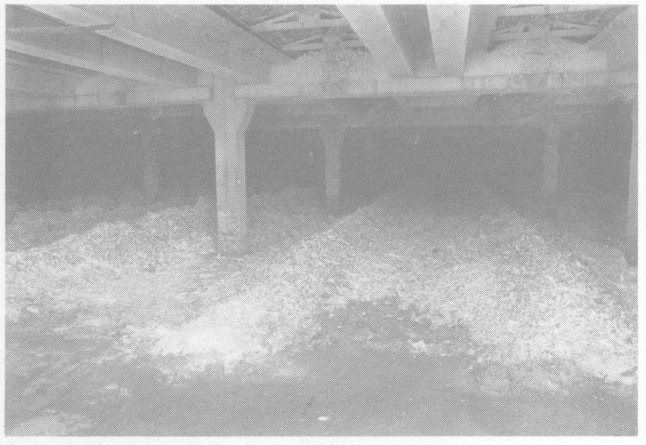
7. Gastrointestinal infections that lead to diarrhea and excessive water consumption by the birds should be avoided by disease prevention measures.

8. Manure should be cleaned out from the poultry house as frequently as possible and whenever the condition of the manure demands action to prevent odor and insect problems. Increases in fly populations that cannot be controlled by larvacides or insecticides must be dealt with by frequent cleaning of the poultry house. Newer European battery cages with manure belts provide a system for daily clean out of manure.

Application of these guidelines should permit keeping moisture levels in manure low enough to avoid significant odor and insect problems when used with other insect control methods.

General Guidelines for Manure Application

There are three different levels of concern in suggesting guidelines for the disposal and/or utilization of poultry manure on the land. The primary concern deals with human and farm animal health or safety associated with land manure application. Ground and surface water levels of nitrates are of greatest interest because they present potential human and animal health problems. To avoid this primary problem the following guidelines are offered:



Deep pit of a cage layer operation.

1. Application of pure cage layer manure should be limited to six dry matter tons per acre of crop land per year unless soil tests and crop requirements for nitrogen show a need for more to maintain high crop yields.

2. Manure applications to land should be incorporated into the soil as rapidly as possible to avoid runoff, odor, and insect problems.

3. When land application to frozen soils is desirable to avoid odor and fly problems and to gain access to fields, applications to land with significant slopes, near wells, streams, and waterways should be avoided.

4. Grassland buffer zones should be used near waterways that are maintained without manure application to avoid lake and stream pollution.

5. Outdoor stockpiling of raw manure should be avoided whenever possible. Manure should only be stored under roof and on a concrete pad.

The second level of concern deals with ecological considerations and environmental alterations in public waters that may have undesir-

able effects on aquatic plant and animal populations. If pollution of streams and lakes with ammonia, phosphates and organic matter takes place, application of pure cage layer manure should be limited to four dry matter tons per acre of cropland per year. Further attention to guidelines two, three and four may also be required to alleviate this second area of concern.

The third level of concern is agronomic. The interest is in the best utilization of poultry manure as a crop fertilizer and its incorporation into soils at levels to provide only the necessary levels of plant nutrients. The rate of manure application should be limited to that amount required for crop production and maintenance of a reasonable level of soil fertility. Generally this means that soil levels of phosphorous and/or potassium govern the amount of poultry manure that it is appropriate to use. In this case supplementary sources of nitrogen usually must be used to produce an appropriate nutrient balance. Phosphorus accumulation takes place in some soils as a result of overfertilization. While the amount of poultry manure used under these conditions depends on crop needs, soil fertility levels, physical characteristics of the soil and the potency of the manure, the limit of pure cage layer manure application will probably be about two dry matter tons per acre of crop land per year. The actual amount of manure applied should be calculated for each crop production situation. Even when manure is used to satisfy agronomic concerns at reduced application rates, guidelines two, three and four should be carefully observed.

The steps to follow in determining how much poultry manure can be utilized as a crop fertilizer are presented in Table 3.

Table 3

How much poultry manure can be utilized as a crop fertilizer?

Steps to follow:

1. Because poultry manure is usually stored for varying lengths of time and is mixed with litter material when it is obtained from floor pens, it will vary in composition from the fresh manures shown in Table 2 and should be analyzed for the main fertilizer elements before it is used.

2. Soil fertility tests should be conducted on land areas to be fertilized.

3. Crop needs for projected yields for each of the main fertilizer elements should be determined from appropriate guides for crop production.

4. Manure application should be limited to amounts needed to make up the difference between crop needs and existing soil fertility levels. In most cases, limiting use of poultry manure to provide crop needs for phosphorous and potassium will result in needs for additional nitrogen fertilizer. Using poultry manure at levels to provide the crop needs for nitrogen will usually result in the excessive application of phosphorous and potassium. Calculation of this type applied to many farms will show needs that vary from 0 to 12 tons of manure per acre of cropland. Most frequently the calculations show needs of 2 to 6 tons of manure per acre.

The primary difference between a cage layer manure and broiler and turkey manure is that the broiler and turkey manure is diluted with litter material. Under most circumstances this results in a manure containing mixture that is easier to handle because it is usually drier and has fewer problems with odor and insect control than pure manure. When this material is used as a fertilizer and soil conditioner, the dilution of the manure with the litter material should be considered. An analysis of the used litter for nitrogen, phosphorus and potassium should be used as the basis for the application rate to soils. In most cases, the dilution of the manure with litter means that substantially higher rates of application of the used litter can be used than those previously suggested for cage layer manure. However, these application rates should not exceed those that would contribute significantly to nitrate levels in ground or surface water supplies or those that relate to sound agronomic practices.

Reasonably dry poultry litter can also be used as a fuel with other fuel sources for combustion to provide heat for broiler or turkey brooding. The composting or ensiling of used poultry litter for feeding to ruminants may be an option where drugs used in broiler and turkey growing diets do not pose a problem for function of the rumen or result in tissue residues in the ruminant animal. Proper composting of used poultry litter can also yield a stable product for use as a fertilizer, soil amendment and mulch in gardens, greenhouses and production of specialty crops.

Good ventilation in the poultry house and stirring of the litter on the floor will help control moisture levels and release of ammonia from the accumulating manure-litter mixture. Water spillage or runoff drainage should be avoided.

The guidelines offered here are general. They are not regulations or standards and therefore must be adapted for use under specific conditions to meet specific concerns. Clearly, the rate of manure application to land depends on the level of concern being expressed as well as many other factors that apply to the specific farm operations and location. The farm manager has an important responsibility for the management of poultry manure in the poultry house and for its disposal or utilization.

References

Boushy, A. R. El and others, "Biological Conversion of Poultry and Animal Waste to a Feedstuff for Poultry." World's Poultry Science Journal, Vol. 41, pp 133-145, 1985.

"Chemical Composition of Broiler and Turkey Manures," Research Bulletin 90, 1971. College of Agriculture Experiment Stations, University of Georgia, Athens, GA 30602.

Naber, E. C., "The Refeeding of Cage Layer Manure Subjected to Aerobic Fermentation, "Agricultural Waste Utilization and Management, 1985. Proceedings of the Fifth International Symposium on Agricultural Engineers, St. Joseph, MI 49085.

Ohio Agronomy Guide, Bulletin 472. Ohio Cooperative Extension Service, The Ohio State University, Columbus, OH 43210.

Schuler, M. L. and others, "Process for the Aerobic Conversion of Poultry Manure into High-Protein Feedstuff." Biotechnology and Bioengineering, Vol. 21, pp 19-38.

"Utilization and Disposal of Dairy and Poultry Manures by Land Application," Bulletin 812, 1977. Agricultural Experiment Station, The Pennsylvania State University, University Park, PA 16802.

Vuori, A. T. and Nasi, J. M., "Fermentation of Poultry Manure for Poultry Diets." British Poultry Science, Vol. 18, pp 257-264, 1977.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