Texas Agricultural Extension Service

People Helping People

Caged Layer Manure Management

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Selection of a manure management system for caged laying hens depends on building and cage design, site topography and soils, location with respect to neighbors, surrounding land use, rainfall, humidity and availability of effective fly control measures.

Poultry manure from caged laying hens can be handled either in solid form (30 to 75 percent moisture), semisolid form (75 to 90 percent moisture), or liquid form (more than 90 percent moisture). Frequent collection and land application preserves most of the fertilizer value while prolonged storage and treatment results in a substantial loss of fertilizer nitrogen. Regardless of the type of system chosen, the manure and wastewater must be disposed of or utilized by spreading or irrigating at rates consistent with soil and crop nutrient requirements. State regulations prohibit discharge of manure or wastewater to streams and emissions of nuisance odors.

Solid and Semisolid Manure Handling

Manure can be collected from shallow pits beneath double or triple-decked cages with motor scrapers, cable scrapers or continuously-scraped conveyor belts. Stacked or coned solid manure in shallow pits is usually collected with a motor scraper at 2 to 6 month intervals and distributed directly on crop or pastureland with a spreader wagon or truck. Motor scrapers can be operated where cages are suspended from roof trusses, but cable scrapers or conveyor-belt scrapers are used where cages are anchored to the floor. Cable-scraped or belt-scraped manure is usually collected daily. It contains 15 to 25 percent solids (75 to 85 percent moisture) and may be odorous when stored. In a "high-rise" poultry house, a small wheel loader may be used to collect solid manure from the ground level basement or storage pit.

Good natural ventilation is necessary to remove manure moisture and gaseous emissions. In Texas, natural ventilation is achieved with narrow, curtain-walled buildings built in an east-west direction. Mechanical ventilation will probably be necessary in high-rise houses in humid climates (less than 30 inch annual moisture deficit). When maintained at 30 to 65 percent moisture content, poultry manure produces relatively low odor; however, it is susceptible to water leakage which causes higher moisture content, adverse drying conditions, odors, fly breeding and manure handling problems.

Fly breeding and emergence can be a problem when solid or semisolid manure is stored unless sound control measures are employed. A biochemical formulation is currently available for inclusion in poultry rations for effective fly control in manure.

Liquid Manure Management with Flush/ Lagoon Systems

Liquid manure management systems include undercage or external manure storage pits with added dilution water or flushed shallow-pits with one or more treatment lagoons. Liquid manure storage pits are not recommended because of significant odor emissions when manure is stored for more than 4 to 7 days.

The flush system involves frequent manure collection in shallow undercage channels using abundant water. Frequent flushing reduces odors and virtually eliminates fly breeding potential. The large volume of wastewater resulting from a flush system dictates that the liquid manure and wastewater be discharged into an earthen lagoon system for storage, biological treatment and recycling as flush liquid. The flush and lagoon system also reduces labor and land area requirements.

Many Texas poultrymen have installed flush and lagoon systems in new or renovated laying houses. The design and operating criteria for these systems is included in this publication. Information on rates of manure production and proper land application is also provided. This information can be used by poultrymen to plan and design manure management systems and to complete the necessary application forms for water and air pollution abatement permits.

Manure Production

Caged layers produce 53 to 70 pounds dry manure solids per day per 1,000 birds. The estimated manure production for laying houses with 30,000 to 120,000-bird capacity is shown in Table 1. The amount of land recommended for manure disposal (assuming 240 pounds of plant available nitrogen (PAN) per acre per year) is 2.5 acres per 1,000 birds for fresh manure and 0.95 acres per 1,000 birds for lagoon effluent (Table 2). The estimated nutrient availability and application rate for effluent irrigation from a lagoon system is shown in Table 3.

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Table 1. Estimated Manure Production from Caged Layers.

	Number of Birds		
	30,000	60,000	120,000
Wet Manure, lbs/day	6,350-8,400	12,700-16,800	25,400-33,700
, tons/year	1,160-1,530	2,320-3,070	4,640-6,150
Dry Manure, lbs/day	1,590-2,100	3,180-4,200	6,350-8,400
, tons/year	290-380	580-770	1,160-1,530
Volatile Solids, lbs/day	1,100-1,450	2,200-2,900	4,400-5,800
Total Nitrogen, lbs/day	87-135	170-270	340-540
, lbs/year	31,900-49,200	62,500-98,500	125,000-197,000
Total Phosphorus (P_2O_5), lbs/day	76-100	150-200	300-400
, lbs/year	28,000-37,000	55,700-74,000	111,000-147,000
Potassium (K_2O), lbs/day	44-59	89-120	180-235
, lbs/year	16,100-21,400	32,500-43,000	65,000-86,000

Table 2. Land Area Recommended for Manure or Lagoon Effluent Disposal. (soil loading rate of 240 lbs. available nitrogen/acre/year)

	Number of Birds			
	1,000	30,000	60,000	120,000
Fresh Manure, without treatment	2.5	75	150	200
Lagoon Effluent, after treatment	0.95	29	57	114

Table 3. Estimated Annual Manure Nutrients in Lagoon Effluent for Application on Pasture or Cropland (100,000 Caged Laying Hens).

Land Application of Manure Nutrients	Nitrogen N	Phosphorus P_2O_5	Potassium K_2O
Nutrients in Fresh Manure, lbs/year	135,000	108,000	62,500
Volatilized from Lagoon Surface, %	75	0	0
Remaining in Lagoon Effluent or Sludge, lbs/year (average)	34,000	108,000	62,500
Nutrient Availability Coefficients in Lagoon Effluent, %	90	75	95
Total Plant-Available Nutrients Applied to Soil, lbs/year	30,000	81,000	59,000
Volatilization Losses from Surface Application, %	25	0	0
Average Annual Soil Loading with Plant-Available Nutrients, lbs/year	23,000	81,000	59,000
Available Nutrient Application Rate, lbs/acre/year	240	850	625
Minimum Land for Effluent Application, acres per 100,000 birds	95	95	95

Flush System

Poultry manure collection pits should be flushed 2 to 3 times per week for odor control. Poultry houses, should have a slope of 0.3 to 0.7 percent (0.3 to 0.7 feet of fall per 100 feet of channel length). More slope (up to 2 percent) is desirable if the available pressure tolerance on the watering system will not be exceeded; consult with the manufacturer. With less than 0.4 percent slope in a flush channel, board check-dams (2" x 6" boards) can be placed in grooves across the channel at 100-foot intervals to retain liquid until the next flushing. These boards should be removed during flushing.

High rate pumping is the most effective method of flushing a modern poultry confinement building. Manure collection channels are too long (350 to 525 feet) and flat for flush tanks with sudden-release devices to be effective. The flow rate of flush water should be at least 80 to 100 gallons per minute (gpm) per foot of channel width (i.e. 480 to 600 gpm for flushing a 6 foot wide collection channel). The estimated volume of flush water required to remove one pound of dry manure is 10 gallons. The average daily volume of flush water needed is shown in Table 4. When flushing is utilized, it is usually necessary to provide manual or cable scraping for complete removal of oyster shell and other heavy solids. Cage

design will determine accessibility for manual scraping versus cable scraping.

Table 4. Estimated Daily Flush Water Requirement*.

Number of Birds	Average Manure Solids, lbs/day	Estimated Daily Flush Water Pumped, gal/day
30,000	1,850	18,000
60,000	3,700	37,000
120,000	7,400	74,000

*Assumes 1.2 percent total solids increase in flushing the channel (outlet minus inlet concentrations).

PVC pipe (6 to 8 inch diameter) should be used to recirculate lagoon effluent, so friction head losses and pumping energy requirements are minimized. Pressure gauges on the intake and discharge sides of the pump or a flow meter on the discharge side of the pump will help monitor changes in the flow rate that could indicate formation of struvite crystals. To remove these crystals, pour a 5 percent solution of sulfuric or hydrochloric acid into the PVC pipeline. Wear protective clothing and follow safety precautions. Ports and valves for injecting the acid solution and holding it 24 to 48 hours should be designed into the PVC pipe used to return lagoon effluent for flush water. The used acid solution can be drained into the lagoon.

Lagoon System

A lagoon system may be necessary for manure storage and treatment (biodegradation) to avoid overloading the soil with nitrogen. A two-stage lagoon system is recommended for maximum treatment efficiency, reduced land requirement, improved flush water quality, increased storage capacity and improved irrigation economy. Lagoons may produce low to moderate odor intensity.

The recommended volume of a primary anaerobic lagoon is 10 cubic feet per caged laying hen. This is based on organic solids loading rate, treatment performance, sludge cleanout interval and odor control. A smaller primary lagoon will generally produce more odor, yield lower quality effluent for flushing and require more frequent solids removal than a larger lagoon. A second-stage lagoon should have a liquid volume of 4.5 cubic feet per bird. Typical lagoon dimensions to provide recommended treatment volumes are shown in Table 5. With typical flush water usage, these lagoons will provide liquid detention for at least 120 days in the primary lagoon and 55 days in the secondary lagoon.

Some producers may want to install a settling pit between the layer houses and the primary lagoon to capture manure solids for direct land application. The size of primary and secondary lagoons can be substantially reduced by 25 percent if the settled solids are to be removed year-around for direct land disposal.

To start a lagoon system, add dilution water to the primary lagoon as soon as it is built (before manure is introduced into it). Runoff water from adjacent buildings, land, and driveways can be diverted into the lagoon to help fill it for proper start up. Fresh water from wells or ponds can be used for flushing at first. It may be helpful to "seed" a new primary lagoon with sludge or effluent from an existing primary lagoon. It may be two or three years before the irrigation system is necessary for effluent disposal; thereafter, periodic irrigation is desirable to utilize nutrients and remove salts from the system.

Land Application of Manure and Wastewater

The land application rate should be based on nitrogen application; however, a poultry producer may be applying much more phosphorous and potassium than the crops require. Excess available phosphorous could cause a zinc deficiency which can be corrected by adding zinc sulfate to the soil. Excess phosphorous is immobilized by the soil and

Table 5. Typical Lagoon Dimensions to Provide Recommended Treatment Volumes.

Number of Birds	Stage	Liquid Volume[1], cu ft	Liquid Depth[2], ft	Inside Dimensions[3] (length x width) Top ft	Waterline ft	Bottom ft
30,000	Primary	300,000	10	215x215	203x203	143x143
	Secondary	135,000	8	165x165	153x153	105x105
60,000	Primary	600,000	10	286x286	274x274	214x214
	Secondary	270,000	10	205x205	193x193	133x133
120,000	Primary	1,200,000	12	271x495	259x483	187x411
	Secondary	540,000	10	274x274	262x262	202x202

[1]Based on liquid volumes of 10 and 4.5 cubic feet per bird for primary and secondary lagoons respectively.
[2]Total depth should be 2-feet greater than liquid depth (i.e. freeboard of 2 feet)
[3]Assumes inside side slopes of 3:1 (horizontal to vertical). Embankment top width should be 10 to 14 feet with vegetative cover.

reverts to an unavailable form. Excess potassium and sodium in the manure could contribute to loss of soil structure and subsequent salinity problems.

Producers should have their soil tested annually to reveal possible chemical imbalances in the soil. The lagoon effluent should be tested each year for salinity and nutrients. The Extension Soil and Water Testing laboratories in College Station and Lubbock analyze samples for a nominal fee and provide recommendations on proper application rates.

Pollution Control Permits: Water and Air

All caged layer producers must obtain a construction permit from the Texas Air Control Board (TACB) for new facilities or for sizeable expansions of existing operations. The main considerations are location relative to surrounding neighbors and prevailing winds, manure management system, and operating practices. The only caged layer operations that are exempted from TACB permits are those housing less than 20,000 caged layers with a dry or solid manure handling system. All new caged layer farms with flush and lagoon systems must get a construction permit before construction begins. The Texas Clean Air Act requires public notification, and a hearing may be requested.

The TACB also regulates odors under a general nuisance regulation. Agency personnel investigate individual complaints and if a probable public nuisance is determined, the producer may need to correct it. If complaints persist, the producer may face corrective action, a public hearing, an administrative board order and eventually a civil lawsuit as a public nuisance.

Water pollution controls for caged layers are specified in a technical guideline of the Texas Water Commission (TWC) for confined and concentrated livestock and poultry operations. A TWC permit is required for caged layer operations with more than 30,000 birds and a liquid manure management system, which includes flush and lagoon systems.

The TWC technical guideline specifies that it is the policy of the state that there shall be no discharge of manure and wastewater from concentrated animal feeding facilities, but rather that the manure and wastewater shall be collected, stored and disposed of on agricultural land at rates that are consistent with crop production practice. The guideline includes: (1) minimum storage requirements; (2) control of any manure-contaminated runoff; (3) equipment to dispose of wastewater within a 3-week period when needed; and (4) specifications for clay liners for earthen lagoons and holding ponds.

Texas Air Control Board and Texas Water Commission permit applications should be filed early in the planning process, several months before construction is scheduled to begin. Send applications to:

Texas Air Control Board Permits Division 6330 Highway 290, East Austin, Texas 78723 (512) 451-5711	Texas Water Commission Wastewater Permits Section P.O. Box 13087 Austin, Texas 78711 (512) 463-7898

The 1945 Texas Sanitation and Health Protection Law regulates general sanitation and public health nuisances, such as flies. Complaints to local health authorities or to the Texas Department of Health sometimes uncover improper sanitation practices that have public health consequences and must be corrected.

Local and Private Regulation

Local governmental entities can also bring suit for odor nuisance in a district court under the Texas Clean Air Act. Local agencies may bring suit in a county court against an operation that causes air pollution, including odors.

Poultry producers are subject to private nuisance lawsuits brought by neighbors without the involvement of governmental agencies. Nuisance is defined legally as any condition or action which interferes with the normal use and enjoyment of property.

The 1981 Texas Right to Farm Law limited the circumstances under which agricultural operations may be regulated or considered to be a nuisance. The law declares that "it is the policy of this state to conserve, protect, and encourage the development and improvement of its agricultural land for the production of food and other agricultural products." Under this law, an agricultural operation cannot be declared a nuisance if: (1) it has been lawfully in operation and without substantial changes for at least l year before nuisance action is brought, and (2) the operation complies with the existing environmental protection statutes and state regulations. When production facilities are expanded, the established date of operation for each expansion is considered separately. The Right-to-Farm Law provides protection against unwarranted private nuisance lawsuits, but it does not restrict state agencies from enforcing water and air pollution or public health protection statutes.

Technical Assistance

The poultryman should obtain technical assistance when planning manure management and pollution control systems. Technical information, guidance and planning assistance is available from Extension specialists in agricultural engineering and poultry science and from county Extension agents. Field offices of the Soil Conservation Service-USDA can provide on-site engineering assistance for designing flush, lagoon and land application systems.

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