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United States Department of Agriculture, Athens, Georgia	Doug Smith
Marion County Extension Agent	Jimmy Howell
Pickens County Extension Agent	Rick Jasperse

NUTRIENT MANAGEMENT PLAN CHECK LIST

- ☐ Obtain soil and litter analysis (contact County Agent)
- ☐ Complete the annual farm manure production form (Section III)
- ☐ Complete a nutrient budget worksheet (Section III)
- ☐ Complete the manure utilization record (Section III)
- ☐ Complete the litter application record (Section III)
- ☐ Complete the litter removal record (Section III)
- ☐ Maintain a file of nutrient management records

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Nutrient Management Plan Checklist

○ Farm Description (# houses or # of birds annually)

○ Annual Manure Generated

○ Litter Sample

○ Soil Samples (All fields to be used for litter application)

○ Maps showing field borders, wells, acreage, surface water, etc.

○ Spreader Equipment (Size and Calibration)

○ Mortality Management

○ Emergency Action Plan

Emergency Action Plan

	Name	Phone#
Primary Contact		
Secondary Contact		
Local Fire Dept.		
Local Police Dept.		
Local EPD		
Local Health Dept.		
Local NRCS Office		
Extension Office		
Gas Company		
Power Company		
Additional Help		

Farm Fire Protection District	
911 Coordinates for farm	
Is there a disconnect between the meter base and the buildings?	☐ Yes ☐ No ☐ N/A
If so where?	
Size of Electrical Service	
Do you have a standby alternator?	☐ Yes ☐ No ☐ N/A
Give the location of electrical panels in buildings	
Location and size of propane tanks	
Other fuels and locations	
Are hazardous materials stored in the facilities?	☐ Yes ☐ No ☐ N/A
If yes, provide the locations and list of materials	
Any medical conditions of farm employess, list	

Cooperative Extension Service
The University of Georgia College of Agricultural & Environmental Sciences

CNMP Development Checklist For Dry Litter Poultry CAFOs

Casey W. Ritz, Ph.D., Extension Poultry Scientist
Greg Sheppard, Lumpkin County Extension Service

New state and federal storm water discharge regulations now require many Georgia poultry farms to develop a Comprehensive Nutrient Management Plan (CNMP) as a part of the NPDES permit program. Farms designated as a Concentrated Animal Feeding Operation (CAFO) are required to obtain an NPDES permit and implement a CNMP. Dry litter CAFOs are those operations which house greater than 125,000 broilers and broiler breeders or 82,000 dry manure layers. This publication outlines the information needed for the development of a CNMP for dry litter poultry operations.

The information from this checklist can be utilized within the *CNMP Generator* computer software developed by The University of Georgia Cooperative Extension Service. This software is available from county extension agents and other state agricultural agency personnel. Completion of a CNMP using the *CNMP Generator* software should meet the NPDES permit requirements of the Georgia Department of Natural Resources Environmental Protection Division.

I. General Information

1. Operator name, mailing address, telephone number, directions to farm.
2. General farm description: number of houses, number of birds produced per year.
3. Farm maps, showing field boundaries, field acreage and location of all surface waters and wells. Aerial photographs, soil maps, or hand-drawn maps can be utilized.
4. Certification statement, signed by operator.

II. Nutrient Generation and Handling

1. Annual waste generation estimate. Record of amount of litter removed from storage and/or production buildings.
2. Manure nutrient analysis for each type of litter generated on the farm (cake, cleanout litter, compost).
3. Description of waste handling facilities: stack houses, compost buildings.
4. Description of manure spreader capacity and calibration frequency.
5. Plan and/or record of off-farm transport of litter, if any, including recipient and amount removed.

III. Crop Information and Litter Application

1. Total acres represented by CNMP.
2. Number of acres in each field, designating the number of spreadable acres.

INTRODUCTION

D.L. Cunningham
Department of Poultry Science
The University of Georgia
Athens, GA 30602

Poultry production operations are receiving increased attention as potential sources of nutrient pollution for our state's water resources. Proper utilization of dry and liquid poultry manures as well as the safe disposal of mortalities are critical to the future of this industry in Georgia. The implementation of comprehensive nutrient management plans by poultry producers can reduce the potential for adverse impacts on the environment, can increase the value of poultry manures, and can have the added benefit of improving public perceptions of poultry producers' commitments to best management practices.

Implementing comprehensive nutrient management plans on poultry farms is not difficult. The basic objectives of a nutrient management plan are the proper storage, handling and application of poultry manures to the land to reduce the potential of excess nutrients being deposited in surface or ground waters. The key components of a nutrient management plan are soil and litter analysis for nutrient compositions, calculations of the appropriate amount of poultry manure for application, and documentation of the process.

Nutrient management plans in Georgia are currently voluntary. Georgia's poultry producers have taken a pro-active position and are committed to implementation of nutrient management plans by 2002. It is likely that at some point in the future nutrient management plans for livestock operations will be required either through federal or state mandates. The implementation of voluntary nutrient management plans prior to any federal or state mandates should make the transition easier and may result in regulations that are consistent with continued profitability and productivity for growers and integrators.

The primary nutrients of concern in poultry manure application for environmental issues are nitrogen and phosphorous.

Nitrogen. Most of the nitrogen found in poultry manure or litter is in the form of organic nitrogen. A smaller amount of the nitrogen in the manure is ammonium. Organic nitrogen can be converted to inorganic nitrogen by bacteria in the soil. Inorganic nitrogen can then be utilized by the plant. Excessive organic and ammonium forms of nitrogen can be transformed into nitrate nitrogen which in high levels can be harmful to human health. Excess nitrogen can be removed from application sites by surface runoff and leaching and can, therefore, end up in surface or ground water supplies.

OVERVIEW OF FEDERAL AND STATE REGULATIONS AFFECTING POULTRY OPERATIONS

The major piece of Federal regulation designed to regulate pollution and protect water quality is the Clean Water Act (CWA) of 1972. This act was primarily established to focus on point-source pollution (i.e. a pipe discharging into a stream or other water body). The CWA was amended in the 1980's and is generally known as the Water Quality Act of 1987 (WQA). The amendment emphasized control of nonpoint-source pollution (NPS). This action brought the agricultural community to the forefront because improperly managed agricultural activities can contribute significantly to NPS.

The EPD is required to establish WQ discharge standards for all impaired water bodies; however, no firm date has been established. These standards are known as total maximum daily loads (TMDL's). The TMDL's may include parameters such as sedimentation, fecal coliform, dissolved oxygen, pH, etc. As an example, a stream segment that has been impaired must have TMDL's established, and all point and nonpoint source dischargers can be held responsible for implementing practices to correct the condition. Violators who exceed the TMDL's will be subject to regulatory actions under the CWA provisions. Agricultural operations within or near the impaired stream segments will certainly come under close scrutiny, especially regarding manure disposal.

Large confined animal feeding operations (CAFO's) are required to have a National Pollutant discharge Elimination System (NPDES) permit. Technically, this means that all facilities with more than 1000 animal units – 1000 slaughter steers or heifers, 700 dairy cows, 2500 hogs each weighing more than 25 kg, 30,000 laying hens or broilers using a liquid manure system, or 100,000 laying hens or broilers using a continuous overflow watering system – already are regulated much like other waste-producing industries. This means they must comply with Federal discharge standards and implement various BMP's and other pollution prevention procedures. To reduce the environmental and public health problems caused by animal waste runoff into waterways, EPA is developing regulatory and voluntary measures to bring CAFOs under tighter control.

The proposed measures include stepped up compliance and enforcement efforts. EPA, along with the states, says it hopes to issue CWA permits to the largest CAFOs by 2002 and regulate and permit all other CAFOs and priority facilities in impaired watersheds by 2005.

At present, Georgia has few farming operations that require NPDES permitting.

Operations in Georgia that generate "dry" animal waste, e.g. poultry litter, are not required to have any permits or special authorization of any kind to dispose of manure unless the farm participates in certain Federal cost-share programs. They simply must insure that water bodies are not contaminated. Regulations on animal waste disposal vary considerably from state-to-state. Producers should be aware of and abide by all regulations. Failure to comply could lead to more restrictive legislation for waste disposal.

Prepared by: Dr. Bill Segars, Professor of Crop and Soil Science and Extension Water Quality Coordinator. The University of Georgia.

Animal Waste and the Environment

Cecil Hammond, Former Extension Engineer

Introduction

Animal waste includes livestock and poultry manure, bedding and litter, plus such things as dairy parlor waste water, feedlot runoff, silage juices from trench silos and even wasted feed. These wastes can affect water quality if proper practices are not followed. These protective practices are very often referred to as best management practices (BMPs) and includes facilities or structures, management practices or vegetative cover.

Animal waste should be considered a valuable resource which, when managed properly, can reduce the need for commercial fertilizer. Such waste can add organic matter which improves water holding capacity and improves soil tilth. Animal waste can provide an economical source of nitrogen, phosphous and potassium as well as other nutrients needed for plant growth.

Waste from animal concentrations and/or manure storage areas which are not protected can wash into streams. Such overland flow of animal waste is commonly referred to as a non-point source (NPS) since the waste does not enter the streams from a point source or pipe.

Such waste in surface waters reduces oxygen in water and endangers aquatic life. The added nutrients produce excessive algae growth causing unpleasant taste and odors. Likewise, when this waste is allowed to seep into ground water the water quality is jeopardized. Nitrates in well water can be particularly dangerous to infants due to oxygen depletion in the blood.

In a speech made to the National Cattlemen's Association Board of Directors in March 1993, EPA Deputy Director David Davis stated that EPA data shows NPS pollution is the largest remaining water quality problem in the United States. He further stated that data from the states attributes 41 percent of the total NPS pollution to agriculture. Further, data indicate that approximately one-third of the agricultural NPS pollution is caused by animal waste runoff from feedlots, holding areas and pastures.

Non-Point Source Pollution (NPS)

NPS pollutants are more difficult to control because they don't come from a clearly identifiable point such as a pipe or ditch. NPS pollution is caused, for example, from rain running over a field carrying pollutants in the water. We often cause NPS pollution without being aware of pollution.

The major NPS pollutants are:

- Sediment from improperly-managed construction sites, farm and forest lands, road cuts and eroding stream banks.
- Nitrogen and other nutrients from farm land, forest, residential areas, septic systems, golf courses, etc.
- Bacteria from livestock, pet waste, wildlife and faulty septic and sewage systems.
- Salt from irrigation, acid drainage from mines and highway salt treatment.
- Pesticides from farms, forest, residential areas, etc.
- Oil, grease and other chemicals from urban runoff, energy production and improper disposal of used oil.

Be Aware

How you manage animal waste can impact water quality. Waste from animal concentrations and unprotected manure storage areas can wash into streams. Steep and unprotected slopes, poor soil conditions, lack of vegetative cover, heavy rains and the proximity to streams are some of the factors which play a role in potential environmental damage. If surface or ground waters are being compromised on your farm, seek help and make changes.

Planning an Animal Waste Management System

Planning proper waste handling will not only help protect the environment, it can improve the overall farming operation and overall cash flow. For example, dairymen who add freestalls not only provide for closed loop waste handling but also provide shade, feeding and loafing areas for the animals. These improvements translate into more milk (and easier management) which normally pays for the construction cost in 3 to 5 years. Adding cow mats in freestalls not only saves time and money but keeps the bedding in the stalls and out of flush gutters, making the liquid manure systems more manageable. Liquid manure systems are very popular, primarily because of the degree of automation. If solids are removed, the liquid waste is considerably easier to pump and recycle for flushing gutters.

Table 1 shows the nutrients in animal waste (N, P, K) for various animals based upon a 1,000 pound animal unit over a period of one year. Data for Tables 1-3 are taken from Midwest Plans Publication Number #1 (1983 Edition).

Table 1. **Annual Pounds of Nutrients in Manure As Excreted Per 1000 Pounds Liveweight**

	Dairy Cow	Beef Feeder	Swine Feeder	Laying Hen	Broiler
Nitrogen N	150	124	164	263	423
*Phosphate P_2O_5	60	91	124	232	216
*Potash K_2O	118	106	132	136	158

*Elemental P & K conversion can be made as follows: To convert P_2O_5 to elemental P, multiply by 0.44, and to convert K_2O to elemental K, multiply by 0.83.

Method of Handling and Land Application

Average nitrogen losses which occur with various manure handling and storage methods are given in Table 2.

Need for Waste Management

Agriculture received a lot of the credit for the pollution of the Chesapeake Bay which has subsequently helped to focus attention on agriculture. Many farmers fear regulations will increase cost and drive them out of business.

More and more state and federal governments are requiring nutrient management plans, tougher regulations and more accountability in waste handling. However, most will agree voluntary control is less costly and more productive than governmental control and regulations. To make it work, every one of us needs the commitment and dedication. A few flagrant offenders gives all of agriculture a bad name.

Water is the world's most abundant resource, but only one percent of water is suitable for drinking. The average person in the U.S. uses about 180 gallons of water per day. We all live in a watershed down stream from someone else.

Where to Get Help to Implement Changes

Contact your local agencies such as the Extension Service, Soil Conservation Service (SCS) and Agricultural Stabilization and Conservation Service (ASCS) for further information and assistance.

Growing concern about waste handling coincides with the public concern about environmental quality. Following best management practices can improve the environment and reduce liability for farmers.

Circular 827/October 1994

The University of Georgia and Ft. Valley State College, the U.S. Department of Agriculture and counties of the state cooperating. The Cooperative Extension Service offers educational programs, assistance and materials to all people without regard to race, color, national origin, age, sex or disability.

An Equal Opportunity Employer/Affirmative Action Organization Committed to a Diverse Work Force

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, The University of Georgia College of Agricultural and Environmental Sciences and the U.S. Department of Agriculture cooperating.

Gale A. Buchanan, Dean and Director

Nutrient Management for Georgia Agriculture

Developing a Comprehensive Nutrient Management Plan

Prepared by the Nutrient Management Task Force • Cooperative Extension Service • The University of Georgia College of Agricultural and Environmental Sciences

What is a Comprehensive Nutrient Management Plan?

A Comprehensive Nutrient Management Plan (CNMP) is a strategy for making wise use of plant nutrients to enhance farm profits while protecting water resources. It is a plan that looks at every part of your farming operation and helps you find better ways to use manures, fertilizers and other nutrient sources. Successful nutrient management requires thorough planning and recognizes that every farm is different. The type of farming you do and the lay of your land will affect your CNMP. For example, CNMPs on farms that do not have animals will not require as much detail as those that do. The best CNMP is one that is matched to the farming operation and the needs of the person implementing the plan—the Georgia farmer!

Who is Required to Have CNMPs?

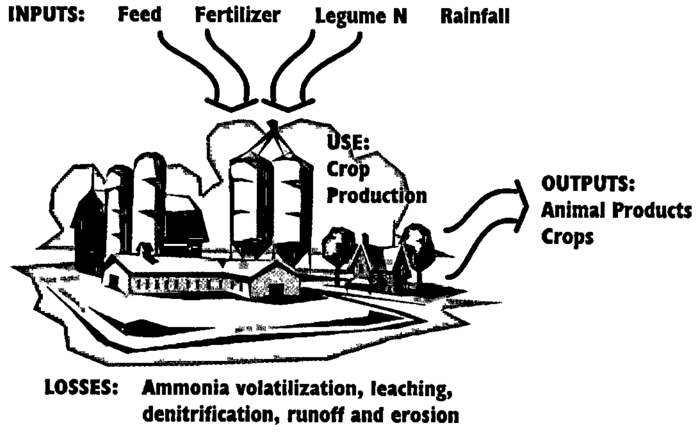
The United States Environmental Protection Agency and the United States Department of Agriculture have recently released a Unified National Strategy for managing animal feeding operations. This strategy sets a national goal for all animal feeding operations to have CNMPs. In Georgia, any animal feeding operation that receives a permit through the Georgia Environmental Protection Division is required to have a CNMP.

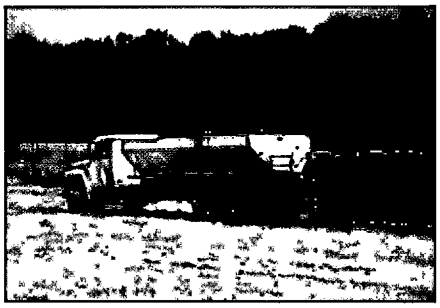
Other producers who are not required to have a permit are being encouraged to voluntarily adopt CNMPs. Many organizations such as the Georgia Poultry Federation and the Georgia Pork Producers have established initiatives to assist producers to better manage nutrients on the farm.

What Are the Parts of a Successful CNMP?

A Comprehensive Nutrient Management Plan looks at how nutrients are used and managed throughout the farm. It is more than a nutrient management plan that only looks at nutrient supply and needs for a particular field. Nutrients are brought to the farm through feeds, fertilizers, animal manures and other off-farm inputs. These inputs are used, and some are recycled by plants and animals on the farm. Nutrients leave the farm in harvested crops and animal products. These are nutrient outputs. Ideally, nutrient inputs and outputs should be roughly the same. When nutrient inputs to the farm greatly exceed nutrient outputs from the farm, the risk of nutrient losses to groundwater and surface water is greater. When you check nutrient inputs against nutrient outputs, you are creating a mass balance. This nutrient mass balance is an important part of a CNMP and important to understand for your farming operation.

Another important part of a successful CNMP is best management practices (BMPs). BMPs, such as soil testing and manure analysis, help you select the right nutrient rate and application strategy so that crops use nutrients efficiently. This not only reduces nutrient losses and protects the environment but also increases farm profitability. BMPs may also include managing the farm to reduce soil erosion and improve soil tilth through conservation tillage, planting cover crops to catch excess nutrients, or using filter strips and buffers to protect water quality. Preventative maintenance, record keeping, mortality management and emergency response plans must also be included in a CNMP for livestock and poultry operations.



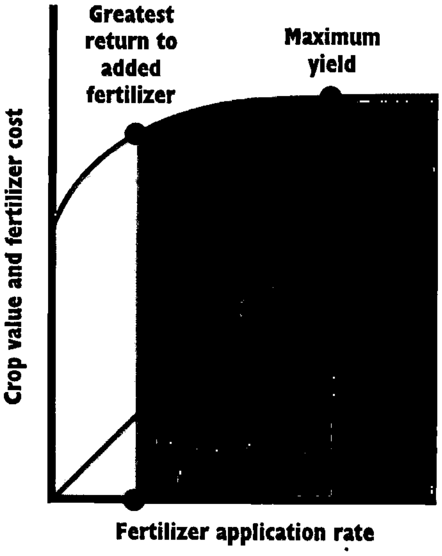


sis of these products tells you the nutrient content so that you can match this with soil test recommendations and determine application rates. The lab results will help you determine how much of the nutrients in the manure will be available to your crops. The amount credited to the nutrient budget should be based on plant available nutrient levels, which may be substantially different from the total nutrient content. The county Extension office has information on manure and litter testing.

Determining Nutrient Balance

Balance Between Supply and Need

Once you have determined both the supply and need of nutrients for each of your fields, a critical aspect of CNMPs is balancing the two. This can be done in several ways. Currently, most CNMPs are developed based on nitrogen; however, other factors such as phosphorus or metals could control how much poultry litter or manure you can put out under certain conditions. A phosphorus index is currently being developed to help producers determine when nutrient management based on phosphorus would be advisable. If your crop acreage is small relative to the number of animals, the nutrient balance will also allow you to evaluate how much manure or litter you may need to move off your farm to avoid over-application of nutrients.

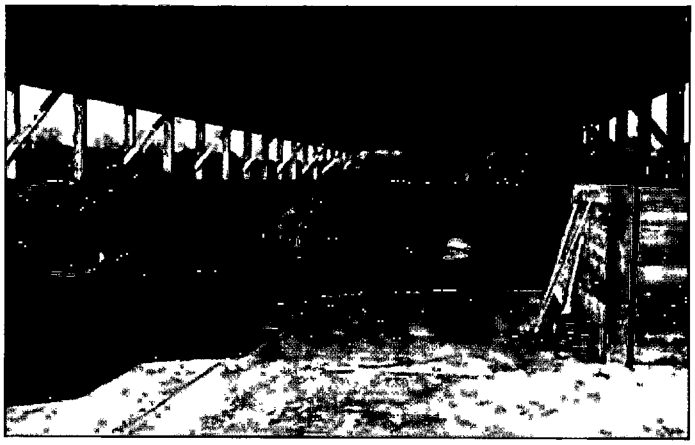


Can the Nutrient Supply on Your Farm Be Managed or Changed?

After evaluation of the nutrient supply on your farm and the nutrient needs of your crops, you may find that the balance of nutrients is not ideal. You may have more of one or more nutrients (usually phosphorus) than you need. Many management practices can change the nutrient balance. These include:

- changes in storage practices,
- adjustments of animal feeds,
- modification of treatment methods, and
- chemical amendments.

For example, you may be able to reduce nutrient losses in your manure treatment and/or storage system. Sometimes reducing nitrogen losses can make manures a better-balanced fertilizer for your crops. In addition, animal diets can sometimes be changed to reduce nutrient excretion in their manure. Enzymes can be added to the diet to reduce nutrients in the manure. Phytase is a supplemental enzyme that allows better use of the phosphorus already present in grains, so less phosphorus has to be added to the animal's diet.

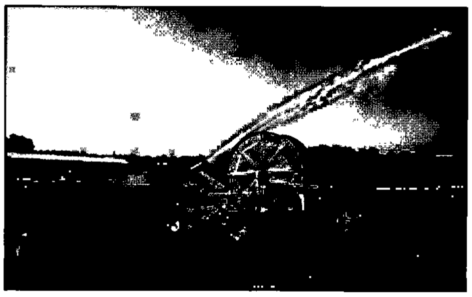


Manure Storage

Manure storage is critical. It effects both the quantity and quality of nutrients that will need to be land applied or exported from the farm. The storage structures and design capacities need to be identified as part of a CNMP. These structures also need to be managed to prevent nutrient losses and protect water quality. For example, clean water should always be diverted from barnyard and manure storage areas to reduce the potential for nutrients reaching ground or surface waters.

Manure Application to Fields

Manures should be applied near the time that crops need nutrients using calibrated spreaders or irrigation equipment. Solid or slurry manure should be incorporated into the soil when appropriate. Incorporation or mixing into the soil greatly reduces losses of nitrogen to the air and keeps more in the soil where it is needed. This reduces potential odor emissions. Slurry manure can also be injected into the soil so that incorporation is not required. Accurate records of application rates and times are also essential.



GEORGIA
FARM*A*SYST

FARM ASSESSMENT SYSTEM

NUTRIENT MANAGEMENT

Julia Gaskin, Educational Program Specialist
Biological & Agricultural Engineering
Glen Harris, Assistant Professor
Crop & Soil Science

Cooperative Extension Service, The University of Georgia, College of Agricultural and Environmental Sciences, Athens

PRE-ASSESSMENT:

Why Should I Be Concerned?

Nitrogen, phosphorus and other nutrients are essential to good crop production. But, the nutrients that are beneficial for plant growth can be harmful if they are present above certain *concentrations** in streams, ponds, coastal waters, or groundwater. In most of our fresh *waterbodies*, phosphorus is the nutrient in shortest supply. When excess phosphorus from animal manures, fertilizers or other sources enters these waters, it causes *algae* to grow faster and turn water a green color. This process is called *eutrophication*. It can prevent recreational uses such as fishing and swimming. In brackish waters such as marshes and estuaries, a similar situation can occur when too much nitrogen is present.

Excess nitrogen can also be a problem in groundwater. Nitrate is a form of nitrogen that can pose health problems for both humans and animals if concentrations are too high in the drinking water. The drinking water standard for nitrate-nitrogen is 10 parts per million (ppm). When concentrations are above this limit, infants younger than six months can develop a disorder called methemoglobinemia or blue baby syndrome. Nitrate-nitrogen concentrations in the range of 20-40 ppm can cause reproductive problems or other health problems in ruminants, horses or baby animals.

Because we need clean drinking water and enjoy water-based recreational activities, excess nutrients in water are a concern to everyone. As a farmer, you are paying to supply your crops with nutrients, so it also makes economic sense to manage these resources as efficiently as possible. Good nutrient management can improve your profitability as well as protect the environment.

How Does This Assessment Help Protect Drinking Water and the Environment?

- This assessment allows you to evaluate your potential impact on the water quality on your farm and in nearby *waterbodies*.
- The assessment uses your answers (rankings) to identify high-risk practices that should be modified.
- The nutrient management facts provide an overview of practices to prevent pollution.
- The assessment assists you in writing an action plan based on your needs as identified by the assessment.

How Do I Use This Farm*A*Syst Assessment?

- The assessment asks a series of questions about your nutrient management practices.
- You are encouraged to complete the entire document.
- Farm*A*Syst is a voluntary program.
- No information from this assessment needs to leave your farm.
- The assessment should be conducted by you for your use. If needed, a professional from the Georgia Cooperative Extension Service or one of the other partnership organizations can provide assistance in completing the assessment or action plan.

**Words found in italics are defined in the glossary.*

NUTRIENT MANAGEMENT PRACTICES

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RANK
POTENTIAL FOR GROUNDWATER POLLUTION					
Main *soil textures* throughout the profile	Fine textures such as clays, silty clay loams, and clay loams	Textures such as silt, silt loams, and sandy clay loams	Textures such as sandy loams, and loams	Coarse textures such as sands and loamy sands	
Depth to *water table*	Greater than 50 feet	Between 10 to 50 feet	Between 5 and 10 feet	Less than 5 feet	
Presence of a *restrictive layer* or *hardpan* under the surface stopping downward water movement	*Restrictive layer* present	————————	————————	No *restrictive layers*	
***Buffers* around ponds, wells, sinkholes or other water-related areas**	*Buffers* greater than 50 feet around all wells, ponds, sinkholes or other water-related areas	*Buffers* 10 to 50 feet around all wells, ponds, sinkholes or other water-related areas	*Buffers* around some wells, ponds, sinkholes or other water-related areas	No *buffers* in place	
NUTRIENT MANAGEMENT					
Frequency of soil testing	Yearly	Every 2 years	Every 3 years	Less frequently than every 3 years	
Soil sampling	At least 15 cores or slices mixed together for a representative sample from fields or areas no bigger than 15 acres, according to *CES guidelines*	At least 7 cores or slices mixed together for a representative sample from fields or areas bigger than 15 acres	Single soil samples taken from areas greater than 15 acres	No soil samples taken	
Realistic yield goals	Yield averages from 5 or more recent years used to set yield goals	Yield goals based on 3 to 5 recent years averages	Yield goals based on 1 to 2 years averages, or old yield information	Yield goals not based on farm performance	
***Nutrient credits* for manure and legumes**	*Nutrient credits* calculated and deducted from nutrient application rate using *CES guidelines*	————————	*Nutrient credits* are calculated and partially deducted from nutrient application rate	No deductions for using legumes or manures	
Fertilizer application rates	Fertilizer is applied at recommended rate based on soil tests and realistic yield goals	————————	Fertilizer application exceeds recommendation by one-half times rate	Fertilizer application exceeds recommendation by two times rate or fertilization with no guidance	

NUTRIENT MANAGEMENT PRACTICES

	LOW RISK (rank 4)	**LOW-MOD RISK (rank 3)**	**MOD-HIGH RISK (rank 2)**	**HIGH RISK (rank 1)**	**RANK**
Soil phosphorus (P) levels in fields	Have identified the soil P level in each field and do not apply P to very high soil test P fields	Have identified the soil P level in each field and only apply what crop needs	Soil phosphorus in fields is unknown	Soil test P is very high but there is no management to reduce excess P loss	
Manure application rates	Manure application to meet plant phosphorus needs based on soil test	————	Manure application is based on nitrogen without regard to P	Manure application is not based on nutrients	
Manure application timing	Manure applied during active crop growth and avoided during wet weather	Manure applied as near as possible to times when crops need fertilization	————	Manure applied nearly every day, or when lagoon or manure storage facility needs emptying or applied during wet weather	
PLANNING AND RECORDKEEPING					
Record-keeping	Good records are kept on fertilizer and manure applications, soil, plant and manure tests, and yields. Maps of fields and soil types for the farm are available	Records are kept on soil tests, some manure or plant tests; information is organized enough to be used for management decisions	Some records kept, but information is not complete or organized enough to make most management decisions	No records kept	
Nutrient management plan	Current (within last two years) *nutrient management plan*	————	*Nutrient management plan* prepared within last five years and not updated	No *nutrient management plan*	

Number of Areas Ranked ________
(Number of questions answered, if all answered should total 28)

Ranking Total ________
(Sum of all numbers in the "RANK" Column)

NUTRIENT MANAGEMENT FACTS:

Improving Nutrient Management on Your Farm

The goal of nutrient management is to maximize farm productivity while minimizing the movement of nutrients into surface and ground water. Nutrient management includes developing a nutrient budget and site management practices. The goal of a nutrient budget is to only put out the nutrients that crops need and thereby reducing excess nutrients. The goal of site management practices is to reduce the potential of any excess nutrients reaching either surface or ground water. Both nutrient budgets and site management practices have to be developed for a particular farm. What works on one farm may not be appropriate for another. Soil characteristics, crops, use of manures or other organic sources, the lay of the land, and closeness of surface water are a few of the things that can influence what the best site management practices may be.

SITE CHARACTERISTICS

Looking at the soils on your farm can help you identify whether you are at risk for polluting surface water or groundwater. Surface water, including streams and ponds, can become contaminated by water flowing over the surface (*surface runoff*) and water flowing through the soil. Surface runoff most often occurs when the soil surface has a high clay content so that rainfall tends to collect on the surface rather than move into the soil. In sandy soils, surface runoff can also occur when the soil surface forms crusts. Surface runoff may carry eroded sediments as well as excess nutrients. Using *cover crops* and leaving *crop residues* can help reduce surface runoff. There is a higher risk of runoff in fields with steeper slopes. Traffic patterns in the field can create soil compaction that promotes surface runoff. *Restrictive soil layers* or bedrock that stop the downward movement of water can cause water to flow through the upper soil layers into nearby streams and ponds. This water flow can carry excess nutrients, such as nitrate or phosphorus, into these surface *waterbodies*.

Buffers are areas near water that are either left in a natural state or carefully managed to keep vegetation. Buffers can be either grassed or wooded areas. These are very important for reducing the amount of nutrients and sediments entering a stream or pond. Buffers help spread out and filter surface runoff. Spreading out the surface runoff allows it a chance to infiltrate into the soils rather than move directly into the stream. Most sediments are trapped by vegetation in the buffer and the plants can use the excess nutrients. Plants growing in buffer zones can also take up nitrogen and phosphorus from water flowing in the soil. Research is showing that the *slope* of the buffer as well as its width is important for protection of surface water. Buffers work best when they have slopes less than 15% or 15 feet of drop in 100 feet. If the buffer slope is greater than 15% then a wider buffer is needed to protect the surface water.

Groundwater pollution is more common in sandy soils, particularly where the *water table* is shallow (less than 10 feet). Water moves quickly through sandy soils and the soils have little ability to retain nutrients. But, groundwater contamination can also occur anywhere excessive nutrients are applied next to wells, sinkholes, or other areas with direct connections to groundwater. Buffers around these types of areas are the best method for protecting groundwater.

NUTRIENT MANAGEMENT

A number of practices can be used to make sure the nutrients needed for realistic yield goals are applied to the site. The first and maybe most important is regular soil testing to determine the nutrient status of the soil. Soil testing allows fertilizer recommendations to be tailored to your field and crop. In order to get good results from the soil tests, fields should be sampled using Cooperative Extension Service (CES) guidelines found in Soil Testing (Leaflet No. 99). These guidelines show you how to take many small samples in fields with fairly uniform soils and mix them to obtain one sample per field or soil type. For a sample to represent the conditions in a field, it is important to take many small subsamples to create a sample that is representative of the entire area. Soils have a lot of variation and water or through shallow subsurface flow into surface water. This process is called leaching. Consequently, nitrogen fertilizer should be applied when plants are actively growing and using it. Crops with heavy nitrogen demands or those grown in sandy soils should receive split applications. This will reduce nitrate-nitrogen leaching and provide a more even supply of nitrogen for plant growth. In the Coastal Plain, where irrigation is used extensively, *fertigation* can be a cost-effective and environmentally safe way of supplying nitrogen and potassium.

Regardless of the application method, calibration of your equipment is critical. *Equipment calibration* includes measuring the application rate and determining the spread pattern. Spread patterns that are uneven can create areas with too little fertilizer that can reduce yields and areas with too much fertilizer that can become a potential pollution source. Information such as Extension Circular 825 - Calibration of Manure Spreader Including Swath Width can be used to calibrate manure spreaders or dry fertilizer spreaders.

ORGANIC SOURCES OF FERTILITY

Using organic sources of nutrients can have many benefits. First, as a fertilizer, the nutrients in organic matter are released over time. This can provide a more constant nutrient source for the plants and reduce the likelihood of excess nutrients moving into ground or surface water. Second, organic matter itself can improve soil tilth. Better soil tilth can increase the amount of water that moves into the soil and reduce erosion. The additional organic matter can also hold more water in the soil and decrease droughtiness. Third, organic sources usually contain many of the micronutrients crops need for maximum yield. Some studies indicate improved yields and pest resistence in fields with higher organic matter. Use of organic sources can decrease the costs for fertilizer, improving your profitability.

The first step in adding organic matter to the soil is using all available on-farm sources. This includes the use of cover crops, *green manures*, and animal manures. Cover crops are grown in the winter and killed in the spring. These crops decrease erosion and add organic matter to the soil. Common cover crops in Georgia are rye and winter wheat. Green manures are legumes that are grown in the winter and killed in the spring to increase the organic matter content of the soil and supply nitrogen. Some green manures used in Georgia are vetch and crimson clover. The nitrogen supplied by legumes should be subtracted from the total amount of nitrogen needed for your crop.

There are other sources of organic matter that can be beneficial. Composts are good sources of organic material. *Biosolids* are a good source of both organic matter and a slow release nitrogen fertilizer. When properly applied, biosolids can provide the benefits of organic matter and nutrients as well as lower fertilizer costs. Cotton gin trash is another off-farm organic material that can add organic matter and nutrients. There are also by-products from food processing, textiles or other industries that can supply some organic matter and nutrients. These by-products should be tested for safety and value before use on the farm. Most suppliers of these by-products should be able to show you that the product is not hazardous, does not present growth problems, and has low metals content. In addition, they should tell you the amount of nitrogen, phosphorus and potassium supplied by the by-product.

The most common source of organic matter is animal manures, including poultry litter. Animal wastes are a good source of nitrogen, phosphorus and potassium. They also contain many essential micronutrients, and can be an important component of your fertilizer program. Although manures are a good source of nutrients, they often do not supply nutrients in the same amounts that crops need. Animal manures are typically high in phosphorus compared to the amount of nitrogen needed for crops, so they are excellent for building phosphorus fertility in the soil. But if they are applied to meet the nitrogen needs of the crop, phosphorus is often over-applied. Over time, excess phosphorus can build up in the soil. This excess phosphorus can then move into nearby water and create pollution. Phosphorus can also be moved from manures that are surface applied into surface water by rainfall.

Animal manures vary widely in nutrient content. The amount of nitrogen and other nutrients present in the manure depends on the type of animal, the

GLOSSARY:
Nutrient Management

Algae: A plant that lives in water. These plants contain chlorophyll but lack true stems, leaves, or roots. Algae imparts a green color to water.

Biosolids: Municipal sludge that has been treated to stabilize organic matter and reduce pathogens.

Buffers: A strip of uncultivated land between farmed land and a sensitive area. Buffers can be grassed but often contain shrubs or trees. These are used to spread out water and sediments leaving the farmed area and help remove excess nutrients or other farm chemicals.

CES Guidelines: Cooperative Extension Service guidelines.

Concentrations: The amount of an element or compound found in a specified amount of another substance. For example, nitrate-nitrogen in water is expressed as milligrams per liter (mg/L) or parts per million (ppm). In solids, concentrations are expressed as milligrams per kilograms (mg/kg) or ppm.

Cover crop: Crops grown for ground cover to reduce erosion and add organic matter.

Crop residues: Leaves, stems or other plant parts left on the soil surface.

Dormant phase: A inactive phase for a plant where nutrient uptake and growth are slow or non-existent.

Equipment calibration: Checking or standardizing equipment so that application rates are even and at a known amount.

Eutrophication: The process by which increasing nutrients in a waterbody promotes plant over animal life, often creating conditions with very low oxygen in the water.

Fertigation: Fertilizing crops through the irrigation system.

Green manures: Legume crops that are grown to supply nitrogen and organic matter.

Hardpan: A soil layer that limits root growth or water movement.

Nutrient credits: An addition of nutrients from legumes, animal manures or other sources that should be subtracted from the total amount of fertilizer needed.

Nutrient Management Plan: A plan for managing animal wastes to maximize economic benefit for the farmer and protection of the environment.

Restrictive layer: A soil layer that limits root growth or water movement.

Slope: Change in elevation across a horizontal distance. (Example: 2:1, first number is the horizontal distance and second number is the vertical distance.)

Soil texture: Classes of soil with differing proportions of sand, silt, and clay. For example - loams, silts, sandy clay loams.

Surface runoff: Rainfall that moves over the soil surface into water.

Waterbodies: All surface water, including streams, rivers, ponds, lakes.

Water table: The level in the ground where the soil or bedrock is saturated; the upper surface of groundwater.

EXAMPLE RECORDS

Field Number ____ **Sample Area** ________________ **Soil Series** ________________

Crop	Date Planted	Soil Test Date	Soil Test Results										Fertilizer Recommended (lbs/ac)					Fertilizer Applied (lbs/ac)				
			pH	Lime Index	P	K	Ca	Mg	Zn	Mn	B	Other	N	P_2O_5	K_2O	Lime	Other	N	P_2O_5	K_2O	Lime	Other

Crop	Date Planted	Application 1			Application 2			Application 3			Application 4			Application 5			Application 6		
		Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date

EXAMPLE RECORDS

FARM CROPPING PLAN (Specify crop, variety, plant population, etc.)

CROP	FIELD 1	FIELD 2	FIELD 3	FILED 4	FIELD 5	FIELD 6
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

PUBLICATIONS:

University of Georgia, Cooperative Extension Service
Athens, Georgia 30602

- Your Drinking Water: Nitrates, Circular 819-5
- Animal Waste and the Environment, Circular 827
- Land Application of Livestock and Poultry Manure, Leaflet 378
- Georgia's Agricultural Waste Regulations, Circular 819-11
- Developing a Nutrient Management Plan for the Dairy Farm, Circular 819-16
- Soil Testing, Leaflet 99
- Calibration of Manure Spreader Including Swath Width, Circular 825
- Beneficial Reuse of Municipal Biosolids in Agriculture, Special Bulletin 27
- Soil Saving Practices - Sediment Erosion Control, Bulletin 916-6
- Soil Saving Practices - Conservation Tillage, Bulletin 916

State Soil and Water Conservation Commission
P.O. Box 8024
Athens, Ga 30603

- Agricultural Best Management Practices for Protecting Water in Georgia
- Planning Considerations for Animal Waste Systems for Protecting Water Quality in Georgia

NOTES

GEORGIA'S ANIMAL FEEDING OPERATION REGULATIONS

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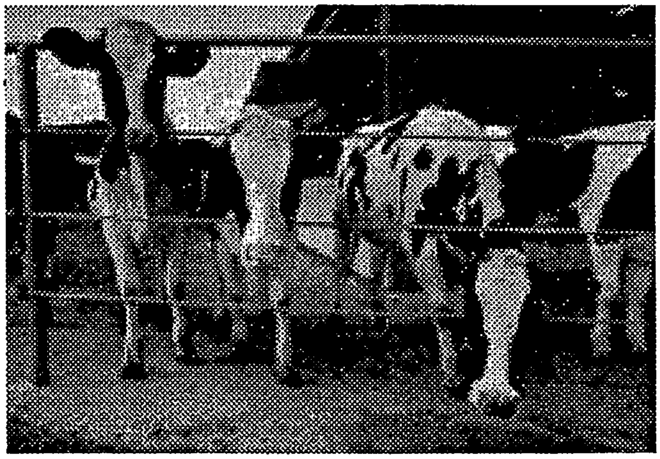
Introduction

The past several years have brought many changes in the way animal feeding operations are regulated in Georgia. These changes are largely driven by an increasing focus on agriculture as a source of non-point source pollution. Since the U.S. Clean Water Act was passed in early 1970, we have put a tremendous amount of resources into cleaning up point source pollution from municipalities and industries through the National Pollution Discharge Elimination Permit (NPDES) system. Large confined animal feeding operations (CAFOs) are regulated under the NPDES system. Because the program has been successful in reducing much of the nation's point source pollution, attention has now turned to reducing pollution from non-point sources such as urban stormwater runoff and agricultural runoff.

As part of the focus on agricultural sources of pollution, the United States Environmental Protection Agency (EPA) and the United States Department of Agriculture (USDA) have developed a *Unified National Strategy for Animal Feeding Operations.* An Animal Feeding Operation (AFO) is defined as an operation that confines animals for feeding for 45 days or more during a year in an area that does not support vegetation. At this time pastures are not considered part of an AFO. The unified strategy focuses on using Comprehensive Nutrient Management Plans to reduce the risk of excess nitrogen and phosphorus entering our surface and ground waters. The strategy also includes a plan to revise the regulations for CAFOs under the NPDES system.



The national focus on animal feeding operations (AFOs) increased pressure for Georgia to develop regulations for these operations. In Georgia, the NPDES program is administered by the Georgia Department of Natural Resources, Environmental Protection Division (EPD) and the state regulations must be at least as stringent as the federal regulations.

In 1999, the Georgia Department of Natural Resources proposed new regulations for the swine industry. These rules were finalized in April of 2000. Then in December of 2000, new rules and regulations were proposed for non-swine animal feeding operations. These regulations were approved in January of 2001, and only apply to operations with liquid manure handling systems. Both the swine and non-swine regulations are amendments to Georgia's Rules for Water Quality Control, Chapter 391-3-6.

The federal and Georgia approach to regulating AFOs are designed to target the largest operations on the assumptions that larger operations pose a greater pollution "risk". Consequently, operations are regulated according to the number of "animal units". An animal unit (A.U.) is the method that EPA uses to standardize the regulations across animal species. Different regulations apply for AFOs with 300 A.U. or less, 301 - 1,000 A.U., 1,001 - 3,000 A.U. and more than 3,000 A.U. Table 1 gives the number of animals of different species in these categories.

Table 1. Animal unit equivalents for different species.

Animal Type	300 A.U.	1,000 A.U.	3,000 A.U.
Beef cattle	300	1,000	3,000
Dairy cattle (milked or dry)	200	700	2,100
Horses	150	500	1,500
Swine (greater than 55 lbs)	750	2,500	7,500
Laying Hens or Broilers*	9,000	30,000	90,000

* Only if liquid manure handling system is used

Although small operations (<300 A.U.) are not subject to these state regulations, they are subject to the Clean Water Act and the Georgia Water Quality and Control Act. They are not allowed to have discharge to surface waters and should use nutrient management planning. Remember, if there is evidence of pollution, even a small operation can be designated a CAFO by EPD, and would be subject to the Georgia animal waste regulations.

There are several things common to the swine and non-swine regulations. Both regulations focus on the operations developing and following a comprehensive nutrient management plan (CNMP) and having a Certified Operator. Smaller operations (301 to 1,000 A.U.) have to apply for a Land Application System Permit (LAS) and larger operations have to obtain the more detailed NPDES permit. Both these permits must be obtained from EPD. A copy of the complete regulations can be obtained from the AWARE website - http://www.engr.uga.edu/service/extension/aware/policy.html.
A brief summary of the regulations follows.

Swine Feeding Operation Permit Requirements

Some of the important regulations and dates that an existing swine producer needs to be aware of are:

Operations with 750 to 2,500 head that are more than 55 lbs:

- submit registration form by October 31, 2000
- submit CNMP by October 31, 2001
- train and certify an operator by October 31, 2001
- implement CNMP by October 31, 2002.

Registration forms and NPDES permit forms are available from EPD. The NPDES forms (Form 1 and Form 2B) are also available from the USEPA website - http://www.epa.gov/owm/npdes.htm#forms.

Requirements for existing swine operations with more than 2,500 head that are 55 lbs or more include all of the requirements above and an individual

NPDES permit. This permit was required by October 31, 2000. If you are in this category and did not apply for the individual NPDES permit, you should do so immediately. As mentioned before, the individual NPDES permits are more complicated to prepare. One major difference is that these operations will have to develop a groundwater monitoring plan for lagoons and sprayfields. These operations may need to obtain a consultant to prepare the individual NPDES.

Requirements for new operations are more stringent than existing operations. The swine regulations are summarized in Tables 2a and 2b.

Non-Swine Feeding Operations

The non-swine regulations are similar to the swine regulations. Important requirements for existing operations are:

Operations with 301 - 1,000 A.U.

- apply for LAS permit by October 31, 2001
- submit CNMP by October 31, 2002
- implement CNMP by October 31, 2003
- train and certify an operator by October 31, 2002

Operations greater than 1,000 A.U. must meet the requirements above and:

- apply for NPDES permit that includes a public notification
- install at least one downgradient well for each lagoon
- monitor effluent and wells semi-annually
- submit documentation of lagoon closure when it occurs

Again, requirements for new operations are more stringent. In addition to the above requirements new operations:

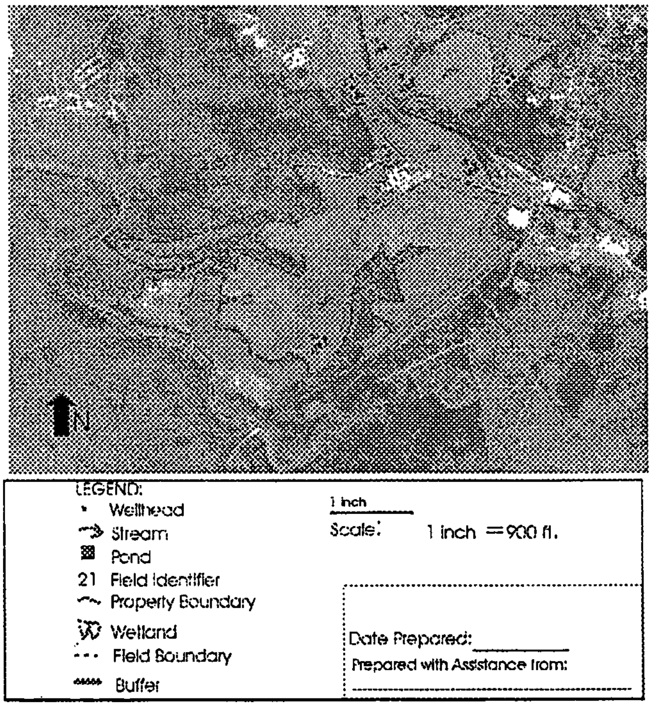
- must have waste handling and storage facilities that meet Natural Resources Conservation Service (NRCS) design criteria
- cannot locate in the 100-year flood plain
- must maintain two feet of freeboard in the lagoon
- must maintain buffers in the land application area
- must meet all requirements and be approved *before* expansion or start up

The non-swine regulations are summarized in Table 3.

Comprehensive Nutrient Management Plans

Comprehensive nutrient management plans are the keystone of all these regulations. A CNMP is a strategy to make wise use of the nutrients on the farm while protecting water quality. In Georgia, a CNMP must contain the following information:

- a scaled map of the farm showing information such as property lines, land use, field boundaries, surface water, well locations, and buffers . See the Extension publication - Maps for Comprehensive Nutrient Management Plans for details
- nutrients produced from either site specific data or book values



- nitrogen available for land application on an annual basis
- details about the land application system such as the system type, frequency of irrigation, crops, and Best Management Practices used
- nutrient balance (the amount of nutrients generated on the farm versus the amount of nutrients that can be used by crops on the farm)
- a mortality management plan for typical annual mortalities and catastrophic mortalities.
- a list of the records kept on the farm
- an emergency response plan
- a closure plan

CNMPs must be developed by Certified Planners. The Georgia Department of Agriculture will certify planners and maintain a list of certified individuals. The certified planners will include NRCS personnel, county agents, certified crop advisors, and other professionals who have attended the CNMP training and demonstrated they can develop an acceptable CNMP.

Certified Operators

In addition to the CNMPs, operations greater than 300 A.U. must have Certified Operators. A Certified Operator must attend training and pass an exam. They must also obtain continuing education. The Georgia Department of Agriculture oversees the training, certification and continuing education requirements.

Resources

Depending on the size of your operation, these plans can be complex. There are resources to help you develop your plan. You can obtain assistance from your county extension agent, NRCS personnel, and from various consultants. There are also various extension publications that can help. These are listed in the bibliography at the end of this publication. Many of these publications and other tools are available on the University of Georgia AWARE website.

Summary

The new regulations require changes in the way AFOs do business. The focus on management of nutrients can improve profitability by better use of nutrients produced on the farms and reduced need for fertilizer purchase. There may also be opportunities for composting and selling manures for off-farm uses. Although the new regulations require more recordkeeping, the records may help improve farm management and productivity. While these regulations may appear complex, they are designed to protect both the farmer and the environment. Compliance with these regulations will provide the farmer documentation that they are making a reasonable effort to operate their farm in a safe and environmentally sound manner.

Other Useful Publications

Gaskin, J.W. and G. H. Harris. 1999. Nutrient Management. Georgia Farm*A*Syst System. Cooperative Extension Bulletin 1152-16. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Gaskin, J.W. and V. Jones. 2001. Maps for Comprehensive Nutrient Management Plans. Cooperative Extension Bulletin 1195. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Gould , M. C., L. Guthrie, and W.I. Segars. 1996. Developing a Nutrient Management Plan for the Dairy Farm. Cooperative Extension Circular 819-16. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Hammond, C., W.I. Segars, and C. Gould. 1994. Land Application of Livestock and Poultry Manure. Cooperative Extension Circular 826. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Nutrient Management Task Force. 1999. Nutrient Management for Georgia Agriculture. Cooperative Extension Bulletin 1185. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Plank, C.O. 2000. Soil Testing. Leaflet 99, Cooperative Extension Service Publications University of Georgia, College of Agricultural and Environmental Sciences.

Table 2a. Summary of the swine regulations for existing operations

Existing Operations 300 A.U. or less	Existing Operations 301 A.U. - 1,000 A.U.	Existing Operations 1,001 A.U. - 3,000 A.U.	Existing Operations > 3,000 A.U.
No permit	Submit registration form to the Division by October 31, 2000	Obtain individual permit from Division by 10/31/2000	***Same regulations as for existing 1001-3000 AU, with the addition of the following:***
Still subject to applicable sections of the GA Water Quality Control Act	NRCS-designed system for new operations operable by October 31, 2002	Permit applications should be submitted 180 days in advance	Wastewater disposal system not located in flood plain unless designed to hold 25 yr./24 hr. storm
	Submit CNMP to Division by October 31, 2001, gain approval by July 1, 2002, and implement by October 31, 2002	Submit CNMP to Division by 10/31/2001, obtain approval by 07/01/2002, and implement plan by 10/31/2002	Lagoon designed to hold 25 yr./24 hr. storm; and minimum of 2 feet of freeboard in lagoons required
	Certified operator by October 31, 2001	Certified operator by 10/31/2001	NRCS design criteria waste management system by 10/31/2002
	Clay or synthetic liner on new operations	Public notice period in local paper	No discharge of pollutants to surface waters or ground water
	New barns and new lagoons cannot be located within 100 year flood plain	Nitrates below 10 mg/l at property lines	Periodic monitoring of ditches/streams near irrigation fields
		Ground water monitoring wells required; must be reviewed and approved prior to permit issuance; must be installed within 24 months after permit issuance	
		Storage lagoon effluent and ground water monitored semiannually as delineated in the permit	
		Must notify Division within 3 months of operation closure; all lagoons must be closed within 18 months and the wastewater land applied	
		No discharge of pollutants from operations to surface waters	
		Must repair lagoons to meet NRCS design criteria	

Table 2b. Summary of the swine regulations for new and expanding operations.

New Operations 300 A.U. or less	**New or Expanding Operations 300 A.U. - 1,000 A.U.**	**New or Expanding Operations 1,001 A.U. - 3,000 A.U.**	**New or Expanding Operations > 3,000 A.U.**
Same regulations as existing operations	*Same regulations as existing operations*	***Same regulations as for existing 1001-3000 AU, with the addition of the following:***	***Same regulations as for existing >3000 operations, with the addition of the following:***
	Requirements met and approved *before* expansion or start up	Individual permit application submitted 180 days before opening or expansion of facility	Individual permit application submitted 180 days before opening or expansion of facility; permit must be obtained prior to commencing construction for the operation
		No discharge of pollutants to ground waters	Final construction inspection required by Division
		NRCS design criteria waste management system prior to feeding	Certified operator prior to startup
		Certified operator prior to feeding	Notify adjoining property owners of intent to feed swine
		Submit CNMP to Division prior to feeding	NRCS design criteria waste management system and CNMP approved *prior* to startup
		Lagoon designed to hold 25 yr./24 hr. storm; and minimum of 2 feet of freeboard in lagoons required	System must be designed to hold 50 yr./24 hr. storm; lagoons must have synthetic liner to control conductivity
		Seepage from lagoon no more than 1/8" per day; clay or synthetic liner in waste impoundments	Spray irrigation of lagoon effluent prohibited
		Barns, lagoons and sprayfields cannot be located within 100 year flood plain; buffer zones required as specified by Division	Lagoons must be covered, airtight, with vents to remove air pollutants
			Owner shall provide evidence of financial responsibility in accordance with 391-3-6-.20 of the Division's Regulations
			Barns and lagoons cannot be located within 100 year flood plain; buffer zones required as specified by Division

Table 3. Summary of non-swine regulations operations.

Existing Operations 300 A.U. or less	**Existing Operations 300 A.U. - 1,000 A.U.**	**Existing Operations 1,001 A.U. - 3,000 A.U.**	**Existing Operations > 3,000 A.U.**
No permit, unless facility is defined as a CAFO	Obtain an LAS permit from EPD; Registration October 31, 2001	Obtain NPDES permit by 10/31/2001	*Same as for 1001-3000 AU operation*, with the addition of:
Still subject to applicable sections of the GA Water Quality Control Act	No discharge	Submit CNMP to DNR by 10/31/2002, and implement by 10/31/2003	Individual NPDES permit may be required, and a 3' x 5' sign is required as public notice for individual permit
	CNMP submitted to DNR by October 31, 2002 and implemented by October 31, 2003	Certify operator by 10/31/2002	
	Certified operator by October 31, 2002	Nitrates below 10 mg/l at property lines	
	Clay or synthetic liner on new operations	Public notice in local paper	
	New barns and new lagoons cannot be located within 100 year flood plain	Monitoring well below lagoon; soil sample in each soil series	
		Monitor waste and wells for TKN and Nitrate N	
		Close out procedure per DNR - 24-month time frame	
New Operations 300 A.U. or less	**New or Expanding Operations 300 A.U. - 1,000 A.U.**	**New or Expanding Operations 1,001 A.U. - 3,000 A.U.**	**New or Expanding Operations > 3,000 A.U.**
Same regulations as existing operations	NRCS design criteria system for new operations *Same regulations as existing operations*	Obtain NPDES permit 180 days in advance	*Same as for 1001-3000 AU operation*, with the addition of 3' x 5' sign required as public notice for individual permit
	Requirements met and approved *before* expansion or start up	NRCS design criteria waste management system	
		CNMP completed before opening facility	
		Certified operator	
		Lagoon designed to hold 25 yr./24 hr. storm	
		Lined lagoons w/ 2 ft. of freeboard; max size - 100 ac-ft; not in flood plain	
		Buffers required: 100 ft. from wells & streams, 500 ft. from public wells	

TABLE OF CONTENTS

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Marion County Extension Agent	Jimmy Howell
Pickens County Extension Agent	Rick Jasperse

NUTRIENT MANAGEMENT PLAN CHECK LIST

- ☐ Obtain soil and litter analysis (contact County Agent)
- ☐ Complete the annual farm manure production form (Section III)
- ☐ Complete a nutrient budget worksheet (Section III)
- ☐ Complete the manure utilization record (Section III)
- ☐ Complete the litter application record (Section III)
- ☐ Complete the litter removal record (Section III)
- ☐ Maintain a file of nutrient management records

Nutrient Management Plan Checklist

- Farm Description (# houses or # of birds annually)
- Annual Manure Generated
- Litter Sample
- Soil Samples (All fields to be used for litter application)
- Maps showing field borders, wells, acreage, surface water, etc.
- Spreader Equipment (Size and Calibration)
- Mortality Management
- Emergency Action Plan

Emergency Action Plan

	Name	Phone#
Primary Contact		
Secondary Contact		
Local Fire Dept.		
Local Police Dept.		
Local EPD		
Local Health Dept.		
Local NRCS Office		
Extension Office		
Gas Company		
Power Company		
Additional Help		

Farm Fire Protection District	
911 Coordinates for farm	
Is there a disconnect between the meter base and the buildings?	☐ Yes ☐ No ☐ N/A
If so where?	
Size of Electrical Service	
Do you have a standby alternator?	☐ Yes ☐ No ☐ N/A
Give the location of electrical panels in buildings	
Location and size of propane tanks	
Other fuels and locations	
Are hazardous materials stored in the facilities?	☐ Yes ☐ No ☐ N/A
If yes, provide the locations and list of materials	
Any medical conditions of farm employess, list	

Cooperative Extension Service
The University of Georgia College of Agricultural & Environmental Sciences

CNMP Development Checklist For Dry Litter Poultry CAFOs

Casey W. Ritz, Ph.D., Extension Poultry Scientist
Greg Sheppard, Lumpkin County Extension Service

New state and federal storm water discharge regulations now require many Georgia poultry farms to develop a Comprehensive Nutrient Management Plan (CNMP) as a part of the NPDES permit program. Farms designated as a Concentrated Animal Feeding Operation (CAFO) are required to obtain an NPDES permit and implement a CNMP. Dry litter CAFOs are those operations which house greater than 125,000 broilers and broiler breeders or 82,000 dry manure layers. This publication outlines the information needed for the development of a CNMP for dry litter poultry operations.

The information from this checklist can be utilized within the *CNMP Generator* computer software developed by The University of Georgia Cooperative Extension Service. This software is available from county extension agents and other state agricultural agency personnel. Completion of a CNMP using the *CNMP Generator* software should meet the NPDES permit requirements of the Georgia Department of Natural Resources Environmental Protection Division.

I. General Information
  1. Operator name, mailing address, telephone number, directions to farm.
  2. General farm description: number of houses, number of birds produced per year.
  3. Farm maps, showing field boundaries, field acreage and location of all surface waters and wells. Aerial photographs, soil maps, or hand-drawn maps can be utilized.
  4. Certification statement, signed by operator.

II. Nutrient Generation and Handling
  1. Annual waste generation estimate. Record of amount of litter removed from storage and/or production buildings.
  2. Manure nutrient analysis for each type of litter generated on the farm (cake, cleanout litter, compost).
  3. Description of waste handling facilities: stack houses, compost buildings.
  4. Description of manure spreader capacity and calibration frequency.
  5. Plan and/or record of off-farm transport of litter, if any, including recipient and amount removed.

III. Crop Information and Litter Application
  1. Total acres represented by CNMP.
  2. Number of acres in each field, designating the number of spreadable acres.

INTRODUCTION

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Poultry production operations are receiving increased attention as potential sources of nutrient pollution for our state's water resources. Proper utilization of dry and liquid poultry manures as well as the safe disposal of mortalities are critical to the future of this industry in Georgia. The implementation of comprehensive nutrient management plans by poultry producers can reduce the potential for adverse impacts on the environment, can increase the value of poultry manures, and can have the added benefit of improving public perceptions of poultry producers' commitments to best management practices.

Implementing comprehensive nutrient management plans on poultry farms is not difficult. The basic objectives of a nutrient management plan are the proper storage, handling and application of poultry manures to the land to reduce the potential of excess nutrients being deposited in surface or ground waters. The key components of a nutrient management plan are soil and litter analysis for nutrient compositions, calculations of the appropriate amount of poultry manure for application, and documentation of the process.

Nutrient management plans in Georgia are currently voluntary. Georgia's poultry producers have taken a pro-active position and are committed to implementation of nutrient management plans by 2002. It is likely that at some point in the future nutrient management plans for livestock operations will be required either through federal or state mandates. The implementation of voluntary nutrient management plans prior to any federal or state mandates should make the transition easier and may result in regulations that are consistent with continued profitability and productivity for growers and integrators.

The primary nutrients of concern in poultry manure application for environmental issues are nitrogen and phosphorous.

<u>Nitrogen</u>. Most of the nitrogen found in poultry manure or litter is in the form of organic nitrogen. A smaller amount of the nitrogen in the manure is ammonium. Organic nitrogen can be converted to inorganic nitrogen by bacteria in the soil. Inorganic nitrogen can then be utilized by the plant. Excessive organic and ammonium forms of nitrogen can be transformed into nitrate nitrogen which in high levels can be harmful to human health. Excess nitrogen can be removed from application sites by surface runoff and leaching and can, therefore, end up in surface or ground water supplies.

OVERVIEW OF FEDERAL AND STATE REGULATIONS AFFECTING POULTRY OPERATIONS

The major piece of Federal regulation designed to regulate pollution and protect water quality is the Clean Water Act (CWA) of 1972. This act was primarily established to focus on point-source pollution (i.e. a pipe discharging into a stream or other water body). The CWA was amended in the 1980's and is generally known as the Water Quality Act of 1987 (WQA). The amendment emphasized control of nonpoint-source pollution (NPS). This action brought the agricultural community to the forefront because improperly managed agricultural activities can contribute significantly to NPS.

The EPD is required to establish WQ discharge standards for all impaired water bodies; however, no firm date has been established. These standards are known as total maximum daily loads (TMDL's). The TMDL's may include parameters such as sedimentation, fecal coliform, dissolved oxygen, pH, etc. As an example, a stream segment that has been impaired must have TMDL's established, and all point and nonpoint source dischargers can be held responsible for implementing practices to correct the condition. Violators who exceed the TMDL's will be subject to regulatory actions under the CWA provisions. Agricultural operations within or near the impaired stream segments will certainly come under close scrutiny, especially regarding manure disposal.

Large confined animal feeding operations (CAFO's) are required to have a National Pollutant discharge Elimination System (NPDES) permit. Technically, this means that all facilities with more than 1000 animal units – 1000 slaughter steers or heifers, 700 dairy cows, 2500 hogs each weighing more than 25 kg, 30,000 laying hens or broilers using a liquid manure system, or 100,000 laying hens or broilers using a continuous overflow watering system – already are regulated much like other waste-producing industries. This means they must comply with Federal discharge standards and implement various BMP's and other pollution prevention procedures. To reduce the environmental and public health problems caused by animal waste runoff into waterways, EPA is developing regulatory and voluntary measures to bring CAFOs under tighter control.

The proposed measures include stepped up compliance and enforcement efforts. EPA, along with the states, says it hopes to issue CWA permits to the largest CAFOs by 2002 and regulate and permit all other CAFOs and priority facilities in impaired watersheds by 2005.

At present, Georgia has few farming operations that require NPDES permitting.

Operations in Georgia that generate "dry" animal waste, e.g. poultry litter, are not required to have any permits or special authorization of any kind to dispose of manure unless the farm participates in certain Federal cost-share programs. They simply must insure that water bodies are not contaminated. Regulations on animal waste disposal vary considerably from state-to-state. Producers should be aware of and abide by all regulations. Failure to comply could lead to more restrictive legislation for waste disposal.

Prepared by: Dr. Bill Segars, Professor of Crop and Soil Science and Extension Water Quality Coordinator. The University of Georgia.

Animal Waste and the Environment

Cecil Hammond, Former Extension Engineer

Introduction

Animal waste includes livestock and poultry manure, bedding and litter, plus such things as dairy parlor waste water, feedlot runoff, silage juices from trench silos and even wasted feed. These wastes can affect water quality if proper practices are not followed. These protective practices are very often referred to as best management practices (BMPs) and includes facilities or structures, management practices or vegetative cover.

Animal waste should be considered a valuable resource which, when managed properly, can reduce the need for commercial fertilizer. Such waste can add organic matter which improves water holding capacity and improves soil tilth. Animal waste can provide an economical source of nitrogen, phosphous and potassium as well as other nutrients needed for plant growth.

Waste from animal concentrations and/or manure storage areas which are not protected can wash into streams. Such overland flow of animal waste is commonly referred to as a non-point source (NPS) since the waste does not enter the streams from a point source or pipe.

Such waste in surface waters reduces oxygen in water and endangers aquatic life. The added nutrients produce excessive algae growth causing unpleasant taste and odors. Likewise, when this waste is allowed to seep into ground water the water quality is jeopardized. Nitrates in well water can be particularly dangerous to infants due to oxygen depletion in the blood.

In a speech made to the National Cattlemen's Association Board of Directors in March 1993, EPA Deputy Director David Davis stated that EPA data shows NPS pollution is the largest remaining water quality problem in the United States. He further stated that data from the states attributes 41 percent of the total NPS pollution to agriculture. Further, data indicate that approximately one-third of the agricultural NPS pollution is caused by animal waste runoff from feedlots, holding areas and pastures.

Non-Point Source Pollution (NPS)

NPS pollutants are more difficult to control because they don't come from a clearly identifiable point such as a pipe or ditch. NPS pollution is caused, for example, from rain running over a field carrying pollutants in the water. We often cause NPS pollution without being aware of pollution.

The major NPS pollutants are:

- Sediment from improperly-managed construction sites, farm and forest lands, road cuts and eroding stream banks.
- Nitrogen and other nutrients from farm land, forest, residential areas, septic systems, golf courses, etc.
- Bacteria from livestock, pet waste, wildlife and faulty septic and sewage systems.
- Salt from irrigation, acid drainage from mines and highway salt treatment.
- Pesticides from farms, forest, residential areas, etc.
- Oil, grease and other chemicals from urban runoff, energy production and improper disposal of used oil.

Be Aware

How you manage animal waste can impact water quality. Waste from animal concentrations and unprotected manure storage areas can wash into streams. Steep and unprotected slopes, poor soil conditions, lack of vegetative cover, heavy rains and the proximity to streams are some of the factors which play a role in potential environmental damage. If surface or ground waters are being compromised on your farm, seek help and make changes.

Planning an Animal Waste Management System

Planning proper waste handling will not only help protect the environment, it can improve the overall farming operation and overall cash flow. For example, dairymen who add freestalls not only provide for closed loop waste handling but also provide shade, feeding and loafing areas for the animals. These improvements translate into more milk (and easier management) which normally pays for the construction cost in 3 to 5 years. Adding cow mats in freestalls not only saves time and money but keeps the bedding in the stalls and out of flush gutters, making the liquid manure systems more manageable. Liquid manure systems are very popular, primarily because of the degree of automation. If solids are removed, the liquid waste is considerably easier to pump and recycle for flushing gutters.

Table 1 shows the nutrients in animal waste (N, P, K) for various animals based upon a 1,000 pound animal unit over a period of one year. Data for Tables 1-3 are taken from Midwest Plans Publication Number #1 (1983 Edition).

Table 1. **Annual Pounds of Nutrients in Manure As Excreted Per 1000 Pounds Liveweight**

	Dairy Cow	Beef Feeder	Swine Feeder	Laying Hen	Broiler
Nitrogen N	150	124	164	263	423
*Phosphate P_2O_5	60	91	124	232	216
*Potash K_2O	118	106	132	136	158

*Elemental P & K conversion can be made as follows: To convert P_2O_5 to elemental P, multiply by 0.44, and to convert K_2O to elemental K, multiply by 0.83.

Method of Handling and Land Application

Average nitrogen losses which occur with various manure handling and storage methods are given in Table 2.

Need for Waste Management

Agriculture received a lot of the credit for the pollution of the Chesapeake Bay which has subsequently helped to focus attention on agriculture. Many farmers fear regulations will increase cost and drive them out of business.

More and more state and federal governments are requiring nutrient management plans, tougher regulations and more accountability in waste handling. However, most will agree voluntary control is less costly and more productive than governmental control and regulations. To make it work, every one of us needs the commitment and dedication. A few flagrant offenders gives all of agriculture a bad name.

Water is the world's most abundant resource, but only one percent of water is suitable for drinking. The average person in the U.S. uses about 180 gallons of water per day. We all live in a watershed down stream from someone else.

Where to Get Help to Implement Changes

Contact your local agencies such as the Extension Service, Soil Conservation Service (SCS) and Agricultural Stabilization and Conservation Service (ASCS) for further information and assistance.

Growing concern about waste handling coincides with the public concern about environmental quality. Following best management practices can improve the environment and reduce liability for farmers.

Circular 827/October 1994

The University of Georgia and Ft. Valley State College, the U.S. Department of Agriculture and counties of the state cooperating. The Cooperative Extension Service offers educational programs, assistance and materials to all people without regard to race, color, national origin, age, sex or disability.

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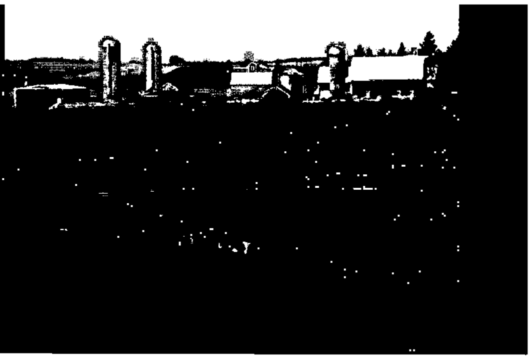
Gale A. Buchanan, Dean and Director

Nutrient Management for Georgia Agriculture



Developing a Comprehensive Nutrient Management Plan

Prepared by the Nutrient Management Task Force • Cooperative Extension Service • The University of Georgia College of Agricultural and Environmental Sciences

What is a Comprehensive Nutrient Management Plan?

A Comprehensive Nutrient Management Plan (CNMP) is a strategy for making wise use of plant nutrients to enhance farm profits while protecting water resources. It is a plan that looks at every part of your farming operation and helps you find better ways to use manures, fertilizers and other nutrient sources. Successful nutrient management requires thorough planning and recognizes that every farm is different. The type of farming you do and the lay of your land will affect your CNMP. For example, CNMPs on farms that do not have animals will not require as much detail as those that do. The best CNMP is one that is matched to the farming operation and the needs of the person implementing the plan—the Georgia farmer!

Who is Required to Have CNMPs?

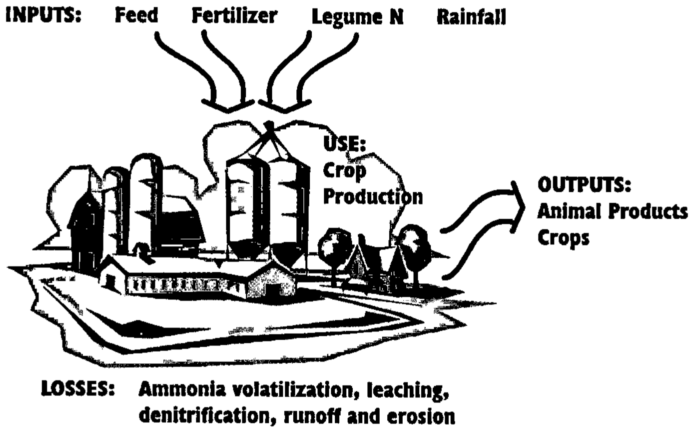
The United States Environmental Protection Agency and the United States Department of Agriculture have recently released a Unified National Strategy for managing animal feeding operations. This strategy sets a national goal for all animal feeding operations to have CNMPs. In Georgia, any animal feeding operation that receives a permit through the Georgia Environmental Protection Division is required to have a CNMP.

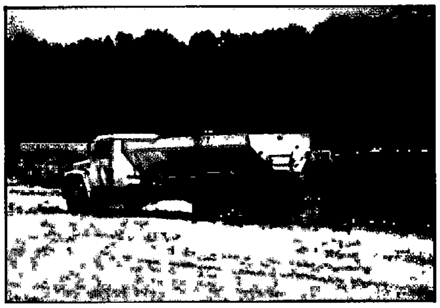
Other producers who are not required to have a permit are being encouraged to voluntarily adopt CNMPs. Many organizations such as the Georgia Poultry Federation and the Georgia Pork Producers have established initiatives to assist producers to better manage nutrients on the farm.

What Are the Parts of a Successful CNMP?

A Comprehensive Nutrient Management Plan looks at how nutrients are used and managed throughout the farm. It is more than a nutrient management plan that only looks at nutrient supply and needs for a particular field. Nutrients are brought to the farm through feeds, fertilizers, animal manures and other off-farm inputs. These inputs are used, and some are recycled by plants and animals on the farm. Nutrients leave the farm in harvested crops and animal products. These are nutrient outputs. Ideally, nutrient inputs and outputs should be roughly the same. When nutrient inputs to the farm greatly exceed nutrient outputs from the farm, the risk of nutrient losses to groundwater and surface water is greater. When you check nutrient inputs against nutrient outputs, you are creating a mass balance. This nutrient mass balance is an important part of a CNMP and important to understand for your farming operation.

Another important part of a successful CNMP is best management practices (BMPs). BMPs, such as soil testing and manure analysis, help you select the right nutrient rate and application strategy so that crops use nutrients efficiently. This not only reduces nutrient losses and protects the environment but also increases farm profitability. BMPs may also include managing the farm to reduce soil erosion and improve soil tilth through conservation tillage, planting cover crops to catch excess nutrients, or using filter strips and buffers to protect water quality. Preventative maintenance, record keeping, mortality management and emergency response plans must also be included in a CNMP for livestock and poultry operations.



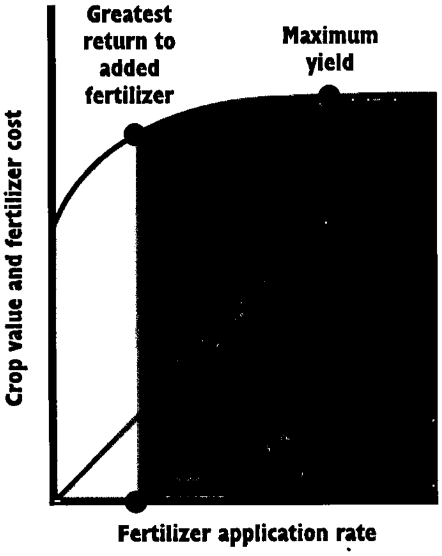


sis of these products tells you the nutrient content so that you can match this with soil test recommendations and determine application rates. The lab results will help you determine how much of the nutrients in the manure will be available to your crops. The amount credited to the nutrient budget should be based on plant available nutrient levels, which may be substantially different from the total nutrient content. The county Extension office has information on manure and litter testing.

Determining Nutrient Balance

Balance Between Supply and Need

Once you have determined both the supply and need of nutrients for each of your fields, a critical aspect of CNMPs is balancing the two. This can be done in several ways. Currently, most CNMPs are developed based on nitrogen; however, other factors such as phosphorus or metals could control how much poultry litter or manure you can put out under certain conditions. A phosphorus index is currently being developed to help producers determine when nutrient management based on phosphorus would be advisable. If your crop acreage is small relative to the number of animals, the nutrient balance will also allow you to evaluate how much manure or litter you may need to move off your farm to avoid over-application of nutrients.

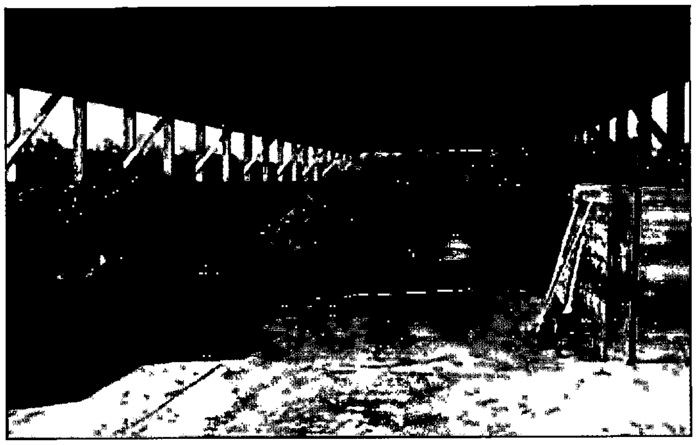


Can the Nutrient Supply on Your Farm Be Managed or Changed?

After evaluation of the nutrient supply on your farm and the nutrient needs of your crops, you may find that the balance of nutrients is not ideal. You may have more of one or more nutrients (usually phosphorus) than you need. Many management practices can change the nutrient balance. These include:

- changes in storage practices,
- adjustments of animal feeds,
- modification of treatment methods, and
- chemical amendments.

For example, you may be able to reduce nutrient losses in your manure treatment and/or storage system. Sometimes reducing nitrogen losses can make manures a better-balanced fertilizer for your crops. In addition, animal diets can sometimes be changed to reduce nutrient excretion in their manure. Enzymes can be added to the diet to reduce nutrients in the manure. Phytase is a supplemental enzyme that allows better use of the phosphorus already present in grains, so less phosphorus has to be added to the animal's diet.

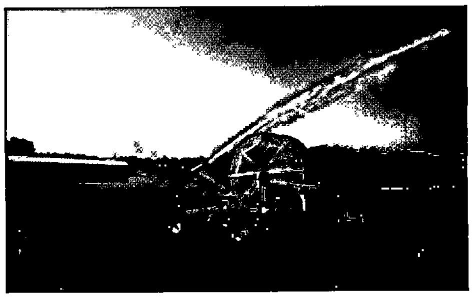


Manure Storage

Manure storage is critical. It effects both the quantity and quality of nutrients that will need to be land applied or exported from the farm. The storage structures and design capacities need to be identified as part of a CNMP. These structures also need to be managed to prevent nutrient losses and protect water quality. For example, clean water should always be diverted from barnyard and manure storage areas to reduce the potential for nutrients reaching ground or surface waters.

Manure Application to Fields

Manures should be applied near the time that crops need nutrients using calibrated spreaders or irrigation equipment. Solid or slurry manure should be incorporated into the soil when appropriate. Incorporation or mixing into the soil greatly reduces losses of nitrogen to the air and keeps more in the soil where it is needed. This reduces potential odor emissions. Slurry manure can also be injected into the soil so that incorporation is not required. Accurate records of application rates and times are also essential.



GEORGIA
FARM*A*SYST

FARM ASSESSMENT SYSTEM

NUTRIENT MANAGEMENT

Julia Gaskin, Educational Program Specialist
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PRE-ASSESSMENT:

Why Should I Be Concerned?

Nitrogen, phosphorus and other nutrients are essential to good crop production. But, the nutrients that are beneficial for plant growth can be harmful if they are present above certain *concentrations** in streams, ponds, coastal waters, or groundwater. In most of our fresh *waterbodies*, phosphorus is the nutrient in shortest supply. When excess phosphorus from animal manures, fertilizers or other sources enters these waters, it causes *algae* to grow faster and turn water a green color. This process is called *eutrophication.* It can prevent recreational uses such as fishing and swimming. In brackish waters such as marshes and estuaries, a similar situation can occur when too much nitrogen is present.

Excess nitrogen can also be a problem in groundwater. Nitrate is a form of nitrogen that can pose health problems for both humans and animals if concentrations are too high in the drinking water. The drinking water standard for nitrate-nitrogen is 10 parts per million (ppm). When concentrations are above this limit, infants younger than six months can develop a disorder called methemoglobinemia or blue baby syndrome. Nitrate-nitrogen concentrations in the range of 20-40 ppm can cause reproductive problems or other health problems in ruminants, horses or baby animals.

Because we need clean drinking water and enjoy water-based recreational activities, excess nutrients in water are a concern to everyone. As a farmer, you are paying to supply your crops with nutrients, so it also makes economic sense to manage these resources as efficiently as possible. Good nutrient management can improve your profitability as well as protect the environment.

How Does This Assessment Help Protect Drinking Water and the Environment?

- This assessment allows you to evaluate your potential impact on the water quality on your farm and in nearby *waterbodies.*
- The assessment uses your answers (rankings) to identify high risk practices that should be modified.
- The nutrient management facts provide an overview of practices to prevent pollution.
- The assessment assists you in writing an action plan based on your needs as identified by the assessment.

How Do I Use This Farm*A*Syst Assessment?

- The assessment asks a series of questions about your nutrient management practices.
- You are encouraged to complete the entire document.
- Farm*A*Syst is a voluntary program.
- No information from this assessment needs to leave your farm.
- The assessment should be conducted by you for your use. If needed, a professional from the Georgia Cooperative Extension Service or one of the other partnership organizations can provide assistance in completing the assessment or action plan.

**Words found in italics are defined in the glossary.*

NUTRIENT MANAGEMENT PRACTICES

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RANK
POTENTIAL FOR GROUNDWATER POLLUTION					
Main *soil textures* throughout the profile	Fine textures such as clays, silty clay loams, and clay loams	Textures such as silt, silt loams, and sandy clay loams	Textures such as sandy loams, and loams	Coarse textures such as sands and loamy sands	
Depth to *water table*	Greater than 50 feet	Between 10 to 50 feet	Between 5 and 10 feet	Less than 5 feet	
Presence of a *restrictive layer* or *hardpan* under the surface stopping downward water movement	*Restrictive layer* present	———	———	No *restrictive layers*	
***Buffers* around ponds, wells, sinkholes or other water-related areas**	*Buffers* greater than 50 feet around all wells, ponds, sinkholes or other water-related areas	*Buffers* 10 to 50 feet around all wells, ponds, sinkholes or other water-related areas	*Buffers* around some wells, ponds, sinkholes or other water-related areas	No *buffers* in place	
NUTRIENT MANAGEMENT					
Frequency of soil testing	Yearly	Every 2 years	Every 3 years	Less frequently than every 3 years	
Soil sampling	At least 15 cores or slices mixed together for a representative sample from fields or areas no bigger than 15 acres, according to *CES guidelines*	At least 7 cores or slices mixed together for a representative sample from fields or areas bigger than 15 acres	Single soil samples taken from areas greater than 15 acres	No soil samples taken	
Realistic yield goals	Yield averages from 5 or more recent years used to set yield goals	Yield goals based on 3 to 5 recent years averages	Yield goals based on 1 to 2 years averages, or old yield information	Yield goals not based on farm performance	
***Nutrient credits* for manure and legumes**	*Nutrient credits* calculated and deducted from nutrient application rate using *CES guidelines*	———	*Nutrient credits* are calculated and partially deducted from nutrient application rate	No deductions for using legumes or manures	
Fertilizer application rates	Fertilizer is applied at recommended rate based on soil tests and realistic yield goals	———	Fertilizer application exceeds recommendation by one-half times rate	Fertilizer application exceeds recommendation by two times rate or fertilization with no guidance	

NUTRIENT MANAGEMENT PRACTICES					
	LOW RISK (rank 4)	**LOW-MOD RISK (rank 3)**	**MOD-HIGH RISK (rank 2)**	**HIGH RISK (rank 1)**	**RANK**
Soil phosphorus (P) levels in fields	Have identified the soil P level in each field and do not apply P to very high soil test P fields	Have identified the soil P level in each field and only apply what crop needs	Soil phosphorus in fields is unknown	Soil test P is very high but there is no management to reduce excess P loss	
Manure application rates	Manure application to meet plant phosphorus needs based on soil test	———————	Manure application is based on nitrogen without regard to P	Manure application is not based on nutrients	
Manure application timing	Manure applied during active crop growth and avoided during wet weather	Manure applied as near as possible to times when crops need fertilization	———————	Manure applied nearly every day, or when lagoon or manure storage facility needs emptying or applied during wet weather	
PLANNING AND RECORDKEEPING					
Record-keeping	Good records are kept on fertilizer and manure applications, soil, plant and manure tests, and yields. Maps of fields and soil types for the farm are available	Records are kept on soil tests, some manure or plant tests; information is organized enough to be used for management decisions	Some records kept, but information is not complete or organized enough to make most management decisions	No records kept	
Nutrient management plan	Current (within last two years) *nutrient management plan*	———————	*Nutrient management plan* prepared within last five years and not updated	No *nutrient management plan*	

Number of Areas Ranked ________
(Number of questions answered, if all answered should total 28)

Ranking Total ________
(Sum of all numbers in the "RANK" Column)

NUTRIENT MANAGEMENT FACTS:

Improving Nutrient Management on Your Farm

The goal of nutrient management is to maximize farm productivity while minimizing the movement of nutrients into surface and ground water. Nutrient management includes developing a nutrient budget and site management practices. The goal of a nutrient budget is to only put out the nutrients that crops need and thereby reducing excess nutrients. The goal of site management practices is to reduce the potential of any excess nutrients reaching either surface or ground water, Both nutrient budgets and site management practices have to be developed for a particular farm. What works on one farm may not be appropriate for another. Soil characteristics, crops, use of manures or other organic sources, the lay of the land, and closeness of surface water are a few of the things that can influence what the best site management practices may be.

SITE CHARACTERISTICS

Looking at the soils on your farm can help you identify whether you are at risk for polluting surface water or groundwater. Surface water, including streams and ponds, can become contaminated by water flowing over the surface (*surface runoff*) and water flowing through the soil. Surface runoff most often occurs when the soil surface has a high clay content so that rainfall tends to collect on the surface rather than move into the soil. In sandy soils, surface runoff can also occur when the soil surface forms crusts. Surface runoff may carry eroded sediments as well as excess nutrients. Using *cover crops* and leaving *crop residues* can help reduce surface runoff. There is a higher risk of runoff in fields with steeper slopes. Traffic patterns in the field can create soil compaction that promotes surface runoff. *Restrictive soil layers* or bedrock that stop the downward movement of water can cause water to flow through the upper soil layers into nearby streams and ponds. This water flow can carry excess nutrients, such as nitrate or phosphorus, into these surface *waterbodies*.

Buffers are areas near water that are either left in a natural state or carefully managed to keep vegetation. Buffers can be either grassed or wooded areas. These are very important for reducing the amount of nutrients and sediments entering a stream or pond. Buffers help spread out and filter surface runoff. Spreading out the surface runoff allows it a chance to infiltrate into the soils rather than move directly into the stream. Most sediments are trapped by vegetation in the buffer and the plants can use the excess nutrients. Plants growing in buffer zones can also take up nitrogen and phosphorus from water flowing in the soil. Research is showing that the *slope* of the buffer as well as its width is important for protection of surface water. Buffers work best when they have slopes less than 15% or 15 feet of drop in 100 feet. If the buffer slope is greater than 15% then a wider buffer is needed to protect the surface water.

Groundwater pollution is more common in sandy soils, particularly where the *water table* is shallow (less than 10 feet). Water moves quickly through sandy soils and the soils have little ability to retain nutrients. But, groundwater contamination can also occur anywhere excessive nutrients are applied next to wells, sinkholes, or other areas with direct connections to groundwater. Buffers around these types of areas are the best method for protecting groundwater.

NUTRIENT MANAGEMENT

A number of practices can be used to make sure the nutrients needed for realistic yield goals are applied to the site. The first and maybe most important is regular soil testing to determine the nutrient status of the soil. Soil testing allows fertilizer recommendations to be tailored to your field and crop. In order to get good results from the soil tests, fields should be sampled using Cooperative Extension Service (CES) guidelines found in Soil Testing (Leaflet No. 99). These guidelines show you how to take many small samples in fields with fairly uniform soils and mix them to obtain one sample per field or soil type. For a sample to represent the conditions in a field, it is important to take many small subsamples to create a sample that is representative of the entire area. Soils have a lot of variation and water or through shallow subsurface flow into surface water. This process is called leaching. Consequently, nitrogen fertilizer should be applied when plants are actively growing and using it. Crops with heavy nitrogen demands or those grown in sandy soils should receive split applications. This will reduce nitrate-nitrogen leaching and provide a more even supply of nitrogen for plant growth. In the Coastal Plain, where irrigation is used extensively, *fertigation* can be a cost-effective and environmentally safe way of supplying nitrogen and potassium.

Regardless of the application method, calibration of your equipment is critical. *Equipment calibration* includes measuring the application rate and determining the spread pattern. Spread patterns that are uneven can create areas with too little fertilizer that can reduce yields and areas with too much fertilizer that can become a potential pollution source. Information such as Extension Circular 825 - Calibration of Manure Spreader Including Swath Width can be used to calibrate manure spreaders or dry fertilizer spreaders.

ORGANIC SOURCES OF FERTILITY

Using organic sources of nutrients can have many benefits. First, as a fertilizer, the nutrients in organic matter are released over time. This can provide a more constant nutrient source for the plants and reduce the likelihood of excess nutrients moving into ground or surface water. Second, organic matter itself can improve soil tilth. Better soil tilth can increase the amount of water that moves into the soil and reduce erosion. The additional organic matter can also hold more water in the soil and decrease droughtiness. Third, organic sources usually contain many of the micronutrients crops need for maximum yield. Some studies indicate improved yields and pest resistence in fields with higher organic matter. Use of organic sources can decrease the costs for fertilizer, improving your profitability.

The first step in adding organic matter to the soil is using all available on-farm sources. This includes the use of cover crops, *green manures*, and animal manures. Cover crops are grown in the winter and killed in the spring. These crops decrease erosion and add organic matter to the soil. Common cover crops in Georgia are rye and winter wheat. Green manures are legumes that are grown in the winter and killed in the spring to increase the organic matter content of the soil and supply nitrogen. Some green manures used in Georgia are vetch and crimson clover. The nitrogen supplied by legumes should be subtracted from the total amount of nitrogen needed for your crop:

There are other sources of organic matter that can be beneficial. Composts are good sources of organic material. *Biosolids* are a good source of both organic matter and a slow release nitrogen fertilizer. When properly applied, biosolids can provide the benefits of organic matter and nutrients as well as lower fertilizer costs. Cotton gin trash is another off-farm organic material that can add organic matter and nutrients. There are also by-products from food processing, textiles or other industries that can supply some organic matter and nutrients. These by-products should be tested for safety and value before use on the farm. Most suppliers of these by-products should be able to show you that the product is not hazardous, does not present growth problems, and has low metals content. In addition, they should tell you the amount of nitrogen, phosphorus and potassium supplied by the by-product.

The most common source of organic matter is animal manures, including poultry litter. Animal wastes are a good source of nitrogen, phosphorus and potassium. They also contain many essential micronutrients, and can be an important component of your fertilizer program. Although manures are a good source of nutrients, they often do not supply nutrients in the same amounts that crops need. Animal manures are typically high in phosphorus compared to the amount of nitrogen needed for crops, so they are excellent for building phosphorus fertility in the soil. But if they are applied to meet the nitrogen needs of the crop, phosphorus is often over-applied. Over time, excess phosphorus can build up in the soil. This excess phosphorus can then move into nearby water and create pollution. Phosphorus can also be moved from manures that are surface applied into surface water by rainfall.

Animal manures vary widely in nutrient content. The amount of nitrogen and other nutrients present in the manure depends on the type of animal, the

GLOSSARY:

Nutrient Management

Algae: A plant that lives in water. These plants contain chlorophyll but lack true stems, leaves, or roots. Algae imparts a green color to water.

Biosolids: Municipal sludge that has been treated to stabilize organic matter and reduce pathogens.

Buffers: A strip of uncultivated land between farmed land and a sensitive area. Buffers can be grassed but often contain shrubs or trees. These are used to spread out water and sediments leaving the farmed area and help remove excess nutrients or other farm chemicals.

CES Guidelines: Cooperative Extension Service guidelines.

Concentrations: The amount of an element or compound found in a specified amount of another substance. For example, nitrate-nitrogen in water is expressed as milligrams per liter (mg/L) or parts per million (ppm). In solids, concentrations are expressed as milligrams per kilograms (mg/kg) or ppm.

Cover crop: Crops grown for ground cover to reduce erosion and add organic matter.

Crop residues: Leaves, stems or other plant parts left on the soil surface.

Dormant phase: A inactive phase for a plant where nutrient uptake and growth are slow or non-existent.

Equipment calibration: Checking or standardizing equipment so that application rates are even and at a known amount.

Eutrophication: The process by which increasing nutrients in a waterbody promotes plant over animal life, often creating conditions with very low oxygen in the water.

Fertigation: Fertilizing crops through the irrigation system.

Green manures: Legume crops that are grown to supply nitrogen and organic matter.

Hardpan: A soil layer that limits root growth or water movement.

Nutrient credits: An addition of nutrients from legumes, animal manures or other sources that should be subtracted from the total amount of fertilizer needed.

Nutrient Management Plan: A plan for managing animal wastes to maximize economic benefit for the farmer and protection of the environment.

Restrictive layer: A soil layer that limits root growth or water movement.

Slope: Change in elevation across a horizontal distance. (Example: 2:1, first number is the horizontal distance and second number is the vertical distance.)

Soil texture: Classes of soil with differing proportions of sand, silt, and clay. For example - loams, silts, sandy clay loams.

Surface runoff: Rainfall that moves over the soil surface into water.

Waterbodies: All surface water, including streams, rivers, ponds, lakes.

Water table: The level in the ground where the soil or bedrock is saturated; the upper surface of groundwater.

EXAMPLE RECORDS

Field Number ____ **Sample Area** ______________ **Soil Series** ______________

Crop	Date Planted	Soil Test Date	Soil Test Results										Fertilizer Recommended (lbs/ac)					Fertilizer Applied (lbs/ac)				
			pH	Lime Index	P	K	Ca	Mg	Zn	Mn	B	Other	N	P_2O_5	K_2O	Lime	Other	N	P_2O_5	K_2O	Lime	Other

Crop	Date Planted	Application 1			Application 2			Application 3			Application 4			Application 5			Application 6		
		Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date

EXAMPLE RECORDS

FARM CROPPING PLAN (Specify crop, variety, plant population, etc.)

CROP	FIELD 1	FIELD 2	FIELD 3	FILED 4	FIELD 5	FIELD 6
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

PUBLICATIONS:

University of Georgia, Cooperative Extension Service
Athens, Georgia 30602

- Your Drinking Water: Nitrates, Circular 819-5
- Animal Waste and the Environment, Circular 827
- Land Application of Livestock and Poultry Manure, Leaflet 378
- Georgia's Agricultural Waste Regulations, Circular 819-11
- Developing a Nutrient Management Plan for the Dairy Farm, Circular 819-16
- Soil Testing, Leaflet 99
- Calibration of Manure Spreader Including Swath Width, Circular 825
- Beneficial Reuse of Municipal Biosolids in Agriculture, Special Bulletin 27
- Soil Saving Practices - Sediment Erosion Control, Bulletin 916-6
- Soil Saving Practices - Conservation Tillage, Bulletin 916

State Soil and Water Conservation Commission
P.O. Box 8024
Athens, Ga 30603

- Agricultural Best Management Practices for Protecting Water in Georgia
- Planning Considerations for Animal Waste Systems for Protecting Water Quality in Georgia

NOTES

GEORGIA'S ANIMAL FEEDING OPERATION REGULATIONS

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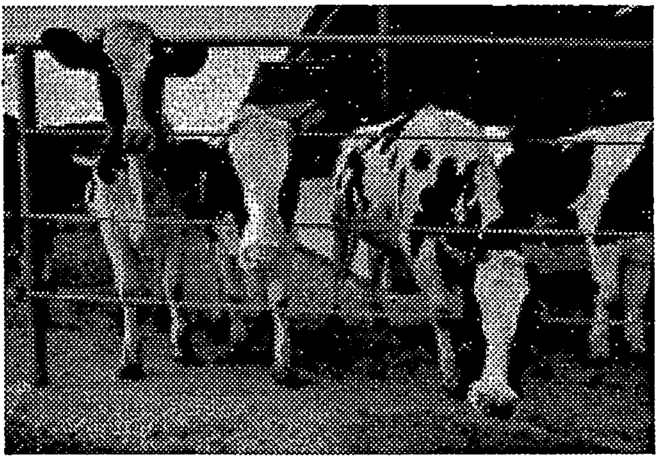
Introduction

The past several years have brought many changes in the way animal feeding operations are regulated in Georgia. These changes are largely driven by an increasing focus on agriculture as a source of non-point source pollution. Since the U.S. Clean Water Act was passed in early 1970, we have put a tremendous amount of resources into cleaning up point source pollution from municipalities and industries through the National Pollution Discharge Elimination Permit (NPDES) system. Large confined animal feeding operations (CAFOs) are regulated under the NPDES system. Because the program has been successful in reducing much of the nation's point source pollution, attention has now turned to reducing pollution from non-point sources such as urban stormwater runoff and agricultural runoff.

As part of the focus on agricultural sources of pollution, the United States Environmental Protection Agency (EPA) and the United States Department of Agriculture (USDA) have developed a *Unified National Strategy for Animal Feeding Operations.* An Animal Feeding Operation (AFO) is defined as an operation that confines animals for feeding for 45 days or more during a year in an area that does not support vegetation. At this time pastures are not considered part of an AFO. The unified strategy focuses on using Comprehensive Nutrient Management Plans to reduce the risk of excess nitrogen and phosphorus entering our surface and ground waters. The strategy also includes a plan to revise the regulations for CAFOs under the NPDES system.



The national focus on animal feeding operations (AFOs) increased pressure for Georgia to develop regulations for these operations. In Georgia, the NPDES program is administered by the Georgia Department of Natural Resources, Environmental Protection Division (EPD) and the state regulations must be at least as stringent as the federal regulations.

In 1999, the Georgia Department of Natural Resources proposed new regulations for the swine industry. These rules were finalized in April of 2000. Then in December of 2000, new rules and regulations were proposed for non-swine animal feeding operations. These regulations were approved in January of 2001, and only apply to operations with liquid manure handling systems. Both the swine and non-swine regulations are amendments to Georgia's Rules for Water Quality Control, Chapter 391-3-6.

The federal and Georgia approach to regulating AFOs are designed to target the largest operations on the assumptions that larger operations pose a greater pollution "risk". Consequently, operations are regulated according to the number of "animal units". An animal unit (A.U.) is the method that EPA uses to standardize the regulations across animal species. Different regulations apply for AFOs with 300 A.U. or less, 301 - 1,000 A.U., 1,001 - 3,000 A.U. and more than 3,000 A.U. Table 1 gives the number of animals of different species in these categories.

Table 1. Animal unit equivalents for different species.

Animal Type	**300 A.U.**	**1,000 A.U.**	**3,000 A.U.**
Beef cattle	300	1,000	3,000
Dairy cattle (milked or dry)	200	700	2,100
Horses	150	500	1,500
Swine (greater than 55 lbs)	750	2,500	7,500
Laying Hens or Broilers*	9,000	30,000	90,000

* Only if liquid manure handling system is used

Although small operations (<300 A.U.) are not subject to these state regulations, they are subject to the Clean Water Act and the Georgia Water Quality and Control Act. They are not allowed to have discharge to surface waters and should use nutrient management planning. Remember, if there is evidence of pollution, even a small operation can be designated a CAFO by EPD, and would be subject to the Georgia animal waste regulations.

There are several things common to the swine and non-swine regulations. Both regulations focus on the operations developing and following a comprehensive nutrient management plan (CNMP) and having a Certified Operator. Smaller operations (301 to 1,000 A.U.) have to apply for a Land Application System Permit (LAS) and larger operations have to obtain the more detailed NPDES permit. Both these permits must be obtained from EPD. A copy of the complete regulations can be obtained from the AWARE website - http://www.engr.uga.edu/service/extension/aware/policy.html.
A brief summary of the regulations follows.

Swine Feeding Operation Permit Requirements

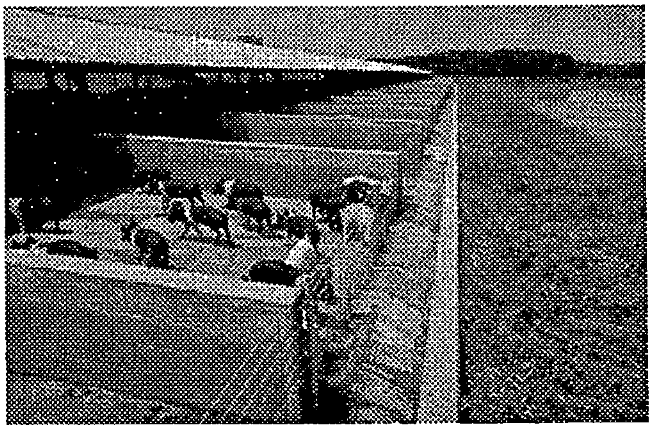
Some of the important regulations and dates that an existing swine producer needs to be aware of are:

Operations with 750 to 2,500 head that are more than 55 lbs:

- submit registration form by October 31, 2000
- submit CNMP by October 31, 2001
- train and certify an operator by October 31, 2001
- implement CNMP by October 31, 2002.

Registration forms and NPDES permit forms are available from EPD. The NPDES forms (Form 1 and Form 2B) are also available from the USEPA website - http://www.epa.gov/owm/npdes.htm#forms.

Requirements for existing swine operations with more than 2,500 head that are 55 lbs or more include all of the requirements above and an individual



NPDES permit. This permit was required by October 31, 2000. If you are in this category and did not apply for the individual NPDES permit, you should do so immediately. As mentioned before, the individual NPDES permits are more complicated to prepare. One major difference is that these operations will have to develop a groundwater monitoring plan for lagoons and sprayfields. These operations may need to obtain a consultant to prepare the individual NPDES.

Requirements for new operations are more stringent than existing operations. The swine regulations are summarized in Tables 2a and 2b.

Non-Swine Feeding Operations

The non-swine regulations are similar to the swine regulations. Important requirements for existing operations are:

Operations with 301 - 1,000 A.U.

- apply for LAS permit by October 31, 2001
- submit CNMP by October 31, 2002
- implement CNMP by October 31, 2003
- train and certify an operator by October 31, 2002

Operations greater than 1,000 A.U. must meet the requirements above and:

- apply for NPDES permit that includes a public notification
- install at least one downgradient well for each lagoon
- monitor effluent and wells semi-annually
- submit documentation of lagoon closure when it occurs

Again, requirements for new operations are more stringent. In addition to the above requirements new operations:

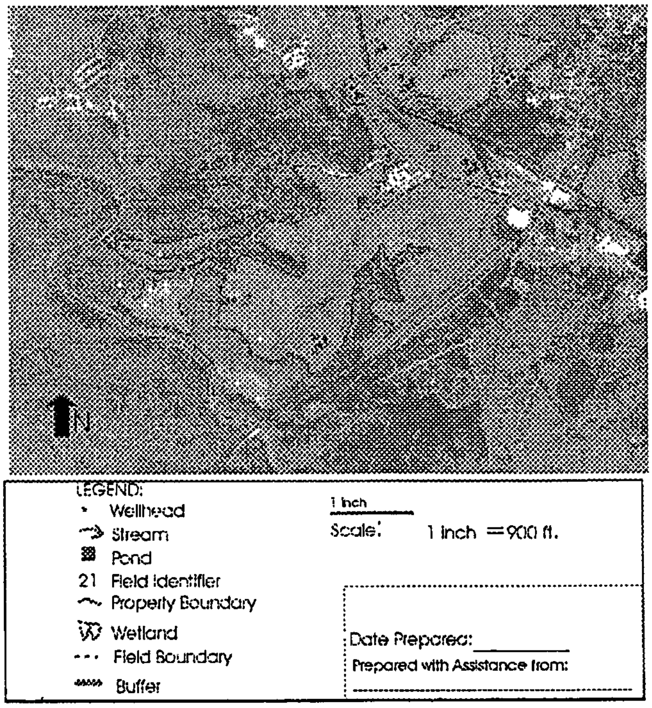
- must have waste handling and storage facilities that meet Natural Resources Conservation Service (NRCS) design criteria
- cannot locate in the 100-year flood plain
- must maintain two feet of freeboard in the lagoon
- must maintain buffers in the land application area
- must meet all requirements and be approved *before* expansion or start up

The non-swine regulations are summarized in Table 3.

Comprehensive Nutrient Management Plans

Comprehensive nutrient management plans are the keystone of all these regulations. A CNMP is a strategy to make wise use of the nutrients on the farm while protecting water quality. In Georgia, a CNMP must contain the following information:

- a scaled map of the farm showing information such as property lines, land use, field boundaries, surface water, well locations, and buffers . See the Extension publication - Maps for Comprehensive Nutrient Management Plans for details
- nutrients produced from either site specific data or book values



- nitrogen available for land application on an annual basis
- details about the land application system such as the system type, frequency of irrigation, crops, and Best Management Practices used
- nutrient balance (the amount of nutrients generated on the farm versus the amount of nutrients that can be used by crops on the farm)
- a mortality management plan for typical annual mortalities and catastrophic mortalities.
- a list of the records kept on the farm
- an emergency response plan
- a closure plan

CNMPs must be developed by Certified Planners. The Georgia Department of Agriculture will certify planners and maintain a list of certified individuals. The certified planners will include NRCS personnel, county agents, certified crop advisors, and other professionals who have attended the CNMP training and demonstrated they can develop an acceptable CNMP.

Certified Operators

In addition to the CNMPs, operations greater than 300 A.U. must have Certified Operators. A Certified Operator must attend training and pass an exam. They must also obtain continuing education. The Georgia Department of Agriculture oversees the training, certification and continuing education requirements.

Resources

Depending on the size of your operation, these plans can be complex. There are resources to help you develop your plan. You can obtain assistance from your county extension agent, NRCS personnel, and from various consultants. There are also various extension publications that can help. These are listed in the bibliography at the end of this publication. Many of these publications and other tools are available on the University of Georgia AWARE website.

Summary

The new regulations require changes in the way AFOs do business. The focus on management of nutrients can improve profitability by better use of nutrients produced on the farms and reduced need for fertilizer purchase. There may also be opportunities for composting and selling manures for off-farm uses. Although the new regulations require more recordkeeping, the records may help improve farm management and productivity. While these regulations may appear complex, they are designed to protect both the farmer and the environment. Compliance with these regulations will provide the farmer documentation that they are making a reasonable effort to operate their farm in a safe and environmentally sound manner.

Other Useful Publications

Gaskin, J.W. and G. H. Harris. 1999. Nutrient Management. Georgia Farm*A*Syst System. Cooperative Extension Bulletin 1152-16. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Gaskin, J.W. and V. Jones. 2001. Maps for Comprehensive Nutrient Management Plans. Cooperative Extension Bulletin 1195. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Gould , M. C., L. Guthrie, and W.I. Segars. 1996. Developing a Nutrient Management Plan for the Dairy Farm. Cooperative Extension Circular 819-16. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Hammond, C., W.I. Segars, and C. Gould. 1994. Land Application of Livestock and Poultry Manure. Cooperative Extension Circular 826. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Nutrient Management Task Force. 1999. Nutrient Management for Georgia Agriculture. Cooperative Extension Bulletin 1185. College of Agricultural & Environmental Sciences, University of Georgia, Athens, GA.

Plank, C.O. 2000. Soil Testing. Leaflet 99, Cooperative Extension Service Publications University of Georgia, College of Agricultural and Environmental Sciences.

Table 2a. Summary of the swine regulations for existing operations

Existing Operations 300 A.U. or less	Existing Operations 301 A.U. - 1,000 A.U.	Existing Operations 1,001 A.U. - 3,000 A.U.	Existing Operations > 3,000 A.U.
No permit	Submit registration form to the Division by October 31, 2000	Obtain individual permit from Division by 10/31/2000	***Same regulations as for existing 1001-3000 AU, with the addition of the following:***
Still subject to applicable sections of the GA Water Quality Control Act	NRCS-designed system for new operations operable by October 31, 2002	Permit applications should be submitted 180 days in advance	Wastewater disposal system not located in flood plain unless designed to hold 25 yr./24 hr. storm
	Submit CNMP to Division by October 31, 2001, gain approval by July 1, 2002, and implement by October 31, 2002	Submit CNMP to Division by 10/31/2001, obtain approval by 07/01/2002, and implement plan by 10/31/2002	Lagoon designed to hold 25 yr./24 hr. storm; and minimum of 2 feet of freeboard in lagoons required
	Certified operator by October 31, 2001	Certified operator by 10/31/2001	NRCS design criteria waste management system by 10/31/2002
	Clay or synthetic liner on new operations	Public notice period in local paper	No discharge of pollutants to surface waters or ground water
	New barns and new lagoons cannot be located within 100 year flood plain	Nitrates below 10 mg/l at property lines	Periodic monitoring of ditches/streams near irrigation fields
		Ground water monitoring wells required; must be reviewed and approved prior to permit issuance; must be installed within 24 months after permit issuance	
		Storage lagoon effluent and ground water monitored semiannually as delineated in the permit	
		Must notify Division within 3 months of operation closure; all lagoons must be closed within 18 months and the wastewater land applied	
		No discharge of pollutants from operations to surface waters	
		Must repair lagoons to meet NRCS design criteria	

Table 2b. Summary of the swine regulations for new and expanding operations.

New Operations 300 A.U. or less	New or Expanding Operations 300 A.U. - 1,000 A.U.	New or Expanding Operations 1,001 A.U. - 3,000 A.U.	New or Expanding Operations > 3,000 A.U.
Same regulations as existing operations	*Same regulations as existing operations*	***Same regulations as for existing 1001-3000 AU, with the addition of the following:***	***Same regulations as for existing >3000 operations, with the addition of the following:***
	Requirements met and approved *before* expansion or start up	Individual permit application submitted 180 days before opening or expansion of facility	Individual permit application submitted 180 days before opening or expansion of facility; permit must be obtained prior to commencing construction for the operation
		No discharge of pollutants to ground waters	Final construction inspection required by Division
		NRCS design criteria waste management system prior to feeding	Certified operator prior to startup
		Certified operator prior to feeding	Notify adjoining property owners of intent to feed swine
		Submit CNMP to Division prior to feeding	NRCS design criteria waste management system and CNMP approved *prior* to startup
		Lagoon designed to hold 25 yr./24 hr. storm; and minimum of 2 feet of freeboard in lagoons required	System must be designed to hold 50 yr./24 hr. storm; lagoons must have synthetic liner to control conductivity
		Seepage from lagoon no more than 1/8" per day; clay or synthetic liner in waste impoundments	Spray irrigation of lagoon effluent prohibited
		Barns, lagoons and sprayfields cannot be located within 100 year flood plain; buffer zones required as specified by Division	Lagoons must be covered, airtight, with vents to remove air pollutants
			Owner shall provide evidence of financial responsibility in accordance with 391-3-6-.20 of the Division's Regulations
			Barns and lagoons cannot be located within 100 year flood plain; buffer zones required as specified by Division

Table 3. Summary of non-swine regulations operations.

Existing Operations 300 A.U. or less	Existing Operations 300 A.U. - 1,000 A.U.	Existing Operations 1,001 A.U. - 3,000 A.U.	Existing Operations > 3,000 A.U.
No permit, unless facility is defined as a CAFO	Obtain an LAS permit from EPD; Registration October 31, 2001	Obtain NPDES permit by 10/31/2001	*Same as for 1001-3000 AU operation*, with the addition of:
Still subject to applicable sections of the GA Water Quality Control Act	No discharge	Submit CNMP to DNR by 10/31/2002, and implement by 10/31/2003	Individual NPDES permit may be required, and a 3' x 5' sign is required as public notice for individual permit
	CNMP submitted to DNR by October 31, 2002 and implemented by October 31, 2003	Certify operator by 10/31/2002	
	Certified operator by October 31, 2002	Nitrates below 10 mg/l at property lines	
	Clay or synthetic liner on new operations	Public notice in local paper	
	New barns and new lagoons cannot be located within 100 year flood plain	Monitoring well below lagoon; soil sample in each soil series	
		Monitor waste and wells for TKN and Nitrate N	
		Close out procedure per DNR - 24-month time frame	
New Operations 300 A.U. or less	**New or Expanding Operations 300 A.U. - 1,000 A.U.**	**New or Expanding Operations 1,001 A.U. - 3,000 A.U.**	**New or Expanding Operations > 3,000 A.U.**
Same regulations as existing operations	NRCS design criteria system for new operations *Same regulations as existing operations*	Obtain NPDES permit 180 days in advance	*Same as for 1001-3000 AU operation*, with the addition of 3' x 5' sign required as public notice for individual permit
	Requirements met and approved *before* expansion or start up	NRCS design criteria waste management system	
		CNMP completed before opening facility	
		Certified operator	
		Lagoon designed to hold 25 yr./24 hr. storm	
		Lined lagoons w/ 2 ft. of freeboard; max size - 100 ac-ft; not in flood plain	
		Buffers required: 100 ft. from wells & streams, 500 ft. from public wells	

Nutrient Management Programs For Georgia Poultry Growers

Dr. Dan L. Cunningham and Dr. Casey W. Ritz
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Cooperative Extension Service/The University of Georgia College of Agricultural and Environmental Sciences

The need to ensure that concentrated animal feeding operations (CAFOs) are not contributing to water quality issues in the United States has led many states to develop *nutrient management plans* (NMPs) for their livestock producers. These NMPs have been implemented through either voluntary participation or through mandated state regulations. Some states, such as Georgia, have used combinations of these two approaches.

NMPs are essentially best management practices for appropriate handling, storage and application of animal manures when used as organic fertilizers. The benefits of such programs are the continued protection of the state's surface and ground waters and the enhancement of the economic value of this organic fertilizer through the most efficient use of the contained nutrients.

Georgia's Response to NMPs

Georgia has responded to the need for poultry NMPs by developing and implementing two distinctly different nutrient management programs: Georgia's Voluntary Nutrient Management Program and State Rule 391-3-6, Animal (Non-Swine) Feeding Operations program. The two plans differ in that the first is directed to all poultry producers in Georgia regardless of the type of manure being managed and is dependent on voluntary compliance. The second is directed specifically to poultry producers with liquid manure systems and/or continuous overflow watering systems and is mandated by state rule. Poultry producers need to understand the differences between these two programs as well as the importance and implications of compliance with these programs.

The Voluntary Program

HISTORY OF THE PROGRAM. The Department of Poultry Science at the University of Georgia and the Georgia Poultry Federation began working collaboratively to develop nutrient management plans for Georgia's poultry producers in 1994. At that time, poultry industry representatives and members of the College of Agricultural and Environmental Sciences realized the importance of establishing and documenting uniform methods to apply poultry manures to the soil through an aggressive and pro-active voluntary program. To achieve these objectives, a task force was created involving members of the Georgia Poultry Federation; UGA faculty from the departments of Poultry Science, Biological and Agricultural Engineering, and Crop and Soil Sciences; and representatives from the Natural Resource Conservation Service.

As a result of the work of this task force, educational materials (NMP manuals and slide sets) were developed specifically for poultry producers to assist in the education and implementation of the voluntary program. These training materials contain sections related to the key components necessary for developing a farm-based nutrient management program.

COMPONENTS OF AN NMP. The important aspects of NMP development covered in the voluntary program training manuals and the educational programs are:

1. Applicable federal and state regulations
2. Procedures for soil and litter analysis
3. Nutrient budgets and worksheets
4. Documentation of the plan (records)
5. Application and storage methods
6. Practices for preventing soil erosion
7. Methods for dead bird disposal

In August of 1999, the Board of Directors of the Georgia Poultry Federation passed a resolution approving the policy of providing all poultry growers in Georgia training related to the voluntary NMP program. This resolution also established the goal of having all poultry producers implementing NMPs by January, 2002.

ACHIEVEMENTS OF THE VOLUNTARY PROGRAM. Beginning in September, 1999, faculty in the departments of Poultry Science and Crop and Soil Sciences began conducting educational programs in conjunction with county extension agents across the state. By the end of 2001, more than 3,800 poultry producers had participated in these educational sessions and were issued certificates of NMP training. In addition, the Georgia Poultry Federation secured state funding to offset the cost of litter analysis needed for completion of an NMP. As a result of these programs, more than 4,000 litter samples were submitted to the University of Georgia Services Lab for analysis between the fall of 1999 and the end of 2002. Estimates are that these samples represented more than 75 percent of the poultry farms in Georgia and likely represent a higher percentage of the farms applying litter. Because of the voluntary nature of this program, we do not know exactly how many farms have fully completed the voluntary NMP program. Informal surveys, however, suggest that a high percentage of Georgia growers are complying with the voluntary approach.

These voluntary programs have provided uni-form manure management practices across Georgia and have been very instrumental in keeping state mandated programs to a minimum. Because of the awareness of the need to protect the environment, NMPs will continue to be very important in the future. Growers are encouraged to continue their participation in the voluntary program even though they may not be required to do so by the state.

Animal (Non-Swine) Feeding Operations Program

In June, 2001, the Department of Natural Resources Board approved the Georgia Environmental Protection Division's Animal (Non-Swine) Feeding Operators Rule 391-3-6. This rule requires poultry producers with liquid manure handling systems or continuous overflow watering systems to be permitted. The permits required under this rule are the Land Application System (LAS) and the National Pollutant Discharge Elimination System (NPDES) permits. To obtain these permits, producers must complete a comprehensive nutrient management plan and certified operator training.

POULTRY OPERATIONS REQUIRING LAS PERMITTING. The LAS permit is required for poultry operators in the following categories:

- 9,000 laying hens or broilers with liquid manure handling systems.
- 30,000 laying hens or broilers if the facility has continuous overflow watering system.
- 16,000 turkeys.
- 1,500 ducks

POULTRY OPERATIONS REQUIRING NPDES PERMITTING. The NPDES permit is required for poultry operators in the following categories:

- 30,000 laying hens or broilers with liquid manure handling systems.
- 100,000 laying hens or broilers with continuous overflow watering systems.
- 55,000 turkeys.
- 5,000 ducks.

With the passage of EPD's Animal (Non-Swine) Feeding Operations rule, the Georgia Department of Agriculture adopted their *Animal Feeding Operators Training and Certification Rule 40-16-5* in June of 2001. The rule provides for certification training required to meet the Georgia Environmental Protection Division's AFO/CAFO permitting rule. Training requires 1½ days of classroom instruction followed by a written examination. A minimum score of 70 percent on the exam is necessary for certification. In addition, the rule requires 4 hours of continuing education every 2 years.

By definition, Georgia's *Animal (Non-Swine) Feeding Operations Rule* exempts dry manure poultry operations from the mandatory program. This exemption, however, will change for some dry manure poultry operators in the near future.

EPA's New CAFO Regulations

In 2001, Georgia's EPD did not include dry manure poultry operations in their AFO rule. This was partly a result of the implementation of the voluntary program and partly due to the fact that the U.S. Environmental Protection Agency (EPA) was expected to release a new version of their CAFO rule in 2002 that would address dry manure operations. In December of 2002, EPA unveiled to the states their "new" CAFO rule, which simplified and clarified the existing rule. This new rule includes some dry manure poultry operations and will require some amendments to the current Georgia rules. States must adopt rules that are at least equal to the federal rules. States do, however, have the option of adopting rules that are more stringent than the federal rules if necessary for protection of the environment. Georgia will be considering amendments of its AFO/CAFO rules in 2003.

NEW REQUIREMENTS FOR POULTRY. Several of the components of EPA's new CAFO rules have implications for poultry producers.

- Large poultry operations will be required to have NPDES permits regardless of the type of manure handled. Large poultry operations are defined as operations with:
  - 125,000 or more broilers
  - 82,000 or more laying hens
  - 55,000 or more turkeys
- NMPs will be required to include phosphorous risk assessments.
- Setbacks of 100 feet from surface water and wells required for application of manures unless a 35-foot vegetative buffer is used.
- Large CAFOs will be required to keep records of manure transfers.
- Large CAFOs will be required to report annually to the permitting authority.

WHAT IS NOT REQUIRED. EPA dropped a number of proposed requirements from their final rule. Some of the more significant requirements dropped are:

- No mandatory national co-permitting requirements.
- No requirement that NMPs have to be prepared by a certified planner.
- No NMP certification of manure recipients by sellers of poultry litter.
- No requirements on when manure may be applied to frozen or saturated land.
- No mandatory national ground water testing requirements.

Georgia's EPD must now consider the new EPA CAFO regulations and decide on what action needs to be taken in Georgia to comply with the new regulations. The state can either decide to go with the new regulations as finalized by EPA, or Georgia can decide to enact more stringent rules. Much of this decision may well depend on how effective and successful the voluntary program is perceived to be. It is imperative that Georgia poultry producers continue to develop and implement NMPs. The voluntary NMP program will serve as a solid basis of permitting for those individuals requiring the NPDES or LAS permits and, in addition, will provide continued assurance of environmentally sound programs for those poultry producers not subject to a state rule program.

Should you need assistance in developing an NMP or if you need more information on Georgia's poultry nutrient management plans, contact your local Cooperative Extension office or the departments of Poultry Science and Biological and Agricultural Engineering, the University of Georgia. Information on developing poultry NMPs can be found on the Department of Poultry Science web page

www.department.caes.uga.edu/poultry/

Information on regulated CNMPs is also available on the AWARE web page:

www.engr.uga.edu/service/aware

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, The University of Georgia College of Agricultural and Environmental Sciences and the U.S. Department of Agriculture cooperating.

Gale A. Buchanan, Dean and Director

Cooperative Extension Service/The University of Georgia College of Agricultural and Environmental Sciences

NPDES Permits for Poultry Operators

Casey W. Ritz, Department of Poultry Science
Dan L. Cunningham, Department of Poultry Science
Mike Giles, The Georgia Poultry Federation

Poultry House Construction

August of 2003, the Georgia Environmental Protection Division approved a new water protection regulation that requires construction activities causing land disturbance of 1 acre or more to be covered by an NPDES (National Pollutant Discharge Elimination System) permit and be in compliance with best management practices for storm water control. The purpose of the permit is to control storm water discharges from construction sites as required by the Georgia Water Quality Control Act and Federal law. As a result of this permit requirement, almost everyone building poultry houses must comply with this permit requirement. The following are key components for compliance with this new regulation.

What Is Needed for Compliance

- Submission of a **Notice of Intent** (NOI)
- An **Erosion, Sedimentation and Pollution Control Plan** (i.e., BMPs, inspections and sampling
- Submission of a **Notice of Termination** (NOT)

Before Construction Starts

Get a copy of the Storm Water General Permit. A complete copy of the General Permit can be found in the "Technical Guidance" section on EPD's web site at www.dnr.state.ga.us/dnr/environ. The necessary forms can also be found at this web site under "Forms."

Complete and submit a Notice of Intent form. Send the NOI by certified mail return receipt to the appropriate EPD District Office at least 14 days before construction begins. A listing of EPD district offices is attached to the NOI form.

Develop an Erosion, Sedimentation and Pollution Control Plan. A template for developing an erosion control plan for poultry house construction is available through your poultry company, the Georgia Poultry Federation, and the Department of Poultry Science at the University of Georgia. Erosion control plans require a site map. Natural Resources Conservation Service (NRCS) personnel should be able to provide the necessary map. The plan, however, must be certified by a qualified design professional such as a local county engineer, landscape architect, geologist, land surveyor, etc., or by a person who is a Certified Professional in Erosion and Sedimentation Control with a current certification by Certified Professional in Erosion and Sedimentation Control Inc.

Individuals in the first category can be found by contacting the Secretary of State's office. (404-656-2881)

Certified Professionals in Erosion and Sedimentation Control can be found at that organization's web site at http://www.cpesc.net. Choose "Georgia" from the drop down menu. Currently, 78 individuals are on the list from Georgia; however, some of these are county or city employees and may not be available to provide the service.

Mail a copy of the erosion control plan and a copy of the NOI by certified mail return receipt requested to the Georgia Environmental Protection Division, Attn: Jan Sammons, 4220 International Parkway, Suite 101, Atlanta, GA 30354.

Also send a copy of the NOI and the Erosion, Sedimentation and Pollution Control Plan by certified mail return receipt requested to the appropriate Soil and Water Conservation District Office for their records.

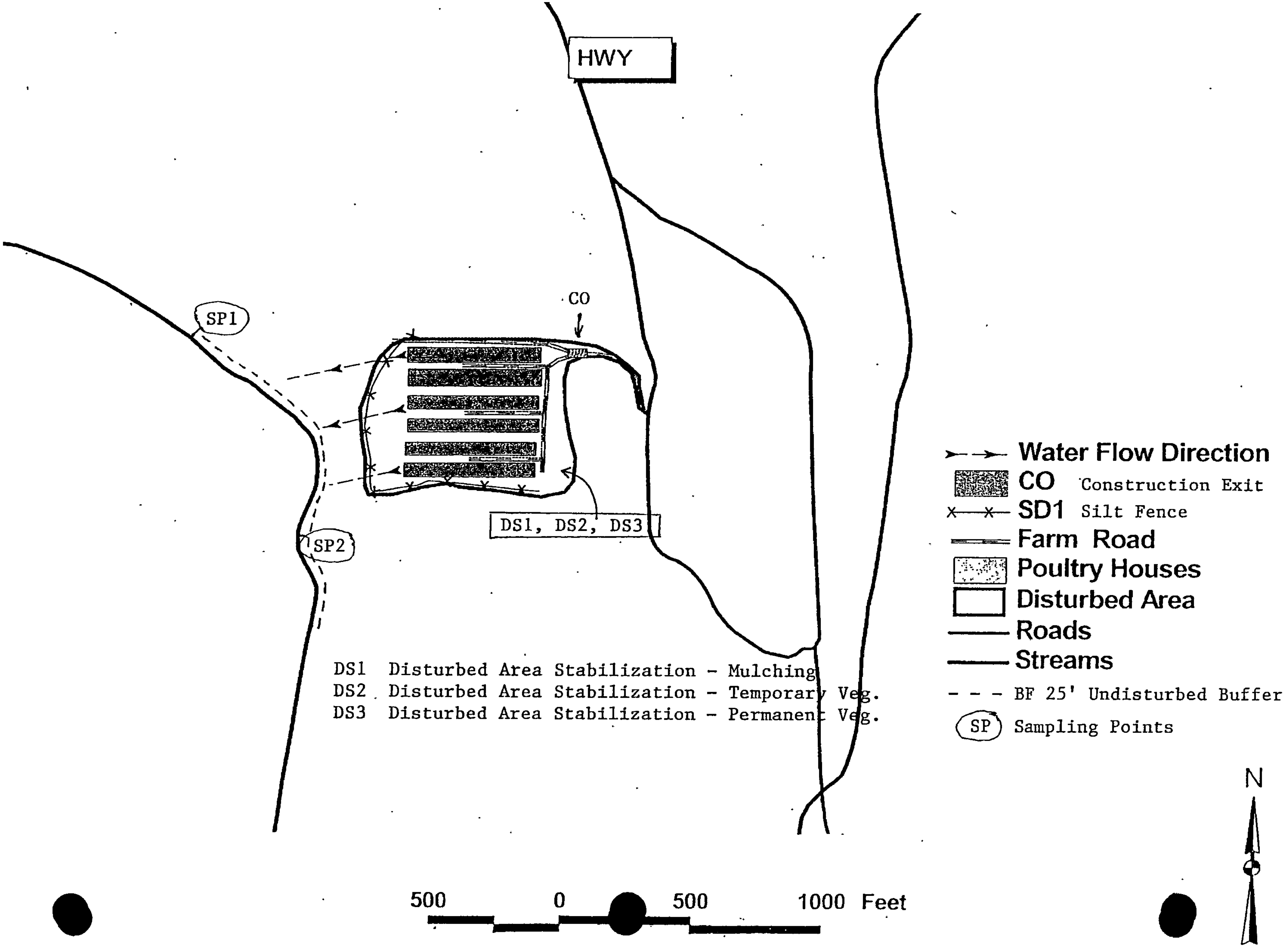
Complete the General Permit Fee Form. The fee for the permit is $80 per disturbed acre. Agricultural construction is exempt from local issuing authority, so the entire fee goes directly to EPD in Atlanta. Mail the fees and the Fee Form to EPD Lockbox, EPD Construction Land Disturbance Fees, P.O. Box 932858, Atlanta, GA 31193-2858.

During Construction

Implement the erosion control plan. Conduct inspections of the best management procedures of the erosion control plan as required by the permit. The permit requires daily, weekly and monthly inspections to assure the BMPs are in place and working properly. Permit holders should refer to General Permit (GAR100001) to determine how these inspections should be conducted.

Inspections can be done by individuals qualified in Erosion, Sedimentation and Pollution Control plan BMPs. The Georgia Poultry Federation sponsored a qualification training for poultry company personnel in August, 2004. Individuals may want to contact their poultry company to identify someone qualified to conduct site inspections. Poultry growers also may want to consider attending training sponsored by the Soil and Water Conservation Commission to become qualified to conduct their own site inspections.

Example - Poultry Farm



PROPER SAMPLING TECHNIQUES FOR DETERMINING BROILER LITTER NUTRIENT CONTENT

Michael P. Lacy

Obtaining an accurate nutrient profile of poultry litter/manure prior to its application to crops or pastures is critically important to ensure that adequate nutrient levels are available to the plants being fertilized as well as to ensure nutrients are being applied in a way that is beneficial to the environment. Take these recommendations into consideration when obtaining litter/manure samples for analysis.

1. Obtain 10 to 12 one pint samples of litter from throughout the poultry house or stockpile of litter.

2. Be certain that samples are representative of the litter in the entire house or stockpile. Samples taken around waterers, feeders, and brooders should be proportionate to the space these areas occupy in the house. When sampling in poultry houses, do not contaminate samples with soil by digging too deeply into the litter.

3. When sampling stockpiles, take samples from a depth of about 18 inches, again being careful not to intermix any soil with the sample.

4. Take the 10 to 12 one pint samples, combine them in a clean bucket or container and mix them together thoroughly. After mixing, place approximately one quart of the litter into a clean, plastic bag or container. Seal it tightly, but allow some room in the bag or container in case the sample expands.

5. Keep the sample cool and ship it to the laboratory the same day it is prepared if possible. If the sample must be held overnight, refrigerate the sample.

6. Collect the sample as close to the time planned for application as practical, taking into account the time needed for shipping and laboratory analysis.

7. In the case of liquid manure systems (such as manure slurries or lagoon sludges) stir the system before sampling if possible. As with dry manure systems, take multiple samples representative of the entire system. Combine and mix the samples prior to shipping for analysis.

8. Request an analysis for total N, P, K, and NH_4+ (ammonium) and any other minerals deemed important.

9. Nutrient analysis of litter and manure can be done at The University of Georgia Agricultural Services Laboratory or other qualified private laboratories. Costs for a basic analysis are usually in the $30 to $40 range. Contact your County Extension Agent for additional information and for assistance in submitting samples to The University of Georgia Analytical Services Laboratory.

SOIL TESTING

Cooperative Extension Service
The University of Georgia
College of Agricultural and Environmental Sciences/Athens

Determining the fertility level of a soil through a soil test is a critical step in developing and implementing a sound nutrient management plan. This step leads to higher crop yields and quality by following recommended application rates. A soil test provides the means of monitoring the soil so deficiencies, excesses and imbalances can be avoided.

The Soil Testing Laboratory

The Soil Testing Laboratory is located on the campus of The University of Georgia at 2400 College Station Road in Athens. It is equipped with the most modern instruments available for rapid and accurate soil analysis. Analysis results and soil nutrient recommendations are returned to your county agent for dissemination and adjustments if necessary.

Procedure

Soil sample bags - available from your county agent - should be used for submitting samples to the laboratory. Supply all the information asked for on the soil sample bag.

List your NAME and ADDRESS, CROP to be grown, sample number (please make simple and do not exceed 3 digits - e.g., 1, 2, 3, ...20, 21, 22, ... 321, 322, 32A, 32B ...) and your COUNTY AGENT'S ADDRESS. This information is essential for the return of your sample results and fertilizer recommendations to the proper county office.

On the bag, indicate tests desired by checking the appropriate space and/or spaces. For most agronomic needs, a routine test will suffice. If you are in doubt about whether to request a special analysis, consult your local county Extension office.

Sampling Instructions

A soil test result can be no better than the sample submitted for analysis. For it to be representative of the area tested, follow these steps for sampling:

1. Use a soil sampling tube, auger, spade, trowel, or other tool which can take a thin vertical slice of soil to the desired depth. Do not take the sample just from the soil surface layer. Depth of sampling will vary depending upon the crop or cropping conditions. The following sampling depths are recommended:

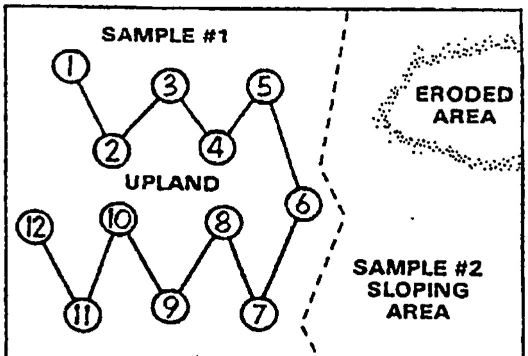


Figure 2. **SOIL SAMPLING SCHEME**

When to Sample

Soil samples can be taken any time during the year; however, fall is the most desirable time. Soils should be dry enough to till when sampling, and fields are usually dry and easily assessable in the fall. The soil pH and nutrient levels will be at or near their lowest points during late summer and early fall. Therefore, samples collected in the fall are more representative of the actual fertility conditions during the growing season than samples collected in late winter or early spring. Fall sampling also allows sufficient time for results and recommendations to be received from the laboratory so that needed limestone and fertilizer can be applied before planting.

Soil nutrient levels change during the year depending on the temperature and moisture content of the soils. It's important, therefore, that samples be taken at or near the same time each year so that results from year to year can be compared.

How Often to Sample

For many situations soils should be tested every 2 to 3 years. However, test the soil when there is a suspected nutrient deficiency, once per crop rotation, or once every other year if the soil is fertilized and cropped intensively. Annual sampling is recommended (1) on areas where high-value cash crops such as tobacco and vegetables are grown and (2) on areas where the annual nitrogen application rate exceeds 150 pounds of N per acre. Soil samples should also be collected following crops where large amounts of nutrients are removed in the harvested portion of the plant, especially for silage crops, hybrid bermuda hay, and when peanut vines are used for hay.

Record Keeping

Keep previous soil test results for each field and refer to them when planning nutrient applications. The fertility level of a soil is similar to a bank account. If the amount of deposits exceed the amount of withdrawals, there is a net buildup of the account. If the amount of nutrients applied exceeds the amount removed in harvested crops and the amount lost by leaching, there will be a net buildup of the soil fertility level. If the opposite is true, the fertility of the soil will decline. Periodic soil sampling of each field will help to determine whether you are following a soil buildup or soil depletion program. If a sound soil testing program is not followed, a deficiency or an excess in fertilization rates can result.

The University of Georgia
Cooperative Extension Service
College of Agricultural and Environmental Sciences / Athens, Georgia 30602-4356
1785

Soil Test Report

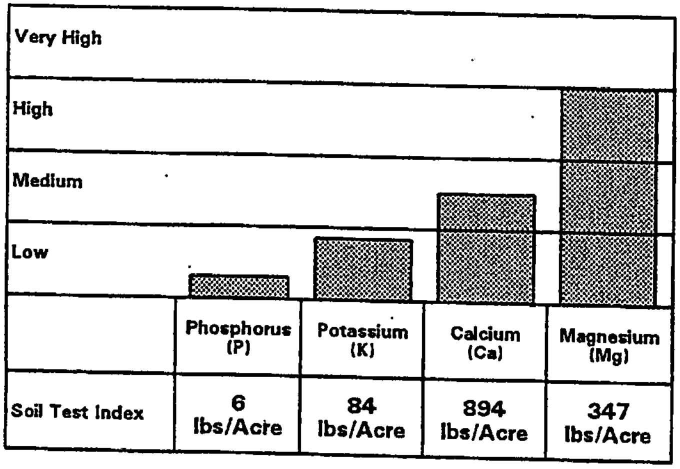
Soil, Water, and Plant Laboratory

____
(CEC/CEA Signature)

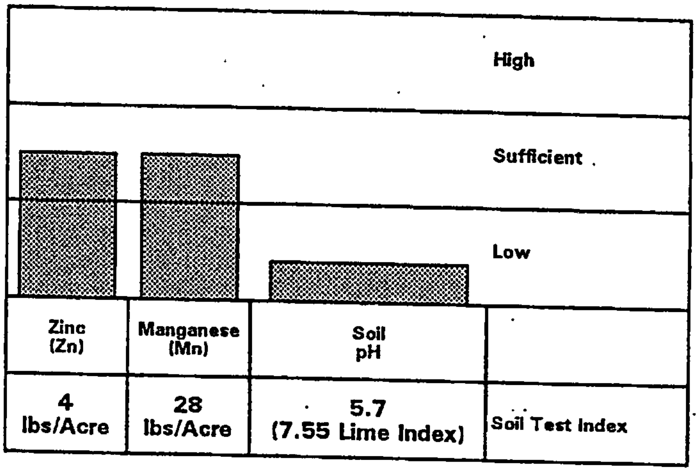
Sample ID

Grower Information	Lab Information	County Information
Client: **Doe, John** 123 McIntosh Street Springdale, GA 54321 Sample: 1 Crop: FESCUE-CLOVER ASSOCIATIONS	Lab #39 Date: 08/23/99	Clarke County 2152 W. Broad Street Athens, GA 30606

Results



	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)
Soil Test Index	6 lbs/Acre	84 lbs/Acre	894 lbs/Acre	347 lbs/Acre



Zinc (Zn)	Manganese (Mn)	Soil pH	
4 lbs/Acre	28 lbs/Acre	5.7 (7.55 Lime Index)	Soil Test Index

Recommendations

Limestone	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Sulfur (S)	Boron (B)	Manganese (Mn)	Zinc (Zn)
0.5 tons/Acre	0 lbs/Acre	110 lbs/Acre	80 lbs/Acre	--	--	--	--

For establishment, apply 20 to 50 pounds nitrogen per acre.

Apply fertilizer in the fall. If the legume represents less than 15% of the stand, treat as a grass stand. In this case consult your local County Extension Agent for appropriate recommendation. (Ask for Fescue Pasture Recommendation.)

NOTE: The amount of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) actually applied may deviate 10 pounds per acre from that recommended without appreciably affecting yields.

The University of Georgia
Cooperative Extension Service

College of Agricultural and Environmental Sciences / Athens, Georgia 30602-4356

Animal Waste Analysis Information Report

Sample ID

(CEC/CEA Signature) ____________________

Grower Information	*Lab Information*	*County Information*
Client: **Doe, John** 123 S. McIntosh Street Athens, GA 30605 Sample: 1 Type: **Litter-Poultry**	Lab #3a Date: 08/23/1999	**Clarke County** 2152 W. Broad Street Athens, GA 30606

Results

(Reported on an as-received wet basis.)

Lab Results	%	lbs/ton
Total Kjeldahl Nitrogen	2.68	53.6
Ammonium-Nitrogen	0.04	0.79
Nitrate-Nitrogen	<0.01	negligible
Phosphorus (P_2O_5)	5.78	116
Potassium (K_2O)	3.06	61.3
Calcium	3.94	78.8
Magnesium	0.89	17.8
Sulfur	0.56	11.3

Lab Results	ppm	lbs/ton
Manganese	442	0.88
Iron	2409	4.82
Aluminum	2426	4.85
Boron	20.5	0.04
Copper	70.6	0.14
Zinc	348	0.70
Sodium	9377	18.8

% Moisture ________

Total Kjeldahl Nitrogen includes ammonium and organic nitrogen combined, and does not include nitrate.

Application Information: The amount of reported nitrogen expected to be available for crop production will vary depending on several factors. Your County Agent can assist in calculating the amount of nitrogen that will be available under your specific set of conditions.

Rates of the animal waste product to apply for crop production should be based on soil test recommendations and take into consideration the nutrient content of the product as well as the method of application, the amount of nutrients applied from commercial fertilizer, and previous crop residue. Where large amounts of animal waste are used annually it is important that regular soil testing be used to monitor the impact on soil fertility levels.

1785

When you have a question...
Call or visit your local office of
The University of Georgia's
Cooperative Extension Service.

You'll find a friendly, well-trained staff ready to help you with information, advice and free publications covering agriculture and natural resources, home economics, 4-H and youth development and resource

Prepared by
C. Owen Plank, Extension Soil Scientist

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Leaflet 99
Reprinted March 1998

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Gale A. Buchanan, Dean and Director

MANURE TESTING

Manures can be quite variable in nutrient content. This variability may be due to different animal species, feed composition, bedding material, storage and handling as well as other factors. Testing at or near the time of application tells you the fertilizer value to make decisions about rates to apply. Some livestock producers are faced with nutrient management regulations that require manure testing. Also, if buying or selling litter/manure for fertilizer use, testing will help both buyer and seller establish the fertilizer value.

Manure Sample Collection

Manure should be tested as close to the date of application as practical. According to the Georgia Environmental Protection Division (EPD) "Swine Feeding Operation Permit Requirements", lagoon effluent is to be sampled semiannually. Preferably, the sample should be taken as near the application time as possible prior to the manure application. However, if it is urgent to pump down a full lagoon or storage pond, you should not wait until you can sample and obtain the results. You should sample the day of irrigation. The results can later be used to determine the nutrients applied to the fields and identify the need for additional nutrients to complete crop production.

As a rule of thumb, manures should be sampled and tested as near to the time of application as possible and practical. This is because the nutrient content can change considerably over time, particularly if stockpiled and unprotected from the weather. Nitrogen (N) is the nutrient that is the most likely to be affected. The frequency for testing your manure will depend upon several factors, but lagoon effluent needs to be tested at least semiannually to satisfy Georgia state regulations. The type of manure and overall management system will also be factors. Animal producers using lagoon manure storage systems should sample every time that the liquid or slurry will be pumped and applied to the land. Proper sampling is the key to reliable manure analysis. Although laboratory procedures are accurate, they have little value if the sample fails to represent the manure product. Manure samples submitted to a laboratory should represent the average composition of the material that will be applied to the field. Reliable samples

One pint of mixed material should be sent to the laboratory. Galvanized containers should never be used for collection, mixing, or storage due to the risk of contamination from metals like zinc in the container.

These recommendations are adequate for average irrigation volumes. If an entire storage structure is to be emptied by such means as furrow irrigation, more frequent sampling with many more sampling points is recommended.

Liquid slurry: Manure slurries that are applied from a pit or storage pond should be mixed prior to sampling. If you agitate your pit or basin prior to sampling, a sampling device pictured in Figure 1 can be used. If you wish to sample a storage structure without agitation, you must use a composite sampling device as shown in Figure 2. Manure should be collected from approximately eight areas around the pit or pond and mixed thoroughly in a clean, plastic container. An 8- to 10-foot section of 0.5- to 0.75-inch plastic pipe can also be used: extend the pipe into the pit with ball plug open, pull up the ball plug (or press your thumb over the end to form an air lock), and remove the pipe from the manure, releasing the air lock to deposit the manure into the plastic container.

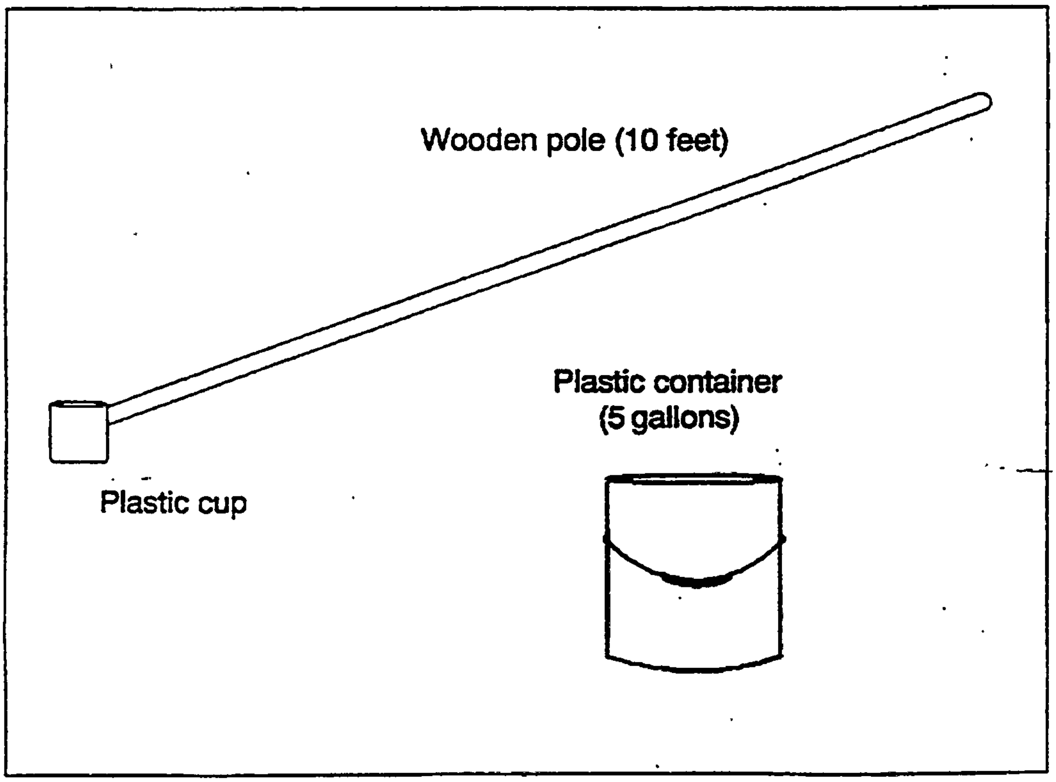


Figure 1. Liquid manure sampling device

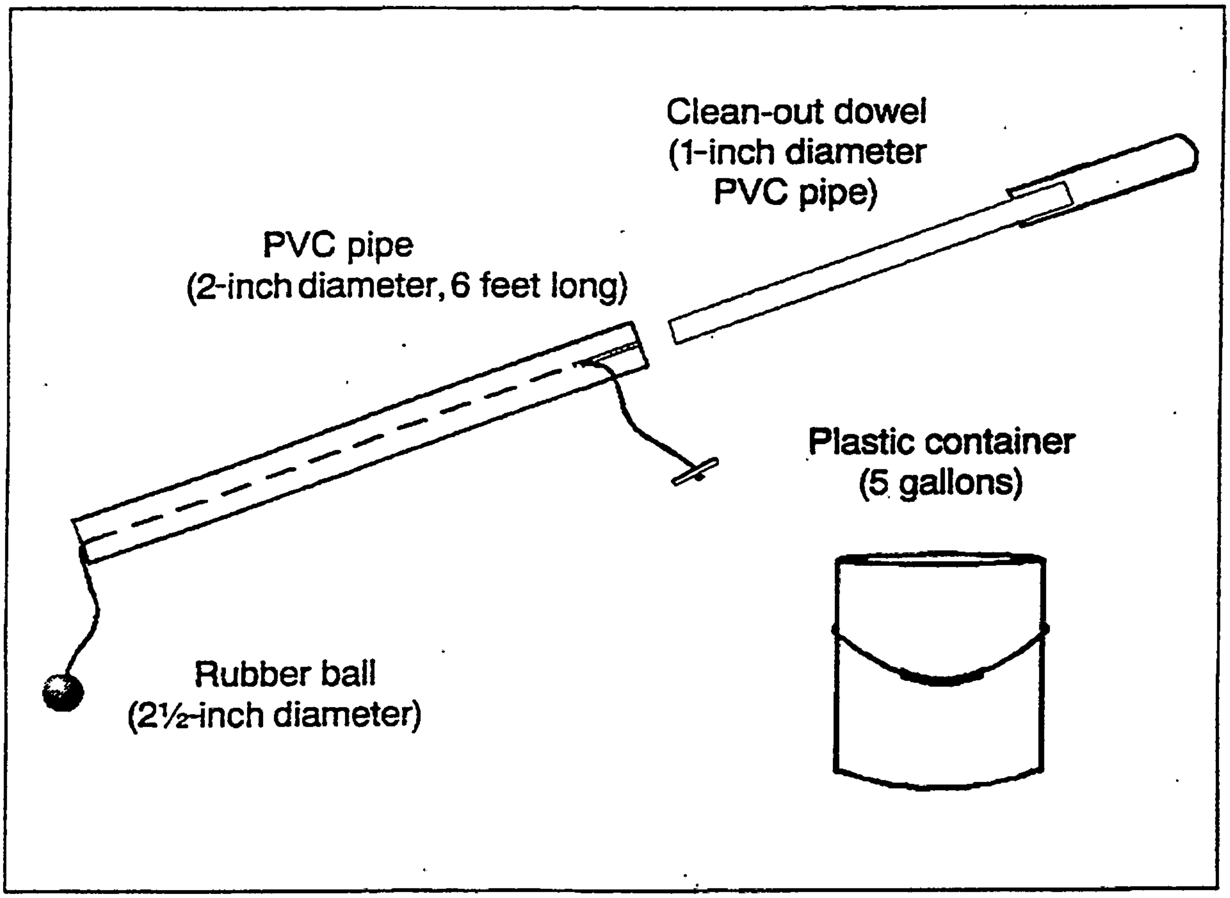


Figure 3. Composite sampling device

Lagoon sludge: Representative samples of lagoon sludge are more difficult to obtain than samples with lower solid contents. Two common methods are used. One method requires lagoon pump-down to the sludge layers. Then, during sludge agitation, a liquid or slurry type of sample described above may be collected. The other method requires insertion of a probe into the lagoon to the bottom to obtain a column of material. A "sludge-judge" is a device commonly used for this type of sampling. The sludge component of this column is then released into a clean plastic bucket, and several (12-20) other sampling points around the lagoon are likewise collected to obtain a composite, representative sample. This procedure must be performed with a boat or mobile floating dock.

For analysis, most laboratories require at least 1 pint of material in a plastic container. The sample should not be rinsed into the container because doing so dilutes the mixture and distorts nutrient evaluations. However, if water is typically added to the

Stockpiled manure or litter: Ideally, stockpiled manure and litter should be stored under cover on an impervious surface. The weathered exterior of uncovered waste may not accurately represent the majority of the material.. Rainfall generally moves water-soluble nutrients down into the pile. If an unprotected stockpile is used over an extended period, it should be sampled before each application.

Stockpiled manure should be sampled at a depth of at least 18 inches at six or more locations. The collected material should be combined in a plastic container and mixed thoroughly. The one-pint laboratory sample should be taken from this mixture, placed in a plastic bag, sealed, and shipped to the laboratory for analysis. If the sample cannot be shipped within one day of sampling, it should be refrigerated.

Surface-scraped manure: Surface-scraped and piled materials should be treated like stockpiled manure. Follow the same procedures for taking samples. Ideally, surface-scraped materials should be protected from the weather unless they are used immediately.

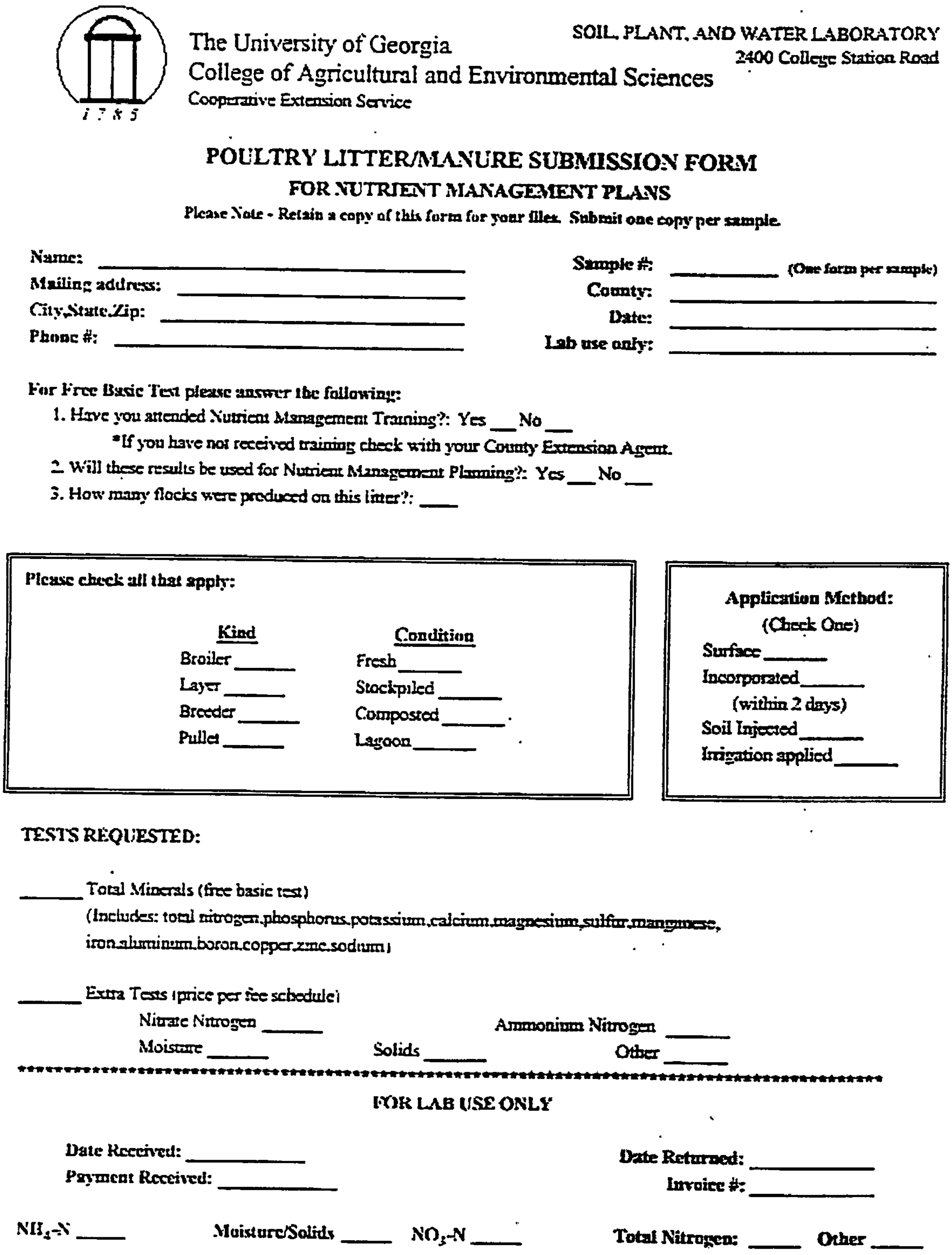
Composted manure: Ideally, composted manure should be stored under cover on an impervious surface. Although nutrients are somewhat stabilized in these materials, some nutrients can leach out during rains. When compost is left unprotected, samples should be submitted to the laboratory each time the material is applied. Sampling procedures are the same as those described for stockpiled waste.

Manure Tests to Request

The County Extension Office has sample submission forms and information on tests that are most often needed and can assist with shipping samples to the University of Georgia (UGA) Ag and Environmental Services Laboratories. Examples of the UGA manure sample submission forms are displayed in Figures 5 and 6. Poultry producers— should use the form illustrated in Figure 6, Poultry Litter/Manure Submission Form for Nutrient Management Plans. All others should use the form illustrated in Figure 5, Animal Waste Submission Form for Land Application. If using an independent or company laboratory, contact them directly about services and prices.

Basic UGA manure test package: Your individual permits will dictate the frequency and kinds of testing. The basic manure test package at the UGA Ag and Environmental Services Laboratories includes:

Therefore, for the present regulatory purposes the basic UGA test package needs additional testing for BOD5, TSS, and pH. These additional tests may be removed from the regulations in the near future, but presently are required for the lagoon effluent. Check with the permitting agency immediately prior to collecting lagoon effluent samples. There is a specific protocol for collecting these samples that includes using the proper containers, preservatives, and holding times. This protocol is beyond the scope of this training and we recommend that the producer should contract with a professional that is familiar with collecting these environmental samples.



The University of Georgia
College of Agricultural and Environmental Sciences
Cooperative Extension Service

1785

SOIL, PLANT, AND WATER LABORATORY
2400 College Station Road

POULTRY LITTER/MANURE SUBMISSION FORM
FOR NUTRIENT MANAGEMENT PLANS

Please Note - Retain a copy of this form for your files. Submit one copy per sample.

Name: ______________________
Mailing address: ______________________
City,State,Zip: ______________________
Phone #: ______________________

Sample #: __________ **(One form per sample)**
County: ______________________
Date: ______________________
Lab use only: ______________________

For Free Basic Test please answer the following:

1. Have you attended Nutrient Management Training?: Yes ___ No ___
   *If you have not received training check with your County Extension Agent.
2. Will these results be used for Nutrient Management Planning?: Yes ___ No ___
3. How many flocks were produced on this litter?: ____

Please check all that apply:

Kind	Condition
Broiler ______	Fresh ______
Layer ______	Stockpiled ______
Breeder ______	Composted ______
Pullet ______	Lagoon ______

Application Method:
(Check One)
Surface ______
Incorporated ______
(within 2 days)
Soil Injected ______
Irrigation applied ______

TESTS REQUESTED:

______ Total Minerals (free basic test)
(Includes: total nitrogen,phosphorus,potassium,calcium,magnesium,sulfur,manganese, iron,aluminum,boron,copper,zinc,sodium)

______ Extra Tests (price per fee schedule)
Nitrate Nitrogen ______ Ammonium Nitrogen ______
Moisture ______ Solids ______ Other ______

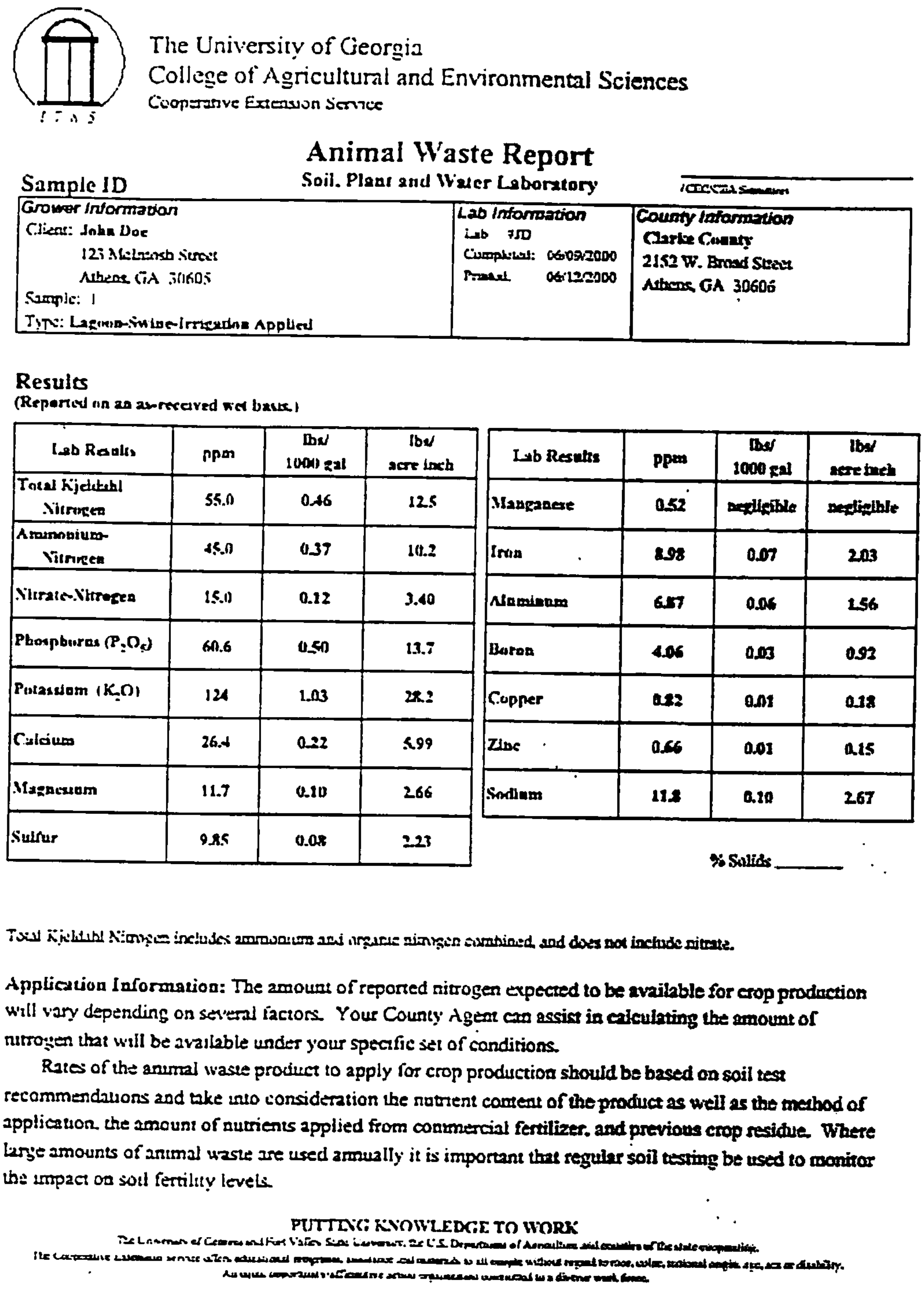
****

FOR LAB USE ONLY

Date Received: ____________
Payment Received: ____________
Date Returned: ____________
Invoice #: ____________

NH_4-N _____ **Moisture/Solids** _____ **NO_3-N** _____ **Total Nitrogen:** _____ **Other** _____

Figure 6. Example of the UGA "Poultry Litter/Manure Submission Form for Nutrient Management Plans"



The University of Georgia
College of Agricultural and Environmental Sciences
Cooperative Extension Service

Animal Waste Report

Soil, Plant and Water Laboratory

Sample ID

[illegible] Signature

Grower Information	*Lab Information*	*County Information*
Client: John Doe 123 McIntosh Street Athens, GA 30605 Sample: 1 Type: Lagoon-Swine-Irrigation Applied	Lab #JD Completed: 06/09/2000 Printed: 06/12/2000	Clarke County 2152 W. Broad Street Athens, GA 30606

Results
(Reported on an as-received wet basis.)

Lab Results	ppm	lbs/ 1000 gal	lbs/ acre inch
Total Kjeldahl Nitrogen	55.0	0.46	12.5
Ammonium-Nitrogen	45.0	0.37	10.2
Nitrate-Nitrogen	15.0	0.12	3.40
Phosphorus (P_2O_5)	60.6	0.50	13.7
Potassium (K_2O)	124	1.03	28.2
Calcium	26.4	0.22	5.99
Magnesium	11.7	0.10	2.66
Sulfur	9.85	0.08	2.23

Lab Results	ppm	lbs/ 1000 gal	lbs/ acre inch
Manganese	0.52	negligible	negligible
Iron	8.98	0.07	2.03
Aluminum	6.87	0.06	1.56
Boron	4.06	0.03	0.92
Copper	0.82	0.01	0.18
Zinc	0.66	0.01	0.15
Sodium	11.8	0.10	2.67

% Solids ________

Total Kjeldahl Nitrogen includes ammonium and organic nitrogen combined, and does not include nitrate.

Application Information: The amount of reported nitrogen expected to be available for crop production will vary depending on several factors. Your County Agent can assist in calculating the amount of nitrogen that will be available under your specific set of conditions.

Rates of the animal waste product to apply for crop production should be based on soil test recommendations and take into consideration the nutrient content of the product as well as the method of application, the amount of nutrients applied from commercial fertilizer, and previous crop residue. Where large amounts of animal waste are used annually it is important that regular soil testing be used to monitor the impact on soil fertility levels.

PUTTING KNOWLEDGE TO WORK

Figure 7. Example of a liquid manure report form the UGA Ag and Environmental Services Laboratories

INCORPORATING GEORGIA'S PHOSPHOROUS INDEX IN POULTRY NUTRIENT MANAGEMENT PLANS

Dr. Dan L. Cunningham and Dr. Casey Ritz
Department of Poultry Science
The University of Georgia

The primary purpose of a nutrient management program is to assure that nitrogen and phosphorous (nutrients found in poultry manure/litter) are applied in agronomically sound method so as to reduce the potential of nutrient contamination of the state's water. For this purpose, Georgia's poultry producers have been implementing CNMPs on their farms since 1999. These CNMPs focused initially on nitrogen-based programs until tools could be developed to incorporate phosphorous. Phosphorous is a very important nutrient from an environmental standpoint. It is the nutrient of greatest concern for protection of Georgia's waters. Georgia's Phosphorous-Index (**P-Index**) has recently been developed to take into consideration phosphorous in nutrient management plans and is now available for use by poultry producers.

Georgia's P-Index is a tool to assess the risk of applying bio-available P found in poultry manures/litter to Georgia soils. **Soil test phosphorous level by itself is not enough to determine environmental risk.** The P-index is a site specific assessment of the possibility of bio-available P loss from grass lands, cropped fields, and other agricultural lands to surface waters. Loss of bio-available P to surface waters is a concern because it can accelerate eutrophication in lakes and streams of the state.

The P-Index is a computer based program developed by a group of scientists with the University of Georgia, USDA, and NRCS*. The P-Index takes into consideration the main pathways of P loss, namely 1.) Soluble P in surface runoff, 2.) Particulate P in surface runoff, and 3.) Soluble P in leachate. For each of these pathways, the P-Index estimates the risk of P loss by considering the sources of P and the transport mechanism involved, as well as management practices that can reduce P losses. These estimates are done based on scientific formulas developed by soil scientist as part of the computer program. The total risk of P loss from a field is computed by adding the various calculations of the risk from each of the pathways. Fields are categorized by cumulative scores as either **Low (less than 40 points), Medium(less than 75 points), High(less than 100 points) or Very High(more than 100 points).** In this scoring system, individuals applying poultry litter/manure would develop or maintain management programs that would keep the P-Index below a score of 75. Scores over 75 indicate a high potential for P movement from the field. The P-Index score could then be reduced below 75 by applying less litter and/or adding buffers or applying other management procedures.

I. Sources of Risk for Soluble P in Runoff

1. <u>Soil Test P</u>- Soil test P for the index should be determined by analyzing soil samples

Surface application from May through October (growing season) represents the lowest risk factor with surface application.

3. Inorganic Fertilizer– Inorganic fertilizer P refers to the amount of P added with commercial fertilizers. The amount of water soluble P in conventional fertilizers is calculated by multiplying total P by the fraction of P present in water soluble form (0.9). Thus the presence of soluble P is greater in commercial fertilizers and the use of these conventional fertilizers will increase the risk of soluble P runoff.

4. Curve numbers and Buffers– The P-Index also uses a curve number for fields based on soil type, slope and crop type to estimate the risk of soluble P runoff. In addition, the risk of soluble P runoff is reduced with the use of a vegetative buffer at the edge of the field. A vegetative buffer is defined as a vegetated area under the producers control with greater than 80% ground cover, no channelized flow, no P application, and a soil test P of less than 450 lb/acre. In the P-Index, providing a vegetative buffer zone as narrow as 10 feet can significantly reduce the risk of P runoff from the field. Thus, the use of a vegetative buffer zone can be a powerful tool for keeping the overall P-Index value below the 75 point threshold.

The risk of soluble P loss in surface runoff is computed by adding the risk rating for each of the soluble P sources and multiplying that number by the curve factor and the buffer effect (Soil Test P + Organic P + Inorganic P x Curve number x Buffer Effect).

II. Particulate P in Surface Runoff

Particulate P is defined as phosphorous that does not pass through a 0.45 micron filter. Although particulate P is not in solution and therefore is not directly bio-available, it can play an important role in accelerating eutrophication by releasing bio-available P. The P-Index estimates the risk of P loss through particulate P by estimating sediment loss from a field, the bio-available P that can be released from particulate P, and taking into account the retention of P by the presence of a vegetative buffer.

1.Sediment Loss from a Field– Sediment loss from a field (ton/acre) requires computation using a procedure referred to as the Revised Universal Soil Loss Equation (RULSE). Determining this sediment loss factor for a field requires knowledge and training in the use of the RULSE. Thus, producers utilizing the P-Index will need assistance from trained individuals.

2. Effect of Buffer Width– The P-Index reduces particulate P losses in runoff when a vegetative buffer is used along the down slope edge of a field. A vegetative buffer is defined as a vegetative area under the producers control, with 80% ground cover, no channelized flow, and no P application. A vegetative buffer can be a very powerful management tool for reducing the overall P-Index score for a field.

Computation of the P-Index

The P-index for a given field is computed by adding the risks associated with the different pathways of P loss described above. Individuals using the P-Index computer- based program do not need to do the various scientific calculations for the risk factors. The P-Index program contains the different calculations needed for the required risk factors and will do the computations upon entering certain basic information. This P-Index has been incorporated into a Poultry CNMP computer program available through the County Extension Agent. This program has simplified the use of the P-Index so that individuals trained in its use can more easily generate a nutrient management plan that also assesses the risk of P application.

Interpretation of the P-Index

Score of 0–39. Low potential for P movement from field.

Score of 40–74. Medium potential for P movement. Use management practices to keep below 75.

Score of 75–99. High potential for movement. Reduce the rate of P application and/or add buffers. If a P-Index below 75 can not be reached, a plan needs to be developed to achieve a P-Index score of less than 75 with in 5 years.

Score of 100 or more. Very high potential for P movement. Reduce the rate of application of P or add buffers to achieve a P-Index of less than 100 in the first year. Develop a 5-year plan for reducing the P-Index score below 75.

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P-Index Survey

Planner Name ______________________ Date ____________

Type of Farm (Species) ______________________

Field ID	# Acres in Field	Management Changes to Reduce P Runoff			
		Install Buffers	Manure P Application		
			Rate	Method	Timing
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Total					

How was Erosion calculated for these fields? (NRCS agent, extension agent, USLE, RUSSLE web version?)

Comments: Please indicate any management changes not included above that have resulted from the development and implementation of your Phosphorus based CNMP. Specifically, changes to reduce P losses.

Attach "Before" and "After" P-Index spreadsheet for each field.

FAX to Tommy Bass at 706-542-1886 or mail to:

Mr. Tommy Bass
Driftmier Engineering Center
University of Georgia
Athens, GA 30602

P-Index

Source

1) Organic P sources
2) Soil test P
3) Application timing and method

Transport

1) Curve # - based on vegetation, rainfall, soil type, field slope
2) Hydrologic soil groups (4)
   - > 8000 soil types
   - runoff and leaching potential
   - long-term averages from watersheds

A - sandy
B - loam (most common)

C - clay
D - very wet

3) Depth to water table
   - P leaching potential only if water table is < 8 ft. from surface
   - enter average depth between summer & winter, or depth at time of application
4) Yearly erosion
   - soil type and land use most important factors
   - select predominant soil type in field

RUSLE (Revised Universal Soil Loss Equation) - annual erosion estimate

$$A(\text{tons/acre/yr}) = RK(LS)CP$$

R = rainfall/runoff erosivity factor (potential)
- typically one value per county

K = soil erodibility factor (how susceptible soil is to erosion)
- need county-specific data to calculate

LS = slope length and steepness factor
- barring site visit, use ballpark figures

C = cover management factor
- cropping and residue management practices with corresponding soil loss
  - - - regional numbers for Georgia

P = support practice factor
- tillage strategies
- assume value of "1" unless unique situation exists (i.e. contour farming, strip cropping, terracing)

Notes - -

1) application method and yearly erosion have medium impact on index (20-35 pts)
2) curve number and buffer have high impact on index (> 60 pts)
3) > 8 ft depth to water table has no impact on index
4) buffer soil test P < 400 has no impact on index; buffer soil test P > 450 has significant impact on index

SAMPLING TECHNIQUES FOR DETERMINING BROILER LITTER NUTRIENT CONTENT

(Revised 9/03)

Armando S. Tasistro, University of Georgia Agricultural and Environmental Services Laboratories

In-house Litter: The nutrient content of litter in a poultry house can vary considerably depending on location within the house. For example, in a recent study, we found the nitrogen content of 30 uniformly spaced broiler litter samples from within a house to vary as shown in the following table:

	Center of the house	Around feeder	Around drinkers
	(%)		
Average	3.31	4.44	3.49
Minimum	2.83	4.15	2.35
Maximum	3.68	4.75	4.50

The average % N of samples taken around feeders was 25% higher than samples taken from the center of the house and 21% higher than the average around drinkers. Samples taken around drinkers varied as much as 48% (range 2.35 to 4.50 %N). Therefore, **it is not recommended** to sample litter while still being used as a bedding layer in the poultry house. Wait until clean out to sample after mixing the litter by scraping it into a pile. Then, follow the procedure given below for sampling litter from piles, stockpiles, or spreader trucks. If sampling of litter is necessary in the house prior to clean out, use the sampling procedures as originally provided.

Piled manure, litter, or from a spreader truck: This procedure is for manure or litter temporarily collected into piles during clean out. To obtain a representative sample, collect at least 10 shovelfuls of manure or litter from the piles or from the spreaders, so that it represent all of the manure or litter, which is hauled or spread. Combine the collected portions in a clean 5-gallon plastic bucket or wheelbarrow, and mix thoroughly. Place a one-quart portion from this mixture in a plastic bag, seal it securely, and ship it to the laboratory as soon as possible. For wet manure, refrigerate the sample if it will not be shipped within one day of sampling. Unless hauling or spreading immediately, protect surface-scraped manure or litter from the weather. Sample stockpiled litter or manure according to the guidelines given below.

Stockpiled manure or litter: A stockpile consists of manure or litter stored in a pile for later use. Store stockpiled manure or litter under cover on an impervious surface. The weathered exterior of uncovered waste may not accurately represent the majority of the material, since rainfall generally moves water-soluble nutrients down into the pile. Sample stockpiles using the same method for piles described above except collect at a dept of 18 inches from the surface of the pile, and as close as possible to its application date.

Summary of poultry litter analysis for Georgia nutrient management plans.

Casey Ritz[1], Armando S. Tasistro[2], David Kissel[2] and Parshall B. Bush[2]. [1]Poultry Science Department, [2]Agricultural and Environmental Service Laboratory, University of Georgia, Athens, GA 30602.

With the increasing awareness of the potential environmental impacts of land application of manures, Georgia poultry producers have entered a voluntary nutrient management plan for litter/manure utilization as fertilizers. From July 2000 to June 2002, 4,154 poultry litter/manure samples were analyzed and the results reported on an "as received" basis. The analysis of data archived in a laboratory database showed the following mean nutrient values in % (N, P_2O_5, K_2O) for the various categories of poultry litters (standard deviations in parenthesis):

Fresh Broiler Litter (2,903 samples):	3.15(0.60), 2.77(0.81), 2.33(0.62)
Stockpiled Broiler Litter (262 samples):	2.78(0.86), 2.84(0.94), 2.29(0.69)
Composted Broiler Litter (62 samples):	2.80(0.98), 3.00(1.00), 2.30(0.83)
Fresh Layer Litter (209 samples):	2.26(0.83), 3.16(1.34), 2.05(0.81)
Broiler Breeder Litter (325 samples):	2.12(0.79), 3.14(1.17), 1.93(0.63)

In the absence of site-specific data these values will provide a good basis for nutrient management planning. The predominant litter category was fresh broiler litter, which includes data for the categories "Litter-Broiler-Fresh-Caked" and "Litter-Broiler-Fresh-Full Cleanout" that were subsets of the "Litter-Broiler-Fresh"). The nutrient concentrations of the two fresh broiler litters are very similar, and are the highest of all kinds of litter. Stockpiled litters contain P_2O_5 and K_2O concentrations similar to fresh litter. Composted broiler litters were about 10% higher in phosphorus and slightly higher in potassium than fresh broiler litter. There is a general (not statistically significant) trend toward increasing N, P_2O_5 and K_2O with increasing number of flock growouts. Litters from layers and breeders are lower in nitrogen, higher in P_20_5 and similar in potassium and nearly four times higher in calcium concentrations (6.5%) than fresh broiler litters. Application of those litters to crops will help to maintain or raise soil pH.

Key Words: Poultry, Nutrient, Litter

temp/Sheron/LitterAnalysis.wpd

	All Broiler	All Broiler	All Broiler	All layers & breeders	All layers & breeders	All layers & breeders
time period	% N	% P	%P_2O_5	% N	% P	%P_2O_5
7/1/01 to 5/14/02	3.03	1.239	2.837	2.21	1.349	3.089
5/15/02 to 8/7/02	3.07	1.309	3.000	2.29	1.324	3.032

The above table is for the analysis of poultry litter at the University of Georgia Agricultural and Environmental Services labs for two time periods and for two types of litter, either all broiler or all layer and breeder samples. The number of samples analyzed was 1666 samples for the broiler litter for the period of July 1,2001 to May 14, 2002. The number of broiler litters samples for the period May 15, 2002 to August 7, 2002 was 176. The number of layer and breeder samples were 176 for the period of July 1,2001 to May 14, 2002 and 44 for the period of May 15, 2002 to August 7, 2002.

AGRICULTURAL
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Sampling Poultry Litter for Nutrient Testing

John A. Lory, Department of Agronomy and Commercial Agriculture Program
Charles Fulhage, Department of Biological and Agricultural Engineering

Poultry litter is a mixture of poultry manure and the sawdust or rice hull bedding from confinement buildings used for raising broilers, turkeys and other birds. Poultry growers must periodically clean their buildings to promote bird health and limit buildup of wet manure. Partial cleaning, known as decaking, occurs after each flock is removed from the building. Litter that has built up, particularly near waterers and feeders, is removed before the new birds are brought into the building. Typically, all litter is removed from the building annually and replaced with fresh bedding.

This byproduct of the poultry industry can be an excellent fertilizer for crops. It contains nitrogen, phosphate, potash, and micronutrients essential for crop growth (see Table 1). Table 2 summarizes the fertilizer content of selected types of poultry litter.

Table 1. Mean nutrient content of broiler litter.

Nutrient	Pounds per wet ton
Total nitrogen	69
Ammonia nitrogen (NH_4-N)	16
Nitrate nitrogen (NO_3-N)	0.1
Phosphate (P_2O_5)	82
Potash (K_2O)	38
Calcium (Ca)	38
Magnesium (Mg)	16
Manganese (Mn)	0.4
Sodium (Na)	15
Zinc (Zn)	0.2
Sulfur (S)	14
Iron (Fe)	2
Copper (Cu)	0.1

Note: Data are based on poultry litter from nine Missouri broiler houses sampled after three to six flocks. All values are on a pounds per wet ton (as-is) basis.

Book values provide an estimate of the nutrient value of poultry litter for planning purposes. However, there can be a wide range of nutrient concentration among poultry houses. Nutrient concentrations in one house can be half or double that in another house under different management. Factors affecting nutrient content of the poultry litter include bird type, feed composition and efficiency, and building management factors such as cleanout frequency, type of waterer and management, decaking management, and the use of litter additives such as alum. The unpredictability of nutrient content from house to house makes nutrient testing of manure an essential part of using poultry litter as a fertilizer for crop production.

Table 2. Estimated range of nutrient concentration in selected types of poultry litter (pounds per wet ton).

Litter type	Total N	Ammonia N	Phosphate	Potash
Broiler	45–75	8–20	50–80	35–75
Broiler cake	40–60	5–15	50–80	45–90
Broiler breeder	20–50	5–15	40–70	15–55
Turkey	50–80	8–20	45–105	25–65

Note: All values are reported on a pounds per wet ton (as-is) basis.

Sampling poultry litter before a full cleanout

Two methods are suitable for sampling poultry litter, the point and the trench methods. The trench method may be difficult with birds in the building because feeders and water lines may complicate digging the trench and maneuvering the wheelbarrow.

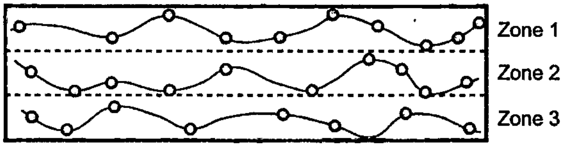
The objective of both methods is to obtain a representative sample of the nutrient content of the litter in the house. It may take more than 30 minutes to sample a building properly. This may seem like an excessive amount of time, but the proper procedure is necessary to obtain usable results.

Point method

The point method requires a 5-gallon bucket, a narrow, square-ended spade and a 1-quart plastic freezer bag. A soil probe can be used instead of the spade.

Visually divide the house in to three zones. If the

a. Point method



b. Trench method

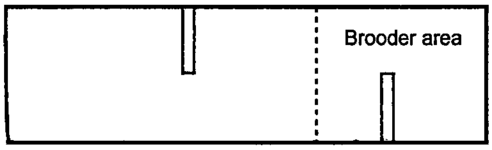


Figure 1. Sampling patterns for the point and trench methods.

house runs in the east-west direction, then divide the house into northern, middle, and southern thirds (Figure 1a). Walk the length of the building in one zone in a zigzag pattern taking a subsample with the spade at 8–10 random points along your path (10–12 points if you are using a soil probe). Be sure to take cores (a representative number) under feeders and waterers. At each sampling point, clear a small trench the width of the spade to the depth of the litter. Then remove a 1-inch slice, being sure to get equal amounts of litter from all depths (Figure 2). If you are using a probe, insert the probe the entire depth of the litter, avoiding the dirt floor below. Obtaining a quality sample with a soil probe can be difficult in dry litter. Repeat the process in each of the three zones, putting all samples into the bucket.

After collecting samples from all three zones, crumble and thoroughly mix all the litter in the bucket. With the larger amount of material collected with the spade, it may be easier to pour the material onto a piece of plastic, plywood or into a wheelbarrow to facilitate mixing. After thoroughly mixing the sample fill the freezer bag with a subsample. Label the sample with the operation name, building name and date of sampling.

Trench method

The trench method requires a square-ended spade, a wheelbarrow, a 5-gallon bucket and a 1-quart freezer bag. At approximately the middle of the brooder portion of the building, dig a trench from the midline of the building to the sidewall (Figure 1b). The square-sided trench should be the width of the spade and extend down to just above the dirt floor (Figure 3). Place all material removed from the trench into the wheelbarrow. Repeat the process at one other point in the building as shown in Figure 1b.

After collecting the sample, crumble and thoroughly mix all the litter from the two trenches in the wheelbarrow with the spade (Figure 4). After thoroughly mixing the sample, fill the freezer bag with a subsample. Label the sample with the operation name, building name and date of sampling.

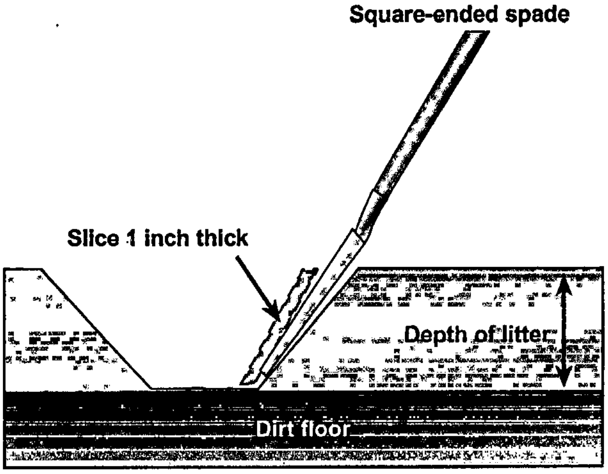


Figure 2. Using the point method with a square-ended spade, first dig a small trench before removing the sample. This ensures that equal amounts of litter are removed from all depths.

Figure 3. The trench method. Use the blade of the shovel to chop the cake so the trench has square sides down to just above the soil surface.

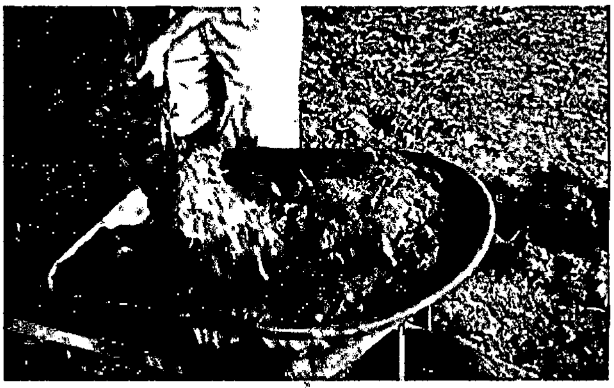


Figure 4. Be sure to crumble chunks of caked litter into small pieces and thoroughly mix the litter before removing your sample.

Often the amount of material collected from the two trenches will exceed the capacity of the wheelbarrow. When this happens, crumble and thoroughly mix the material in the wheelbarrow each time it is two-thirds full with material from the trenches. After mixing, place one shovelful in the 5-gallon bucket, empty the remainder of the litter from wheelbarrow to the side of the trench and repeat the process until you have completed both trenches. Then thoroughly mix the material collected in the bucket and fill the freezer bag with a subsample from the bucket.

Sampling cake litter

Use the same sampling methods for cake litter as for sampling before a full cleanout, but remove litter only to the depth of the cake. Alternatively, follow the procedure below for sampling litter during cleanout.

Sampling litter during cleanout

This method requires a shovel, a wheelbarrow and a 1-quart freezer bag. Take a shovelful of litter from each truckload and put it in the wheelbarrow. After collecting litter from all truckloads from a barn, thoroughly mix the litter in the wheelbarrow. Fill the freezer bag with a subsample and label it with the operation name, building name and date of sampling. Alternatively, use the trench or core method immediately before cleaning the building.

Sampling litter piles

Collecting a representative sample from a litter pile requires a shovel, a 5-gallon bucket and a 1-quart freezer bag. From each of 10 to 12 widely dispersed points on the pile, remove 2 to 5 shovelfuls of litter and set it aside. Mix this litter and place one shovelful in the bucket.

After collecting samples from all points, crumble and thoroughly mix all the litter in the bucket. Fill the freezer bag with a subsample, and label it with the operation name, building name and date of sampling.

The key to sampling litter piles in composting or other storage facilities is to obtain multiple samples throughout the stack at a time the nutrient content of the stack is relatively stable. Do not sample a freshly stacked or turned pile unless you plan to spread litter from the pile within the next day or two. Nutrient content should stabilize about two weeks after forming a new pile or turning an existing pile.

Handling and timing of poultry litter samples

Manure samples should be sent to the testing lab the same day they are collected. If you hold the sample longer than 24 hours, freeze the sample until it is sent to the testing lab. Do not let your samples sit in a hot spot such as the dashboard of a vehicle. It is best to send samples early in the week so that they do not sit in the mail over the weekend.

At a minimum, request the following laboratory tests for each sample:

- Total nitrogen (N) or total Kjeldahl N (TKN)
- Ammonium or ammonia N
- Total phosphorus
- Total potassium
- Percent moisture or percent dry matter

Not all testing labs report ammonia N. Ammonia

Adjusting units of measure in manure test results

Conversion factors

pounds per ton = percent × 20
pounds per ton = ppm × 0.002
nutrient level wet basis = nutrient level dry basis × (100 − % moisture) ÷ 100
phosphate = elemental phosphorus (P) × 2.27
potash = elemental potassium (K) × 1.2

Example

A laboratory test of a poultry litter sample yields the following values (on a wet or as-is basis).

Moisture, %	26.8
Total nitrogen, %	3.2
Ammonia nitrogen, %	0.5
Phosphorus, %	1.5
Potassium, %	2.1

The nutrient results need to be converted from percent to pounds per wet ton basis, and phosphorus and potassium need to be converted to phosphate and potash fertilizer basis.

Total nitrogen = 3.2% × 20 = 64 lb/ton
Ammonia nitrogen = 0.5% × 20 = 10 lb/ton
Phosphate = 1.5% × 20 × 2.27 = 68 lb/ton
Potash = 2.1% × 20 × 1.2 = 50 lb/ton

N typically makes up 15 to 25 percent of the total N in a sample; dry litter has lower ammonia N concentrations than other manure types. If the lab does not report this value, assume 20 percent of the total nitrogen is ammonia N.

Ideally, poultry litter should be sampled before cleaning so that sample results are available when the litter is spread. Samples taken too early will under-represent the nutrient content of the litter; results of samples taken too late will not be available to guide land application of manure. Alternatively, samples can be taken at the time of cleanout, and historic values can be used for land application. Calculation of the actual fertilizer value of the applied litter can be made when the manure test results are returned.

Interpreting poultry litter test results

The first step in interpreting a manure test is to check the units used to report the results. Poultry litter is typically applied on a pounds of nutrient per wet ton (as-is) basis. Manure test results may be reported as percent nutrient (%) or parts per million (ppm) or, on rare occasions, on a dry weight basis. The phosphorus and potassium may be reported on an elemental basis (P and K) rather than the phosphate (P_2O_5) and potash (K_2O) basis typical of fertilizers. See the box above (on page 3) to convert your manure test results into the proper fertilizer units.

Poultry litter is an excellent fertilizer if care is taken to spread the litter uniformly on a field. A pound of manure phosphate or potash has a nutrient value equivalent to that of commercial fertilizer.

Poultry litter also has value as a nitrogen fertilizer, but only a portion of the nitrogen is available to crops. Typically, 70 percent of the total nitrogen applied is available to the crop. See MU publications WQ 221, *Spreading Poultry Litter With Lab Analysis but Without Soil Tests*, or WQ 223, *Spreading Poultry Litter With Lab Analysis and With Soil Tests*, for help in calculating the poultry litter application rate based on a fertilizer recommendation.

Poultry litter is an unbalanced fertilizer; repeated applications based on the nitrogen need of pasture, hay or row crops will lead to a rapid buildup of soil test P and K levels in the soil. Poultry litter typically has nearly equal concentrations of nitrogen and phosphate. This is beneficial on soils testing low in P, but excessive buildup can occur if manure is applied based on crop nitrogen need year after year. Excessively high soil test P can result in reduced water quality in lakes and streams. Apply manure to fields that have the greatest need for phosphate and potash. See MU publication G 9182, *Managing Manure Phosphorus to Protect Water Quality*, for further information.

Calibrate your manure spreader

Effective management of poultry litter as a fertilizer requires periodically checking the capacity of your spreader. The quantity (weight) of litter applied per load will change as the moisture content and litter type varies. Determine the capacity of your spreader by weighing it both full and empty. See MU publication WQ213, *Calibrating Your Manure Spreader*, for more information.

For further information

G 9182	*Managing Manure Phosphorus to Protect Water Quality*
WQ 213	*Calibrating Manure Spreaders*
WQ 215	*Laboratory Analysis of Manure*
WQ 221	*Spreading Poultry Litter With Lab Analysis but Without Soil Tests*
WQ 223	*Spreading Poultry Litter With Lab Analysis and With Soil Tests*

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DEVELOPING A NUTRIENT MANAGEMENT PLAN

D. L. Cunningham and M.P. Lacy

A nutrient management plan is a method of matching the nutrients in a given amount of litter or manure to the needs of crop or pasture land. A nutrient management plan is like a budget, the nutrients in the litter or manure need to be balanced with the needs of the crop or pasture. An effective nutrient management plan will require soil and litter/manure analysis, computation of the appropriate application rates, and documentation of the litter/manure utilization on the farm. These plans do not have to be complicated or difficult, but like other management activities will require some time and effort. The material in this section contains budgets and record sheets for use in developing and maintaining a nutrient management plan.

A key component of a comprehensive nutrient management plan is the completion of a nutrient budget worksheet. This section contains two worksheets; (1) Crop Nitrogen Requirement Worksheet and (2) Nutrient Budget Worksheet. The Crop Nitrogen Requirement Worksheet can be used when the primary concern is controlling nitrogen application. The Nutrient Budget Worksheet can be used when a complete budget including nitrogen, phosphorus, or potassium are considered to be necessary.

Example: Calculations of nutrient application rates are included in the two budgets. Completing these worksheets will indicate whether the amount of nutrients in the manure or litter to be applied is appropriate for the acres of land available. If the nutrients are less than needed, supplemental commercial fertilizers may be required to promote ideal crop or pasture yields. If the nutrients are more than that required by the crop or pasture, only an appropriate portion of the litter or manure should be spread. In this case, additional land will need to be found for application of the remainder.

A nutrient management plan needs to account for all locations that litter or manure is being applied. This does not mean that all of the litter or manure must be applied on the poultry growers property. The litter can be spread on other land not owned by the poultry producer. Poultry litter/manure removed from the farm should be documented by the owner. The Poultry Manure Utilization Record and the Litter/Manure Removal Record contained in this section can be used to document this information.

ESTIMATING ANNUAL FARM MANURE PRODUCTION

Broilers

a. Numbers of broilers produced (total annual) ______
b. Pounds of manure per broiler 2.5
c. Total pounds of manure (a x b = c) ______
d. Tons of manure (c ÷ 2000) ______
e. Pounds of Nitrogen (d x *) ______
f. Pounds of Phosphorus (d x *) ______

Breeders

a. Number of breeders ______
b. Pounds of manure per breeder 44
c. Total pounds of manure (a x b = c) ______
d. Tons of manure (c ÷ 2000) ______
e. Pounds of Nitrogen ______
f. Pounds of Phosphorus (d x *) ______

Pullets

a. Number of pullets (total annual) ______
b. Pounds of manure per pullet 8.0
c. Total pounds of manure (a x b = c) ______
d. Tons of manure (c ÷ 2000) ______
e. Pounds of Nitrogen (d x *) ______
f. Pounds of Phosphorus (d x *) ______

Commercial Layers (Dry Manure)

a. Number of layers ______
b. Pounds of manure per layer 40
c. Total pounds of manure (a x b = c) ______
d. Tons of manure (c ÷ 2000) ______
e. Pounds of Nitrogen (d x *) ______
f. Pounds of Phosphorus (d x *) ______

*To calculate pounds of plant nutrient per ton multiply the percent of each nutrient by 20

Example problem:

3.5 percent nitrogen x 20 = 70 pounds per ton
150 tons of litter x 70 pounds per ton = 10,500 pounds Nitrogen

DETERMINING POUNDS OF NUTRIENTS IN LAGOON WATER

To determine the pounds of plant nutrients (N, P, K) from lagoon water that is applied to the land two types of data are required;

- The volume in gallons of lagoon water applied
- The concentration of nutrients measured in parts per million (ppm). Laboratory analyses are also reported in milligrams per liter (mgL). This number can be used interchangeably as they are the same unit of measurement.

When these two data are determined, the following equation can be used to calculate pounds to be applied.

$$\frac{\text{gallons of water to be applied}}{1{,}000{,}000} \times 8.34 \times \text{analysis in ppm} = \text{pounds}$$

Determining volume to be applied

1. Volume of lagoon
   To determine the volume of a lagoon:
   Measure the surface area in acres and determine how much the lagoon will be drawn down. One acre foot of water contains 325,830 gallons of water.

   Example problem:
   Your lagoon has two acres of surface and you want to pump it down two feet.
   2 acres x 2 foot pump down x 325,830 gallons/acre foot = 1,303,300 gallons

   $$\frac{1{,}303{,}300}{1{,}000{,}000} \times 8.34 \times 1{,}000 \text{ ppm nitrogen} = 10{,}875 \text{ pounds of nitrogen}$$

   A meter on the pump or pump run time (gallons per minute x minutes pumped) can also be used to determine volume.

Sampling the lagoon

A representative sample of the lagoon water should be collected at several places in the lagoon at the approximate depth of the pump inlet. These samples should be mixed and a one quart sample collected for laboratory analysis.

Laboratory reports

Analysis of lagoon water for nitrogen (N), phosphorus (P) and potassium (K) will be reported in ppm (mgL).

Nitrogen is reported directly, however, phosphorus must be converted to P_20_5 and potassium to K_20. This is the way fertilizer valves are expressed. To convert phosphorus (P) to P_20_5, multiply the P value by 2.30. To convert K to K_20, multiply K by 1.30.

Poultry Waste

Georgia's 50 Million Dollar Forgotten Crop

COOPERATIVE EXTENSION SERVICE ✦ THE UNIVERSITY OF GEORGIA
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES ✦ ATHENS

Prepared by Larry Vest and Bill Merka, Extension Poultry Scientists and William I. Segars, Professor of Crop and Soil Science

INTRODUCTION

The value of manure as a source of plant nutrients has been recognized for centuries. Poultry manure contains all essential nutrients required for crop production. In spite of its beneficial effects on plant growth, manure constitutes only a small percentage of nutrients applied to cropland when compared to commercial fertilizer.

There are several reasons why poultry manure is not used to its fullest potential. Among these are: (a) lack of information on the value of manure as a source of plant nutrients; (b) failure to recognize how and where to utilize it; and (c) lack of recognition of its economic value.

QUANTITY OF POULTRY WASTE GENERATED

This publication summarizes the information presently available which promotes the better use of this by-product of the poultry industry.

Growth of Georgia's poultry industry has produced large quantities of poultry manure and used litter. In 1994, Georgia's poultry population was estimated at 1 billion broilers; 12 million commercial laying hens; 13.4 million broiler breeder hens; 12 million replacement pullets (both light and heavy). These birds produced a valuable by-product, poultry manure, with a potential gross value of over 50 million dollars.

For each pound of feed consumed, a chicken will produce approximately 1 pound of fresh manure with a moisture content of about 75 percent. Once voided from the bird, the manure will rapidly loose water until the final product has a moisture content of 20 to 40 percent. The final moisture content will vary depending on type and quantity of bedding, bird concentration, watering equipment and ventilation system.

Good estimates of annual manure production are: 2.5 pounds of manure per broiler, 40 pounds per commercial layer, 44 pounds per broiler breeder, and 8 pounds per replacement pullet.

Table 2. Average Nutrient Composition of Layer Manures

Manure Type	Total N	Ammonium NH_4-N	Phosphorus P_20_5	Potassium K_20
	lb/ton			
Undercage scraped[1]	28	14	31	20
Highrise stored[2]	38	18	56	30
	lb/1,000 gallons			
Liquid slurry[3]	62	42	59	37
Anaerobic lagoon sludge	26	8	92	13
	lb/acre-inch			
Anaerobic lagoon liquid	179	154	46	266

[1]Manure collected within two days. [2]Annual manure accumulation.
[3]Six-1 2 months' accumulation of manure, excess water usage, and storage surface rainfall surplus; does not include fresh water for flushing.

Source: Biological and Agricultural Engineering Department, NCSU.

Table 3. Average Secondary and Micronutrient Content of Poultry Manures

Manure Type	Ca	Mg	S	Fe	Mn	Zn	Cu	B
	lb/ton							
Layer								
Undercage scraped	43	6	7	0.5	0.3	.3	Trace	Trace
Highrise stored	86	6	9	1.8	0.5	.4	Trace	Trace
Broiler Litter								
Broiler house	43	9	15	3.8	0.8	.6	.4	Trace
Roaster house	47	10	14	4.0	0.8	.7	.6	Trace
Breeder house	120	11	8	9.4	1.6	1.0	.4	Trace
Stockpiled	54	10	12	3.9	0.8	.7	.6	Trace
	lb/1,000 gallons							
Layer								
Liquid slurry	35	7	8	2.9	0.4	0.43	0.080	Trace
Lagoon sludge	71	7	12	2.2	2.3	0.80	0.14	Trace

phosphorus and nitrogen needs of the crops as possible. Use commercial fertilizer to furnish other nutrients to the levels needed as indicated by soil tests.

Ammonia production begins upon adding manure to a warm, moist soil. Maximum levels of ammonia occur during the first two weeks. Nitrate production usually is slow during the first week and gradually increases until about the fourth week when it reaches a maximum rate of production; maximum levels of nitrate usually occur at this time if no leaching has occurred. Research shows that 30 to 60 percent of the total nitrogen comes available during the first six weeks, depending upon the nitrogen content of the manure and the form in which it is present. The ratio of carbon to nitrogen is also important. High carbon litters such as sawdust may materially retard nitrate accumulations. The remaining nitrogen will be released very slowly during the process of decomposition of the organic residues. This release may require considerably more than one season.

A study of the rate at which carbon dioxide is evolved from manure mixed with soil also confirms that most of the microbial activity probably occurs during the first two weeks. During this period of time take care to prevent damage to plants either by an under or over supply of nitrogen. With poultry manure, it is usually the latter. Occasionally some poultry manures contain so little nitrogen that decomposition of the manure uses nitrogen present in the soil.

Phosphorus, except for small quantities in the urates, is in the organic form in chicken manure. Availability of phosphorus, therefore, is directly related to the rate at which the manure decomposes. This element becomes available much slower than nitrogen because it's easily bound by elements in the soil. Most potassium in living tissue is believed to be in ionic form and is moderately retained. Upon death of the cell, the potassium is no longer retained and is easily leached from the tissue. Potassium in chicken manure is present as an inorganic salt in the excretions from the kidneys and in the living and dead cellular material in the feces. All forms of potassium in manure are quite readily available to plants in most cases, but may be rapidly lost by leaching.

Many other elements are present in chicken manure in very small quantities (Table 3). Little is known concerning the rate of release of these elements, but essentially all become available in the course of decomposition.

Table 6. Maximum Yearly Broiler Litter Application Rates

Crop	Maximum Application Rates		Time of Applications	Buffer Zone[1] ≤ 8% slope	> 8% slope
	Yearly Total	Single Application			
	tons/acre			feet	
Forages					
Bahia, Bermuda & dallis grass pasture	6	4	Spring - Summer	50	100
Fescue & orchardgrass pasture	5	4	Fall & Spring	50	100
Bermuda & Bahia hay	4/cutting	4	Spring - Summer	50	100
Cool season annual grass	6	4	Fall & Spring	50	100
Cool season annual grass with legume	3[2]	3	Fall	50	100
Warm season annual grass	5[2]	4	Spring - Summer	50	100
Row Crops[3]					
Corn, grain	6.5[2]	4	Fall - Spring	25	--
Corn, silage	8[2]	4	Fall - Spring	25	--
Cotton	3[2]	3	Fall - Spring	25	--
Grain sorghum & sweet sorghum	4[2]	4	Fall - Spring	25	--
Sorghum silage	8[2]	4	Fall - Spring	25	--

[1] Buffer zone is vegetation (grass, trees, or wetland) required between spreading area and intermittent or permanent stream or pond.
[2] Decrease the total application rate by 25 percent if incorporated immediately after application.
[3] Maximum application rates should not be applied on cropland with greater than 8 percent slope.

For recommendations, contact your local SCS or Extension office.

Table 7. Nitrogen Fertilization Guidelines

Commodity	lb N/RYE[1]
Corn (grain)	1.0 - 1.25 lb N/bu
Corn (silage)	10 - 20 lb N/ton
Cotton	0.06 - 0.12 lb N/lb lint
Sorghum (grain)	2.0 - 2.5 lb N/cwt
Wheat (grain)	1.7 - 2.4 lb N/bu
Rye (grain)	1.7 - 2.4 lb N/bu
Barley (grain)	1.4 - 1.6 lb N/bu
Triticale (grain)	1.4 - 1.6 lb N/bu
Oats	1.0 - 1.3 lb N/bu
Bermudagrass (hay[2, 3])	40 - 50 lb N/dry ton
Tall fescue (hay[2, 3])	40 - 50 lb N/dry ton
Orchardgrass (hay[2, 3])	40 - 50 lb N/dry ton
Small grain (hay[2,3])	50 - 60 lb N/dry ton
Sorghum-sudangrass (hay[2, 3])	45 -55 lb N/dry ton
Millet (hay[2, 3])	45 - 55 lb N/dry ton
Pine and hardwood trees[4]	40 - 60 lb N/acre/year
Peanuts and soybeans[5]	0

[1] RYE = Realistic Yield Expectation
[2] Annual maintenance guidelines
[3] Reduce N rate by 25 percent when grazing
[4] On trees less than 5 feet tall, N will stimulate undergrowth competition
[5] Not recommended for peanuts and soybeans

Table 8 Land requirement for manure nitrogen.

A. Available Manure Nitrogen (Generated on entire farm) = ________lbs. N

B. Field ID	C. Acres	D. Crop	E. Yield Units	F. Crop N Requirement[1]	G. N Credits[2]	H. Manure-N Requirement (= F - G)	H. Manure-N Use by Field (= C X H)	Remaining Manure N (A – I)[3]
Example	*160*	*Corn*	*170 Lb./bu.*	*150 lb./acre*	*30 lb./acre*	*120 lb./acre*	*19,200 lbs.*	
				lb. acre	lb. acre	lb. acre		
				lb. acre	lb. acre	lb. acre		
				lb. acre	lb. acre	lb. acre		
				lb. acre	lb. acre	lb. acre		
				lb. acre	lb. acre	lb. acre		
				lb. acre	lb. acre	lb. acre		
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				lb. acre	lb. acre	lb. acre		
				lb. acre	lb. acre	lb. acre		
				lb. acre	lb. acre	lb. acre		

1. Crop Nitrogen Requirements should be based upon historical soil tests and/or recommendations. If this information is not available, crop nitrogen removal rates is an alternative. For the corn example, Crop N Removal equals 170 bu./ac. times 0.9 lb. N /acre or 153 lbs. of N/acre.
2. Nitrogen credits should include commercial fertilizer use, legume credit, or residual soil nitrogen credit (if not already discounted by soil test recommendation).
3. Remaining Manure Nitrogen must be is calculated for the first field by subtracting "Manure-N Use by Field" from "Available Manure Nitrogen." For all remaining fields, it is calculated by subtracting "Manure-N Use by Field" from the "Manure Nitrogen Remaining" results of the previous field.

Table 10 Land requirement for anaerobic lagoon sludge phosphorus.

Available Sludge Phosphorus (Total Production for Clean out period) =________Lbs. P

B. Field ID[1]	C. Acres	D. Crop	E. Yield Units	F. Crop P Requirement[2]	G. Years of Crop P Needs to be Supplied[3]	H. Sludge-P Use by Field (= C X F X G)	Remaining Sludge-P (A – H)[4]
Example	*160*	*Corn*	*170 Lb./bu.*	*61 lb./acre*	*0 lb./acre*	*9,760 lbs.*	
				lb./acre	lb./Acre		
				lb./acre	lb./Acre		
				lb./acre	lb./Acre		
				lb./acre	lb./Acre		
				lb./acre	lb./Acre		
				lb./acre	lb./Acre		
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				lb./acre	lb./Acre		
				lb./acre	lb./Acre		
				lb./acre	lb./Acre		
				lb./acre	lb./Acre		

1. Fields not receiving regular manure applications should be selected for sludge application.
2. Crop Phosphorus Requirements may be based upon historical soil tests and/or recommendations or crop phosphorus removal rates (select larger value). For the corn example, Crop P Removal equals 170 bu./ac. times 0.36 lb. N/acre or 61 lbs. of N/acre.
3. If soil phosphorus levels are near or below agronomic rates, it may be desirable to build soil phosphorus levels by applying sufficient phosphorus to supply several years crop needs.
4. Remaining Manure Phosphorus must be is calculated for the first field by subtracting "Sludge-P Use by Field" from "Available Sludge Phosphorus." For all remaining fields, it is calculated by subtracting "Sludge-P Use by Field" from the "Sludge-P Remaining" results of the previous field.

Field # ______________

CROP NITROGEN REQUIREMENT WORKSHEET

	Example	Your Farm
1. Crop to be grown	Corn	
2. Crop yield expectations from farm records or NRCS standards	140 bu/acre	
3. Nitrogen guidelines per unit of yield (Table 7)	1.0 lb/bu	
4. Crop nitrogen requirement (2 x 3)	140 lb/acre	
5. Starter fertilizer nitrogen or previous legume nitrogen	10 lb/acre	
6. Commercial fertilizer nitrogen added	0 lb/acre	
7. Crop nitrogen need from poultry manure (4 minus 5 and 6)	130 lb/acre	
8. Poultry manure plant available nitrogen		
a. Nitrogen composition of poultry manure from farm average or state average (Table 1, UGA publication)	66 lb/ton	
b. Nitrogen availability coefficient (Table 5, UGA publication)	0.7	
c. Plant-available nitrogen (a x b)	46.2 lb/ton	
9. Poultry manure application rate (7 ÷ 8 c)	2.8 ton/acre	
10. Acres of crop to be grown	100 acres	
11. Total poultry manure required (9 x 10)	280 tons	

NUTRIENT BUDGET WORKSHEET

1. Producer Farmer Jones 2. County Clarke 3. Date 7-23-98
4. Farm # 1 5. Tract # A 6. Field # 1 7. Acres 100
8. Soil Series Cecil 9. Leaching Potential Low
10. Tillage Practices Conventional
11. Planned Crop Corn 12. Yield Expectations 140 bu/acres
13. Soil Test Rating: (a) P 23 Med (b) K 120 Med (c) pH 6.2
14. Nutrients recommended (lbs/ac): (a) N 140 (Table 6); (b) P_2O_5 50-soil test ; (c) K_2O 50-soil test
15. Lbs/ac starter fertilizer used: (a) N 10 ; (b) P_2O_5______ ; (c) K_2O______
16. Residual nitrogen credit from legumes (see back) 0 lbs/ac
17. Net N needs of crop (14a minus 15a and 16) 140 - 10 = 130 lbs/ac
18. Net P_2O_5 needs of crop (14b minus 15b) 50 lbs/ac
19. Net K_2O needs of crop (14c minus 15c) 50 lbs/ac
20. Type of manure High rise layer manure
21. Manure nutrient content:
    (a) N 38 72 (lbs/ton) (lbs/ac-in)
    (b) P_2O_5 56 60 (lbs/ton) (lbs/ac-in)
    (c) K_2O 30 40 (lbs/ton) (lbs/ac-in)
22. Manure application method (see back) Broadcast
23. Nutrients in manure available to crop: (21a, b & c multiplied times the availability coefficient)(see back)
    (a) Available N 38 x 0.5 = 19 (lbs/ton) (lbs/ac-in)
    (b) Available P_2O_5 56 x 0.8 = 45 (lbs/ton) (lbs/ac-in)
    (c) AvailableK_2O 30 x 1.0 = 30 (lbs/ton) (lbs/ac-in)
24. Manure application rate to supply the priority nutrient:
    (a) Priority nutrient Nitrogen
    (b) Amount of priority nutrient needed (17, 18 or 19) 130 lbs/ac
    (c) Rate of manure needed (24b divided by 23a, 23b, or 23c) 6.8 (tons/ac) (in/ac)
25. Pounds per acre of available nutrients supplied at the manure application rate needed to supply the priority nutrient:
    (a) N 19 x 6.8 = 129.2 lb/ac
    (23a) (24c) (tons/ac or in/ac)
    (b) P_2O_5 45 x 6.8 = 306 lb/ac
    (23b) (24c) (tons/ac or in/ac)
    (c) K_2O 30 x 6.8 = 204 lb/ac
    (23c) (24c) (tons/ac or in/ac)
26. Nutrient balance: (Net nutrient need (-) or excess (+) after the application of manure at the calculated rate)
    (a) N balance 129.2 x 130 = 0 lb/ac
    (25a) (17)
    (b) P_2O_5 balance 306 x 50 = 256 lb/ac
    (25b) (18)
    (c) K_2O balance 204 x 50 = 154 lb/ac
27. Completed by Bruce Webster Title Extension Poultry Scientist
    Agency The University of Georgia Cooperative Extension Service

LITTER/MANURE REMOVAL RECORD

Farm Location ______________________________

Farm Owner ______________________________

Litter/Manure Type Produced ______________________________

Date Removed	Amount Removed (tons)	Name of Removal Agent	Phone #

Litter Application Field Record
For Recording Litter Application Events on Different Fields

Farm Owner

Spreader Operator

Tract #	Field #	Date (mm.dd.yr)	Crop Type	Field Size (acres)	Application Method[1]	# of Loads Per Field	Volume of Loads[2] (tons)

---

[1] SI=soil incorporated (disked); BR = broadcast (surface applied)

[2] Can be found in operator's manual for the spreader. Contact your local dealer if you do not have an owner's manual.

POULTRY MANURE UTILIZATION RECORD

Date of Clean Out	Total Removed (tons)	Spread on Farm (tons)	Other use (tons)	Removed From Farm (tons)	Temporary Storage (tons)

Structures for Broiler Litter Manure Storage

William Merka and Michael Lacy
Department of Poultry Science
The University of Georgia, Athens

Common procedures for managing broiler litter manure after removal from the broiler house result in losses of valuable fertilizer nutrients that have the potential of contaminating ground and surface waters. Stockpiling manure uncovered on the soil for the winter season before application on cropland can result in a fivefold reduction of nitrogen in the manure. In addition, the nitrogen lost from the manure can be carried by water to surface streams or ditches and into the ground water. The nitrogen lost represents a loss of farm income because the manure nitrogen can be used to replace purchased fertilizer nitrogen.

Why Is Storage Necessary?

The cleaning period of a broiler house depends on the schedule of the broiler flocks. This does not always coincide with the availability of open cropland or the proper soil moisture conditions that allow distribution of the manure. Storage must be provided to hold the manure until the proper application time. This will allow the most beneficial use of the manure nutrients on cropland.

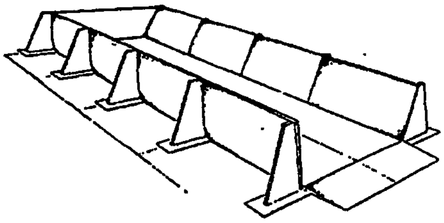
Can Management Reduce the Storage of Manure?

Proper management of the litter in the broiler house can reduce the need to remove manure between flocks. It can also provide for a cleanout schedule that allows direct application of manure to cropland without intermediate storage. Direct field application will allow the most efficient utilization of the manure nitrogen by avoiding potential losses and reducing handling costs.

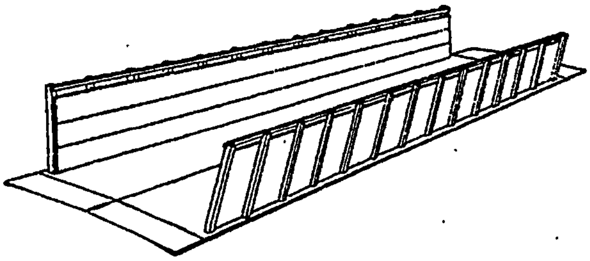
A primary management objective should be to operate bird watering systems to minimize water accumulation in the litter.

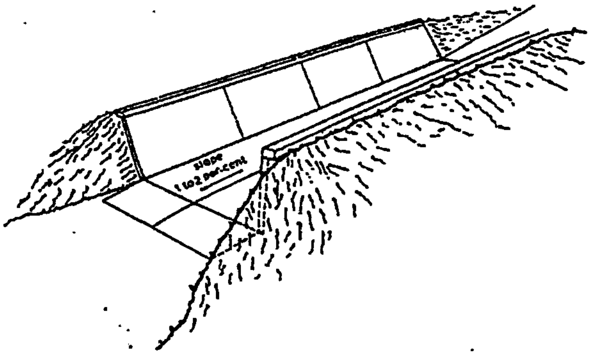
Dollars spent on water and ventilation system management provide economic and environmental returns to all phases of bird and manure management.

Stockpiles With Permanent Ground Liners
If you desire a permanent location for manure storage, a concrete slab can be constructed on which you can place a covered stockpile. Using concrete removes the problems associated with using a plastic liner. The concrete should be 6 inches thick, reinforced with wire mesh and placed on 6 inches of compact gravel. To prevent concrete failure, thicken the perimeter of the concrete to form a footer where traffic enters and exits. Grade the site to achieve maximum underdrainage. An improved gravel roadway will allow stockpile construction during poor soil conditions. Construct the stockpile as described previously. Anchor the cover sheet edges with wood poles, concrete blocks or other heavy objects on the concrete slab.



Bunker-Type Storage Structures
Bunkers are permanent above ground concrete slabs with two parallel walls of concrete identical to those used for storing silage on livestock farms. A bunker allows deeper piling and compaction of manure to reduce the total area required of the manure storage. An end wall can be constructed to slightly increase the storage capacity. However, loading the structure is more easily accomplished without an end wall. A cover of plastic sheeting can be attached to the walls with batten strips and anchored with tires. You can use a more permanent cover of fiberglass reinforced fabric with edge anchorage eyelets similar to that used for truck covers. With careful use, storage, and repair the reinforced fabric cover will last many years.





A Simplified Method of Determining Application Rates for a Manure Spreader by Measuring the Distance the Spreader Truck Travels

Collecting and weighing the amount of litter spread on tarps is the preferred method of calibrating a manure spreader. Another method is to measure the distance traveled to spread one load. Two types of information are needed to use this method:

1. The capacity of the spreader
2. The swath width of the spreader.

These two specifications can be gotten from the manufacturer.

The following example uses litter spreader specifications of a Georgia company that makes litter spreaders for the poultry industry.

Specifications

- A spreader bed holds 20 cubic feet of litter per one foot of bed length
- Litter weighs about 30 pounds per cubic foot
- The litter swath width of the spreader is 40 feet
- The most common spreader unit used in Georgia has a 16 foot long bed, therefore, a 16 foot long bed will hold 9600 pounds of 30 pounds per cubic foot litter.

(20 cubic feet per foot of bed x 30 pounds per cubic foot x 16 foot long bed = 9600 pounds)

If the swath width is 40 feet, the spreader truck will cover one acre for each 1089 feet it travels. Use 1100 feet per acre for round numbers.

Distance/Spreader Truck Traveled		Tons per Acre
Feet	Miles	
1100	0.20	5
1360	0.25	4
1800	0.35	3
2700	0.50	2
5400	1.00	1

To determine the application rate, use the odometer to measure the distance traveled to put out one load. In this example, five tons per acre was applied when the truck put out one load as it traveled 1100 feet.

The University of Georgia College of Agricultural & Environmental Sciences
Cooperative Extension Service

Calibration of Manure Spreader Including Swath Width

Cecil Hammond, former Extension Engineer; Charles Gould, Special Agent; Wayne Adkins, Extension Engineer

Contents

Manure spreaders similiar to dry fertilizer spreader trucks, can be calibrated correctly when a swath width is determined along with spread pattern evaluation and application rate on "as spread" basis. This procedure helps ensure good nutrient management and utilization of waste as well as protect the environment if buffer zones and vegetative covers are properly used. Manure storage in stack houses for timely application to the land also improves environmental aspects.

Calibrating a manure spreader is a simple, easy management tool that can help the farmer use nutrients from animal waste more efficiently. The procedure takes less than an hour but can save hundreds of dollars. By knowing the application rate of the manure spreader, correct amounts of manure can be applied to meet the crop needs. Over-application of manure wastes nutrients and increases the chance of ground water contamination. Using manure wisely is important for the farmers' crops and for their pocketbooks.

There are two parts to "calibrating" a manure spreader: determining the application rate and determining the spreader swath width. The following procedures work best for solid or semi-solid animal waste including broiler litter, horse and cow manure.

Materials Needed

- Large plastic bucket (five gallon bucket)
- Plastic tarps (5-10' x 10')
- Tent stakes or large nails (20)
- Scale
- 100' tape measure
- Broom
- Small flag or colored rag
- *Soil, Crop, Fertilizer and Chemical Recordbook* (UGA Publication Agronomy 2-2)
- Calculator

Determining the Spreader Swath Width

1. Weigh individual tarps and bucket.
2. Lay the tarps out in a line perpendicular to the travel of the spreader. Fasten the tarp at each corner, eyelet on eyelet, with a tent stake or long nail through eyelets.

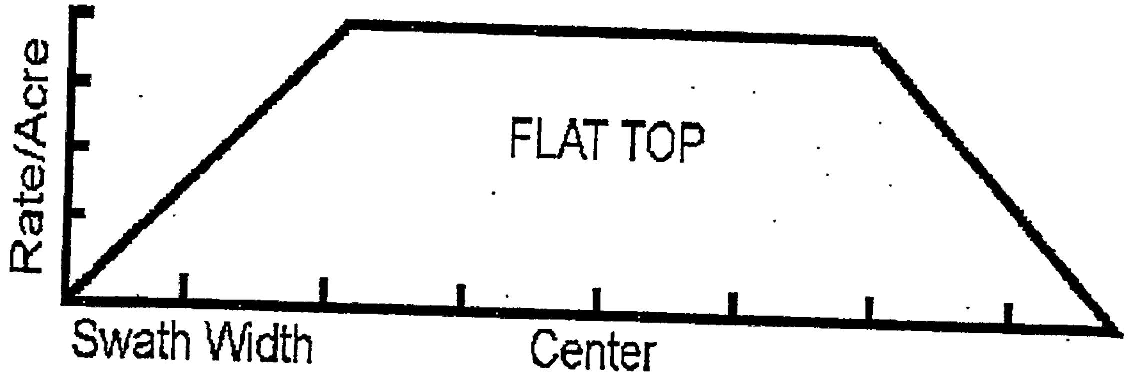
Determining the Manure Application Rate

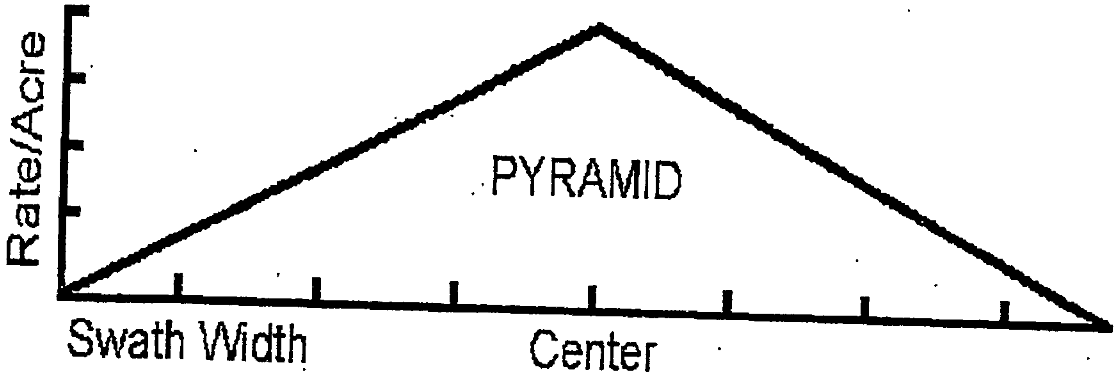
Spreader Size (Bushels)	Tons of Manure
70-75	1.5
90-100	2.0
125-135	2.5
180	3.0

1. Determine manure spreader capacity.
2. After determining the swath width, lay tarps and flag or rag back as outlined in Steps 2 and 3 previously mentioned.
3. Drive the spreader centered over the tarps, plus over each side using the proper swath width, at the speed normally driven when applying manure on the field. Make sure speed and application rate are under steady state conditions.
4. Carefully pull up a tarp and weigh it. If Step 3 is followed carefully, the weight per square foot of each tarp should be the same.
5. Check Chart 1 on Manure Application Rate for pounds applied and size of tarp, then read tons of manure applied per acre if you have tarps sized for the chart.
6. If the size of your tarp is not listed, use the following equation to determine the amount of manure applied per acre: (Pounds of manure on the sheet *21.79) divided by (Area of the sheet in square feet) = Tons per acre.
7. Record the tons per acre applied in the *Soil, Crop, Fertilizer and Chemical Recordbook* available at your County Extension office. Soon, possibly by the next Farm Bill, documentation of manure application rates will be required.
8. Sweep the tarps to get off any sticky or dry manure before folding.

Chart 1. Manure Application Rate

Pounds of Manure Applied to Sheet	Size of Plastic Sheet		
	8' x 8'	10' x 10'	10' x 12'
	Tons Manure Applied/Acre		
1	0.34	0.22	0.18
2	0.68	0.44	0.36
3	1.02	0.65	0.54
4	1.36	0.87	0.73
5	1.70	1.09	0.91
6	2.04	1.31	1.09
7	2.38	1.52	1.27
8	2.72	1.74	1.45
9	3.06	1.96	1.63


Rate/Acre
FLAT TOP
Swath Width
Center


Rate/Acre
PYRAMID
Swath Width
Center

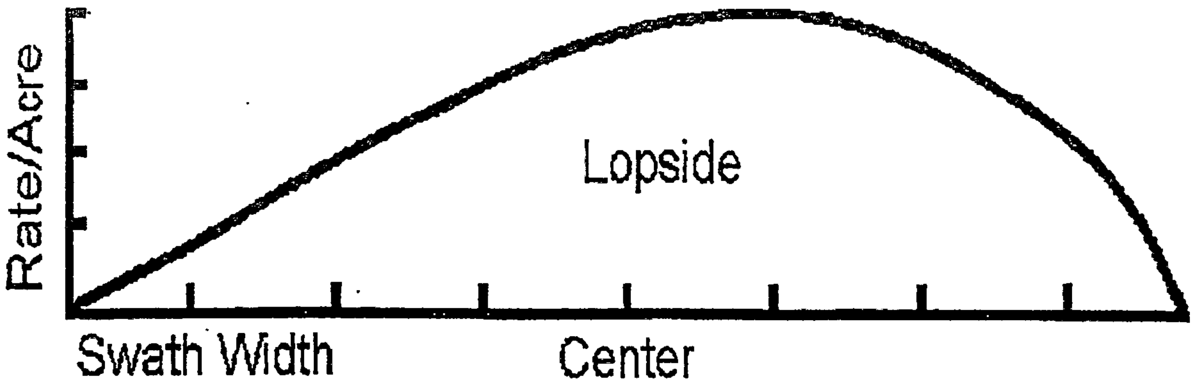


Figure 3. Unacceptable spread patterns.

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Gale A. Buchanan, Dean and Director

Land Application and Calibration

Mark Risse and Kerry Harrison

This lesson and the material in it are adapted from the National Animal and Poultry Waste Management Curriculum Lessons 7 and 10 by Ron Sheffield of North Carolina State University

Intended Outcomes

The participant will

- Identify appropriate land application BMPs for their farm
- Identify appropriate land application system(s) for their farm
- Identify activities related to timing of applications that may lead to higher environmental risk
- Understand the importance of equipment calibration
- Become familiar with the procedures to calibrate various pieces of application equipment

Selecting and Managing Land Application Sites

The importance of selecting the best site to apply manure cannot be over emphasized. Site selection is one of the major factors that directly affect the success of your operation. Spend the time up front selecting the best sites so that future, potentially expensive environmental problems and adverse public relations can be avoided. Even though the site may look good initially, its use may result in problems that could easily have been avoided by choosing another site. The earlier section on maps presented some considerations and details but a few good rules to remember in selecting application sites are as follows:

1. Find a site that is as isolated as possible. Buffer restrictions can significantly reduce available land. Buffers are designed to minimize the potential for impacts to adjacent homeowners as well as impacts to the environment. It is also crucial to consider the direction of the prevailing wind in relation to the site and residential development in the area.
2. Find a site that is not too steep. The flatter the land, the lower the potential for runoff. In addition, flatter slopes generally have better soils and make the maintenance of a cover crop easier.
3. Find a site that is as far away from surface water as possible. This minimizes impacts should some of the wastewater be washed off the site. This extra buffer can be very important.
4. Find a site that has as deep a seasonal groundwater table as possible. This can reduce the risk of potential groundwater contamination.
5. Find a site that has good separation from bedrock. Areas where bedrock is close to the land surface make poor wastewater application sites. Cracks in the rocks can make direct channels for the wastewater constituents to be transported to the groundwater.
6. Find a site where the soils are suitable for the intended crops to be grown.
7. Find a site where soils that are not too sandy. The clays and organic matter in soils help hold the nutrients and metals found in the wastewater, thereby preventing their movement to the groundwater and maximizing potential for plant uptake.

Obviously, the chances of finding the perfect site may not be easy and in some areas of the state may be difficult or impossible. But as stated earlier, every effort to find this perfect site, or one as close as possible, will definitely be worthwhile.

Since the dawn of agriculture, man has known that longer and steeper slopes produce more soil erosion and has used methods such as the construction of levies and terraces to reduce slope length and steepness. More recently, practices such as strip cropping and vegetated waterway construction have been used to reduce runoff velocities and slope length. Crop canopy and surface cover or residue acts as a buffer between the soil surface and the raindrops, absorbing much of the rainfall energy and ultimately reducing soil erosion. Therefore, crops that produce more vegetative cover, have longer growing seasons, or produce a persistent residue will have less soil erosion. Any cropping system with less tillage or greater amounts of vegetative production, such as perennial systems, will result is less sediment leaving the field.

While most BMP's reduce soil erosion and transport, some BMP's use other mechanisms to reduce the impact of a pollutant. There are three stages to the pollutant delivery process: availability, detachment, and transport. BMP's may be effective by addressing any of these three factors. Availability is a measure of how much of a substance in the environment can become a pollutant. For example, an effective BMP for reducing the amount of animal waste entering surface water may be to simply decrease the amount that you are land applying to an area so that less is available. Once a substance is available; however, it must be detached from the target site to become a pollutant. Pollutants may be detached as individual particles in the water or attached to soil particles. If a pollutant is soluble, then detachment occurs when it is dissolved in water. For example, dry manures applied to the surface are more easily detached than the same amount of liquid manure that has soaked into the soil. Transport is the final link in the pollutant delivery chain. To become a pollutant, the element must travel from the point where it was applied to the surface or ground water. Pollutants are often transported by surface runoff or infiltration, however, this transport can often be reduced through BMP's. For example, using a filter strip to collect sediment before entering a stream is an example of reducing the amount of pollutant transport.

BMPs, when properly carried out, improve water quality. Generally, an animal operation will have a combination of several BMPs. Best management practices relating to manure management are those practices that optimize nutrient uptake by plants and minimize nutrient impact on the environment. They will change over time as technology and understanding of the complex environment improve. Likewise, BMPs are very site specific, and a BMP in one place may not be useful for another location. Key BMPs for land application systems include:

- Soil, manure, and plant sampling
- Nutrient management plan
- Manure injection
- Critical area plantings
- Water diversions
- Riparian buffers
- Buffer filter strips
- Winter "scavenger" crops
- Grassed waterways
- Calibrated application equipment

BMPs to Reduce Nutrient Losses

Managing the amount, source, form, placement, and timing of nutrient applications are activities that will accomplish both crop production and water quality goals. This holds true for all nutrient sources including manure, organic wastes, chemical fertilizers, and crop residues.

Crop Factors

- Use on-farm yield records or NRCS soils data for determining the yield that can be expected on each field. To calculate a field's average yield, take the average of the best three yields over the past five years. Apply animal manure at rates that do not exceed the nitrogen needs for Realistic Yield Expectation (R.Y.E.) for the crop being grown. Deduct nitrogen credits for last year's legume crop from this year's fertilizer requirements.
- Use commercial fertilizer only when manure does not meet crop requirements.
  - Manure should not be applied more than 30 days prior to planting of the crop or forages breaking dormancy. A suitable cover crop should be planted to scavenge nutrients especially in sandy, leachable soils. On soils with a high potential for leaching, multiple applications at lower rates should be used.
- Incorporate manure to reduce N loss, odors, and nutrient runoff for crops where tillage is normally used.
- Harvest and remove the crop from the field it was grown in. Hay should be removed from the harvested area within one year.
- Applications of animal manure should not be made to grassed waterways. If applications are made, they should be conducted at agronomic rates and during periods of low rainfall to minimize runoff from the site.
- On manure application sites that are grazed, reduce nitrogen rate by 25% or more to account for nutrient cycling through the grazing animals.

Soil Factors

- Avoid applying manure to wet soils to reduce compaction, runoff, denitrification, and leaching.
- Evaluation of the soil analysis should consider concentration of elements to assess potential toxicity or if increased concentrations of one element (such as phosphorus) have reduced the availability of another element (such as zinc) to plants.
- Soil test should be kept for at least five years to document changes in soil quality.
- Apply manure to sandy soil near planting time to minimize nitrate leaching. Apply smaller amounts of N more often rather than a large amount at one time to minimize leaching.

Which Manure Where?

- Apply manure with the highest N content in the spring or fall; apply the lowest N manure in the summer.
- Haul the highest nutrient content manure to the furthest fields.
- Apply lowest nutrient content manure to closest fields. If possible, irrigate with collected runoff water and lagoon effluent.
- Apply the highest nutrient manure to crops with high nutrient demands.
- To avoid N leaching to groundwater, limit N applications on sandy soil and avoid soils with high water tables, tile drains or controlled drainage.
- To receive the most value from your manure, apply high-P manure to fields with the lowest soil P test levels.

Table 1 Field assessment for manure application.

CATEGORY		Field # ____ *Points*
1. Planned crop (check one)		
a. Continuous corn or corn not following legume	10	
b. Second-year corn following legume	8	
c. First-year corn following legume	1	
d. First-year corn following nonforage legume	8	
e. Nonforage legume	2	
f. Small grains (for grain)	6	
g. Small grain with seeding (removed as grain)	2	
h. Small grain with seeding (removed as hay or silage)	4	
i. Prior to direct seeding legume forage	8	
j. Topdress (good legume stand)	1	
k. Topdress (fair legume stand)	2	
l. Topdress (poor legume stand)	3	
m. Grass pasture or other nonlegumes	6	____
2. Soil test P & K (check one for each category)		
a. Phosphorus		
1. > 150 ppm	1	
2. 75–150 ppm	3	
3. 30–75 ppm	5	
4. < 30 ppm	10	
b. Potassium		
1. >200 ppm	6	
2. 100–200 ppm	8	
3. <100 ppm	10	+ ____
3. Site/soil limitations (check one for each category)		
a. Surface or groundwater proximity		
1. Applied and incorporated within 10-year floodplain or within 200 feet of surface water or groundwater access	1	
2. Application outside these restrictions	5	
b. Slope		
1. Slope > 12%	1	
2. Slope 6-12%; > 12% (incorporated, contoured, or terraced)	3	
3. Slope 2–6 %; 6-12% (incorporated, contoured, or terraced)	5	
4. Slope < 2%; <6% (incorporated, contoured, or terraced)	10	
c. Soil texture		
1. Sands, loamy sands	1	
2. Sandy loams, loams/sands, loamy sands; spring applied	3	
3. Other soils/sandy loams, loams, clays, spring applied	5	
d. Depth to bedrock		
1. 0–10 inches	0	
2. 10–20 inches	1	
3. > 20 inches	5	+ ____
4. Total Points **(higher field score = higher priority for land application)**		= ____

of manure to meet crop nutrient needs and minimize nutrient loss. Investments and planning decisions that enhance the farm's capacity to move manure or that store manure in closer proximity to application sites will enable improved timing of manure applications.

Conservation of nitrogen. The availability of nitrogen and phosphorus in manure does not meet crop needs. Typically, high soil phosphorus levels results from long-term applications of manure. The ammonium fraction, originally representing roughly half of the potentially available nitrogen, is lost by long-term open lot storage of manure, anaerobic lagoons, and surface spreading of manure. Systems that conserve ammonium nitrogen and provide nutrients more in balance with crop needs increase the economic value of manure.

Odor Nuisances. Odor nuisances are the primary driving factor of more restrictive local zoning laws for agriculture. Application systems that allow you more flexibility in application timing and location can reduce odor nuisances. Manure application systems that minimize odor deserve consideration and preference where neighbors live close to application sites.

Soil Compaction. Manure spreaders are heavy. The manure alone in a 3,000-gallon liquid manure tank weighs more than 12 tons. In addition, manure is often applied at times of the year, late fall and early spring, when high soil moisture levels and the potential for compaction are common. Impact of manure application on potential soil compaction deserves consideration.

Table 2. Environmental rating of various manure application systems.

	Uniformity of Application	Conservation of Ammonium	Odor	Compaction	Timeliness of Manure Application
Solid Systems					
Box spreader: tractor pulled	poor	very poor	fair	fair	poor
Box spreader: truck mounted	poor	very poor	fair	fair	fair
Flail-type spreader	fair	very poor	fair	fair	poor
Side-discharge spreader	fair	very poor	fair	fair	poor
Spinner Spreader	fair	very poor	fair	fair	fair
Dump truck	very poor	very poor	fair	poor	fair
Liquid Systems: Surface Spread					
Liquid tanker with splash plate	poor	poor	poor	poor	fair
Liquid tanker with drop hoses	fair	fair	good	poor	fair
Big gun irrigation system	good	very poor	very poor	excellent	excellent
Center pivot irrigation system	excellent	very poor	very poor	excellent	excellent
Liquid Systems: Incorporation					
Tanker with knife injectors	good	excellent	excellent	poor	fair
Tanker with shallow incorporation	good	excellent	excellent	poor	fair
Drag hose with shallow incorporation	good	excellent	excellent	good	good

maintain uniform and consistent application rates. Several considerations specific to solids application equipment follow:

- The operator must control application rate. Feed aprons or moving push gates, hydraulically driven or PTO powered, impact the application rate. Does the equipment allow the operator to adjust rate of application and return to the same setting with succeeding loads?
- Uniformity of manure application is critical for fertilizer applicators. Variations in application rate both perpendicular and parallel to the direction of travel are common.
- Transport speed and box or tank capacity impact timely delivery of manure. Often 50% or more of the time hauling manure is for transit between the feedlot or animal housing and field. Truck-mounted spreaders can provide substantial time savings over -pulled units for medium- and long-distance hauls. Trucks used for manure application must also be designed to travel in agriculture fields. Available four-wheel drive and duel or flotation-type tires should be considered for trucks that will apply manure. Increased box or tank capacities speed delivery. Spreaders must be selected to move and apply manure quickly.
- Ammonia losses are substantial for solid manure application that is not incorporated. Most of the ammonia nitrogen, representing between 20% and 65% of the total available nitrogen in manure, will be lost if not incorporated within a few days. Practices that allow for incorporating manure into the soil on the same day as applied will reduce ammonia losses and increase nitrogen available to crops.

Calibrating Manure Spreaders

Calibration of your spreader is a simple, effective way of improving utilization of nutrients in manure more effectively. Only by knowing the application rate of your spreader can you correctly apply manure to correspond to your crop needs and prevent water quality problems. Applicators can apply manure, bedding, and wastewater at varying rates and patterns, depending on forward travel and/or PTO speed, gear box settings, gate openings, operating pressures, spread widths, and overlaps. Calibration defines the combination of settings and travel speed needed to apply manure, bedding, or wastewater at a desired rate and to ensure uniform application.

Solid and Semisolid Manure Spreaders

To calibrate a spreader for solid manure (20% or more solids), the following materials are needed:

1. Bucket
2. Plastic sheet, tarp, or old bed sheet. An even size, 8 feet by 8 feet, 10 feet by 10 feet, or 12 feet by 12 feet, will make calculations easier.
3. Scales

Solid and semisolid spreaders are rated by the manufacturer either in bushels or cubic feet (multiply bushels by 1.25 to get cubic feet). Most spreaders have two rating capacities: (1) struck or level full and (2) heaped. Calibration of solid manure spreaders based on its capacity (volume) is difficult to estimate accurately because the density of solid and semisolid manures is quite variable. Density is the weight of the manure per volume of manure (pounds per cubic foot). Manure density varies depending on the type and amount of bedding used as well as its storage method. Therefore, if you estimate spreader application rates as the volume of the

Table 3. Calibration of solid manure spreaders.

Pounds of Manure Applied to Sheet	Tons of Manure Applied/Acre		
	Size of Ground Sheet		
	8' × 8'	10' × 10'	12' × 12'
1	0.34	0.22	0.15
2	0.68	0.44	0.30
3	1.02	0.65	0.45
4	1.36	0.87	0.61
5	1.70	1.09	0.76
6	2.04	1.31	0.91
7	2.38	1.52	1.06
8	2.72	1.74	1.21
9	3.06	1.96	1.36
10	3.40	2.18	1.51
15	5.10	3.27	2.27
20	6.81	4.36	3.03

Many times it may be necessary to adjust the rate in which waste is applied from the way it is normally spread. Changes in application rate can be accomplished by increasing or decreasing the speed at which the waste is being applied. To perform these calculations, the spreader load (tons), duration of application (minutes), and the average width (feet) of a normal application needs to be known. The application rate and travel speed can be found using the following equations:

$$\text{Application rate (tons/acre)} = \frac{\text{spreader load (tons)} \times 495}{\text{time (min)} \times \text{width (ft)} \times \text{travel speed (mph)}}$$

$$\text{Travel speed (mph)} = \frac{\text{spreader load (tons)} \times 495}{\text{time (min)} \times \text{width (ft)} \times \text{application rate (tons/acre)}}$$

Example #1:
What is the application rate (tons per acre) if you collect 8.5 pounds of manure on a 10-foot by 10-foot tarp during a calibration run?

$$\text{Application rate (tons/acre)} = \frac{8.5 \text{ lb manure} \times 21.78}{10 \text{ ft} \times 10 \text{ ft}} = 1.85 \text{ tons/acre}$$

Example #2:
What speed should you run if you wish to apply 4 tons of manure per acre with a 3-ton spreader? Your spreader application width is 20 feet, and your spreader empties in 6 minutes.

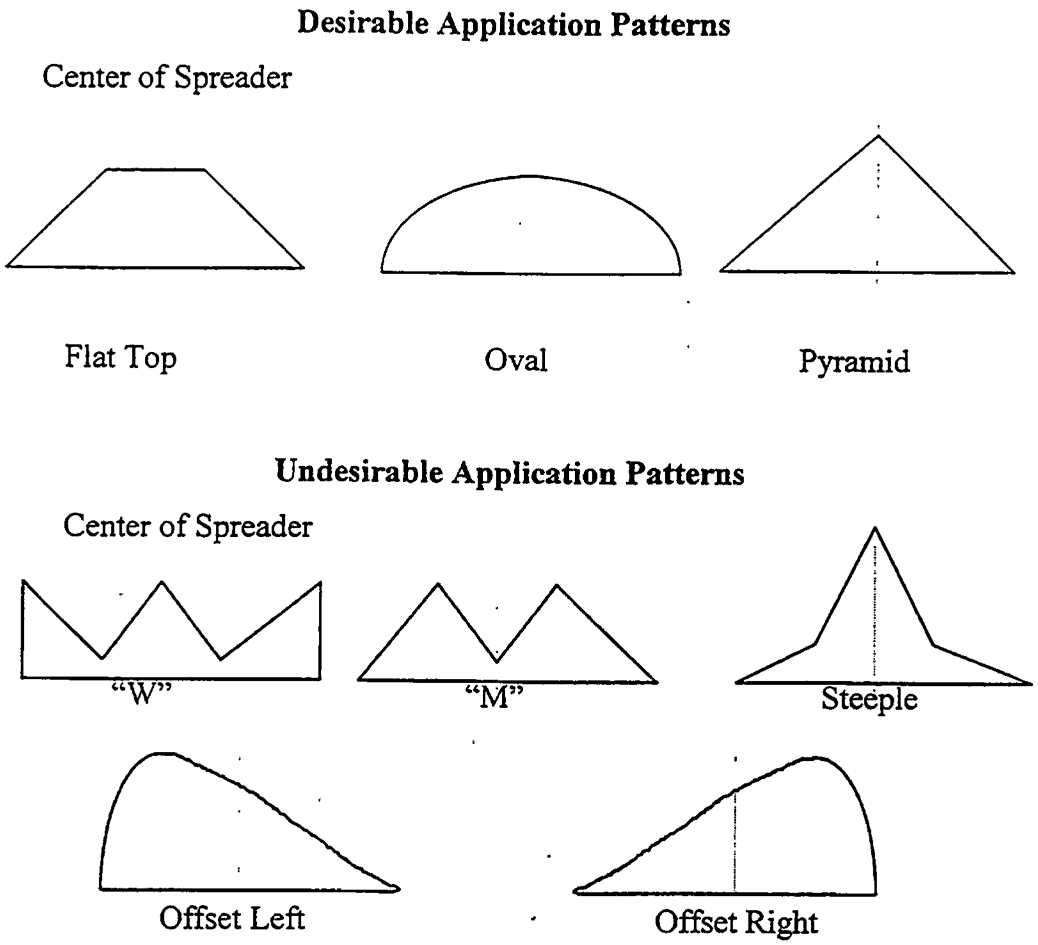

Figure 1. Desirable and undesirable application uniformity.

Hauling Liquid Manure

The standard 2,000- to 4,000-gallon tractor-pulled tanker cannot move manure fast enough for some livestock operations. In some regions, over-the-road tankers are being employed to shuttle manure from the manure storage to the edge of the field. Manure is then transferred to separate liquid application equipment or remote storage. Often, used semi-tractor milk or fuel tankers with capacities of 6,000 gallons or more are purchased for shuttle duty. Prior to implementing this approach, an individual should check licensing and inspection requirements and carrying capacity of local bridges.

Flexible Hose Systems

Pumping of liquid manure from the manure storage to the field is becoming increasingly common. Manure of up to 8% solids is being pumped several miles to a remote storage or field application equipment. Pipe friction is the primary limiting factor. Manure at solids content below 4% can be treated as water in estimating friction losses. An additional allowance for friction loss is required for pumping manure with a solids content above 4%. Manure handling systems that involve addition of significant dilution water or liquid-solids separation equipment provides a slurry that is most appropriate for this application.

Surface Broadcast of Liquid Manure

Surface application of liquid slurries provides a low-cost means of handling the manure stream from many modern confinement systems. Tank wagons equipped with splash plates are commonly used to spread a lot of manure. However, surface application suffers from several disadvantages including

- Ammonia losses. Surface application of slurries results in losses of 10% to 25% of the available nitrogen, due to ammonia volatilization (Table 4).
- Odor. Aerosol sprays produced by mixing manure and air carry odors considerable distances.
- Uniformity. Splash plates and nozzles provide poor distribution of manure nutrients.

A few recent developments attempt to address these concerns. Boom-style application units for attachment to tank wagons or towed irrigation systems are appearing commercially for the first time. These systems use nozzles or drop hoses for distributing a slurry. They offer the opportunity to reduce odor concerns and improve uniformity of distribution.

Table 4. Nitrogen losses during land application. Percent of total nitrogen lost within 4 days of application.

Application Method	Type of Waste	Nitrogen Lost, %
Broadcast	Solid	15-30
	Liquid	10-25
Broadcast with immediate incorporation	Solid	1-5
	Liquid	1-5
Knifing	Liquid	0-1
Sprinkler irrigation	Liquid	0-1

Direct Incorporation of Liquid Manure

Options for direct incorporation of liquid manure are growing (Figure 3). Injector knives have been the traditional option. Knives, often placed on 20- to 25-inch centers, cut 12- to 14-inch deep grooves in the soil into which the manure is placed. Limited mixing of the soil and manure and high power requirements are commonly reported concerns.

Injector knives with sweeps that run four to six inches below the soil surface allow manure placement in a wider band at a shallower depth. Manure is placed immediately beneath a sweep (up to 18 inches wide), improving mixing of soil and manure. Location of the manure higher in the profile minimizes potential leaching and reduces power requirements. Sweeps can be used to apply a higher rate of manure than a conventional injector knife.

Other shallow incorporation tillage implements (s-tine cultivators and concave disks) are increasingly available options on many liquid manure tank wagons. These systems are most commonly used for pre-plant application of manure. Manure is applied near the tillage tool, which immediately mixes the manure into the soil. Speed of application, low power requirements, and uniform mixing of soil and manure have contributed to the growing popularity of this approach. In addition such systems are being used to side dress manure on row crops without foliage damage. Side dressing expands the season during which manure can be applied and improves the use of manure nutrients. All soil incorporation systems also offer the advantage of ammonia conservation and minimal odors.

Example #3:
Your waste application method is a tractor-drawn tanker (honeywagon) with a 2,500-gallon capacity. You apply a load to a field and measure the application area as 22-feet wide by 280-feet long. What is the application rate in gallons per acre?

First, figure the coverage area:

$$\text{Coverage area (acres)} = \frac{280\text{ ft} \times 22\text{ ft}}{43{,}560\text{ ft}^2} = 0.14\text{ acre}$$

Then figure the application rate:

$$\text{Application rate for spreader (gal/acre)} = \frac{2{,}500\text{ gal}}{0.14\text{ acre}} = 17{,}857\text{ gal/acre}$$

Drag-Hose Injectors

This method calculates the required speed to travel when pulling a drag hose application system (Figure 4) around the field. If you are not using a flow meter, you will have to operate the system for at least one hour before you can get an accurate reading of what you have removed from the storage tank or basin.

To calculate the required speed, you need to know

- The **volume** applied per hour (in gallons per hour) from a flow meter, the manufacturer's information or the amount removed from manure storage.
- The desired application **rate**, in gallons/acre
- The **width** of application, in feet

$$\text{Speed (miles/hr)} = \frac{8.25 \text{ x Volume/hr.}}{\text{Rate x Width}}$$

Select the appropriate gear in the field tractor to match the calculated speed. If the calculated speed is too fast, you could reduce the volume applied per hour by decreasing the power to the main pump. At the same time, you may also have to reduce the nozzle (or orifice) size to keep adequate pressure in the drag hose. Another way to compensate for an excessive calculated tractor speed is to increase the width of application. This could be accomplished by using a boom-style application.

IRRIGATION

Direct irrigation of manure slurry through a large-diameter sprinkler nozzle is an alternative for farms that produce larger quantities of manure and have nearby pasture or cropland. Irrigation of liquid manure requires less labor, time, and operating expense than hauling and does not have the soil compaction problems.

Centrifugal pumps that can deliver at least 30 psi pressure at the sprinkler nozzle are needed for irrigation. In addition, due to the high solids content of the slurry, a lift pump or chopper-agitator pump is needed to help the centrifugal pump maintain its prime. Internal pump chopper mechanisms can help avoid clogging. Slurries with more than 4% solids cause higher friction losses in the pipes, requiring more pump pressure and horsepower. It is essential that the irrigation lines be flushed with clean water after slurry pumping. With proper management, slurry manure up to 7% total solids can be irrigated.

Over application of nutrients is a concern with slurry irrigation systems. Moving sprinklers frequently helps to avoid this. Thus, traveling irrigators are usually recommended. A properly designed irrigation system provides uniform wastewater application at agronomic rates without direct runoff from the site. However, a "good design" does not guarantee proper land application. Management is also critical. You should be familiar with the system components, range of operating conditions, and maintenance procedures and schedules to keep your system in proper operating condition.

Types of Systems

As with water irrigation, there is no one system that is superior over another system. The following systems can be used for effluent irrigation:

- Stationary volume gun
- Solid set sprinkler
- Traveler
- Center pivot and linear move systems
- Hand-move sprinkler
- Side roll
- Furrow/Flood irrigation

Each of these systems are described in the next few pages. Although the equipment required for pumping and distributing lagoon effluent may be similar to conventional irrigation equipment, the smaller volume of water handled in most livestock lagoons and holding basins generally allows the use of smaller, less costly systems. It also is possible to use an application system for both effluent and fresh water irrigation. The type of irrigation system chosen depends on many farm specific parameters including the particle size of the solids in the effluent, the amount of available capital and how much time and labor is available for pumping, and the land available for application. Nevertheless, knowledge of the potential options available and their advantages and disadvantages could lead you to better decisions.

Stationary Volume Gun

This system can be used in many small effluent application systems. The system includes a pump and a main line similar to the hand-move systems, but with a single or multiple large-volume gun sprinklers. Advantages of the volume gun systems include larger flow rates and a larger wetted area so less labor is required in moving the sprinkler. Some volume guns are wheel mounted to facilitate moving the unit. Stationary volume guns typically have nozzle sizes

Table 7. Characteristics of Stationary Sprinkler Systems.

Advantages:	*Limitations:*
Good for small or irregular-shaped fields	High initial investment
Flexible with respect to land area	Must protect from animals in fields
Do not have to move equipment	Small-bore nozzles likely to get plugged or broken
Low labor requirement	No flexibility to move to other (new) fields

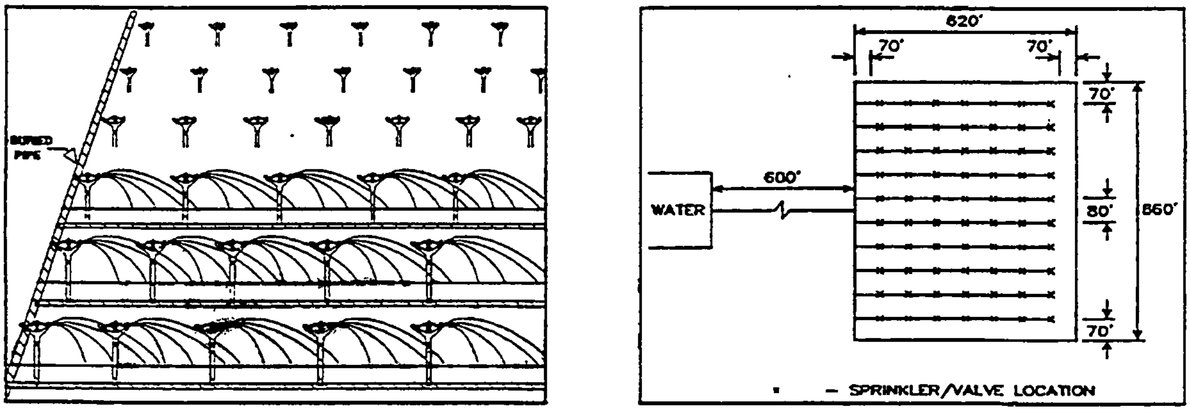

Figure 5. Stationary Sprinkler System

Traveling Sprinklers

Traveling sprinkler systems can be cable-tow traveler, hard-hose traveler, center pivot, or linear-move systems. The cable-tow traveler consists of a single-gun sprinkler mounted on a trailer with water being supplied through a flexible, synthetic fabric, rubber, or PVC-coated hose. Pressure rating on the hose is normally 160 PSI. A steel cable is used to guide the gun cart. The hose-drag traveler consists of a hose drum, a medium-density polyethylene (PE) hose, and a gun-type sprinkler. The hose drum is mounted on a multiwheel trailer or wagon. The gun sprinkler is mounted on a wheel or sled-type cart referred to as the gun cart. Normally, only one gun is mounted on the gun cart. The hose supplies wastewater to the gun sprinkler and also pulls the gun cart toward the drum. The distance between adjacent pulls is referred to as the lane spacing. To provide proper overlap, the lane spacing is normally 70% to 80% of the gun-wetted diameter.

The hose drum is rotated by a water turbine, water piston, water bellows, or an internal combustion engine. Regardless of the drive mechanism, the system should be equipped with speed compensation so that the sprinkler cart travels at a uniform speed from the beginning of the pull until the hose is fully wound onto the hose reel. If the solids content of the wastewater exceeds 1%, an engine drive should be used.

Nozzle sizes on gun-type travelers are 1/2 to 2 inches in diameter and require operating pressures of 75 to 100 PSI at the gun for uniform distribution. The gun sprinkler has either a taper bore nozzle or a ring nozzle. The ring nozzle provides better breakup of the wastewater stream, which results in smaller droplets with less impact energy (less soil compaction) and also provides better application uniformity throughout the wetted radius. But, for the same operating

Hand-move Sprinkler Systems

The least costly sprinkler system for effluent irrigation are the hand-move types that require labor to set up and move the system. Although considerable labor input is required, these systems may be desirable for small lagoons. Used hand-move systems may be available, but small nozzles in the sprinklers may not be suited for effluent irrigation. A screened inlet pipe will reduce problems with small nozzles. Nozzle sizes used for moderately to heavily loaded lagoons are generally in the 1/2- to l-inch range and typically cover 1/2 to 2 acres per sprinkler, depending on nozzle size and system operating pressure.

Side-Roll Systems

These systems roll sideways across a rectangular field but are limited to low-growing crops. Crop clearance is slightly less than one-half the diameter of the wheel. These systems use small sprinklers, require rectangular fields, and have several mechanical devices.

Furrow or Gated Pipe Irrigation

These systems consist of a pump or gravity flow arrangement from a lagoon storage basin to a distribution pipe that has holes at intervals along its length. Effluent is discharged through the holes at a rate compatible with the land slope and soil infiltration rate. The gated distribution pipe usually is laid as level as possible across the upper end of a sloped soil-plant filter or manure receiving area. Gate pipe systems are suitable for lands from 0.2% to 5.0% slope. Flatter slopes result in ponding or manure at the discharge point of the gated pipe, while steeper slopes cause effluent runoff with little opportunity for infiltration into the soil.

The advantages of gated pipe systems are relatively low cost, low operating pressures, and even distribution of effluent if the holes in the pipe are properly located ad sized. The disadvantages of the gated pipe systems are high labor and management to ensure the proper operation of the systems. Gated pipe systems do not perform well on uneven or steeply sloped land. Traditionally, gated pipe has been used to irrigate row crops. However, properly designed and managed gated pipe systems have been successfully used to apply lagoon effluent to grassed areas.

Calibrating Irrigation Systems

Operating an irrigation system differently than assumed in the design will alter the application rate, uniformity of coverage, and subsequently the application uniformity. Operating with excessive pressure results in smaller droplets, greater potential for drift, and accelerates wear of the sprinkler nozzle. Pump wear tends to reduce operating pressure and flow. With continued use, nozzle wear results in an increase in the nozzle opening, which will increase the discharge rate while decreasing the wetted diameter. Clogging of nozzles or crystallization of main lines can result in increased pump pressure but reduced flow at the gun. Plugged intakes will reduce operating pressure. An operating pressure below design pressure greatly reduces the coverage diameter and application uniformity. Field calibration helps ensure that nutrients from liquid manure or lagoon effluent are applied uniformly and at proper rates.

The calibration of a hard hose or cable tow system involves setting out collection containers, operating the system, measuring the amount of wastewater collected in each container, and then computing the average application volume and application uniformity.

An in-line flow meter installed in the main irrigation line provides a good estimate of the total volume pumped from the lagoon during each irrigation cycle. The average application gauge on each end of the row should extend past the furthest distance the gun will throw wastewater to ensure that the calibration is performed on the "full" wetted diameter of the gun sprinkler. Multiple rows increase the accuracy of the calibration.

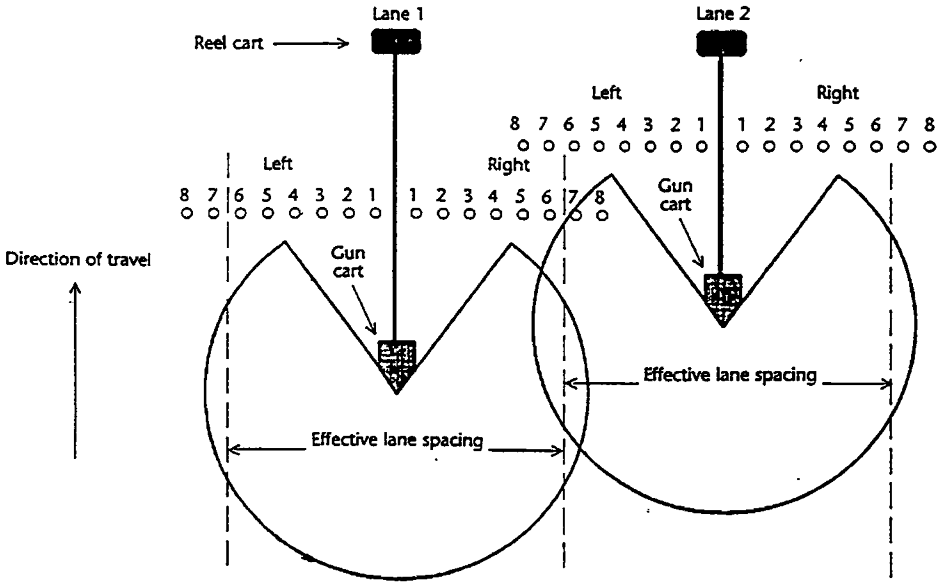

Figure 6. Calibration setup for hard hose travelers. .

Containers should be spaced no further apart than 1/16 of the wetted diameter of the gun sprinkler not to exceed 25 feet. At least 16 gauges should be used in the calibration. Sixteen gauges will be adequate except for large guns where the wetted diameter exceeds 400 feet. (Maximum recommended spacing between gauges, 25 feet X 16 = 400 feet.) As shown in Figure 6, gauges should be set at least one full wetted diameter of throw from either end of the travel lane. The system should be operated such that the minimum travel distance of the gun cart exceeds the wetted diameter of throw.

Calibration Method

1. Estimate the wetted diameter of the gun. Check the actual operating pressure at the sprinkler and verify the nozzle type and size. Determine wetted diameter from manufacturer's charts.
2. Determine the number of collection gauges and spacing between gauges. For a wetted diameter of 320 feet, the rain gauge spacing should not exceed 20 feet (320 ft/16 = 20 ft).
3. Label gauges outward from the gun cart as either left or right (L1, L2, L3, etc; R1, R2, R3, etc.)
4. Set out gauges along a row as labeled and shown in Figure 6, equally spaced at the distance determined in item 2 (20 feet). The row should be at least one wetted diameter from either end of the pull. The first gauge on each side of the travel lane

12. The precipitation rate (inches/hour) is computed by dividing the average application depth (inch) (#9) by the application time (hours) (#5).

$$\text{Precipitation rate, inches/hour} = \frac{\text{Average application depth, inch}}{\text{Application time, hours}}$$

13. Compute the average travel speed.

$$\text{Average travel speed} = \frac{\text{Distance traveled, feet}}{\text{Time, minutes}}$$

14. Determine the application uniformity. The application uniformity is often computed using the mathematical formula referred to as the Christiansen Uniformity Coefficient (U_c). It is computed as follows:

$$U_c = \frac{\text{Average depth (\#9)} - \text{Average deviation (\#11)}}{\text{Average depth (\#9)}} \text{ X } 100$$

15. Interpret the calibration results. The higher the index value, the more uniform the application. An index of 100 would mean that the uniformity is perfect; the exact same amount was collected in every gauge.

For travelers with proper overlap and operated in light wind, an application uniformity greater than 85 is outstanding and very rare. Application uniformity between 70 to 85 is in the "good" range and is acceptable for wastewater application. Generally, an application uniformity below 70 is considered unacceptable for wastewater irrigation using travelers. If the computed U_c is less than 70, system adjustments are required. Contact your irrigation dealer or technical specialist for assistance.

Center Pivot

As Figures 7 and 8 show, center pivot and linear move irrigation systems are calibrated by placing one or more rows (transect) of collection containers parallel to the system.

For center pivot systems with multiple towers, place the first collection container beside the first moving tower (140 to 180 feet from the boss tower [pivot point]). This will miss the area between the boss and first tower, but it is necessary to omit this system through this zone. The area missed will be less than 3 acres and will usually represent less than 10% of a typical sized system. If the system has only one moving tower, place the first container 100 feet from the boss tower. Place containers equally spaced to the end of the system. For lateral move systems, place containers throughout the entire length of the system.

Containers should be spaced no further apart than 1/2 the wetted diameter of rotary impact sprinklers, 1/4 the diameter of gun sprinklers, or 50 feet, whichever is less. On systems with spray nozzles, collection containers should be spaced no further than 30 feet. A 20- to 25-foot spacing is generally recommended for all types of sprinklers, which will result in six to eight collection containers between each tower. Collection containers should be placed such that they

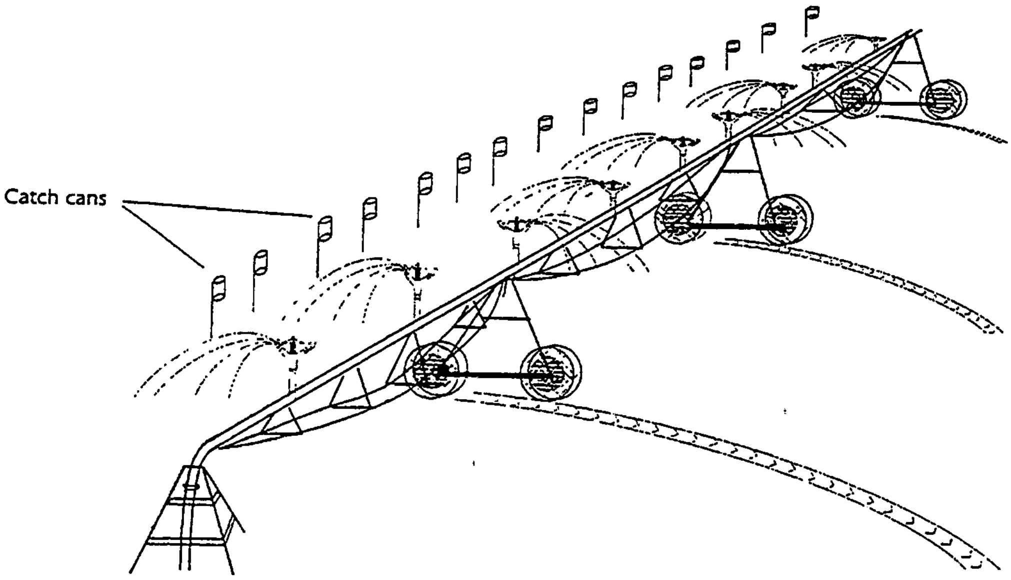

Figure 8. Calibration layout for center pivot irrigation systems.

6. Immediately record the amounts collected in each gauge.
7. Add the amounts in item 6 and divide by the number of gauges. This is the average application depth (inches).

$$\text{Average application depth} = \frac{\text{Sum of amounts collected in all gauges}}{\text{Number of gauges}}$$

8. Where an end gun is used, identify those gauges at the outward end where the depth caught is less than 1/2 the average application depth computed in item 7. The distance to the last usable gauge is the effective diameter of the system from which the effective acreage is computed.
9. Recompute the average application depth for the "usable" gauges identified in item 8 that fall within the effective width of the system. (Eliminate gauges on the outer end of the system where the depth caught is less than half the average application depth.)

Note: All gauges interior to the "effective width" of the system are included in the computations regardless of the amount caught in them.

10. Compute the reference travel speed and compare to the manufacturer's chart.

$$\text{Travel speed, ft/min} = \frac{\text{Distance traveled, ft}}{\text{Time, min}}$$

11. Calculate the deviation depth for each "usable" gauge. The deviation depth is the difference between each individual gauge value and the average value of all gauges (item 9). Record the absolute value of each deviation depth. (Absolute value means the sign of the number [negative sign] is dropped, and all values are treated as positive).

Deviation depth = |Depth collected in gauge I – average application depth|
"I" refers to the gauge number

to an inspection can easily be dealt with if proper records are available. The following items should be available at an individual farm:

1. Manure application records
2. Map of farm fields including waste application fields and acreage
3. Manure Management Plan
4. Waste sample analysis
5. Annual soil analysis for each field receiving waste applications

Most of these records should be part of your comprehensive nutrient management plan. These records should be maintained for five years at the individual farm.

It may be beneficial for you to maintain the additional following records for verification of conditions on your farm. Contact your state water quality agency to see if any of these or other items may be required to be maintained to comply with state guidelines:

1. Daily farm rainfall records
2. Weekly lagoon level (freeboard) records
3. Animal population
4. Crop yields
5. Surface water and groundwater quality records

Forms included here are as follows:

1. **IRR-1:** Irrigation Field Record is used to record each irrigation event. The IRR–1 or 2 forms can be used with all types of irrigation systems including solid-set sprinklers, solid-set volume guns, hard hose travelers, center pivots, and liner move irrigation systems. The irrigation field record forms would also be used to record applications with a drag-hose injector.
2. **IRR-2:** Cumulative Irrigation Field Record is to record the total annual waste application to one field per crop cycle. It enables the operator to calculate the total nitrogen application to the field and compare it to the recommended nitrogen loading rate.
3. **SLUR-1:** Liquid Manure Slurry Field Record is used to record manure application from liquid tanks. These forms would be used to record the broadcast or injection of any liquid manure, effluent, and sludge.
4. **SLUR-2:** Cumulative Liquid Manure Slurry Field Record is to record the total annual waste application to one field per crop cycle with a slurry or pump and haul system. It provides for calculating the total nitrogen application to the field and comparing it to the recommended nitrogen loading rate.
5. **SLD-1:** "Solid" or Semisolid Manure Field Record is to be used to record each application event from a manure box, flail, or side-discharge spreader. These forms would be used to record the broadcast of any solid manure, separated manure solids, bedding, litter, or compost.
6. **SLD-2:** Cumulative Solid Field Record is to record the total annual waste application to one field per crop cycle. It provides for calculating the total nitrogen application to the field and comparing it to the recommended nitrogen loading rate.

Form IRR-1

Irrigation Field Record
For Recording Irrigation Events on Different Fields

Farm Owner ____________________

Irrigation Operator ____________________

Facility Number ________ - ________

Tract #	Field #	Date (mm/dd/yr)	Crop Type	Field Size, acres	Irrigation Time			Number of Sprinklers Operating
					Start Time	End Time	Total Minutes	

Form SLUR-1

Slurry and Sludge Application Field Record
For Recording Slurry Application Events on Different Fields

Farm Owner
Spreader Operator

Facility Number -

Tract #	Field #	Date (mm/dd/yr)	Crop Type	Field Size, acres	Application Method [3]	# of Loads Per Field	Volume of Loads [4], gallons

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[3] SI = soil incorporated (disked); BR = broadcast (surface applied)
[4] Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.

Manure Storage and Treatment Systems

John W. Worley

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Advantages of lagoon storage of manure may include cost per animal unit, ability to store large amounts of manure and/or runoff, treatment of manure to reduce odors, and potential to handle manure with conventional pumping and irrigating equipment. Disadvantages of lagoons may include lack of appropriate soil materials for construction, the need for solids separation or sludge removal equipment if bedding or other non-biodegradable materials are present, aesthetic appearance and/or public perception. In addition, the effluent from a lagoon is less well balanced with crop needs, since nitrogen is released, and phosphorus and potassium remain in the lagoon.

Manure Slurry Storage Systems

Manure slurry storage systems tend to be used when the need for nutrients for crop growth in the area is high since these systems tend to maintain higher levels of nutrients (particularly nitrogen) than do lagoons. Many types of facilities are used to store manure in the slurry form. One type is the under floor pit in which manure is deposited directly into the pit (usually 6 ft deep or more) through slatted floors. Slurry manure storage facilities not located under the production buildings may be fabricated or earthen structures. Fabricated manure storage tanks are usually either concrete or coated metal (glass-lined steel). Such tanks may be above ground, or partially or fully below ground. Manure is usually scraped or flushed from the production buildings and may flow into these tanks by gravity or be pumped into the tank from a collection sump or reception pit. Adequate agitation is necessary to suspend solids and facilitate complete removal of the contents of these manure tanks. If needed for odor control, fabricated tanks are usually the least costly to cover.

Slurry manure may also be stored in earthen structures or basins. Because storage volume can usually be obtained at less cost in an earthen basin, these facilities are often used when manure and wastewater volumes are relatively large due to wash-water use or lot runoff. Earthen structures require a relatively high degree of planning and preliminary investigation to ensure that proper soil materials are available to create a seal and that the seal is constructed properly. These facilities are basically just like lagoons, but smaller since less water is added to the manure. Space requirements are greater with earthen structures than constructed manure storage tanks due to the required berms and front/back slopes that have structural integrity and can be properly maintained. Maintenance requirements may be greater with earthen structures due to the need for maintaining and mowing a vegetative cover on the berm area and keeping it free of weeds, trees, and shrubs. Agitation is equally important in earthen structures, and access points for agitation and pumping should be part of the design plan. Some earthen storage units are partially or completely lined with concrete and built with an access ramp so that loading and hauling equipment can enter the basin. Earthen storage structures are more difficult to cover than tanks if odor control is needed. Odor is generally a greater problem in slurry storage structures than in a properly operating lagoon, but if coverage is necessary, it is less costly in a slurry storage facility because of the smaller size.

Advantages of storing manure in the slurry form may include less volume (higher solids content compared to a lagoon), adaptability to tank storage either under floor or above ground, possibility of covering the manure storage facility to reduce odors, higher nutrient retention, and the potential to collect and transport hydraulically. Disadvantages may include higher odor potential (unless storage unit is covered), increased danger of toxic or combustible gas buildup in

Lagoons must be designed by a properly trained engineer (NRCS or consulting engineer). The berms (walls) must be designed to be stable under load and the lagoon must be properly lined with either a compacted clay or synthetic liner to prevent leakage into ground water. The owner/operator should understand the limitations of the system, and how the expansion of animal numbers will prevent the lagoon from operating properly. He/she should know the capacity of the lagoon, how many animals it is supposed to handle, how often it should be pumped down, and to what level it should be pumped down. Any major expansion or change in the operation of a facility would require a reassessment by the design engineer.

Manure Slurry Storage

The actual size of a manure slurry storage structure needed depends upon the same factors used in sizing a lagoon with the notable exception that no treatment volume of water must be added since microbial breakdown of manure is not desired. Manure is left in a more solid state, which hinders bacterial growth. Also, sludge accumulation is not accounted for since this facility should be completely emptied one or more times per year. The design storage period plays a significant role in sizing these structures. Storage period needed depends primarily upon cropping system, climatic conditions, and labor/equipment availability. Most operations utilizing a single, full-season annual row crop or small grain crop will need at least six months manure storage to schedule land spreading around cropping operations. Experience has shown that even a full year's storage is beneficial when wet conditions may make fall application difficult and manure needs to be stored until spring.

A manure storage facility for a given number of animals is much smaller than a lagoon for the same farm (See Figure 2), since no storage space is needed for dilution water. However, adequate size must still be supplied for manure storage, rainwater, and a safety factor for severe storms.

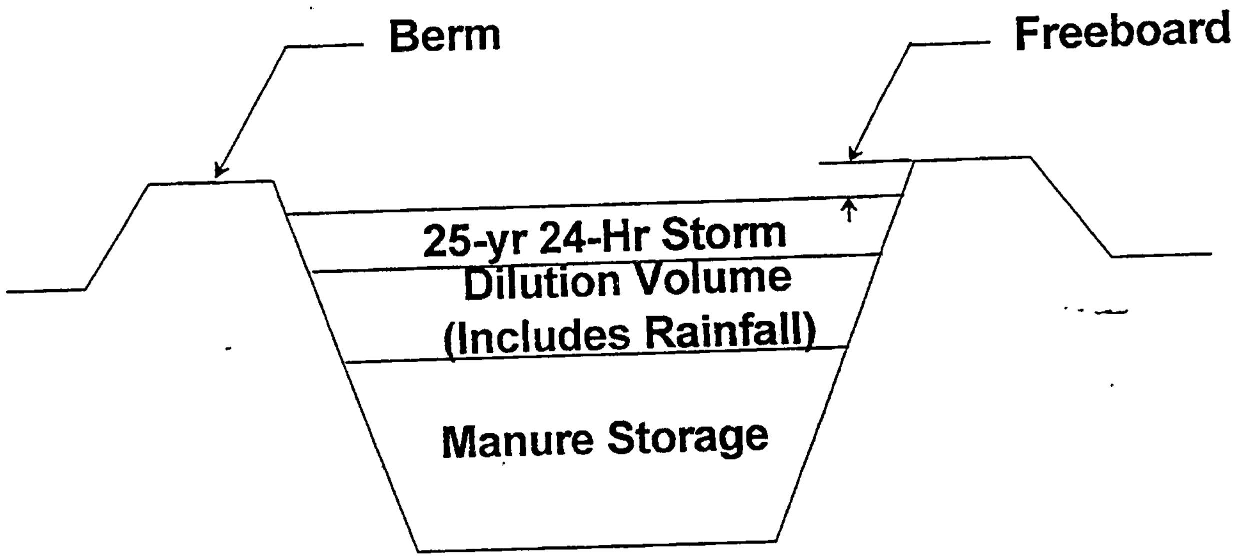


Figure 2. A manure storage facility is smaller than a lagoon, but must still be sized to handle volumes according to the planned management.

Salt and nutrient levels, testing

Bacterial activity is somewhat sensitive to salt levels in the lagoon. Salts are a natural byproduct of the biological degradation of manure. The removal of some salts as the lagoon is pumped and the addition of fresh water via rainfall, runoff, and wash water combine to generally keep salt levels within an acceptable range. However, some conditions can occur that may lead to elevated salt levels. These include extended periods of dry weather, high rates of evaporation, little or no dilution with lot runoff and wash water, and perhaps overloading of the lagoon. Elevated salt levels inhibit bacterial activity, and lagoon performance is characterized by increased odors or "sour" smells and increased sludge buildup rates. A simple field test called "electrical conductivity" (EC) is effective in monitoring salt levels. A University of Missouri study found that EC values in the range of 8,000 to 12,000 µmho/cm (or S/cm) were associated with greatest bacterial activity. If salt levels rise too high in a lagoon, the most effective remediation is to pump the lagoon and add water from a freshwater source (pond or lake). The availability of such a freshwater source is an enhancement to long-term lagoon operation, and consideration should be given to such a source when planning a lagoon.

While overall salt levels are the primary concern in lagoon health, occasionally other more specific compounds may affect lagoon performance. These might include copper, arsenic, (dietary inputs), certain medications, and perhaps excessive use of harsh cleaning agents. If reduced lagoon performance is suspected due to factors such as these, specific testing may be required to isolate the source.

Overall Monitoring Activities

Certain activities are advisable and necessary in maintaining a manure storage structure and ensuring that it is performing as expected. Some of these activities may be required by regulation, but all are evidence of good management and stewardship regardless of regulatory requirements.

Monitoring during pumping activities

Experience has shown that unplanned discharges and spills sometimes occur with pumping activities. Sources of such unplanned discharges include burst or ruptured piping, leaking joints, operation of loading pumps past the full point of hauling equipment, and other factors. Hence, pumping activities should be closely monitored, especially in the "start-up" phase, to ensure that no spills or discharges occur. Continuous pumping systems such as drag-hose or irrigation systems can be equipped with automatic shut-off devices (which usually sense pressure) to minimize risk of discharge in the event of pipe failure.

Liners

Liners in earthen manure storage impoundments are designed and constructed to provide an adequate barrier between the potential contaminants in the impoundment and groundwater. Hence, liner integrity is extremely important in maintaining an environmentally sound manure storage facility. To the extent possible, liners should be regularly inspected for signs of damage, erosion, or other compromising factors. Wave action can cause liner erosion at the level of the liquid in the impoundment. If this condition is severe, consideration might be given to the use of

A common practice is to install steel fence posts at the upper and lower pump-down levels for earthen impoundments. While this approach provides basic information on beginning and ending pump-down, experience has shown that more knowledge is needed. Also, fence posts installed in this manner are subject to damage and displacement. A good pump-down marker will indicate the level, or elevation, of manure throughout the possible range (from lower pump-down level to overflow, or spillway) in the storage facility. Experience has shown that a 6" x 6" treated wood pole properly imbedded makes a good pump-down marker. Notches or other indicators can be carved into the pole to show pertinent elevations. Painted numbers or colors on the pole are not durable enough to maintain readability over a number of years. Figure 20-1 shows a type of pump-down marker that provides the information needed.

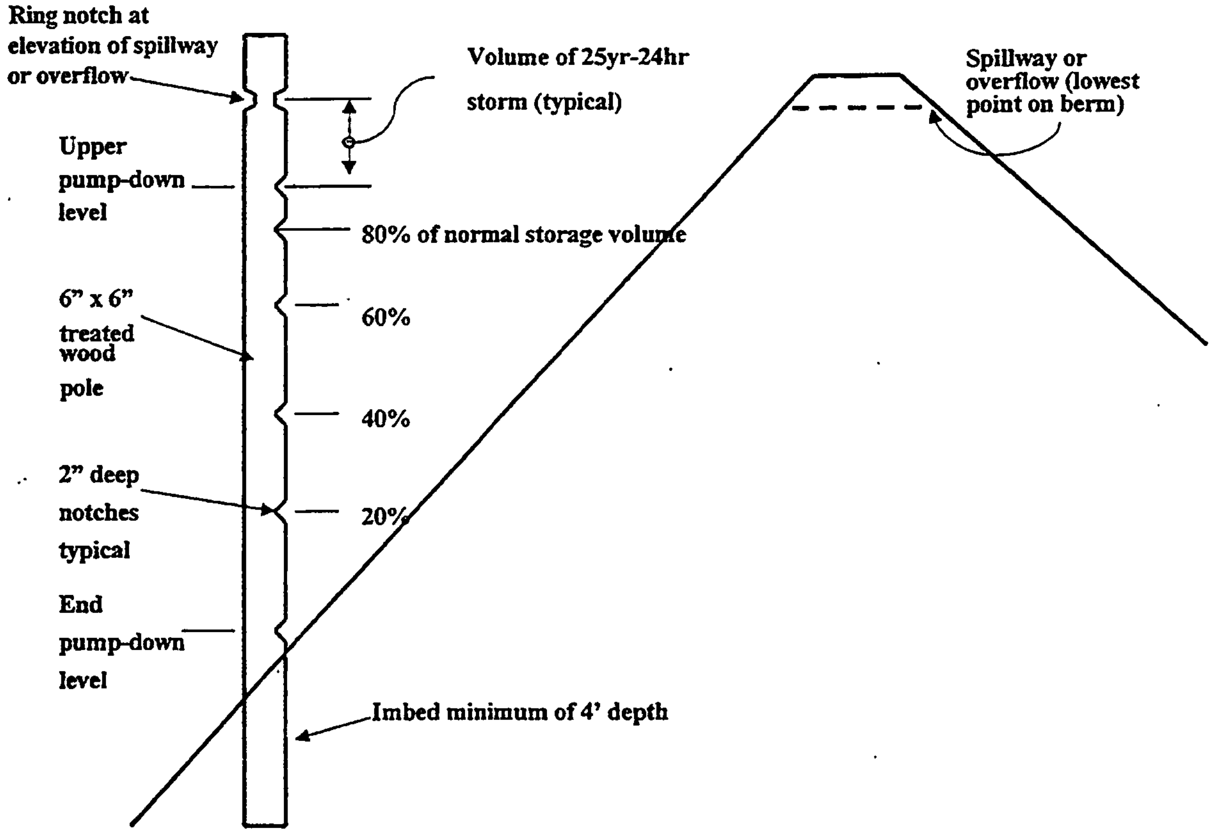


Figure 3. Pump-down marker in earthen impoundment

Control of surface water

As confined production units become larger, control of surface water in the production area is a primary concern. Wider, longer buildings, placed relatively close together, create high rates of discharge from roof and paved areas. Special considerations and landscaping are needed to manage this water in a manner that does not create erosion and unwanted ditches and washed-out culverts or waterways. A surface water management plan should be developed based on a design storm event, expected runoff rates, soil types and erosive velocities, and properly designed and vegetated channels for carrying surface water away from the production area. Some states may require that surface water from production areas be contained and/or checked for contaminant levels before discharge to a watercourse.

Closure of Earthen Impoundments

Earthen manure storage impoundments may be abandoned for a number of reasons. These reasons may include termination of the livestock production enterprise, financial hardship or bankruptcy, or a change in the way manure is handled in the manure management system. Regardless of the reason, abandoned earthen manure storage facilities represent a potential environmental concern.

Regulations

Georgia regulations require that a closure plan be developed and submitted for approval by EPD for any CAFO greater than 1000 animal units.

Management of impoundment before closure

There is often an interim period when animals are no longer produced and manure is not being introduced into the lagoon. During this period, the lagoon should be managed and maintained in accordance with normal recommended practices. Overflow or discharge must not be allowed, and the contents should be land applied in accordance with good agronomic practice.

Removal of impoundment contents

An earthen impoundment closure plan (if required) will include partial or complete removal of the impoundment contents. This operation can be quite challenging due to the materials to be removed. The contents usually include some relatively dilute liquid, some slurry, and some sludge accumulation. The dilute liquid and slurry portions can usually be agitated and removed with pumping equipment. Complete sludge removal may be difficult due to the highly viscous nature of the sludge and difficulty in maneuvering within the impoundment with the necessary equipment. Preservation of the existing impoundment seal may be more important than complete sludge removal.

Appendix A
Monthly Manure Storage Facility Checklist

Farm:____________________ Facility ID:____________________

Inspected by:____________________________ Date:__________

Manure Level

Manure level today:________ft. Last observation:________ft. Date:________

Distance below overflow/spillway:________ft. Last observation:________ft.

Approximate percent filled:______% Last observation:______%

Earthen Storage Facilities

Item	Low Risk	Potential Problem	Corrective Measures Taken/Planned
Are embankments well-sodded with no bare areas?	Yes	No	
Are embankments free of trees or woody shrubs?	Yes	No	
Does the berm or embankment have a consistent elevation (i.e., no low or settled areas other than the planned spillway)?	Yes	No	
Is the spillway free of erosion?	Yes	No	
Are all berms and embankments free of erosion?	Yes	No	
Is the base of the embankment free of soggy, damp areas and other evidence of seepage or leaks?	Yes	No	
Are the embankments free of burrowing or other rodent damage?	Yes	No	
Is the liner free of damage due to rainfall, wind, or wave action?	Yes	No	
Is the liner free of erosion damage around inlet/outlet pipes and agitation points?	Yes	No	
Does the lagoon contain at least the minimum volume for treatment?	Yes	No	

Concrete/Steel Tanks

Item	Low Risk	Potential Problem	Corrective Measures Taken/Planned
Are tanks free of visible cracks or structural damage in walls or foundation?	Yes	No	
Is the area around the tank free of seepage or other evidence of leakage?	Yes	No	
Is the manure loadout area free of spills or accumulations of manure?	Yes	No	
Does surface water properly drain away from the manure tank?	Yes	No	

Summary

Both lagoons and manure slurry storage structures have their advantages and disadvantages. Lagoons reduce the nitrogen and organic matter in the waste stream by volatilizing them (converting them to gases and moving them into the air.) They also reduce the odor released compared to a slurry storage, but they are more expensive because of their larger size and must be carefully managed to maintain a healthy bacterial population. Slurry storage structures are smaller (do not include treatment volume or sludge storage), conserve more nutrients in the waste, and are easier to cover if necessary, but they tend to produce more odor if not covered. Whichever type of system is used, it is important to understand that it cannot perform as designed unless it is managed properly. For a lagoon, that includes starting it about 1/3 full of water before waste is added, preferably in the Spring, loading it evenly, and maintaining the level between the minimum and maximum levels. For a slurry storage, it includes cleaning it out on a regular schedule, according to crop needs, and minimizing the amount of water entering the storage.

Regular inspections and records of these inspections are vital to maintaining any manure storage and handling facility and to being able to prove that you are doing a good job managing your facility. Inspections should include investigations of existing or potential leaks, aesthetic appearance of facilities, and variations in odor levels. Regular monitoring and recording of lagoon levels is aided by the use of an easily read marker that shows **at a minimum** the overflow level, maximum storage level, and minimum pump-down level for the lagoon. Lagoon levels and weather forecasts should be studied so that pumping can be scheduled before it has to be done on an emergency basis. Berms should be checked for leaks, rodent burrows, erosion, and tree growth. Aesthetics include regular mowing and establishing vegetative screens where needed to present a pleasing picture to neighbors and those passing the farm.

If a lagoon is no longer used to store animal waste, it should be properly closed, including removal of all waste material, along with six inches of soil, and the area should be regraded to return the land to its original contours. Until this occurs, the lagoon should be managed just as it was before closure.

Use of Poultry Litter as a Feed Source

The use of poultry litter as a livestock feed can provide for increased net returns to the farmer through reduced feed costs. To provide for the safe, effective use of litter as a livestock feed, a few precautions should be considered:

* Poultry litter utilized for livestock feed should be analyzed to determine total digestible nutrients (TDN), crude protein, crude fiber, minerals, and ash. Ash content should not exceed 28 percent. Ash can be a problem with poultry litter from birds raised on dirt floors if management techniques that reduce the soil content of litter at cleanout are not practiced.

* West Virginia law prohibits the feeding of unrendered poultry carcasses to livestock (WVDA §61-1C-3). Litter utilized for livestock feeding must be free of dead bird or rodent carcasses to avoid potential botulism problems. The litter must also be free of nails, wire, glass or other trash that may be present within poultry houses.

* Litter should be deep stacked and covered tightly to exclude oxygen for 3 weeks or more at a temperature of 130 degrees F to destroy pathogens and inhibit molds. The temperature should be monitored to avoid excessive heating (greater than 140 degrees F) which will greatly reduce the nitrogen digestibility and feed value.

* Young calves do not effectively utilize the non-protein nitrogen within poultry litter as readily as more mature cattle. The potential for a coccidia infestation is also elevated. For best response, feed litter to cattle weighing over 400 pounds. It is recommended that cattle not be fed high litter rations longer than six continuous months and that there be a minimum 15-day withdrawal period prior to slaughter.

* Do not feed litter in excess of 80% of livestock rations. Bovatec™ or Rumensin™ should be included in rations that contain poultry litter.

* It is not recommended that litter be fed to lactating dairy cows because of the lack of opportunity for a withdrawal period to eliminate residues from the milk. Cows within 30 days of parturition should receive no more than 30% of their dry matter intake from litter due to the increased potential for milk fever.

* Litter high in copper can be toxic to sheep. A litter nutrient analysis should be obtained to determine copper levels before utilizing litter in a sheep ration.

* Because poultry litter is virtually devoid of Vitamin A, a supplemental source of Vitamin A should be added to all rations that utilize litter.

* Litter is more available for purchase in the off-season (August to February). Follow recommended storage practices to retain litter nutrients and sustain water quality until the litter is utilized.

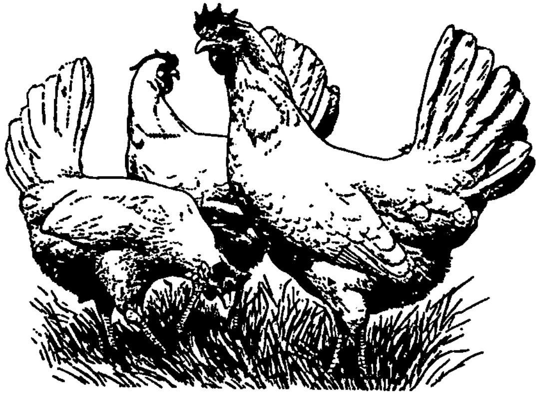
References
Safe Use Of Poultry Litter As A Feed Source, by C.W. Ritz, West Virginia University.
USDA Natural Resources Conservation Service Field Office Technical Guide.
Poultry Water Quality Handbook, by the Poultry Water Quality Consortium.

For further information about litter utilization or water quality improvement practices, contact the Potomac Inter-Agency Water Quality Office at (304) 538-7581.

For litter nutrient analysis, contact the WVDA Moorefield Field Office (304) 538-2397.

The use of trade or product names within this publication does not imply endorsement to the exclusion of other products that might be equally suitable.

Best Management Practices for Poultry Litter Users



West Virginia Poultry Water Quality
Advisory Committee

To calibrate your spreader:

1. Locate a large and reasonably smooth, flat area where manure can be applied.
2. Spread the collection sheet smoothly and evenly on the surface of the test field.
3. Start driving the spreader at the normal application speed toward the collection sheet spread on the ground; allow the manure to begin leaving the spreader at an even, normal rate.
4. Drive over the collection sheet at the normal application speed while continuing to apply manure.
5. Collect all manure spread on the collection sheet and pour it into the bucket.
6. Weigh bucket with manure, then subtract empty-bucket weight. This will give you the pounds of manure applied to the collection sheet.
7. Repeat the procedure three times to get a reliable average.
8. Determine average weight of the three manure applications.
9. Refer to the table for the size of the collection sheet and pounds of manure applied to the collection sheet. Then read "Tons of Manure Applied Per Acre."

This procedure is particularly suitable for dry waste such as broiler and broiler breeder litter. Wet litter or manure is more difficult, but the basic procedure can still be used. A plastic sheet works well to catch wet manure. The main difference in the procedure is that you will place the plastic sheet and the wet manure in the bucket together, then subtract the dry weight of both bucket and plastic sheet as in Step 6. The remaining steps are the same.

This publication was adapted from "Calibration of Manure Spreaders" by Elridge R. Collins, Virginia Polytechnic Institute & State University; and "Calibrating Spreaders for the Application of Poultry Manure" by Charles Goan, University of Tennessee.

* * *

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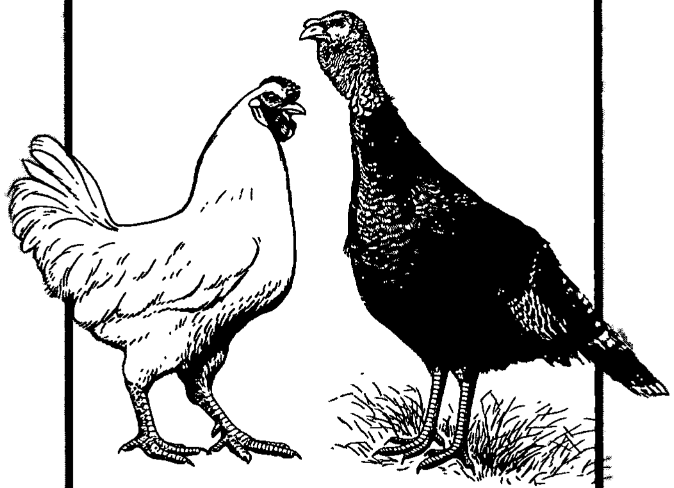
West Virginia University
Extension Service

SPREADER CALIBRATION FOR THE APPLICATION OF POULTRY MANURE

Casey W. Ritz, Ph.D.
Poultry Program Coordinator

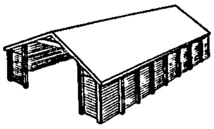


Poultry Litter Management

Nutrient Management and
Water Quality Improvement Series

Fact Sheet #2 West Virginia Poultry Water Quality Advisory May 1998

Poultry Litter Siting, Storage, and Transport



Proper nutrient siting, storage, and transport practices are critical for successful litter management.

Flock schedules determine when litter is cleaned from poultry production buildings. Cleanout schedules do not always coincide with good weather and the best time of year to land apply litter as a fertilizer. Poultry litter must therefore be stored under proper conditions in order to retain nutrients, prevent pest and odor problems, and maintain water quality.

Managing litter appropriately to ensure nutrient containment and protection is an important aspect of any approved nutrient management plan. Whether it is the location of storage sites, actual storage practices and structures, or the transport of litter to the fields for application, appropriate best management practices governing these factors need to be applied.

Siting for Storage

Pests, odors, water quality and neighbor perceptions are factors that must be considered when utilizing any form of litter storage. The most critical consideration is location. A site should be chosen that is not in close proximity to neighbors or local traffic and one that is not likely to cause or potentially increase negative environmental impacts. All storage sites require protection from a 25-year 24-hour rainfall event.

Siting and set-back recommendations associated with poultry operations are based on environmental stability, ventilation requirements, and vehicle maneuverability around poultry facilities. It is recommended that litter storage sites, poultry houses, and mortality management sites be at least:

a) 1000 feet from a school, public water source, or town. Excluded are residential dwellings used for home instruction.

b) 400 feet from a single residential dwelling in active use, place of retail business, church or public building.

c) 150 feet from any property line (reducible with neighbor's notarized written consent).

d) 75 feet from the near edge of the right of way of any public road.

Litter not kept within a permanent storage structure should be covered to prevent nutrient loss and stored on a site with less than a 15% grade and located at least 50 feet from all drainage ways, surface water or sinkholes. Locate all storage sites at least 100 feet from any well. Avoid cobbly flood plains or seasonally high water areas as stock-

West Virginia Laws Governing Poultry Litter Management

WVDOH §17C-17-6 Loads To Be Securely Fastened And Not Allowed To Leak, Escape, Etc.

(a) No vehicle or combination of vehicles shall be operated on any highway unless such vehicle or combination of vehicles is so constructed or loaded as to prevent any of its load from dropping, sifting, leaking, or otherwise escaping therefrom, except that sand may be dropped for the purpose of securing traction, or water or other substance may be sprinkled on a roadway in cleaning or maintaining such roadway.

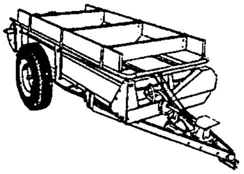
(b) It shall be unlawful to operate on any highway any vehicle or combination of vehicles with any load unless said load and any covering thereon is securely fastened so as to prevent said covering or load from becoming loose, detached, or in any manner a hazard to other users of the highway.

Poultry Litter Nutrient Management

Nutrient Management and
Water Quality Improvement Series

Fact Sheet #3 West Virginia Poultry Water Quality Advisory Committee May 1998

Nutrient Assessment and Poultry Litter Application



Adherence to the best management practices of an approved nutrient management plan is essential for successful management of litter nutrients.

Nutrient management incorporates the usage of animal production by-products and commercial fertilizers to provide for crop nutrient requirements. Proper application of all nutrient sources will reduce excessive nutrient loading on pasture, hay, and crop land and minimize the need for additional commercial fertilizer application. Nutrient management can reduce negative environmental impacts on each farm. Crop production costs can be decreased by effectively utilizing farm-generated nutrients.

A nutrient management plan (NMP) is a system of best management practices (BMP) that are important to all farming operations. A nutrient management plan when followed can help to minimize adverse impacts of nutrient application on surface and groundwater and encourage plant growth. The plan will address farm nutrients through measures to manage animal production by-products. Each plan should provide for the proper utilization of 100% of the manure and mortality produced on the farm.

All poultry producers or individuals who utilize poultry litter should have a NMP prepared. Producers are encouraged to seek the assistance of qualified individuals in developing a NMP.

Nutrient Assessment

The use of organic and inorganic fertilizers on the farm should come only after there has been an assessment of the farm nutrient status.

a) Review or establish field histories (previous crops grown, crop yields, and the amount of fertilizer and litter usage).

b) Determine the type of crops to be produced for the current year.

c) Determine the crop nutrient requirements based on reasonable yield expectations.

d) Determine the available on-farm nutrients (manures, soil nutrient residuals, legume credits, etc.).

e) Have soils tested for phosphorus, potassium and pH.

f) Determine the amount of off-farm nutrients to meet crop requirements beyond that which is supplied by litter and other manure applications.

g) Nitrogen quick-testing is recommended for corn plots.

West Virginia Laws Relating to Poultry Litter Management

WVDA §61-22B Best Management Practices for Fertilizers and Manures

Rules for the establishment of voluntary best management practices to prevent or minimize the entry of nutrients from fertilizers and manures into groundwater while maintaining and improving the soil and plant resources of the state.

WVDA §11-13K Tax Credit For Agricultural Equipment

The Legislature finds that it is an important public policy to promote environmentally sound practices within the agricultural industry in this state. Therefore, a credit against the taxes imposed... shall be allowed in an amount equaling twenty-five percent of all expenditures for the purchase and installation of agricultural equipment and structures for agricultural operations within this state which serve to protect the environment....such shall include, but not be limited to: Advanced Technology Pesticide and Fertilizer Application Equipment; Conservation Tillage Equipment; Dead Poultry Composting Facilities; Mortality Incinerators; Nutrient Management Systems; Streambank and Shoreline Protection Systems; Stream Channel Stabilization Systems; Stream Crossing or Access Plans; Waste Management Systems; Waste Storage Facilities; and Waste Treatment Lagoons.

Litter Spreader Truck Calibration

Introduction

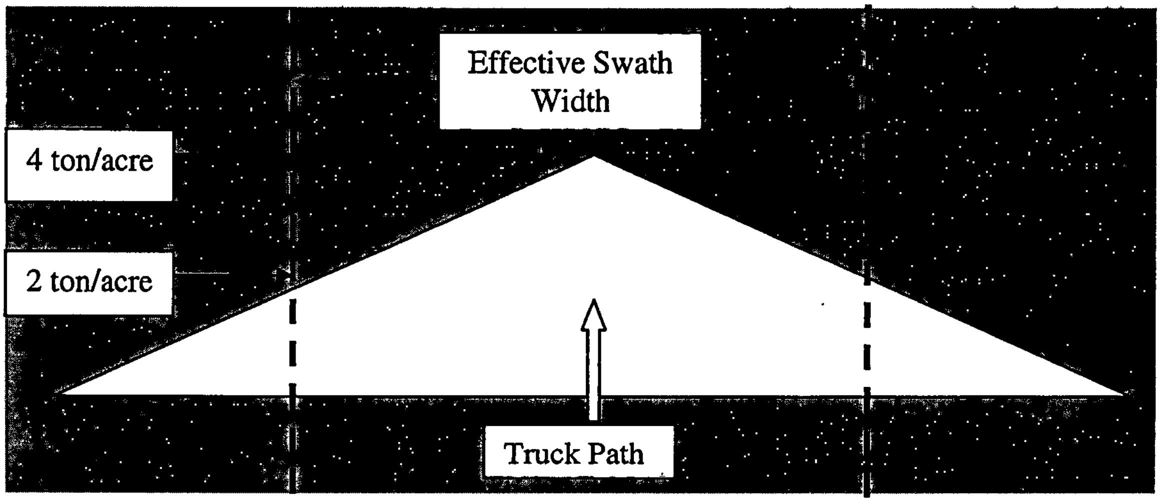
Spreader truck calibration has three main goals:

1. Determine **application rate** (tons per acre applied at a given setup and speed).
2. Determine the **effective swath width** (how far apart each pass should be).
3. Determine the **uniformity** of distribution of litter.

To determine the **application rate**, we can either do a mass balance (weigh the truck before and after spreading and determine the area covered) or we can take one or more samples from the spread area. When we take samples, we must convert pounds in the sample to tons per acre. The conversion is actually fairly simple. There are 43,560 ft^2 in an acre and 2,000 lb in a ton. If we divide 43,560 by 2,000, we get 21.8. We then divide 21.8 by the number of square feet in the sample (might be 2 ft^2 for a feeder pan or 108 ft^2 for a 9 x 12 tarp). If we multiply the result by the number of pounds in the sample, we get tons/acre. Simply stated:

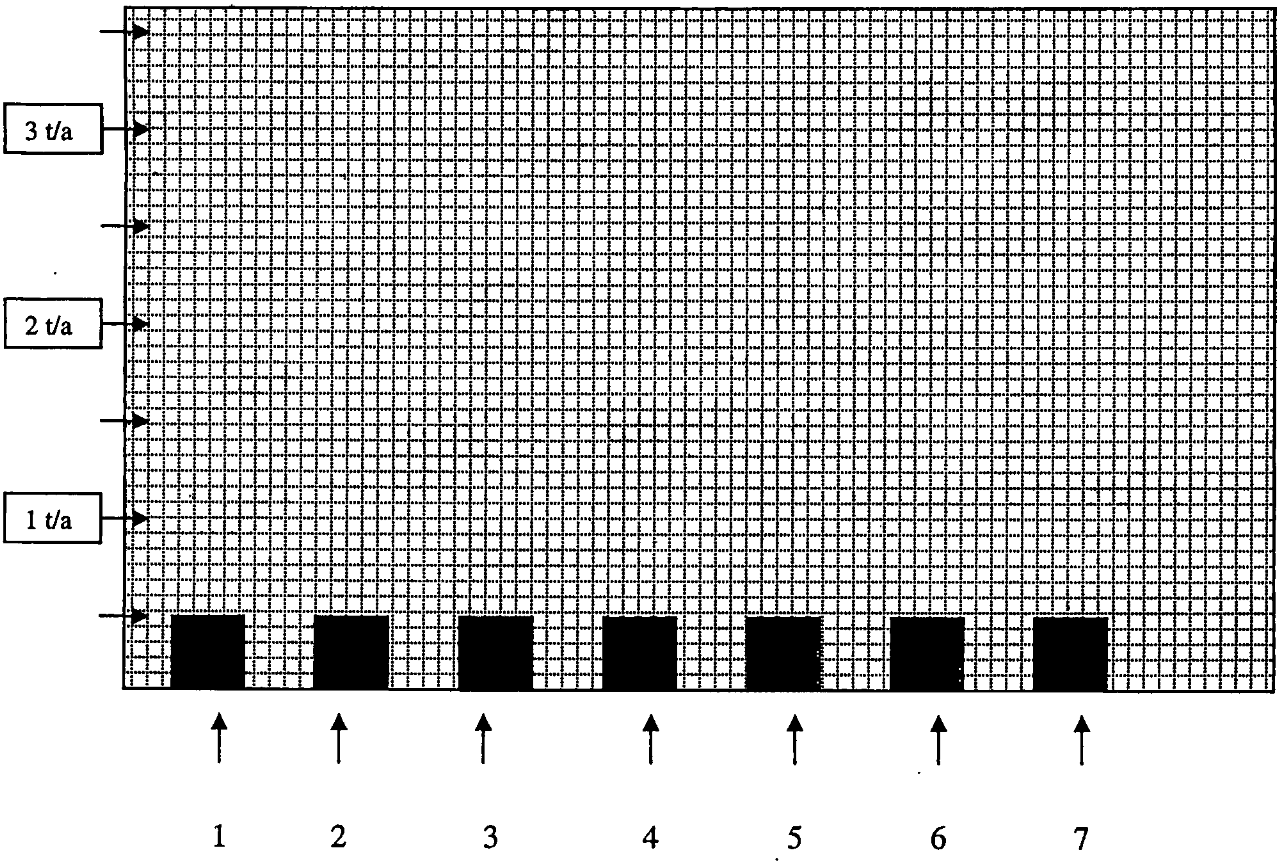
Sample weight (lbs) x 21.8/sample area (ft^2) = tons/acre.

To determine **effective swath width**, we start with the understanding that the distribution from a spreader truck normally resembles a triangle with the maximum amount near the truck, and decreasing application rate as we go away from the truck (See figure below.) Where the application rate reaches ½ the maximum rate, is the edge of the effective swath width. If the rate is 4 tons/acre in the middle, and decreases to 2 tons per acre 20 ft to the side of the truck, then 20 ft is the edge of the effective swath. Since this occurs on both sides of the truck, the effective swath width is 40 ft. The overlap is necessary to even out the distribution of the litter.



Uniformity can be calculated statistically, given enough data, but it can be fairly effectively evaluated visually by simply looking at the spreader pattern based on samples pulled from various distances from the truck.

Graphing the Application



Tarp #

1 _____
2 _____
3 _____
4 _____ middle
5 _____
6 _____
7 _____
Total _____
Avg. _____ of tarps

True Rate = Avg. of tarps _____ (sample width _____/ eff. swath _____)

True Rate = ______ tons per acre with _____ lane spacing.

Other Methods

Mass Balance

1. Weigh truck (gross weight). ______________ lb
2. Spread a known distance (say 500 ft.) Distance (____________ ft)
3. Weigh truck (tare) and subtract from gross. Tare _________ lb Net _________ lb
4. Visually or by other means determine the effective swath width. __________ ft
5. Area spread is [length (2 above) x effective swath width (4 above)] / [43, 560 (ft^2 /acre)] __________ acres
6. Application rate is Net pounds (3 above) / 2,000 / area spread (5 above) _________ ton/acre

Merka Method

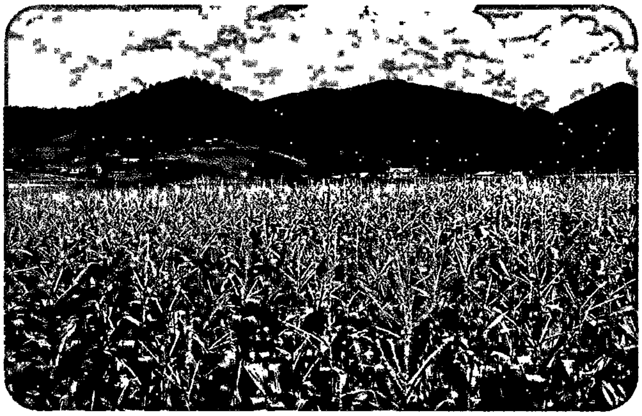
1. Determine cubic ft of manure in spreader. ___________ ft^3
2. Assume 30 lb/ ft^3 and divide by 2,000 to estimate tons. _________ tons
3. Assume 40-ft swath width.
4. Use odometer to estimate ft traveled (miles x 5,280) ____________ ft
5. Calculate area covered (40-ft swath x ft traveled / 43,560) ________ acres
6. Determine application rate (tons applied / acres covered) ________ ton/acre

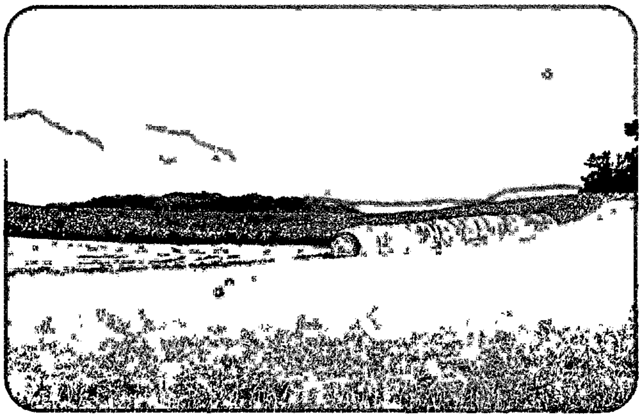
THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXTENSION SERVICE

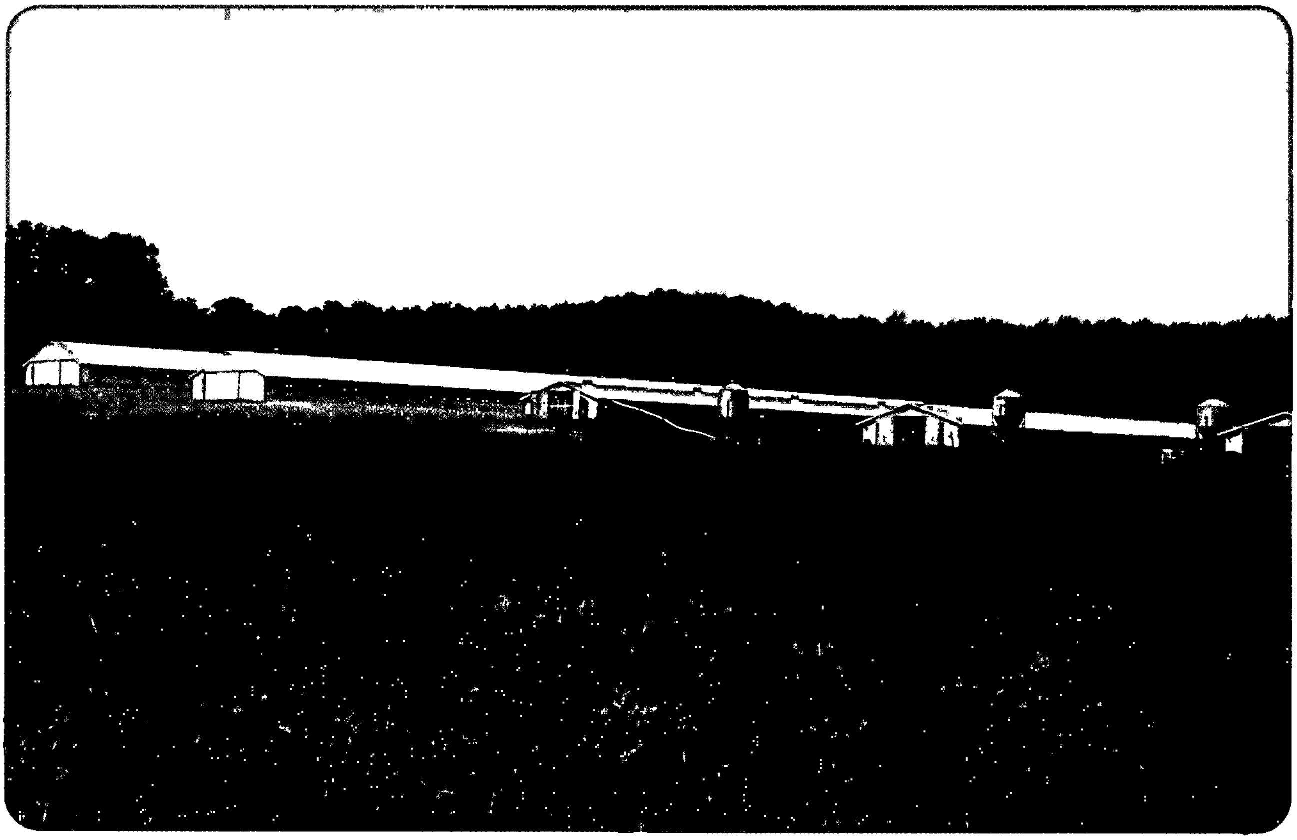
PB 1421

Poultry Manure

Proper Handling and Application to Protect Our Water Resources







These pathogens, when transmitted from manure to water, can infect humans through drinking water, water contact with the skin and consumption of aquatic animals. Fortunately, most pathogens die in a short period of time. However, given the right conditions, they may live and persist in surface and ground water for an extended period of time.

Manure Handling and Storage

The clean-out of poultry houses often results in some form of stockpiling or storage of the manure. Limited clean-out time and/or unfavorable weather conditions mean that manure may be stored before it is applied to the land.

Proper storage of manure is essential to maintain its fertilizer value for crops. In some cases, the manure is stockpiled outside the chicken house, and is subject to rain, snow and other environmental conditions. Stockpiled manure decomposes rapidly when wet and exposed to heat. Decomposing poultry manure is ashy gray in color and the nitrogen and organic content are greatly reduced. Also, there will be a loss of phosphorus and potassium when water leaches through the stockpiled manure. The longer the stockpiled poultry manure is allowed to stand, the greater the nutrient loss.

Covering the stockpiled poultry manure with a six mil plastic cover will help to reduce nutrient loss. In addition, the cover will help to reduce leaching and runoff potential, which reduce potential water contamination.

Never stockpile manure near a well, stream, pond or any other water source. The water drained from the storage area should filter through a grassy area before it enters any body of water. When removing the manure from the storage area, be sure to remove all the waste and clean the area thoroughly.

Test Poultry Manures

One of the first steps in using poultry manure as fertilizer is to determine its nutrient content. This is most accurately done by testing in the laboratory. However, laboratory results are no better than the sample collected.

Sample Properly

The sample must represent the entire supply of manure that will be spread. Subsamples should be collected from 10 to 12 locations throughout the house to the depth the litter or manure will be removed. Subsamples taken near waterers and feeders should be proportionate to the space these areas occupy in the house. When testing stockpiled litter, subsamples should be taken from at least six locations around the pile, at depths of 18 to 24 inches.

After subsamples have been collected from a given source of poultry manure, a composite sample is removed from the thoroughly mixed material and prepared for mailing to a qualified laboratory. The producer may wish to contact the laboratory in advance to determine the size of sample to submit and the type of container to use for mailing. The county Extension office can provide a list of laboratories that analyze poultry wastes. (The University of Tennessee Soil Testing Laboratory DOES NOT analyze waste materials.)

The Laboratory Report

Laboratory results are usually reported in milligrams per kilogram (mg/kg) or milligrams per liter (mg/l), both of which are equal to parts per million (ppm). To convert ppm to percent (parts per hundred), move the decimal point to the left four places. For example, if a laboratory report for a manure sample indicates 41,875 ppm of total nitrogen on a dry-weight basis, the material would contain 4.1875 or 4.2 percent nitrogen.

the various types of waste. Remember, there can be a wide range in nutrient content.

Nutrient Availability

The nutrients in poultry manure will not be 100 percent available for crop use. While about 80 percent of the phosphorus and potassium is estimated to be available for use the first year, the availability of the nitrogen present will be much less. Two important aspects must be considered.

First, about 75 percent of the total nitrogen present in poultry manure is in the organic form and is slowly released to crops.

Secondly, much of the remaining nitrogen is in the ammonium (NH_4) form which can readily transform into ammonia (NH_3) and evaporate if not mixed with the soil. Only about 50 percent of the organic form will become available during the first year following application, while one-half to almost all of the ammonium form will be available depending upon how the material is handled and spread.

Using the above criteria, one ton of broiler litter with the analysis indicated in Table 1 would supply 36 pounds of available nitrogen, 57 pounds of available P_2O_5 (71 x .80 = 56.8) and 38 pounds of available K_2O (47 x .80 = 37.6) the first year following application.

If a material with a similar analysis is applied to the same field year after year, about 46.0 pounds of nitrogen per ton would be available on a continuing basis (Table 2). Phosphate and potash would continue to be added each year at rates of 57 and 38 pounds per ton respectively. Therefore, soil phosphorus and potassium levels should be monitored by soil testing.

Rate to Apply

After the nutrient content of the waste has been determined, the next step is to determine the rate of application. Amounts of poultry manure to use are often based on the nitrogen requirement of the crop to be grown. However, phosphorus should be considered. Applying manures to meet crop needs for nitrogen alone will usually result in excessive use of phosphorus and potassium. If application rates are to be based on phosphorus needs, apply the amount suggested by soil test recommendations. Avoid excessive rates where soil test levels of phosphorus are very high and/or soil erosion is likely.

Table 1. Nutrient Content of Poultry Manures[1]

Manure Type	Moisture %	Nitrogen				Phosphate	Potash
		Total	Ammonium	Organic[3]	Available[4]	P_2O_5	K_2O
Layer (fresh)	75	27	6	21	15	28	14
Layer (high rise)[2]	25	36	21	15	23	41	20
Broiler Litter[2]	20	67	12	55	36	71	47

1/ Averages based on data from several sources.
2/ Based on annual accumulations.
3/ Organic N = total N - ammonium N.
4/ Available N = 50% of organic and 75% of ammonium.

Table 3. Guidelines to Tons Per Acre of Poultry Manure to Apply by Type and Crop for First Year Application.[1]

Crop	Layer		Broiler
	Fresh	High Rise	Litter
	tons per acre[2]		
Corn			
100-125 bu.	8	5.5	3.5
125-150 bu.	10	6.5	4.5
Cotton			
upland	4 - 5	3 - 3.5	2 - 2.5
bottomland	2 - 4	1.5 - 3	1 - 2.0
Small Grain	2 - 4	1.5 - 3	1 - 2
Grain Sorghum	4 - 6	3 - 4	2.5 - 5
Bermudagrass Pasture			
common	4 -12	3 - 8	2 - 5
hybrid	8 -12	5 - 8	3.5 - 5
Fescue Pasture			
spring	3	2	1
fall	4	3	2
Grass Hay	4 - 7	3 - 5	2 - 3.5
Summer Annuals	4 - 8	3 - 5	2 - 3.5
Tobacco	5.5 - 7.5	4 - 5.5	2.5 - 3

1/ Based on N requirements of crops and pounds of available N per ton as shown in Table 1.
2/Ranges in tons per acre to apply reflect ranges in N recommendations for the various crops.

feet between the spread area and adjacent streams, lakes, ponds, sinkholes and wells.

- Test soils regularly to monitor nutrient and pH levels. Proper soil pH will help maximize crop yields, increase nutrient utilization and promote the decomposition of manures.
- Be considerate of your neighbors and try to minimize conflicts when spreading manure.

Poultry manure is a valuable resource when handled and utilized properly. To protect the environment, it is extremely important to use good management practices when handling, storing and spreading poultry manure.

GEORGIA
FARM*A*SYST

FARM ASSESSMENT SYSTEM

BROILER PRODUCTION

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PRE-ASSESSMENT:

Why Should I Be Concerned?

Farmers have always been concerned about soil and water quality. Perhaps more so than any other time in history, today's farmers want to ensure that their land is protected for future generations. Proper utilization of waste materials is essential to maintaining soil and water quality.

Broilers are Georgia's largest single agricultural commodity. Some of the *nutrients** contained in broiler litter and dead bird carcasses from broiler and broiler pullet/breeder operations are mobile and may be leached from litter and dead bird *compost*.

On average, the annual manure produced from a typical broiler house should be applied to no less than 35-40 acres of crop or pasture land in two applications per year. Exceeding that amount may result in over application and increases the risk of nitrate *leaching* into ground water. The manner in which litter is stored and applied to land makes a big difference in the litter's value as fertilizer. Unprotected litter and improperly handled dead bird carcasses may threaten farm water sources.

How Does This Assessment Help Protect Drinking Water and the Environment?

- This assessment allows you to evaluate the environmental soundness of your farm and operational practices relating to your broiler production practices.
- The assessment evaluation uses your answers (rankings) to identify practices or structures that are at risk and should be modified to prevent pollution.
- The broiler production facts provide an overview of sound environmental practices that may be used to prevent pollution caused directly by broiler production practices.
- You are encouraged to develop an action plan based on your needs as identified by the assessment.
- Farm*A*Syst is a voluntary program.
- It is recommended that you involve your broiler company in this farm assessment. Your, company has recommendations on dead bird disposal and litter clean out that will be pertinent to this process.
- Do not make any management changes based on this assessment that may affect your birds without consulting your flock supervisor.
- You are encouraged to work through the entire document and use all eight areas when completing the assessment.
- The assessment should be conducted by you for your use. If needed, a professional from the Georgia Cooperative Extension Service or one of the other partnership organizations can provide assistance in completing the assessment.
- No information from this assessment needs to leave your farm

Soil testing of litter and compost application sites	Yearly	Every 2 years.	Every 3 years.	Less frequently than every 3 years.	
Nutrient (N, P, K) budgeting	Based on waste analysis, soil test, and crop *nutrient* utilization information or done according to NMP.	Soil test used. No waste analysis. *Nutrient* value based on published estimates.	No waste analysis or soil test. Nutrient value based on published estimates alone.	No waste analysis or soil test or effort toward nutrient accounting.	
Record keeping	Complete records kept on farm applications and *nutrients* leaving farm through sales or giveaways.	Partial records kept on farm applications and *nutrients* leaving farm through sales or giveaways.	Partial records kept on farm applications but no records on *nutrients* leaving farm.	No records kept.	
Application timing	According to accurate *nutrient* accounting or NMP. Never applied in wet conditions.	Based on when crop is at growth stage that usually needs fertilizing. Try to avoid applying in wet conditions.	Based on convenience. When manure cleaned out of houses and compost is available. Try to avoid applying in wet conditions.	Based on convenience. When litter cleaned out of houses and compost is available. Often applied when soil is wet.	
Application areas	All areas are more than 25 feet from rock outcrops, 100 feet from surface water sources, wells, dwellings or sinkholes and have slopes of 15% or less. Or all areas are approved by NMP	Most areas are more than 25 feet from rock outcrops, 100 feet from surface water sources, wells, dwellings or sinkholes and have slopes of 15% or less. Or most areas are approved by a NMP.	Litter is occasionally spread over areas that are less than 25 feet from rock outcrops or less than 100 feet from surface water sources, wells, dwellings or sinkholes, or have slopes greater than 15%.	Litter is routinely spread over areas that are less than 25 feet from rock outcrops or less than 100 feet from surface water sources, wells, dwellings, or sinkholes, or that have slopes greater than 15%.	
Calibration	*Nutrient* application equipment calibrated to proper application rate before each application and checked at least once during application period. Uniform application over area is assured.	*Nutrient* equipment calibrated before each application but not rechecked during the application period. No effort to assure uniform *nutrient* application over the area.	Use custom *nutrient* hauler and applicator and assume equipment is calibrated, or calibrate equipment only once a year.	Never calibrate *nutrient* application equipment or ask custom applicator about calibration procedure.	
AREAS AROUND POULTRY HOUSES					
Drainage and areas around broiler houses	All areas without vehicle traffic have more than 90% vegetative cover. High traffic areas are paved or graveled. No visible soil erosion or surface drainage problems.	More than 50% of the area has established vegetative cover. Traffic areas are graveled. Few erosion or drainage problems.	Less than 50% of the area has established vegetative cover. Erosion and drainage problems are evident in traffic areas.	Area around broiler house has less than 25% vegetative cover. Erosion gullies are evident in many areas.	

** These conditions are in violation of State and/or Federal Law

STEP 3: Read the Information/Fact Section on Improving Your Broiler Production Practices
While reading, think about how you could modify your practices to address some of your moderate and high risk areas. If you have any questions that are not addressed in the broiler production practices facts portion of this assessment, consult the references in the back of this publication or contact your county Extension agent for more information.

STEP 4: Transfer Information to the Total Farm Assessment
If you are completing this assessment as part of a "Total Farm Assessment," you should also transfer your broiler average ranking and your identified high risk practices to the broiler farm assessment.

BROILER PRODUCTION FACTS:

Reducing the Risk of Pollution by Improving Broiler Litter Management

Broiler litter and compost from *mortalities*(dead bird carcasses) are *nutrient*-rich materials. These materials can benefit the farm if they are protected adequately and correctly land applied following storage or treatment. However, storage, disposal, or application of these *nutrient*-rich materials can be a threat to farm water sources if not done properly.

Litter storage and land application are important management concerns for poultry producers. Sound management maximizes fertilizer value while reducing the risk of water contamination.

Several dead bird disposal options are available to Georgia poultry producers. Specific requirements and guidelines for these disposal methods can be obtained from your broiler company or the Georgia Department of Agriculture (GDA), call 404-656-3671.

Stored litter and *compost* residue materials should be sampled and tested to determine their nitrogen, phosphorus and potassium content. These *nutrient* values, combined with the amount of litter or residue applied per acre, allow for determination of whether more commercial fertilizer should be added to meet realistic crop production goals.

A *nutrient management plan* (NMP) assists you in effectively using broiler waste in an environmentally safe manner. Any situation where waste is not effectively managed gives rise to potential pollution. Broiler waste can be a source of fecal bacteria. Nitrogen in broiler manures also can be converted into nitrate-nitrogen. Runoff of phosphorus can cause excessive aquatic growth in surface water.

A sound *nutrient management plan* begins with the kind and number of animals in the farm operation and includes every aspect of waste handling. It includes how the waste will be gathered and stored including how large the storage facilities need to be. It also specifies areas to be used for manure application, crops to be grown, the area of land needed to utilize available *nutrients*, and the method and timing of application.

For more information and assistance in developing your *nutrient management plan*, contact your local Natural Resources Conservation Service, agricultural consultant, or county Extension office.

All disposal methods require permits from the Georgia Department of Agriculture (GDA), 404-656-3671. Some disposal methods require a special application form.

Composting of poultry carcasses has proven to be an effective on-farm disposal method. There are several different versions of composters available. All must:

- Be practically odorless.
- Operate at a temperature high enough to destroy pathogenic bacteria (>125° F.).
- Provide for complete *decomposition* of carcasses (only feathers and bones remaining).
- Be adequately protected from flies so that larvae are not a problem.
- Protect the *compost* area from vermin.

Some Georgia farmers use a storage and treatment shed that has primary and secondary *composting* bins and ample room for temporary storage of broiler litter. These facilities allow ready access to the storage and *compost* bins. Materials can be added or removed as often as necessary for their effective treatment and land application.

LAND APPLICATION

Poultry Litter Application

At this writing, there are no state of Georgia regulations governing the land application of poultry litter. Some counties, however, have regulations. Contact your county Extension office to determine if such regulations exist. A farm *nutrient management plan* should be developed with Natural Resources Conservation Service (NRCS) or your county Extension office assistance.

The *nutrient management plan* (NMP) should identify the locations, acreage, and types of crops or pasture to which any wastes are to be applied. An owner may have plenty of land for application of animal wastes, but some of it may be located a great distance from the poultry houses. The practice of spreading animal manures only on the nearest fields can result in excessive *nutrient* loading rates to the soil and possibly cause water quality problems.

Dead Bird Compost Application

Application rates, calibration and timing, and record keeping should be handled like manure. The Georgia Cooperative Extension Service, NRCS county offices and GDA can provide information on *composting* as well as other disposal methods.

Application Rates

The best application rate depends on the crop being produced, the soil's nutrient content and the *nutrient* content of the applied material. Soil testing and litter nutrient analyses are recommended procedures for best determining litter application amounts. Application equipment should be calibrated for accurate and even distribution.

Poultry litter should be evenly distributed over application sites at a rate not to exceed 5 tons per acre per year, with no more than 2.5 tons/acre in each application or according to a site-specific nutrient management plan. As a rule of thumb, annual litter production from one standard 20,000 square feet house 40 X 500 feet should be spread over no less than 35-40 acres.

ABANDONED SITES

Under certain circumstances abandoned chicken houses or old earthen chicken house foundations can be threats to the environment and farm water sources. Any abandoned structure should be completely emptied and the litter properly land applied or stored.

In the case of earthen floor facilities where floor soil is high in *nutrients*, remove soil to a depth of 1 foot and spread with the litter. The remaining hole should be filled and leveled. Litter packs remaining from moved or demolished poultry houses should also be removed and properly land applied or stored. The soil area under the litter pack should be cored and tested for nitrogen, phosphorus, potassium, sodium chlorides, nitrates and sulfates. If any of these compounds and elements are high, you should contact your county Extension agent or NRCS for guidance in dealing with the soil.

GLOSSARY:

Broiler Management

Compost: Organic residues that have been collected and allowed to *decompose.*

Composting: A controlled process of decomposing organic matter by microorganisms.

Cost Sharing: A program in which Consolidated Farm Service Agency (formerly the Agricultural Stabilization and Conservation Service) pays a percentage of the costs of a project, facility or effort.

Decompose: The breakdown of organic materials.

Leaching: The removal of soluble substances from soils or other material by water.

Mortality: Birds that died during production.

Nutrient: Usually referring to those elements necessary for plant growth - *nitrogen (N), phosphorus (P) and potassium (K).*

Nutrient Management Plan: A specific plan designed to manage animal manures and *mortalities* so that the most benefit is obtained and the environment is protected.

Stacking Shed: A structure designed and built for the storage of poultry manure.

ACTION PLAN:

An action plan is a tool that allows you to take the needed steps to modify the areas of concern as identified by your assessment. The outline provided below is a basic guide for developing an action plan. Feel free to expand your plan if you feel the need for detail or additional areas not included. Consult the list of references on the next page if additional assistance is needed to develop a detailed action plan.

Consolidated Farm Service Agency (CFSA, formerly the Agricultural Stabilization and Conservation Service)	Agricultural Conservation Programs (ACP)	Contact Your Local Consolidated Farm Service Agency Office	
Agricultural Pollution Prevention (P^{2}AD)	Opportunities for pollution prevention in poultry operations.	BAE Department 305 Hoke Smith Bldg. Athens, GA 30602	706-542-2154 404-651-5120
Cooperative Extension Service, County Extension Office	Information on nutrient management planning.	See local directory under county government.	

PUBLICATIONS:

State Soil and Water Conservation Commission
P.O. Box 8024
Athens, GA 30603

- Agricultural Best Management Practices for Protecting Water in Georgia

University of Georgia, Cooperative Extension Service or Local County Extension Office
Athens, Georgia 30602

- Georgia's Ground Water Resources, Bulletin 1096
- Well Head Protection for Farm Wells, Circular 819-3
- Animal Waste and the Environment, Circular 827
- Poultry Waste, Georgia's 50 Million Dollar Forgotten Crop, Leaflet 206
- Calibration of Manure Spreaders, Circular 825
- Land Application of Livestock Manures, Leaflet 378
- Composting Poultry Mortalities, Circular 819-5
- Facilities for Storing and Handling Broiler Litter, Newsletter

Poultry Water Quality Consortium
TVA, Suite 4300
5700 Brainerd Rd., 6100 Building
Chattanooga, TN 37402-2801

- Poultry Water Quality Handbook

Georgia Farm*A*Syst
- Dead Bird Composting

WELLHEAD PROTECTION FOR FARM WELLS

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Contents

Ground water in Georgia is generally of very high quality and, for the most part, is free of man-made contamination. Where wells have been tested and found to be contaminated, the source of contamination is usually at or very near the well site. For this reason, it is very important to do all you can to protect your well and the surrounding area from all potential sources of contamination which may be present on your farm.

A good supply of fresh water is essential to all farming operations. We use fresh water for watering livestock, irrigating crops, mixing pesticides, cleaning equipment and human consumption. In Georgia, 90 to 95 percent of farmers obtain at least part of their water supply from farm wells. If they are not properly protected, these wells are at risk of being contaminated from several sources. Potential sources of ground water contamination on the farm include:

1. livestock waste and waste lagoons
2. pesticides
3. fertilizers
4. fuel storage tanks
5. septic tanks

There are several important steps that you as a farmer should do to ensure that you do not contaminate your own well and, in the process, possibly contaminate other wells in your area. The six principles of wellhead protection are as follows:

"The drilling contractor shall maintain in his office and shall furnish the owner a copy of the well construction data within 30 days of the well completion."

"A well having an open annular space between the casing and the bore hole ***shall be grouted*** *and shall be filled with neat or sand cement grout or other impervious materials to prevent the entrance of pollutants or contaminants to the well."* The minimum depth of seal for individual wells is 10 feet. It is preferred, however, that the well grout extend all the way from the ground surface to the water-bearing formation.

"All individual and nonpublic wells shall be curbed at the surface by the owner with a watertight curbing of concrete at least four inches thick and extending at least two feet in all directions from the well casing and sloping away from the casing;"

The requirements most frequently violated which pose a threat to ground water include lack of adequate grouting, lack of a proper seal at the top of the casing, lack of a concrete slab around the well casing and failure to disinfect the well after construction or well service.

Keeping Contaminants Away from Well

In order to reduce the chances of an accidental spill in the vicinity of a well, or contamination of soil around a well, you should maintain certain minimum horizontal distances between the well and sources of contamination. The following are recommended minimum distances from potential pollution sources on the farm:

1. septic tank - 50 feet
2. septic tank absorption field - 100 feet
3. waste lagoon - 150 feet
4. dead animal burial pits - 150 feet
5. animal or fowl enclosure - 100 feet
6. pesticide storage, mixing and loading facilities - 100 feet
7. fertilizer storage - 100 feet
8. petroleum storage - 100 feet

Never mix pesticides or discard empty pesticide containers adjacent to a well. All such activities should be kept at least 100 feet from the well. The safest way to mix pesticides is to fill a nurse tank with water from the well and carry the water to the field where you can you fill the sprayer and mix chemicals a safe distance away from any water source. Empty containers should be pressure rinsed or triple rinsed, punctured and properly disposed of.

Backflow Prevention

One hazardous situation which can occur on the farm results when chemicals are accidently back-siphoned into a well. This can occur as a result of improperly filling spray tanks or when chemicals are injected into irrigation systems without proper safety devices.

As mentioned previously, filling spray tanks directly from a well is not recommended, especially after the chemical has already been added to the tank. However, if you do fill a spray tank in this

In order to have your water tested, you may contact your local county extension agent for mineral analysis, nitrates, pesticides or volatile organic chemicals. The health department in most counties will perform a coliform bacteria test. There are also several private labs in the state who offer these services.

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Circular 819-13 Revised January 1993

Gale A. Buchanan, Dean & Director

GEORGIA FARM*A*SYST

MANAGING RUNOFF AND EROSION ON CROPLANDS AND PASTURES

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Biological & Agricultural Engineering

FARM ASSESSMENT SYSTEM

Cooperative Extension Service, The University of Georgia, College of Agricultural and Environmental Sciences, Athens

PRE-ASSESSMENT:

Why Should I Be Concerned?

Nonpoint source pollution can be defined as pollution from miscellaneous and scattered sources rather than a specific point. Since it is difficult to recognize and monitor, historically only pollution from point sources has been regulated. Today, we realize that nonpoint sources contribute as much or more of the pollutant load than point sources and must be managed as well. Often, the best method for preventing nonpoint source pollution is to reduce *runoff* and sediment resulting from rainfall on land areas we manage.

Runoff occurs when the rate of rainfall exceeds the rate that soil can absorb it (infiltration). Problems may arise when too much rainfall runs off of the land. These include increased drought stress to plants, productivity losses, flooding of low lying areas, and increased soil erosion and transport of other pollutants. Cotton yields from eroded soils in Georgia can be as much as 50% less than yields from non-eroded fields. This problem is compounded by the fact that eroded soils will often require increased inputs to sustain desired yields.

Sediment transported to streams and lakes by *runoff* is the largest single pollutant of surface water. Sediment resulting from soil erosion causes considerable off-farm damage. Sediment can accumulate and fill in stream channels and lakes, disrupt aquatic reproduction, and contribute to downstream flooding. It can also clog water filters, damage pumping equipment, and shorten the economic life of reservoirs and farm ponds. While soil erosion is a natural process, the actions of man greatly affect the amount of soil eroded by wind and water.

How Does This Assessment Help Protect the Environment?

- This assessment allows you to evaluate the environmental soundness of your practices relating to your management of croplands and pastures.
- You are encouraged to work through the entire document.
- The assessment asks a series of questions about your land management practices.
- The assessment evaluation uses your answers (rankings) to identify practices or structures that are at risk and should be modified to prevent pollution.
- The *runoff* and erosion facts provide an overview of sound environmental practices that may be used to prevent pollution.
- You are encouraged to develop an action plan based on your needs as identified by the assessment.
- Farm*A*Syst is a voluntary program.
- The assessment should be conducted by you for your use. If needed, a professional from the Georgia Cooperative Extension Service or one of the other partnership organizations can provide assistance in completing the assessment or action plan.
- No information from this assessment needs to leave your farm.

**Words found in italics are defined in the glossary.*

RUNOFF AND EROSION CONTROL

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RANK
EROSION CONTROL (CROP LAND)					
***Rill* Erosion**	No *rills* are evident in crop land throughout the year.	*Rills* occur in some years but erosion control plan is used for prevention in most areas.	Small *rills* are evident at the end of most growing seasons.	*Rills* that make tillage difficult occur most years.	
Crop Rotation	All rotations include a different crop and winter cover each year, and at least one *legume* is in the rotation.	Crop rotation including a winter cover crop or significant residue is used each year.	Some crop rotation with limited fallow periods or a continuous cropping system with winter cover is used.	Continuous cropping of the same crop more than three years without winter cover or significant residue is used.	
Conservation Tillage	*Conservation tillage* system in place and crops are always planted into at least 30% cover.	*Conservation tillage* used when possible. Most crops are planted into at least 30% residue cover.	Tillage or soil preparation in the spring. Less than 15% residue cover after planting.	Tillage or soil preparation in the fall. Less than 10% residue cover after planting.	
Cropping on Sloping Fields (Do not answer for fields less than 3% slope)	Strip cropping used with forage or densely planted crop alternated with row crops planted on contour.	*Contour tillage and planting* with filter strips, waterways, or terraces used to keep slope lengths short.	*Contour tillage* and planting is used.	Up and down slope tillage and planting is used.	
Critical or Highly Erodible Areas	No areas in any field where erosion occurs regularly, all of these areas are grassed or removed from production	Some highly erodible areas appear after large rainfall events, but most highly erodible areas are grassed.	Some spots erode in most years, but these discharge into other fields or grassed areas.	Several spots erode regularly every year.	
EROSION CONTROL (PASTURES OR HAYFIELDS)					
Pasture Condition	Pastures maintained so forage height is usually greater than two inches. No visible bare spots.	Pastures maintained so forage height is usually greater than two inches. Few bare spots.	Pasture is usually maintained with forage height of less than two inches. Some bare spots.	Pasture is often trampled and dying. Many large bare spots.	
Gully Erosion	All former gully erosion sites are controlled with no gullies present.	Gully erosion sites are controlled and stabilized with vegetation or proper fill materials	Gully erosion sites are somewhat controlled and not advancing.	Several gullies exist and appear to be growing each year.	
Livestock Access to Water	Livestock are fenced out of natural water bodies (streams, ponds, lakes, wetlands, and ditches).	Livestock have access to natural water bodies at a few locations which have erosion control measures in place.	Livestock have access to natural water bodies but alternate watering sources are available in upland areas.	Livestock have uncontrolled access to natural water bodies.	

ASSESSMENT EVALUATION:

What Do I Do with These Rankings?

STEP 1: Identify Areas That Have Been Determined to be at Risk

Low risk practices (4s) are ideal and should be your goal. Low to moderate risk practices (3s) provide reasonable protection. Moderate to high risk practices (2s) provide inadequate protection in many circumstances. High risk practices (1s) are inadequate and pose a high risk for causing environmental, health, economic, or regulatory problems.

High risk practices, rankings of "1", require immediate attention. Some may only require little effort to correct, while others could be major or costly and may require planning or prioritizing before you take action. All activities identified as "high risk" or "1s" should now be listed in the action plan. Rankings of "2s" should be examined in greater detail to determine the exact level of risk and attention given accordingly.

STEP 2: Determine Your *Runoff* and Erosion Risk Ranking

The Risk Ranking provides a general idea of how your practices and land use might be affecting ground and surface water, and degrading soil quality.

Use the Rankings Total and the Total Number of Areas Ranked as determined from the questionnaire portion of this assessment to determine the *Runoff* and Erosion Risk Ranking.

RANKINGS TOTAL ÷ TOTAL NUMBER OF AREAS RANKED = RUNOFF/EROSION RISK RANKING

_______ ÷ _______ = _______

RISK RANKING	LEVEL OF RISK
3.6 to 4	Low Risk
2.6 to 3.5	Low to Moderate Risk
1.6 to 2.5	Moderate Risk
1.0 to 1.5	High Risk

This ranking gives you an idea of how your practices and land use might be affecting your water and soil quality. This ranking should serve only as a general guide, not a precise diagnosis, because it represents an averaging of many individual rankings.

STEP 3: Read the Information/Fact Section on Reducing *Runoff* and Erosion

When reading this, give some thought to how you could modify your practices to address your moderate and high risk areas. If you have any questions that are not addressed in the following portion of this assessment consult the references in the back of the publication or contact your county Extension agent.

STEP 4: Transfer Information to Total Farm Assessment

If you are completing this assessment as part of a "Total Farm Assessment," you should also transfer your Runoff and Erosion Risk Ranking and your identified high risk practices to the total farm assessment.

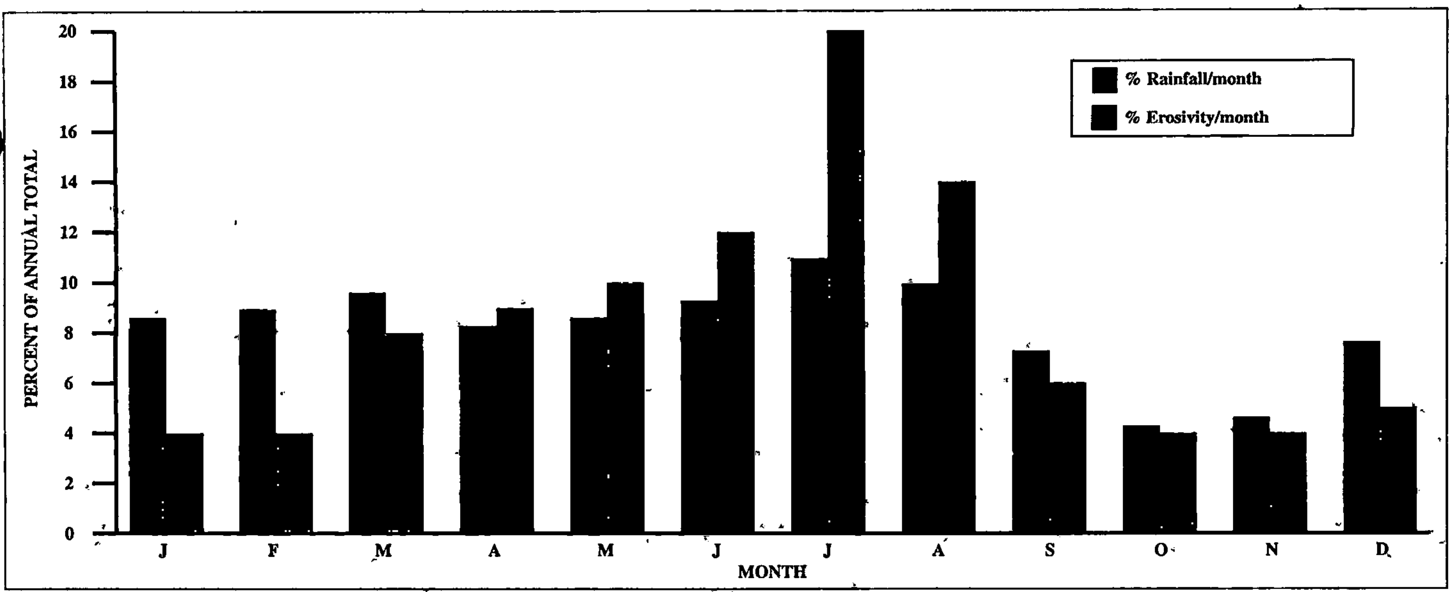

FIGURE 1. Graph showing the distribution of rainfall and *erosivity* of that rainfall for Douglas, Georgia.

grass sod areas absorb more rainfall than other land uses. The infiltration is proportionately less based on the cropping practices (see Table 1 on the next page). Note that under row crop conditions we would expect 5 to 10 times more *runoff* and up to 300 times more soil loss than under forested conditions. Second, crop canopy and surface cover or residue act as a buffer between the soil surface and raindrops, absorbing much of the rainfall energy and ultimately reducing soil erosion. Therefore, crops that produce more vegetative cover, have longer growing seasons, or produce more residue will generate less soil erosion. Management is also important as tillage can reduce surface cover and residue. No-till and *conservation tillage* systems are effective in maintaining surface cover and reducing soil erosion. Any cropping system that requires less tillage or greater amounts of biomass production, such as *perennial* systems, will result in less sediment leaving the field.

Soil Structure

Soil type will determine its vulnerability to erosion. Properties affecting soil *erodibility* are texture, structure, organic matter, and its ability to absorb water. Soil containing high percentages of fine sands and silt are normally the most erodible. As clay and organic matter content increases, *erodibility* decreases. While clay acts as a binder or "glue" to reduce erosion, once eroded clay particles are easily transported off site. Organic matter can also bind soil particles making them more resistant to erosion. The organic matter of a given soil can be built up over time to produce improved soil structure that will result in less erosion.

Infiltration rate of a soil determines *runoff* amount and corresponding erosion. In general, sandy soils can absorb from 0.50 to greater than 2.0 inches of rainfall per hour while most clay soils can only absorb 0.50 inches per hour or less. In addition, rainfall may cause soil "*crusting*" on freshly prepared seedbeds. Soil particles tend to seal soil pores and reduce infiltration. When this happens, only a small part of the rain soaks in and the rest runs off the field. This may increase irrigation demands. Irrigation water may also run off the field under this condition. This may require another irrigation soon to avoid crop stress, thus increasing the cost of production. *Compaction* can further reduce infiltration resulting in even greater soil erosion.

Slope and Slope Lengths

Historically, reducing slope steepness and length have been the primary means of erosion control. Since the dawn of agriculture, man has known that longer and steeper slopes produce more soil erosion and has used methods such as the construction of levies and terraces to reduce slope length and steepness. More recently, practices such as strip cropping and vegetated waterway construction have been

TABLE 2. Best Management Practices for Controlling Runoff and Erosion

BMP	Description	Cost Install / Maintain	Mode of Action
Buffer Zone	Undisturbed or planted vegetative strip around a site or bordering a stream	Med/Low	Filters/removes sediment and stabilizes banks
Check Dam	Small temporary barrier constructed across a swale, drainage ditch, or area of concentrated flow	Med/Med	Short term measure. Reduces low velocity, deposition of sediment
Conservation Tillage	Planting and culturing crops with less tillage to maintain at least 30% residue cover on the surface	Med/Low	Increases infiltration and soil quality and protects soil from raindrop impact
Contour Farming	Planting across the slope rather than up and down the slope	Low/Low	Increases infiltration and reduces flow velocities
Cover crops/Crop Rotation	Planting crops in the winter or sequences of crops resulting in more soil coverage	Low/Low	Improves soil quality and reduces periods of soil exposure to rainfall
Critical Area Planting	Removing highly erodible area from production by planting them to permanent cover	Med/Low	Stabilizes highly erodible areas
Filter Strips	Strips of grass planted around a site or bordering a stream	Med/Low	Filters sediment from *runoff*
Diversion	Ridge of soil constructed above, across, or below a slope	Med/Low	Reduces slope lengths. Routes *runoff* to stable outlets
Level Spreader	Outlet device constructed across the slope where concentrated *runoff* is discharged at low velocity into vegetated areas	High/Med	Converts concentrated *runoff* into sheet flow that can infiltrate the soil or be filtered.
Sediment Barrier	Temporary structure made of silt fence, sand bags, straw bales, or other filtering material	Low/Med	Slows *runoff* velocity and filters or deposits sediment
Sediment Basin	Basin or pond created to collect sediment	High/Med	Holds *runoff* temporarily to trap sediment
Stripcropping	Planting alternating strips of crops and small grains or forage across the slope	Low/Low	Forage or grain strips are used to filter sediment from *runoff* from cropped area
Streambank Stabilization	Use of readily available plant materials to prevent, restore, maintain or enhance stream banks	High/Low	Filters/removes sediment and stabilizes banks
Terracing	Earthen embankment constructed across the slope to collect *runoff*	High/Low	Reduces slope length and flow concentration
Vegetated Waterway	Waterway that is shaped or graded and stabilized with vegetation	High/Med	Removes *runoff* on stabilized surface

example, using a small pond to collect sediment before entering a stream is an example of reducing pollutant transport.

When selecting BMP's, a systematic approach should be used to insure that the selected practice will solve the problem. The most effective plan will probably consist of several different BMP's that target different mechanisms. Finally, if a BMP is not economically feasible and well suited for the site, it should not be selected. Consider all costs including effects on yield, production and machinery costs, labor and maintenance, and field conditions. Often effective BMP's will become a problem if all costs are not considered before implementation. The list of BMP's in Table 2 should be helpful in devising a plan to reduce soil erosion. Many of these BMP's are a "telltale" sign of significant sediment loss and will grow into gullies if left unchecked. They are most noticeable at the end of the growing season since they develop over time between tillage operations. Studies have shown that productivity is reduced in areas that are prone to *rill* erosion. While tillage can remove *rills*, they will often erode again unless other BMP's are used to prevent upslope *runoff*. Simple monitoring of your fields during the growing season will help you recognize where *rills* are regularly occurring and may help you develop strategies for addressing problem areas.

Crop Rotation

Cropping practices and rotations have a dramatic effect on soil quality, *runoff* and erosion, and nutrient and pesticide loss. By simply changing practices or crop sequence, you can substantially reduce erosion and improve productivity. Crop rotations involve a planned sequence of changing crops grown on a particular field. A typical rotation often involves a year or two of a high value crop such as peanuts, corn, or cotton followed by a grass or *legume* such as soybeans, small grains, or hay. Crop rotations not only reduce erosion by improving soil properties, but they also provide increased cover during certain times within the growing season to lower the overall erosion rate. In addition, rotations can be used to reduce or control nematodes, insects, and diseases. By including a non-host crop in the rotation, they prevent the buildup of certain pests associated with continuous crop production resulting in less pesticide use. Finally, when *legume*s are used in a rotation, nitrogen formed by fixation can reduce nitrogen supplement required for the subsequent crop. This is a great example of a BMP that makes both economic and environmental sense.

Cover crops are often used to protect the soil surface during the winter and early spring. Besides being an effective and economical BMP, *cover crops* will also improve soil quality over time if tillage is also reduced. Most crop lands are only used 50 to 75% of the year for production of a winter and/or summer crop. The remainder of the time, crop lands lie idle. In addition to controlling erosion by blanketing the soil, when tillage is reduced, *cover crops* can also add organic matter, thus increasing soil quality and holding the soil in place. *Legume*s, grasses, and grains commonly grown as *cover crops* in Georgia include crimson clover, winter rye, and wheat.

Conservation Tillage

Soil disturbance or tillage is the primary reason that agricultural fields produce more erosion than other land uses. It exposes the soil surface to rainfall that detaches soil particles, increases soil *crusting* causing greater *runoff*, and decreases vegetation at the soil surface. In addition, soil *compaction* from tillage causes substantial reductions in productivity. Many Georgia row crops can be produced using *conservation tillage* which is generally considered the most effective single practice for reducing erosion and sediment transport. *Conservation tillage* is a means of planting and culturing crops with minimum soil disturbance. It can include no-till, strip till, ridge till, and mulch till systems. In *conservation tillage*, at least 30 percent of the soil surface is covered with a cover crop or crop residue immediately after planting. Crop residues, including old plant stalks and leaves, dissipate rainfall energy and protect the soil surface from water and wind erosion. It also creates a rougher soil surface that reduces flow velocities and increases surface storage and infiltration. The amount of tillage needed with *conservation tillage* varies with soil type and crop. The key in conservation till systems is obtaining a suitable growing environment that is weed free and non-compacted, without burying large amounts of residue beneath the soil surface. New equipment for tillage and planting have been extremely helpful. In-row subsoilers are especially valuable for summer crops like soybeans, cotton, and corn in Georgia.

The most common approach to *conservation tillage* in Georgia is to grow a winter small grain, harvest it, spread the residue, then use special *conservation tillage* planters to plant directly into the small grain residue. *Conservation tillage* has been shown to reduce surface soil temperature by as much as 30° F and *runoff* by as much as 95% over that of conventional tillage. On average, *conservation tillage* reduces soil loss by 50 to 95%. Actual ditches from being filled with sediment. Waterway surroundings and ditch banks are susceptible to degradation and erosion if not properly protected from agricultural practices and adverse seasonal conditions. Grassed cover protects the soil and holds the banks which helps to prevent soil accumulation within the watercourse. Wooded strips are known to retain up to 90% of the sediment from agricultural land.

Other benefits of vegetative buffer strips include the following:

- Stabilizes watercourse banks,
- Provides a sediment filter or barrier to surface water flow,
- Prevents water warming (benefit for fish and aquatic life),
- Filters nutrients from agricultural land and prevents them from reaching groundwater or waterways,
- Creates habitat for wildlife,
- Provides a natural windbreak, depending on the vegetative species utilized, and
- Increases land value.

In Georgia, several programs are available to assist you in establishing vegetative buffers. For example, the Conservation Reserve Program (CRP), will provide you with cost sharing and rental payments for acreage that you use to protect water quality. Contact NRCS or FSA for more information on these programs.

Erosion Control (Pastures or Hayfields)

Although areas used for pasture and forage production have a low potential for pollution due to an abundance of soil cover and relatively low amounts of chemical and nutrient input, if improperly managed they can contribute significant amounts of nonpoint source contamination. Grasslands or pastures are essential to almost any livestock operation. They provide nutrition for livestock and food and cover for wildlife. Well-managed grasslands protect valuable soil resources and improve water quality. The fibrous root systems of healthy grasses hold soil in place preventing erosion and off site contamination.

Pasture Condition

Keys to maintaining adequate and sustainable pastures must be recognized. Plant selection is critical. The plant must be adapted to both the soil and climate to insure adequate cover throughout the year. Determining proper *stocking rates* that will not damage the vegetative cover, resulting in increased soil erosion, is also essential. Controlling animal traffic can help to prevent bare spots that could lead to the formation of *rills* and gullies. Weeds may be a problem in some pastures; however, proper grazing management and fertilization should reduce weed problems. When pasture renovation becomes necessary, no-till or other *conservation tillage* practices that minimize erosion should be used.

Properly designed rotational grazing systems may improve pastures and often increase productivity. Long-term persistence of forage species is increased when proper grazing heights are used to manage cattle access to a pasture. Proper grazing heights vary by forage species with creeping species sustaining closer grazing than upright-bunch-type species. Once defoliated, forages need time to accumulate energy reserves and initiate new growth before being grazed again. When management allows a rest period, by either stocking method or grazing pressure, pasture plants tend to maintain more vigorous growth. *Stocking rates* on pastures should be low enough to maintain a minimum plant cover. While this varies with plant species, usually heights of 3 to 4 inches are recommended. Continuous, close grazing may weaken the stand, exposing the soil surface to sunlight and eroding forces of rainfall, allowing the opportunity for weeds to invade.

Gully Erosion

Since pastures usually have adequate cover in Georgia, gullies are a prime source of sediment in most systems. It is essential to understand how excess water is drained from their fields and pastures. Often this can be observed following large rain storms. Find locations where *runoff* concentrates and watch these areas for *rill* development. If rilling occurs, these areas should be smoothed and stabilized with vegetative cover before gullies are attention to placement is an effective and inexpensive way to minimize negative environmental impacts, decrease pasture degradation, and prevent large commonly used loafing areas.

A practice known as *Heavy Use Area Protection* stabilizes areas that are frequently used by livestock. *Heavy use area* protection should be considered around water troughs, hay rings, mineral feeders, and livestock lanes. *Heavy use areas* are typically protected by (1) grading and leveling the area to provide for drainage and prevent ponding of water, (2) removing undesirable materials to design specifications, (3) placing geotextile over the treatment area, and (4) spreading graded aggregate base (GAB) stone to a minimum depth of 6 inches over the treatment area. Including grading, materials and installation, the approximate cost for *heavy use area* protection is $1 to $1.25 per square foot. Once installed these areas should be maintained by routine inspection, scraping, proper redistribution of animal wastes, and additions of crusher run stone, as needed.

Deposition or Off-site Impacts

Deposited sediment and murky or turbid water running off your fields are indications that erosion is occurring in upslope areas. These indicators should be used to measure the impact that your upland BMP's are having and improve your practices when necessary.

Color of Water Leaving Fields After Large Storms

Sediment concentrations in rivers and streams range from 100 to 50,000 parts per million (ppm) with occasional concentrations as high as 500,000 ppm. Sediment carried within flowing water is often measured as "suspended solids." Since heavier soil particles settle out of water quicker than light particles, large sand particles are often deposited as soon as they enter a river or stream. Smaller particles, such as silt and clay, are often carried much further downstream until the flow reaches a lake or pond. Turbidity, a measure of the light that can pass through water, is an indirect measure of sediment since suspended solids often make the water appear cloudy. While both turbidity and suspended solids affect the aesthetic quality of water, neither have a direct impact on human or animal health. If your water is running red or cloudy in north Georgia and murky in south Georgia, then it is probably carrying significant amounts of your topsoil off of your property.

Deposited Sediment

Like turbidity, deposited sediment indicates that soil erosion is occurring up slope. Since heavier particles settle first, areas of deposition may look like sandy areas in a field. Since sand does not hold much water, these areas of deposition are usually less productive. Another problem is that the sand is being removed from more productive areas of the field and leaving a denser, often clayey subsoil that is also less productive. This is how soil erosion, in general, lowers your overall soil quality and negatively impacts your production. While deposition indicates that at least some particles are not leaving your farm and affecting downstream water quality, it also indicates that more up slope erosion control may be required to sustain productivity.

Other Sources of Erosion

The goal of this assessment is to address erosion on crop lands and pastures; however, no discussion of erosion is complete without at least mentioning a couple of other major sources of soil erosion.

Stream Banks

Stream channels and banks should be protected to reduce erosion. Often this can be accomplished using vegetation; however, at times structural measures such as rock riprap may need to be used. Generally, livestock should never have unlimited access to any body of water, but when necessary the areas should have dense vegetation, smooth stable slopes, and firm surfaces. If your farm has areas where stream banks are nearly vertical or the land is occasionally sloughing off into the stream, you may want to contact the NRCS or State Soil and Water

ACTION PLAN:

An action plan is a tool that allows you to take the needed steps to modify the areas of concern as identified by your assessment. The outline provided below is a basic guide for developing an action plan. Feel free to expand your plan if you feel the need for detail or additional areas not included. Consult the list of references at the end of this publication if additional assistance is needed to develop a detailed action plan.

Area of Concern	Risk Ranking	Planned Action to Address Concern	Time Frame	Estimated Cost

REFERENCES:

CONTACTS AND REFERENCES			
Organization	**Responsibilities**	**Address**	**Phone number**
Agricultural Pollution Prevention (P^2AD)	Questions concerning pollution prevention practices that can save you money.	BAE Department, University of Georgia Driftmier Engineering Center Athens, GA 30602	706-542-9067
County Extension Service – The University of Georgia	Information about management of crops, pastures, and livestock.	Local county Extension Service	Local – check your local telephone directory blue pages under County Government
Georgia Conservation Tillage Alliance	Technical assistance regarding conservation tillage	Local alliances throughout State	912-982-4285
Georgia Environmental Protection Division	Nonpoint source pollution and water quality	4220 International Parkway, Suite 101 Atlanta, GA 30354	404-675-6420
Georgia Soil and Water Conservation Commission	Best Management Practices and implementation of erosion and sediment control activities in Georgia	4310 Lexington Road P. O. Box 8024 Athens, GA 30603	706-542-3065
USDA-Natural Resource Conservation Service	Technical assistance and federal cost share programs on conservation practices	Local county or multi-county Field Office	Local – check your local telephone directory blue pages under U.S. Government

PUBLICATIONS:

State Soil and Water Conservation Commission
P.O. Box 8024
Athens, GA 30603

- Agricultural Best Management Practices for Protecting Water in Georgia
- A Georgia Guide to Controlling Erosion with Vegetation: establishing and maintaining vegetation on erosive sites
- Guidelines for Streambank Restoration
- Field Manual for Erosion and Sediment Control in Georgia

University of Georgia, Cooperative Extension Service
Athens, Georgia 30602

- Soil Saving Practices: Conservation Tillage, Bulletin 916-5, 1985.
- Soil Saving Practices: Sediment Erosion Control, Bulletin 916-6, 1985.
- Soil Saving Practices: Predicting Peak Rates of Runoff from Small Watersheds, Bulletin 916-3, 1985.
- Soil Saving Practices: Wind Erosion Control, Bulletin 916-2, 1985.
- Soil Saving Practices: Terraces, Bulletin 916-4, 1985.
- Soil Saving Practices: Grassed Waterways, Bulletin 916-1, 1985.

USDA Natural Resources Conservation Service, Local Field Office

- Conservation Practice Standards, Field Office Technical Guide

Nutrient Management Planning
Proper Dead Bird Disposal

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The traditional method of dead bird disposal in Georgia has been burial pits. The area where most of the broiler industry originally developed and is still heavily concentrated (Northeast) happens to have soil characteristics that are beneficial for pits (clay). As the industry has expanded to other areas of the state where limestone or sandy soils are prevalent, especially when high water tables are present, pits generally do not work well and may have the potential for contaminating water outside the pits. Concern over potential problems associated with pits have led to development of alternative disposal methods, including composting, incineration, and other methods.

The pit is the simplest and cheapest method currently available to dispose of mortality. The most common method of construction involves using a backhoe to dig a trench approximately 3 feet wide by 10 feet long by 6-8 feet deep. A prefabricated concrete slab with one or two openings is placed over the trench, and the pit is ready for use. The rough cost for the digging ($75) plus the slab ($150) is minimal, especially as the slab is reusable on a new pit once the old one is filled and covered (using dirt from the new pit). The life of the pit is variable, depending on soil conditions, number of birds loaded into it, and other management factors, but 1 to 4 years is common. Although guidelines have been issued by some states regarding pit construction that recommend lining the walls and/or floor with wood or concrete blocks, most pits in North Georgia do not. Over 90% of poultry growers in Georgia have pits as a primary or backup disposal method. There are nearly 4000 active pits and many thousands of inactive pits in the state. There have been no documented cases of soil or water contamination from poultry pits in Georgia.

Problems associated with pits are minimal in North Georgia. If properly located away from a spring area or where ground water collects and then sealed by the slab, mortality decomposes at a good rate and larger animals are prevented from removing contents. The clay soils do not appear to allow leakage of microbial or chemical pit contents very far from the pit into surrounding soil or water. Problems may occur in other areas with little or no clay soils, where pit contents may escape into surrounding soil or water. This concern has prompted many states to ban pits statewide or regionally within a state. Unfortunately, bans have been instituted with little or no scientific data regarding either the escape of pit contents or of soil types within those states. The bans have had a positive effect by forcing research on alternative disposal methods.

The two most common alternative disposal methods have been composting and incineration. Composting is the most widespread method used in states that have banned pits in the past ten years, but correct operation requires a covered area with a concrete floor, plus continued management. Incineration requires an incineration device plus a fuel supply; future

ANIMAL PRODUCTION

GEORGIA
FARM*A*SYST

FARM ASSESSMENT SYSTEM

COMPOSTING POULTRY MORTALITIES

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PRE-ASSESSMENT:

Why Should I Be Concerned?

Farmers are concerned with soil and water quality. With a rapidly expanding poultry industry and equally rapid urban growth, it is becoming more difficult for farmers to safely dispose of poultry *mortalities**.

An acceptable system for the disposal of dead birds is essential to any well run poultry operation. Current practices include incineration, burial pits, land filling, digestion/fermentation, rendering and *composting*. *Composting* of dead birds is a more recent disposal alternative that is environmentally sound. This process converts dead birds into a humus-like material that can be spread on land for crop utilization and/or soil improvement. This relatively inexpensive method of dead bird disposal is rapidly gaining acceptance in the poultry industry.

Assessment Objective

Unlike the other Farm*A*Syst assessments that focus on farmer stewardship and the environmental soundness of facilities and management practices, this assessment focuses on your *composting* facilities and procedures to ensure that the process prevents health risk or soil and water contamination. This assessment should be used in conjunction with the Broiler or Layer Production Farm*A*Syst assessments that address other environmental concerns pertaining to your operation.

How Does This Assessment Improve the Composting Facility On My Farm?

- This assessment is designed to ensure that your *composting* facilities, tools and techniques are part of a sound waste management plan.
- If you are a contract farmer, it is recommended that you involve your integrator in this farm assessment. Your company has recommendations on carcass disposal and *litter* clean-out pertinent to this process.
- Do not make any management changes based on this assessment that may affect your animals without consulting your integrator.
- You are encouraged to complete the entire document.
- The assessment should be conducted by you for your use. If needed, a professional from the Georgia Cooperative Extension Service or one of the other partnership organizations can provide assistance in completing the assessment.
- You are encouraged to develop an action plan.
- Farm*A*Syst is a voluntary program.
- No information from this assessment needs to leave your farm.

**Words found in italics are defined in the glossary.*

POULTRY MORTALITY COMPOSTING PRACTICES

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RANK
COMPOSTER OPERATION					
Employee training in dead bird composting methods	All employees associated with *composting* are thoroughly trained in dead bird *composting* procedures.	Employees who regularly compost are thoroughly trained in dead bird *composting* procedures.	Employees associated with *composting* re-ceive limited training on dead bird *composting.*	Employees associated with *composting* re-ceive no training on dead bird *composting.*	
Composting procedures	Are outlined in an easy-to-follow recipe, available to all composters, which de-scribes amount, order, placement and treatment of all ingredients being composted.	Recipe is used, but does not contain all needed information.	Operator has a quality recipe for *compost*, but recipe is seldom used.	Operator either does not have a *compost* recipe or never uses a recipe for *composting.*	
Microorganisms responsible for composting are supplied by	A double layer of fresh active (warm) *litter/litter cake* with 40-60% moisture, reactivated litter or active compost.	A double layer of dry *litter*/dry *litter cake*, or less than a double layer of active *litter/litter cake.*	Less than a double layer of dry *litter* or dry *litter cake* used as starter.	No starter used.	
Carcass placement	Carcasses are never placed closer than 6 inches from sidewalls or top of bins.	Carcasses are never placed closer than 6 inches from bin sidewalls, but are sometimes left uncapped overnight.	Carcasses are sometimes placed within 6 inches of bin side walls.	No attempt is made to keep carcasses away from top or sides of bins.	
Filling birds	Birds are covered daily with at least a double layer of *litter cake* or 1.5 parts by weight of *litter* for each volume/weight of birds. When full, bins area capped off with a double layer of litter.	Birds are sometimes left uncovered overnight.	Less than two volumes of *litter cake* are added for each volume of birds or less than 1.5 parts by weight of litter per bird weight.	When compost bin is filled to a height of 4 to 4 /2 feet, *compost* is either left uncapped, or is capped with less than a double layer of *litter.*	
How is the moisture content of compost determined?	Moisture meter.	Estimated by hand.	Estimated visually.	No attempt made to monitor or adjust moisture.	

POULTRY MORTALITY COMPOSTING PRACTICES

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RANK
Application rates	*Compost* applied to fields at rates that meet crop *nutrient* requirements based on a *nutrient management plan* (NMP). Litter and soils are tested.	*Compost* applied to cropped fields at rates that do not exceed 2.5 tons/acre/application, and do not exceed 5 tons/acre/year. Soils in application areas tested.	*Compost* applied to cropped fields at rates that do not exceed 2.5 tons/acre/application, and do not exceed 5 tons/acre/year. Soils in the application areas are not tested.	*Compost* applied to cropped lands at rates that exceed 2.5 tons/acre/application, or exceed 5 tons/acre/year or materials applied to uncropped lands at any rate.	
Application timing	According to accurate *nutrient* accounting or NMP, Never applied in wet conditions.	Based on when crop is at growth stage that usually needs fertilizing. Try to avoid applying in wet conditions.	Based on convenience. When manure cleaned out of houses, and *compost* are available. Try to avoid applying in wet conditions.	Based on convenience. When *litter* cleaned out of houses and *compost* are available. Often applied when soil is wet.	
Application areas	All areas are more than 25 feet from rock outcrops, 100 feet from surface water sources, wells, dwell-ings or sinkholes and have slopes of 15% or less. Or all areas are approved by an NMP.	Most areas are more than 25 feet from rock outcrops, 100 feet from surface water sources, wells, dwell-ings or sinkholes and have slopes of 15% or less. Or most areas are approved by an NMP.	*Litter* is occasionally spread over areas that are less than 25 feet from rock outcrops or less than 100 feet from surface water sources, wells, dwellings or sinkholes or have slopes greater than 15%.	*Litter* is routinely spread over areas that are less than 25 feet from rock outcrops or less than 100 feet from surface water sources, wells, dwellings, or sinkholes or that have slopes greater than 15%.	
Record keeping	Complete records kept on farm applications and *nutrients* leaving farm through sales or giveaways.	Partial records kept on farm applications and *nutrients* leaving farm through sales or giveaways.	Partial records kept on farm applications but no records on *nutrients* leaving farm.	No records kept.	
Calibration	*Nutrient* application equipment calibrated to proper application rate before each application. Uniform application over the area is assured.	*Nutrient* equipment calibrated annually. No effort to assure uniform *nutrient* application over the area.	Use custom *nutrient* hauler and applicator that does not calibrate equipment, or calibrates equipment less than once a year.	Never calibrate *nutrient* application equipment or ask custom applicator about calibration procedure.	

Number of Areas Ranked ________

umber of questions answered. There are a total of 22 questions.)

Ranking Total ________

(Sum of all numbers in the "Rank" Column)

COMPOSTING FACTS:

Composting is a natural, biological process by which organic material is broken down and decomposed because of the bacteria and fungi that digest the organic material and reduce it to a stable humus. The principles of *composting* are quite simple: just provide the microorganisms with an environment conducive to their growth—a balanced diet, water and oxygen.

In order for composting to be successful as a method of dead bird disposal, the following must take place:

- All birds must be decomposed beyond recognition.
- Risk from disease transmission must be eliminated.
- Fire hazards must be minimized.
- Any threats to water resources must be prevented.

Permitting for Poultry Mortality Composting Facilities

All methods for the disposal of dead animal carcasses require permits from the Georgia Department of Agriculture (GDA). Growers must submit a written request to the state veterinarian at the following address:

Georgia Department of Agriculture
Animal Industry
19 M.L. King Jr. Drive
Room 106
Atlanta, GA 30334
404-656-3671

The letter requesting the permit should state the name that the producer wants to appear on the certificate of compliance and describe the *composting* procedures and the type of facility to be used. It must also include the producer's pit number, if he or she has one. If this is a new farm, this should be stated at the time of request.

If the producer plans to have a *composting* facility inside the poultry house, approval from the poultry contracting company is required. A form is available from the Georgia Poultry Federation.

Interested growers should first contact their local Natural Resources Conservation Service (NRCS) to obtain information on *composting* and *compost* facilities.

Composting procedures (or recipes) developed by the Cooperative Extension Service (CES), NRCS, Farm Service Agency (FSA), or the Resource Conservation Development Council (RC&D) must be used.

COMPOSTER CAPACITY

In order to meet peak disposal requirements, *compost* facilities must be properly sized.

Primary Bin Capacity:
The total minimum volume of the primary bins of composters can be calculated from the expression below:

$$V = B \times (M/T) \times W_B \times 2.5$$

- **V** is the total minimum volume in the primary bin in cubic feet
- **B** is the total number of birds on the farm
- **T** is the days of flock life
- **W_B** is the average market weight of the birds in pounds
- **M** is the percent mortality expressed as a decimal (example 5% = 0.05)
- The factor of 2.5 in this equation represents 2.5 cubic feet of composter volume required per pound of dead birds.

Secondary Bin Capacity:
The total volume of the secondary bins should be the same as the primary composter capacity.

COMPOST FACILITY DESIGN AND CONSTRUCTION

Roof Design

Some materials are composted outside. However, this is not recommended for dead bird composters. A roof ensures all-weather operation and helps control rain, snow, runoff and percolation which can be major concerns. In order to prevent excessive moisture in *compost*, the roof over *compost* bins must poster. (The base layer should not be placed more than a few days prior to use for *composting* birds or it will cool as bacterial numbers reduce when moisture or oxygen becomes limited.)

- Unless *litter cake* is used which is bulky with much air-holding ability, a thin layer of peanut hulls, coarse shavings or straw is added next.
- A layer of dead bird carcasses is then added. The carcasses should be arranged in a single layer side by side, touching each other. Carcasses should be placed no closer than 6 inches from the walls of the composter. Carcasses placed too near the walls will not compost as rapidly, since the temperature is cooler near the walls.
- A layer of *litter cake* (40 to 60 percent moisture content) twice as thick as the layer of carcasses underneath or litter (1.5 parts by weight) is added next. This layer should be twice as thick as the layer of carcasses underneath.
- If only a partial layer is needed for a day's mortality, the portion should be covered with *litter.* The rest of that layer can be used with subsequent mortality.
- A small amount of water may be needed after each layer. If much water is required, the *litter* is too dry and probably low in live bacteria.
- After completing the initial layer, subsequent layers of either *litter cake* and carcasses or *litter*, bulking ingredient and carcasses follow. Keep adding layers until compost height approaches 4 to 4½ feet.
- Cap off with a double layer of litter, so that the height of compost in the bin does not exceed 5 feet. Excessive height increases the chance that the composter temperature will exceed 160°F which increases the risk of spontaneous combustion.

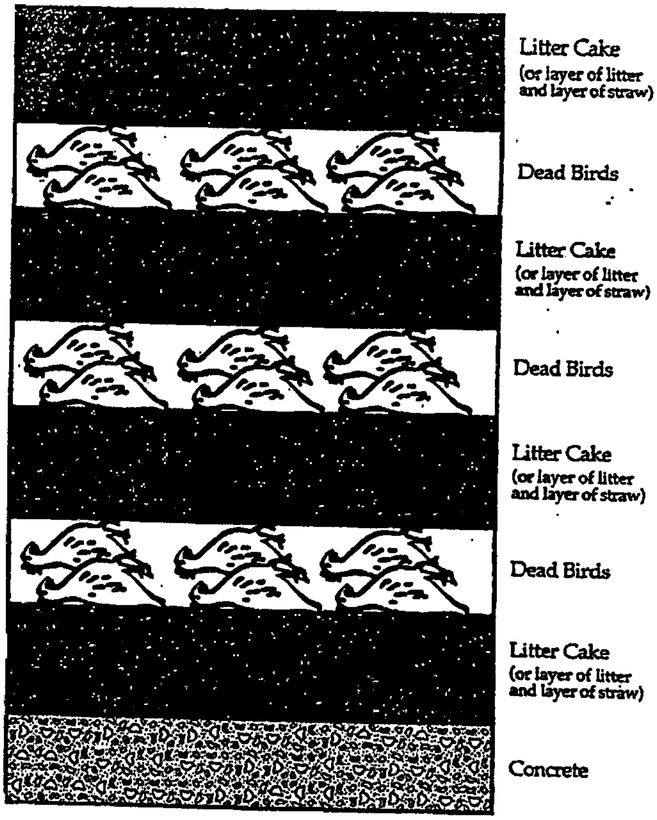


Figure 1: Composter Bin

Table 3. C:N Ratio

Ingredient	C:N Ratio
Birds	5:1
Litter	7:1 to 25:1
Straw	80:1
Peanut hulls	50:1
Shavings	300-700:1

If 2 parts by volume of *litter*, 1 volume of dead birds, and adequate bulking agent is either contained in the *litter*, or added prior to the carcasses, the C:N ratio should be adequate. If moisture and aeration are adequate, materials with lower C:N ratios usually compost at higher temperatures.

Microorganisms

Starter:

The microorganisms responsible for *composting* are initially supplied by active *litter* or *litter cake.* The microbes in the *litter* used in the *composting* process need to be kept alive and in sufficient numbers so that *composting* can begin immediately to break down the carcasses and the *litter. Litter* that is cade" from the loader bucket to provide good turning and re-aeration as it is deposited in the secondary treatment area. The movement to a second bin will probably be necessary to get adequate *decomposition* if the birds exceed 4 to 5 pounds or if material is removed from below and added above (see package composters on next page).

The product temperature should again rise to 150°F within days. Delayed movement, poor aeration, poor mixing or moisture above 60 percent or below 40 percent will cause the mass not to heat properly.

Once the temperature (determined by daily monitoring) drops from 150° to 130°F (7 to 21 days), the product is ready to be used as a fertilizer.

Flies and Odor

Flies and odor are not a problem where composters are operating properly. The heat destroys the habitat for flies and since the process is *aerobic* (in the presence of oxygen) very little odor is produced. Improved management is usually the best solution to odor and fly problems.

Composter Types and Layouts

Composters presently used for dead birds consist of four types.

- **Package composters:** These composters are commercially available. The composted by-products fall to the bottom of the composter down to the concrete slab where they are then shoveled by hand back to the top to *compost* new dead birds. A 5-gallon bucket of new *litter* material is normally added to each *composter* each week. A few operators will add a small amount of bulking agent such as peanut hulls or cotton seed hulls to trap oxygen and promote heating.

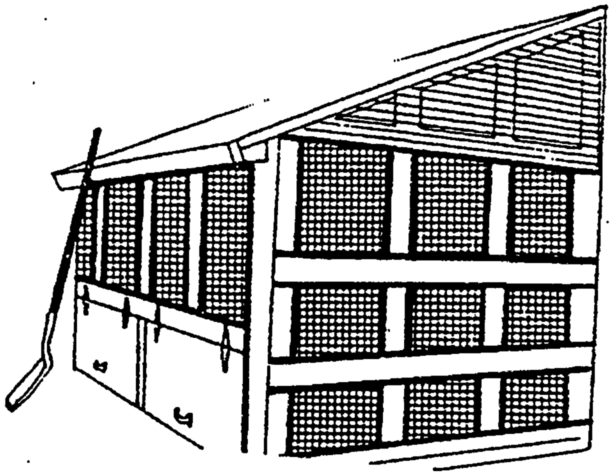


Figure 2. Package Composter

- **Delmarva (small bin):** The front wall of these bins consists of 2-inch thick boards which are mobile to help with filling and removing the material to be composted. The material in the composters is moved with some type of end loader or skid steer loader. Therefore, the width of the small bin composter must allow the loader bucket to get into the bin. Normally these small bin composters are 8 to10 feet wide by 5 feet high and 5 feet deep. The depth is limited to 5 feet due to the reach required to drop the composted material into the secondary bin which is immediately behind the primary or small bin. Moving the material from the primary bin to the secondary bin after 10 to 21 days is common for Delmarva type composters to mix in oxygen in the mass to promote heating. The oxygen is added as the mixture is dropped or moved from the primary bin to the secondary bin.

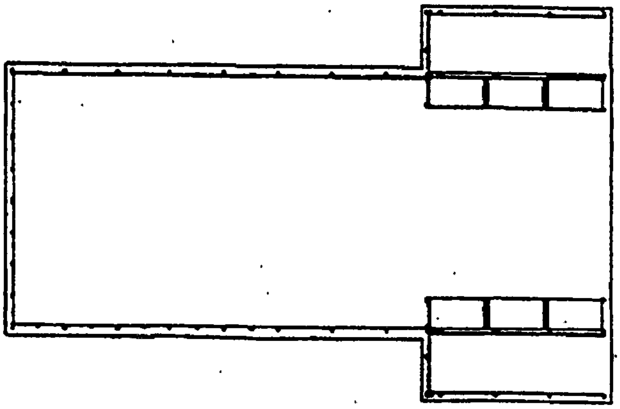


Figure 3. Small Bin Composter—Plan View

- **Big bin (adaptation of the Delmarva):** The big bin uses a primary bin which does not have a removable front. In fact, the front is totally open and the *compost* material slopes back slightly with the front face of the composted material

At this writing, there are no state of Georgia regulations governing the land application of poultry litter. However, some counties do have regulations. Contact your county extension office to determine if such regulations exist.

Dead Bird Compost Application

Application rates, calibration and timing, and record keeping should be handled like manure. The Georgia Cooperative Extension Service, NRCS county offices and Georgia Department of Agriculture (GDA) can provide information on *composting* as well as other disposal methods. *Compost* should go through at least two decomposing cycles (primary and secondary treatment) before being land applied.

Soil Testing of Application Sites

Compost can be sampled and tested to determine their nitrogen, phosphorus and potassium content. These *nutrient* values combined with values for manures, crop residues and starter fertilizer help determine whether more commercial fertilizer should be added for desired crop production.

All land applications of poultry *mortality* compost should be based on soil test, *compost* analysis, and realistic crop yield goals.

Record Keeping

Keep records of the dates, quantity and specific application sites. If you sell the *litter*, keep a record of buyers, dates, amounts and the farm sites where buyers apply or use the *litter*. These records can assist you with management and protect you from liability.

Application Rates

The best application rate depends on the crop being produced, the soil's *nutrient* content and the *nutrient* content of the applied material. Soil testing and *litter nutrient* analyses are recommended procedures for best determining *litter* application amounts. Application equipment should be calibrated for accurate and even distribution.

Poultry *compost* should be evenly distributed on application sites at a rate not to exceed 5 tons per acre per year, with no more than 2.5 tons/acre in each application or according to a site-specific *nutrient* management plan.

Vehicles must be covered or tarped for transporting poultry *compost* on state or federally maintained roads or any public road.

Your county extension office can provide more information on soil testing, *litter* analyses, equipment calibration, record keeping and other areas related to poultry *compost* land application.

Application Timing

Surface land application of poultry manure and *compost* residue should not be undertaken when soil is saturated, during rainy weather or when rain is in the immediate forecast.

Application Areas

Consider unique features of the farm and make your management plan specific for these features. Do not apply poultry *compost* to the surface and subsurface within 100 feet of streams, ponds, lakes, springs, sinkholes, wells, water supplies and dwellings. Grass, vegetative and/or forest buffer strips along stream, pond or lake banks are helpful in preventing *nutrient* runoff from adjacent fields and pastures.

Do not apply *nutrients* on slopes with a grade of more than 15 percent or in any manner that will allow *nutrients* to enter the waters of the state.

Calibrating

Calibration of waste application equipment, such as irrigation systems, tank wagons and manure spreaders is needed to ensure safe and efficient distribution of waste materials. Equipment should be calibrated and rechecked at least once during the application period since the consistency of the *compost* can vary greatly. For more information about calibration of waste-spreading equipment, contact your county extension office.

NOTES:

ACTION PLAN:

[illegible]tion plan is a tool that allows you to take the needed steps to modify the areas of concern as identified by your assessment. The outline provided below is a basic guide for developing an action plan. Feel free to expand your plan if you feel the need for detail or additional areas not included. Consult the list of references on the next page if additional assistance is needed to develop a detailed action plan.

Area of Concern	Risk Ranking	Planned Action to Address Concern	Time Frame	Estimated Cost

PUBLICATIONS:

State Soil and Water Conservation Commission
P.O. Box 8024
Athens, GA 3063

- Agricultural Best Management Practices for Protecting Water in Georgia

University of Georgia, Cooperative Extension Service
Athens, Georgia 30602

- Georgia's Ground Water Resources, Bulletin 1096
- Well Head Protection for Farm Wells, Circular 819-3
- Animal Waste and the Environment, Circular 827
- Poultry Waste, Georgia's 50 Million Dollar Forgotten Crop, Leaflet 206
- Calibration of Manure Spreaders, Circular 825
- Land Application of Livestock Manures, Leaflet 378
- Composting Poultry Mortalities, Circular 819-5
- Poultry Composting Facilities, Circular 828
- Facilities for Storing and Handling Broiler Litter, Newsletter

Poultry Water Quality Consortium
TVA, Suite 4300
5700 Brainerd Rd., 6100 Building
Chattanooga, TN 37402-2801

Poultry Water Quality Handbook

Poultry Mortality Management

Nutrient Management and
Water Quality Improvement Series

Fact Sheet #1 West Virginia Poultry Water Quality Advisory Committee July 1998

Poultry Mortality Management Methods

Poultry production facilities must deal with the disposal of farm mortalities on a regular basis. Death loss in animal production is an anticipated yet unfortunate reality that requires appropriate handling to prevent the spread of disease, the potential for odor and pest problems, and the possible contamination of surface and ground water. Convenient, sanitary, and rapid disposal is critical for mortality management to be effective and practical.

Responsibility for the safe and appropriate management of poultry mortality begins with choosing the best method suited for each poultry operation. Each management method has advantages, disadvantages and associated best management practices with its use as a poultry mortality management option. Proper management is the key to the successful use of each method.

Composting

\+ Considered by many as the best alternative.
\+ Natural process that generates a value-added end-product.
\+ Keeps nutrients and biosecurity on the farm.
\+ Pathogen control is accomplished when temperatures of at least 145°F are reached through at least two heat cycles.
– To have maximum pathogen control, all compost must be turned at least once before spreading.
– Poultry mortality compost should not be fed to livestock and is not recommended for use on crops for human consumption.

Rendering

\+ Removes mortality from the farm and relieves the grower of environmental concerns related to other methods of mortality management.
– Potential biosecurity threat, though adhering to appropriate management practices can alleviate biosecurity concerns.
\+ Means of recycling mortality into a valued, biologically safe protein by-product.
\+ Perhaps the most environmentally safe method of mortality management.
– Cold storage of carcasses is necessary unless they are delivered daily to renderer.
– Carcasses must be stored in pet and pest-proof containers.
– Mortality must be covered and contained during delivery to the rendering facility.

Proper nutrient utilization and adherence to biosecurity practices are essential for successful mortality management.

West Virginia Laws Governing Poultry Mortality Management

WVDA §19-9-34a; §61-1C Disposal of Dead Poultry

Notwithstanding any other provision of the law, the commissioner of agriculture is authorized to...regulate the disposal of dead poultry and other domestic fowl by persons, firms or corporations engaged in growing poultry or other domestic fowl for commercial purposes. It is unlawful for any person to dispose of, or cause to be disposed of, dead poultry in any manner other than by incinerator, disposal pit, composting or through rendering...except where the commissioner of agriculture authorizes other methods of disposal...for emergency situations of flock depopulation, abnormal death losses or serious disease outbreak...

WVDA §19-9A Feeding of Untreated Garbage to Swine

...no person shall feed garbage to swine without first securing a permit to do so from the commissioner...garbage includes putrecible animal and vegetable wastes...including animal carcasses or parts thereof.

Extension Service
West Virginia University

Composting Substantial Poultry Losses

Casey W. Ritz, Ph.D.
Extension Poultry Specialist

Poultry Fact Sheet

POUL 4.4
November 1998

Composting is a natural process where beneficial microorganisms decompose and transform organic materials into a useful and biologically stable end-product that is safe for the environment. This process has worked well for many poultry producers nationwide as a means of processing their daily poultry mortality.

Large volumes of poultry mortality have commonly been disposed of by means of burial. However, this practice poses health and environmental risks from pathogens, particularly in areas prone to flooding or having a high water table. When substantial poultry mortality occurs due to disease, chemical residue, or natural disaster, on-site composting of the carcasses will effectively reduce large mortality numbers in an environmentally sound way.

Composting large volumes of mortality requires a commitment to proper management in order for the process to be effective and successful. Proper siting of the windrow is necessary to facilitate composting and preventing nutrient runoff.

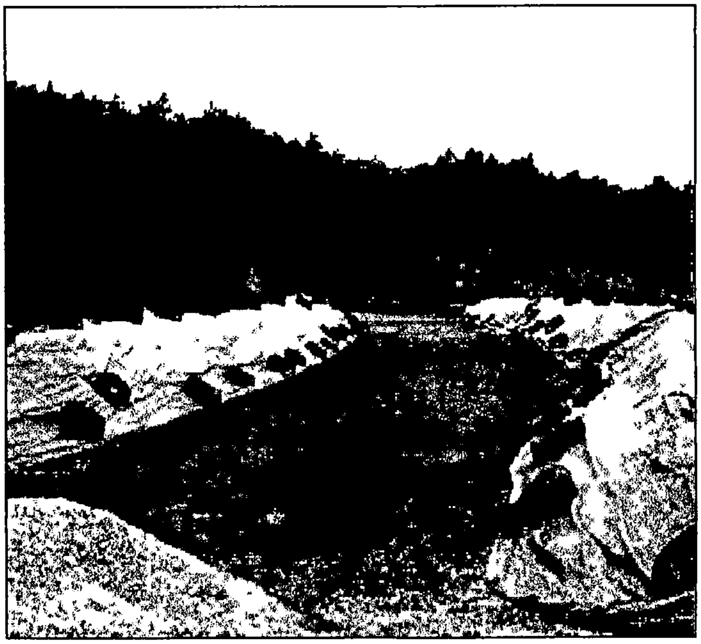
Constructing the Windrow

If flock repopulation time schedules permit, windrow formation within the poultry house or litter shed is the ideal location for composting, with a level, firm base and protection from rainwater. If an under-roof site is not available, a site should be found that is well-drained, out of the flood plain, relatively free of rocks, accessible to machinery, and located away from areas of running or standing water. A temporary ground liner can be used to prevent any potential leaching from the windrow. Bear in mind that the liner can cause difficulties with spreading equipment as it will likely be torn during removal of the windrow. Open air piles should be protected from prolonged contact with rainwater with a surface that repels water, such as composting fleece or a plastic tarpaulin. A well-rounded windrow also will aid the shedding of rainwater.

Proper layering of the windrow is important for effective composting and helps to ensure appropriate heating. The diagram on the back illustrates proper windrow design. Begin building the windrow with a base layer of poultry litter, followed by a layer of straw, sawdust, or some other coarse carbon source that can be used as a bulking agent. This bulk material aids in aeration of the pile and helps provide an adequate supply of carbon.

The carcass layer should be one bird deep. If the birds are carelessly loaded into the windrow, compost completion may be delayed and the carcasses may putrefy instead of decompose. Add sufficient water to the carcass layer to thoroughly wet the birds' feathers. It is unlikely that any additional water will be needed for the windrow.

Repeat the layering sequence until the recommended windrow height of 5 to 6 feet is reached. Once the layering is complete, top the windrow off with at least 8 inches of dry poultry litter, making sure that all carcasses are well covered. The carbon-to-nitrogen (C/N) ratio needed for windrow composting is the same as that needed for composting of daily mortalities. A C/N ratio between 20:1 and 30:1 is ideal for this process. Since the C/N ratio plays a role in regulating the rate of biological activity within the pile, variations from this ratio will alter the composting process, leading to delayed, ineffective, or malodorous composting. Windrows that have sawdust, straw and mortalities as the recipe ingredients have been shown to maintain high temperatures for longer periods of time compared to recipes that use poultry litter[2]. Poultry litter will supply both carbon and nitrogen to the recipe, which can lead to a nitrogen excess. Maintaining the proper C/N ratio will facilitate the composting process.



Composting mortality windrows covered with a water-repelling compost fleece. Discarded auto tires help to keep the fleece in place.

Emergency Action Plans

Dr. Mark Risse, The University of Georgia

Adapted from Lesson 50 of National Animal and Poultry Waste Management Curriculum written by Ron Sheffield of North Carolina State University

Manure spills and discharges largely just don't happen, they are caused. Behind most spills is a chain of events that leads up to an unsafe act, improper judgement, unsafe conditions, or a combination of factors. Manure spills and discharges are the most common cause of regulatory penalties in Georgia and the Nation. Preventing and properly responding to discharges on the farm is everyone's concern. Communication between the farm owner, supervisors, agencies with emergency response responsibilities and employees generates ideas and awareness that leads to accident prevention and quick response in the event a spill occurs. Education programs, response plans, and regular inspections of your manure management and application system are essential in providing the lines of communication that lead to a safe, accident-free operation.

Intended Outcomes

The producer will:

- Recognize the need for developing an Emergency Action Plan
- Identify the steps involved in reporting and responding to a manure spill
- Identify activities related to their manure management system that may lead to higher environmental or human health risk
- Be prepared to develop an Emergency Action Plan for their facility

What is an Emergency Action Plan?

- A basic, yet thorough, common sense plan that will help you make the right decision during an emergency.

Why have an Emergency Action Plan?

- Murphy's Law: accidents will happen.
- If it is written down, you will use it.
- Plan before potential emergencies.
- To protect you and other against environmental damage.
- It should be part of a Comprehensive Farm Plan.

Emergency action plans are needed to minimize the environmental impact in the event of manure spills, discharges or mishaps. In several states these plans are required on all livestock operations, especially those with liquid manure management systems. Using resources found in this chapter, you should develop an emergency action plan. Your plan should be available to all employees and they should be trained in its use. This plan will be implemented in the event that manure or other wastes from your operation are leaking, overflowing, or running off the site. You should NOT wait until manure or wastewater reaches a stream or leaves your property. You should make every effort to ensure that this does not happen.

Another prevention practice is the installation of low-pressure, low-flow or other automatic shut-off switches on pumping equipment for liquid irrigation systems. If these devices are not used, you should keep radio or cellular communications with someone who will remain close to the pump. Check all irrigation lines prior to pumping and look for defects, insecure or worn connections. Place solid pipes over any watercourses, wetlands, ditches or containment areas so that they are always visible for inspection.

Types of Emergencies

Your response to emergency situations will be governed by site- and situation-specific circumstance, which your own plan should address. However, there are responses you should consider based on the type of emergency you are experiencing. These responses can be broken down according to three stages of emergency defined as imminent pollution or emergency, pollution in progress, and pollution discovered after the fact. These instructions should be available to all employees at the facility, as accidents, leaks, and breaks can happen at any time.

Imminent Pollution

In this type of situation, there have not yet been any leaks or spills. However, ignoring the fact that an emergency exists will probably result in a spill or leak within a short time. The main sources of this type of emergency are when lagoons, holding ponds, or pits are nearing capacity, or when there is potential for wastes to run off an application field.

Storage capacity about to be exceeded. Long periods of excessive rain or malfunctioning livestock water systems may cause your storage to unexpectedly reach capacity. Your response should be to prevent the release of wastes. Depending on your situation, this may or may not be possible, but suggested responses to this type of problem include:

- Add soil to the berm to increase the elevation of the dam.
- Planned emergency utilization of manure by pumping onto fields at acceptable rates.
- Stop all additional flow to the storage (waterers).
- Call a pumping contractor.
- Make sure no surface water is entering the storage.
- Consider maintaining some grassland near the storage for emergency manure application.

These activities should be started when your lagoon has exceeded the temporary storage level as defined for the lagoon. Waiting for the lagoon to reach the freeboard level may result in spills as you never know when the pumping equipment will malfunction. Start early!

Potential runoff from application field. This situation could result from unexpected rains during field application of manure. Again, the response is to prevent the release of wastes to neighboring areas. Possible solutions include:

- Immediately stop additional waste application.
- Create a temporary diversion or berm to contain the waste on the field.
- Incorporate waste to prevent further runoff.

Hurricanes and tropical storms. These severe storms are unpredictable in nature, and depending on their intensity, they can cause a great deal of damage to an area. They normally occur from

Tankwagon leak or overturn. There is a good chance that this emergency will be off your property and may include personal injuries (e.g., automobile accident). If there are injuries in any livestock waste emergency, they take precedence over all other responses. Once injury response is taken care of, limiting the environmental impact becomes the main goal in responding to this type of emergency. Possible solutions include:

- Stop additional spill of material.
- Contain material that has spilled.
- Begin clean-up procedures.
- Contact appropriate agencies if waste is on or off your property or there is surface or ground water impact.

Pollution Discovered After the Fact

This situation occurs when a leak or spill is discovered several days after it occurs. There is a potential for increased environmental impact due to the late discovery of waste leakage. Response should be swift in order to minimize damage as much as possible. Responses should include:

- Stop additional leakage.
- Contain spilled wastes.
- Attempt application of spilled wastes on cropland.
- Notify agencies and local authorities.
- Assess environmental impact of fish kill, surface water pollution, well or ground water impact, and amount of waste released and for what duration.

Components of Emergency Action Plans

While every emergency is different, response actions should be similar. As stated earlier, human health and injuries take precedence and should be dealt with first. Also, you should never put someone in life threatening or risky situations as part of your response plan. These following steps should provide a framework for developing your plan.

1. Eliminate the source. Depending on the situation, this may or may not be possible. Suggested responses to several problems are listed below:
   a. *Lagoon or slurry basin overflow*—possible solutions are:
      - add soil to berm to increase elevation of dam
      - pump manure and wastewater to fields at an acceptable rate
      - stop all additional flow to the structure (waterers, flushing system, etc.)
      - call a pumping contractor
      - make sure no surface water is entering storage structure

   b. *Runoff from manure application field*—actions include:
      - immediately stop application
      - create a temporary diversion or berm to contain manure on the field
      - evaluate and eliminate the reason(s) that caused the runoff
      - evaluate the application rates for the fields where runoff occurred
      - if possible, incorporate manure to reduce further runoff or till strips across the runoff path to increase infiltration

   c. *Leakage from the manure distribution or irrigation system:*

c. Contact CES, local SWCD/NRCS office, or your Comprehensive Nutrient Management planner for advice/technical assistance.

d. If none of the above works, call 911 or the Sheriff's Department and explain your problem to them. Ask them to contact the agencies as listed above.

5. Clean-up the spill and make repairs.

Perform any modifications that were recommended by your state water quality agency and technical assistance agencies or professional engineers to rectify the damage, repair the system, and reassess the manure management plan to ensure the problem will not happen again in the future. The emergency action plan must include provisions for emergency spreading or transfer of manure from all storage structures in the system. This may include emergency pumping or spreading (to prevent overtopping of a storage structure) during periods when the soil or crop conditions are not conducive to normal spreading or application. You should contact your state water quality agency or local soil and water conservation district for guidance to apply manure in this instance. You should consider which fields are best able to handle the manure and wastewater without further environmental damage. Application rates, methods, and minimum buffer distances must all be addressed. If transferring waste to another location for application, consider the limitations that may be involved with the transfer of waste to that site and application considerations at that location.

Creating a Community Response Plan

When an emergency arises you may need the assistance of neighboring farmers, fire departments or other county services. Communities have developed and are encouraged to develop Community Response Plans that assist livestock producers in the event of manure spills or catastrophic animal deaths. These plans allow livestock producers to review or develop the components of their farm's Emergency Action Plan with the assistance of neighboring livestock producers and farmers as well as community emergency response personnel. Collectively, this process gives producers the opportunity to find out who in the community (producers, farmers or community services) owns equipment that may be available locally to use in the event of a manure spill. Large equipment that may be necessary to respond to and clean up a manure spill include graders, bulldozers, back hoes, front-end loaders, portable electric generators, portable diesel pumps and irrigation pipe, vacuum tank wagons, and dump trucks.

In the event of a manure spill, the local Emergency Medical Services (EMS) should also be contacted. EMS is traditionally who you contact to report a fire or medical emergency. Several communities utilize the EMS network for other emergencies including manure spills. The EMS network organizes local and state agencies such as the Soil and Water Conservation District, county health departments, state water quality agencies, fire department and the local police or county sheriff to respond and address any manure spill. This level of response may seem excessive but depending on the size and nature of the spill each of these groups may be needed to minimize the extent of environmental damage or risk to public health.

As with most emergencies, it is always better to be prepared than to "test" a response plan during an actual emergency. Several communities have taken this lesson to the farm. Mock "spills" have to be conducted to train Manure Spill Teams and test the effectiveness of a community's response plan. Livestock producers, farmers, volunteer fire departments, county health department and local police or sheriff office work together to form the Manure Spill Teams. These exercises are not meant to address every possible type of spill or area that may be affected by a spill. Rather these drills allow the Manure Spill Team (or responding agencies or groups) to work together, develop communication protocols and establish general procedures that will need to be implemented to protect human health, minimize environmental impact, and foster a quick clean-up.

Developing an Emergency Action Plan

Every farm, dairy, feedlot, or hatchery should have an Emergency Action Plan. This plan is your first response to spill even before it occurs. Simple things, such as collecting phone numbers and listing hazardous chemicals on the farm, will shorten the response time in the event of an emergency. Whether the emergency is a lagoon breach, fire, flood or overturned spreader your emergency action plan should help you prepare to reduce the risk to you, your coworkers, the farm and to the environment.

At the end of this chapter there are two emergency action plans that can be implemented on your farm. A more "comprehensive" emergency action plan follows a "simple" one. Review them both before preparing your own. Use these examples to prepare a plan that will be used on your farm. There is a blank version of the simpler plan and at the bear minimum this should be completed at posted on the farm. The more comprehensive plan would provide you and your employees with more information and better prepare you for dealing with emergency situations. Extension employees, NRCS specialist, and consultants should also be able to assist you with development of these plans if necessary.

Once completed, this plan should be available and understood by all employees at the farm. The main points of the plan (order of action) along with the relevant phone numbers should be posted by all telephones at the site. A copy should also be available in remote locations or vehicles if the land application sites are not close by the facility office. It is the responsibility of the owner or manager of the facility that all employees understand what circumstances constitute an imminent danger to the environment or health and safety of workers and neighbors. The employees should be able to respond, and have the authority to initiate containment and cleanup activities, during emergencies as well as notify the appropriate agencies of conditions at the facility. Lastly, post emergency contact phone numbers by every phone on the farm.

Manure Spills, Accidents and Discharges .... real stories, real issues.

Learning from the mistakes in the past gives us the opportunity to make appropriate changes in the future. The following is a collection of case studies that reviews several manure spills that have occurred on livestock operations. These are real events and unfortunately they are not the only examples of manure discharges and spills into our surface and ground waters.

As you read these case studies of real farms, ask yourself:

- Was the manure spill an accident?
- What could have been done to prevent this spill from happening?
- Could this happen on my farm?
- Would I know how to handle or have the resources to address a similar spill on my farm?
- Do I have an emergency action plan if a spill occurs?
- Would an Emergency Action Plan have been helpful?

Case Study #1

.... *Equipment Failure*

Location: Ontario, Canada
Operation: Swine

Background:

- A portable irrigation system was laid out over a stream to reach a field for the application of swine lagoon effluent.
- When the pump was turned on, a section of pipe over the bridge became disconnected.
- The farmer wired the pipes back together then continued the manure application.
- No attempt was made to collect the effluent released into the stream.
- The farmer had never notified regulators of the incident two days after the event occurred.

Result:

- Lagoon effluent leaked from the separated pipes and flowed directly into the stream below.
- Fish were killed in the creek downstream of the spill.

Response:

- Ontario investigators confirmed the spill had caused the fish kill in the creek.
- Charges were laid onto the farmer citing a lack of 'due diligence' and 'failure to notify' regulatory authorities in a timely manner.

Action:

- No further action was taken by the farmer.
- The farmer was convicted and fined.

How Could this Spill have been Avoided?

- Use a section of flexible pipe to carry manure over streams and bridges.
- Monitor the pipeline during application.
- Be prepared to shut down immediately if a problem develops by having manpower and radios on hand.
- Notify the appropriate state and local authorities as soon as possible.

Case Study #3

... Over Application of Manure

Location: Southern, Ohio
Operation: Dairy

Background:

- The gasoline powered drive engine on a travelling gun irrigation system ran out of fuel while the irrigation pump was still running
- Excessive amounts of liquid manure were applied to a level untilled field

Result:

- Manure leached down to a tile system and drained into a open drainage ditch
- The water quality was impaired by low dissolved oxygen levels downstream in the drainage ditch and adjoining stream
- The farmer observed discolored water and foam discharging from the field tile into the open drain

Result:

- State water quality officials responded to an anonymous call
- Water samples were taken to identify the source of contamination
- Discolored water and foam were found discharging from a field tile outlet into the drainage ditch
- The dairyman was charged with applying manure at a rate that exceeds his manure utilization plan and for violating the water quality standards of the state.

Action:

- No further action was taken by the farmer.
- The farmer was convicted and fined.

How Could this Spill have been Avoided?

- Check engine fuel and oil levels before each "pull" on a travelling gun irrigation system
- Delay manure application until field tiles stop flowing
- Inspect irrigation systems during application events. Ensure drive engines and turbines are operating.
- Check soils for their "antecedent" moisture condition before selecting application rates and pumping duration
- Postpone irrigation of manure and wastewater until drainage from tile drains cease.

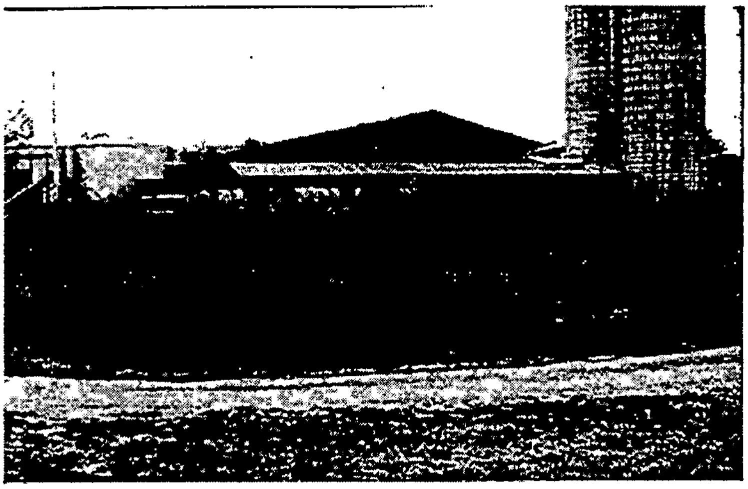
Case Study #5

.... Lack of Storage Capacity

Location: Southern Pennsylvania
Operation: Dairy

Background:

- Farm's manure storage basin was overflowing into a field
- An irrigation gun and tank wagon was used to apply manure on a bottomland field of wheat stubble
- Application occurred in the evening and at night in November, following several days of rain and snow
- Application rates of 7,200 gal/acre were reported, but were believed to be higher by investigators



Result:

- Manure from the overflowing storage basin entered a nearby field tile system which drained into a ditch that crossed the property line, and then into a stream on the neighbor's property
- Liquid manure entered the ditch via a tile blowout and open catch basins, eventually contaminating two in-stream ponds on the neighbor's property

Response:

- State water quality officials were informed by the producer and investigated the following day
- Water samples were taken identifying the source of contamination
- The producer was charged with failing to provide adequate storage and discharging manure into surface waters

Action:

- The stream was temporarily dammed to prevent further movement of manure laden water downstream
- The producer pumped contaminated water from the stream and applied onto adjacent fields under the supervision of state investigators
- Producer paid a fine with no contest

How Could this Spill have been Avoided?

- Ensure adequate storage to allow flexibility in application due to weather
- Do not apply manure when soil is nearly saturated from snow or rain
- Inspect fields regularly, especially before manure application, to ensure tile blowouts are repaired
- Monitor tiles during and after manure application
- If a problem occurs, notify your state water quality agency as soon as possible.

Emergency Action Plan

Post, clearly by every phone on farm

Farm Name:
Permit Number:

IF There is an EMERGENCY.......

1) **Shut off all flow into storage area**

2) **Assess the extent of the emergency and determine how much help is needed**

3) **Contact Farm Supervisors**

Name:	Phone #:
Name:	Phone #:

4) **Give supervisor the following information:**
   - *Your name*
   - *Farm ID/Permit Number*
   - *Description of Emergency*
   - *Estimates of the amounts, area covered, and distance traveled from manure storage*
   - *Whether manure has reached ditches, waterways, streams or crossed property lines*
   - *Any obvious damage: employee injury, fish kill, or property damage?*
   - *What is being done, any assistance needed*

5) **Contact state water resources division, contractors, emergency officials, technical specialists and media, as needed.**

a) **Georgia Environmental Protection Division-** 800-241-4113

b) **Emergency Response-**	Name________________	Phone____________
c) **Pumping-**	Name________________	Phone____________
d) **NRCS--**	Name________________	Phone____________
e) **County Extension Office-**	Name________________	Phone____________
f) **Consultants-**	Name________________	Phone____________

Build a containment dam downstream of discharge area, then progressively build additional dams upstream

- Add soil to the berm of the manure storage area/basin
- Remove manure from the discharge are with a trash pump if necessary
- Pump manure and wastewater from the manure storage at a lower rate to lower the volume in basin

EMERGENCY PHONE NUMBERS

Site Location[1]:

Owner's name: Phone #:

Livestock Manager: Phone #:

Ambulance (EMS) Phone #:

Fire Dept. Phone #:

County Sheriff #

STATE Emergency Management Agency Phone #

STATE WATER QUALITY AGENCY Phone #:

STATE Department of Agriculture Phone #:

LOCAL/COUNTY Public Health Department Phone #:

Natural Resources Conservation Service Phone #:

Soil and Water Conservation District Phone #:

Technical Specialist/Comprehensive Nutrient Management Planner Phone #:

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[1] Provide directions that anybody can direct someone to the site by telephone.

Runoff Retention Plan

For emergencies involving an unplanned release of manure, the action plan normally will involve recognition and assessment of the problem, notification of authorities, enlistment of help from cooperating producers and others to correct the problem, and restoration of the affected area to its original condition.

Planning for containment below the lagoon in direction of runoff: Study the drainage patterns from your farm and envision where a manure discharge will move while it's still on your property and after it leaves your property. Determine the point at which the discharge might enter surface waterways. For some farms, manure may travel long distances before entering a ditch or stream. In other cases, the stream may be nearby, demanding a much faster response. Describe the procedures to be followed for retaining runoff. Include any equipment that would be required and how it is to be used. Note location where spoil piles are located. Denote storm drains and runoff ditches on aerial site map for easy identification.

Emergency Action Plan for:

Dike overtopping pr eroding or above ground storage leak

Emergency Actions:

Emergency Action Plan for:

Lagoons, Ponds or Pits are Full and planned application areas not available

Emergency Actions:

Emergency Action Plan for:

Spill during delivery of liquids to field -specify situation

Emergency Actions:

Pre-arranged Emergency Response Agreements

List any arrangements made with other producers to share personnel and/or equipment and supplies and land access during an emergency.

Pre-arranged land access agreements

Contact #1 ____

Contact #2 ____

Location of Pre-Arranged Emergency Supply Equipment and Supplies

Available 24 hours a day. Include phone numbers and primary contacts. Put list in the order you want equipment operators contacted. Copy posted in each animal building on site, in site office and owners residence. Preferably posted by a phone or main doorway if no phone.

Owner	**Phone**	**Location**
Irrigation Pumps		
Dozer/Track Loader		
Backhoe		
Vacuum Slurry Tank		

Lagoon/Basin Pumping Services

Name:
Address:
Phone #:

Name:
Address:
Phone #:

Power Outage Information Sheet

Farm Name:

Farm Fire Protection District:

Size and type of operation:

Owner/Operator: *Phone Number:*

2nd Contact person if owner/operator is not available:

Name: *Phone Number:*

3rd Contact person if owner/operator and 2nd contact person is not available:

Name: *Phone Number:*

Electrical Power Company Name:

Electrical Power Company Phone Number:

Size of Electrical Service:

Do you have a standby alternator?	Y	N
If so, is there a double-throw disconnect to isolate the farm from the utility during alternator operation?	Y	N
Do you have a disconnect between meter base and panel?	Y	N

Give the location (sketch preferable) of electrical panels in buildings:

Name and number of electricians who perform service on your barns:

Name: Phone Number:

Name: Phone Number:

Post-Emergency Assessment and Documentation

1.) Assess the extent of the spill and note any obvious damages.
   Did the waste reach any surface waters?
   Approximately how much was released and for what duration?
   Any damage noted, such as employee injury, fish kills, or property damage?

2.) Contact appropriate agencies:
Reporting a Release of Livestock Waste from a Lagoon

a) Reports of releases to surface waters, including to sinkholes, drain inlets, broken subsurface drains or other conduits to groundwater or surface waters, shall be made upon discovery of the release, except when such immediate notification will impede the owner's or operator's response to correct the cause of the release or to contain the livestock waste, in which case the report shall be made as soon as possible but no later than 24 hours after discovery.

b) The report required under subsection (a) shall be given to the State Water Quality Agency by calling:

Phone #: (800) 241-4113

Contents of Report
The report should include, as a minimum, each of the following to the extent that it is known at the time of the report:

a) name and telephone number of the person reporting the release;
b) county, distance and direction from nearest town, village or municipality of the release;
c) an estimate of the quantity in gallons that was released, and an estimate of the flow rate if the release is ongoing;
d) area into which the release occurred (field, ditch, stream, or other description) and apparent environmental impacts of the release;
e) time and duration of the release;
f) the names and telephone numbers of persons who may be contacted for further information;
g) dangers to health or the environment resulting from the release;
h) actions taken to respond to, contain and mitigate the release; and
i) name of facility and mailing address.

3.) Implement procedures to prevent similar occurrences. Seek professional assistance if problem is berm or structure related.

DOCUMENTATION OF CLEAN-UP EFFORTS

All responses to emergencies should be documented and kept with the manure management plan. This documentation should include all agency and local authority contacts made during the response phase. This information can be used to assess response to the emergency, prepare for future problems, and train employees.

Emissions from Animal Production Systems

John W. Worley

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there may be a higher percentage of complaints in the future associated with manure storage units and animal buildings.

Table 1. Number and source of odor complaints received during a one-year period in a United Kingdom country

Odor Source	Pigs		Cattle		Poultry		Total	
	No.	%	No.	%	No.	%	No.	%
Buildings	224	22	65	18	163	36	452	25
Slurry storage	169	17	98	28	78	17	345	19
Slurry spreading	526	52	122	34	190	42	838	46
Animal feed production	84	8	4	1	11	3	99	5
Silage storage	10	1	68	19	8	2	86	5
Total	1,013		357		450		1,820	
Percent	56		20		24			100

Source: Hardwick, 1985

Most of the odorous compounds that are emitted from animal production operations are by-products of anaerobic decomposition/transformation of livestock wastes by microorganisms. Livestock wastes include manure (feces and urine), spilled feed and water, bedding materials (i.e., straw, sunflower hulls, wood shaving), wash water, and other wastes. This highly organic mixture includes carbohydrates, fats, proteins, and other nutrients that are readily degradable by microorganisms under a wide variety of suitable environments. The by-products of microbial transformations depends, in a major part, on whether it is done aerobically (i.e., with oxygen) or anaerobically (i.e., without oxygen). Microbial transformations done under aerobic conditions generally produce fewer odorous by-products than those done under anaerobic conditions. Moisture content and temperature affect the rate of microbial decomposition.

A large number of volatile compounds have been identified as by-products of animal waste decomposition. Kreis (1978) developed one of the earliest lists of volatile compounds associated with decomposition of cattle, poultry, and swine wastes. He listed 32 compounds reported to have come from cattle wastes, 17 from poultry wastes, and more than 50 compounds from swine wastes (Kreis; 1978). O'Neill and Phillips (1992) compiled a list of 168 different compounds identified in swine and poultry wastes. The compounds are often listed in groups based on their chemical structure. Some of the principal odorous compounds, individual and as groups, are ammonia, amines, hydrogen sulfide, volatile fatty acids, indoles, skatole, phenols, mercaptans, alcohols, and carbonyls (Curtis, 1983). Carbon dioxide and methane are odorless.

Some of the gases that are emitted have implications for global warming and acid rain issues. Among these gases are ammonia and non-odorous gases such as methane and carbon dioxide. European countries have instituted strict ammonia emission limits in recent years. It has been estimated that one third of the methane produced each year comes from industrial sources, one third from natural sources, and one third from agriculture (primarily animals and manure storage units). Although animals produce more carbon dioxide than methane, methane contribution to the greenhouse effect is estimated at 15 times that of an equal amount of carbon dioxide.

Dust is another airborne emission concern that is difficult to eliminate from animal production units. It is a combination of manure solids, dander, feathers, hair, and feed. It is

Minnesota) may have an ambient gas concentration (H_2S in the case of Minnesota) standard at a property line that may impact animal agriculture. Another possibility is a odor standard that only a few states have adopted (North Dakota, Colorado, Wyoming, and Missouri) that is again measured at the property line. Gas and odor standards are difficult to enforce since gases and especially odor are hard to measure on-site with a high degree of accuracy.

Measuring Outdoor Air Quality Components

Olfaction: the sense of smell: The sense of smell is complex. The basic anatomy of the human nose and olfactory system is well understood. Odorous compounds are detected in a small region known as the olfactory epithelium located high in the rear of the nasal cavity.

Odors evoke a wide range of physiological and emotional reactions. Odors can be either energizing or calming. They can stimulate very strong positive or negative reactions and memories. The development of aromatherapy illustrates how important smells can be to people.

The power, complexity, and our limited understanding of the sense of smell make olfaction a challenging field. Even though humans can detect over ten thousand different odors, they are sometimes simply categorized as being either pleasant or unpleasant. They are often described using terms like floral, minty, musky, foul, or acrid. The large number of recognizable odors and the general terms used to describe them make it difficult to measure and describe odors consistently and objectively.

Most odors consist of a mixture of many different gases at extremely low concentrations. The composition and concentration of the gas mixture affects the perceived odor. To completely measure an odor, each gas would need to be measured. Some odorous gases can be detected (smelled) by humans at very low concentrations (Table 2). The fact that most odors are made up of many different gases at extremely low concentrations makes it very difficult and expensive to determine the exact composition of an odor.

Odor vs. Gas Measurement: Two general approaches are used to measure odor: either measure individual gas concentrations or use olfactometry. Both approaches have strengths and weaknesses. Future developments will hopefully close the gap between the two approaches.

The specific individual gaseous compounds in an air sample can be identified and measured using a variety of sensors and techniques. The results can be used to compare different air samples. With good sensors and proper techniques, valuable information about the gases that emanate from a source can be collected and evaluated. Gas emission rates and control techniques can be compared rigorously. Regulations can be established to limit individual gas concentrations.

The gas measurement approach has some weaknesses when used to measure and control odors. The greatest weakness of the gas measurement approach is that there is no known relationship between the specific gas concentrations in a mixture and its perceived odor (Ostojic and O'Brien; 1996). As a result, controls based on gas concentrations may reduce specific gas emissions but not adequately address the odors sensed by people downwind of a source.

readings will vary more and have higher and lower individual readings than average readings over a sampling period.

Technique precision or detection limit is an important measurement characteristic. Some devices or methods have an accuracy of ± 1 part per million (ppm). Others may only be accurate to ± 20 ppm. Devices with greater precision can be used to detect small differences in concentrations that less precise devices cannot detect. However, devices with greater precision usually cost more.

Patches: Patches are single-use pieces of cardboard or plastic coated with a chemical that changes color when exposed to the gas being measured. Both the amount of time exposed and the amount of color change are important. Patches give an integrated or average value but are not very precise. They can be hung in a space, worn by workers, or combined with small fans for different applications. Hydrogen sulfide patches are the most commonly used patches in livestock odor work.

Tubes–Indicator and Diffusion: Indicator tubes are available to measure a wide range of gases. To take a reading with an indicator tube (a sealed glass tube), the tips on both ends of the tube are broken off, and the tube is attached to a hand-held pump. The pump pulls a known amount of air through the tube. The media in the tube reacts and changes color with select gases in the air sample. A scale on the tube is used to measure the amount of media that reacted with the gas and indicates the concentration. Indicator tubes give nearly instantaneous readings, but they come with limited scales, and precision is around 10% of the full-scale reading on the tube. They cost around $5 each, and the hand-held pump costs from $100 to $250.

Diffusion tubes that provide an average concentration are also available for some gases. To take a reading, one end of the tube is opened and the tube is hung in the space to be monitored. Some known time later, usually six to eight hours, a reading is taken by noting the amount of media that changed color. The amount of color change in the tube and the time exposed are used to calculate an average concentration over the sampling time. Tubes cost around $8 each.

Jerome® Meter: The Jerome® meter is a portable electronic device for measuring hydrogen sulfide concentrations. It samples the air for several seconds to give a nearly instantaneous reading. The meter can measure hydrogen sulfide concentrations down to 3 parts per billion (ppb). It detects hydrogen sulfide concentrations by measuring the difference in the electric resistance of a gold leaf cover metal strip, which is exposed to the air sample. Jerome® meters cost around $10,000.

MDA-Single-Point Monitor: The MDA s-p m is used to monitor ambient air concentrations of individual compounds over extended periods of time. The units use the Chemcassette® Detection System. The cassette tape reacts, causing a color change, with the chemical being monitored. The color change is measured and used to indicate the gas concentration in the ambient air. MDA monitors can be used to measure ambient hydrogen sulfide concentrations between 2 and 90 ppb over 15-minute periods. Units with different electronics and cassettes can be purchased to monitor other gases. Units cost around $7,000.

Electronic Sensors: A number of different electronic sensors are available for measuring gas concentrations. Their method of action and precision vary. Some units have multiple gas sensors. Some units are used in the safety field to monitor gas concentrations and sound alarms

Intensity: Intensity describes the strength of an odor sample and is measured at concentrations above the detection threshold. It changes with gas or odor concentration. Intensity can be measured at full-strength (i.e., no dilution with non-odorous air) or diluted with non-odorous air. In either case, it can be measured against a five-step scale using n-butanol, a standard reference chemical (ASTM, 1988). To learn the scale, trained panelists sniff containers of n-butanol at different concentrations in water (Table 3). They then are presented diluted or full-strength (diluted is always presented first) odorous air samples that they rate against the n-butanol scale.

Table 3. Odor intensity reference scale based on n-butanol.

Intensity Category		Equivalent Head Space Concentration of N-Butanol in Air, (ppm)*	Mixture of N-Butanol in Water, (ppm)
0	No odor	0	0
1	Very light	25	250
2	Light	75	750
3	Moderate	225	2250
4	Strong	675	6750
5	Very strong	2025	20250

* Based on air temperature of 20.3°C.

Odor Measurement Devices and Techniques

Electronic nose: The term "electronic nose" describes a family of devices, some commercially available, that measure a select number of individual chemical compounds to measure the odor". The devices use a variety of methods for measuring the gas concentrations. Researchers have and continue to evaluate these devices. To date, they have not successfully correlated livestock odors with the output of commercial or current research electronic noses.

Scentometer: The scentometer, developed in the late 1950s (Barnebey-Cheney 1973), is a hand-held device that can be used to measure odor levels in the field.. It is a rectangular, clear plastic box with two nasal ports, two chambers of activated carbon with air inlets, and several different sized odorous air inlets. A trained individual breathes through the scentometer. All of the odorous air inlets are initially closed so that the inhaled air must pass through the activated carbon and is deodorized. The individual begins sampling by opening the odorous air inlets one at a time until an odor is detected. The number and size of open holes is used to calculate the dilution-to-threshold concentration. Portability and relatively low cost are some advantages of scentometers (Barnebey-Cheney, 1992). However, the scentometer is not known for high accuracy (Jones; 1992).

Dynamic, triangular forced-choice olfactometer: Most laboratories measuring odors from agricultural sources use a dynamic, triangular forced-choice olfactometer to determine detection and recognition threshold concentrations. These are designed to be operated in accordance with ASTM Standard E679-91 and proposed European Standard ODC 543.271.2:628.52 (Air Quality Determination of Odour Concentration by Dynamic Olfactometry). Standardized procedures and four hours of panelist training are used to achieve repeatable olfactometer results. Panelists are required to follow strict rules which help panelists

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Chapter 2: Emissions Control Strategies from Buildings and Storage Structures

Odors and gases are emitted from the buildings that house animals and poultry through ventilation fans, or by buoyancy or wind forces in naturally ventilated barns. Methods to reduce these odors and gas emissions are less well documented than either manure storage units or land application control methods. Of the three sources, buildings are believed to release a relatively constant amount of the total odor and gas emissions generated. Building emissions, combined with releases from the manure storage unit, form the "baseline" emission levels from an animal production operation. Two approaches to minimizing odors from buildings and storage structures are first, minimize the odor generation, and second, treat an odor that is generated as it exits the building. Both approaches will be discussed in this text.

General management strategies

Swine production and manure management facilities should be planned as a total system that reduces environmental impacts while promoting animal performance and worker safety. Proper adjustment of feeders to minimize spillage will also reduce odors and save money on feed. An orderly system for manure collection and storage or treatment reduces potential pockets of odor production. All surfaces on which manure may collect and on which animals are maintained should be as clean and dry as possible. Manure, wet feed, and other products that could produce odors in the building should be removed regularly. This includes dust buildup both on the inside and on the outside of buildings, but especially inside animal housing facilities and on fan housings. Dirty, manure-covered animals promote accelerated bacterial growth and the production of gases that are quickly vaporized by animal body heat. Odor from floor surfaces will be reduced if the floors are kept clean and dry. Minimizing the floor surface area on which manure can accumulate reduces the gases and odors emitted from these surfaces. All components of the production/manure treatment system should be maintained and operated in good functional order. Proper disposal of dead animals and good fly and rodent control programs are also essential.

Ventilation system: A properly designed and well managed ventilation system will keep animals and surfaces dry and thereby reduce odor emissions. Clean fans, shutters, and air inlets will improve the efficiency of the ventilation system and simultaneously prevent "odor episodes" that can occur when atmospheric conditions exist that encourage odor generation.

Relationship between dust and odor: Dust on livestock farms affects odor measurement and control in several ways. Dust particles adsorb odorous compounds. As the dust particles are carried by the wind, so is odor. Most of the dust generated on a farm comes from feed, fecal matter, hair and in the case of poultry, from feathers and litter. Dust also comes from animal skin, insects, and other sources. Some of the dust particles, such as those from manure and feed, omit odorous compounds as a result of bacterial decomposition. Odorous dust can increase the transport of some odor compounds. Dust concentrates odorous compounds, and as a result, odorous dust can cause an intense odor sensation. An understanding of the role dust plays in concentrating and transporting odor is important if we are to develop economical methods of controlling odor because some methods of removing dust from the air are less expensive than direct methods of treating the air to remove odorous compounds.

by lowering bacterial activity, but it economic feasibility has not been proven at this time.

Natural windbreaks: Rows of trees and other vegetation known as shelterbelts, which have historically been used for snow and wind protection in the Midwest, may have value as odor control devices for all species and systems. Similarly, natural forests and vegetation near animal facilities in other sections of the country may serve the same purpose. These shelterbelts also create a visual barrier. A properly designed and placed tree or vegetative shelterbelt could conceivably provide a very large filtration surface (Sweeten 1991) for both dust and odorous compound removal from building exhaust air and odor dispersion and dilution, particularly under stable nighttime conditions (Miner 1995; NPPC 1996). Currently, a few studies are addressing the total impact of vegetative barriers on odor reduction from animal farms, but many people already attest to their value. Shelterbelts are inexpensive, especially if the cost is figured over the life of the trees and shrubs, but it may take 3 to 10 years to grow an effective vegetative windbreak.

It is generally felt that windbreaks reduce odors by dispersing and mixing the odorous air with fresh air, although solid research has not confirmed these effects. Windbreaks on the downwind side of animal houses create mixing and dilution. Windbreaks on the upwind side deflect air over the houses so it picks up less odorous air. Producers should avoid placing dense windbreaks so close to naturally ventilated buildings that cooling breezes and winds exchanging the air in these buildings are eliminated or greatly reduced. A minimum distance of 50 feet, or five to ten times the tree height, from a naturally ventilated building is recommended.

Bedded systems

Using solid manure systems rather than liquid manure systems is generally considered to reduce odor. Although gases and dust are emitted from solid or bedded systems, most people feel that odor from bedded systems is less objectionable than the odor from liquid systems. Using bedding/dry manure systems for animals is generally considered to be more environmentally acceptable from both water quality and outdoor air quality viewpoints.

Anecdotal evidence suggests that organic bedding such as straw, corn stalks, compost, wood chips, or newspaper may reduce odor emissions. European research seems to support the use of some type of bedding (especially sawdust) to reduce odor generation/levels in buildings and subsequent odor release or emission (Nicks et al. 1997). Relatively small bedding levels may be enough to have an effect on odor generation/emission. Until liquid systems were adapted, primarily for convenience, bedding had been used for livestock production for generations. Many dairy and poultry facilities still use dry or solid manure systems.

Hoop structures have recently become popular for a few swine and dairy producers, in part due to their odor control effectiveness. They feature a deep-bedded pack system using straw or other crop residues to provide animal comfort and soak up manure liquids. Bedding availability is crucial for solid manure systems except for high-rise layer houses. Hoop structure bedding requirements for finishing swine are estimated to be 200 pounds of baled corn stalks per pig marketed. MWPS Publications AED 41 and 44 give details on using bedded hoop structures for swine production.

drop across the fans reached a maximum of 0.4 inches of water, 0.2 inches of that could be attributed to the building's ventilation inlet system.

The amortized construction and operating costs over three years for this full-sized biofilter were $0.22 per piglet produced per year. Rodent control costs were $275 per year. Additional operating costs of $125 per year included sprinkling costs and costs of operating the higher power ventilating fans (Nicolai and Janni 1998b, 1998c). In general, initial costs for a biofilter are approximately $0.10/cubic foot per minute (cfm) of ventilation air with annual operating costs of $0.02/cfm.

Recent research has led to the following recommendations concerning biofilters used to treat air from swine and dairy facilities:

- A residence time (amount of time the ventilation air is in contact with the media) of at least 5 seconds should be provided. This amount of time has resulted in 80% to 90% odor reductions; longer times do not increase this already high level of efficiency.
- The minimum depth of the biofilter media should be 10 inches.
- Fans need to be purchased with the capability of moving sufficient air exchange at a total static pressure (includes pressure drop of the barn air inlets as well as the biofilter's media) of 0.4 inches of water. When designing a biofilter, this pressure drop and its impact on the ventilating system must be considered.
- The Proper moisture control of the biofilter media is essential.
- A rodent control program is necessary.
- Vegetative growth on the biofilter surface must be limited.

Many common materials can be used for a biofilter, including dark red kidney bean straw and compost (Nicolai and Janni 1997), shredded wood and compost (50% by weight) (Nicolai and Janni 1998a, b, c), and even shredded wood and soil (50% by weight). Shredded wood is used to increase porosity, making it easier for the air to flow through the biofilter. Compost and soil are a source of microorganisms and nutrients.

Continual excessive moisture can lead to increased airflow resistance (pressure drop) and limited oxygen exchange that could create anaerobic zones. Insufficient moisture leads to drying, microbe deactivation, and channeling, which reduce contaminant removal efficiency. If present, mice and rats will burrow through the warm media in cold winter months, causing channeling and poor treatment. Rabbits, woodchucks, and badgers have also been suspected of burrowing through and nesting in biofilters. Finally, excessive vegetative growth on the biofilter surface can reduce its efficiency by causing channeling and limiting oxygen exchange. Root systems can cause plugging, and noxious weeds need to be removed before they produce seed. Excessive vegetative growth may also detract from the site's aesthetic appearance.

Summary: Biofilters effectively reduce odor, hydrogen sulfide, and ammonia emissions from mechanically ventilated livestock buildings. While simple in appearance, they are rather complex biological systems that need to be designed properly to perform well and prevent ventilation problems. Research is continuing to demonstrate their performance and to develop better design and management recommendations.

Windbreak walls

Walls erected downwind from the fans that exhaust air from tunnel-ventilated poultry buildings are being used on more than 200 farms in Taiwan to reduce dust and odor emissions onto neighboring land. These structures, known as windbreak walls, provide some blockage of the fan airflow in the horizontal direction. They can be built with various materials covering a wood or steel frame; plywood and tarps are common. The walls are placed 10 to 20 ft downwind of the exhaust fans of tunnel ventilated barns (Figure 2).

Another variation of the windbreak wall is called a straw wall. These systems have been used in North Dakota and elsewhere. They are made with wooden structures and "chicken wire." Straw is placed inside the structures, providing a barrier to dust and other air emissions. They may also offer some filtration capability.

Windbreak walls work by reducing the forward momentum of airflow from the fans, which is beneficial during low-wind conditions, because odorous dust settles out of the airflow and remains on the farm. In addition, the walls provide a sudden, large vertical dispersion of the exhausted odor plume that acts to entrain fresh outside air into the odor plume at a faster rate than would naturally occur, providing additional dilution potential.

The data and observations taken by Bottcher et al. (1998) using scentometers at a full-scale windbreak wall site in North Carolina showed that

- Dust builds up on the wall surfaces.
- The walls redirect airflow from the building exhaust fans upward.
- When wind speeds are low and blowing from the buildings toward the lagoon, the walls move the fan airflow upward so that it blows 10 ft or more above the lagoon surface. Without the windbreak wall in place, the fan air flows directly on top of the lagoon surface.
- Dust and odor levels are greater in the airflow from the fans than they are 10 ft downwind of the windbreak wall, because the fan airflow is deflected upward.

A model study done in Iowa predicted that tall wind barriers placed around a manure storage or lagoon would reduce odor emissions (Liu et al. 1996). Anecdotal evidence suggests a swine farm located in Minnesota benefited when a steel wall was built around an earthen storage basin. Although the operating cost of windbreak walls is relatively low, periodic cleaning of odorous dust from the walls is necessary for sustained odor control, unless rainfall is sufficient to clean the walls. Installation of windbreak walls is estimated to cost at least $1.50 per pig space (e.g., $1,500 for a building that houses 1,000 pigs).

Research to evaluate windbreak walls for dust and odor control is continuing. However, it is difficult to determine the effectiveness of windbreak walls due to several factors. As wind speed and direction shift, the airflow from building fans changes direction. As a result, it is difficult to measure odor downwind. Also, windbreak walls may not be suited for animal buildings equipped with multiple fans at non-uniform locations around the building.

Recent measurements taken by Bottcher et al. (1999) show that the system can apparently reduce total dust levels as much as 65% at a relatively low ventilation rate but only by about 16% at a high airflow rate typical of maximum hot weather ventilation. Although the changes in odor levels across the wetted pad scrubber were not as great as desired at the high ventilation rate, the data does indicate a modest odor reduction, consistent with the dust reduction. These results agree with other observations that dust removal from swine building airflow is associated with odor reduction. The wetted pad wall also reduced ammonia levels in the ventilation airflow by 50% at low ventilation rates and by 33% at medium ventilation rates.

Wetted pad wall installation costs are approximately $5.70 per pig space for an 880-head finishing building (Swine Odor Task Force 1998). The main operating cost is the 1-hp water pump, which will cost about $600 annually. The wetted pad wall does not impose a significant airflow restriction on the building fans. Maintaining adequate airflow is important if a healthy indoor environment is to be provided for the animals in warm weather.

Biomass filters

Researchers at Iowa State University have tested biomass filters as a means of removing odorous dust from swine buildings (Hoff et al. 1997a). Biomass filters use the principle that dust, if removed from the ventilation exhaust stream, will capture a large portion of the odors with it. Hoff et al. (1997b) were able to demonstrate a relationship between scrubbing dust and odors in controlled laboratory experiments and in a full-scale field trial. Using inexpensive material, a biomass filter removes odorous dust from the air stream. The biomass consists of either chopped corn stalks or corn cobs (Figure 12-6), but other materials can be used. Both odor and dust levels significantly reduced: odor by up to 90% and dust by up to 80%. These reductions occurred with low resistance to airflow at cold weather ventilation rates.

Chemical additives

In some instances, chemical additives are an option for odor or gas emission control. One application where additives were shown to be effective is the addition of alum to poultry litter. Moore et al. (1995) reported on a number of products that reduced ammonia volatilization from poultry litter, including alum, which provided a 99% reduction in ammonia volatilization when 200 g/Kg (20%) was added to the litter in broiler houses. Many other additives for both liquid and solid manure are on the market. A review of products tested across the United States and Europe for ammonia reduction revealed 39 products that worked versus 18 that did not. Of the products tested for odor reduction, 22 were reported to help while 33 did not. Many products worked for only a short time. Until the mechanisms for the various products are understood so reliable performance can be predicted, the additional costs for additive products may be hard for producers to justify.

Ozonation

Ozone is a powerful oxidizing agent and a very effective natural germicide. Ozone high in the atmosphere protects the earth from solar radiation. At ground level, however, the gas can be toxic at high levels. The current OSHA permissible exposure limit for ozone is 0.1 ppm for an 8-hour, time-weighted average exposure (OSHA 1998). Ozone has been used to treat

Summary of technologies for odor control

Process/System		Description	Advantages	Disadvantages	Cost
Exhaust air treatment	Biofilters	Odorous gases are passed through a bed of compost and wood chips; bacterial and fungal activity help oxidize organic volatile compounds	Reduces odors and hydrogen sulfide emissions effectively	May need special fans because of pressure drop	$0.50 to $0.80/pig
Dust reduction	Windbreak walls	A wall made of tarp or with any other porous material is placed 10-20 ft. from exhaust fans. The walls provide some blockage of the fan airflow in the horizontal direction. Dust and odor levels downwind of the windbreaks can be lower since the plume is deflected.	May reduce dust and odor emissions effectively	Periodic cleaning of dust from the walls is necessary for sustained odor control.	$1.50/pig space of bldg capacity
	Shelterbelts	Rows of trees and other vegetation are planted around a building, creating a barrier for both dust and odors from building exhaust air. Trees can absorb odorous compounds, and create turbulence that enhances odor dispersion	May reduce dust and odor emissions effectively	It may take several years to grow an effective vegetative wind-break	$0.20/pig space of bldg capacity or more
	Washing walls	A wetted pad evaporative cooling system is installed about 1.5 m upwind of ventilation fans and downwind of hogs in a tunnel-ventilated building. Exhaust air passes through the wet pad before being pulled through the fans	Reduces about 50% of dust and 33% of ammonia at medium ventilation rate	Residence time inside the pad is very small; thus odor removal may not be highly effective.	$5.70/pig space of bldg capacity installation cost
	Oil sprinkling	Vegetable oil is sprinkled daily at low levels in the animal pens.	Helps reduce airborne dust and odors	Creates a greasy residue on the floor and pen partitions if too much oil is used	$2.50/pig space of bldg capacity
Diet manipulation	Phytase	Product (enzyme) is mixed into the feed	Lower P content in the manure	Not known yet	N/A
	Low-phytate corn	Use low-phytate corn for feed	Lower P content in the manure	Not known yet	N/A
	Synthetic amino-acids and low crude protein	Products are mixed into the feed	Lower N content in the manure, may reduce odor and ammonia emissions	Not known yet	N/A
	Feed additives (Yucca schidigera)	Product is mixed into the feed	May reduce odor and ammonia emissions	Not known yet	$.20/pig marketed or more
Bedding		Dry carbon source added to animal pens to promote comfort and soak up manure	Reduced less obnoxious odors. Works for all species	Must harvest or buy bedding, and add it throughout the year. Increased volume of manure to haul	$3.00/head capacity for swine buildings
Manure additives		Chemical or biological products are added to the manure	May reduce odor and ammonia emissions	Usually questionable results.	$0.25 to $1.00/pig or more

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Chapter 3: Emission Control Strategies for Land Application

The land application of manure from livestock and poultry facilities is the most frequent source of odor complaints from the public (Pain 1995, Hardwick 1985). Land application of manure to cropland is an important component to the long-term sustainability of animal agriculture. Manure application returns nutrients and organic matter to the soil, keeping it healthy and productive. Unfortunately, manure application to cropland does present some environmental risk. Over application of manure can lead to nitrate leaching into groundwater, phosphorus runoff into surface water, and a variety of other pollution problems. Proper manure application requires knowledge of the nutrient content of manure, the nutrient requirements for the crops, the availability of the manure nutrients, the physical limitations of the application equipment, and some understanding of the critical environmental hazards associated with manure application.

Along with water quality problems are nuisance odor concerns. Odor from manure is, in general, offensive to most people. One of the key factors in odor control is the surface area of the emitting source. The larger the surface area, the more odors are emitted. As such, manure applied on the surface of cropland presents one of the most significant sources of odor for any livestock or poultry operation. Applying manure at low rates to avoid over applying nutrients may in fact exacerbate odor problems since the manure must be spread on larger land areas.

Odor may last for a few hours to as much as two weeks, depending on weather conditions and the manure source. Manure that is applied beneath the soil surface (injected) or covered immediately after spreading (incorporation) eliminates most of the odor because the odorous gases must then travel up through a soil layer before being emitted into the atmosphere. The soil layer acts as both a trap for odorous gases and an aerobic treatment system, changing odorous gases into less odorous gases through microbial processes. Manure injection or incorporation also reduces manure nitrogen losses to the atmosphere by reducing ammonia volatilization. Field research suggests odor and ammonia emission reductions of 90% are attainable using shallow or deep injector manure systems versus surface application (Phillips et al. 1988).

Liquid Manure Odor Control Techniques

As indicated previously, reducing odor from the land application of liquid manure offers special challenges. Several methods of reducing odor from liquid manure land applications include incorporating the manure into the soil either during or shortly after it is spread, placing the liquid manure on the surface but in the crop canopy, or treating the manure in the storage unit before it is spread on land.

Injection and incorporation: Manure injection into the soil is the most effective way to reduce odor during the land application of untreated liquid manure (Figure 1). Table 1 shows odor dilution thresholds for various land application methods. One can see that the injection and the unmanured (control) methods have essentially the same odor units. The other common option is to simply spread liquid manure on the surface and immediately incorporate (plow or harrow methods in Table 1) into the soil. This method also reduces the odors considerably compared to the broadcast method. However, incorporation after spreading on the surface does

The types of injectors used today include narrow tines, sweeps, disk covers, and conventional chisel plows. Besides their ability to achieve complete manure coverage for odor control, it is also important that these injector methods leave crop residue on the surface to minimize erosion and limit energy (tractor horsepower) requirements. Sweeps require more horsepower than simple tines for a given depth, but the sweeps more than compensate for this by operating at a shallower depth, permitting complete coverage. The disk covers, when set properly, require the least horsepower while still providing complete coverage, but they may also cover more crop residue. When the manure is placed on top of the soil surface and a conventional chisel plow is used for incorporation, complete coverage cannot be achieved. Thus a high level of odor control may be at the expense of higher energy requirements and the potential for greater erosion. The additional cost of manure incorporation or injection for odor control is offset somewhat by the savings in manure nitrogen. An Iowa study suggests that injecting the manure from a storage system increases costs $0.49 per year per breeding sow and $0.17 per finish hog while injecting the manure from a lagoon system increases costs $1.39 per year per breeding sow and $0.68 per finish hog (Fleming et al. 1998). However, these cost increases did not consider reduced nitrogen losses with the injection system. An Iowa survey of commercial manure applicators showed an average difference of 1/10 of a cent per gallon more for injection versus broadcast (see http://www.ae.iastate.edu/manurdir99.htm).

Drop hoses: Another method of application, used in northern European countries, is to simply place liquid manure on the surface through a series of drop hoses much like a sprayer hose or boom (Figure 2). This technique has been used to spread manure slurry (liquid manure from under barn pits) on tilled cropland and on growing crops (especially small grains), producing minimum odor and minimum potential runoff and/or erosion. The system has been used with manure tanks but could be adapted to drag hose technology on pastures or some crops such as forages. Adoption of this technology may be limited in the United States because of the prevalence of row crops and the difficulty of matching tanker tire size with rows and wheel spacing.

Pretreated manure: Treated liquid manure may be less offensive than raw or untreated manure, although this depends on the degree of treatment. Liquid manure can be treated either aerobically or anaerobically (anaerobic digestion) to significantly reduce odors. Research indicates odor reductions of 80% or more during anaerobic treatment of manure (Pain et al.1990). In such cases, manure can be surface applied or even irrigated with very little odor emissions. The same can be said for solid manure that is applied frequently (hauled daily), dried, or composted since it will generate less odor during land application.

Surface application by irrigation: Applying liquid manure with irrigation (both surface and spray) systems (Figure 3) remains a popular and efficient method to distribute manure nutrients onto crop land in some sections of the United States. As mentioned previously, it can produce considerable odors if not managed properly and/or the liquid manure is untreated or has a high nutrient content. Characteristics of irrigation systems that reduce odor include use of nozzles and pressures that produce large droplet sizes, installing drop nozzles on center pivot systems, and the addition of dilution water to the liquid manure before applying.

Droplet size is of importance because of the much higher surface area per unit volume associated with smaller droplets as well as the potential for greater drift of smaller droplets. In general, larger droplets are better for odor control. Droplet size is determined by a combination of nozzle size and pressure. To overcome their tendency to drift, droplets generally must be greater than 150 microns in size, depending on wind speed. Traveling guns must operate at high pressures, but the nozzle size is large, resulting in primarily large droplets. Center pivot irrigation units have wide latitude for nozzle size and pressure combinations. To minimize droplet drift and odor emissions from irrigation and other broadcast application systems, maximize nozzle size and minimize spray pressures.

Equipping center pivot irrigation systems with drop lines and downward spraying nozzles will reduce odors as well as reduce water evaporation. Drop lines can extend from 8 feet down to only 2 or 3 feet from the ground with appropriate nozzles and nozzle spacings to give good water distribution.

Fresh water dilution can also be used to reduce manure odors and nitrogen loss during irrigation applications. A Midwestern state (Iowa) requires a 15:1 dilution with fresh water if untreated slurry is to be irrigated. Burton (1997) reported that 3:1 fresh water additions to manure slurry reduced ammonia losses from 20% to 90%. Lagoon liquid is often mixed into irrigation water in states that commonly use irrigation for crop production. The lagoon effluent is then spread in a very dilute and greatly odor reduced manner.

Treating manure in pits: One other factor that contributes to odor and gas emission during manure application is the agitation or mixing of the manure before pumping (Figure 4). This mixing is necessary to remove the solids that have built up in the bottom of the storage and to distribute the nutrients evenly throughout the manure. Odor and gas emissions during agitation and pumping are difficult to control. The best method for reducing the impact of these odor emissions is to agitate during times when the outside air is heating (sunny clear mornings), causing the odorous air to rise and disperse.

Other techniques to reduce these emissions, such as the addition of chemical additives to the manure, are also being evaluated. Research has shown reductions in hydrogen sulfide emissions of over 90% with additions of calcium hydroxide, ferric chloride, ferrous chloride, ferrous sulfate, hydrogen peroxide, potassium permanganate, or sodium chlorite (Clanton et al. 1999). Although these reductions in emissions do not guarantee reductions in odor emissions, odor reductions are likely.

Solid Manure Odor Control Techniques

Technologies that reduce the odors released during land application of solid manure parallel those of liquid manure, namely, treating solid manure before it is spread and incorporating surface-applied solid manure into the soil as soon as possible after it is applied.

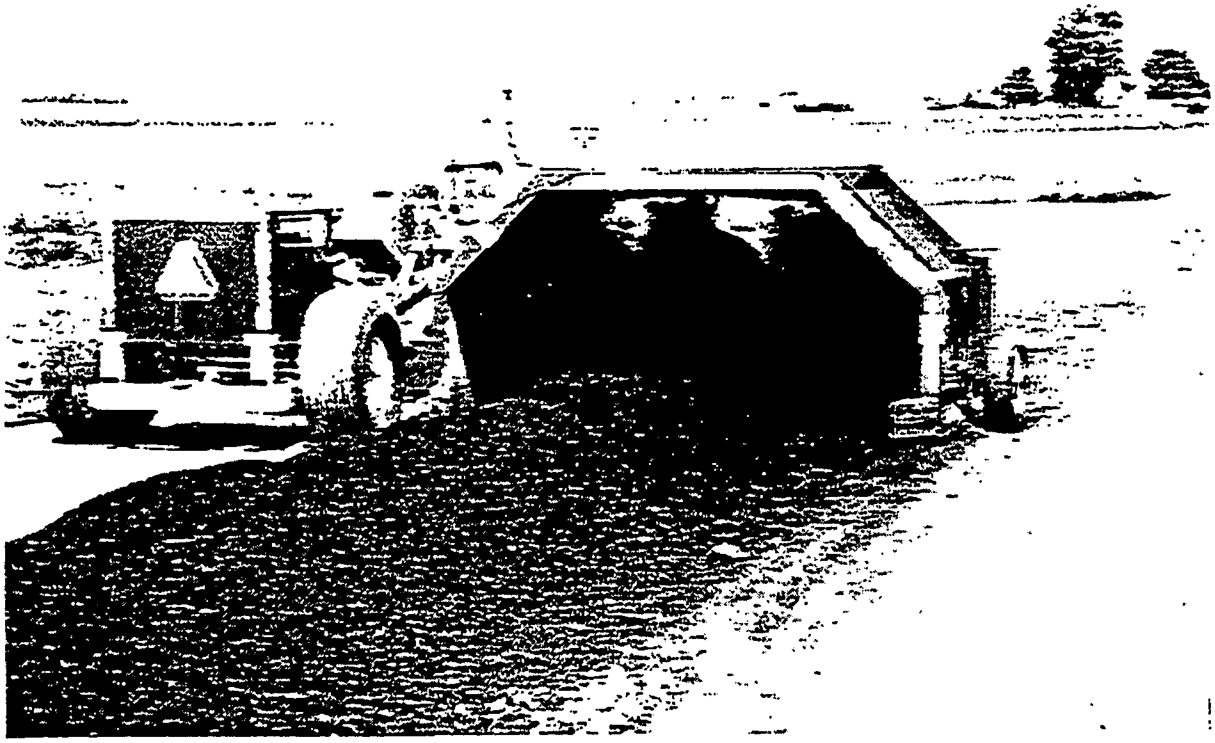


Figure 5. Mechanical turner used in composting solid manure

Time and location constraints: When applying manure, always consider wind direction especially if you are broadcasting. Select days when the wind is blowing away from neighbors and dwellings. If feasible, spread manure on weekdays when neighbors are likely to be away from their home; avoid weekends, especially Sundays and holidays. Before spreading manure, check with neighbors to be sure that they do not have a social event planned for the same day that you are planning to spread. If they do, change your plans. Finally, one of the most effective practices is simply to tell your neighbors or those who may be affected that you plan to apply manure to your farmland. Typically, people will object less if they know ahead of time and feel that they have some control or at least some input into what is happening around them.

Summary: Manure application can cause significant odor emissions. Several methods of reducing odor from both liquid and solid manure land applications include incorporating the manure into the soil either during or shortly after it is spread, placing manure on the surface but beneath the crop canopy, or treating the manure before it is spread on land. The agitation and/or loading of manure from long or short-term storage facilities will also create odors that need to be managed to avoid complaints during the application process.

Summary

Emissions from livestock housing and waste management systems have become a major concern in livestock production systems primarily because of odor impacts on neighbors and the resistance to expansion and/or siting of new facilities that result from the public perception of these facilities. Odors are very real, but are very hard to measure objectively. Individual gases can be measured with a good deal of accuracy, although many of the necessary procedures are fairly expensive. Odors, however, are not the result of any one or two gases. Swine odors have been shown to contain around 200 or more components and the interaction of these components is not fully understood.

Another aspect of odors that make them hard to measure is their variability. They vary with time, temperature, topography, and with the sensitivity of different individuals. They tend to be worst during times of low wind speed such as late at night or early morning. Low wind speeds do not disperse the odors, but can carry them a great distance from the source. Another aspect of odors that is not completely understood is the relationship between odors and dust. Odors can adhere to dust particles and be carried great distances on the particles.

There are a number of approaches used to reducing odor impacts including reduction of the amount of odorants produced or emitted, reduction of dust levels to aid in dispersal of odors, and encouraging the dispersal (dilution) of odors into the atmosphere. A healthy, well-managed anaerobic lagoon reduces odor emissions by maintaining a balance of bacteria that break down odorous emissions. The reddish color in a healthy lagoon is caused by purple sulfur bacteria that break down odors before they are emitted from the lagoon.

Several technologies have been tried aiming at removing dust from exhaust streams including windbreak walls placed just outside buildings, washing walls (wet scrubbers) placed just inside buildings, and straw wall filters. All of these have been shown to be fairly effective at low ventilation rates, but much work needs to be done to optimize them for different operating conditions and to evaluate their economic feasibility. Natural windbreaks (rows of trees and bushes planted around buildings and lagoons) have been shown to be effective and have the added advantage of improving the appearance of the area. Probably the best odor control strategy for manure slurry storages is some type of cover. Covers can range from the natural crust that forms on some slurries to organic cover (chopped straw, etc) to synthetic covers. Ozonation of manure before placing into the storage is also effective, but has not been proven economically feasible at this point.

The best way to reduce application odors in liquid manure application systems is to incorporate the manure into the soil during or soon after application. Other strategies include using low pressure systems to minimize drift, applying when winds are low or in a direction such that neighbors will be minimally impacted, and notifying neighbors of your plans to apply so that their scheduled activities can be planned around your plans.

PERMIT COMPREHENSIVE NUTRIENT MANAGEMENT PLAN
to
MEET REGULATORY REQUIREMENTS

Farm Name: Eggs In One Basket, Inc.
Owner: Eggbert A. Layer
Address: 2468 Spent Hen Rd.
Coop, GA
Telephone No. ______________________

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Owner/Operator ______________________________ date ________

Certified Planner ______________________________ date ________
GA Dept. of Agriculture # ______________________

Approvals

GA Dept. of Agriculture ______________________________ date ________

GA Dept. Nat. Res. EPD ______________________________ date ________

Manure Storage Facilities Description

(Use a separate form for each structure that holds manure or wastewater)

Type of structure (circle one) Manure Slurry Storage [✓ Anaerobic Lagoon]

Solids Settling Basin Dry Litter Storage Above Ground Tank

Other (describe)

For earthen storage, describe type of liner used (synthetic, compacted clay…). Give design information if available (permeability rate, etc…).

compacted clay

Date structure was installed and engineer or design agency (if available)

1993 by Dig-A-Hole, LLC

Is the structure designed to hold a 25yr/24hr storm event? ☒ YES ☐ NO

Estimated Capacity (gallons, cubic feet [ft^3], or tons [if dry storage])

3,000,000 gallons

Surface Water Diversions (circle one)

[✓ All surface water diverted] Some surface water allowed into storage

Explain if surface water allowed into storage. (give roof area, animal lot area, grassed area, etc.)

Leakage (prevention and inspection)

Are all berms/diversions inspected for leaks, proper vegetative cover, tree growth, and rodent damage at least monthly? ☒ YES ☐ NO

Operating Levels (lagoons)

Maximum fill level (ft below overflow) 2 ft.

Minimum Pump-down level 6 ft.

Is a staff gauge present in the lagoon, which clearly indicates these levels?
☒ YES ☐ NO

Table C1 . Annual On-Farm Nutrient Utilization: This Table is for planning and not actual applications. Please record all fields that you intend to use manure on. For each field there should be a corresponding Nutrient Budget Sheet.

Field #	Crop (or rotation if two crops grown in one year)	BMP's used[1]	Annual Manure N Use (lbs)[2]	Application Method	Application timing (record season and splits)
1-A	Fescue pasture	4,9	3,000	irrigation	1.5 ac-in bi-annually
		Total	3,000		

[1]: Insert BMP numbers from listing of BMP's in Table C2 or write in additional practices.
[2]: From Nutrient Budget Worksheets, spreadsheet, or other recommendations.

Table C2: Listing of BMP's used on Land Application Fields

1. Plant sampling/tissue analysis
2. Manure injection or incorporation
3. Manure treatments such as alum
4. Conservation or Reduced Tillage
5. Contour plantings
6. Terraces or other water control structures
7. Critical area plantings/vegetated waterways without manure applications
8. Upslope Water diversions or down-slope ponds or retention structures
9. Riparian buffers or filter strips around field border
10. Winter "scavenger" or cover crops (without nutrient application)
11. Rotational Grazing
12. Application Timing
    A. no wet weather application
    B. apply only within 1 month of maximum plant nutrient uptake
    C. apply in less than 15mph winds

Part F: RECORD KEEPING

Records kept on farm:

Yields	[✓ Y]	N	NA
Soil tests	[✓ Y]	N	NA
Manure Analysis	[✓ Y]	N	NA
Water Quality Monitoring (if required)	Y	[✓ N]	NA
Land application(IRR1&2,SLUR1&2, or SLD1&2)	Y	[✓ N]	NA
Monthly lagoon/storage/diversions inspc. checklist	Y	[✓ N]	NA
Equipment calibration	Y	[✓ N]	NA
Equipment maintenance	Y	[✓ N]	NA
Farm*A*Syst or other environmental assessments	Y	[✓ N]	NA
Field Nutrient Budget Sheets	[✓ Y]	N	NA
Off-farm nutrient utilization sheets	[✓ Y]	N	NA

Comments or additional records kept on farm: ______________________________

____

____

____

____

Part G: EMERGENCY RESPONSE PLAN

Describe emergency response plan or attach Emergency Response Sheet G1 for operations with just solid manure or Emergency Response Sheets 1(5 step plan) and 2(emergency resources and contacts) for operations with liquid manure:

See attached sheets

Part H: CLOSURE PLAN

Closure plan required: ☒ YES ☐ NO

If required, briefly describe closure plans or attach Closure plan worksheet:

Pre-arranged Emergency Response Agreements

List any arrangements made with other producers to share personnel and/or equipment and supplies and land access during an emergency.

Pre-arranged land access agreements

Contact #1 ____________________

Contact #2 ____________________

Location of Pre-Arranged Emergency Supply Equipment and Supplies

Available 24 hours a day. Include phone numbers and primary contacts. Put list in the order you want equipment operators contacted. Copy posted in each animal building on site, in site office and owners residence. Preferably posted by a phone or main doorway if no phone.

Owner	**Phone**	**Location**
Irrigation Pumps		
Dozer/Track Loader		
Backhoe		
Vacuum Slurry Tank		

Georgia Field Level Nutrient Budget Worksheet

A Worksheet for Managing the Nutrients in Manures from Georgia's Farms

Producer: John Doe **County:** Lumpkin **Date:** July '01
Farm #: 1 **Tract #:** 1 **Field #:** 1 **Acres:** 15.0
Soil Series: **Surface Soil Texture:** Clay Loam
Planned Crop: Fescue Pasture **Realistic Yield Expectation:** 3.0 Tons/acre
Soil Test Index: P = 107 (Lb/A) K = 159 (Lb/A) pH = 6.0
Manure Type: Lagoon-Layer **Application Method:** Irrigation

	N	P2O5	K2O			
Crop Nutrients Needs:	100	0	40	Lb/A		
Commercial Fertilizer Applications:	0	0	0	Lb/A		
Residual N from Legumes:	0	NA	NA	Lb/A		
Manure Nutrient Concentration:	126.0	25.3	434.0	Lb/A-In		
Availability Coefficients:	0.50	0.80	1.00	NA		
Equivalent Fertilizer Price:	0.34	0.25	0.16	$/Lb		
Net Manure Nutrient Needs of Crop:	100.00	0.00	40.00	Lb/A		
Manure Nutrients Available to Crop:	63.0	20.2	434.0	Lb/A-In		
Fertilizer Value:	21.42	5.06	69.44	Total =	95.92	$/A-In

Manure application rate for supplying crop : N needs = 1.6 In/A
P2O5 needs = 0.0

N based Application			P2O5 based Application		
Nutrients Applied		Balance	Nutrients Applied	Balance	
N	100.8	0.8	0.0	-100.0	Lb/A
P2O5	32.4	32.4	0.0	0.0	Lb/A
K2O	694.4	654.4	0.0	-40.0	Lb/A

Total manure applied to field based on: N needs = 24.0 Inches
P2O5 needs = 0.0

* If peanuts or tobacco are included in your crop rotation be sure to test soil following each manure application for recommendations on avoiding nutrient toxicity from high soil concentrations of Zn, or other micronutrients.

* See Farm*A*Syst Publications for information on applying animal waste, especially around streams, wells and on other environmentally sensitive areas.

* When making liquid manure applications, proper irrigation techniques must be used to to prevent manure liquids from running off into surface water or leaching into groundwater.

NUTRIENT BUDGET WORKSHEET

1. Producer John Doe 2. County Lumpkin 3. Date 7-23-98

4. Farm # 1 5. Tract # A 6. Field # 1 7. Acres 15

8. Soil Series Clay Loam 9. Leaching Potential Low

10. Tillage Practices Conventional

11. Planned Crop Fescue pasture 12. Yield Expectations 3 Ton/acres

13. Soil Test Rating: (a) P 107 Med (b) K 149 Med (c) pH 6.0

14. Nutrients recommended (lbs/ac): (a) N 100 (Table 6); (b) P_2O_5 0-soil test ; (c) K_2O 40-soil test

15. Lbs/ac starter fertilizer used: (a) N ; (b) P_2O_5 ; (c) K_2O

16. Residual nitrogen credit from legumes (see back) 0 lbs/ac

17. Net N needs of crop (14a minus 15a and 16) 100 lbs/ac

18. Net P_2O_5 needs of crop (14b minus 15b) 0 lbs/ac

19. Net K_2O needs of crop (14c minus 15c) 40 lbs/ac

20. Type of manure layer manure - lagoon

21. Manure nutrient content:
    - (a) N 126 ~~(lbs/ton)~~ (lbs/ac-in)
    - (b) P_2O_5 25.3 ~~(lbs/ton)~~ (lbs/ac-in)
    - (c) K_2O 434 ~~(lbs/ton)~~ (lbs/ac-in)

22. Manure application method (see back) Irrigation

23. Nutrients in manure available to crop: (21a, b & c multiplied times the availability coefficient)(see back)
    - (a) Available N 126 x 0.5 = 63 ~~(lbs/ton)~~ (lbs/ac-in)
    - (b) Available P_2O_5 25.3 x 0.8 = 20.2 ~~(lbs/ton)~~ (lbs/ac-in)
    - (c) AvailableK_2O 434 x 1.0 = 434 ~~(lbs/ton)~~ (lbs/ac-in)

24. Manure application rate to supply the priority nutrient:
    - (a) Priority nutrient Nitrogen
    - (b) Amount of priority nutrient needed (17, 18 or 19) 100 lbs/ac
    - (c) Rate of manure needed (24b divided by 23a, 23b, or 23c) 1.6 ~~(tons/ac)~~ (in/ac)

25. Pounds per acre of available nutrients supplied at the manure application rate needed to supply the priority nutrient:

    (a) N 63 x 1.6 = 100.8 lb/ac
    (23a) (24c) (tons/ac or in/ac)

    (b) P_2O_5 20.2 x 1.6 = 32.3 lb/ac
    (23b) (24c) (tons/ac or in/ac)

    (c) K_2O 434 x 1.6 = 694 lb/ac
    (23c) (24c) (tons/ac or in/ac)

26. Nutrient balance: (Net nutrient need (-) or excess (+) after the application of manure at the calculated rate)

    (a) N balance 100.8 - 100 = 0.8 lb/ac
    (25a) (17)

    (b) P_2O_5 balance 32.3 - 0 = 32.3 lb/ac
    (25b) (18)

    (c) K_2O balance 694 - 40 = 654 lb/ac

27. Completed by Title

Agency The University of Georgia Cooperative Extension Service

The University of Georgia
College of Agricultural and Environmental Sciences
Cooperative Extension Service

Soil Test Report

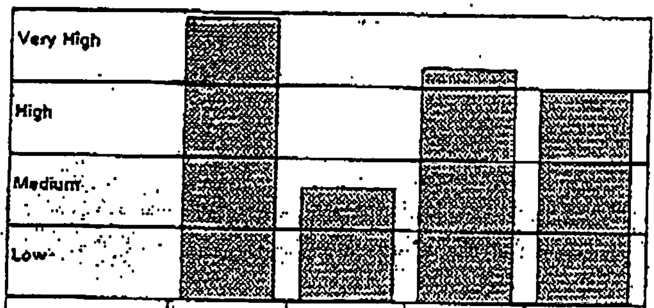
Soil, Plant and Water Laboratory

(CEC/CEA Signature)

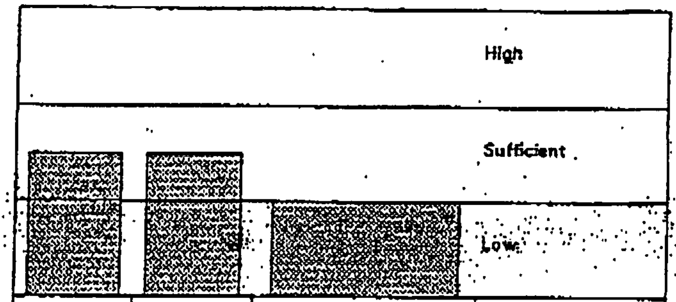
Sample ID

Grower Information	*Lab Information*	*County Information*
Client: John Doe Dahlonega, GA 30533 Sample: 2 Crop: Fescue Pasture	Lab #88910 Completed: 04/09/01 Printed: 04/10/01	Lumpkin County 26 Johnson Street, Suite A Dahlonega, GA 30533

Results



	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)
Soil Test Index	107 lbs/Acre	159 lbs/Acre	1966 lbs/Acre	193 lbs/Acre



Zinc (Zn)	Manganese (Mn)	Soil pH	
10 lbs/Acre	42 lbs/Acre	6.00	Soil Test Index

Recommendations

Limestone	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Sulfur (S)	Boron (B)	Manganese (Mn)	Zinc (Zn)
0.0 tons/Acre	*	0 lbs/Acre	40 lbs/Acre	--	--	--	--

*For establishment, apply 20 to 50 pounds nitrogen per acre.

*When grazed adjust nitrogen (N) rate according to stocking rate. If 2 acres per cow, apply 50 pounds nitrogen per acre; 1 acre per cow, increase the rate to 100 pounds nitrogen per acre.

*When harvested for hay as well as grazed, apply 100 pounds nitrogen per acre, applying half in early fall and the remainder in early spring. Increase the potassium application by 20 pounds potash per acre, and apply phosphate (P_2O_5) as recommended.

Where grass tetany (magnesium deficiency in animals) may be a problem, split the nitrogen and potash fertilizer applications. If the potassium soil test level is very high do not apply potash fertilizer. If the soil magnesium level is low, magnesium should be added to the animal diet.

If no phosphate (P_2O_5) or potash (K_2O) is recommended and none is applied, sample soil again next year.

NOTE: The amount of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) actually applied may deviate 10 pounds per acre from that recommended without appreciably affecting yields.

PUTTING KNOWLEDGE TO WORK

The University of Georgia
College of Agricultural and Environmental Sciences
Cooperative Extension Service

Animal Waste Report

Soil, Plant and Water Laboratory

(CEC/CEA Signature)

Sample ID

Grower Information	Lab Information	County Information
Client: John Doe 123 McIntosh Drive Dahlonega, GA 30533 Sample: 1 Type: Lagoon-Layer	Lab #1Samp Completed: 06/26/2001 Printed: 06/26/2001	Lumpkin County 26 Johnson Street, Suite A Dahlonega, GA 30533 706-864-2275

Results

(Reported on an as-received wet basis.)

Lab Results	ppm	lbs/ 1000 gal	lbs/ acre inch
Total Kjeldahl Nitrogen	555	4.61	126
Ammonium-Nitrogen	488	4.05	111
Nitrate-Nitrogen	<1.00	<0.01	<0.23
Phosphorus (P_2O_5)	112	0.93	25.3
Potassium (K_2O)	1917	15.9	434
Calcium	87.0	0.72	19.7
Magnesium	29.0	0.24	6.56
Sulfur	32.0	0.27	7.26

Lab Results	ppm	lbs/ 1000 gal	lbs/ acre inch
Manganese	0.18	negligible	negligible
Iron	2.19	0.02	0.50
Aluminum	2.58	0.02	0.59
Boron	1.72	0.01	0.39
Copper	<0.04	negligible	negligible
Zinc	0.44	negligible	negligible
Sodium	314	2.60	71.1

% Solids ________

Total Kjeldahl Nitrogen includes ammonium and organic nitrogen combined, and does not include nitrate.

Application Information: The amount of reported nitrogen expected to be available for crop production will vary depending on several factors. Your County Agent can assist in calculating the amount of nitrogen that will be available under your specific set of conditions.

Rates of the animal waste product to apply for crop production should be based on soil test recommendations and take into consideration the nutrient content of the product as well as the method of application, the amount of nutrients applied from commercial fertilizer, and previous crop residue. Where large amounts of animal waste are used annually it is important that regular soil testing be used to monitor the impact on soil fertility levels.

PUTTING KNOWLEDGE TO WORK

Maps for Comprehensive Nutrient Management Plans

Julia W. Gaskin, Biological & Agricultural Engineering Dept., University of Georgia
Vernon Jones, USDA Natural Resources Conservation Service

Introduction

A comprehensive nutrient management plan (CNMP) is a planning tool for making wise use of plant nutrients while protecting water resources. The basis of a CNMP is an accurate map of your farm. The map or maps will help you identify areas suitable for land application of manures and areas that need protection or that may need special management due to environmental sensitivity. The maps will also help you evaluate your crop rotation and calculate acreage you have available for using animal manures. Although a CNMP evaluates the use of all sources of nutrients, this document will focus on preparing maps for the management of nutrients from organic sources such as manures.

Maps for CNMP should be on a known scale and include:

- farm property lines
- land use - cropland, pasture, forest, etc
- farm field boundaries with field identification
- surface water locations, including streams, rivers, ponds, ditches, and wetlands
- arrows showing the direction of stream or river water flow
- well locations
- buffers around sensitive areas
- any residences or public gathering areas
- North arrow
- date prepared
- "Prepared with assistance from (NAME)"
- road names or numbers
- name of county
- legend with map symbols
- BAR SCALE on the map

Making a Base Map

How do you go about getting this information? First is the "old-fashioned way".

You will need:

- several copies of the Farm Service Agency (FSA) maps of your farm
- a copy of the county soil survey map of your farm from Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS)
- colored pencils
- a ruler
- a transparent dot grid or other method to determine acreage

Use the FSA map as your base map. Remember when maps are photocopied, the scale can change. You should use a bar scale to make sure your scale is accurate. Draw a 1-inch line

Take out the copy of the county soil survey map with your farm on it. Figure 2 shows the corresponding soils map for Figure 1. Locate your farm on the map. The soil survey map is <u>NOT</u> the same scale as the FSA map, but you should be able to use features such as roads, rivers, fields, etc to locate your property boundaries. The soils map will have streams marked on it in this symbol ~~~~ or this symbol ~~ ··· ~~. Use these markings, with your knowledge of your farm, to determine where streams are on the FSA map.

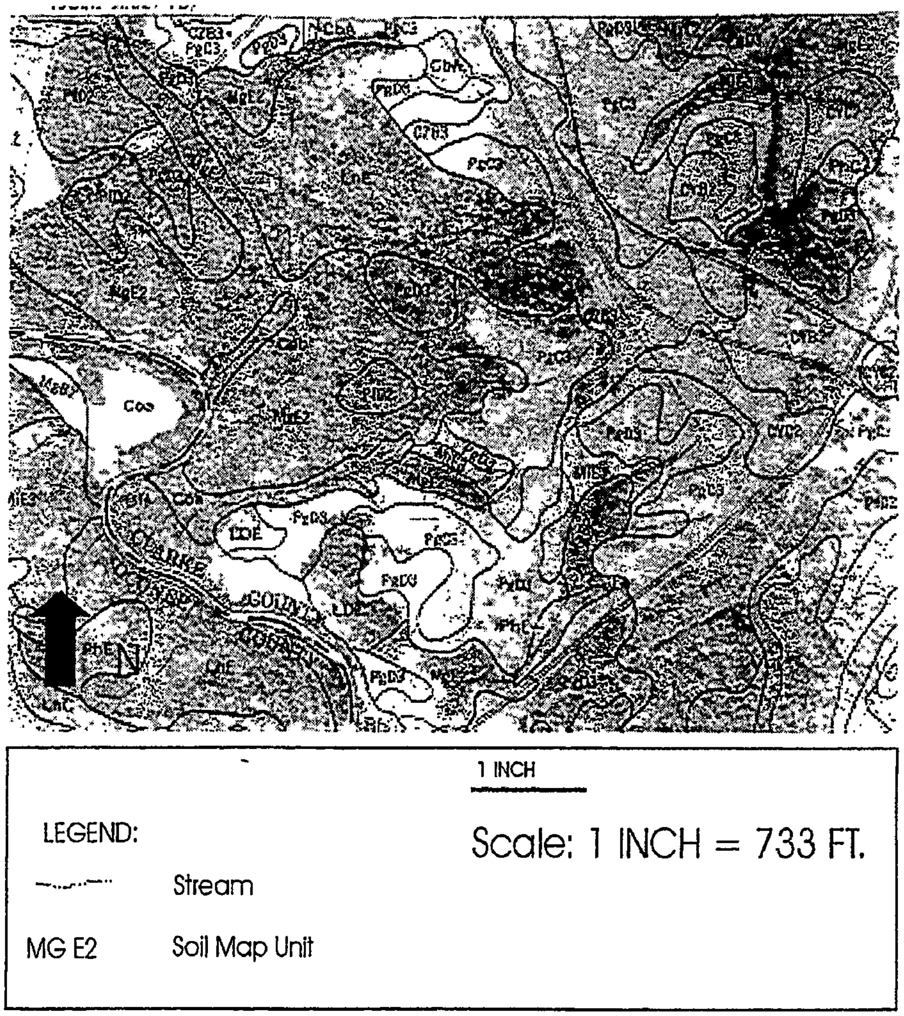


Figure 2. Corresponding soils map for Figure 1.

Using the symbols above or a solid blue line, mark the streams on the FSA map in blue pencil. Add arrows to the stream symbol to show the direction of stream flow. Outline other surface waterbodies such as ponds, rivers, and wetlands in blue. Your FSA map may already have wetlands marked on it. If it doesn't and you are unsure about whether an area on your farm is a wetland, contact the NRCS for a wetland determination. Finally, mark any wellhead locations in blue. Figure 3 shows the base FSA map with the water symbols added.

You should discuss these areas with NRCS or county extension personnel to determine if the need to be permanently excluded from your land application program or if they can be used seasonally or with special management.

You should keep the soils information you have developed with your CNMP. The information may prove useful if the CNMP needs to modified.

Buffering Sensitive Areas - Sensitive areas are things such as wellheads, streams, or wetlands that are sensitive to nutrient inputs. Buffers around wellheads will reduce the potential for groundwater contamination due to nutrients from manures, fertilizers or pesticides. Table 1 gives the distances required by law that you need to have separating wellheads from various potential contaminants. Table 2 gives recommendations for separation distances from potential contaminants.

Table 1. Minimum distances between wells and potential contaminants based on the Georgia Well Standards Act of 1985.

Distance from Well (feet)	Potential Contamination Source
10	Sewer line
50	Septic tank
100	Septic tank absorption field
150	Cesspool or Seepage pit
100	Animal or fowl enclosure

Table 2. Recommended separation distances from various potential contaminants.*

Distance from Well (feet)	Potential Contamination Source
150	Waste lagoon
50	Dead animal burial pits
100	Pesticide storage, mixing & loading facilties
100	Fertilizer storage
500	Petroleum tanks
250	Manure or chemical application

*Tyson, A. 1996.Improving Drinking Water Well Condition. Georgia Farm*A*Syst, Cooperative Extension Service Bulletin 1152-3.

Buffers around streams, rivers, ponds and wetlands reduce the chance these surface waters will become overloaded with nutrients. Most fresh waterbodies in Georgia are particularly sensitive to phosphorus. Phosphorus in runoff or in water moving through the soil into the surface water can cause excessive algae growth that creates problems for recreation and other uses. Table 3 gives some general guidelines for buffer widths. Effective buffers are highly site specific and depend on land use, slope, and vegetation. You should review any

Now calculate the acreage in each field that is not useable for manure application due to the buffers, sensitive areas or unsuitable areas. Buffer areas can be calculated using a planimeter, measuring the area with a ruler, or a dot grid. A dot grid is a transparent piece of paper with a known number of dots per square inch. Place the dot grid over the buffer area and count the number of dots within the buffer. If a dots fall on the buffer line, include every other dots in your count for the buffer area. Divide the total number of dots by the number of dots per square inch to get the square inches of land in the buffer. Now find the scale of your map. Multiply the number of feet per inch by itself to get square feet per square inch. Then multiply the number of square inches from your dot grid by the square feet for your base map, convert to acres, and you're done. The example below may help you remember this procedure.

Find Field 21 on Figure 4. This field has buffers drawn around public roads, the property boundary and along a wetland area. The buffer along the public road is 150 feet, and those around streams, wetlands and the pond are 100 feet. Using a dot grid with 40 dots per square inch, we counted 19 dots within the buffer area. We divided the 19 dots by 40 dots per square inch to get 0.48 square inches. Our map in Figure 4 has a scale of 1 inch = 900 feet, which is equivalent to 810,000 square feet per square inch. Dividing 810,000 by 43,560 square feet, we get 19 acres per square inch. If we multiply 0.48 square inches by 19 acres per square inch, we find we have 9.1 acres in buffers. We have to subtract this 9.1 acres from the total field acreage of 119.8 acres to get the number of "spreadable" acres. Remember to subtract all the buffer areas or other areas unsuitable for manure application from the field acreage, so you have an good idea about how much land is available for use.

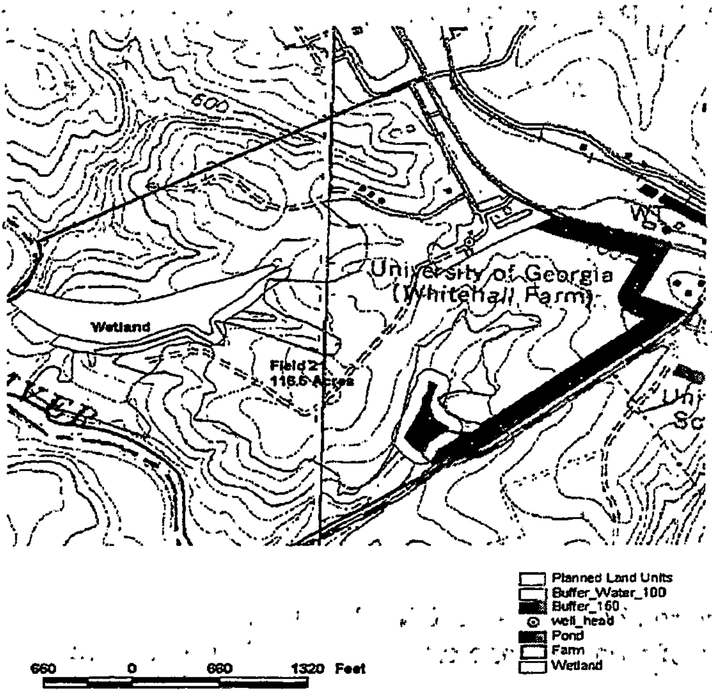
You may also want to limit your use of manures in areas close to houses or public gathering places, if there is a potential for odor complaints. These areas should also be marked on your map, and subtracted from your useable land acres. Note Fields 16 and 17 in Figure 4. These fields border a busy public road. If a 150 -foot buffers is used to reduce possibility of complaints, the useable area in the fields is too small to use. So these fields will not be included in the land to be used for manure application.

Computer Generated Maps

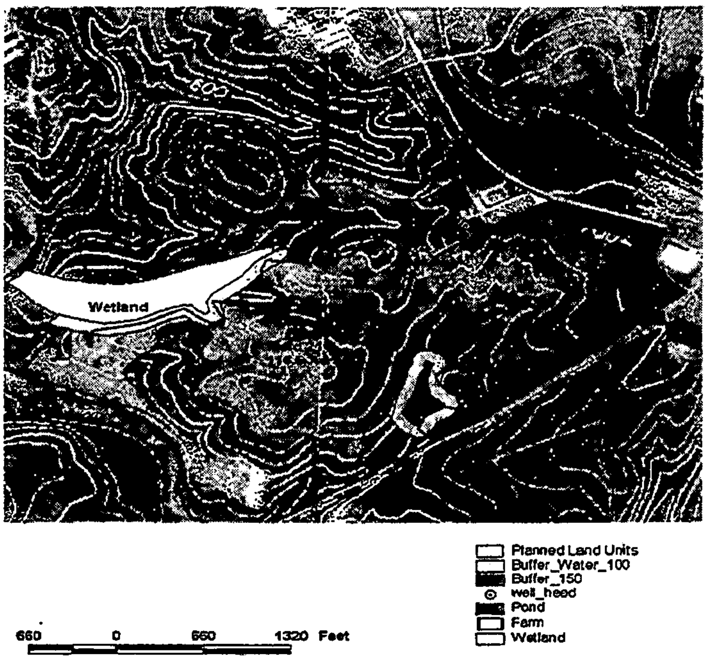
NRCS Toolkit - A second way to acquire the map information needed for a CNMP is to use the NRCS Toolkit. USDA Service Center Offices are equipped with computers and technology that can generate a similar map for you. A conservationist can come to your farm, and use an electronic aerial photo of the farm with the FSA property lines and field lines. You can work with the conservationist to add streams, as well as other water bodies, and locate buffers. This technology is in place in several district offices and should be available throughout the state in the near future. To read more about the NRCS Toolkit go to *http://www.ga.nrcs.usda.gov/ga/gapas/index.html.*

The maps labeled as GIS Map 1, GIS Map 2 and GIS Map 3 are examples of computer generated maps. GIS Map 1 is an electronic aerial photo with the farm boundaries (black line), field boundaries (red line), 150 foot setback around the property line (green line), 100-foot buffer around surface water and wetlands (light violet) well (small circle), streams and pond (blue) overlain on the photo. GIS Map 2 is the electronic version of a USGS topographic map with the same information as GIS Map 1 on it. GIS MAP 3 is GIS MAP 1 with GIS Map 2 overlain on it. The computer will calculate the area of the fields, buffers and any other area that is desired. As more soil surveys are digitized, the soil map will be available for overlaying on the base aerial photo.

USDA GIS Map 2



USDA GIS Map 3



POULTRY: FLY CONTROL

Nancy C. Hinkle, Veterinary Entomologist

IMPORTANT: Effective, economical fly control depends on producer management. Check fly-breeding areas (manure, around feed bins, etc.) weekly and maintain an integrated pest management program (IPM) to ensure long term fly control.

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS[1]
RESIDUAL AND BAIT SPRAYS			
Residual and bait sprays are used when a residual insecticide deposit is needed for adult fly control Apply to surfaces in poultry operations where flies rest and feed. **NOTE**: Use of residual sprays promotes insecticide resistance Use of synthetic pyrethroid (SP) insecticides virtually eliminates the implementation of a dump fly (*Hydrotaea aenescens*) biological control program.			
cyantraniliprole Zyrox Fly Granular bait	28	Ready-to-use when purchased.	Apply in bait station, inaccessible to children, pets, and food animals. Use 0.2-0.4 lb bait/1000 sq ft/yr.
esfenvalerate 35%	3A	Apply according to label directions.	Do not apply when feed is present.
permethrin Atroban, Ectiban, Insectrin, Permectrin 5.7% EC, 10% EC or 25% WP	3A	5.7% EC is ready-to-use as a mist-spray OR mix 1 qt 5.7% EC in 12 1/2 gal of water OR mix 6 oz 25% WP in 11 gal of water OR mix 1 qt 10% EC in 25 gal of water.	Apply as a residual surface spray to fly resting areas (walls, ceilings, etc.). Do not spray manure or litter. Do not apply directly to poultry. Do not apply in egg storage areas. Apply 5.7% EC undiluted at 4 oz/1000 sq ft of surface area or apply diluted WP and EC mixtures at 1 gal/750 sq ft. Don't apply more than once every 2 weeks.
Beauveria bassiana HF 23 balEnce 1.12% ES (5.6x10^9 cfu/ml)		Follow label instructions for dilution instructions.	Apply at a rate of 1.5-2 fl oz/5000 sq ft of floor area. Apply to floors, walls, posts, and manure areas where the greatest number of pests are located. Equipment must not be used with a filter or screen smaller than 50 microns. Re-treat every 2-7 days while pests persist.
beta-cyfluthrin Tempo 11.8% SC, 24.3% EC, 20% WP	3A	Mix 8-16 milliliters of 11.8% Tempo SC Ultra Premise Spray in sufficient water to cover 1000 sq ft.	
bifenthrin Actishield	3A	Mix 0.33-1 oz with 1 gal water; apply/1000 sq ft	For adult fly control in and around animal facilities, spray application should target areas where flies will rest.
chlorpyrifos Durashield, Duratrol	1B	Restricted use pesticide for use by certified applicators	Apply according to label directions to adult fly resting sites
cyfluthrin Optashield CS	3A	Mix 1-2 fl oz with 1 gal water	Apply 1 gal/1000 sq ft.
deltamethrin Deltagard 2%	3A	Follow label instructions for dilution recommendations.	Product intended for use with handheld, backpack, portable and truck mounted ULV or mist-sprayers. Apply in areas where flies congregate. Cover all feed and water sources. Follow application rate chart for flow rate recommendations.
dichlorvos Vapona	1B	Ready-to-use	Apply as coarse spray, 1 pt/1000 sq ft of surface.
gamma-cyhalothrin StandGuard 5.9%	3A	Mix 0.16 fl oz (5 ml)/gal of water	Spray 1 gal of diluted spray to treat 500-1000 sq ft of fly resting surfaces.
imidacloprid QuickBayt Spot Spray 10%	4A	Mix at the rate of 1 lb/gal of water to treat 1000 sq ft of fly resting areas.	Product can be sprayed on virtually any surface (out of reach of animals) where flies rest or congregate, indoors or outdoors. Examples include posts, beams, ceilings, railings, door frames, windows, and walls. Residual activity of up to 6 weeks indoors and 2 weeks outdoors.
lambda-cyhalothrin 9.7% Grenade ER Insecticide Demand CS	3A	Mix 0.2-0.4 oz (6-12 ml)/gal water.	Make a directed application to fly-resting surfaces and allow to dry before reintroduction of animals. Do not apply when animals are present

POULTRY: FLY CONTROL

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS[1]
LARVICIDE (MAGGOT) SPRAYS AND FEED THROUGH LARVICIDES			
Another way to control flies is to destroy the immature fly (maggot) Heavy use of a given insecticide could result in flies developing resistance to the insecticide. To kill adult flies, use fly traps and apply baits, residual sprays, bait sprays, and contact sprays either alone or in combination.			
Beauveria bassiana balEnce Biological Fly Spray	Biological	15 oz container diluted in 6-8 gal water. Treats up to 50000 sq ft.	Apply spray to manure. Repeat treatment as recommended on label.
cyromazine Larvadex 1% Premix, HE	17	5 parts/million in total diet of commercial layers or hatching egg layers. Mix 1 lb of 1% premix/2000 lb of feed.	Administer treated feed as daily ration as needed to control house flies. Treated feed must not be fed to layers for a minimum of 3 days (72 hours) before slaughter for food.
Flyzine 1% Premix			Blend into poultry ration for layer and breeder operations at the rate of 1 lb/ton of feed.
Neporex 2SG		Ready-to-use when purchased.	Scatter directly and evenly on wet fly larval development sites (manure). Wear gloves. To spray, mix 1 lb in 1 gal of water and spray 200 sq ft. Do not apply directly to birds or feed. Do not use in conjunction with other *cyromazine* products.
Larvadex 2SL		Mix 32 fl oz/5 gal water.	Apply 1 gal/100 sq ft of maggot breeding area.
diflubenzuron Dimilin 2L	15	Mix 5 fl oz in 10 gal water	Apply spray in spot treatments to maggot developmental sites in manure
novaluron Tekko 10 IGR 9.3%	15	Mix 2-3 oz in 1 gal water	Apply as a coarse spot, crack, or crevice spray at a rate of 1.5-3 oz/1000 sq ft. Product is stable, not volatile and may be used while facility is in operation so long as exposed feed and water sources are covered. Do not spray into the air or over water sources. Allow at least 1 day between application and slaughter of animals.
pyriproxyfen Archer Nylar Insect Growth Regulator 1.3%	7C	Mix 1 fl oz in 1 gal water.	Wet surfaces where larvae are found; may repeat 14 days afterward.
NyGuard IGR 10%		Mix 4 ml in sufficient water to cover 1000 sq ft.	Apply to litter at rate of 4 ml/1000 sq ft.
Pyri-Shield EC 1.3%		Mix 1 fl oz in 1 gal water.	Apply to 1500 sq ft of surface area.
Ravap	1B	1% spray. Mix 1 gal EC in 25 gal of water.	Under cages, broadcast treatment as a coarse low-pressure spray at a rate of 1 gal/100 sq ft of manure.
Rabon 2 lb ai/gal 23% and Vapona 0.5 lb ai/gal 5.7% EC			Apply at 7-10 day intervals along with an intensive adult house fly control program until manure begins to dry or cone up. Spot spraying of manure and continued use of adult house fly control will maintain control. Do not contaminate eggs, feed, or water. Keep spray away from birds.
Vapona or DDVP *dichlorvos* 2 lb ai/gal 21.8% EC	1B	0.5% spray. Mix 3 1/3 cups EC in 10 gal of water.	Apply enough spray to penetrate manure (until thoroughly wet). Since Vapona has such a short residual, heavy treatment is required for larval kill. Once control is established, Vapona is an economical spot spray. Observe same methods of application and safety restrictions as for Ravap above.

POULTRY EXTERNAL PARASITE CONTROL

Nancy C. Hinkle, Veterinary Entomologist

BEDBUGS, CHICKEN LICE, FLEAS, FOWL TICKS, AND MITES FOR DIRECT TREATMENT TO BIRDS OR POULTRY FACILITY

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS[1]
		DUSTS[2]	
permethrin Ectiban, Insectrin, Permectrin 0.25% Dust	3A	Ready-to-use dust.	Apply 1 lb/100 birds. Ensure thorough treatment of vent for northern fowl mite control.
Sulfur Yellow Jacket Wettable Dusting Sulfur II	Inorganic	Ready-to-use dust.	Dust liberally on birds and rub into plumage, concentrating on area around vent
		SPRAYS[3]	
permethrin Ectiban, Permectrin 5.7% EC	3A	Mix 1 qt 5.7% EC **OR** 1 pt 11% EC in 25 gal water.	Apply 1 gal diluted spray to 100 hens using high pressure. Apply to vent area for best results. A second application may be needed 4 weeks later.
23% *stirofos* + 5.7% *dichlorvos* Ravap 28.7% EC	1B	Mix 2 qt EC in 24 gal water.	Apply 1 gal/100 birds. Apply directly to birds. Spray vent and fluff areas from below using high pressure (100 psi and up) sprays. Wet feathers around vent area for effective control. Do not spray birds more often than once every 14 days. For floor birds, apply 1-2 gal of spray/1000 sq ft of litter. Spray birds lightly.
spinosad Elector PSP 44.2% *spinosad*	5	Mix 3 fl oz Elector PSP in 10 gal water.	Apply 100 gal of coarse spray/100 Elector PSP to birds to ensure adequate coverage, directed toward the vent area.
sulfur Yellow Jacket Wettable Dusting Sulfur II	Inorganic	Mix 25-50 lb/100 gal water.	Spray 200-250 lb/20000 sq ft to all interior services, forcing into cracks and crevices. Do not spray birds.

BEDBUGS, CHICKEN MITES, FLEAS AND FOWL MITES FOR TREATMENT OF POULTRY FACILITY ONLY (Not For Direct Application To Birds)

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS[1]
pyrethrins 1-2% + piperonyl butoxide + 3% *bicycloheptane dicarboximide* Surekill SK 100	3A	Concentrate designed for undiluted use in mechanical sprayers that give particles of aerosol size.	Apply at a rate of 3 fl oz/1000 cu ft undiluted, using a ULV spraying device. Remove feed, water, and live animals before application. Apply to all areas where insects take shelter. Allow product to thoroughly dry before re-entry.
sulfur Yellow Jacket Flowable Sulfur	Inorganic	Mix 1-2 gal/100 gal water; apply 20 gal/20,000 sq ft.	Remove poultry before spraying.
tetrachlorvinphos + (5.7%) *dichlorvos* 28.7% Ravap (23%)	1B	1.25% or 2.5% spray or 1.25% roost paint. Mix 1 gal EC in 12.5 gal of water to make 2.5% mixture or mix 1 gal EC in 25 gal of water to make 1.25% mixture.	Apply roost paint at the rate of 1 pt of finished mixture/100 ft of roost area with brush or spray OR apply 1 gal of spray/100-150 sq ft for fowl ticks or 1 gal of spray/500-1000 sq ft for other parasites.

[1] Do not contaminate feed, water, or feeding and watering equipment.

[2] Dust birds thoroughly, especially under the wings and around the vent. Provide thorough ventilation while dusting.

[3] Penetration of feathers around vent is essential for northern fowl mite control. Apply directed sprays using 100-125 psi Provide thorough ventilation while spraying. Force sprays into cracks and crevices when treating for chicken red mites, bedbugs, fleas, and fowl ticks.

POULTRY HOUSE PEST CONTROL

LITTER BEETLES – Darkling Beetles (black bugs, black poultry bugs, lesser mealworms) and Hide Beetles

INSECTICIDE[1]	MOA	MIXING INSTRUCTIONS	APPLICATION INSTRUCTIONS AND SAFETY RESTRICTIONS[2]
orthoboric acid Safecide Brand IC 99% Borid 99% BorActin 99% Safecide Brand IC	8D	Ready-to-use when purchased.	Remove birds. Apply dust uniformaly to floor of poultry house or old litter with a fertilizer or seed spreader, at the rate of 1-2 lb/100 sq ft in bands along feeder lines. Cover with fresh shavings.
permethrin Tengard SFR 36.8%	2A	Apply at rate of 4 fl oz in 12.5 gal water. Spray 1 gal/750 sq ft.	Do not apply when birds are present.
pyrethrins Riptide ULV 5%	3A	Ready-to-use when purchased.	Apply undiluted at 0.25-1 fl oz/1000 cu ft for knockdown of accessible insects; provides no residual.
pyriproxyfen Archer Insect Growth Regulator 1.3%	7C	Mix 1 fl oz in 1 gal water.	Wet surfaces where larvae are found; water volume may be increased to enhance litter penetration.
NyGuard IGR 10%		Mix 4 ml in sufficient water to wet surface being treated.	Wet area where larvae are found.
Pyri-Shield EC 1.3%		Mix 1 oz in 1 gal.	Apply 1 gal/1000 sq ft where larvae are found.
spinosad 44.2% Elector PSP	5	Mix 2 fl oz (60 ml) in 10 gal of water to treat 5000 sq ft.	Use sufficient water to ensure thorough coverage, treating litter along feed and water lines, walls, and support beams. Reapply after each grow-out.
Extinosad PSP 44.2%		Mix 2 oz with 10 gal water.	Apply 1 gal/500 sq ft.
tetrachlorvinphos Rabon Beetle Shield 3% dust	1B	Ready-to-use when purchased.	Use 4-8 oz/100 sq ft, applied using plunger or rotary type duster
Rabon 50WP			Use rotary, mechanical or electrostatic duster to apply 3/4 oz/100 sq ft of surface.
tetrachlorvinphos + *dichlorvos* Ravap E.C. 23% *tetrachlorvinphos* + 5.3% *dichlorvos*	1B	1 gal in 25 gal water (for extreme infestations dilute 1 gal in 12.5 gal water)	Apply 1 gal of spray/500-1000 sq ft to cover walls, floors, and other sites where beetles congregate.
Rabon 50WP	1B	Mix 8 lb with 100 gal water.	Apply 1-2 gal/100 sq ft.
thiamethoxam Agita 10 WG	4A	Mix 2 oz in 32 fl oz water.	Apply 2 fl oz to shavings under each feeder (do not broadcast).
zeta-cypermethrin ZetaGard LBT	3A	RTU dust	Use a drop spreader to make band applications under feedlines and along walls; 50 lb/20,000 sq ft broiler house.

MOTHS IN FEED (webbing clogging auger and feed lines)

INSECTICIDE[1]	MOA	MIXING INSTRUCTIONS	APPLICATION INSTRUCTIONS AND SAFETY RESTRICTIONS[2]
Diatomaceous earth DE	Inorganic	Ready-to-use when purchased.	Mix 4-6 lb of DE/ton of feed and run through lines monthly to prevent caterpillars from spinning webbing. Existing webbing must be removed by hand; DE does not affect silk webbing.

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[1] Abbreviations used: CR - carbamate; NP - natural pyrethrum, OP - organophosphate; INO - inorganic, SP - synthetic pyrethroid.

[2] Do not contaminate feed, water or feeding and watering equipment.

UGA
extension

Calibration of Manure Spreaders

Reviewed by John W. Worley, Professor and
Melony Wilson, Animal Waste Management Specialist
Contributions to the original manuscript by Paul E. Sumner, Former Extension Engineer and
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Calibrating a manure spreader is a simple, easy management tool that can help producers use nutrients from animal manure efficiently and safely. Overapplication or uneven application of manure wastes nutrients and increases the chance of ground or surface water contamination. By knowing the application rate of the manure spreader, correct amounts of manure can be applied to meet crop needs. The procedure takes less than an hour but can save hundreds of dollars through more efficient use of manure nutrient resources. Calibration, along with timely application to provide nutrients when crops can use them, helps ensure efficient and safe use of animal manures.

This publication primarily focuses on rear discharge, twin spinner spreaders common for poultry litter application in the southeast (Figure 1). The concepts discussed, however, do apply to other types of spreaders. Slight changes in the described procedures may be required to calibrate other types of spreaders.

Manure spreader calibration has three main goals:

1. Determine application rate (tons per acre applied at a given setup and speed).
2. Determine the effective swath width (how far apart each pass should be).
3. Optimize the uniformity of distribution of manure.

Application Rate

The application rate can be determined by mass balance. (Weigh the spreader before and after spreading and determine the area covered.) This procedure tells us how much was applied over a given area, but it tells us nothing about how evenly the manure was applied. A much better method is to catch samples at locations across the path of the spreader and use them to determine the spreader application pattern. The application rate at a given point can be determined using the amount (lbs) of manure captured on a tarp at that point and the following simple formula:

Application Rate (tons/acre) =

Sample weight (lbs) x 21.8/tarp area (ft^2).

To make the math even simpler, if you use tarps that are 4' 8" x 4' 8", the area of those tarps is 21.8^{2}ft and the application rate in tons/acre is equal to the pounds of manure on the tarp.

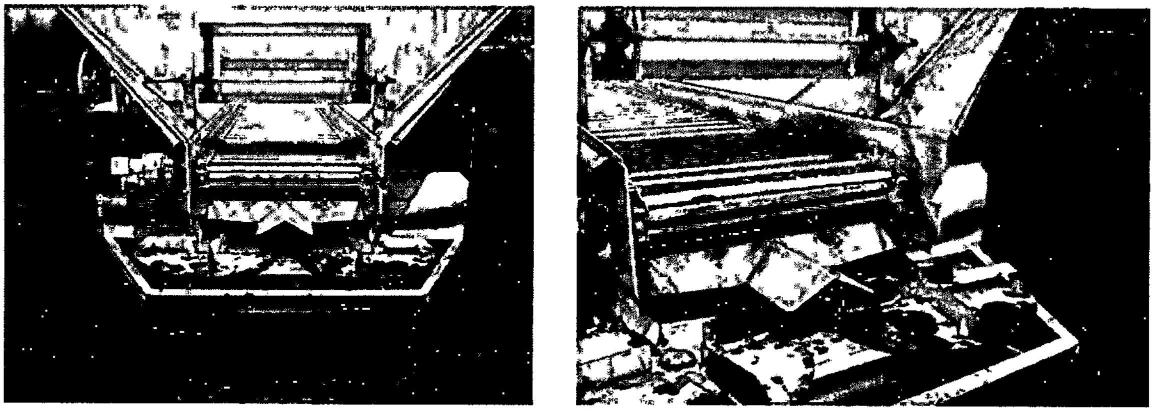
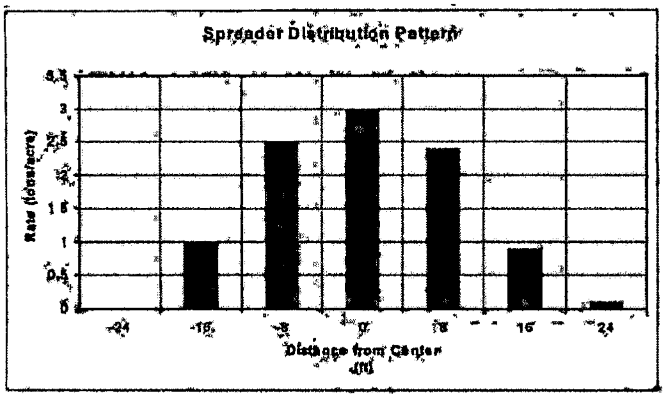


Figure 1. Typical twin-disk spinner manure spreader truck.



Tarp area: 21.8 ft^2 Tarp spacing: 8 ft

Tarp #	1	2	3	4	5	6	7
	0.0	1.0	2.5	3.0	2.4	0.9	0.1

Figure 4. A sample data sheet and graph of distribution pattern.

8. Plot the spreader distribution on a graph with the vertical ("y") axis equal to the application rate for each tarp and the horizontal ("x") axis as the distance from the center of the spreader path to the center of each tarp (Figure 4). An Excel spreadsheet is available that will do the plotting automatically. (See Resources section.)
9. The points on both sides of the center that are approximately one-half the maximum value represent the edge of the effective swath width. By identifying the effective swath width and overlapping swaths each trip up or down the field, even distribution of the manure can be achieved.
10. Sweep the tarps (and wash if necessary) to remove any manure before folding.

Spread Patterns

Acceptable spread patterns are shown in Figure 5. The area between the dashed lines represents the approximate effective swath width. If spreader paths are spaced at this interval, a uniform distribution should be achieved.

Unacceptable patterns are shown in Figure 6. A uniform distribution pattern is almost impossible to achieve without an acceptable spread pattern. If your spreader does not spread any of the acceptable patterns or something very close, make adjustments to the spreader using the operators manual until an acceptable pattern is realized.

A common problem seen with twin disk spreader trucks is that the door over the spinner disks is opened so wide that much of the litter bypasses the disks and is deposited directly on the ground behind the spreader. This causes a high peak in the center of

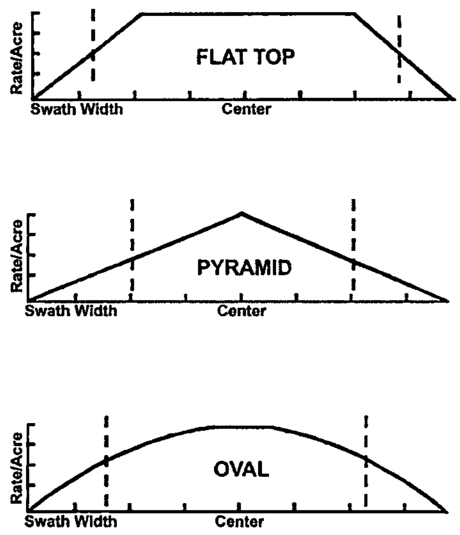


Figure 5. Acceptable spread patterns.

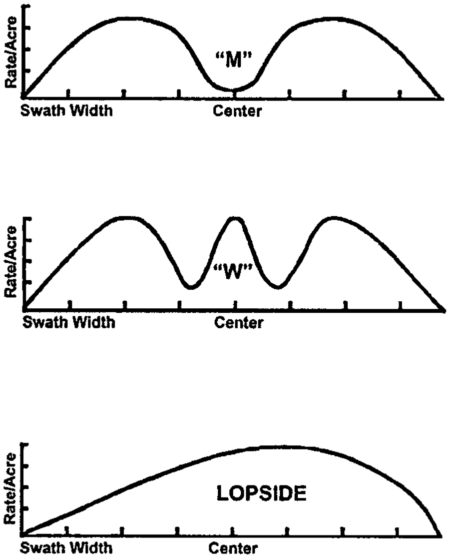


Figure 6. Unacceptable spread patterns.

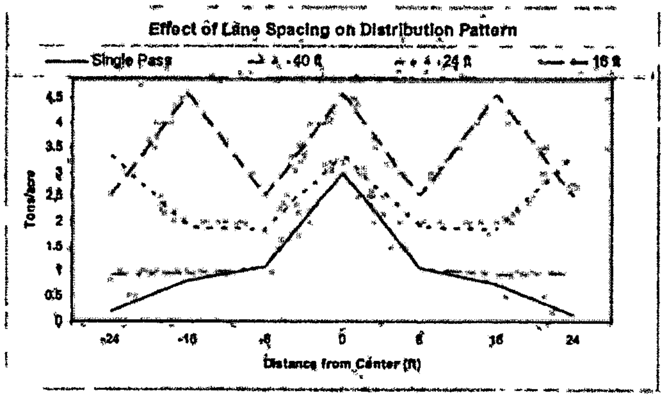


Figure 7. Lane spacing effects on uniformity and application rate.

THE UNIVERSITY OF GEORGIA
COOPERATIVE EXTENSION
Colleges of Agricultural and Environmental Sciences & Family and Consumer Sciences

Maps for Nutrient Management Planning

Maps for Nutrient Management Planning

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Introduction

A nutrient management plan (NMP) is a tool for making wise use of manure nutrients while protecting water resources. Accurate farm maps are a central component to the NMP. The map will help you identify areas suitable for land application of manure and areas that need protection or special management due to environmental sensitivity. Maps will also help you evaluate your crop rotation and calculate acreage you have available for using animal manure. This document will explain the process of preparing maps for the management of nutrients from organic sources such as manures.

Maps for NMPs should include:

- ☐ farm property lines
- ☐ land use – cropland, pasture, forest, etc.
- ☐ farm field boundaries with field identification
- ☐ surface water locations, including streams, rivers, ponds, ditches and wetlands
- ☐ arrows showing the direction of stream or river water flow
- ☐ well locations
- ☐ buffers around sensitive areas including surface water, wetlands, wellheads, springs, rock outcrops or sinkholes
- ☐ any residences or public gathering areas
- ☐ spreadable acres
- ☐ north arrow
- ☐ road names or numbers
- ☐ name of county
- ☐ legend with map symbols
- ☐ BAR SCALE on the map
- ☐ date prepared
- ☐ name of person who prepared map

Dry Poultry NMP Exceptions

In Georgia, a nutrient management plan for a dry litter poultry operation has less detailed mapping requirements. The map is still a valuable planning tool, but it is required to have only the following:

- ☐ road names or numbers
- ☐ farm field boundaries with field acreage
- ☐ field identification (should match related documents in the NMP)
- ☐ farm property lines

Making a Base Map

There are several ways to create a farm map; one is with computer generated maps. Most of these options require the assistance of a professional.

NRCS Toolkit

The easiest way to acquire map information needed for an NMP is to use the Natural Resources Conservation Service Toolkit. U.S. Department of Agriculture Service Center Offices are equipped with computers and technology that can generate a map for you. A conservationist can provide an aerial photo of the farm with the Farm Service Agency property lines and field lines. You can work with the conservationist to add streams and other water bodies, and locate buffers. This technology is in place in many district offices and is widely available throughout the state in local offices.

Figure 1 (page 2) is an electronic aerial photo with the farm boundaries (black line), field boundaries (red line), 150-foot setback around the property line (green line), 100-foot buffer around surface water and wetlands (light violet), well (small circle), streams and pond (blue) overlain on the photo. This electronic map was developed

Any time a document is photocopied, the image size may change, so use a bar scale to make sure your scale is accurate. Draw a 1-inch line on a piece of paper and place it on the map **before** it is copied. Then measure the 1-inch line on the map copy to make sure it still measures 1 inch. If it does not, you will have to set up a ratio to determine the true scale of the map.

An example of how to set up a ratio for a map follows. The original scale is 1 inch = 660 feet, and on the copy, the 1-inch line measures 1.2 inches. On the new map, 1.2 inches = 660 feet as well. If you wish to adjust the new map back to a 1-inch scale, the ratio looks like this:

1 in/1.2 in = x ft/660 ft
(660 ft) (1 in/1.2 in) = x
(660 ft) (.83) = x
x = 550 ft
New scale is 1 inch = 550 feet

Because the FSA maps are aerial photographs, they will show land use and many surface water features as well as roads with road names or numbers. Identify your property lines and field boundary lines if not shown on the base map. Fields must be identified with a unique name or number, and the total acreage and spreadable acreage of each field must be shown. (See the section on "Calculating Acreage" for explanation.) You can add these features by hand with pens or colored pencil. Leaving a blank or white area below the map will leave you room for the legend, scale and any necessary comments.

Additional or Supporting Maps

A soil survey map may also be a valuable tool in planning for nutrient applications. It is especially valuable when considering phosphorus application and using the Georgia Phosphorus Risk Analysis Index (P Index).

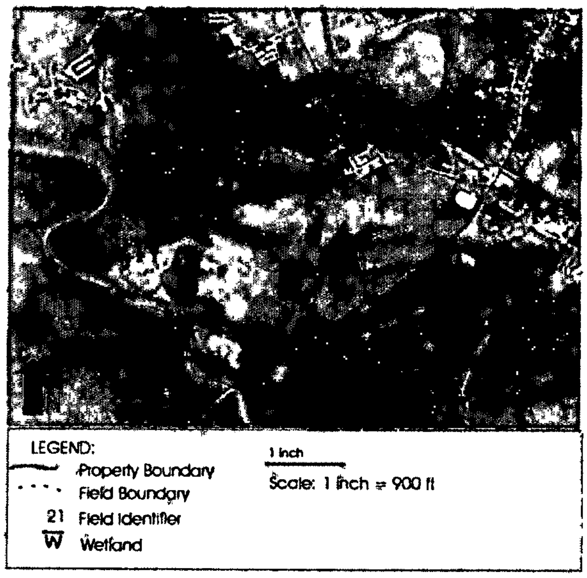


Figure 3. Example of hand-drawn features on photo

Figure 4. Example of soils map

Land Suitability

Site suitability for manure application is largely determined by the soils, topography and location of surface water. You also may want to consider how close a field is to public roads, public gathering areas or residences. The best sites for manure application are on level to gently sloping, deep, well-drained soils with some clay content. You should avoid:

- ☐ Soils less than 24 inches to bedrock
- ☐ Soils with water tables less than 36 inches below the soil surface
- ☐ Slopes greater than 12 to 15 percent.

You should also be careful about irrigation with manure wastewater on deep sandy soils. Water moves very rapidly through these soils and they have a limited ability to hold nutrients.

You probably have a good idea where these types of soils occur on your farm, but you can obtain this soils information from the county soil survey. Your soils map will have symbols on it that indicates the type of soils you have. Look up the symbol in the Soil Legend to get the name of the soil and the range of slopes associated with that map unit. Then go to the Soil and Water Feature Table, where you can look up the water table depth and depth to bedrock for that map unit. Remember, the county soil survey is on a large scale and maps the dominant soils on the site.

This means that soils other than the one mapped can and most likely will exist in a given field. If you have questions about whether the soils on your farm have the above characteristics, contact the NRCS.

If you have fields or parts of fields with the characteristics listed above, you may need to exclude them from every other dot in your count for the buffer area. Divide the total number of dots by the number of dots per square inch to get the square inches of land in the buffer. Now, find the scale of your map. Multiply the number of feet per inch by itself to get square feet per square inch. Then multiply the number of square inches from your dot grid by the square feet for your base map, convert to acres, and you're done.

Limitations of Land Application Equipment

The acreage remaining for application after all appropriate buffers and setbacks have been considered may still not be the actual acreage available. This is most true when considering liquid waste applied through an irrigation system. For example, a center pivot system will not reach all the corners of a field. The may should show the wetted areas for irrigation systems. This final area is what should be used for budgeting applications in a field. NRCS Toolkit is recommended for illustrating coverage are and calculating actual acreage.

Summary

You have now developed the basis for your NMP. These maps are critical for conservation, planning land application of manures and crop rotations. Keep them as accurately as possible.

Regulatory Definitions of Large CAFOs, Medium CAFO, and Small CAFOs

A **Large CAFO** confines at least the number of animals described in the table below.

A **Medium CAFO** falls within the size range in the table below and either:

- has a manmade ditch or pipe that carries manure or wastewater to surface water; **or**
- the animals come into contact with surface water that passes through the area where they're confined.

If an operation is found to be a significant contributor of pollutants, the permitting authority may designate a medium-sized facility as a CAFO.

A **Small CAFO** confines fewer than the number of animals listed in the table **and** has been designated as a CAFO by the permitting authority as a significant contributor of pollutants.

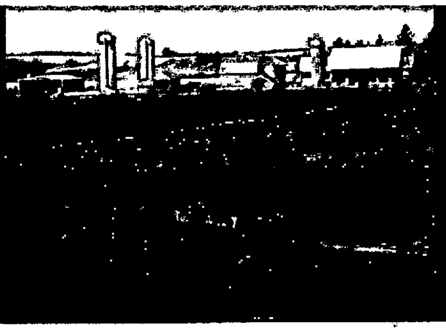
Animal Sector	**Size Thresholds (number of animals)**		
	Large CAFOs	**Medium CAFOs**[1]	**Small CAFOs**[2]
cattle or cow/calf pairs	1,000 or more	300 - 999	less than 300
mature dairy cattle	700 or more	200 - 699	less than 200
veal calves	1,000 or more	300 - 999	less than 300
swine (weighing over 55 pounds)	2,500 or more	750 - 2,499	less than 750
swine (weighing less than 55 pounds)	10,000 or more	3,000 - 9,999	less than 3,000
horses	500 or more	150 - 499	less than 150
sheep or lambs	10,000 or more	3,000 - 9,999	less than 3,000
turkeys	55,000 or more	16,500 - 54,999	less than 16,500
laying hens or broilers (liquid manure handling systems)	30,000 or more	9,000 - 29,999	less than 9,000
chickens other than laying hens (other than a liquid manure handling systems)	125,000 or more	37,500 - 124,999	less than 37,500
laying hens (other than a liquid manure handling systems)	82,000 or more	25,000 - 81,999	less than 25,000
ducks (other than a liquid manure handling systems)	30,000 or more	10,000 - 29,999	less than 10,000
ducks (liquid manure handling systems)	5,000 or more	1,500 - 4,999	less than 1,500

[1] Must also meet one of two "method of discharge" criteria to be defined as a CAFO or may be designated.

[2] Never a CAFO by regulatory definition, but may be designated as a CAFO on a case-by-case basis.

Nutrient Management for Georgia Agriculture

Developing a Comprehensive Nutrient Management Plan



Prepared by the Nutrient Management Task Force • Cooperative Extension Service • The University of Georgia College of Agricultural and Environmental Sciences

What is a Comprehensive Nutrient Management Plan?

A Comprehensive Nutrient Management Plan (CNMP) is a strategy for making wise use of plant nutrients to enhance farm profits while protecting water resources. It is a plan that looks at every part of your farming operation and helps you find better ways to use manures, fertilizers and other nutrient sources. Successful nutrient management requires thorough planning and recognizes that every farm is different. The type of farming you do and the lay of your land will affect your CNMP. For example, CNMPs on farms that do not have animals will not require as much detail as those that do. The best CNMP is one that is matched to the farming operation and the needs of the person implementing the plan—the Georgia farmer!

Who is Required to Have CNMPs?

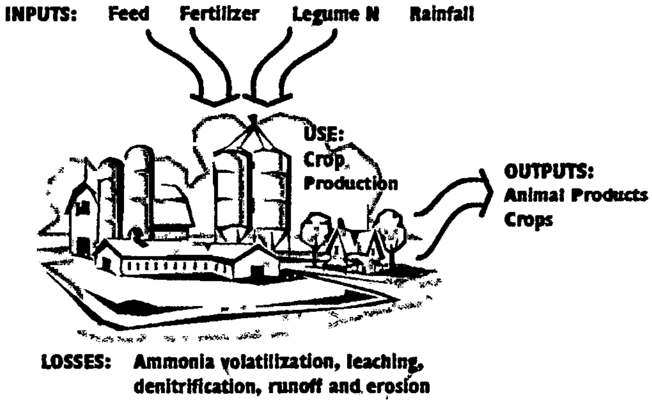
The United States Environmental Protection Agency and the United States Department of Agriculture have recently released a Unified National Strategy for managing animal feeding operations. This strategy sets a national goal for all animal feeding operations to have CNMPs. In Georgia, any animal feeding operation that receives a permit through the Georgia Environmental Protection Division is required to have a CNMP.

Other producers who are not required to have a permit are being encouraged to voluntarily adopt CNMPs. Many organizations such as the Georgia Poultry Federation and the Georgia Pork Producers have established initiatives to assist producers to better manage nutrients on the farm.

What are the Parts of a Successful CNMP?

A Comprehensive Nutrient Management Plan looks at how nutrients are used and managed throughout the farm. It is more than a nutrient management plan that only looks at nutrient supply and needs for a particular field. Nutrients are brought to the farm through feeds, fertilizers, animal manures and other off-farm inputs. These inputs are used, and some are recycled by plants and animals on the farm. Nutrients leave the farm in harvested crops and animal products. These are nutrient outputs. Ideally, nutrient inputs and outputs should be roughly the same. When inputs to the farm greatly exceed outputs from the farm, the risk of nutrient losses to groundwater and surface water is greater. When you check nutrient inputs against nutrient outputs, you are creating a mass balance. This nutrient mass balance is an important part of a CNMP and important to understand for your farming operation.

Another important part of a successful CNMP is best management practices (BMPs). BMPs, such as soil testing and manure analysis, help you select the right nutrient rate and application strategy so that crops use nutrients efficiently. This not only reduces nutrient losses and protects the environment but also increases farm profitability. BMPs may also include managing the farm to reduce soil erosion and improve soil tilth through conservation tillage, planting cover crops to catch excess nutrients or using filter strips and buffers to protect water quality. Preventative maintenance, record keeping, mortality management and emergency response plans must also be included in a CNMP for livestock and poultry operations.



THE BASIC STEPS

CNMPs consist of six major parts: evaluation of nutrient needs, inventory of nutrient supply, determination of nutrient balance, mortality management, preventative maintenance and inspection, and an emergency response plan. Not all farms will require all six parts. For example, farms without livestock or poultry may not need sections on mortality management or emergency response plans.

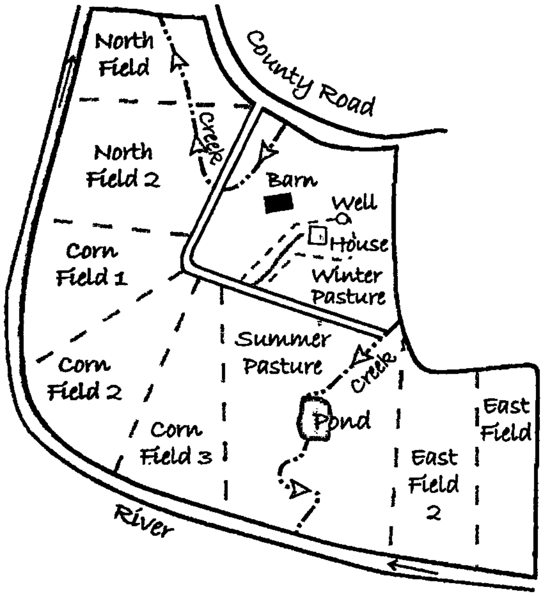
Evaluation of Nutrient Needs

Maps and Field Information

You will need a detailed map of your farm. The map should include the following:

- farm property lines,
- your fields with the field identification,
- the location of all surface waters such as streams, rivers, ponds or lakes,
- arrows showing the direction that streams or rivers flow, and
- a soils map, if available.

This map will serve as the basis for the entire plan, so each field should have a unique identification. In addition to the map, prepare a list of the crops to be grown in each field with a realistic yield goal for each crop. Most of this information is available at your local USDA Farm Service Center.



Locate Critical Areas

Certain areas on your farm such as streams and rivers, wellheads, and lakes or ponds are sensitive to nutrient overload. You should create zones around these areas on your map where nutrient use will be reduced or eliminated. By buffering these areas, water quality problems may be decreased. Areas such as roads, off-site dwellings and areas of public gatherings should also be noted on your map. Your plan may want to limit the use of manures near these types of areas to reduce odor complaints.

Soil Testing

Complete and accurate soil tests are important for a successful nutrient management plan. You will need annual soil tests to determine how much nutrient addition is needed. The needed nutrients can be supplied from commercial fertilizer and/or organic sources. Be sure to take representative soil samples and have them tested by a reputable laboratory familiar with Georgia soils and crop production. Your county Extension agent can help you submit samples to the University of Georgia Extension Soil, Plant and Water Laboratory.

Determine Nutrients Needed for Each Field

Once you have set realistic yield goals and you have your soil test results, you can determine the nutrients that your crops will need. The amount of nutrients needed should be based on your local growing conditions. At a minimum, the amounts of nitrogen, phosphorus and potassium should be listed in the plan for each field. Most soil and plant analysis labs will give you recommended application rates based on the soil test results. Your county Extension agent can also help you with this.

Inventory of Nutrient Supply

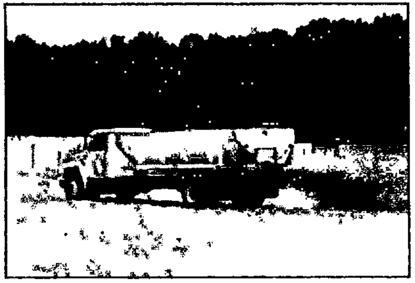
Many of the nutrients needed to grow your crops are already present on your farm in the soil, in animal manures, or in crop residues. Knowing the amounts of nutrients already present in these sources is important so that you do not buy more nutrients than needed.

Determine the Quantity of Nutrients Available on Your Farm

Supply planning starts with an inventory of the nutrients produced on the farm. Animal manure is an important source of nutrients. The quantity of manure collected and stored, either dry or liquid should be determined. An inventory should also be performed of any other by-products available, such as: mortality compost, lagoon sludge (if lagoon cleaning is planned), crop residue nutrients or nitrogen from legumes. This information will allow you to balance your nutrient purchases with what is available on your farm for the realistic production level of the crops grown.

Nutrient Analysis

Animal manure and other organic products are not all the same as far as nutrient content is concerned. An analy-

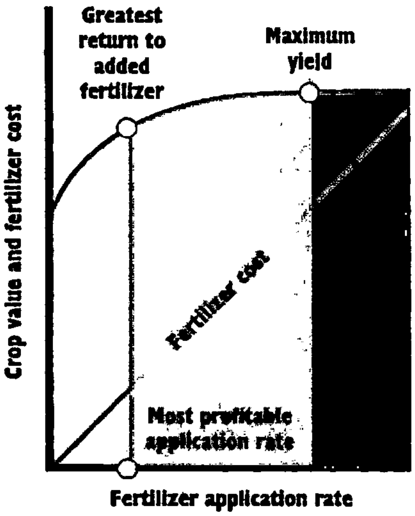


sis of these products tells you the nutrient content so that you can match this up with soil test recommendations and determine application rates. The lab results will help you determine how much of the nutrients in the manure will be available to your crops. The amount credited to the nutrient budget should be based on plant available nutrient levels, which may be substantially different from the total nutrient content. The county Extension office has information on manure and litter testing.

Determining Nutrient Balance

Balance Between Supply and Need

Once you have determined both the supply and need of nutrients for each of your fields, a critical aspect of CNMPs is balancing the two. This can be done in several ways. Currently, most CNMPs are developed based on nitrogen; however, other factors such as phosphorus or metals could control how much poultry litter or manure you can put out under certain conditions. A phosphorus index is currently being developed to help producers determine when nutrient management based on phosphorus would be advisable. If your crop acreage is small relative to the number of animals, the nutrient balance will also allow you to evaluate how much manure or litter you may need to move off your farm to avoid over-application of nutrients.

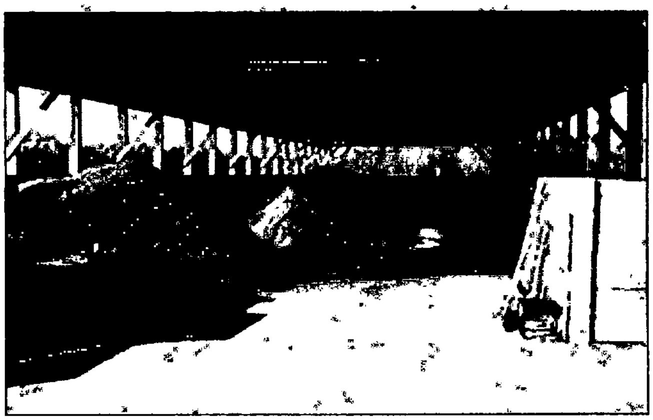


Can the Nutrient Supply on Your Farm Be Managed or Changed?

After evaluation of the nutrient supply on your farm and the nutrient needs of your crops, you may find that the balance of nutrients is not ideal. You may have more of one or more nutrients (usually phosphorus) than you need. Many management practices can change the nutrient balance. These include:

- changes in storage practices,
- adjustments of animal feeds,
- modification of treatment methods, and
- chemical amendments.

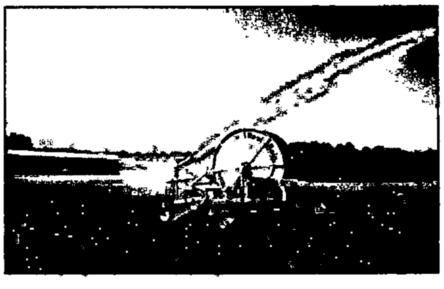
For example, you may be able to reduce nutrient losses in your manure treatment and/or storage system. Sometimes reducing nitrogen losses can make manures a better-balanced fertilizer for your crops. In addition, animal diets can sometimes be changed to reduce nutrient excretion in their manure. Enzymes can be added to the diet to reduce nutrients in the manure. Phytase is a supplemental enzyme that allows better use of the phosphorus already present in grains, so less phosphorus has to be added to the animal's diet.



Manure Storage

Manure storage is critical. It effects both the quantity and quality of nutrients that will need to be land applied or exported from the farm. The storage structures and design capacities need to be identified as part of a CNMP. These structures also need to be managed to prevent nutrient losses and protect water quality. For example, clean water should always be diverted from barnyard and manure storage areas to reduce the potential for nutrients reaching ground or surface waters.

Manure Application to Fields



Manures should be applied near the time that crops need nutrients using calibrated spreaders or irrigation equipment. Solid or slurry manure should be incorporated into the soil when appropriate. Incorporation or mixing into the soil greatly reduces losses of nitrogen to the air and keeps more in the soil where it is needed. This reduces potential odor emissions. Slurry manure can also be injected into the soil so that incorporation is not required. Accurate records of application rates and times are also essential.

Identify Alternative Uses for Excess Manures

If your manure production exceeds nutrient needs on-farm, you should identify alternatives to land application of your manure. Potential options include selling manures to other farmers, composting manures for use by homeowners or possibly selling it to other off-farm users.

Mortality Management

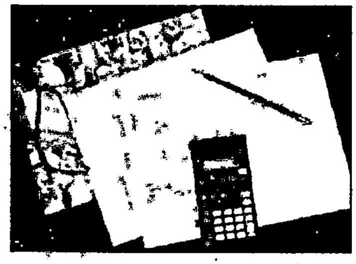
A complete CNMP should identify how livestock or poultry mortalities will be managed. This should include:

- estimated amounts of normal mortality,
- methods of disposal or utilization, and
- plans for dealing with catastrophic mortality events.

The Georgia Department of Agriculture regulates mortality disposal and all plans should meet its requirements. Approved methods of disposal include burial, composting, incineration and rendering.

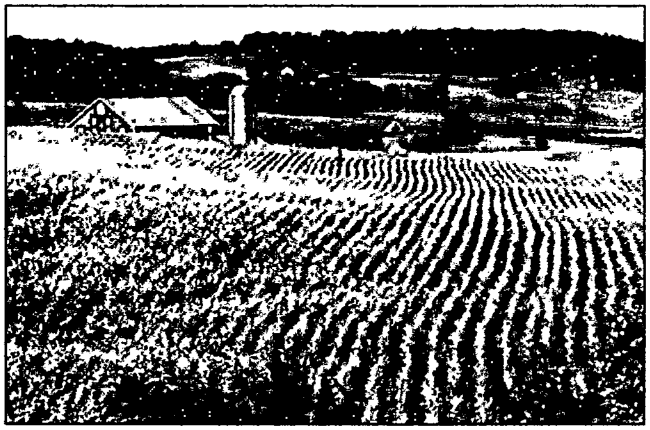
Preventative Maintenance and Inspections

Keeping good, detailed records that help you monitor your progress is essential to know if your CNMP is accomplishing the goals you have set. You should keep all results from soil, plant and manure tests, and examine how they change with time due to your management practices. Records should also be kept on crop yields, manure production, manure exports, nutrient application rates, timing and application methods. Keep detailed schedules and records on calibration of spraying and spreading equipment, maintenance of pumps and other machinery, and inspections and current capacities on manure storage facilities. When you have a major change in production, your plan should be updated to reflect these changes.



Emergency Response Plans

The final aspect of your plan should include the procedures to be followed in an emergency. This may include actions taken to contain or manage any unauthorized discharge of manure or wastewater, listing of the proper authorities to notify when certain events occur and any authorizations necessary to obtain essential equipment or access to neighboring properties during these events. It should also outline a plan for training new employees in these procedures.



Where Can You Obtain Information Needed for Your CNMP?

The University of Georgia Cooperative Extension Service, the USDA Natural Resources Conservation Service, the Georgia Department of Agriculture and Certified Crop Advisors, or other private consultants, should all be able to assist you in developing parts of a comprehensive nutrient management plan. In addition, computer software and publications will be available through your county Extension agent to aid you in the process.

A CNMP is a good tool to help you use your on and off farm resources more efficiently and prevent future problems. A successful CNMP will help you obtain the maximum profit while protecting the environment.

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Gale A. Buchanan, Dean and Director

UGA extension

Coexisting with Neighbors:

A Poultry Farmer's Guide

Casey W. Ritz, Ph.D.
Extension Poultry Scientist

The farming environment in which we live is continually changing. Several factors stand out as influences of that change in this day and age: the geographic consolidation of agricultural industries is creating a concentration of agricultural wastes, national public awareness of the environment and pollution has heightened, urban growth is spilling over into our nation's farmland, and few people understand typical farming practices. All too often people feel that law-suits are the only way to settle these conflicts. Each of these conditions has an influence on the relationship between farmers and their non-farm neighbors.

Like most livestock enterprises, poultry operations have to deal with neighbor-related issues on a regular basis. As the urban community continues to expand into the rural landscape, conflicts between farm and non-farm neighbors will increase. Many urbanites who move to the country to get away from urban pressures are not accustomed to, nor even understanding of, farming practices and "country living" conditions. They have a disconnect as to where their food comes from and what it takes to get it to their plates. This lack of knowledge has caused the general public to expect pristine environments and aseptic conditions even within production agriculture systems. The presence of dust, odors and insect pests that are normal occurrences with farming operations are not on the radar screen of many urbanites who move to a more rural setting seeking "pastoral" living conditions.

Problems between neighbors can and do arise as the boundaries between rural and urban life blur. A number of issues can cause contention between neighbors, often the result of differing viewpoints. From the farmer's point of view, increases in road traffic and trash, trespass from pets and people, and constraints about normal farming practices may become an issue. For non-farm neighbors, dust and odors, insect pests, noise and obstructed views may become sources of irritation. Common complaints of non-farm neighbors include:

- Odors that make them physically ill, forcing them to stay inside with closed windows.
- Not being able to invite friends over because of odors and insect pests.

Allow a little flexibility in your spreading schedule to accommodate unfavorable spreading conditions. Windy or wet conditions can displace nutrients from where they were intended, causing poor fertilization uniformity and potential contamination problems on adjacent properties. Incorporate manure into the soil wherever and whenever possible to maximize the fertilization benefits from the available nutrients and to minimize odor dispersion and potential nutrient runoff due to storm water.

Land apply manure in the morning hours to allow for greater odor dissipation and manure drying throughout the day. Applying manure in the late afternoon and evening hours allows the still night air to trap and spread odors close to the ground, a common complaint of poultry farm neighbors.

Inform neighbors when you intend to spread manure. Be willing to be flexible with your spreading schedule to avoid disrupting special occasions such as a backyard wedding, family reunion, etc. Maintain no-spread buffer zones at the property line and avoid spreading on weekends or holidays when neighbors are more likely to be out-of-doors.

Keep manure, feed and other organic material around poultry facilities as dry as possible. Wet materials generate more odors and flies than do those that are kept dry. Clean up spilled feed and manure around the facilities and roadways to pre-vent an increase of flies, rodents, and odors.

Make your farm appealing. The appearance of the farm plays an important part in what others in the community think of you and your farming operation. Eyesores create less goodwill and public sympathy if problems arise. Farm appearance can easily be construed as a reflection of a farmer's professionalism, competence and concern for neighborhood conditions.

Maintain property line fences. Sage advice continues to hold true that "good fences makes for good neighbors."

Develop manure and odor control management plans. Make sure all employees understand the importance of appropriate manure handling and odor control. Use manure management practices that reduce the release of offensive odors such as composting or transfer of excess manure off the farm. Maintain records of manure application rates and timing as evidence of adhering to appropriate Best Management Practices for manure use.

Communicate plans for new construction or expansion with neighbors. Show how you have taken their concerns about manure management and odor control into consideration. At times this may go further than just being neighborly; it may actually be a requirement where county ordinances stipulate the need for a public hearing or comment period prior to construction or expansion.

Give prompt and genuine responses to complaints or problems when they arise. Be sympathetic and understanding of neighbors' concerns and avoid being uncaring or arrogant. Sometimes it is better to bite your tongue to do what is best for your farm over the long term. Ignoring issues, whether you feel they are relevant or not, can quickly drive a neighbor to seek legal action. Maintaining open lines of communication will always help resolve issues when they arise. Inform your poultry company of any potential nuisance situations with a neighbor and seek their advice on the issue. Solving the problem may be as simple as making a management change.

Consider new alternatives and technologies for manure handling and odor control. A small investment now may prevent large legal expenses later on.

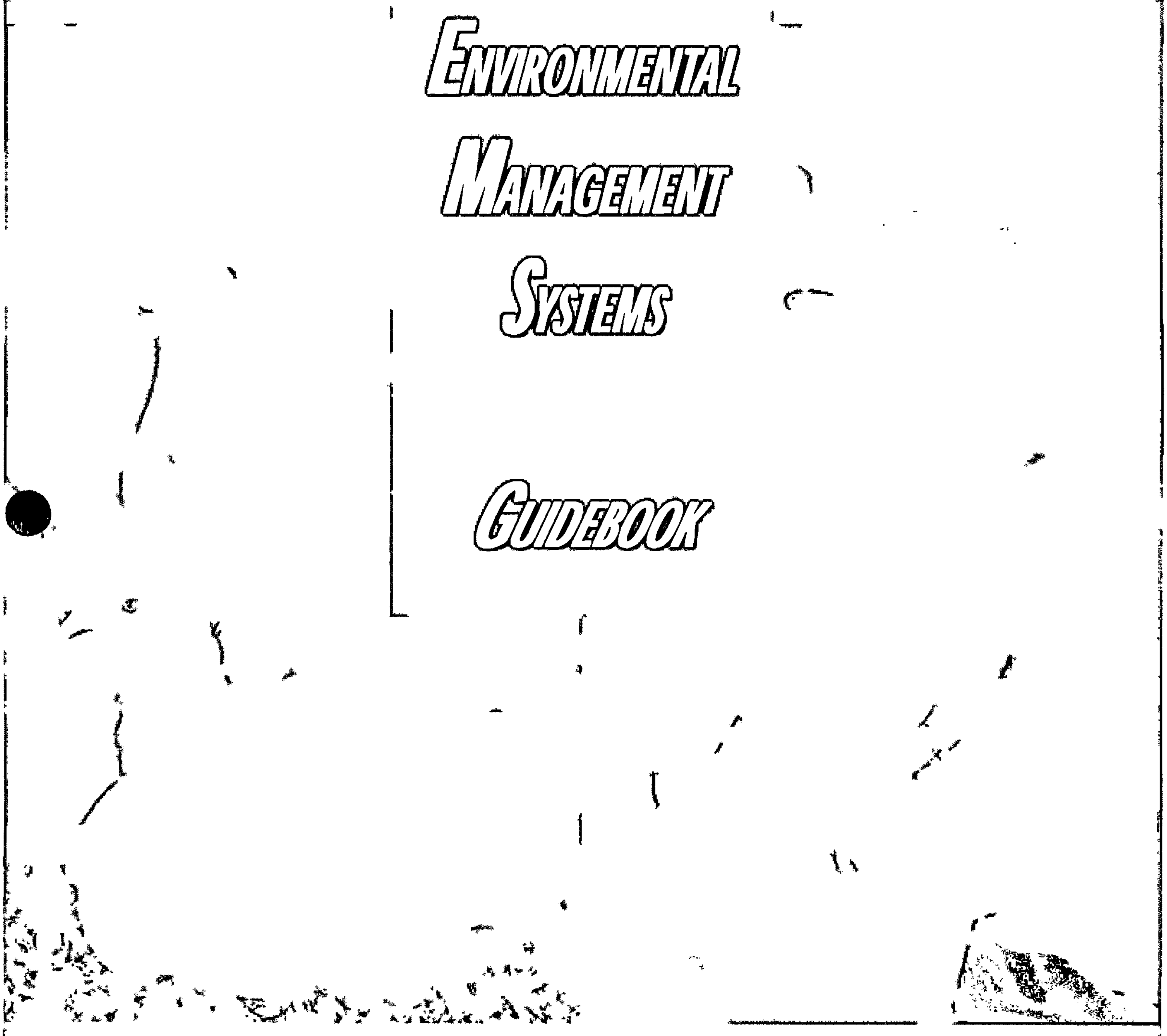
Comply with applicable federal, state and local environmental regulations. Don't give neighbors legal reason to investigate or sue over environmental infractions.

Conduct an environmental self assessment similar to the University of Georgia Farm*A*Syst program, or have a third party help you identify environmental concerns before they become a nuisance or legal problem.

Be active in the community. Better educate the public by supporting agricultural education activi-

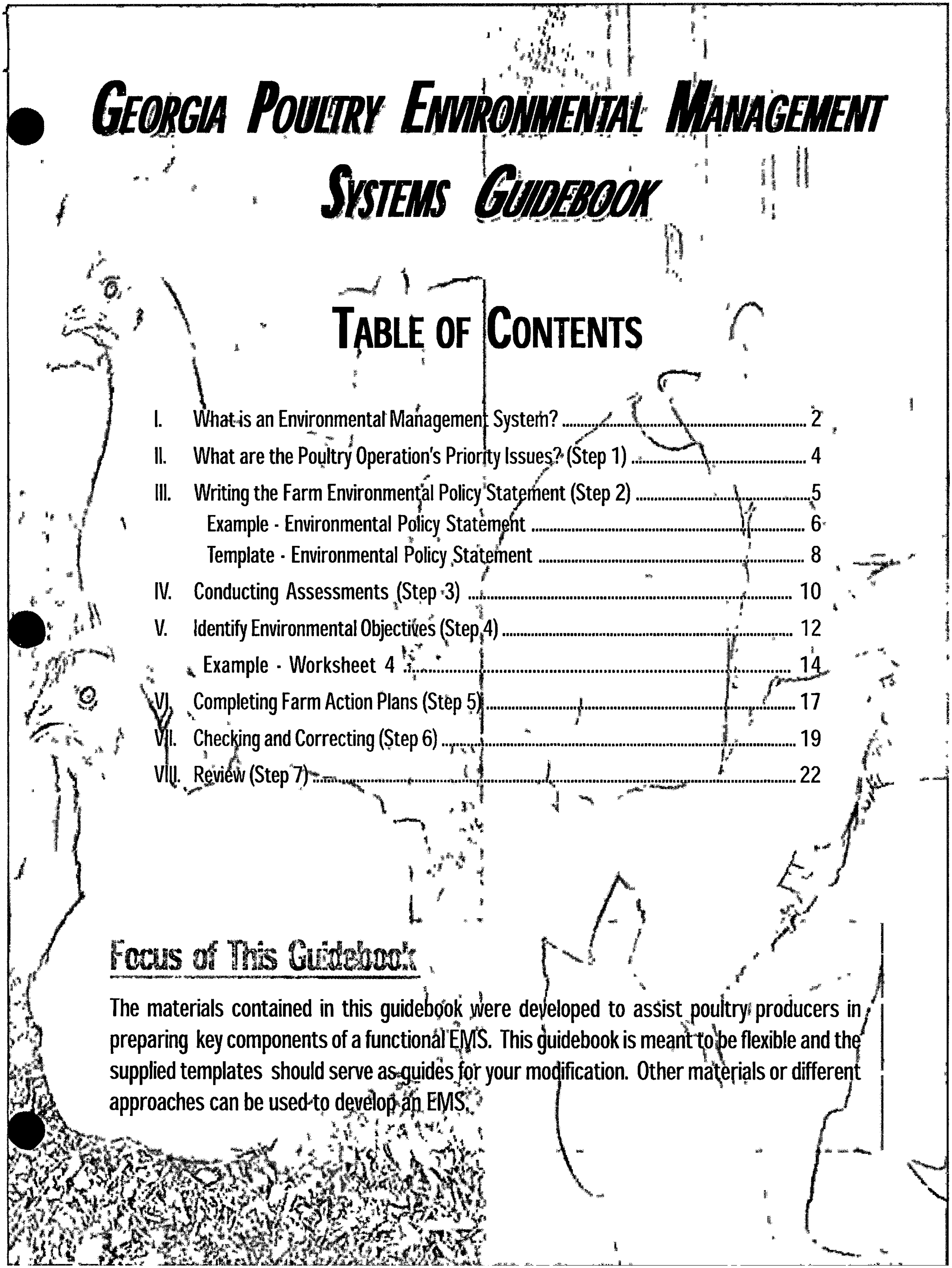
GEORGIA POULTRY ENVIRONMENTAL MANAGEMENT SYSTEMS

GUIDEBOOK



FARM MANAGEMENT FOR IMPROVING YOUR ENVIRONMENTAL AND ECONOMIC BOTTOM LINE

GEORGIA POULTRY ENVIRONMENTAL MANAGEMENT SYSTEMS GUIDEBOOK



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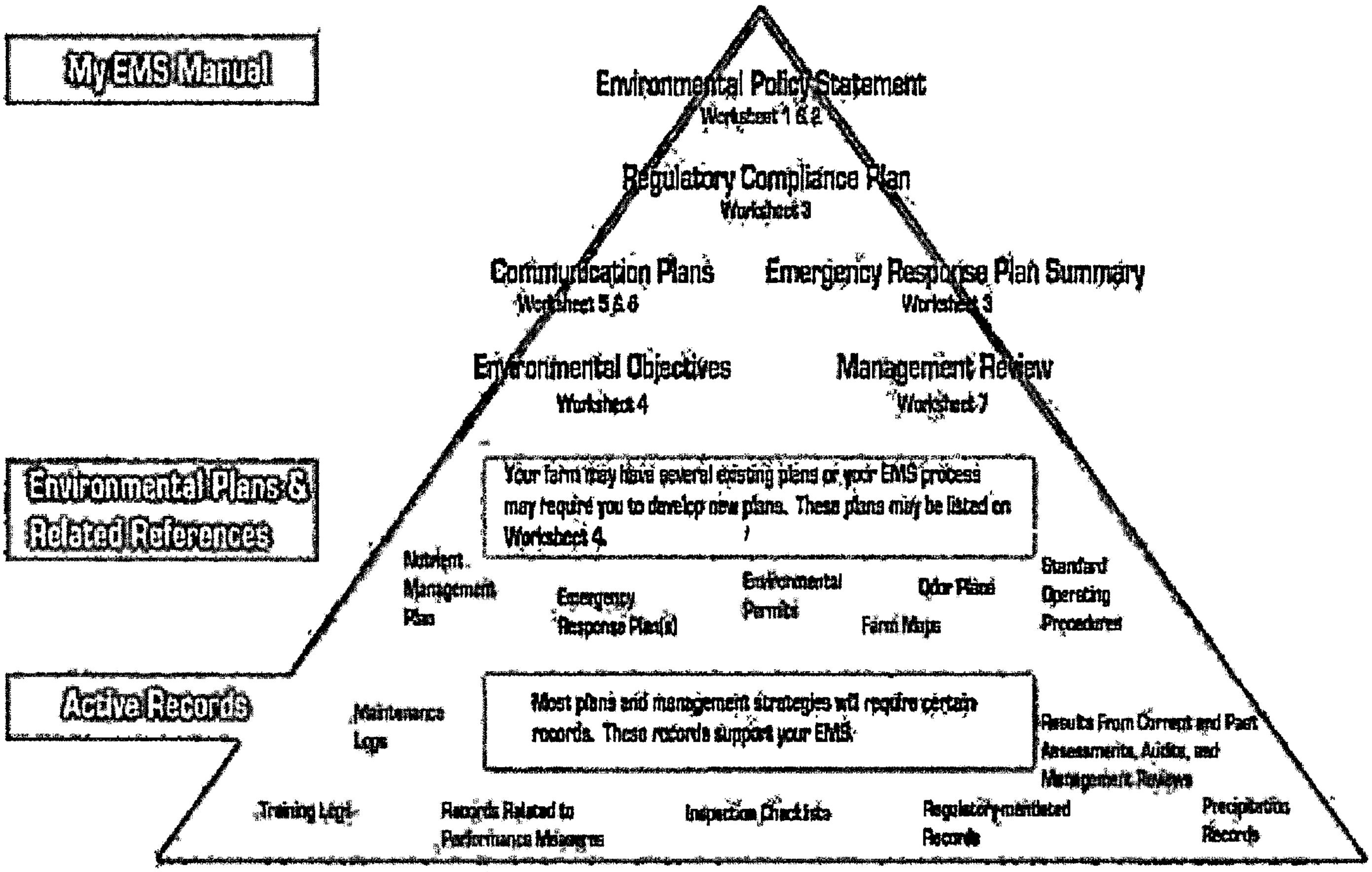
Focus of This Guidebook

The materials contained in this guidebook were developed to assist poultry producers in preparing key components of a functional EMS. This guidebook is meant to be flexible and the supplied templates should serve as guides for your modification. Other materials or different approaches can be used to develop an EMS.

Three levels of EMS's have been identified. They are: assessment based EMS, functional EMS, and "registered" or certified EMS. The most basic EMS is an assessment based EMS that provides a "snapshot in time" of a farm's environmental performance. If conducted over time, these assessments can be used to indicate whether or not a farm's environmental performance is improving. Some sort of evaluation examining potential environmental impacts of an operation is a core component to a functional EMS. A functional EMS contains a few extra steps and components that complete the "Policy Development and Plan, Do, Check, Act" sequence of this management tool. A registered or certified EMS undergoes a verification process and adheres to certain standards. ISO 14001 is the most well known standard for EMS. One major difference is that ISO certified EMS's have a 3rd party verification system completed by registered consultants. Following the steps in this guidebook leads towards a functional EMS which uses certain philosophies of the ISO standard but DOES NOT require third party verification. Any of the contacts listed on this publication can provide you with more information on this issue.

The following graphic (Organizational Triangle) depicts how the EMS process and its components fit into overall farm management. The EMS should be an umbrella that helps streamline the various plans and record keeping requirements of the operation. The pieces of this graphic will make more sense as you progress through the guidebook. It may be helpful to refer back to it throughout the process.



An Environmental Action Plan Summary should be created for each environmental objective or closely related group of objectives.

III. Writing the Farm Environmental Policy Statement

Step 2

The Farm Environmental Policy Statement sets the foundation for the EMS and provides the framework for setting environmental objectives and targets. The policy statement is one of the most important activities associated with EMS development. All future environmental management of the farm operation will be measured by the question "Is this compatible with our environmental policy?"

Time that is spent in creating a policy statement that is meaningful and visionary will be worthwhile, especially when asked to defend or explain the farm's environmental management. A policy statement that is hastily scribbled will provide little guidance for the farm's environmental management system. It will also do little to reassure concerned employees, neighbors, and/or members of the community that the farm will uphold environmental laws and regulations and is committed to being a good environmental steward.

A policy statement includes several components. At a minimum, it should include commitments to:

- Environmental stewardship
- Continual improvement
- Compliance with all pertinent laws and regulations

In addition, identification of the environmental stewardship principles to which the farm is committed will be required when writing the policy statement. Being a "good" environmental steward is a goal shared by many farm operators. What goes into being a good steward is not always easy to define. After selecting two or three principles most important to the farm, an operator should be able to answer the question, "What makes you a good environmental steward?"

Sample Environmental Stewardship Principles

"This livestock/poultry operation places importance on…"

- "…being a good neighbor and member of the community."
- "…compliance with all environmental regulations."
- "…regular reviews of environmental risks and identifying priority environmental issues."
- "…managing riparian areas and other buffers to surface water to protect and enhance the quality of the water."
- "…preserving soil quality by minimizing the loss of soil and maintaining soil characteristics that contribute to its productivity."
- "… preventing discharge of manure or contaminated water from animal housing, or manure handling and storage facilities from reaching surface waters."
- "…efficient management of nutrients including those that enter, leave, and are recycled within the cropping system."
- "…expansion only after environmental and neighbor impacts are carefully reviewed."
- "…minimizing impact of odor and dust emissions that create community nuisance concerns."
- "…minimizing emissions of methane, ammonia, and other gaseous emissions that may add to air pollution concerns."

Sample Environmental Policy Statements

The following are samples of different environmental policy statements (in different formats) appropriate to base an EMS on. Following these examples is a worksheet for assistance in developing an original policy.

Sample 3)

Environmental Policy Statement for:
Jones Family Farms

Purpose

Jones Family Farms is a diversified operation with poultry, cow/calf and alfalfa production. The farm employs its husband and wife owners on a full-time basis and two employees on a part-time basis. The families of the owners provide additional help as needed.

Environmental Issues

Jones Family Farm is located near a small housing development along a busy highway; therefore our impact on our neighbors is an important aspect of our operations. We will strive to maintain a neat and professional appearance on our farmstead. Litter applications will be made with consideration to potential impacts on neighbors.

Compliance

Jones Family Farm is committed to compliance with all pertinent environmental laws and regulations. Where laws and regulations are not sufficient to safeguard the health and safety of our families, employees, or neighbors, we will develop our own procedures and guidelines.

Stewardship Principles

Our profitability depends upon maintaining long-term productivity and minimizing waste. The principles that guide our operations are:

- To manage riparian areas in such a way that protects and even enhances the associated plant communities and quality of the water
- To preserve soil quality by minimizing erosion and maintaining soil characteristics that contribute to its productivity.

Continuous Improvement

We are committed to reviewing our environmental risks on a regular basis and identifying ways to improve our environmental performance.

Signed____________________________________ Date:____________________

Signed____________________________________ Date:____________________

Some tips for writing the environmental policy statement:

- A policy statement should be revised when necessary, but avoid including statements that will cause it to become outdated quickly. A good policy statement should continue to fit the farm operation for many years.
- Include other people in the writing or review of the policy statement. Input from those who will be involved in implementing the EMS will especially be important. Consider asking family members, employees, or trusted advisors.

Avoid using words such as "never", "always", and "eliminate". These terms are very rigid and can make your policy statement commitments difficult or impossible to attain.

Table 1: Examples of written commitments that can be fulfilled versus those more difficult to fulfill are shown below.

Difficult to Fulfill	Can be Fulfilled
Our farm is committed to eliminating odor nuisances experienced by neighbors.	Our farm is committed to reducing odor emissions generated by our livestock operations.
We will never apply excess nutrients to cropland.	Our farm is committed to applying manure and fertilizer nutrients to cropland at agronomically determined rates.
Our farm will always protect surface waters from livestock manure discharges.	We are committed to minimizing grazing livestock contact with surface waters.

Summary of Environmental Policy Statements

An environmental policy statement is the cornerstone of an EMS. In addition to providing focus to the EMS, this statement is also a valuable tool for handling public relations issues. It is something that can be provided to the public, when necessary, describing the general management commitments of the farm. In the event of an accusation against a farm, the policy is readily available until other statements or actions can be made or taken. It may also be useful in marketing to an environmentally conscious public or group of consumers. Some have chosen to present an appropriate portion of their environmental policy statement on farm signs, letterhead, or websites.

Note: If you have not already done so, please complete Worksheet 2 in the EMS Template Pack at this time.

- Brainstorming sessions with employees, neighbors, and other knowledgeable parties such as Cooperative Extension, NRCS and consultants.
- Georgia Farm*A*Syst Materials (Contact your UGA County Extension Agent)
- Pennsylvania Poultry Environmental Assessment Tool (Tommy Bass at UGA 706.542.2735)
- Assessment tools associated with the national Livestock and Poultry Environmental Stewardship curriculum available through your local Cooperative Extension office or http://www.LPES.org.
- America's Clean Water Foundation OFAER (On-Farm Assessment and Environmental Review) Program visit http://www.acwf.org.
- Ontario's Environmental Farm Plan at http://www.gov.on.ca/OMAFRA/english/environment/efp/efp.htm
- P-Index and Leaching Index assessment tools typically available through your local Natural Resources Conservation Service office or local Soil and Water District organization.
- Private consultant initiated tools.
- Process Mapping

Check it Off...

☐ **Complete at least one assessment method for the whole farm OR choose to only assess the areas related to environmental concerns identified as important in Lesson 2 (Step1)! Remember, while it is often not practical to immediately address all environmental concerns, a comprehensive assessment to identify concerns is recommended. It is also essential that you conduct an assessment of your regulatory compliance.**

Objectives (for this step).

Develop and write one or more environmental objectives. An objective should include a target or quantifiable level of performance or deadline where possible. Not all improvements need to be done immediately. The objectives can reflect both long and short-term goals. These objectives will be used to determine if you are successful in improving management as part of your review and check steps. This will become clear as you proceed with the guidebook.

Worksheet 4: Environmental Objective and Farm Action Plan (Continued)

Communication Needs

Internal:

All employees must be trained in and use record keeping forms. Management team will discuss all option

External:

Will update policy statement once P based application is obtained. Will talk with integrator about training opportunities and interest in off-farm use options.

What Performance Measures Will Be Used to Determine Success? (include frequency of measure and acceptable level of performance)	Describe records to be kept, if applicable and location	Written Procedures Needed?
Annual income or expense associated with litter removal. - Goal is to create profit center Soil test P levels in land application areas (Biannual) - Maintain status in high area (Below 300 ppm) Note: Performance outside acceptable levels may trigger the need for corrective/preventive action. Document any corrective/preventive actions taken and resulting changes in the Check section below.	Land Application Record Sheet (office) Litter Export Record Sheet (office) Litter Export Agreement with each broker (Contract on file) Soil tests and litter analysis as part of NMP (on file with NMP) - All records entered into computer monthly	SOP for soil testing, litter analysis, and record keeping as part of EMS.

Check

Date and Initials	Were appropriate corrective or preventive actions taken?	Were tasks completed as scheduled and by the appropriate persons?	Are records legible, findable and complete?
Scheduled semi-annually			

Management Review

Scheduled annually

VI. Completing Farm Action Plans

Step 5

The assessment(s) or related activities completed as part of Step 4 have assisted in identifying and prioritizing farm environmental practices that need to be improved. They should also have assisted in identifying those areas that are environmental strengths of the farm. Both are important and should be addressed in the farm's action plan.

The plan for areas that require improvement will focus on the "who, what, how, and when" of making that improvement. Areas that are currently well managed, well controlled, or otherwise are environmental strengths of the farm should not be ignored. There should be a plan for maintaining that high level of performance. If not given proper attention, performance in these areas can suffer, resulting in an expensive and/or time-consuming problem that takes resources from other needed improvements. Also, a written plan for areas of good performance documents your high degree of environmental stewardship.

This process is not a one-time shot at improvements, nor is it set in stone. The majority of the time invested in this plan will be spent on this initial development, but it will need to be reviewed and if necessary, revised, on a regular basis.

Assigning Roles and Responsibilities

One of the benefits of developing an EMS is the opportunity to improve communication between those involved in the farm operation. Part of communication is to define roles and responsibilities clearly so that all bases are covered but that duplication of effort is avoided.

There are two levels of responsibility within the EMS. The first includes broad, overarching issues related to the planning process. The second type of responsibility includes specific duties related to an environmental objective or planned improvement. Examples of these types of responsibilities are listed below.

Who is responsible for...

- ...inspecting the manure storage structure?
- ...taking soil samples?
- ...calibrating a piece of equipment?

These types of responsibilities will be designated on the farm action plan summary sheets initiated in Steps 4 and 5.

Note: Since many poultry farms in Georgia are one person operations, some individuals will be able to skip this step. However, if you have full- or part-time employees, this step can be beneficial in clarifying what is expected of each worker. This process will also expedite the training process of any new employee you may obtain in the future since their expected duties will be clearly outlined.

Identifying Training Needs

Similar to the two levels of responsibility in an EMS, there are also two types of training required. There are general types of training that relate to overall EMS awareness and understanding. These would include things like, communicating and understanding the farm's environmental policy statement and environmental objectives.

The second type of training is more specific and relates to the responsibilities assigned for each environmental objective. Training needs related to objectives and improvements include things like teaching the designated person(s) how to read a meter, fill out an inspection checklist or record rainfall amounts. These types of training needs will be recorded in the farm environmental action summary sheets initiated in Lesson 4.

VII. Checking and Correcting

Step 6

At this point, your plan for environmental improvement should be largely committed to paper. It is time to start doing the things written on the action summaries. As the actions are carried out, it is inevitable that mistakes are found, corrective actions need to be made, or that better options become available for improvement. These are expected and adjustments can be made without pitching all of the hard work previously done.

The purpose of this step is to assist in documenting improvements, corrective actions and maintenance so that you can demonstrate environmental improvements to others. As you review the information in this step, complete the suggested sections on the second page of Worksheet 4.

Establish Performance Measures

A performance measure can be a very simple observation, or it can be a series of measurements. They should allow a farmer to assess whether or not things are improving.

Some example situations and the related performance measures include the following:

- leachate from a stackhouse could seep into ground water and contaminate your well. A performance measure could be a monthly visual assessment of the stackhouse made at regular intervals and recorded stackhouse inspection checklist.
- repeated manure applications have caused elevated soil phosphorus (P) levels in a field near a feedlot. A soil-sampling program is begun to carefully monitor nutrient application to the field. The performance measure of interest would be the soil P levels and whether they increase, decrease or remain constant over time.
- a poultry producer must move 1,000 tons of manure to off-farm users to comply with their state regulatory permit. The performance measure is to record the load weights of all manure transferred to off-farm users.

Environmental assessment tools, introduced in Step 3, provide another excellent performance measure tool. Comparing the number of "low risk" and "high risk" responses from the assessment tools over time can be an excellent measure of performance. Maintain a copy of any original assessments completed as you implement an EMS in an additional issue area. Plan to repeat that assessment at regular future intervals and compare results.

Good performance measures will:

- Be quantifiable, often numerically (e.g., Soil P level)
- Be regularly calibrated (e.g., Manure spreader application rates checked annually)
- Include a permanent record, easily accessed (e.g., Manure storage inspection checklist)
- Will be repeated regularly (e.g., Monthly inspection of manure storage)
- Are periodically checked against objectives and regulations (e.g., Farm owner reviews records every 3 months)

Use EMS Template Worksheet 4 to record the performance measure that will be utilized as well as the frequency of measurement. Some measurements may be taken daily, monthly, annually or as needed.

- Serious environmental consequences could result from doing it improperly (e.g., Procedure for disposing of excess pesticide).
- In your absence, someone else will have to do it (e.g., Monitoring and ordering feed).

Written SOPs will help you in training new employees and allowing existing managers and employees to gain flexibility in work scheduling. Often new SOP do not need to be developed but can be taken from existing resources such as manuals and extension publications. For example, procedures for soil and litter sampling, calibration, and record keeping are readily available from your County Extension Agent. If SOP's are developed, these should be listed in Worksheet 4.

Check

On a regular basis, it is important to review the procedures and records to be sure they are adequate and that any identified changes actually were made. This "check" can take place on a scheduled basis (quarterly, annually, etc.) and can also be triggered by the need for corrective/preventive actions.

Often the individual checking the EMS is someone internal to the farm operation such as a family member, or can be someone outside of the farm. Either type of person should be able to objectively review the records, and environmental performance and suggest improvements where needed. The basic questions that should be asked when reviewing records include the following:

- Are records complete? (Can the records be found?, Are they readable?, Did the appropriate action get done?, When did it get done and by whom?)
- Is SOP something you can do/understandable? (Is it missing a step?, Is it posted where it is needed?, Should it be translated into another language?, Are new employees aware of the SOP?)
- Did the plan, SOP's and records lead to appropriate actions? (Did a preventable problem occur?, Did the responsible person(s) act appropriately?, Were changes made to procedures and records to prevent reoccurrence?)

Check it Off...

☐ **At this point, Worksheet 4 of the EMS Template Pack should be completed down to the *Management Review* section.**

Is the plan you put together working? Are communications working? Are appropriate records being kept?

1. Based on the performance measures selected, is the objective being met?
2. Based on a reassessment of performance (using assessment tools listed in Step 3 or other methods), are we improving, environmentally speaking? This assessment should include a review of regulatory compliance.
3. Do checks show the need for any further changes?
4. Is the objective and plan outlined on the worksheet still suitable based on the environmental policy statement and most recent conditions and information (including the concerns of stakeholders)?

If an objective has been met, it may need revision to reflect necessary ongoing maintenance or to specify acceptable levels of continued performance. For example, if an objective was "to reduce the use of diesel fuel by 15%" then the management review would need to evaluate whether or not that actually occurred. If it did, is the objective still appropriate as written? Can the farm operation reduce diesel fuel use by another 15% or has an acceptable level of use been reached? In some instances the objective may not need to remain part of the action plan after it has been met.

If an objective has not been met, ask why? Was it too ambitious? Did unforeseeable circumstances interfere with plans (such as a drought, loss of a key employee, or changing priorities)? If the objective is still appropriate for the action plan, it may need only slight revisions to the timeline or designation of responsibilities. Revise each action summary sheet as needed to update or complete a new worksheet if revisions are extensive.

Check it Off…

☐ **On a regular basis, continue to repeat the questions outlined in Step 7.**

This continued review and revision is the process that allows for continual improvement to environmental performance. The planning process will become easier each time this cycle is repeated and much of the process will become second nature. Just like any other business management system, spending a small amount of time on a regular basis will keep the workload from piling up and reaching overwhelming proportions. Your plan should also suit your management style and the contents of this guidebook can be adapted as needed. Remember, this is a farm operation and your plan. You are the one who has to live with and carry out the things committed to paper. An EMS is tremendous tool for environmental and economic improvement—but only as long as you continue to use it. Worksheet 7 is an optional tool to perform a more in-depth and systematic management review.

Georgia EMS Template Pack

Worksheets 1-7

One copy of each worksheet is provided. We encourage you to make multiple copies of each so that you will always have new forms if changes need to be made. You can also download these templates at http://www.agp2.org.

Record Keeping for Your Farm

Maintaining records and planning based on those records is essential to the success of any farming operation. Nutrient Management planning is simply making sure that your nutrient inputs (whether organic or chemical) are meeting the needs of your crops in an economical and environmentally friendly way.

No two nutrient management plans will be exactly alike. Every farm is different; therefore, every NMP will be different and specific to that farm. Nutrient applications vary from field to field, even on the same farm. By soil testing and monitoring records from year to year, you will reduce the likelihood of overapplying nutrients and wasting money. Your nutrient management plan is key to making sure that your are making sound economic and environmental decisions while maximizing your crop yields.

This record keeping notebook is designed to help you easily keep track of your farm records. There are eight tabs in this notebook including:

- Soil Tests
- Litter Tests
- Field Records
- Application Records-Calibration Records
- Pesticide Applications
- Farm Assessment & Recommendations
- NMP
- Permits and Other Records

This is just a start to nutrient management planning and record keeping. Customize this notebook to fit the needs of your farming operation.

Soil Testing

Cooperative Extension Service/The University of Georgia College of Agricultural and Environmental Sciences

C. Owen Plank, Extension Agronomist

Determining the fertility level of a soil through a soil test is the first step in planning a sound lime and fertilization program. This step leads to higher crop yields and quality by following recommended application rates. A soil test provides the means of monitoring the soil so deficiencies, excesses and imbalances can be avoided.

Many Georgia soils are low in pH and one or more of the essential plant nutrients. Therefore, to maintain normal plant growth, lime and fertilizer must be supplied in sufficient quantity to meet the crop's requirement. A soil test will determine the soil's contribution to the crop requirement, with lime and fertilizer supplying the remainder.

The Soil Testing Laboratory

The Soil Testing Laboratory is located on the campus of the University of Georgia at 2400 College Station Road in Athens. It is equipped with the most modern instruments available for rapid and accurate soil analysis. Analysis results and fertilizer recommendations are returned to your county extension agent for dissemination and adjustments, if necessary.

The laboratory offers a number of tests to meet specific soil and cropping circumstances. The tests and their applications are listed in Table 1 (page 3).

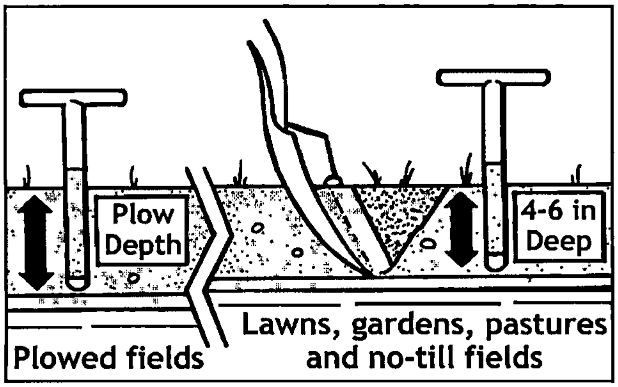


Figure 1. Take a thin vertical slice to desired depth.

Procedure

Use soil sample bags – available from your county extension office – for submitting samples to the laboratory. Supply all the information asked for on the sample bag.

List your **NAME AND ADDRESS, CROP** to be grown, **SAMPLE NUMBER** (please make these simple and do not exceed three digits, e.g., 1, 2, 3 ... 20, 21, 22 ... 321, 322, 323 ... 32A, 32B ...) and your **COUNTY AGENT'S ADDRESS.** This information is essential for the return of your sample results and fertilizer recommendations to the proper county extension office.

On the bag, indicate the tests you want by checking the appropriate space and/or spaces. For most agronomic needs, a routine test will be enough. If you are in doubt about whether to request a special analysis (OM, NO_3, B) refer to Table 1 or consult your local county extension office.

Sample Instructions

When soil samples are submitted to the laboratory for analysis, reliable analytical results are necessary for making limestone and fertilizer recommendations. A soil test result, however – regardless of analytics – can be no better than the sample submitted for analysis. For the sample to be representative of the area tested, follow these steps for sampling:

1 Use a soil sampling tube, auger, spade, trowel or other tool that can take a thin, vertical slice of soil to the desired depth (Figure 1).

2 Take at least 15 to 20 cores or thin slices at random over the field or area (Figure 2). In general, 15 acres should be the maximum size area represented by a single composite sample. Place the cores in a clean plastic bucket or other nonmetal container and thoroughly mix the soil. Fill the soil sample bag to the "fill line" marked on the bag. Fold the top of the bag and fasten the

amount withdrawn, there is a net buildup of the account. If the amount of nutrients applied in fertilizer and limestone exceeds the amount removed in harvested crops and the amount lost by leaching, there will be a net buildup of the soil fertility level. If the opposite is true, the fertility of the soil will decline. Periodic soil sampling of each field will help determine whether you are following a soil buildup or soil depletion program. If a sound soil testing program is not followed, a deficiency or an excess in fertilization rates can result.

Laboratory Tests and Fees

1. **Routine Tests:** pH, L.R., Soil Test P, K, Ca, Mg, Mn and Zn
2. **Micronutrient Tests:** Boron (B)
3. **Other Tests:** Organic Matter Content, Soluble Salts, Nitrate Content
4. **Commercial Greenhouse or Nursery Soil Test:** pH, Soluble Salts, NH_4, NO_3, P, K, Ca, Mg

The laboratory charges a nominal fee (subject to change) for these analyses. Please contact your county extension office for the most recent information about current fees.

A check to cover cost of tests should accompany the soil sample and be made payable to the Cooperative Extension Service.

Table 1. Selecting the Proper Soil Test Determination

Not all the soil tests apply equally to every soil and cropping situation. Suggestions for selecting the proper soil analysis and/or analyses are as follows:

ROUTINE TEST:	
pH, Lime Requirement (L.R.), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Zinc (Zn)	Routinely recommended for all commercial field and vegetable crops as well as lawns and gardens
MICRONUTRIENT TESTS:	
Boron (B)	Primarily for sandy or eroded soils low in organic matter on which cotton, peanuts, alfalfa and vegetable crops are to be grown.
OTHER TESTS:	
Organic Matter Content (O.M.)	For all soils and crops, knowing the O.M. content is of primary interest for special situations where soil tilth and water-holding capacity are important.
Soluble Salts (S.S.)	Of interest where large quantities of fertilizers have been applied, particularly for potted plants, greenhouse beds, lawns or ornamental plantings or beds. Not generally applicable to field soils except in problem-solving situations.
Nitrate Content (NO_3)	Of particular interest for greenhouse soils, potted plants and beds. Not generally applicable for field soils. However, as more interest in pollution from fertilizer sources develops, this test may become more important in field crop situations. As the residual NO_3-N level of a soil increases, the application rate of fertilizer nitrogen should be adjusted downward.
COMMERCIAL GREENHOUSE OR NURSERY SOIL TEST:	
pH, Soluble Salts, NH_4, NO_3, P, K, Ca, Mg	For mixes that include soil, sand, peat, pine bark, pearlite, vermiculite used to produce greenhouse or potted vegetable, flower or ornamental plants. Not recommended for unamended soil.

SOIL SUBMISSION FORM

LAB USE ONLY

SET ID: ________________

Login Date: ________________

DATE MAILED: ______ **COUNTY CODE:** ______ **ROUTINE** or **SPECIAL** *(list tests)*: ______________

PHONE: ________________________________

EMAIL: ________________________________ *(for returning soil report)*

NAME Last First	**ADDRESS** *(required)* Street, City, Zip Code	**Sample ID**	**Crop Codes** *(up to 5)*	Lab Number
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				

INSTRUCTIONS:

If samples are not paid for through an Extension office, **payment must be included.**

Include only 12 samples per form, 1 sample per line. Info on sample bag should match info on form.

Crop and **County** codes must be used.

Samples for **Special** analyses must be listed on a separate form.

All samples listed on sheet should be enclosed in same box.

Enclose forms **inside** envelope and place **inside** box.

Name	Address	Sample ID	Crop Code
1. Doe, John	3657 Rocky Rd. Atlanta 30303	Lawn	CLM, 087, 086
2. Smith, Mae	1254 Peach Dr. Atlanta 30078	1	112, 098, 105, 101

LAB USE ONLY

CASH CREDIT CHECK #

RECEIPT # ________________

TECHNICIAN ________________

Soil Test Collection Records

Field Name/Location:

Date of Soil Sample	Number of Samples Collected in Field	Samples Collected By:	Sample Submission Date	Results Date

Litter Testing

Utilizing poultry litter on your farm is an economical way of adding nutrients to your soil. However, poultry litter is variable from source to source and even from house to house on the same farm. It is essential that each load of litter you apply on your farm be tested so that you know what nutrients you are putting out on your fields and pastures.

Litter testing should be completed as close to application time as possible in order to get an accurate nutrient analysis. Without an accurate analysis, you could actually lower your crop yields. Poultry litter is typically much higher in phosphorus than it is in nitrogen so it's important to apply litter at the appropriate rate to avoid over applying phosphorus.

Included in this section:

UGA extension

Poultry Litter Sampling

Casey W. Ritz, Extension Poultry Scientist
Paul F. Vendrell and Armando Tasistro,
Agricultural and Environmental Services Laboratory

Poultry litter is a mixture of poultry manure, feathers, wasted feed, and bedding material that contains nitrogen, phosphate, potash, and other nutrients essential for plant growth. Poultry litter can vary considerably in nutrient content due to bird type, feed composition, bedding materials used, clean-out frequency, storage and handling practices, use of litter amendments, and other factors. Therefore, sampling poultry litter to obtain a nutrient content analysis is an important step for managing manure nutrients appropriately.

Moisture management has perhaps the greatest effect on litter nutrient content. Crusted or caked litter around drinkers and feeders is usually wetter and higher in nitrogen and phosphorous than whole house litter. This caked litter represents approximately 30-35 percent of the weight of the whole litter and typically has different handling characteristics than the rest of the house litter. Poultry litter testing determines the fertilizer value of the litter, which can be used to calculate land application rates or market value. Table 1 summarizes the fertilizer content of selected types of poultry litter.

Table 1. Nutrient values for various whole-house poultry litters on an "as-received" basis.

Litter Type	Nitrogen	Phosphate (P_2O_5)	Potash (K_2O)
	----------------	%	----------------
Fresh Broiler Litter (2,903 samples)	3.15 (0.60)	2.77 (0.81)	2.33 (0.62)
Stockpiled Broiler Litter (262 samples)	2.78 (0.86)	2.84 (0.94)	2.29 (0.69)
Composted Broiler Litter (62 samples)	2.80 (0.98)	3.00 (1.00)	2.30 (0.83)
Fresh Layer Manure (209 samples)	2.26 (0.83)	3.16 (1.34)	2.05 (0.81)
Broiler Breeder Litter (325 samples)	2.12 (0.79)	3.14 (1.17)	1.93 (0.63)

(Standard deviation in parenthesis.)
Values listed are from samples submitted to the University of Georgia Agricultural and Environmental Services Laboratory between July, 2000, and July, 2002.

Producers who fail to test poultry litter nutrient sources and the soils to which they are applied are faced with a number of questions they cannot answer. Are they supplying plants with adequate nutrients? Are they building up excess nutrients in the soil that may ultimately move into surface water or groundwater? Are they applying trace metals at levels that can accumulate and become toxic to plants, permanently altering soil productivity, or creating runoff water that is toxic to aquatic life?

Obtaining nutrient concentration data for poultry litter is a crucial step in developing and using a nutrient management plan (NMP). Measuring the average nutrient concentrations of litter within a poultry house requires sampling procedures that ensure representative samples. Research shows that spatial variability of nitrogen and phosphorous concentrations can be influenced by conditions such as litter moisture content and waste feed.

Book values provide an estimate of the nutrient value of poultry litter for planning purposes. However, there can be a wide range of nutrient concentration among poultry houses under different management. The unpredictability of nutrient content from farm to farm, even house to house, makes nutrient testing an essential part of using poultry litter to supply plant available nutrients. The attention to detail in the sampling of litter will determine how well nutrient applications match the nutrient requirements of the crops to which it is applied.

Collecting Samples

Collecting samples that are representative of the entire litter volume is essential for reliable nutrient analysis and subsequent nutrient management planning efforts. Subsampling is needed to obtain a composite sample that is representative of the volume of material being land applied. Samples should be taken as close to application as possible, allowing time for laboratory analysis, house cleanout, and litter spreader calibration when needed.

In-House Litter

Sampling litter while still in the poultry house has been the standard method of sampling with the advent of nutrient management planning. However, the nutrient content of litter in a poultry house can vary considerably depending on

The University of Georgia
College of Agricultural and Environmental Sciences
Cooperative Extension Service

SOIL, PLANT, AND WATER LABORATORY
2400 College Station Road

****
| LAB# ______________ |
*********[Lab Use Only]*********

POULTRY LITTER/MANURE SUBMISSION FORM
FOR NUTRIENT MANAGEMENT PLANS

Please Note - Retain a copy of this form for your files. Submit one copy per sample.

Name: ______________________
Mailing address: ______________________
City,State,Zip: ______________________
Phone #: ______________________

Sample #: __________ **(One form per sample)**
County: ______________________
Date: ______________________

For Free Basic Test please answer the following:

1. Will these results be used for:
   Nutrient Management Planning? Yes __ No __ Marketing of litter? Yes __ No __
2. Treatment product(s) used on this litter (e.g. Alum, PLT, etc.) ____________
3. How many flocks were produced on this litter? __
4. Was the litter caked __ or full clean-out __ ? *(Check One)*
5. Describe the kind of litter, its condition, and the application method **by checking below:**

Kind
Broiler _____
Layer _____
Breeder _____
Pullet _____

Condition
Fresh _____
Stockpiled: *Stackhouse* __
Under tarp __
Other __
Composted _____
Lagoon _____
Other ______________ *(Describe)*

Application Method
(Check One)

Surface _____
Incorporated _____
(within 2 days)
Soil Injected _____
Irrigation applied _____

TESTS REQUESTED

____ Total Minerals (free basic test)
(Includes: total nitrogen,phosphorus,potassium,calcium,magnesium,sulfur,manganese iron,aluminum,boron,copper,zinc,sodium)

____ Extra Tests (price per fee schedule)
Nitrate Nitrogen ___ Ammonium Nitrogen ___
Moisture ___ Solids ___ Other ___

****

FOR LAB USE ONLY

Date Received: __________ **Date Returned:** __________
Payment Received: __________ **Invoice #:** __________

NH_4-N _____ **Moisture/Solids** _____ **NO_3-N** _____ **Total Nitrogen** _____ **Other** _____

Litter Submission Records

Date of Soil Sample	Source of Litter:	Quantity of Litter Received:	Sample Submission Date:	Results Date:

Crop Yield Record

Field ID	Acres	Crop Planted	Planting Date	Harvest Date	Yield	Units	Notes
EXAMPLE Field	*45*	*Bermuda*	*N/A*	*5/15/2010*	*4*	*Tons/acre*	

Application/ Equipment Calibration

Maintaining a record of all nutrient applications, both manure or commercial fertilizer applications, is a key component of farm record keeping. Records allow you to compare application rates and times from year to year and field to field. These records, along with your soil test results will be indicative of improving soil fertility which will increase crop yields.

Equipment used for land application should be calibrated on a yearly basis. Refer to your NMP for individual field application rates when you're calibrating your equipment. Document yearly calibrations on the record sheet included in this section.

Included in this section:

UGA Extension Land Application of Livestock and Poultry Manure Circular

Whole Farm Solid Manure Application Record Sheets

Individual Field Nonorganic Fertilizer Application Record Sheets

UGA Extension Spreader Calibration Circular

Equipment Calibration Record Sheets

Land Application of Livestock and Poultry Manure

THE UNIVERSITY OF GEORGIA
COOPERATIVE
EXTENSION

College of Agricultural and Environmental Sciences
College of Family and Consumer Sciences

Land Application of Livestock and Poultry Manure

Mark Risse, Extension Engineer
Department of Biological and Agricultural Engineering

Livestock and poultry manures contain nutrient elements that can support crop production and enhance the chemical and physical properties of soil. Manure can be an asset to livestock and poultry operations when its nutrients are used for fertilizer. This publication provides information on (1) the nutrient content of manures available for land application, (2) how to determine manure application rates and whether supplemental fertilizer will be needed for maximum crop production and (3) how to use management techniques to maximize the fertilization potential of farm manures.

Factors Affecting Fertilizer Value of Manure and Recommendations for Application

The type and amount of nutrients in livestock and poultry manures and the nutrients' eventual availability to plants may vary considerably. Some factors affecting nutrient value of applied manure are type of ration fed, method of collection and storage, amount of feed, bedding and/or water added, time and method of application, soil characteristics, the crop to which the manure is applied, and climate.

Increasing levels of various elements (copper, arsenic, etc.) and inorganic salts (sodium, calcium, potassium, magnesium, etc.) in feed will increase their concentrations in manure. There is concern about the potential toxic effects to plants of high concentrations of heavy metals and salts in soil as a result of high application rates of manure to the land. Perform regular soil tests and manure analyses to monitor the balance of nutrients in the soil on your farm, especially on land receiving heavy manure applications. From an environmental standpoint, limit the rate of manure application to the needs of the crop grown on the land.

Bedding and water dilute the nutrient concentration of manure and reduce its value. On the other hand, feed spilled and incorporated into the manure increases the nutrient concentration. Excessive feed spillage and/or inadequate agitation may cause sludge buildup in liquid systems, making removal of the manure more difficult.

The type of housing and/or waste handling system you use greatly affects the nitrogen (N) concentration of manures (Table 1). Major N losses occur when manure is dried by sun and air movement or leached by rain, as is the case in open lot systems. In contrast, manure loses comparatively little N in a completely covered facility using a manure pack or liquid pit storage system. Loss of N is greatest in long-term treatment or storage systems such as oxidation ditches or lagoons.

Table 1. Approximate Nitrogen Losses from Manure as Affected by Handling and Storing Methods

Handling, Storing Methods	Nitrogen Loss*
Solid Systems:	
Manure Pack	35%
Poultry Litter	35%
Liquid Systems:	
Anaerobic Pit	25%
Oxidation Ditch	60%
Lagoon	80%

* Based on composition of manure applied to the land vs. composition of freshly excreted manure.

Phosphorus (P) and potassium (K) losses are minimal (5 to 15 percent) for all but open lot and lagoon manure handling systems. In an open lot, you can lose from 40 to 50 percent of the manure's P and K to runoff and leaching. However, most of the P and K can be retained for fertilizer use by runoff control systems (setting basins, detention ponds). In lagoon systems, from 50 to 80 percent of the P in manure can settle in the sludge layer and thus be unavailable if only the liquid portion is applied to the land.

Determine How Much Manure Can Be Applied

You can only determine the exact amount of nutrients available for land application from your operation by laboratory analysis. But you can use Tables 1, 2, and 3 to calculate the approximate nutrient value of your manure from Table 3, then subtract storage and handling losses (Table 1) and application losses (Table 2) to get the nutrients available at time of application. With these figures you can estimate the amount of manure to apply to a given crop area and whether your crop will require additional commercial fertilizer. If you know the quantity of nutrients available from your operation per year, you can determine how much land is needed for manure disposal. Table 4 gives nutrient needs for various crops. Apply to the land at such a rate that the amount of available nutrients does not greatly exceed the amount removed by the growing crop.

Example

A swine producer has a 1,000-head finishing operation (averaging 125 pounds weight per animal) in an enclosed confinement building. Liquid manure is collected in a lagoon. If the manure is spread by irrigation annually on land producing 150 bushels of corn per acre, how many acres are required for maximum fertilizer utilization?

Step 1. Determine the nutrient needs of the crop. From Table 4, for 150 bushels of corn: N = 225 pounds/acre, P_2O_5 = 80 pounds/acre, K_2O = 215 pounds/acre.

Step 2. Determine the nutrient value of manure from Table 3. Pounds nutrient/year/animal unit in manure as excreted: N = 164, P_2O_5 = 124, K_2O = 132. Reduce nitrogen value 80 percent for storage losses (Table 1) and 30 percent for application loss (Table 2). This means only 23 pounds of N/1,000 pound animal unit are available for crop utilization. At 125 pounds/ head the number of 1,000 pound animal units = 1,000 head x 125 lbs/head divided by 1,000 lbs/animal unit =125 animal units.

To determine total pounds of each nutrient available, multiply unit values by number of animal units:

N = 23 x 125 = 2,875 pounds
P_2O_5 = 62 x 125 = 7,750 pounds*
K_2O = 66 x 125 = 8,250 pounds*

* Assumes 50 percent recovery with little or no agitation of the lagoon.

Step 3. Determine number of acres required for maxi-mum nutrient utilization. Divide total pounds of each nutrient (from Step 2) by pounds of that nutrient required per acre (from Step 1).

Acres Required for N = 2,875 225 = 12.8
Acres Required for P_2O_5 = 7,750 80 = 96.8
Acres Required for K_2O = 8,250 215 = 38.4

Table 4. Approximate N, P_2O_5 and K_2O Utilization by Various Crops

		Nutrient Uptake, lb/A*		
Crop	**Yield/Acre**	**N**	**P_2O_5**	**K_2O**
Corn (grain)	150 bu	170	80	215
	180 bu	225	100	240
	32 tons	480	80	245
Corn silage				
Wheat	40 bu	80	27	81
	70 bu	140	47	142
	100 bu	200	68	203
Bermudagrass	6 tons	258	60	288
(Hybrid)	8 tons	368	96	400
Clover/grass	6 tons	270	90	360
Sorghum/Sudan Hybrid	8 tons	360	122	466
Grain Sorghum	6,000 lb	225	63	180
Barley	100 bu	150	55	150

* Figures given are total amounts taken up by the crop in both the harvested and the above-ground unharvested portions. These numbers are estimates for indicated yield levels taken from research studies, and should be used only as general guidelines.

Management Factors

Some additional management techniques that will help ensure safe and effective application of manure to cropland follow:

- Incorporate manure into the soil immediately. Otherwise, apply manure to surface at reasonable distances from streams, ponds, open ditches, neighboring residences and public buildings to minimize runoff and odor problems.
- Minimize odor problems by using common sense, especially during the summer. Spread early in the day when the air is warming up and rising rather than later when the air is cool and settling, and do not spread on days when the wind is blowing toward populated areas or when the air is still. Good management helps avoid neighbor complaints. Analysis from liquid manure varies considerably depending on the amount of dilution. Laboratory analysis is recommended for all animal waste and soil samples are recommended as well. Table 6 shows average nutrients in liquid manure.
- Apply manure to relatively level land — if slope exceeds 10 percent, knife liquid manure into sod.
- Agitate or mix liquid manure thoroughly in pits to facilitate removal of settled solids and thus insure uniform application of the nutrients.
- Consider irrigating with dilute manures (lagoon or runoff liquids) during dry weather to apply needed water and nutrients to growing crops.
- Wash the plants with clean water to avoid leaf burn when irrigating manure on growing crop.
- Avoid spreading liquid manure on water-saturated or frozen soils where runoff is apt to occur.
- Apply sufficient water sometime during the year to avoid accumulation of salts in the root zone of soils in arid regions.
- Use good safety measures when moving manure from tanks or pits. Because of oxygen deficiency or toxic gas accumulation, avoid entering storage structures when agitating the liquid manure.

The chemical and physical properties of soil, such as water infiltration rate, water-holding capacity, texture and total exchange (nutrient-holding) capacity also affect how much manure can be safely applied to land. Fine-textured soils have low water infiltration rates; therefore, the rate at which liquid manure, especially lagoon effluent, can be applied without runoff may be restricted to the intake rate of the soil. Coarse-textured soils, on the other hand, are quite permeable and can accept higher rates of liquid manure applications without runoff. But because most coarse soils have a very low exchange (nutrient-holding) capacity, you may have to apply smaller amounts of manure during the growing season to minimize the chance of soluble nutrients entering ground water. Organic matter in the manure is decomposed more rapidly in coarse-textured than fine-textured soil and during warm, moist conditions rather than cold, dry conditions. However, fine-textured soils will retain the nutrients longer in the upper profile, where plants can get them.

Table 6. Nutrients in Liquid Manure — Approximate Fertilizer Value of Manure — Liquid Handling Systems

Animal	Waste Handling	Dry Matter	Available N	Total N	P_2O_5	K_2O
		%	lbs/1,000 gal of waste			
Dairy cattle	Liquid pit	8	12	24	18	29
	Lagoon*	1	2.4	4	4	5
Swine	Liquid pit	4	20	36	27	34
	Lagoon*	1	3.2	4	2	4
Beef	Liquid pit	11	24	40	27	34
	Lagoon*	1	2	4	9	5
Poultry	Liquid pit	13	64	80	36	96

* Lagoon — including lot runoff water

Note: There will be little odor if manure is immediately incorporated.

WHOLE FARM SOLID MANURE APPLICATION RECORD

Date	# of Loads	Weight (tons/load)	Nutr. Conc. (lb/ton)			Weight (tons)	Total Nutrients Applied			Field #	Weather
			N	P_2O_5	K_2O		N	P_2O_5	K_2O		
			Total Applied								

WHOLE FARM SOLID MANURE APPLICATION RECORD

Date	# of Loads	Weight (tons/load)	Nutr. Conc. (lb/ton)			Weight (tons)	Total Nutrients Applied			Field #	Weather
			N	P_2O_5	K_2O		N	P_2O_5	K_2O		
			Total Applied								

INDIVIDUAL FIELD SOLID MANURE APPLICATION RECORD

Field Name (#)

Spreadable Acres - 1

Annual PAN Needs (lb/acre)

Date	Amount (tons)	Total Nutrients Applied (lb)			N Avail. Coeff.	Total Applied (lb/acre)			
		N	P_2O_5	K_2O		N	PAN	P_2O_5	K_2O

Crops Grown

N Availability Coefficients

(Solid Manure)

Incorporated

Dairy	0.6
Beef	0.6
Swine	0.6
Layer	0.6

Broadcast

Dairy	0.5
Beef	0.5
Swine	0.5
Layer	0.5
Horse	0.5

INDIVIDUAL FIELD SOLID MANURE APPLICATION RECORD

Field Name (#) Spreadable Acres - 1 Annual PAN Needs (lb/acre)

Date	Amount (tons)	Total Nutrients Applied (lb)			N Avail.	Total Applied (lb/acre)			
		N	P_2O_5	K_2O	Coeff.	N	PAN	P_2O_5	K_2O

Crops Grown

N Availability Coefficients

(Solid Manure)

Incorporated

Dairy	0.6
Beef	0.6
Swine	0.6
Layer	0.6

Broadcast

Dairy	0.5
Beef	0.5
Swine	0.5
Layer	0.5
Horse	0.5

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Calibration of Manure Spreaders

Reviewed by John W. Worley, Professor and
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Thomas M. Bass, Former Extension Specialist currently at Montana State University

Calibrating a manure spreader is a simple, easy management tool that can help producers use nutrients from animal manure efficiently and safely. Over-application or uneven application of manure wastes nutrients and increases the chance of ground or surface water contamination. By knowing the application rate of the manure spreader, correct amounts of manure can be applied to meet crop needs. The procedure takes less than an hour but can save hundreds of dollars through more efficient use of manure nutrient resources. Calibration, along with timely application to provide nutrients when crops can use them, helps ensure efficient and safe use of animal manures.

This publication primarily focuses on rear discharge, twin spinner spreaders common for poultry litter application in the southeast (Figure 1). The concepts discussed, however, do apply to other types of spreaders. Slight changes in the described procedures may be required to calibrate other types of spreaders.

Manure spreader calibration has three main goals:

1. Determine application rate (tons per acre applied at a given setup and speed).
2. Determine the effective swath width (how far apart each pass should be).
3. Optimize the uniformity of distribution of manure.

Application Rate

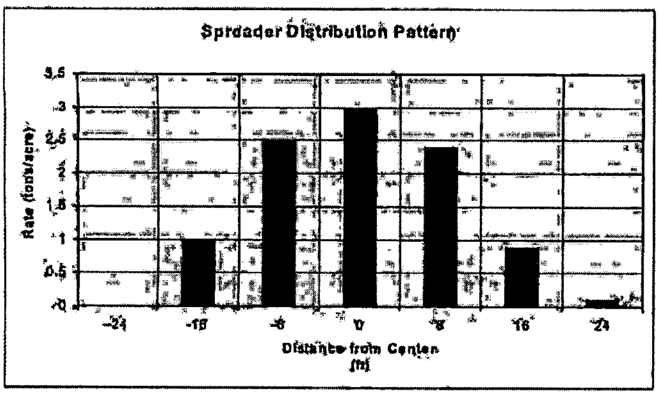
The application rate can be determined by mass balance. (Weigh the spreader before and after spreading and determine the area covered.) This procedure tells us how much was applied over a given area, but it tells us nothing about how evenly the manure was applied. A much better method is to catch samples at locations across the path of the spreader and use them to determine the spreader application pattern. The application rate at a given point can be determined using the amount (lbs) of manure captured on a tarp at that point and the following simple formula:

Application Rate (tons/acre) =

Sample weight (lbs) x 21.8/tarp area (ft^{2}).

To make the math even simpler, if you use tarps that are 4' 8" x 4' 8", the area of those tarps is 21.8^{2}ft and the application rate in tons/acre is equal to the pounds of manure on the tarp.

Figure 1. Typical twin-disk spinner manure spreader truck.



Tarp area: 21.8 ft^2 Tarp spacing: 8 ft

Tarp #	1	2	3	4	5	6	7
	0.0	1.0	2.5	3.0	2.4	0.9	0.1

Figure 4. A sample data sheet and graph of distribution pattern.

8. Plot the spreader distribution on a graph with the vertical ("y") axis equal to the application rate for each tarp and the horizontal ("x") axis as the distance from the center of the spreader path to the center of each tarp (Figure 4). An Excel spreadsheet is available that will do the plotting automatically. (See Resources section.)
9. The points on both sides of the center that are approximately one-half the maximum value represent the edge of the effective swath width. By identifying the effective swath width and overlapping swaths each trip up or down the field, even distribution of the manure can be achieved.
10. Sweep the tarps (and wash if necessary) to remove any manure before folding.

Spread Patterns

Acceptable spread patterns are shown in Figure 5. The area between the dashed lines represents the approximate effective swath width. If spreader paths are spaced at this interval, a uniform distribution should be achieved.

Unacceptable patterns are shown in Figure 6. A uniform distribution pattern is almost impossible to achieve without an acceptable spread pattern. If your spreader does not spread any of the acceptable patterns or something very close, make adjustments to the spreader using the operators manual until an acceptable pattern is realized.

A common problem seen with twin disk spreader trucks is that the door over the spinner disks is opened so wide that much of the litter bypasses the disks and is deposited directly on the ground behind the spreader. This causes a high peak in the center of

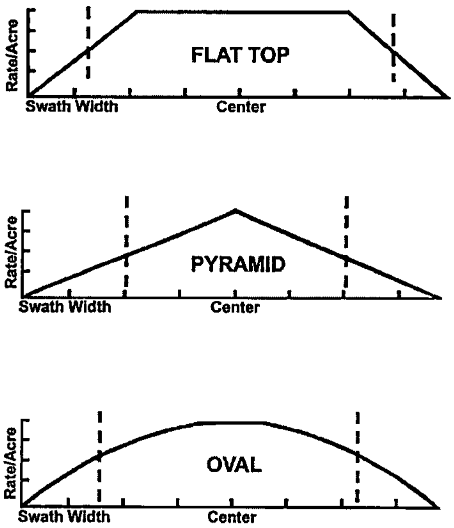


Figure 5. Acceptable spread patterns.

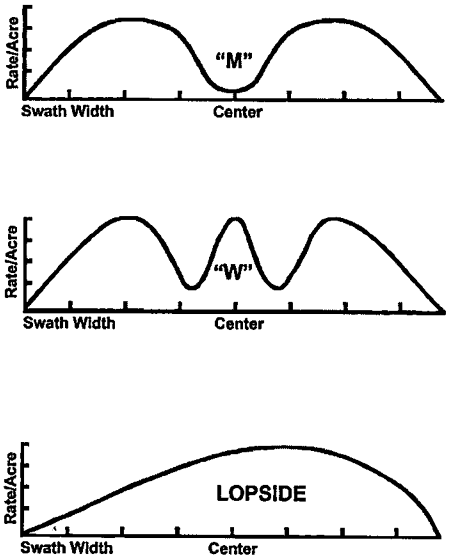


Figure 6. Unacceptable spread patterns.

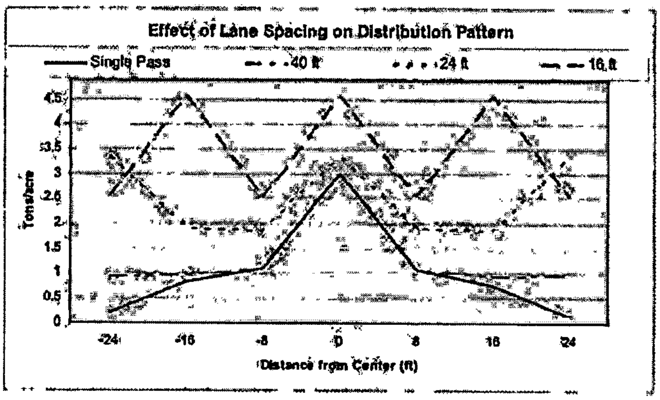


Figure 7. Lane spacing effects on uniformity and application rate.

Equipment Calibration Record

Date	Equipment Type	Manure Type	Rate	Units
Ex:09/09/2009	*Traveling Gun*	*Agitated dairy liquid*	*3*	*Ac-in/AC*