

AGRICULTURE WASTE MANAGEMENT FIELD HANDBOOK SOUTH CAROLINA SUPPLEMENT 1

Use of Animal Waste and/or Sewage Sludge and Effluent as a Source of Plant Nutrients.

This document for South Carolina is to supplement the criteria and guidance provided in the NRCS Agriculture Waste management Field Manual and the Conservation practice Standards for Nutrient Management, and Waste Utilization. Guidance in this document shall be used to support those referenced documents and provide procedures, guidance, and data for design and implementation of systems in accordance with those criteria. The guidance provided in this supplement is not to be use in lieu of the Agricultural Waste Management Field Handbook or the conservation practice standards for Waste Utilization or Nutrient Management

I APPLICATION OF ANIMAL WASTE CRITERIA

- A. All state and local laws, rules, regulations, governing waste management and special conditions to an operating permit will be adhered to strictly. See NRCS Practice Standard 312, Waste Management System, for compliance and permit requirements.
- B. Application of wastes shall not be made to portions of fields that are within the prohibited distances from residences, wells, streams or reservoirs as per South Carolina Department of Health and Environmental Control regulations. These criteria will be specifically addressed by DHEC in the special conditions of the construction permit. However, the plan will identify the location of all setbacks and the respective widths on the plan map and assure that sufficient acreage will be available for waste application after elimination of prohibited fields and/or prohibited portions of fields. Plans shall identify fields to which waste is to be applied.
- C. The amount of animal wastes produced varies depending on size of animals; feed; shavings or other bedding, and other factors. **When site specific or other more reliable data are not available, the values from Table 1 shall be used to estimate the amount of animal wastes produced.** The values must be changed if the percent of water is changed or other materials are added.
- D. N, P₂O₅ and K₂O content of the waste is quite variable depending on the type of animals, feed, moisture content of wastes, amounts of shavings or bedding, time of year, and frequency of waste removal. **Thus, the values provided in Table 3 shall be used only for estimating the amount of land needed for waste utilization. If local data exists for the specific type of operation being planned, the local data should be used in lieu of Table 3. Actual amounts of waste to be applied shall be adjusted at application based on an analysis of the waste or on historical data for the facility (at least 3 years).** If inputs or management are altered, waste should be analyzed. Where abnormal amounts of water are to be added to storage structures, calculations to determine estimates of nitrogen shall be made using information in the Agricultural Waste Management Field Handbook or other appropriate sources.
- E. Nitrogen from applied waste may be lost through leaching, denitrification, and volatilization. The procedure used to arrive at the recommended rates in Nutrient Management for South Carolina-Based on Soil- Test Results, Circular 476, accounts or losses through leaching and denitrification. If recommendations are taken from sources which have not already accounted for losses through leaching or denitrification, those losses shall be adjusted for as specified in Chapter 11 of

the Agricultural Waste Management Field Handbook. Nitrogen volatilization losses in Table 2 (see page 5) apply when fresh manure is surface applied and not promptly incorporated into the soil. For waste applied by sprinkler irrigation, deduct 25% from the estimated amount of N due to losses through volatilization. For other high moisture waste (> 75% H₂O) applied to the soil surface but not incorporated promptly, deduct 10% for nitrogen volatilization losses.

- F.** Recommendations as per Nutrient Management for South Carolina, CUCES, February 2001 (or current edition) shall be used for crops and forages.

Animal waste can be applied to pine trees at the following rates:

1. Pine trees with understory – 230 lbs. of plant available N/acre
2. Pine trees without understory – 180 lbs. of plant available N/acre

Only one application every four years is permissible at the above rates. Annual applications of 75 lbs. of plant available N/acre are permissible. These rates have not been adjusted for losses through leaching, denitrification, and volatilization. Application should not be made to woodlands until canopy closure (Dickens, 1995).

- G.** Use of waste to produce legumes is not efficient use of the nitrogen component. However, if maximum crop utilization and consumption are desired and the application is not limited by considerations of nitrogen or phosphorus loss from the site via leaching or runoff application of the quantity of waste to supply as much as 75 lbs. of N per acre is permitted on soybeans, cowpeas, and solid stands of sericea lespedeza or alfalfa. This application, however, may increase competition from nonlegumes and decrease the legume population and yields.
- H.** Soils to which animal waste are being applied shall be analyzed for nutrient content at least once each year. Samples for soil test should be taken from the 0-6

inch depth except pastures and other untilled areas should have separate samples for the 0-2 inch depth and the 2 to 6 inch depth. Soils receiving long term applications of animal waste should be tested for heavy metals periodically, approximately every five years, to monitor any buildup. Applications of heavy metals are limited to the same lifetime loading rates as for applications of municipal sludge and effluent.

- I.** Other sources of fertilizers should be used to supplement the plant nutritive value of wastes as needed.
- J.** Wastes applied to forage plants will be at a rate that permits no more than 25 percent of the leaf surface of plants to be covered by solids.
- K.** Animal wastes will not be applied to root vegetable crops during the current growing season or to other vegetable crops within one month prior to harvest.
- L.** The method of application shall be consistent with the planned method and equipment for storing and handling of the waste (Chapter 11, Agricultural Waste Management Field Handbook, 1992).
- M.** Minimizing the potential for pollution of soil, air, surface waters, and wells and other underground waters will be a primary consideration in planning the manner of application.
- N.** Runoff and erosion shall be controlled at levels, which will prevent adverse off-site effects from nutrients being applied in waste. The erosion rate shall not exceed the quality criteria specified in Section III, Field Office Technical Guide. Pollutants in runoff shall be minimized through vegetative filters as warranted. If incorporation of waste is planned, the method and timing of incorporation must be such that increased erosion will not be incurred.
- O.** Application of wastes shall not be made when there is a likelihood of prevailing winds carrying the odors into inhabited

areas. Waste Management Plans shall include a specific plan for management of odors and vectors. Animal waste management plans are developed for the client, typically the generator. If responsibility for proper utilization of the waste is transferred to another individual, that individual should receive a copy of the generator's waste management plan (if applicable to the recipient's utilization) or should have a waste management plan developed which is specific to his utilization of the waste. An advisory statement shall be added stating that the plan is valid only for the animal types and numbers, fields, and crops specified. If there are changes in these the producer should contact the local NRCS office or DHEC for revisions in the plan.

II. APPLICATION OF MUNICIPAL SEWAGE SLUDGE BIOSOLIDS AND EFFLUENT FOR PRIVATE LAND OWNERS

CRITERIA

- A.** The plan for land application shall be in accordance with the regulations of EPA and DHEC pertaining to land application of sewage and/or effluent from domestic wastewater and domestic septage and industrial sludge. The Guidance Manual "Beneficial Use of Waste Water Biosolids - South Carolina Guide on Land Application of Wastewater Sludge, SCDHEC, 1996" shall be used as the primary reference in preparation of these plans. Other references include Federal Register, February 19, 1995 (40 CFR 257, 403,503) and NPDES Permits, Regulation 61-9, SCDHEC, April 23, 1993.
- B.** An analysis of the sludge or effluent to be applied shall be obtained from a DHEC approved laboratory prior to plan development.
- C.** Sludge must be non-hazardous; processed to significantly reduce pathogens, if human wastes are present; stabilized so odors and vectors are not a problem; and be applied in a manner that metals or other constituents do

not create a problem to animal or human health, crops, or future land use.

- D.** Soils to which sludge or effluent is applied shall be sampled and analyzed annually as required in the Guidance Manual.
- E.** Maximum annual rates of application to meet the agronomic requirements of the crop shall be determined using the same nutrient accounting procedures as for land application of animal wastes. In most situations, the agronomic rate will be based on nitrogen. However, in some cases phosphorus, potassium or magnesium could be present in high enough concentrations to necessitate basing the application rate on that nutrient. The criteria in 1 and 2 should be used in assessing the quantity of plant available N in Sludge or effluent.
 - 1. Inorganic nitrogen: The amount of the inorganic nitrogen actually present for plant uptake after application is dependent upon application method. For surface application, about 50% of the inorganic nitrogen is lost by volatilization. If waste is injected, losses through volatilization should be minimal.
 - 2. Organic nitrogen: The amount of plant available nitrogen from the organic nitrogen in the sludge or effluent shall be determined from Table 4.
- F.** The application rate may be further limited by the content of heavy metals in the sludge or in the soils. Regulations related to heavy metals, including permissible levels are in "Beneficial Use of Wastewater Biosolids - South Carolina Guide on Land Application of Wastewater Sludge, 1996".
- G.** Time of application shall be accordance with the Criteria in the Conservation Practice Standard for Nutrient Management.
- H.** Site restrictions: The site restrictions as outlined in the "Beneficial Use of Wastewater Biosolids - South Carolina Guide on Land Application of Wastewater Sludge, 1996" shall be adhered. These restrictions pertain to use on food, feed, and forage crops and public access.
- I.** Site Selection

1. Sludge or effluent shall not be applied to soils with less than 20 inches (50 cm) of depth to bedrock or to other restricting layers.
2. Sludge or effluent shall not be applied to cropland with soils having a seasonal high water table within 3 feet of the surface. However, if the soil is artificially drained to lower the water table below 3 feet of the surface, application of sludge or effluent will be permissible. Sludge or effluent shall not be applied to woodland on soils having a seasonal high water table within 1.5 feet of the surface.
3. Sludge or effluent shall not be applied on slopes exceeding 8% on cropland or 10% on

pastureland unless the waste is incorporated, in which case application on slopes up to 12% is permissible.

M. NRCS assistance on plans for land application sewage or sludge typically is limited to Site Inventories and Evaluations. However, at the request of the receiving landowner/producers, NRCS field office personnel may develop management plans for land application of sewage or effluent. These plans must be submitted to the NRCS state conservation engineer for approval.

REFERENCES:

“Agricultural Waste Management Field Handbook”
USDA, SCS, April 1992

Barth, Clyde L., et.al. “Using Animal Manure as Fertilizer”,
Clemson University Circular 578, October 1997

“Beneficial Use of Waste Water Biosolids-South Carolina Guide on Land Application of Waste Sludge, SCDHEC, 1996”.

Camberato, James J. “Land Application of Animal Manure”
EC 673, Clemson University, Cooperative Extension Service, January 1993

Dickens, David, Personal Communication
Clemson University, Cooperative Extension Service, November 1995

“NPDES Permits”, Regulation 61-9, S. C. Department of Health and Environmental Control, April 1993

“Nutrient Management for S. C. - Based on Soil Test Results”,
EC 476, Clemson University Cooperative Extension Service, January 1998.

“Pollution Potential and Fertilizer Value of Three Animal Waste Lagoons in North Alabama”, SCS and TVA, March 1981. Wilkinson, S.R., Dr.

“Standards of the Use of Disposal of Sewage Sludge; Final Rules”,
40 CFR Part 257, February 19, 1993

TABLE 1. Production of Livestock Wastes

Animal	Amount *	Moisture
Dairy Cattle (continuous confinement)	15.3 T/Yr/1000 Lb. Live Weight <u>1/</u>	90%
Beef Cattle	11.3 T/Yr/1000 Lb. Live Weight <u>1/</u>	85%
Swine		
Feeders	12.5 T/Yr/1000 Lb. Live Weight <u>1/</u>	90%
Breeders	9.1 T/Yr/1000 Lb. Live Weight <u>1/</u>	90%
Poultry		
Caged Layers	35.8 T/Yr/1000 Bird Spaces <u>1/</u> <u>6/</u> *	75%
Caged Layers (pit storage)	17.9 T/Yr/1000 Bird Spaces <u>1/</u> <u>6/</u> *	50%
Broilers	6.1 T/Yr/1000 Bird Spaces <u>5/</u> <u>3/</u> *	25%
Breeders	14.8 T/Yr/1000 Bird Spaces <u>2/</u> <u>9/</u> *	25-30%
Pullets	4.0 T/Yr/1000 Bird spaces <u>7/</u> *	25-30%
Roasters	9.6 T/Yr/1000 Bird spaces <u>8/</u> *	25-30%
Turkeys		
Brooder & Growout Houses	30.0 T/Yr/1000 Bird spaces	25-30%
Brooder Houses	15.6 T/Yr/1000 Bird Spaces	25-30%
Growout Houses	40.0 T/Yr/1000 Bird Spaces	25-30%
Sheep	6.6 T/Yr/1000 Lb. Live Weight <u>1/</u>	75%
Horses	9.1 T/Yr/1000 Lb. Live Weight <u>1/</u>	65%

* To determine tons of waste at differing percent moisture the following formula should be used.

Tons of Waste to be applied: $\frac{\text{(Tons of initial waste) (\% solids initially)}}{\% \text{ Solids of applied waste}}$

1/ Chapter 4, Agricultural Waste Management Field Handbook 1992. (Fresh manure, removed daily).

2/ Land Area Guidelines for Livestock Waste Application, NCSU, 1980.

3/ Values for dry litter with shavings, 25-30% moisture; full production for year (5 flocks), 57 non-occupied days.

4/ Values for dry litter with shavings, 25-30% moisture, full production for one year (2.5 flocks), 25 non-occupied days.

5/ Values for dry litter with shavings; data collected for SC. (Same value for hens and roasters).

6/ With average weight of 3.7 lbs.

7/ Full production for 1 year (2 flocks). (Values for dry litter with shavings).

8/ Full production for 1 year (4 flocks). Feathered Facts. Clemson University, 1988. (Values for dry litter with shavings).

9/ Full production 1 year (1 flock).

* Bird space references occupied house capacity.

TABLE 2. Nitrogen Loss (volatilization) from Fresh Manure at Ground Surface 1/

Days Between Application and Incorporation	Percent N Lost		
	Warm, Dry Soil	Warm, Wet Soil	Cool, Wet Soil
1	30	10	0
4	40	20	5
7 or more	50	30	10

1/ These losses do not apply to dry litter

TABLE 3. Types of Wastes and Their Estimated Nutrient Content

Beef Cattle:

Types of Waste (As Applied)	Approximate Percent H ₂ O	Estimated Amount Available *					
		(From Application)					
		1st Year Rotational			Continuation Application		
		N - P ₂ O ₅ - K ₂ O			N - P ₂ O ₅ - K ₂ O		
BEEF CATTLE		Pounds Per Ton					
1. Fresh manure collected, applied and incorporated before drying.	86	9	5	8	9.6	5.8	9.0
2. Manure collected daily, stored in covered tank, no dilution or drying, applied semi-annually; incorporated before drying.	86	7	6	8	7.3	5.8	9.0
3. Bedded manure pack under roof, cleaned in spring, incorporated before drying (bedding = 7.5% by wt.)	80	5	5	7	5.7	6.0	8.1
4. Open lot storage, cleaned in spring, incorporated before drying; warm, humid climate (or stockpiled outside and applied and incorporated in 4-6 weeks).	70	6	9	14	6.7	10.0	16.5

* Data are from the Agricultural Waste Management Field Handbook, chapter 11, unless otherwise noted. Losses by volatilization, leaching, and denitrification have not been subtracted from these estimates. Crop nutrient needs recommendations as per "Lime and Fertilizer Recommendations for South Carolina" already consider losses to leaching and denitrification. However, for certain types of waste, adjustments are needed for volatilization (see 1.F).

Pounds of N, P₂O₅, or K₂O per ton can be estimated for moisture levels not given in Table 3 by using the following relationship: (lbs. of Nutrient = (lbs. of nutrient at listed moisture level) (% solids of applied waste) (% solids listed))

TABLE 3. Types of Wastes and Their Estimated Nutrient Content

Dairy Cattle:

Types of Waste (As Applied)	Approximate Percent H ₂ O	Estimated Amount Available *					
		(From Application)					
		1st Year Rotational			Continuation Application		
		N - P ₂ O ₅ - K ₂ O			N - P ₂ O ₅ - K ₂ O		
DAIRY CATTLE 1/							
Pounds Per Ton							
1. Fresh manure collected and applied daily, incorporated before drying.	89	7	3	5	9.3	3.8	5.2
2. Manure collected daily, 50 percent processing water added, stored in covered tank or pit, applied semi-annually incorporated before drying.	92	3	3	5	6	3.8	5.8
3. Manure collected daily in open storage pond, 30 percent processing water added, stored in open tank or pit, applied semi-annually, incorporated.	92	3.0	3.0	4.0	3.4	3.6	4.7
4. Open lot storage cleaned in spring and incorporated before drying.	35 70	13 6.0	19.5 9.0	30 14.0	26 12	24.3 11.2	35.3 16.4
5. Bedded manure, unroofed stacking facility (bedding is 10% of weight); spreading in spring before drying.	55 85	9 3.0	6 2.0	12.0 4.0	18 4.5	7.5 2.5	14.1 4.7
6. Manure, no bedding, stored outside; leach lost; spread in spring before drying.	87	3	2.5	4.0	3.5	2.9	4.7

* Data are from the Agricultural Waste Management Field Handbook, chapter 11, unless otherwise noted. Losses by volatilization, leaching, and denitrification have not been subtracted from these estimates. Crop nutrient needs recommendations as per "Lime and Fertilizer Recommendations for South Carolina" already consider losses to leaching and denitrification. However, for certain types of waste, adjustments are needed for volatilization (see 1.F)

1/ Approximately 75% and 25% of the nutrients are in the feces and urine respectively.

Pounds of N, P₂O₅, or K₂O per ton can be estimated for moisture levels not given in Table 3 by using the following relationship: $(\text{lbs. of Nutrient} = \frac{(\text{lbs. of nutrient at listed moisture level}) (\% \text{ of applied waste})}{(\% \text{ solids listed})})$

TABLE 3. Types of Wastes and Their Estimated Nutrient Content

Poultry:

Types of Waste (As Applied)	Approximate Percent H ₂ O	Estimated Amount Available *					
		(From Application)					
		1st Year Rotational			Continuation Application		
		N - P ₂ O ₅ - K ₂ O			N - P ₂ O ₅ - K ₂ O		
POULTRY (CHICKENS)		Pounds Per Ton					
1. Fresh layer manure collected and applied daily, incorporated.	75	27	21	15	27.6	24.4	17.2
2. Broiler manure in sawdust or shavings, cleaned every 4 to 12 months and incorporated.	25	36	35	30	37.4	36	31
3. Layer manure stored in a shallow pit, cleaned every 3 months and incorporated.	65	25	27	23	26	27	24
4. Layer manure, ventilated deep pit, yearly incorporated.	50	23	45	42	24	52	45
5. High-rise houses cleaned annually, no dilution, incorporated. 2/	25	38	56	30	43.5	53	48
6. Breeder Houses. 3/	25	37	45	30	40	45	40

*Data are from the Agricultural Waste Management Field Handbook, chapter 11, unless otherwise noted. Losses by volatilization, leaching, and denitrification have not been subtracted from these estimates. Crop nutrient needs recommendations as per “Lime and Fertilizer Recommendations for South Carolina” already consider losses to leaching and denitrification. However, for certain types of waste, adjustments are needed for volatilization (see 1.F)

2/ Estimated based on “Land Application of Animal Manure”, Clemson University, CES, January 1993.

3/ Approximately ½ of the waste (roost area) is manure only and ½ of the waste (range areas in aisles between rows of laying cages) is manure in sawdust or shavings.

Pounds of N, P₂O₅, or K₂O per ton can be estimated for moisture levels not given in Table 3 by using the following relationship: (lbs. of Nutrient = (lbs. of nutrient at listed moisture level) (% solids of applied waste) (% solids listed)

TABLE 3. Types of Wastes and Their Estimated Nutrient Content

Poultry (Turkey):

Types of Waste (As Applied)	Approximate Percent H ₂ O	Estimated Amount Available *					
		(From Application)					
		1st Year Rotational			Continuation Application		
		N - P ₂ O ₅ - K ₂ O			N - P ₂ O ₅ - K ₂ O		
POULTRY (TURKEY)		Pounds Per Ton					
1. Breeder houses with sawdust or shavings, cleaned after each flock (2 months), incorporated.	25	24	21	14	34	26	17
2. Grow out houses, with sawdust or shavings, cleaned annually, incorporated.	25	42	41	32	52	50	39
3. Grow out houses, with sawdust or shavings, cleaned annually, stacked and covered for no more than 3 months, incorporated.	25	29	39	26	36	47	32
4. Brooder house, with bedding cleaned annually incorporated.	25	34	39	25	42	47	30

* Data are from the Agricultural Waste Management Field Handbook, chapter 11, unless otherwise noted. Losses by volatilization, leaching, and denitrification have not been subtracted from these estimates. Crop nutrient needs recommendations as per "Lime and Fertilizer Recommendations for South Carolina" already consider losses to leaching and denitrification. However, for certain types of waste, adjustments are needed for volatilization (see 1.F).

Pounds of N, P₂O₅, or K₂O per ton can be estimated for moisture levels not given in Table 3 by using the following relationship: (lbs. of Nutrient = (lbs. of nutrient at listed moisture level) (% solids of applied waste) / (% solids listed))

TABLE 3. Types of Wastes and Their Estimated Nutrient Content

Swine:

Types of Waste (As Applied)	Approximate Percent H ₂ O	Estimated Amount Available *					
		(From Application)					
		1st Year Rotational			Continuation Application		
		N - P ₂ O ₅ - K ₂ O			N - P ₂ O ₅ - K ₂ O		
Pounds Per Ton							
SWINE							
1. Fresh manure collected and applied daily, no dilution or drying, incorporated before drying.	90	9	7	10	9.8	8.8	11.5
2. Manure collected in a covered storage tank, diluted 50 percent with water, and incorporated before drying.	93	4	6	6	4.5	6.0	6.9
3. Manure collected in a ventilated storage pit under a slotted floor, diluted 50 percent with water, applied at 3 to 6 month intervals and incorporated promptly.	95	2.5	3.0	5.0	2.7	3.6	5.8

* Data are from the Agricultural Waste Management Field Handbook, chapter 11, unless otherwise noted. Losses by volatilization, leaching, and denitrification have not been subtracted from these estimates. Crop nutrient needs recommendations as per "Lime and Fertilizer Recommendations for South Carolina" already consider losses to leaching and denitrification. However, for certain types of waste, adjustments are needed for volatilization (see 1.F).

Pounds of N, P₂O₅, or K₂O per ton can be estimated for moisture levels not given in Table 3 by using the following relationship: $(\text{lbs. of Nutrient} = \frac{(\text{lbs. of nutrient at listed moisture level}) (\% \text{ solids of applied waste})}{(\% \text{ solids listed})})$

TABLE 3. Types of Wastes and Their Estimated Nutrient Content

Liquid Systems :

TABLE 3. Types of Wastes and Their Estimated Nutrient Content				
Types of Waste (As Applied)	Approximate Percent H ₂ O	Estimated Amount Available *		
		(From Application)		
		1st Year Rotational	Continuation Application	
		N - P ₂ O ₅ - K ₂ O		
		Pounds Per Acre Inch		
WASTE TREATMENT LAGOONS 4/				
1. All Cattle		30-40-100	36-48-116	
2. Poultry and Turkey		56-60-110	70-72-127	
3. Swine		30-35-90	36-43-104	
WASTE STORAGE PONDS 4/				
1. All Cattle	97.5	56-85-140	70-102-160	
2. Dairy Cattle - Liquid Waste and Waste in open lot runoff only 5/	99	15-20-50	18-24-58	
	97.5	105-200-200	29-240-232	
3. Poultry and Turkey				
4. Swine	97.5	55-70-135	68-84-155	

* Data are from the Agricultural Waste Management Field Handbook, chapter 11, unless otherwise noted. Losses by volatilization, leaching, and denitrification have not been subtracted from these estimates. Crop nutrient needs recommendations as per "Lime and Fertilizer Recommendations for South Carolina" already consider losses to leaching and denitrification. However, for certain types of waste, adjustments are needed for volatilization (see 1.F).

4/ Estimates are based on analysis of waste treatment lagoons and waste treatment ponds respectively. Actual amounts of N, P₂O₅, and K₂O are quite variable depending on loading rate, time of year, and frequency of waste removal. Thus, these values should be used only in estimating total land needed for waste utilization. Actual amounts of waste to be applied should be based on an analysis of the waste or on previous experience with similarly managed waste.

5/ Estimates are representative of flushwater from scraped lots and other situations for which the amount of solids in the wastewater is only 1 % or less.

Pounds of N, P2O5, or K2O per acre inch can be estimated for moisture levels not given in Table 3 by using the following

relationship: (lbs. of Nutrient = $\frac{\text{lbs. of nutrient at listed moisture level} \times (\% \text{ solids of applied waste})}{(\% \text{ solids listed})}$)

TABLE 4. Plant Available N for Biosolids

TABLE 4 PLANT AVAILABLE N FOR BIOSOLIDS	
Wastewater Biosolids Treatment Process	% ORG-N Mineralized
Unstabilized primary & waste-activated	40
Alkaline-stabilized	30
Aerobically digested	30
Anaerobically digested	20
Composted	10