

Comprehensive Nutrient Management Planning *A 12 Step Guide*

Getting More From Animal Manure and Fertilizer



**While Protecting
Water Quality**

Why Manage Nutrients?

Utah farmers and livestock producers are responsible for producing a safe and abundant food supply. They also take pride in being good stewards of land, air, and water resources. In Utah, livestock populations are increasing and concentrating in certain parts of the State. This concentration poses potential problems for environmentally-sound manure management. Runoff from farm fields and feedlots can contaminate ground and surface waters with nitrogen, phosphorus, bacteria, and sediment. Many of Utah's water sources are used for human consumption, recreation, and fisheries, as well as irrigation. Improper handling and use of manure and inorganic fertilizer can impair the quality of these waters and cause human health problems.

The recent development of the joint USDA and EPA *Unified National Strategy for Animal Feeding Operations* calls for large and small livestock producers to address water quality problems, if present, and to improve nutrient management and record-keeping practices. Producers can be proactive and avoid the possibility of regulatory action, fines, and permitting by voluntarily addressing water quality problems.



Where to go for further assistance

The following state and federal agencies, as well as private consultants and industry groups, can help producers address water quality problems and develop nutrient management plans:

- Utah State University Cooperative Extension
- USDA Natural Resources Conservation Service
- Utah Farm Bureau Federation
- Local Soil Conservation Districts
- Utah Department of Agriculture and Food
- Livestock commodity groups

See the government or white pages in your local phone directory for contact information.

This booklet describes successful farm nutrient management practices, and is meant to assist farmers and livestock producers in developing a comprehensive nutrient management plan (CNMP) – the cornerstone of the USDA and EPA *Unified National Strategy for Animal Feeding Operations*. For more information on the USDA and EPA Strategy see the Internet site: <http://www.epa.gov/owm/finafost.htm>. Other helpful Internet site addresses are referenced throughout this document.



Comprehensive Nutrient Management Planning

The benefits of manure have long been recognized. However, many farmers may not know the nutrient content of manure produced on their farm, how much is being applied to each field, and whether the application is meeting or exceeding crop nutrient needs. The objective of nutrient management planning is to use both manures and inorganic fertilizers to maximize economic benefits and minimize impacts on the environment.

Comprehensive nutrient management planning addresses all aspects of manure production, collection, storage, and land application, as well as land management practices, record keeping, and other manure utilization options. Managing nutrients efficiently involves developing and maintaining a written comprehensive nutrient management plan (CNMP). According to the *Unified National Strategy for Animal Feeding Operations*, all facilities with more than 1000 animal units are required to develop and implement a CNMP. Facilities with less than 1000 animal units but with unacceptable environmental conditions can avoid being permitted by developing and implementing a CNMP. Smaller facilities with no environmental concerns are strongly encouraged to develop and implement a CNMP.

Comprehensive Nutrient Management Planning and the Three E's

CNMPs incorporate the three E's of stewardship: Economics, Efficiency and Environment.

Economics

The majority of Utah farmers raise some type of livestock. More than 13 million tons of manure are produced by livestock in Utah each year.¹ The N-P-K fertilizer value of this resource exceeds \$60 million.¹

Farmers can test manure to determine its nutrient content. Using manure and soil tests together when developing a nutrient management plan can reduce the need for commercial fertilizers.

¹ Source: Utah Agricultural Statistics and USDA-NRCS.



Efficiency

While it may be convenient to apply manure during the winter or on fields near the barn, this is often not an efficient use of nutrients contained in manure. Efficiency means applying manure at the proper rate, time, and in the proper location so that nutrients can be utilized for optimum crop yields.

Environment

Manure is a valuable resource. It benefits plant growth by improving soil structure and fertility. However, if manure is handled improperly water pollution may result. Responsible farmers who manage manure appropriately gain maximum benefits while protecting the environment.

This guide describes how nutrient management practices can be integrated into an economical, efficient and environmentally-sound CNMP.

As with any farm management program, developing a CNMP requires planning. Planning will help ensure that nutrients and money are not wasted and that ground and surface waters are protected. Below is a summary of the steps involved in comprehensive nutrient management planning.



12 Steps to Comprehensive Nutrient Management Planning

1. Assess your operation and identify potential water quality problems.
2. Evaluate storage requirements for critical periods.
3. Estimate the land base required to utilize manure from the animals you raise.
4. Test soil and manure.
5. Determine manure application rates based on nitrogen or phosphorus, and supplemental fertilizer needs as appropriate.
6. Determine how and when to apply manure.
7. Calibrate application equipment.
8. Incorporate land management practices to reduce leaching and runoff.
9. Consider other options for using manure.
10. Identify options for handling livestock mortalities.
11. Manage feeds to reduce nutrient excretion.
12. Review and update the plan.



Step 1. Assess your operation.

The first and perhaps most important step in nutrient management planning is to assess your operation and current manure management practices. Throughout the year are there any farm practices that result in discharges to surface or ground water sources? Some of these practices may be obvious while others may not. When assessing the operation be honest. Keep in mind that, according to federal law, no manure or contaminated wastewater can be discharged into any surface water sources, including ditches, that leave an operators property. Similarly, according to Utah State law contaminants cannot be discharged into ground waters such as through a leaking pond or lagoon liner. There is no minimum volume required for a release to be considered a discharge. All manure and contaminated wastewater from livestock facilities, manure storage sites, and land application areas must be contained.

When assessing your operation consider where manure, wastewater, and field runoff goes during the year. Rainwater that comes into contact with manure on a feedlot and then runs into an irrigation ditch may not appear to cause any problems. However, if the ditch leaves the owner's property or connects to any natural stream this could be considered a discharge. Similarly, storing contaminated wastewater in a structure without a proper lining to limit leaching is against the law. Even manure applied on fields can lead to a discharge if rainfall, snow melt, or irrigation tail water leaves the site and enters a surface water body.

Several resources are available to help farmers assess their operations. The Farm*A*Syst program includes a series of farm assessment guides and worksheets which lead individuals through a structured evaluation of farm activities and practices. The assessment provides a separate risk rating for individual activities. Recommendations are provided to improve the situation if the risk rating for any activity is high. These as well as other materials on farm assessment and nutrient management are available through your local Utah State University Extension or USDA-NRCS office, and on the Internet at: <http://extension.usu.edu>, <http://extension.usu.edu/coop/natres/wq/index.htm>, and <http://www.ut.nrcs.usda.gov>

It may be helpful to have an outside, nonregulatory assessment of your operation. Someone unfamiliar with the day-to-day activities of a facility may be able to identify problems not apparent to the owner or manager. Consider organizing an assessment team made up of local producers with similar interests. Have the team assess each member's facility and discuss recommendations for improvements. Contact local employees of the Soil Conservation District, USDA-NRCS, Utah State University Extension, the Utah Farm Bureau Federation or the appropriate commodity group to obtain additional information on assessing livestock operations.

Step 2. Evaluate storage requirements for critical periods.



Estimating the volume of manure and wastewater produced is important to determine if storage facilities are adequate for critical periods. The critical storage period is the number of continuous days manure and wastewater cannot be land applied or otherwise used. This may occur during winter or during the growing season when applications cannot be made to crops. In Utah, the critical winter storage period may range from 45 to 150 days depending on location (see Table 1) and manure handling/treatment system. Storage requirements for wastewater may be longer than for solids depending on the type of wastewater application system. Contact your local NRCS office for assistance in estimating the number of days of storage needed for your area and situation.

Table 1. Approximate number of days of winter storage for various Utah locations and climate conditions.

Number of Days of Storage	Location or Winter Climate Conditions Similar to
150	Randolph, Tabiona
120	Manti, Logan, Heber, Roosevelt
90	Cedar City, Delta, Ogden
45	Kanab

Manure production estimates for various livestock types are presented in Table 2. Use Worksheet 1 to estimate the total cubic feet (ft³) of manure produced by livestock during the critical storage period. Wastewater production estimates include process water from milk houses and other handling facilities as well as lot runoff water coming into contact with manure. Also estimate the volume of wastewater produced during the critical storage period using Worksheet 2.

Table 2. Livestock type and daily manure volume production.

Livestock type	ft ³ /day/1000 lb of animal
Dairy, milking/dry	1.3
Dairy, heifer	1.3
Beef feeder	0.9
Beef cow	1.0
Swine, sow/grower	1.0
Poultry, layer*	0.3
Turkey**	0.3
Sheep	0.6
Horse	0.8

*high-rise facility

**includes litter

Worksheet 1. (A) Enter the number of animals for each type/class, the average animal weight, and the length of time manure must be stored on Worksheet 1. Obtain the appropriate manure production estimates from Table 2 and calculate the total volume of manure produced by each livestock type/class. Repeat the procedure for each livestock group and add the results together to determine the total volume produced for the storage period.

Measured or estimated manure and wastewater production?

Estimates of manure and wastewater production are never as accurate as measured values. Use Worksheets 1 and 2 to generate initial manure and wastewater volume estimates. Refine these estimates with measurements of actual manure and wastewater volumes produced. Also, monitor storage volumes over time to verify the adequacy of storage for the length of time and volumes of manure and wastewater produced.

(B) Calculate the volume of manure storage currently available. Compare the cubic feet (ft³) of manure produced to the volume of storage available. *Is the solid manure storage volume adequate for the critical period?* If not, additional storage or alternative manure handling practices may be needed.

Critical storage period (dates) from _____ to _____ = _____ days

(A) Manure produced (ft³)

Livestock type/class _____:	Number	×	Avg. weight	÷	1000	×	Days of storage	×	Table 2 Production	=	Total
1. _____:	_____	×	_____	÷	1000	×	_____	×	_____	=	_____
2. _____:	_____	×	_____	÷	1000	×	_____	×	_____	=	_____
3. _____:	_____	×	_____	÷	1000	×	_____	×	_____	=	_____
4. _____:	_____	×	_____	÷	1000	×	_____	×	_____	=	_____
Total ft³ of manure produced (add lines 1-4):											_____

(B) Current storage capacity (ft³):

Structure ID _____:	Length (ft)	×	Width (ft)	×	Height (ft)*	=	Total ft ³
1. _____:	_____	×	_____	×	_____	=	_____
2. _____:	_____	×	_____	×	_____	=	_____
3. _____:	_____	×	_____	×	_____	=	_____
Total ft³ of storage (add lines 1-3):							_____

*subtract 1 foot of freeboard space from structure height.

Worksheet 1. (A) Manure volume production estimate for the designated storage period; (B) existing manure storage volume.

Worksheet 2. (A) Enter the number of gallons of wastewater produced per animal per day and the length of time wastewater must be stored on Worksheet 2. The number of gallons produced may be determined from water bills or through actual measurements of water use. Also calculate the number of gallons of contaminated lot runoff expected during the storage period. Determine lot runoff by estimating the amount of effective precipitation (in inches) received during the critical storage period and multiplying by the lot area (length × width). Note that facilities must be able to contain lot runoff up to and including a 25 year, 24 hour storm event. Therefore, the liquid storage structure must be able to contain runoff from this storm. For normal and 25 year, 24 hour storm precipitation data see the Internet web pages: <http://www.wrcc.dri.edu/pcpnfreq/> and <http://www.wrcc.dri.edu/climsum.html> or contact the NRCS. Add the results together to estimate the total volume of wastewater and runoff produced during the storage period.

(B) Calculate the volume of wastewater storage available. Compare the volume of wastewater produced to the available storage volume. *Is the wastewater storage volume adequate for the critical period?* If not, additional storage or alternative handling practices may be needed.

Critical storage period (dates) from _____ to _____ = _____ days.			
(A) Wastewater and runoff produced (gallons)			
<u>Number of animals</u> × <u>gallons/animal/day</u> × <u># days of storage</u> = <u>Total gallons</u>			
1. _____ × _____ × _____ = _____			
<u>Rainfall depth (in)*</u> ÷ <u>12</u> × <u>lot area (sq ft)</u> × <u>6.0</u> = <u>Total gallons</u>			
2. _____ ÷ <u>12</u> × _____ × <u>6.0</u> = _____			
3. _____ ÷ <u>12</u> × _____ × <u>6.0</u> = _____			
Total gallons of wastewater and runoff produced (add lines 1-3):			_____ gallons
*for line 2 use the rainfall received during the storage period; for line 3 use the 25 year, 24 hour rainfall depth.			
(B) Current wastewater storage capacity (gallons)			
1. Structure _____: length (ft) _____ × width (ft) _____ × height (ft)* _____ × 7.5 = _____ gallons			
2. Structure _____: length (ft) _____ × width (ft) _____ × height (ft)* _____ × 7.5 = _____ gallons			
Total gallons of wastewater and runoff storage (add lines 1 and 2):			_____ gallons
*subtract 1 foot of freeboard space from the structure height.			

Worksheet 2. (A) Wastewater and lot runoff production estimate for the designated storage period; (B) existing wastewater storage volume.



Step 3. Estimate the land base required to utilize manure.

The land base requirement is an estimate of the number of acres needed to fully utilize the nutrients produced in manure

over the crop rotation. Most manure, if applied according to crop needs for nitrogen (N), will oversupply crop needs for phosphorus (P_2O_5). Land base requirements in Utah are made on the basis of phosphorus needs for alfalfa. This generally represents the total number of acres needed to balance phosphorus needs over the entire crop rotation. In any given year, the number of acres that manure is actually applied to will be less than the land base requirement. Records should be kept to determine the number of acres manure is applied to on an annual basis, and the exact land base requirement for the farm.

Land base requirements are based on crop yield and can be refined by accounting for nutrient transformations such as mineralization, or for composting or offsite transport. Table 3 land base requirements are based on manure production estimates for various livestock types and mineralization rates for phosphorus with no composting or offsite transport. Use the information in Table 3 for general planning purposes. For further information on how composting or offsite transport may influence land base requirements contact NRCS or Utah State University Extension.

Table 3. Approximate number of acres needed to fully utilize the phosphorus in manure from 100 animals on alfalfa with a yield of 4, 6, or 8 tons/acre.

Livestock type	Alfalfa yield (tons/acre)		
	4	6	8
Dairy, milking/dry (1400 lb)	138*	92	69
Dairy, heifer (800-1000 lb)	50	33	25
Beef cow (1000 lb)	166	111	83
Beef feeder (500-800 lb)	92	61	46
Beef or dairy calf (200-400 lb)	42	28	21
Swine, sow	63	43	31
Swine, grower (150 lb ave.)	34	23	17
Poultry, layer	1.4	0.95	0.7
Turkey	6.8	4.6	3.4
Sheep	12.2	8.2	6.2
Horse	136	91	68

*Divide by 100 to estimate the number of acres required per animal.

Step 4. Test soil and manure.



Soil testing is essential to determine the current nutrient status of soil and how much supplemental nitrogen, phosphorus, and other nutrients are needed to meet crop needs. Soils should be tested annually when manure applications are made based on the nitrogen needs of crops, and at least once every three years when manure applications are made based on phosphorus. Soil testing generally costs less than \$1.00 per acre and can save many times this amount by reducing fertilizer costs or improving crop yields.

For nitrogen-based applications, collect separate soil samples at depths of 0 to 12 and 12 to 24 inches. For phosphorus-based applications collect soil samples at a depth of 0 to 12 inches. A soil probe is the most efficient way to collect samples. Probes are available on loan from County Extension Agents. Collect a composite sample by combining a minimum of 8-10 samples taken randomly throughout a field in a plastic bucket. Mix the samples and send at least one pint to the lab for analysis. More than one composite may be needed for large or highly variable fields.

Manure testing is necessary to accurately determine manure nutrient content. Since manure is a variable material, proper procedures must be followed to ensure a representative sample is collected. For liquids, sample directly from the storage structure, from the outlet pipe where liquid is removed, or from the field using catch cans to collect samples applied through sprinklers. When sampling liquids, collect a minimum of six separate subsamples. Combine the subsamples in a clean bucket, mix well, and transfer approximately one pint of liquid to a clean bottle or other rigid container.

For solids, remove the surface six inch crust and use an auger or shovel to core into the pile.

Manure samples or book values?

Recent research shows that western manure moisture and nitrogen contents are lower, and phosphorus contents higher, than book values. Whenever possible use recent manure sample data instead of book values to calculate manure application rates.

Take a minimum of six separate subsamples from around the pile and combine them in a clean bucket. Mix well and transfer approximately one quart to a clean plastic bag. Keep all samples cool until they can be transported to a lab. The Utah State University Analytical Laboratory analyzes soil and manure samples. Contact your local County Extension Agent for information and sample submission forms, or see the Internet site: <http://www.tal.agsci.usu.edu/~tal/Soil.Science/usual>

Step 5. Determine manure application rates.



Calculating the correct rate of manure to apply is important to prevent the buildup of excess nitrogen or phosphorus in soil and the contamination of ground and surface waters. Various methods can be used to calculate manure application rates. Worksheet 3 on page 12 describes one method for calculating application rates of manure based on nitrogen or phosphorus.

Using Worksheet 3

Reproduce several copies of this worksheet. Complete one worksheet per field each year manure is applied. Keep completed worksheets as a record of the manure applied to each field.

If soil test phosphorus levels are below 50 parts per million (ppm) calculate manure application rates based on nitrogen (N) or phosphorus (P_2O_5) recommendations, or N or P_2O_5 removal by the crop. Between 50 and 100 ppm soil test phosphorus, calculate application rates based on crop P_2O_5 removal. No further applications of manure are recommended when soil test phosphorus levels are above 100 ppm.

1. *Nutrients needed* are based on the crop to be grown and yield. Refer to soil test reports, fertilizer guides, or local Cooperative Extension or NRCS office for this information.
2. *Nutrients from other sources (credits)* may include residual nitrate-N from soil tests, supplemental fertilizers, N in irrigation water, previous legume crop credits, or nutrients from previous manure applications.
3. *Additional nutrients needed* is the amount of N or P_2O_5 to be supplied by manure.
4. *Total N and P_2O_5 in manure* (on a fresh weight or as-sampled basis) is based on a recent manure analysis or book estimate for your manure type. If you do not have a recent manure test contact your local Extension or NRCS office for more information.
5. Nutrients, particularly nitrogen, are released over time as manure decomposes in soil. The *nutrient availability factor* is the fraction of total N or P_2O_5 in manure available in the year of application. See Table 4 and Worksheet 3 for more information.
6. *Available nutrients in manure* is the amount of N or P_2O_5 available for plant use in the year of manure application.
7. *Manure Application Rate* is the rate of manure to apply to meet crop nutrient needs.

For planning it may be helpful to have an aerial photograph of your farm. Aerial photos can be obtained from your local NRCS office or through the Internet at: <http://teraserver.microsoft.com>.

Manure Application Rate/Record Keeping Worksheet

Field and soil information

Date: _____

Field number or description: _____	Number of acres: _____
Crop: _____	Yield goal: _____
Soil test nitrate-N: _____ lb N/acre or _____ ppm	Soil test phosphorus: _____ ppm
Crop nitrogen (N) recommendation or removal: _____ lb N/acre	
Crop phosphorus (P ₂ O ₅) recommendation or removal: _____ lb P ₂ O ₅ /acre	
Date of application: _____	Field condition/notes: _____

Manure information

Manure form: Solid Slurry Liquid

Manure N content: _____ lb/ton lb/1000 gallons lb/acre-inch

Manure P₂O₅ content: _____ lb/ton lb/1000 gallons lb/acre-inch

Method of application: Broadcast Broadcast-incorporation Injection

	<u>N-based</u>	<u>P₂O₅-based</u>
1. Nutrients needed (lb/acre) (soil test recommendation or crop removal):	_____	_____
2. Nutrients from other sources (credits) (lb/acre):	_____	_____
3. Additional nutrients needed (lb/acre) (subtract line 2 from line 1):	=====	=====
4. Total N and P ₂ O ₅ in manure (lb/ton, lb/1000 gal, or lb/acre-inch) (from manure test):	_____	_____
5. Nutrient availability factor (for N-based see page 13, Table 4; for P ₂ O ₅ -based use 1.0):	_____	_____
6. Available nutrients in manure (lb/ton, lb/1000 gal, or lb/acre-inch) (multiply line 4 by line 5):	_____	_____
7. Manure application rate (tons/acre, 1000 gal/acre or acre-inch/acre) (divide line 3 by line 6):	=====*	=====

*note: this column assumes manure will be incorporated immediately. If manure will be incorporated more than 4 days after application, multiply the N-based rate on line 7 by 1.4.

Worksheet 3. Manure application rate and record keeping worksheet.

Supplemental N Needed

When soil test phosphorus (STP) levels are between 50 and 100 ppm and manure is applied on the basis of P₂O₅ removal by crops like small grains, corn, or grass hay and pasture, the amount of nitrogen supplied by manure is less than that required by the crop. In these situations, supplemental applications of inorganic nitrogen (N) fertilizer may be required for optimum yields. Worksheet 4 calculates the rate of supplemental N needed when manure applications are made based on crop P₂O₅ removal. Complete Worksheet 4 and attach it to the appropriate copy of Worksheet 3. Apply additional fertilizer nitrogen in the spring just before the seeding of annuals, or before the initiation of growth of perennial grasses.

Table 4. Estimated fraction of total nitrogen in manure available in the year of application. These values are estimates and may change with site conditions. Contact your local NRCS or County Extension agent for more information.

Manure type	Fraction of Total N Available*
Poultry	0.75
Dairy	0.55
Swine	0.55
Beef	0.50
Horse	0.40
Compost	0.50
Liquids	0.50

*assumes manure is incorporated within 4 days. If manure is not incorporated within 4 days additional losses of nitrogen in the form of ammonia will occur. See page 12, bottom of Worksheet 3 for more details.

Field number or description: _____ **Crop:** _____ **Year:** _____

1. Nitrogen (N) recommendation: _____ lb/acre

2. Manure application rate (tons/acre, 1000 gal/ac, or acre-inch/acre) (from Worksheet 3, line 7): _____

3. Total N in manure (lb/ton, lb/1000 gallons, or lb/acre-inch) (from manure test): _____

4. Total N applied in manure (multiply line 2 by line 3): _____ lb/acre

5. Nitrogen availability factor (see Table 4): _____

6. Available N from manure (multiply line 4 by line 5): _____ lb/acre

7. Supplemental N needed (subtract line 6 from line 1): _____ **lb/acre**

Worksheet 4. Supplemental nitrogen (N) needed when manure is applied on the basis of crop phosphorus (P₂O₅) removal.

Step 6. Determine how and when to apply manure.



The main factor governing the type of manure application method is moisture content (Table 5). Select an application

method based on the manure storage system and moisture content of manure produced. Water is heavy and expensive to haul. Therefore, hauling semi-solid and slurry forms of manure long distances is not desirable. Some form of solid-liquid separation may be advantageous to allow

solids to be transported and applied with a box spreader while liquids are applied through an irrigation system or water is evaporated.

Table 5. Manure forms and application method.

Manure form	% Moisture	Method
Solid	less than 80	Box spreaders
Semi-solid	75-90	Flail spreaders
Slurries	88-98	Tank wagons
Liquid	93-99	Big guns or gated pipe
Ponds/lagoon	96-99	Sprinklers*, big guns, gated pipe

*may require screening or chopping.

Most manure applications are made in Spring before planting, or Fall after harvest. Wastewater applications can be made during the cropping season through an irrigation system. Winter applications of manure should not be made unless measures are taken to ensure no field runoff occurs.

The NRCS has developed a manure application risk index which should be used to identify field and cropping conditions when winter applications of manure on frozen and/or snow-covered ground are low risk. Regardless of when manure is applied, additional land management measures may be needed to ensure manure and runoff water do not leave a site after spreading. See Step 8 (page 16) for more details.

The NRCS has developed a manure

Winter Application of Manure

Producers should be aware that the practice of applying manure on frozen or snow-covered ground (during winter) is coming under increased scrutiny. Many Eastern U.S. states have already banned this practice. It is the responsibility of the producer to ensure that all field runoff is contained when manure is applied during winter. Winter applications should not be made on fields near any surface water source, including ditches that may carry runoff water to a stream or other water body.

Step 7. Calibrate application equipment.



Equipment calibration is necessary to ensure manure and wastewater applications are made at desired rates.

Solid and slurry spreaders

Spreaders discharge at varying rates depending on ground and PTO speeds, equipment settings, and manure moisture content. To calibrate solid manure spreaders, first load and weigh the contents of the spreader. An alternative method is to weigh a 5 gallon bucket of manure and take the weight $\times 1.5 \times \text{length} \times \text{width} \times \text{height} \div 2000$ to estimate tons per load. To calibrate liquid/slurry spreaders, first determine the volume of material in gallons from manufacturer specifications, or by taking the length $\times \text{width} \times \text{height}$ of the spreader $\times 7.5$. For the volume in cylindrical tanks multiply length $\times \text{diameter} \times \text{diameter} \times 0.8 \times 7.5$.

Complete Worksheet 5 by estimating the distance in feet required to spread the entire load. Distance can be measured or estimated based on known field length or by counting fence posts along the length of the spread and multiplying by the average distance between posts. Also estimate the width of spread in feet, allowing for a 10-20% pass overlap to ensure uniform coverage. Multiply the length by the width and divide by 43,560 to convert to acres.

Divide the weight or volume of manure in the spreader by the area covered to determine the application rate at this setting. If necessary re-adjust settings and calibrate for different rates.

Sprinkler systems

Design specifications for the sprinkler system may be used to estimate liquid application rates. An alternative method is to place straight-sided catch cans at various locations under the sprinkler system. Measure the depth of liquid in inches accumulated in the cans over a period of time (e.g., 1 hour). Calculate the average depth of liquid in the cans and divide by the time interval to determine application rates in inches per hour.

Spreader: _____	Date: _____
1. Load weight (tons) or volume (gallons)	_____
2. Distance traveled to spread one load (ft)	_____
3. Width of spread (ft)	_____
4. Area of spread (ft ²) (multiply line 2 by line 3)	===== sq ft
5. Acres covered (divide line 4 by 43,560)	===== acre
6. Application rate (tons/acre or gal/acre) (divide line 1 by line 5)	=====
Notes on settings:	

Worksheet 5. Spreader calibration worksheet.

Step 8. Incorporate land management practices to reduce leaching and runoff.



Minimizing surface runoff and leaching reduces the likelihood that contaminated water from fields will enter a surface or ground water source. Many land management practices have been proven to reduce leaching and runoff. These practices are referred to as Best Management Practices (BMPs). The following list of BMPs should be adopted on sites where the risk of contaminating surface or ground water is high.

General BMPs

- Identify fields at high risk for leaching and/or runoff and don't apply manure there or apply at lower rates, and don't apply manure to these fields during winter.
- Consider grazing as an alternative to confinement to reduce the need for manure storage, handling, and spreading.
- Regularly sample manure and soils and calculate manure application rates based on realistic crop yields and procedures described in this publication.
- Reduce commercial fertilizer rates accordingly when manure is used as a nutrient source.
- Document all land management practices used to prevent surface runoff and leaching. Both photos and written documentation demonstrate awareness and implementation of BMPs.

Specific BMPs to reduce leaching

- Irrigation water management. Maintain irrigation systems and practice good water management during the growing season, especially on coarse textured soils.
- Don't apply manure, or apply manure at reduced rates (e.g., based on phosphorus), on fields with shallow water tables, coarse-textured soils, or other soil limitations.

Specific BMPs to reduce runoff

- Berm fields adjacent to surface water sources to contain runoff.
- Use application setbacks and/or vegetated filter strips where manure is applied to fields adjacent to a surface water source.
- Don't apply manure, or apply manure at reduced rates (e.g., based on phosphorus), to steeply sloped fields and/or fields near surface water sources.
- Apply manure to fields with as much vegetative or crop residue cover as possible, or incorporate manure immediately following application.

Step 9. Consider other options for using manure.



Some livestock operations may find that they do not have a sufficient land base to utilize all of the manure produced on the farm. Urban encroachment, increasing livestock numbers, or excessive phosphorus loading may necessitate the development of other options for using manure. If the land base is not adequate for the manure generated consider the following options and incorporate them into the CNMP as necessary.

Composting is one option for treating manure and converting it into a higher value product. Composted manure can be sold in urban markets, used for livestock bedding, and may be used as a feed source or supplement for some livestock. Equipment requirements, facility location, increased labor costs, and odors may limit the feasibility of composting. For more information about composting contact your local County Extension Agent or NRCS office, or Compost Education Resources for Western Agriculture on the Internet at:

<http://www2.aste.usu.edu/compost/>

Agreements with nearby landowners to use manure can reduce on-farm acreage requirements for manure spreading. If manure is being sold or given away, provide a recent manure test report to the recipient. Also, require that landowners receiving manure apply it according to proper guidelines such as those found in this publication. The amount of liability retained by the livestock owner when manure is sold or given away is a gray area. Therefore, document how much manure is sold or given away each year, to whom, and what information and instructions are provided with the manure. In addition, periodically check with landowners receiving manure to ensure it is being used properly.

Other, experimental options such as **power generation** and **aquatic plant or fish production** may, in the future, become available for using manure. Altering the **manure treatment** system may also reduce both the quantity and nutrient content of manure, thereby reducing the land base requirement.

Contact your local Utah State University Cooperative Extension or NRCS office for more information about options for using manure.

Step 10. Identify options for handling mortalities.



Between 1 and 5% of animals die on Utah farms each year. These mortalities must be disposed of in a manner acceptable to the producer and according to local, state, and federal regulations. Where available and economical, **rendering** is often the method of choice. On site **burial** was once a common method for mortality disposal and may still be acceptable if mortalities are buried at the proper depth in soils where a water table or other limitations do not exist. **Landfills** may also accept mortalities. **Incineration** is used by larger operations, particularly for smaller animals. Finally, **composting** is a relatively new option for mortality disposal. Check with local county and city officials for guidelines or regulations regarding burial, landfilling, incineration, or composting of mortalities. A fact sheet describing cow mortality disposal is available from County Extension offices, or at <http://extension.usu.edu/publica/index.htm> (publication #AG-507).

Step 11. Manage feeds to reduce nutrient excretion.



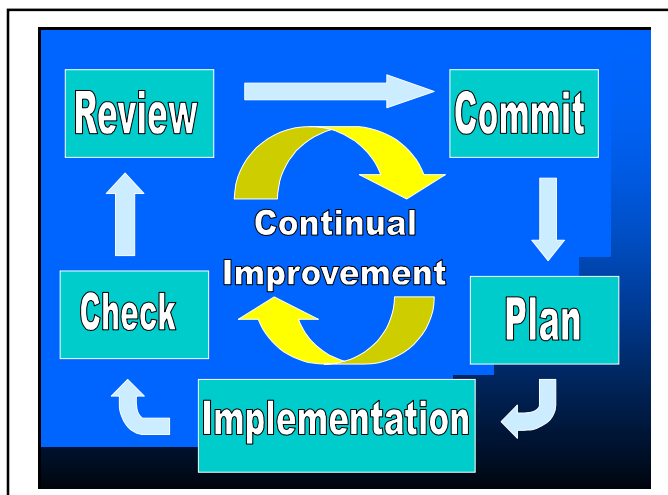
Recent advances in feed formulation, supplementation, and livestock monitoring indicate that feed management can be used to reduce nutrient excretion without affecting animal performance. For example, the milk urea nitrogen test can be used to determine whether dairy cows are being overfed protein in the ration. Recent evidence also suggests that many animals are fed more phosphorus than needed for optimum performance. Phosphorus monitoring in crops and supplements can lead to better dietary phosphorus balancing and reduced phosphorus excretion in the manure. Phytase, an enzyme supplement added to the feed of swine and poultry, enhances phosphorus absorption in the digestive track, thereby reducing phosphorus feeding requirements and excretion in manure. Feed management to reduce nutrient excretion is an emerging field and will likely become a more important management tool in the near future. Contact livestock nutritionists or performance monitoring programs such as the Dairy Herd Improvement Association (DHIA) for more information on feed management to reduce nutrient excretion.

Step 12. Review and update the plan.

Developing a comprehensive nutrient management plan (CNMP) is not a one-time process, nor should the CNMP exist and operate separately from the overall farm management plan. As part of the farm management plan, the CNMP must be regularly reviewed and updated as conditions change.

The Agriculture Environmental Management System (AEMS) model describes a cycle of

continuous improvement through regular plan review, updating, implementation, and monitoring. This model is used extensively by manufacturing industries, but is adaptable to the livestock industry. Adaptation of the AEMS model can help facility owners and managers continuously improve environmental conditions, productivity, and profits. For more information about AEMS see the Internet at: <http://extension.usu.edu/aems/>



The Agriculture Environmental Management System (AEMS) model.

Here are some final suggestions for developing and implementing a CNMP:

- **Commit** to the planning process. Set aside a large block of time (40 hours or more) to initially develop a CNMP. Winter or other slack times may work well with fewer interruptions.
- Develop the **Plan**. Purchase a large (4-inch spine) 3-ring binder and tab system to organize the CNMP. A 12 tab system works well, using one tab divider for each part of the CNMP.
- **Implement** the plan. Refer to the plan regularly as the appropriate farm activities are conducted. Document activities, quantities, yields, soil test information, etc., and file all documentation in the appropriate place in the plan binder.
- **Check** the plan and organize documentation frequently.
- **Review** the CNMP at the end of the year and make necessary modifications in preparation for next year. Set new goals during the review. Also, at this time transfer any older documentation to an archive file such as a metal cabinet for long term storage.
- Include photographs where necessary to document improvements made over time.

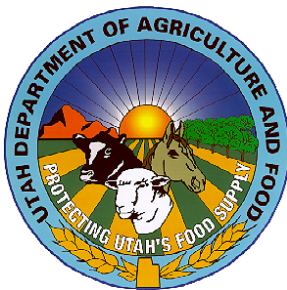
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