Nutrient Management Planning for Livestock Producers

A 10-Step Guide

Getting More From Animal Manure and Fertilizer While Protecting Water Quality

UtahStateUniversity
COOPERATIVE EXTENSION

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. Current production practices encourage greater concentrations of livestock. 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.

To address some of the issues posed by large, concentrated, operations, the Environmental Protection Agency (EPA) and the United States Department of Agriculture (USDA) adopted the Unified National Strategy for Animal Feeding Operations in 1999. This strategy is based on a national performance expectation that all animal feeding operations (AFOs) develop site-specific nutrient management plans (NMPs). It calls for large and small livestock producers to address water quality problems, if present, and to improve nutrient management and record-keeping practices. Additional regulations were implemented with the Concentrated Animal Feeding Operation (CAFO) Rule in 2003, and modified in 2008 and 2012. Producers can be proactive and avoid the possibility of fines and regulatory action by voluntarily addressing water quality problems. This booklet describes successful farm nutrient management practices, and is meant to assist farmers and livestock producers in developing a nutrient management plan (NMP).

History of AFO Regulations

1999 Unified National Strategy for Animal Feeding Operations (AFOs)
- Outlined the national strategy for cleaning up environmental issues from AFOs.

2003 Final CAFO Rule
- Implemented rules requiring all CAFOs to have NMPs and NPDES permits.

2008 Final CAFO Rule
- Removed the requirement that all CAFOs need NPDES permits. Requires public notice for all NMPs for CAFOs.

2012 Revision of CAFO Rule
- CAFOs can not be required to obtain a CAFO permit until after having a discharge.

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.

For more information on the USDA and EPA Strategy see the Internet site:
http://cfpub.epa.gov/npdes/afo/aforule.cfm
Or go to the Producer's website at http://agwastemanagement.usu.edu.

Nutrient Management Planning

The benefits of manure have long been recognized. However, as livestock operations become more concentrated, manure management has become more difficult. Not fully valuing the nutrients in manure and high transportation costs can result in nutrient applications that exceed crop needs. The objective of nutrient management planning is to manage both manures and inorganic fertilizers to maximize economic benefits and minimize any impacts on the environment.

What is an Animal Unit?

One animal unit (A.U.) is generally defined as 1,000 pounds of live animal weight.

EPA guidelines use an average weight for each animal type to determine the A.U. values for each animal type.

Nutrient management planning addresses all aspects of manure production, collection, storage, and land application, as well as land management practices, record keeping, commercial fertilizer inputs, and other manure utilization options.

Managing nutrients efficiently involves developing and maintaining a written nutrient management plan (NMP). Facilities with more than 1,000 animal units are often required to develop and implement a NMP. Facilities with less than 1,000 animal units but with unacceptable environmental conditions can avoid needing a permit by developing and implementing a NMP. Smaller facilities with no environmental concerns are strongly encouraged to develop and implement a NMP. Proper utilization of nutrients can result in increased yields, economic improvements, and environmental benefits.

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 NMP.

Economics

The majority of Utah farmers raise some type of livestock, with more than 13 million tons of manure being 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 Agriculture Statistics and USDA-NRCS

Efficiency

While it may be convenient to apply manure during the winter or on a field near the barn, this is often not an efficient use of the 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.

10 Steps of Nutrient Management Planning

1. Assess your operation for any potential discharges.
2. Determine livestock numbers and manure production quantities.
3. Calculate manure storage capacity needs.
4. Test soil and manure.
5. Determine crop requirements and application rates for manure and other fertilizers.
6. Establish how and when to apply manure.
7. Use land management practices that reduce leaching and runoff.
8. Calibrate application equipment.
9. Identify options for handling livestock mortalities.
10. Consider alternative management options to deal with excess nutrients or manure:
    - transfer to another entity (e.g., sell compost)
    - change cropping systems to utilize more nutrients
    - manage feeds to reduce nutrient excretion (e.g., phytase)

As with any farm management program, developing a NMP requires planning.

Planning helps ensure that nutrients and money are not wasted and that ground and surface waters are protected. Listed is a summary of the steps involved in developing a nutrient management plan.

Step 1. Assess your Operation for any Potential Discharges

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? Some of these practices may be obvious while others may not. When assessing the operation be honest. Keep in mind that, according to federal and state law, no manure or contaminated wastewater (including animal feed products) can be discharged into any surface water sources, including ditches, that leave an operator's 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 prevent leaching is against the law. Even manure applied on fields can lead to a discharge if rainfall, snowmelt, or irrigation tail water leaves the site and enters a surface water body.

Several resources are available to help farmers assess their operations. Materials on farm assessment and nutrient management are available at your local Utah State University Extension or USDA-NRCS office, and on the Internet.

It may be helpful to have an outside, non-regulatory 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 Utah Association of 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.

Visit these online references:

http://agwastemanagement.usu.edu

http://extension.usu.edu

http://go.usa.gov/KoB

Step 2. Determine Livestock Numbers and Manure Production Quantities

Manure Production

Use Worksheet 1 to determine the total quantity of manure produced. For each animal group, enter the number of animals and the corresponding manure production volume (Table 1). An animal group is any logical collection of animals generating manure that needs to be managed. Animals can be divided into groups by species, production phase, season, or physical location on the operation. Enter the average number of animals of each animal group. Obtain the appropriate manure production estimates from Table 1 and calculate the total volume of manure produced by each animal group. Repeat the procedure for each livestock group and add the results together to determine the total volume produced for the year.

If your animal numbers vary considerably based on the season, it may be helpful to fill out a copy of Worksheet 1 for each month. Then add the totals for each month together to generate the total amount of manure produced in one year. This may be especially helpful for manure storage calculations needed later on.

Table 1 - Livestock type and daily manure production volume. *

Livestock Type	ft^3/day/1000 lb of animal
Dairy, milking	1.9
Dairy, dry	0.84
Dairy, heifer	0.90
Beef feeder	1.1
Beef cow	1.7
Swine, grower	1.1
Swine, sow (gestating)	0.41
Poultry, layer	0.93
Turkey (toms)	0.57
Sheep (feeder lamb)	0.63
Horse	0.83

For livestock not included in Table 1, please contact your local NRCS office or go to:

http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/quality/?&cid=stelprdb1045935

(Note: use the excreted values per 1,000 lb animal unit.)

WORKSHEET 1 - Manure Produced (ft^3)

Month or Year: ______________________

	Livestock Group	:	Number	x	Avg. weight	÷	1000	x	Days	x	Table 1 Production Value	=	Total
1.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
2.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
3.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
4.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
5.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
6.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
7.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
8.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
9.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________
10.	______________	:	______	x	_________	÷	1000	x	____________	x	_________	=	_________

Total ft^3 of manure produced (add lines 1-10): _____________

Step 3. Calculate Manure Storage Capacity Needs

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. NRCS guidelines no longer permit manure application on frozen ground unless the manure is contained and the field is classified as low risk according to the Utah Manure Application Risk Index (UMARI). In Utah, the critical winter storage period may range from 45 to 150 days depending on location (see Table 2) and the type of 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 2 - 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

UMARI Version 2.2 is available at: http://efotg.sc.egov.usda.gov/toc.aspx?CatID=15030

Solid Manure Storage

Calculate the volume of manure storage currently available using Worksheet 2. Compare the cubic feet (ft^3) 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.

Liquid Manure Storage

Calculate the volume of wastewater storage available using Worksheet 3. 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.

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 x width). Note that facilities must be able to contain all lot runoff generated during the critical storage period and an additional amount obtained from a 25-year, 24-hour storm event. Add the results together to estimate the total volume of wastewater and runoff that must be contained during the storage period.

For normal and 25-year, 24-hour storm precipitation data see the Internet web pages:

- http://www.wrcc.dri.edu/pcpnfreq
- http://www.wrcc.dri.edu/climsum.html
- Or contact your local NRCS office

WORKSHEET 2 - Existing Solid Manure Storage Volume & Manure Production during Critical Period

MANURE STORAGE VOLUME

Storage Depth = Height (ft) - 1* = __________________

Length = Length of Manure Storage Area (ft) = __________________

Width = Width of Manure Storage Area (ft) = __________________

	Structure ID:	Length (ft)	x	Width (ft)	x	Storage Depth (ft)	=	Total ft^3
1.	________________:	__________	x	____________	x	_____________	=	___________
2.	________________:	__________	x	____________	x	_____________	=	___________
3.	________________:	__________	x	____________	x	_____________	=	___________

Total ft^3 of storage (add lines 1-3): ___________

*1 foot is subtracted from the height to allow for freeboard space.

MANURE PRODUCTION DURING CRITICAL STORAGE PERIOD

Critical Storage Period* (dates) from _____________ to _____________ = __________ days

* Obtain from Table 2 or your Local NRCS Office

Manure produced (ft^3) during critical period. (Use values from Worksheet 1).

	Livestock Group	:	Number	x	Avg. weight	÷	1000	x	Days in Critical Period	x	Table 1 Production Value	=	Total
1.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
2.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
3.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
4.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
5.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
6.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
7.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
8.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
9.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________
10.	_______________	:	______	x	_________	÷	1000	x	__________	x	__________	=	__________

Total ft^3 of manure produced during critical period (add lines 1 - 10): __________

WORKSHEET 3 - Existing Wastewater Storage Volume during Critical Period

WASTEWATER PRODUCTION DURING CRITICAL STORAGE PERIOD (GALLONS)

Critical Storage Period* (dates) from ____________ to ____________ = _________ days

* - Obtain from Table 2 or your Local NRCS Office

Wastewater Calculation:

	Number of Animals	x	Gallons Animal/Day	x	Number Days Critical Storage	=	Gallons	
1. Wastewater from Animals =	___________	x	__________	x	__________	=	____________	gallons

Runoff and Storm Event Calculation****:**

	Rainfall Depth (inches)	x	Lot Area*** (ft^2)	x	0.625	=	Gallons	
2. Runoff from Rainfall =	__________	x	__________	x	0.625	=	__________	gallons
3. Runoff from Storm Event† =	__________	x	__________	x	0.625	=	__________	gallons

Total Wastewater and Runoff Produced (add lines 1-3): ____________________ gallons

** - Short version. Full calculation is Rainfall Depth (inches) ÷ 12 (converts to feet) x Lot Area (ft^2) x 7.5 (converts to gallons).
*** - Lot area calculation: Length (ft) x Width (ft) = Lot Area (ft^2)
† - Precipitation received from a 25-yr, 24-hr storm event available at: http://www.wrcc.dri.edu/pcpnfreq/

CURRENT LAGOON WASTEWATER STORAGE CAPACITY (GALLONS)

Storage Depth = Height (ft) - 1* = _________________
Correction Factor (CF) for angled sides = 2 x Storage Depth (ft) = _______________
Adjusted Length = Length of Lagoon (ft) - CF = _________________
Adjusted Width = Width of Lagoon (ft) - CF = _________________

	Structure ID:	Adjusted Length (ft)	x	Adjusted Width (ft)	x	Storage Depth (ft)	x	7.5	=	Gallons	
1.	______________:	________	x	_________	x	_________	x	7.5	=	_____________	gallons
2.	______________:	________	x	_________	x	_________	x	7.5	=	_____________	gallons
3.	______________:	________	x	_________	x	_________	x	7.5	=	_____________	gallons

Total gallons of storage (add lines 1-3): __________________ gallons

* - One foot is subtracted from the height to allow for freeboard space.

Step 4. Test Soil and Manure

Soil Testing

Soil testing is essential to assess the current nutrient status of soil and determine 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 $2.00 per acre and can save many times this amount by reducing fertilizer costs or improving crop yields.

Either grid sampling or management unit sampling can be utilized for soil sampling. Grid sampling takes samples at prescribed locations throughout the field. Management unit sampling divides a field into units that are uniform and treated the same. Management unit sampling provides accurate data without the expense of grid sampling. Divisions into management units are based on factors such as soil texture, topography, drainage, crop history, and soil test values.

Good soil samples are important for accurately determining nutrient needs. A minimum of 10-12 randomly collected soil cores from each management unit should be gathered and mixed together for each soil sample. Care should be taken to avoid the entry point(s) in the field where the manure spreader is first turned on as application rates are likely to be non-uniform and not representative of the field. Mix all soil cores for a specific depth together in a plastic bucket and send one pint to the lab for analysis. Nitrogen and phosphorus cores should be taken at a depth of 0-12 inches. It is recommended that nitrogen samples also be taken at a depth of 12-24 inches. This more accurately determines the nitrogen available for plant growth and helps minimize the purchase of unneeded fertilizer.

Manure Testing

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, rigid plastic container such as a water bottle.

For solids, remove the surface six-inch crust and use an auger or shovel to core into the pile. 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. It is helpful to double bag these samples.

Keep all samples cool until they can be transported to a lab. The Utah State University Analytical Laboratory (http://www.usual.usu.edu) analyzes soil and manure samples. For more information on soil and manure sampling, contact your local County Extension Agent or go to the Producer's website at http://agwastemanagement.usu.edu.

Step 5. Determine Crop Requirements and Manure & Other Fertilizer Application Rates

Calculating the correct amount of manure or other fertilizers to apply is important to prevent the buildup of excess nitrogen or phosphorus in the soil and the contamination of ground and surface waters. First identify the crop(s) that will be grown and the nutrient requirements. Use your average yield when determining crop nutrient needs. Crop nutrient needs can be based on soil test reports or calculated using Table 3 or Chapter 6 in the NRCS Agricultural Waste Management Field Handbook (p. 6-17 to 6-22). Record crop nutrient requirement information using Worksheet 4.

NRCS Ag Waste Management Field Handbook

Available at:
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/waterquality/?&cid=stelprdb1045935

Various methods can be used to calculate manure application rates. Worksheet 4 describes one method for calculating manure and other fertilizer application rates, whether based on nitrogen or phosphorus needs. Records should be kept documenting the location and number of acres manure and other fertilizers were applied to on an annual basis, the rate of manure application, the weather at time of application, and whether or not, and when, the manure or other fertilizers were incorporated.

Table 3 - Crop Nutrient Requirements

Nutrient Removal by Crops Commonly Grown by Dairy Producers in Colorado, Utah, and New Mexico				
Crop	**lb. N**		**lb. P_2O_5**	
Alfalfa Hay	56	per ton	15	per ton
Alfalfa Haylage	45	per ton	10	per ton
Grass Hay	40	per ton	13	per ton
Corn Silage (35% dry matter)	22	per ton	11	per ton
Oat Haylage (40% dry matter)	32	per ton	13	per ton
Wheat Haylage (30% dry matter)	50	per ton	13	per ton
Forage Sorghum (30% dry matter)	29	per ton	9	per ton
Sorchum Sudangrass (50% dry matter)	27	per ton	7	per ton
Barley Grain	1.4	per bushel	0.55	per bushel
Corn Grain	0.9	per bushel	0.37	per bushel
Wheat Grain	1.7	per bushel	0.85	per bushel
Check with state Extension or NRCS personnel for appropriate crops, expected, yield, water requirements, and nutritional value when developing nutrient budgets. The table above serves as an initial estimate of nutrient removal by these crops.				

Source: Manure Best Management Practices: A Practical Guide for Dairies in Colorado, Utah and New Mexico. Utah State University Extension.
Available at: http://extension.usu.edu/files/publications/publication/AG_WM-04.pdf.

Using Worksheet 4

NRCS Ag Waste Management Field Handbook

Available at:
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/quality/?&cid=stelprdb1045935

Reproduce several copies of this worksheet. Complete one worksheet per field each year that 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) needs, or N or P_2O_5 crop removal rates. If your soil test phosphorus levels are between 50 and 100 ppm calculate application rates based on crop P_2O_5 removal. No further applications of manure should be applied when soil test phosphorus levels are above 100 ppm.

1. Nutrients Needed are based on the crop to be grown and the average yield obtained. Refer to Table 3, fertilizer guides, soil test reports, or your local Cooperative Extension Office or NRCS office for this information. For legumes such as alfalfa, nutrient needs are based on the phosphorus needs of the crop, as legumes obtain their nitrogen from the atmosphere (in a process called nitrogen fixation) after they have utilized the nitrogen available in the soil. Your soil test results provide information on the amount of fertilizer needed to meet your crop needs. Soil test recommendations have already taken the nutrients available in the soil into account.

2. Nutrients from Other Sources (credits) may include residual nitrate-N based on soil tests, previous legume crop credits, nutrients from previous manure applications, N in irrigation water, and even atmospheric deposition. If using fertilizer recommendations from your soil test report, do not adjust for the soil nitrate values -- these were already accounted for when developing your specific fertilizer recommendation.

3. Additional Nutrients Needed is the amount of N or P_2O_5 to be applied in manure or commercial fertilizer. Most manure, if applied according to crop needs for nitrogen (N), will oversupply crop needs for phosphorus (P_2O_5). Additional sources of nitrogen will likely be needed if you are using a P-based manure application system.

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, or go to Chapter 4 in the NRCS Agricultural Waste Management Field Handbook, Table 4-16 (p. 4-24 to 4-25)

5. The Nutrient Availability Factor is the fraction of total N or P_2O_5 in manure available in the year of application. Nutrients, particularly nitrogen, are released over time as manure decomposes in soil. See Table 4 and Worksheet 5 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 amount of manure needed to meet crop nutrient needs. Most manure, if applied according to crop needs for nitrogen (N), will oversupply crop needs for phosphorus (P).

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://maps.google.com.

WORKSHEET 4 - Manure Application Rate and Record Keeping

FIELD AND SOIL INFORMATION **Date:** _______________

Field number/management unit description: ___________________________ Number of acres: ________

Crop: ____ Average yield: ________________

Soil test nitrate-N: __________ lb N/acre or __________ ppm Soil test phosphorus: __________ ppm

1. Crop nitrogen (N) recommendation or removal (Soil test or Table 3): _______________ lb N/acre
2. Crop phosphorus (P_2O_5) recommendation or removal (Soil test or Table 3): __________ lb P_2O_5/acre

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

Nutrients Needed	**N-based**	**P_2O_5-based**
A. Nutrients needed (lb/acre) (Lines 1 & 2):	__________	__________
B. N credits from previous manure applications (mineralization rate)		
Manure applied last yr (tons, 1000 gal/acre, or inches) x Manure N content (lbs per ton, 1000 gal, acre-inch) x Mineralization value (Table 4, Yr 2 Values)		
__________ x __________ x __________ =:	__________	
C. N credits from previous legume crops (lb/acre) (Table 5):	__________	
D. N credits from other sources in lb/acre (e.g., irrigation water):	__________	
E. Additional nutrients needed (lb/acre): (subtract lines B, C, and D from line A):	__________	__________

Manure Needed	**N-based**	**P_2O_5-based**
F. Total N and P_2O_5 in manure (lb/ton, lb/1000 gal, or lb/acre-inch) (from manure test):	__________	__________
G. Nutrient availability mineralization factor (mineralization rate) (for N-based use Table 4, Yr 1 values; for P_2O_5-based use 1.0:	__________	__________
H. Nitrogen incorporation factor (time to incorporation) (multiply by 1.0 if incorporated within 3 days; by 1.4 if more)	__________	____1.0___
I. Available nutrients in manure (lb/ton, lb/1000 gal, or lb/acre-inch) (multiply lines D, E and F together [F x G x H]):	__________	__________
J. Manure application rate* (tons/acre, 1000 gal/acre or acre-inch/acre) (divide line E by line I):	__________	__________

TOTAL MANURE NEEDS ____________________________ tons 1000 gal acre-inch
(Multiply Line J by number of acres)

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 N Available in Yr 1*	Fraction of N Available in Yr 2
Poultry	0.75	0.25
Dairy	0.55	0.30
Swine	0.55	0.30
Beef	0.50	0.30

Manure Type	Yr 1*	Yr 2
Horse	0.40	0.30
Compost	0.50	0.30
Liquids	0.50	0.50

*Assumes manure is incorporated within 3 days. If manure is not incorporated within 3 days additional losses of nitrogen in the form of ammonia will occur. See page 8, Worksheet 2 for more details.

WORKSHEET 5 - Supplemental Nitrogen Needs (when manure is applied based on crop P needs)

Field number/Management unit description: ______________________________

Crop: ______________________________ Year: ______________

1. Nitrogen (N) recommendation (Worksheet 4, Line E): __________ lb/acre

2. Manure application rate (tons/acre, 1000 gal/ac, or acre-inch/acre) (from Worksheet 3, line J): __________
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 5, Yr 1 Values): __________

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

ACTUAL APPLICATION RECORDS

Field number/Management Unit: ____________________ Number of acres: ______________

Date of Application: ______________________________ N-based P-based

Manure Actual Application Rate: ____________________ tons 1000 gal acre-inch

Weather Conditions & Field Notes:

Supplemental Nitrogen Needed

When soil test phosphorus (STP) levels are between 50 and 100 ppm manure should be applied based on crop P_2O_5 removal. For many crops such as 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 5 calculates the rate of supplemental N needed when manure applications are made based on crop P_2O_5 removal. Complete Worksheet 5 and attach it to the appropriate copy of Worksheet 4. Apply additional fertilizer nitrogen in the spring just before the seeding of annuals, or before the initiation of growth for perennial grasses.

Table 5. Nitrogen Credits from Legume Crops.

Previous Crop	Yr. 1 Credit	Yr. 2 Credit
Alfalfa		
>4 plants/ft^2	110-150 lb N/ac	50-75 lb N/ac
1.5-4 plants/ft^2	70-120 lb N/ac	25-50 lb N/ac
<1.5 plants/ft^2	40-80 lb N/ac	0 lb N/ac
Other Legumes		
Red Clover	60-80 lb N/ac	
White Clover	60-80 lb N/ac	
Birdsfoot Trefoil	60-80 lb N/ac	
Grass-Legume Mix 71-90% legume)	50 lb N/ac	
Grass-Legume Mix (31-70% legume)	25 lb N/ac	
Winter Pea	20-40 lb N/ac	

Step 6. Establish How and When to Apply Manure

The main factor governing the type of manure application method is moisture content (Table 6). 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.

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

The Utah Manure Application Risk Index should be used to identify when winter applications of manure on frozen and/or snow-covered ground are considered low risk and therefore allowed. 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 7 (page 18) for more details.

Winter Application of Manure

Producers should be aware that the practice of applying manure on frozen or snow-covered ground (during winter) is only allowed under specific conditions. Most Eastern U.S. states have already banned this practice, and NRCS guidelines prohibit winter manure application unless the field and cropping conditions meet the guidelines in UMARI. It is the responsibility of the producer to ensure that all field runoff is contained if 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.

UMARI Version 2.2 is available at: http://efotg.sc.egov.usda.gov/toc.aspx?CatID=15030

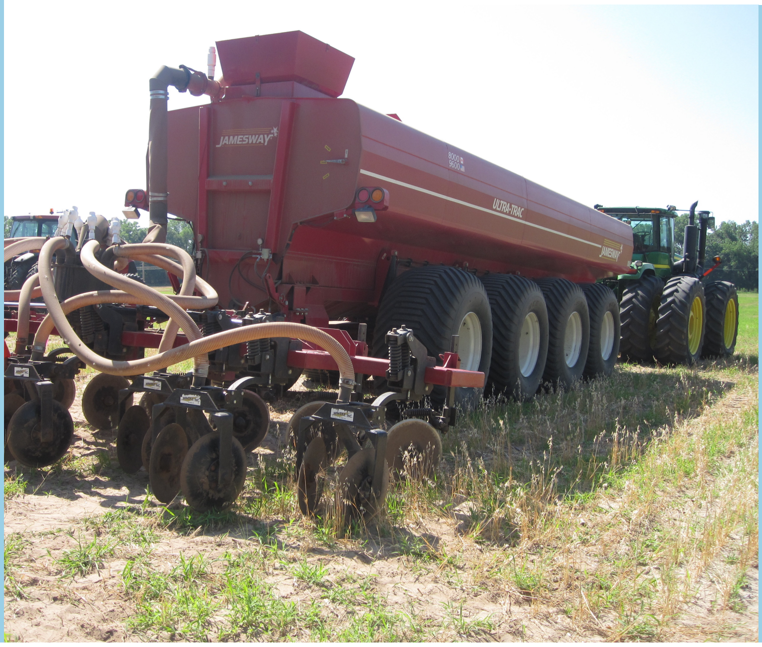


Table 6 - Manure forms and application method

Manure form	% Moisture	Method
Soild	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

*may require screening or chopping

Step 7. Use Land Management Practices that 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 great.

General BMPs

- Identify fields at high risk for leaching and/or runoff. Elimanate or reduce manure applications to these fields. Do not apply manure to these fields during the winter.
  - Fields at risk for leaching are those with a high groundwater table or very permeable soil (e.g., sand, gravel).
  - Fields at risk for runoff are those with a slope and limited or no groundcover.
- 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.
- 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. Manage water application so it matches plant uptake needs. Don't apply excessive water resulting in either runoff or leaching.
- 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 irrigation ditches or 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.
- Incorporate manure immediately after application.
- Apply manure to fields with as much vegetative or crop residue cover as possible, or incorporate manure immediately following application.

Step 8. Calibrate Application Equipment

Equipment calibration is necessary to ensure manure and wastewater applications are made at the 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 weigh the spreader without any manure, then load the spreader with manure and weigh again. The difference between the two weights is the weight of the manure. An alternative method is to weigh a 5 gallon bucket of manure and take the weight x 1.5 x spreader capacity in ft^3 (length x width x height) ÷ 2000 to estimate tons per load. To calibrate liquid/slurry spreaders, first determine the volume of material in gallons from the manufacturer's specifications, or by taking the length x width x height of the spreader x 7.5. For the volume in cylindrical tanks multiply length x diameter x diameter x 0.8 x 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 readjust 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 and measure the amount of liquid accumulated in the cans over a period of time (e.g., 1 hour). Calculate the average depth of liquid in the cans (in inches) and divide by the time interval to determine application rates in inches per hour.

WORKSHEET 5 - Manure Spreader Calibration

Spreader: __________________________ Date: __________

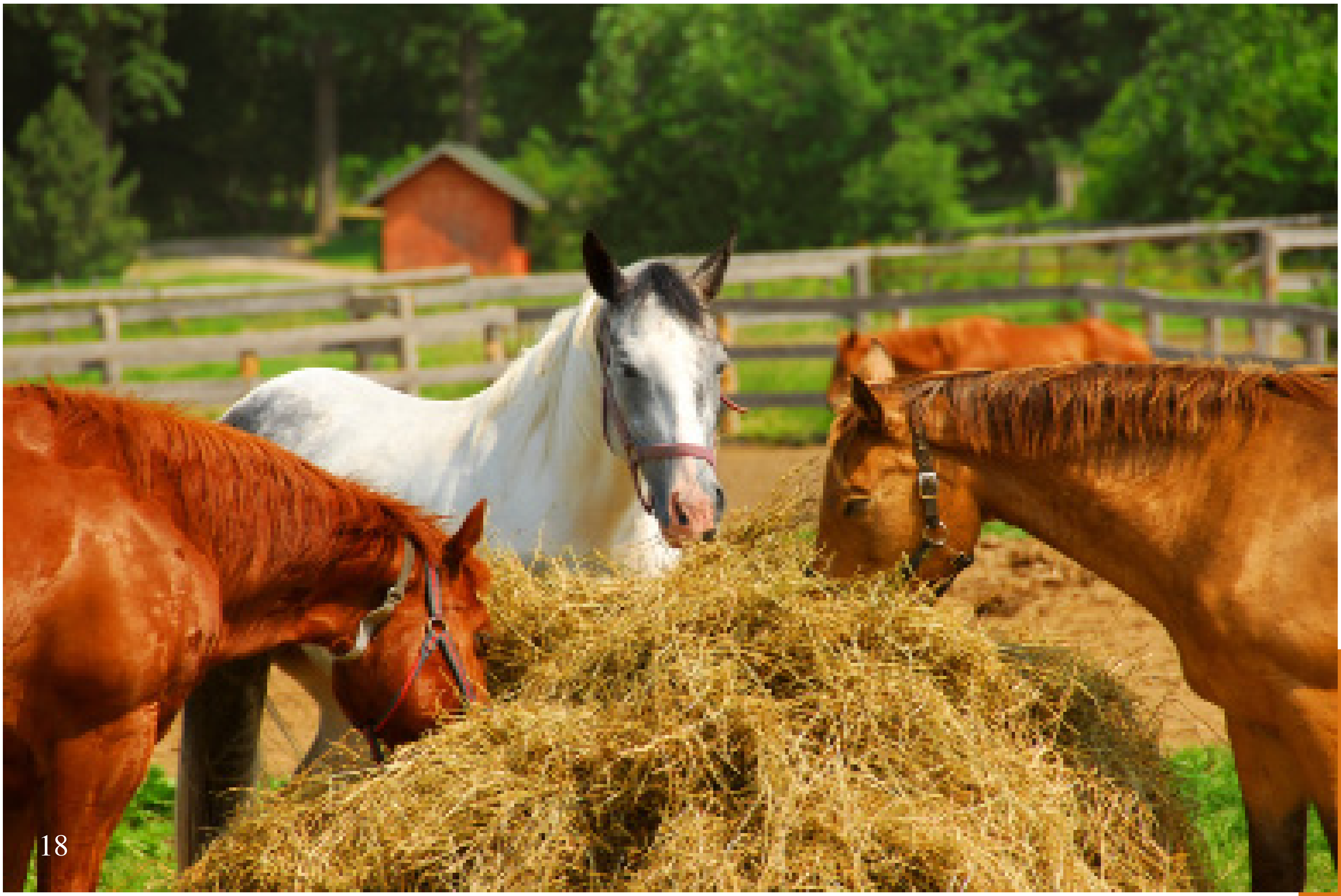
1. Load weight (tons) or volume (gallons) __________
2. Distance traveled to spread one load (ft) __________
3. Width of spread (ft) __________
4. Area of spread (ft^2) (multiply line 2 by line 3) __________ ft^2
5. Acres covered (divide line 4 by 43,560) __________ acre
6. Application rate (tons/acre or gal/acre) (divide line 1 by line 5) __________

Notes on settings:

Step 9. 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 economically feasible, rendering is often the method of choice. Composting is becoming a more common approach for dealing with mortality disposal. Where available and economically feasible, 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 like chickens. However, regulations and increased fuel costs are reducing the use of incineration. Check with local county and city officials for guidelines or regulations regarding burial, landfilling, incineration, or composting of mortalities in your area. In addition, state regulations must be followed for mortality composting and incineration.

A fact sheet describing cow mortality disposal is available from County Extension offices (publication #AG-507) Or at http://agwastemanagement.usu.edu/htm/bmp/land-treatment-practices/mortality-compost



Step 10. Consider Alternative Management Options to Deal with Excess Nutrients or 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 NMP as necessary.

Dietary Changes

Managing the nutrients in the feed is often overlooked as an approach for managing excess nutrients. High producing dairy cows need 0.33-0.40 percent dietary phosphorus (P). Swine and poultry can benefit from the addition of phytase, which makes the P more available to the animal. Dietary nitrogen (N) and P levels above those needed for animal requirements are excreted in the feces and urine.

Composting

Composting is one option for treating manure and converting it into a higher value product. Composted manure can be sold in urban markets, or used for livestock bedding. Composting reduces the volume and weight of the manure, reducing transportation costs. Generally, composting can be done utilizing existing equipment, with minimal labor investment. However, facility location (no run-off or run-on allowed), equipment needs, and additional management and labor are factors that should be considered when examining the feasibility of composting.

Transfers

Agreements with nearby landowners to use manure can reduce on-farm acreage requirements for manure spreading. If manure, or compost, is being sold or given away, a recent manure test report should be given to the recipient. And landowners receiving the manure should sign a paper verifying that they will 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 the manure to ensure it is being used properly.

The type of manure handling and storage system used will affect how much nitrogen is retained or lost in the manure; however, the phosphorus content remains unchanged. Options for phosphorus removal (e.g., struvite, steel slag) are being studied and developed. Using manure for power generation may also become more feasible and produce a revenue stream from the manure; however, power generation from methane production does not significantly reduce the nitrogen and phosphorus content of the manure.

Contact your local Utah State University Cooperative Extension or NRCS office for more information about dietary nutrient management or other options for using manure or go to:
http://agwastemanagement.usu.edu

Review and Update the Plan.

Developing a nutrient management plan (NMP) is not a one-time process, nor should the NMP exist and operate separately from the overall farm management plan. As part of the farm management plan, the NMP must be regularly reviewed and updated as conditions change. Changes in animal numbers, land base, or crops grown may dictate a revision of the NMP. As a general guideline, changes +/- 10% require a revision of the NMP.

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

- **Commit** to the planning process. Set aside a large block of time (40 hours or more) to initially develop a NMP. 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 NMP. A tab system works well, using one tab divider for each part of the NMP.
- **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 NMP 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.

Acknowledgements

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