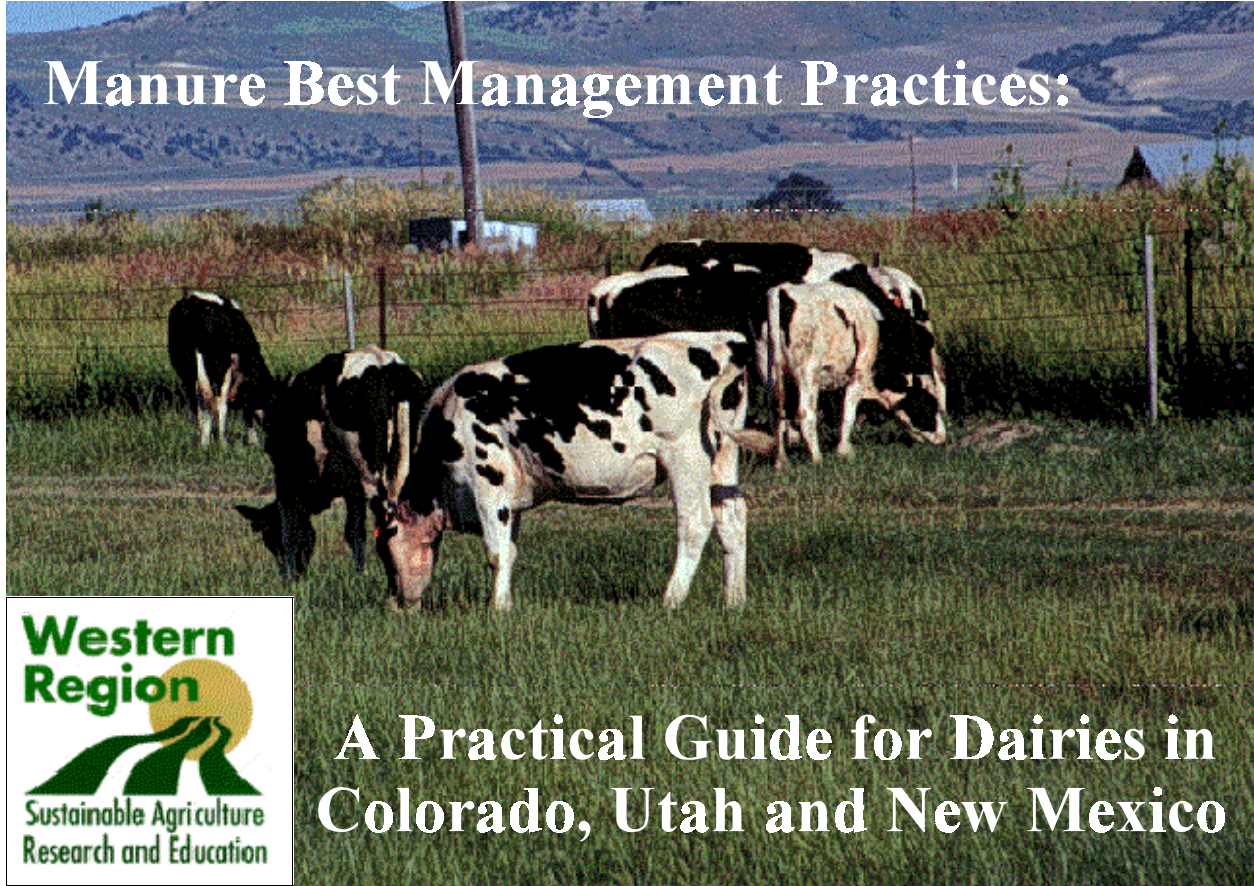




Reviewed December 2010



Manure Best Management Practices:

A Practical Guide for Dairies in Colorado, Utah and New Mexico



Jessica Davis
Colorado State University



Richard Koenig
Utah State University



Robert Flynn
New Mexico State University

Table of Contents

THE NEED FOR A REGIONAL GUIDE

DAIRY SITE ASSESSMENT

CALCULATING LAND BASE REQUIREMENTS FOR MANURE

LAND BASE REQUIREMENT WORKSHEET

NUTRIENT CONTENT OF COMMON CROPS

MANURE COLLECTION AND TREATMENT

ADDING VALUE TO MANURE - COMPOSTING

MANURE AND WASTEWATER STORAGE

MANURE CHARACTERISTICS AND SAMPLING

CALCULATING MANURE APPLICATION RATES

MANURE APPLICATION RATE/RECORD-KEEPING WORKSHEET

MANURE APPLICATION METHODS

EQUIPMENT CALIBRATION

Feeding to Reduce Nutrient Excretion

Recent advances have been made in feed formulation to reduce nitrogen (N) and phosphorus (P) excretion without reducing animal performance. The ideal protein concept is a feeding method in which crude protein levels are reduced and amino acids are supplemented in order to reduce N excretion. For reduction of P excretion, adding phytase to the diet has been shown to increase P availability to hogs and chickens. Most of the research on nutritional approaches to reducing manure nutrient excretion has been done on monogastrics, but research is now in progress on cattle feeding methods for this purpose.

A National Strategy for Animal Feeding Operations

In March 1999 the U.S. Environmental Protection Agency and U.S. Department of Agriculture completed a joint national strategy for the management of manure and wastewater from animal feeding operations. The strategy initially divides animal feeding operations into two categories: concentrated animal feeding operations (CAFOs, operations with a significant potential for causing environmental pollution) and animal feeding operations (AFOs, operations with less potential for causing environmental pollution). CAFOs will have to obtain a pollution discharge permit and develop a comprehensive nutrient management plan (CNMP) detailing how manure and wastewater will be handled, stored and used. AFOs are also asked to voluntarily develop a CNMP. The foundation of a CNMP is the adoption of best management practices for manure and wastewater handling, and the determination of application rates that properly meet crop nutrient needs



Best Management Practices

Best management practices (BMPs) recommended are structural, vegetative, or management practices designed to prevent or reduce water pollution. Implicit within the BMP concept is a voluntary, site-specific approach to solving water quality problems. BMPs are both environmentally and economically beneficial.

The Need for a Regional Guide

Many manure management guides and regulations are based on the acidic soils and high precipitation climatic patterns common to the mid-West and eastern United States. Western climates and soils are very different from eastern conditions and warrant BMPs tailored to these conditions in order to maximize the beneficial reuse of manure while minimizing the pollution potential.

Western agriculture has always had manure to utilize for crop production, but not in the quantities that are currently produced. Colorado, New Mexico, and Utah are home to many livestock producers who use confined feeding operations. Furthermore, intensive livestock feeding operations are often concentrated along narrow river corridors where many of the region's crops are produced. Consequently, several thousand tons of manure are generated in a small area, and disposal quickly becomes an issue. Couple manure quantity with the economics of moving it to sites where it can be used, and a dilemma develops which creates debate as well as opportunity. Much of the debate surrounds the disposal of manure, while opportunities for enhanced crop production, production of value-added commodities like composts, and improved soil quality are often overlooked.

How is the West different?

Soils

Alkaline soils receive the majority of the manure applied in the West. The alkaline soil environment and free calcium carbonate (lime) content of western soils will render certain nutrients unavailable to plants. Additionally, saline and sodic soils common in this region require special management considerations. Therefore, manure application rates may need to be adjusted for western soil conditions. For example, the salinity content

of the manure may limit applications to rates less than those required to meet the nutrient needs of plants.

Climate

Yearly evaporation exceeds yearly rainfall for most production agriculture regions in Colorado, Utah and New Mexico. Irrigation is used to supplement crop water requirements, and proper irrigation water management must be practiced together with manure management to minimize nutrient losses.

The West also has intense storms that can cause movement of soil and nutrients away from the field of intended use. These summer, monsoon-type storms may increase pollution potential if precautions are not taken to reduce soil erosion and surface runoff.



Climatic differences also result in western manure stockpiles which are often lower in moisture content than eastern manures. Other manure characteristics, such as ammonium content, also vary based on the climate under which the material is stored.

Finally, western precipitation patterns are different from eastern states, which can influence the timing of manure applications and the amount of field runoff that occurs.

Dairy Site Assessment

Proper site selection can prevent many of the problems related to dairy manure and wastewater control. Several factors in addition to land availability and cost should be considered when deciding where to locate a new facility. A site assessment for new and even established facilities can aid in planning and design, improvements, and operation and maintenance. The following guidelines are meant to be a checklist of desirable attributes for a dairy site location.

✓Topographic features

The topography of the site is important for runoff control and ease of facility maintenance (e.g., lot scraping). Consider the following topographical characteristics:

- Slope 3 to 5% to facilitate lot drainage.
- Slope direction away from buildings and water sources.
- West or south facing aspect to increase evaporation rates.
- Location above the 100-year flood plain.

✓Soil features

Soil features such as texture and depth to water table are important considerations for siting dairy facilities. It is not possible to visually evaluate all important soil features. Cooperative Extension Service or NRCS personnel can assist with soil evaluations. Also, soil surveys (published for most areas) contain information such as soil texture, depth to water table, and special limitations of soils for various uses.

Building site and lot areas

- Medium texture, low shrink-swell potential.
- More than 50 feet to a water table.

Storage ponds, lagoons, and stockpiles

- High clay soils with low permeability.

Land application site

- Relatively deep (3 or more feet), level, productive soils.
- Medium texture and moderate permeability and drainage.

✓Water quality and quantity

- Good groundwater quality and quantity for livestock and crop production.
- Facilities located 150 feet from wells and at least 1/4 mile from surface waters.

✓Land application site

- Sufficient land base for manure use (see pp. 5-6), or adequate neighboring farmland to utilize manure.
- Reasonable transport distance for manure and wastewater.
- Minimum of 100 feet from wells and surface water sources.



✓Other factors to consider

- Utility, labor, and market access.
- Urban growth potential of the area and future compatible land uses.
- Visual barriers between the facility and the public view.

Calculating Land Base Requirements for Manure

As dairies increase herd size, they often do not increase acreage. Therefore, a growing dairy may have to buy feed from other sources and may not have an adequate land base for manure utilization. Applying increasing quantities of manure to the same land area may result in water quality problems. It is of critical importance that every livestock producer know whether their land base is adequate for manure utilization.

If the land base is determined to be inadequate, arrangements must be made to reduce manure production (reduce herd size) or find alternative outlets for manure. Neighbors may own land with poor soils; manure could improve the productivity of these soils. There may also be opportunities to compost manure and sell it to area gardeners and landscapers.

Gathering information

In order to calculate the minimum land base required, you will need the following information:

- Number of lactating cows, dry cows, heifers, and other animals (e.g., beef cows).
- Average weight of lactating cows, dry cows, heifers, and other animals.
- Crop type which receives most of the manure.
- N removal by the crop (lbs/acre).
- P_2O_5 removal by the crop (lbs/acre).

Use conservative estimates of annual crop nutrient removal, and assume that all N and P in the manure is available to the crop. This assumption is appropriate for long term sustainable manure use. Once you have this information, complete the worksheet on the following page to determine the land base requirement for your dairy.

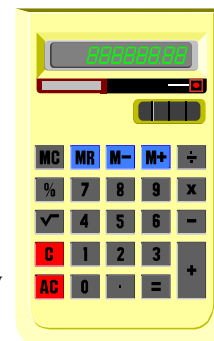
Using this worksheet

This calculation only has to be done once unless you decide to expand your herd, buy additional acreage, or change cropping systems.

Fill in your herd information including numbers and weight of each type of cow. Multiply the number of cows in each category by the average weight. Then multiply the result by the nutrient production values shown in the worksheet. In the first section you will calculate the total annual nitrogen (N) excretion by your herd, and in the second section you will calculate the total annual phosphorus (P_2O_5) excretion. This approach is conservative to ensure that your dairy has an adequate land base for manure application.

In the third section, you will need to know how much nitrogen and phosphorus are removed by an average yielding crop in your area. Use the table on page 7 or see your county Extension or NRCS office for local information. Divide the excretion values calculated in the first two sections by the crop removal. The answer is how many acres of that crop you need to utilize the manure nutrients.

In the West, manure applications are usually based on crop N needs. However, if soil test phosphorus (P) levels are high to very high and runoff into nearby streams is a problem, then base manure applications on P. Note that the land base requirement is considerably higher when it is P-based than when it is N-based.



Land Base Requirement Worksheet

Herd information

		Average weight (lbs)		Table values (lb N/yr/lb cow)		Nitrogen Excretion (lb N/yr)
Number of lactating cows: _____	x	_____	x	0.164	=	_____
Number of dry cows: _____	x	_____	x	0.131	=	_____
Number of heifers: _____	x	_____	x	0.113	=	_____
Number of beef cows: _____	x	_____	x	0.109	=	_____
TOTAL					=	=====

		Average weight (lbs)		Table values (lb P ₂ O ₅ /yr/lb cow)		Phosphorus Excretion (lb P ₂ O ₅ /yr)
Number of lactating cows: _____	x	_____	x	0.059	=	_____
Number of dry cows: _____	x	_____	x	0.042	=	_____
Number of heifers: _____	x	_____	x	0.033	=	_____
Number of beef cows: _____	x	_____	x	0.084	=	_____
TOTAL					=	=====

Field information

Crop receiving manure: _____	Yield goal: _____
N removal by crop: _____ lbs N/acre	
$N\text{-based Land Base} = \frac{\text{Total N excretion (lbs/year)}}{N\text{ removal (lbs/acre)}} = \text{_____ acres}$	
P removal by crop: _____ lbs P ₂ O ₅ /acre	
$P\text{-based Land Base} = \frac{\text{Total P}_2\text{O}_5\text{ excretion (lbs/year)}}{P_2\text{O}_5\text{ removal (lbs/acre)}} = \text{_____ acres}$	

Nutrient Removal by Crops Commonly Grown by Dairy Producers in Colorado, Utah and New Mexico†

Crop	lb N		lb P ₂ O 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
Sorghum 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.

Manure Collection and Treatment

✓Collection BMPs

- ❑ Collect manure from pens as frequently as possible to achieve optimum animal health and to comply with regulations.
- ❑ Maintain a firm, dry corral surface with the loose manure layer less than 1 inch deep and 25-35% pen moisture content.
- ❑ Clean corrals to provide a smooth pen surface with 3-5% slope and maintain the integrity of the hardpan below the corral surface.
- ❑ Collect runoff from corrals, and divert other runoff water from pen areas.



✓Dust, fly, and odor control BMPs

- ❑ Harrow pens frequently to expose manure and accelerate drying.
- ❑ Sprinkle the corrals in dry weather to reduce dust problems.
- ❑ Change stocking density, if possible, to control moisture content of the corral surface and reduce odor and dust problems when weather conditions warrant.
- ❑ Use windbreaks to reduce dust and odor problems.
- ❑ Communicate with neighbors to ensure they understand the dairy operation and are not harboring complaints.

Treatment options

Solid separation is a treatment for wastewaters from milking parlors. Settling basins or mechanical separators are used to remove solids from the wastewater resulting in reduced odor and less solids loading into lagoons. This treatment requires some investment in equipment and maintenance, but improves the ease of liquid storage and handling.

Lagoons are earthen structures designed to treat manure by bacterial degradation. Not every storage structure functions as a lagoon. Properly functioning lagoons reduce the solid and nitrogen contents of liquid manure. In order to achieve these treatment goals, minimum depths of 6 ft for anaerobic and 3-5 ft for aerobic lagoons, as well as a pH above 6.5, must be maintained so that bacteria thrive and odors are controlled.

Aeration of wastewater storage structures increases the oxygen level and reduces odors and solids. Aeration can be achieved through mechanical means or through gas exchange with the air in large, shallow ponds. The disadvantages of mechanical aeration include high energy and maintenance costs.

Anaerobic digestion is another treatment option in which manure is digested to produce energy for farm use or possibly for sale to a local power company. This treatment requires a large start-up investment and high maintenance, but also reduces manure odors because the treatment vessel is enclosed.

Constructed wetlands can be a useful option because of high nutrient uptake by wetland plants and denitrification which transforms nitrate into gaseous nitrogen forms. The disadvantages include construction costs, the need for solid settling prior to treatment, and possibly increased biological oxygen demand of the treated water.

Adding Value to Manure—Composting



expectations for particle size, and salt, nutrient, and moisture content. Many landscaping companies and government agencies have specifications for compost. Check market requirements.

Weed control. Although weed seeds can be destroyed during composting, some dormant seeds survive the process. Control weeds at the composting site and storage area.

Profitability? Composting is usually not a profitable enterprise for agricultural use of the product. Urban uses could provide a higher value market. Evaluate the costs of composting and transportation to markets before adopting composting.

Composting mortalities

Whole cows can effectively be composted by burying the cow in a carbon source such as sawdust or wheat straw. Lay the cow between two, 2-foot thick layers of organic material. Turn every 2 to 3 months. The cow should be composted within one year.

Information resources

Composting Education Resources of Western Agriculture:
www2.aste.usu.edu/compost/

Why compost?

- Volume reduction of 20 to 40% depending on the method of aeration.
- Nitrogen reduction by up to 50% due to ammonia volatilization.
- Uniform particle size product which is easier to spread and is more acceptable in landscape and garden markets.
- Can assist in carcass disposal when the cost of rendering becomes prohibitive.

Things to consider

- Do not compost within 300 yards of a residential neighborhood.
- Aerobic, active turning of the manure will increase volume reduction but increase odors during the first week of composting.
- Extra management is required (frequent aerating and moisture control) in the first four weeks of composting.
- Additional water is usually needed since western manure stockpiles are often less than 60% water (the optimum for composting).
- Contractual services are becoming more common in many regions where private enterprise will compost on-site.

Meeting expectations

If you plan to give away, sell or market compost, the material must meet buyer

Some compost recipes by percent volume

Carbon source	Manure	Wood chips [†]
none	-	60%
Cotton gin trash	45%	22%
Small grain straw	25%	75%
Sawdust	55%	45%

[†]Add wood chips as a bulking agent to achieve an initial bulk density of 700 to 1,000 lbs per cubic yard. Though not absolutely necessary, bulking the pile does increase temperatures. Adjustments should be made to achieve optimum performance.

Manure and Wastewater Storage

✓General BMPs

- Locate manure stockpiles and wastewater storage ponds at least 150 ft down stream from any well and above the 100-year flood plain.
- Protect wellheads with grassed buffer areas.
- Locate stockpiles and wastewater storage ponds in slow permeability clay soils with a deep watertable.
- Ensure adequate storage capacity to avoid winter application.

✓Stockpile BMPs

- Use berms or trenches to keep stormwater runoff away from stockpiles.
- Use grassed filter strips below stockpiles to reduce solids and nutrient contents in runoff.
- Any potential runoff from stockpiles should be collected in a lined or otherwise impermeable holding structure.
- Soil sample downhill from stockpiles to monitor nitrate buildup in soil.



✓Storage pond BMPs

- Remove solids from wastewater with a settling basin or separating screen before liquids are transported to the

storage pond. This will reduce odors and extend the storage period.

- Seal storage ponds to prevent seepage. Liners can be made of compacted soil, bentonite clay, or heavy plastic.
- Ensure that the storage pond has the capacity to handle runoff from a 25-year, 24-hour storm, in addition to normal wastewater from the milking parlor.
- Mark the top of the normal storage level in the pond with adequate room above that for the 25-year, 24-hour storm. If the pond level rises above the marker, the pond should be drawn down within 15 days.
- Maintain at least 2 ft of freeboard in the pond at all times.
- Remove solids from the bottom of the pond when they exceed 8 inches in depth.
- Inspect your pond regularly. Maintain vegetated slopes, look for settling or bulges in the slopes, fill rodent holes, repair drying cracks, look for seepage outside of embankments, and inspect inlet and outlet structures and valves.
- Keep cows away from storage pond banks to maintain the seal.
- Consider aerating or covering storage ponds or planting windbreaks if the odor bothers neighbors.
- When using ponds for either evaporation purposes or storage prior to land application consider a second pond to divert runoff and allow for cleaning out the solids that collect in ponds.
- Store solids from separators so that drainage water will collect in the storage pond.
- Have a contingency plan for wastewater storage or utilization in case of heavy rainfall.

Manure Characteristics and Sampling

Manure is a highly variable material whether in solid or liquid form. It is, therefore, critical that a representative sample be taken to accurately determine manure nutrient content.

Sampling liquids

When sampling liquid manure or wastewater, use a clean bucket and a plastic sample jar. There are several ways to sample:

- Sample from the storage pond directly with a water sampler. Walk or boat around the pond and collect a minimum of six sub-samples. If possible, agitate the pond prior to sampling.

- Sample from a valve inserted in irrigation line or directly from pond outlet pipe.

- Sample using cups placed in the field when manure is sprinkler irrigated.

Combine individual liquid sub-samples in a bucket and mix thoroughly. Transfer approximately one pint to a clean sample jar. Store the sample in a cooler or freezer and immediately (within 24 hours) deliver to a lab. Some labs require sample preservation for nitrogen and supply sampling bottles with the preservative.

Sampling solids

When sampling a solid manure stockpile, remove the surface crust and use a

bucket auger or a sharpshooter (a narrow shovel) to core into the pile as deeply as possible. Take samples from all sides of the pile, collecting a minimum of six sub-samples. Mix the sub-samples together in a clean bucket and transfer about one pint to a heavy-duty, freezer-type plastic bag. Store the sample in a cooler or freezer and immediately (within 24 hours) deliver to a lab.

Laboratory analysis

Have the manure sample analyzed for moisture content, pH, salts (electrical conductivity or EC), and N, P₂O₅, and K₂O concentration. Check with the lab prior to sampling in case they have any specific requirements.

Average values

Values given in the table below are average nutrient contents of dairy manures in Colorado, Utah, and New Mexico. These values should be used with caution due to the large amount of farm-to-farm variability in manure. Different feeding practices and management techniques can have a significant impact on manure nutrient concentrations and salt contents. It's best to take a sample from your own dairy following the procedure outlined above.

Average nutrient contents of western dairy manures (fresh weight basis).

	Solid	Slurry	Liquid
Moisture Content	46%	92%	99%
Electrical Conductivity	18 mmhos/cm	12 mmhos/cm	6 mmhos/cm
Total N	13 lbs/ton	24 lbs/1000 gal	4 lbs/1000 gal
P ₂ O ₅	16 lbs/ton	18 lbs/ 1000 gal	4 lbs/ 1000 gal
K ₂ O	34 lbs/ton	29 lbs/ 1000 gal	10 lbs/ 1000 gal

Calculating Manure Application Rates

Calculate the correct rate of manure application to prevent excess nitrogen (N) and phosphorus (P_2O_5) from accumulating in soil and contaminating ground and surface water. Various methods can be used to calculate manure application rates. The worksheet on the following page describes relatively simple methods for calculating application rates based on N and P_2O_5 .

Gathering information

In order to calculate manure application rates you will need the following information:

- The crop to be grown and expected yield.
- Recent soil test results for each field.
- An estimate of other nutrient credits.
- A manure analysis for total N and P_2O_5 .

Using this worksheet

Photocopy the worksheet as needed. Complete one worksheet per field each year manure is applied. Keep the worksheets as a record of the manure application history for each field.

If soil test phosphorus (STP) levels are very high (for example, greater than 100 ppm STP by the Olsen or sodium bicarbonate extract method), apply manure on the basis of P_2O_5 removal by the crop (second column on worksheet), or take measures to prevent runoff from these high phosphorus fields.

1. *Nutrient recommendations* are based on the crop to be grown and yield. Refer to soil test reports, fertilizer guides, or your local Extension or NRCS office for nutrient recommendations. If manure applications will be made on the basis of P_2O_5 , use crop P_2O_5 removal (see page 6) as the basis for the nutrient recommendation.

2. *Nutrients from other sources (credits)* may include residual nitrate-N from soil tests, supplemental fertilizers, N in

irrigation water or from previous legume crops, or nutrients from previous manure applications.

3. *Supplemental nutrients needed* is the amount of N or P_2O_5 supplied by the manure.

4. *Total N or P_2O_5 in manure* (on a *fresh weight* basis) is based on a manure analysis. If a manure analysis is not available, use average values given on page 11 for your manure form.

5. Nutrients 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. All of the P_2O_5 is assumed to be available in the year of manure application to prevent further phosphorus accumulation in high P-testing soils.

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 rate of manure to apply to meet crop nutrient needs.



✓ Other factors to consider

- Soil testing improves the accuracy of manure rate calculations. Soil test annually on fields receiving manure.
- Monitor soil test nitrate and phosphorus and rotate manure to other fields if levels are approaching high values.
- Keep records.

Manure Application Rate/Record-Keeping Worksheet

Field and soil information

Year: _____

Field number or description: _____	Number of acres: _____
Crop: _____	Yield goal: _____
Soil test nitrate-N: _____ lb N/ac or _____ ppm*	Soil test phosphorus: _____ ppm*
Crop nitrogen (N) recommendation: _____ lb N/ac *ppm = parts per million.	
Crop phosphorus (P ₂ O ₅) removal (see page 6): _____ lb P ₂ O ₅ /ac	

Manure information

Manure form: <input type="checkbox"/> Solid <input type="checkbox"/> Slurry <input type="checkbox"/> Liquid		
Manure N content: _____ lb/ton or _____ lb/1000 gallons		
Manure P ₂ O ₅ content: _____ lb/ton or _____ lb/1000 gallons		
Method of application: <input type="checkbox"/> Broadcast <input type="checkbox"/> Broadcast-incorporation <input type="checkbox"/> Injection		

Application rate worksheet

	<u>N-based</u>	<u>P₂O₅-based</u>
1. Nutrient recommendations (lb/acre) (soil test report or calculation)	_____	_____
2. Nutrients from other sources (credits) (lb/ac)	_____	_____
3. Supplemental nutrients needed (lb/ac) (subtract line 2 from line 1)	=====	=====
4. Total N or P ₂ O ₅ in manure (lb/ton or lb/1000 gal) (from manure test or assumed value)	_____	_____
5. Nutrient availability factor (<i>N-based</i> : use 0.4 for solids, 0.3 for liquids or slurries, and 0.2 for composts; <i>P-based</i> : use 1.0)	_____	_____
6. Available nutrient in manure (lb/ton or lb/1000 gal) (multiply line 4 by line 5)	=====	=====
7. Manure application rate (tons/ac or 1000 gal/ac†) (divide line 3 by line 6)	=====*	=====

*Note: This worksheet assumes solid manure will be incorporated immediately. If manure will be incorporated more than one week after application, then multiply the N-based rate on line 7 by 1.4.

† There are 27,154 gallons per acre-inch and 325,851 gallons per acre-foot.

Manure Application Methods

The type of manure collection and storage system, as well as transport distances and cost, influence the choice of application methods. The main factor governing the type of application method used is manure moisture content (see table below).

- Use larger capacity units for longer transport distances to minimize the number of trips required.

Types of manure and spreading equipment.

Manure form	% Solids	Equipment
Solid	35-80	Box spreaders
Semi-solids	10-35	Flail spreaders (slingers)
Liquid slurry	2-12	Tank wagons
Liquid manure	0-7	Big guns or gated pipe
Storage pond or lagoon water	0-4	Sprinklers*, big guns, gated pipe

*may require screening or chopping



Semi-solids and slurries

Transport of semi-solid or slurry forms of manure should be limited to short distances. Consider drying the manure or adding water to handle the material as a true solid or liquid.

Solid manure

Using tractor-drawn or truck-mounted box units for spreading solid manure is a standard practice on many dairy farms. Consider the following points for solid spreading:

- Water is heavy and expensive to haul even short distances. Minimize the water content in manure by installing a solid-liquid separator, or drainage slats in the solid manure storage structure.
- Solid manure spreaders come in various sizes and configurations. Dump trucks do a poor job of distributing manure. Spreaders with a hydraulic ram or walking floor to push manure out the rear of the unit facilitate more uniform spreading.

Liquids

Handling manure as a liquid minimizes the need for additional tractor-driven implements and offers the advantage of using the irrigation system already in place for manure transport and application. Consider the following points for liquid manure application:

- Open ditches, furrows, and basin irrigation systems are not recommended for liquids due to poor uniformity of application.
- Manure with less than 4% solids is pumped as easily as water through normal irrigation systems.
- Run clean water through the system at the end of the irrigation cycle to flush the system and wash manure off leaf surfaces.

Equipment Calibration

The value of carefully calculating manure application rates is seriously diminished if application equipment is not properly calibrated.

Solid and slurry spreaders

Manure spreaders discharge at widely varying rates, depending on travel speed, PTO speed, gear box settings, discharge openings, and manure moisture and consistency.

Calibration requires measurement of the amount of manure applied on a given area. This can be accomplished on three scales:

- field scale (many spreader loads)
- one spreader load
- tarp size (< 1 spreader load)

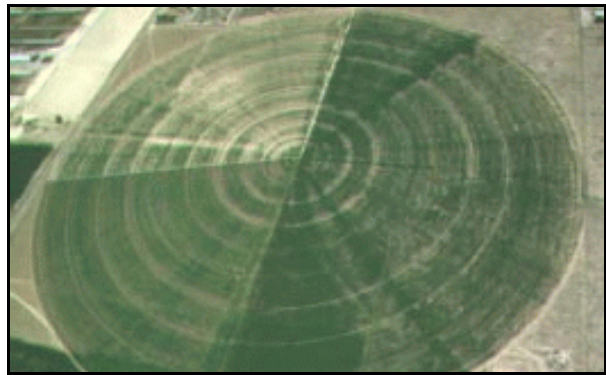
The smaller the scale, the more potential for error. Therefore, where possible use field scale calibration.

Field scale calibration steps

1. Determine the size of the area or field where manure will be spread.
2. Count the number of loads of manure applied to the field. For solid manure, weigh at least three loads and calculate the average weight. For slurry manure, use volume measurements instead of weight. Calculate the volume of a cylindrical tank by measuring the tank length, depth, and width in feet. Multiply length \times depth \times width \times 0.8 to get cubic feet of slurry. Convert to gallons by multiplying cubic feet by 7.48.
3. Multiply the number of loads by the average weight (or volume), and then divide by the field or area acreage. This gives the average application rate per acre. Adjust the spreader setting or ground speed as necessary to achieve the desired application rate.

Other factors to consider

Check the calibration whenever a different manure source with a new moisture content or density is applied. Using well-maintained equipment and proper overlap distances will ensure better nutrient distribution and help avoid “hot spots” or areas with nutrient deficiency.



Sprinkler systems

When liquid manure is applied through sprinkler irrigation systems, it is essential that manure contain <4% solids, nozzles are large enough to avoid clogging, and that nozzles are the same size throughout the system to ensure uniform application (except for center pivots).

There are three methods for calibrating sprinkler systems for manure application:

1. **Can test.** Place 12 rain gauges or straight-sided cans under sprinkler system. Measure the depth of liquid collected over time.
2. **Flow meter.** Note the flow meter reading and the duration of application, and divide by the area receiving the manure.
3. **Depth measurement.** Measure the change in effluent depth in the pond and multiply that by the area of the pond. Then divide this volume by the area of land receiving the application.

Meet the Authors



Jessica G. Davis, Ph.D.

Department of Soil and Crop Sciences
Colorado State University
Fort Collins, CO 80523-1170

Jessica is the Extension Soil Specialist for Colorado State University Cooperative Extension. Her research emphasizes using manure to improve soil properties while protecting water quality, economically and environmentally sound fertilizer utilization, and diagnosis and restoration of “alkali” soils. She teaches a class in manure management. Jessica can be reached at jgdavis@colostate.edu or by phone at 970-491-1913.

Richard T. Koenig, Ph.D.

Department of Plants, Soils and Biometeorology
Utah State University
Logan, UT 84322-4820

Rich is a Soil Specialist for the Utah State University Cooperative Extension Service. He serves as the statewide specialist in soil fertility, nutrient management, and soil improvement. Rich can be reached at richk@ext.usu.edu or by phone at 435-797-2278.



Robert P. Flynn, Ph.D.

New Mexico State University
Agricultural Science Center at Artesia
67 E. Four Dinkus Rd.
Artesia, NM 88210

Robert has a dual appointment with the New Mexico Cooperative Extension Service and the Agricultural Experiment Station. He serves as an extension agronomist with an emphasis in

soil management and conducts a research program in soil fertility. His program seeks to improve cropping systems that receive manure, and assist producers in achieving a productive and environmentally sound farming system. Robert can be reached at rflynn@nmsu.edu or by calling 505-748-1228.

Utah State University is committed to providing an environment free from harassment and other forms of illegal discrimination based on race, color, religion, sex, national origin, age (40 and older), disability, and veteran's status. USU's policy also prohibits discrimination on the basis of sexual orientation in employment and academic related practices and decisions.

Utah State University employees and students cannot, because of race, color, religion, sex, national origin, age, disability, or veteran's status, refuse to hire; discharge; promote; demote; terminate; discriminate in compensation; or discriminate regarding terms, privileges, or conditions of employment, against any person otherwise qualified. Employees and students also cannot discriminate in the classroom, residence halls, or in on/off campus, USU-sponsored events and activities.

This publication is issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Noelle E. Cockett, Vice President for Extension and Agriculture, Utah State University. AG/WM-04,1999