1998

EC98-757 Farm*A*Syst Nebraska's System for Assessing Water Contamination Risk Fact Sheet 11: Improving Land Application of Manure

Robert Grisso
University of Nebraska at Lincoln

DeLynn Hay
University of Nebraska-Lincoln, dhay1@unl.edu

Paul J. Jasa
University of Nebraska at Lincoln, pjasa1@unl.edu

Richard K. Koelsch
University of Nebraska - Lincoln, rkoelsch1@unl.edu

Sharon Skipton
University of Nebraska–Lincoln, sskipton1@unl.edu

See next page for additional authors

Authors
Robert Grisso, DeLynn Hay, Paul J. Jasa, Richard K. Koelsch, Sharon Skipton, and Wayne Woldt

University of Nebraska Cooperative Extension EC 98-757-S

Farm-A-Syst

FACT SHEET 11

Nebraska's Farm Assessment System for Assessing the Risk of Water Contamination

Improving Land Application of Manure

Resource or waste?

Stewardship of soil and water resources should be a goal of every livestock producer. Management decisions made relative to land application of livestock manure will influence the ability to attain that goal. An evaluation of your land application practices should focus on the following question:

Is manure a waste or a resource?

The ease of use and reliability of commercial fertilizers have allowed reliance upon them for crop nutrient needs. Manure is often given limited value and often treated as a **waste** to be disposed. However, treating manure as a waste to be disposed of has several potential implications:

- High nitrates in drinking water for your family, livestock, and neighbors. This is a risk to human health and livestock performance.
- High nitrogen and phosphorus levels in local ponds, streams, and lakes. Excess nutrients lead to excess algae growth, lower water oxygen levels, and reduced fish populations.
- Fecal coliforms in local surface waters. At greatest risk are surface drinking water supplies and surface waters used for recreation.
- Odor nuisances to neighbors.

Land applying manure as a **resource** at rates appropriate for crop nutrient needs is fundamental to reducing environmental risk. Treating manure as a nutrient resource has several potential advantages beyond the environmental benefits. These include:

- reducing the purchase of commercial fertilizers, and lowering cost of crop production;
- improving soil water infiltration resulting from manure additions; and
- reducing soil erosion potential due to increased soil organic matter content.

Efficiently managing nutrients in manure promotes a recycling of nutrients from animals to crops and back to animals again. If these nutrients are not recycled effectively, they can be lost into the environment. A well-planned soil fertility program which includes accurately crediting manure nutrients is a

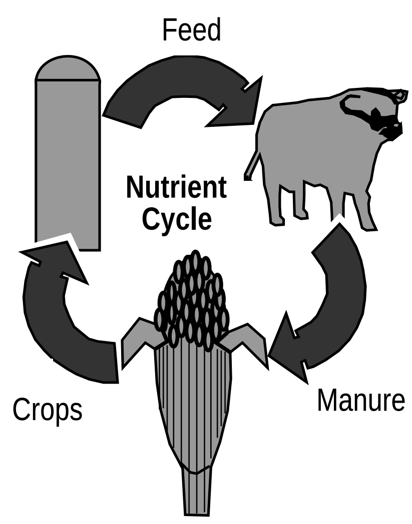

Figure 1. Recycling of manure nutrients through crops minimizes environmental risks.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture.
Elbert C. Dickey, Interim Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

key component of efficient management of nutrients on livestock farms.

Giving credit to manure nutrients

Using manure as a resource is based upon giving appropriate credit to the "crop available nutrients in manure" and reducing commercial fertilizer inputs accordingly. This process involves five steps.

Step 1. Soil testing.

Soil testing is the foundation for a manure application program. Without soil test results, it is impossible to consider any manure management system acceptable. From soil test data, application rates can be calculated and any long-term nutrient changes can be monitored.

Soil testing of 13 fields with manure history in northeast Nebraska revealed several common observations. Phosphorus values were reported to range from 16 to 551 ppm. Fifteen ppm is the cutoff for University of Nebraska recommendations of supplemental phosphorus. Potassium values were reported to range from 207 to 583 ppm (125 ppm is the cutoff for University of Nebraska recommendations). Nitrate-nitrogen ranged from 56 to 795 pounds per acre. Land application of manure commonly results in excess nutrient application. This is a wasteful use of a resource and an environmental liability. Planning manure application based on soil testing is essential.

Since manure is unlikely to contain the appropriate mix of nitrogen, phosphorus, and potassium for crop production, rate of application must give preference to one of these nutrients. The most appropriate nutrient is a source of some controversy due to competing economic, agronomic, and environmental considerations. Site specific conditions should also impact this decision. Manure should never be applied at rates exceeding nitrogen requirements and, if practical, should be applied based upon phosphorus needs. Selecting the most appropriate nutrient for selection of a rate of application will require close consultation with your farm's agronomy advisor.

Step 2. How much manure is applied?

Knowledge of application rates is critical for crediting manure nutrients. Simple calibration procedures can provide a good estimate of application rate. For solid manure spreaders, several 22-square-feet plastic sheets laid in the path of a manure spreader can provide a reasonable estimate of application rate (see *Figure 2*). The weight of manure in pounds on one 22-square-foot sheet will equal the tons of manure applied per acre. Several sheets are suggested to develop an average application rate. For information on calibration procedures for other manure application methods, refer to *Manure Applicator Calibration,* NebGuide G95-1267.

Record keeping is also necessary. It is desirable to maintain records for at least a three-year period. The organic nitrogen is mineralized over three to four cropping seasons and becomes available to crops. Knowledge of the current and past years' application amounts are needed for estimating nitrogen available to the current year's crop. Records are also critical if past practices are called into question by regulatory agencies. The increasing potential for environmental liability suggests a need for documentation of manure applications. An example of a daily manure application record that should be kept is illustrated in *Table 1*.

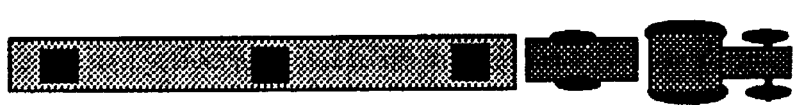

Figure 2. Three or more plastic sheets placed in the path of the manure spreader can be used to estimate application rate.

Table 1. Record keeping of manure application is key to crediting manure nutrients.

Date	Field	Spreader	Incorporated within:	Number of loads
			days	
			days	
			days	
			days	
			days	

Step 3. Manure nutrient analysis.

Manure nutrient concentration varies according to many factors including animal species, feeding program, animal housing, time of year, and type of manure storage and treatment. The only way to account for all these variables is to collect a representative sample of manure for lab analysis. Considerations to conducting a manure analysis include:

- Obtain a representative sample. Collect manure from multiple spreader loads, locations and depths in the storage or lagoon, or locations in the feedlot. Pool these samples, mix thoroughly, and pull a sub-sample to be sent to the lab.
- Freeze the sample as quickly as reasonable. The ammonium nitrogen fraction in manure can be altered within hours if the sample is not cooled. Store this sample in a plastic container and allow some room for manure expansion when frozen.
- Express mail the frozen sample to the laboratory. Packing the container in a box insulated with newspaper or other packing material reduces the risk of thawing. Send the sample to the lab early in the week when it is unlikely to set over a weekend.
- Ideally, manure should be sampled a few weeks prior to land application. Time of year will impact the nitrogen content of manure and changes in animal feeding programs will impact all nutrient levels. However, obtaining a representative sample from a storage or lagoon in advance can be a challenge without adequate agitation. An alternative is to build up a history of analysis from past years and use those samples that most closely match the time of year that you intend to spread manure.

If manure analysis is not used, table values provide an alternative that is better than nothing at all. *Table 2* provides some typical manure nutrient concentrations.

Step 4. Determine crop available manure nutrients.

If all the nutrients were available from manure during the year in which they were applied, this would be a simple step. However, because of the chemical and physical characteristics of manure nutrients, the answer is slightly more complex.

Nitrogen in manure comes in two forms: stable organic nitrogen and an unstable ammonium nitrogen *(Figure 3)*. The stable organic nitrogen in the feces provides a slowly released nitrogen source to crops over several years. Mineralization of organic nitrogen provides approximately 25 to 35 percent of the total organic nitrogen to the crop during the first growing season. During succeeding growing seasons, mineralization of organic nitrogen will continue to contribute some additional nitrogen. It is estimated that 12, 5, and 2 percent are available in the second, third, and fourth growing seasons.

The unstable ammonium nitrogen is the most immediately available nitrogen source

Table 2. Typical nutrient concentrations for manure.

Species	% Dry Matter	Nitrogen		P_2O_5	K_2O
		Ammonium-N	Organic N		
Slurry Manure (lbs. of nutrient per 1,000 gallons of manure)					
Dairy	7	9	13	14	20
Beef	12	14	20	22	31
Swine	5	17	10	19	15
Layer	11	37	20	51	33
Dairy (lagoon sludge)	10	4	17	20	16
Swine (lagoon sludge)	8	6	19	52	76
Beef (runoff pond)	17	10	42	40	17
Solid Manure (lbs. of nutrient per ton of manure)					
Beef (dirt lot)	59	5	20	18	22
Beef (paved lot)	29	5	9	9	13
Swine	18	6	7	13	9
Dairy	22	3	8	7	9
Broiler (litter from house)	79	14	57	69	47
Layer (scrapped)	35	14	14	31	20
Turkey (grower house litter)	73	12	43	63	40
Liquid Effluent from lagoon or holding pond (lbs. per acre-inch)					
Beef (runoff holding pond)	0.3	41	4	10	203
Swine (lagoon)	0.25	50	29	17	86
Dairy (lagoon)	0.25	27	18	13	113

to crops because all of it is available during the current growing season. It represents approximately 50 percent of the total nitrogen in raw manure. It is also the most easily lost to the atmosphere. The animal excretes urea in the urine, same as urea in commercial fertilizer, which is transformed quickly to ammonium nitrogen. If ammonium is not properly managed, it is lost as ammonia gas. Manure held on barn floor, feedlot surface or cropland surface loses most ammonium within a few days (see *Figure 3*). As a result of ammonia volatilization potential, ammonium concentration is variable in manure samples. On-farm tests are available for checking ammonium levels.

The availability of ammonium nitrogen to a growing crop depends on the time of application, method of application, and time between land application and incorporation. Immediate incorporation conserves practically all ammonium nitrogen. Ammonium nitrogen is preferably applied in relatively close timing to crop growth. Fall injection of manure may conserve ammonia but it may not be entirely available for a spring-planted corn crop due to leaching losses. Follow similar procedures as used with fall application of anhydrous ammonia to minimize leaching losses. *Figure 3* illustrates the process for estimating crop available nitrogen from ammonium and organic nitrogen.

The crop availability of phosphorus and potassium nutrients in manure are more easily predicted. Most is available in the first year. Seventy percent of the phosphorus and 80 percent of the potassium in manure can be assumed to be

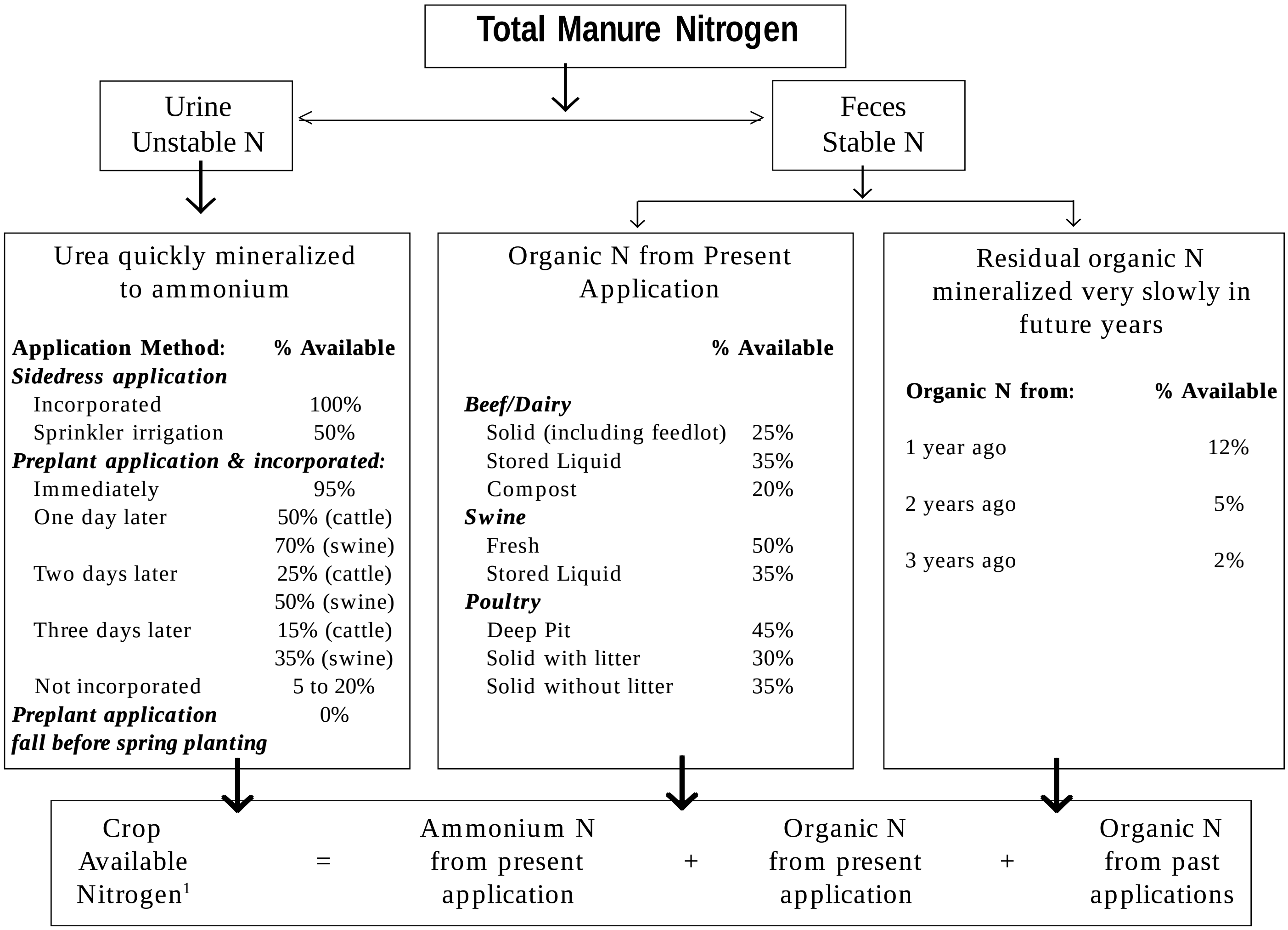

Figure 3. Procedure for estimating crop available nitrogen from total manure nitrogen. Crops typically take up nitrogen in the nitrate form. Ammonium-N and organic-N indicates the original forms of the nitrogen before conversion to nitrate.

available to the crop during the cropping season following application.

Step 5. Nutrient management plan.

The previous knowledge should be converted into a field-by-field plan for nutrient applications from all nutrient sources including manure. Efficient management of farm resources and costs has always required planning. Growing environmental concerns provide an additional incentive for producer documentation of how nutrients are managed. Planning and good records have assisted many producers whose environmental liability has been called into question by regulatory agencies or neighbors.

With information from the previous steps, a livestock producer should assemble a plan for manure application detailing timing and amount of planned manure application for each field. The plan will need to be revised for each growing season. These nutrient-based application rates may need to be altered to take into consideration site conditions that contribute to excessive leaching or runoff potential (i.e. excess slopes, frequent flooding), proximity to neighbors, or manure hauling distance.

Summary

Land application of manure can be managed to minimize the cost of crop production and protect the environment simultaneously. However, this does not happen by chance. Soil sampling, calibration of manure spreaders, record of manure applications, manure analysis, and nutrient management planning are keys to achieving these objectives. Fundamental to all of these efforts is the willingness of the producer to value manure as a resource rather than dispose of it as a waste.

CONTACTS AND REFERENCES

Who to call about...

Land application of manure:
Your local University of Nebraska Cooperative Extension office, Natural Resources Conservation Service office, or commercial crop consultant.

Manure application through irrigation systems:
Approval from the Nebraska Department of Environmental Quality must be obtained by the livestock owner or operator if manure is land applied through an irrigation system that is also connected to a fresh water supply (groundwater, stream, or pond). Department of Environmental Quality, Suite 400, 1200 N Street, The Atrium, Lincoln, NE 68509-8922, (402) 471-4239 can provide information on installation guidelines and permit process.

Manure testing:
Commercial laboratories are available. Contact your county University of Nebraska Cooperative Extension Educator, or Nebraska Cattlemen's office at (402) 475-2333.

What to read about...

Publications are available from sources listed at the end of the reference section. (Refer to number in parentheses after each publication.)

Drinking water quality:
Understanding Groundwater. NebGuide G93-1128. (1)
Drinking Water: Bacteria. NebGuide G90-989. (1)
Water Testing Laboratories. NebGuide G89-907. (1)
Well Water, Nitrates, and the "Blue Baby" Syndrome Methemoglobinemia. NebFact NF 91-49. (1)
Drinking Water: Nitrate-Nitrogen. NebGuide G763. (1)
Consequence of Nitrate in Groundwater. Solutions magazine, July / August 1986.
Water Quality and Requirements for Dairy Cattle. NebGuide G93-1138. (1)
Nitrates in Livestock Feeding. NebGuide G74-170. (1)

Land application of livestock manure:
Livestock Waste Facilities Handbook. MWPS-18. (2)
Liquid Manure Application Systems. NRAES-79. (3)
Manure Applicator Calibration. NebGuide G95-1267. (1)
Environmental Considerations for Manure Application System Selection. NebGuide G95-1266. (1)
Fertilizing Crops with Animal Manure. Extension Circular EC 89-117. (1)

Publications available from...

1. Your local University of Nebraska Cooperative Extension office or directly from IANR Communications and Information Technology, 105 ACB, P.O. Box 830918, University of Nebraska-Lincoln, Lincoln, NE 68583-0918, (402) 472-9713.

2. MWPS publications are available through your local University of Nebraska Cooperative Extension office or Agricultural Engineering Plan Service, University of Nebraska-Lincoln, 219A LW Chase Hall, P.O. Box 830727, Lincoln, NE 68583-0727, (402) 472-1646.

3. NRAES, Riley Robb Hall, Cornell University, Ithaca, NY 14853, (607) 255-7654.

Partial funding for materials, adaptation, and development was provided by the U.S. EPA, Region VII (Pollution Prevention Incentives for States and Nonpoint Source Programs) and USDAa (Central Blue Valley Water Quality HUA). This project was coordinated at the Department of Biological Systems Engineering, Cooperative Extension Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

Nebraska Farm*A*Syst team members included: Robert Grisso, Extnesion Engineer, Ag Machinery; DeLynn Hay, Extension Specialist, Water Resources and Irrigation; Paul Jasa, Extension Engineer; Richard Koelsch, Livestock Bioenvironmental Engineer; Sharon Skipton, Extension Educator; and Wayne Woldt, Extension Bioenvironmental Engineer.

This unit was written by Richard Koelsch.

Editorial assistance was provided by Nick Partsch and Sharon Skipton.

Technical reviews provided by: Charles Shapiro, Northeast Research and Extension Center; Don Sanders, Agronomy; Dean Settje, Nebraska Cattlemen’s Association; Jim Schilds, Cooperative Extension Educator; Tom Hamer, USDA Natural Resources Conservation Service; Paul Jasa, Biological Systems Engeinering.

The views expressed in this publication are those of the author and do not necessarily reflect the views of either the technical reviewers or the agencies they represent.

Reprinted on recycled paper.

NOTES