Managing Manure Nutrients for Crop Production

2020 Soil Fertility Short Course

Part 1

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Distribution of Liquid Manure Application

The Manure Scoop

The Value of Adding Small Grains and Hays to Improve Manure Management in Iowa

The Science Behind Manure Management Plans - Nitrogen

Manure Management Plans – What are they?

- http://www.agronext.iastate.edu/immag/

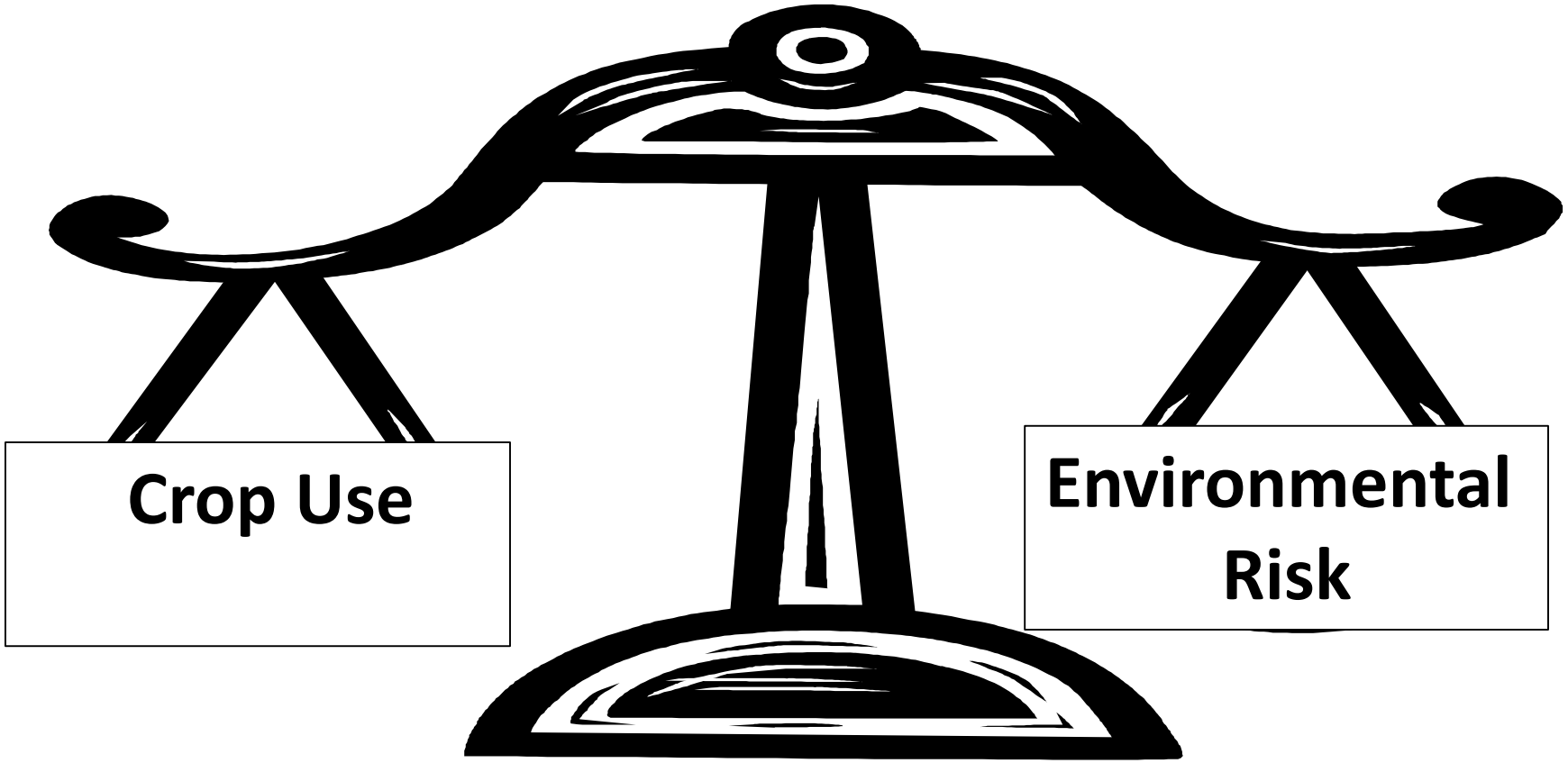
In this month's news update:

Manure

A Twitter list by @ISUANR

Daniel Andersen

Why is this important?



AE 3608 April 2017

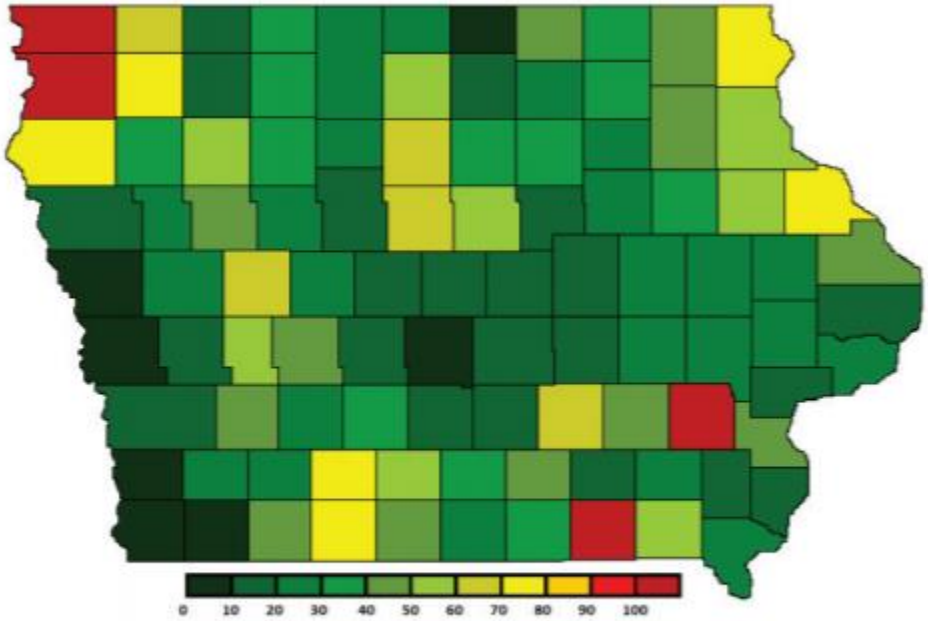


Figure 2. Manure phosphorus available relative to phosphorus removed with crop production in 2015.

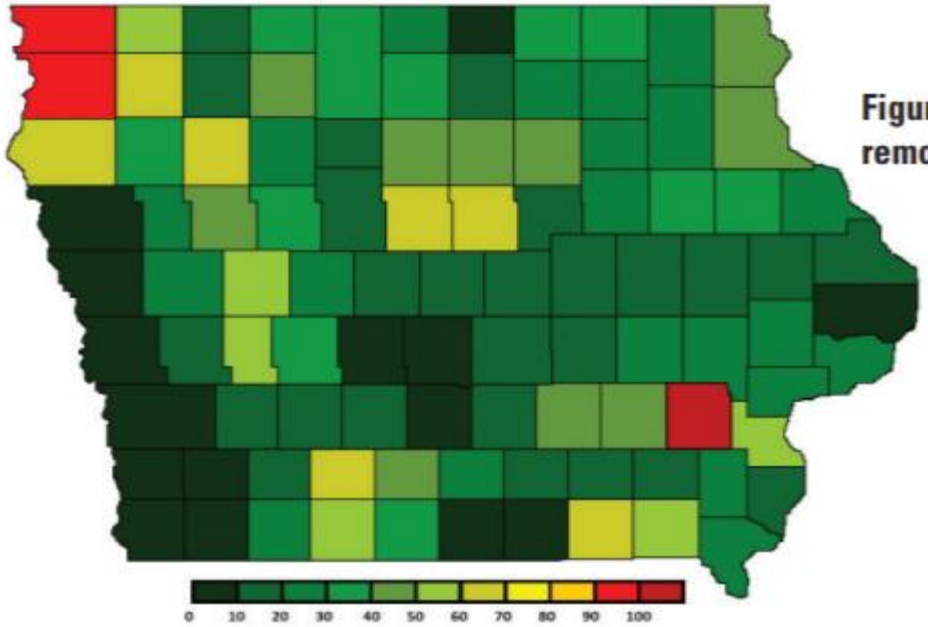


Figure 1. Available manure nitrogen relative to nitrogen removed with crop production (does not include nitrogen removed with soybean or alfalfa) in 2015.

Long-Term Benefits From Agronomic Application of Manure To Crop Land

- Improved productivity
  - Improved fertility
    - Essential plant nutrients
  - Adds organic matter
  - Stimulates biological activity
- Improves physical structure
  - Infiltration
  - Stability
  - Water holding capacity
  - Bulk density

The Value of Manure?

You have 500,000 gallons of manure with a chemical analysis of 40 lb N, 25 lb P_2O_5, and 30 lb K_2O per 1,000 gallons. The total amount of manure in storage is:

N:	40 lb x 500 = 20,000 lb N
P_2O_5 :	25 lb x 500 = 12,500 lb P_2O_5
K_2O :	25 lb x 500 = 12,500 lb K_2O

Value at $.30, .44 & .33/pound = $15,625
*(Iowa average January 2020 prices, **assuming all available**).*

It Is Easier to Manage Commercial Fertilizer. Why??

- Commercial Fertilizer – you can order the amount of each nutrient you want – it can be mixed for you!
- Consistency of product
- Availability isn’t a concern
- Application is more uniform

Nutrients in animal manure should be managed with the same (more?) care as commercial fertilizer

- The availability of the nutrients to the crop
- The amount of nutrients needed to optimize crop yields
- That it is being applied uniformly
- That the available nutrients *supply* crop needs at the right time

- To do so it is first necessary to determine:
  - The total amount of nutrients in the manure

How to determine the nutrient content of animal manure

The best method is to have a sample chemically analyzed.

Chemical (lab) analysis:

- Eliminates the need to make assumptions about storage and handling losses.
- Requires a representative sample of the manure.
  - From pile? From applied manure in field?

How to Sample Manure for Nutrient Analysis

A field-by-field nutrient management program requires multiple components to maintain adequate fertility for crop growth and development. A well-designed soil sampling plan, including proper soil test interpretations along with manure sampling, manure nutrient analysis, equipment calibration, appropriate application rates and application methods are all necessary components of a nutrient management plan. Implementing these components allows manure to be recognized and used as a credible nutrient resource, potentially reducing input costs and the potential of environmental impacts.

Animal manure has long been used as a source of nutrients for crop growth. Standard nutrient values are guides to determine the amount of nutrients that animal manure will supply as a fertilizer source. Iowa State University Extension publication, *Managing Manure Nutrients for Crop Production* (PM 1811), recommends manure nutrient content and credits by type of animal, handling system and application methods.

While "book values" like those in PM-1811 are reasonable average values, an individual farm's manure analyses can vary from those averages by 50 percent or more. Species, age of animal, feed rations, water use, bedding type, management, and other factors make every farm's manure different. Two key factors affecting the nutrient content of manure are manure handling and type of storage structures used. Each handling system results in different types of nutrient losses—some unavoidable and others that can be controlled to a certain degree. Because every livestock production and manure management system is unique, the best way to assess manure nutrients is by sampling and analyzing the manure at a laboratory.

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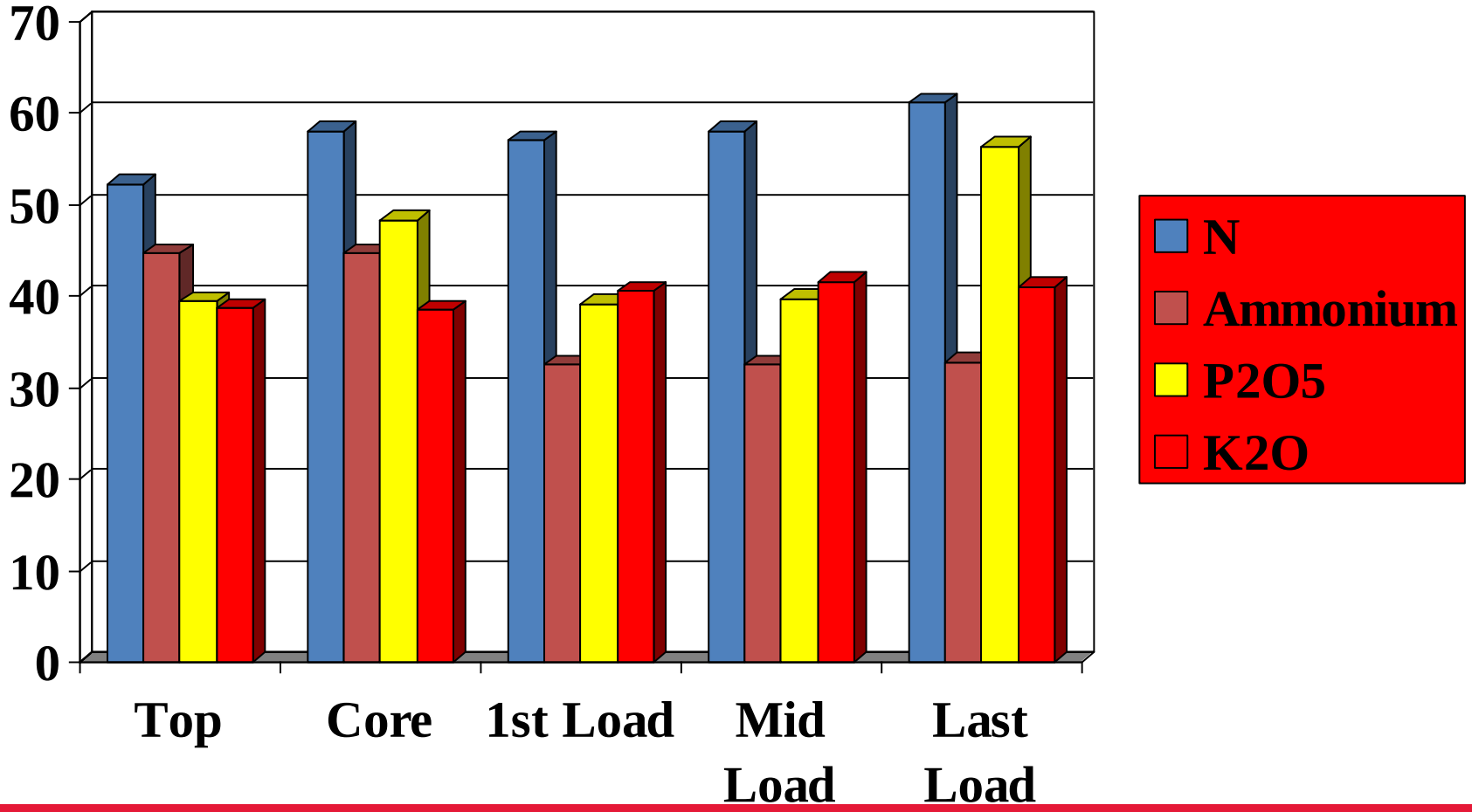
PM - 1558

Swine Pit Samples, Sioux County, Dry Feeders, n=19, Fall 2001



Handling the Sample

- Sample as close to application time as possible.
- Collect representative samples.
- Use Freezer bags or lab-supplied bags. Keep the “zip-lock” area clean.
- Mark well so you know where the sample came from.
- Ship immediately or freeze, then ship.

Lab Analysis Fees

Lab	Standard (TKN, P, K and moisture/ solids)	Standard + NH4-N	Standard + NH4-N+ Micro
Lab A	$24.00	$34.00	$54.00
Lab B	$30.00	$37.00	$59.00
Lab C	$32.00	$45.00	$55.00

How to Interpret Your Manure Analysis

Introduction

Manure analysis is a critical component of proper nutrient management planning. Table or book values of manure nutrient concentrations can serve as a starting point for planning purposes, but actual manure sample analysis provides a better indication of manure nutrient concentrations and will help better define application rates. Utilizing manure testing will help achieve the potential as a crop nutrient source, and result in reduced chance for misapplication that could lead to lower crop productivity or increased environmental risk.

Sampling Frequency and History

Collecting manure samples for nutrient analysis should not be a one-time event. Manure samples should be taken at least yearly, near the same time every year to account for any seasonal changes, and preferably near or during land application. Once samples have been collected for at least three years, and with no significant changes due to feed inputs, management or storage, then sampling frequency can be reduced. If feed

Nutrient Analysis

As a minimum, all manure samples should be analyzed for total nitrogen (N), total phosphorus (P), total potassium (K), and moisture content (or dry matter). You may choose to have your sample analyzed for ammonium-N as well. Other tests may include micronutrients and total salts.

Total N is often reported as TN or TKN. TKN is Total Kjeldahl Nitrogen. Kjeldahl refers to a specific analytical method. Total N is a measure of all N contained in the sample and represents both organic and inorganic N fractions. Because organic N is not immediately available to plants, the total N value does not, necessarily, represent plant available N, nor does it represent any losses that may occur due to volatilization, denitrification, or leaching after application.

Ammonium-N (NH_4-N) represents the inorganic N fraction commonly occurring in manure. Typically there is no or little inorganic nitrate-N (NO_3-N). Ammonium-N is plant avail-

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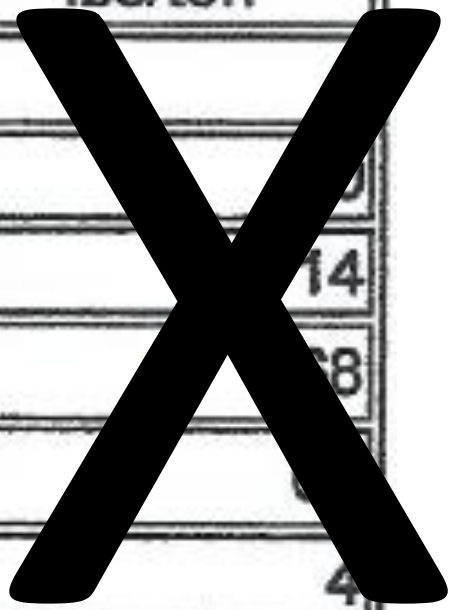
PM - 3014

Analytical Results

- Dry matter (% solids) and/or Moisture
- Total Nitrogen (Total N or TKN)
- Ammonium Nitrogen (NH_4-N)
- Phosphorus (P as P_20_5)
- Potassium (K as K_20)
- Secondary and Micronutrients
  - (If requested)
- pH – (if requested)
- Total Salts/Electrical Conductivity
  - If requested

An Example, layer manure

			Est. First Year
	Analysis	Nutrients	Availability
Parameters	as Received	lbs/ton	lbs/ton
Ammonium Nitrogen (N)	0.40 %	8.1	
Organic Nitrogen (N)	1.48 %	29.5	
Total Nitrogen (N)	1.88 %	37.6	14
Phosphorus (P_2O_5)	4.88 %	97.6	68
Potassium (K_2O)	3.39 %	67.7	
Sulfur (S)	0.50 %	10.1	4



Using Manure Nutrients for Crop Production

Nutrients in Animal Manure

Manure can supply nutrients required by crops and replenish nutrients removed from soil by crop harvest. Since manure contains multiple nutrients, applications should consider not only what is needed for the crop to be grown but also how the ratio of nutrients in manure could affect soil test levels. This ensures adequate nutrient supply and reduces potential for over- or under-application and subsequent buildup or depletion in the soil. Good manure nutrient management should consider short-term and long-term impacts on crop nutrient supply and soil resources.

Manure has characteristics that make nutrient management different and sometimes more complicated than fertilizer. These include a mix of organic and inorganic nutrient forms; variation in nutrient concentration and forms; variation in dry matter and resultant handling as a liquid or solid; and relatively low nutrient concentration requiring large application volumes. Since manure nutrient composition can vary significantly, sampling and laboratory analysis are always needed, while with fertilizer nutrient concentrations are provided at a guaranteed analysis.

The manure nutrient concentration varies considerably between animal species; dietary options; animal genetics; animal performance; production management and facility type; and collection, bedding, storage, handling, and agitation for land application. Use of average or "book" nutrient values can be helpful for designing a new facility and creating manure management plans but is not very helpful in determining specific manure nutrient supply or application rates due to wide variation in nutrient concentrations between production facilities. For example, a recent sampling across swine finishing facilities found a range in total N from 32 to 79 lb N/1,000 gal, P from 17 to 54 lb P_2O_5/1,000 gal, and K from 23 to 48 lb K_2O/1,000 gal. A similar or larger range can be found with other manure types. Nutrient analyses often vary greatly as storage facilities are emptied or manure is stockpiled, and also among multiple samples collected from loads during land application. Therefore, collecting multiple manure samples and maintaining a history of analysis results will improve use of manure nutrients.

For determining manure application rates and equating to crop fertilization requirements, it is most helpful if manure analyses give N, P_2O_5, and K_2O based on an as-received or wet basis in lb per ton or lb per 1,000 gal units. It is beyond the scope of this publication to give detailed manure sampling and laboratory analysis

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PMR 1003 Revised May 2016

1st Year Availability, without application losses

First-Year Availability Estimates

Table 1. First-year nutrient availability for different animal manure sources.

Manure Source	Nitrogen[1]	Phosphorus[2]	Potassium[2]
	Percent of Total Nutrient Applied		
Beef cattle (solid or liquid)	30–50	80–100	90–100
Dairy (solid or liquid)	30–50	80–100	90–100
Liquid swine (anaerobic pit)	90–100	90–100	90–100
Liquid swine (anaerobic lagoon)	90–100[3]	90–100[3]	90–100
Poultry (all species)	50–60	90–100	90–100

[1]The estimates for N availability do not account for potential volatile N losses during and after land application. Correction factors for volatile loss are given in Table 2. The ranges are provided to account for variation in the proportion of ammonium N (and for poultry manure also uric acid), bedding type and amount, and both sampling and analysis.

[2]The ranges in P and K availability are provided to account for variation in sampling and analysis, and for needed P and K supply with different soil test levels. A small portion of manure P may not be available immediately after application, but all P is potentially available over time. Use lower P and K availability values for soils testing in the Very Low and Low soil test interpretation categories, where large yield loss could occur if insufficient P or K is applied and a reasonable buildup is desirable. Use 100% when manure is applied to maintain soil-test P and K in the Optimum soil test category, when the probability of a yield response is small.

[3]Values apply for the liquid portion of swine manure in lagoons; the N and P availability will be less and difficult to estimate with settled solids.

But, application losses for N can occur, also!

Table 2. Correction factors to account for N volatilization losses during and after land application of animal manure.[1]

Application Method	Incorporation	Volatilization Correction Factor[2]
Direct injection	—	0.98–1.00
Broadcast (liquid/solid)	Immediate incorporation	0.95–0.99
Broadcast (liquid)	No incorporation	0.75–0.90
Broadcast (solid)	No incorporation	0.70–0.85
Irrigation	No incorporation	0.60–0.75

An Example, layer manure, left on surface

Parameters	Analysis as Received	Nutrients lbs/ton	Est. First Year Availability lbs/ton
Ammonium Nitrogen (N)	0.40 %	8.1	
Organic Nitrogen (N)	1.48 %	29.5	
Total Nitrogen (N)	1.88 %	37.6	

37.6 x .55 x .75 =
15.5#/ton

37.6# N/ton

x .55 (availability of this manure source in year 1)

x .75 (assuming 25% loss for leaving it on the surface)

= 15.5#/ton (Available for the crop)

2 Ton/Acre Application Rate:

- 31#/Acre available N
- 195#/Acre P_2O_5
- 135#/Acre K_2O

Removal Rates of P & K

- Corn P_2O_5: .32#/bushel
  200 bu = 64#
- Soybean P_2O_5: .72#/bushel
  60 bu = 43# (107)

- Corn K_2O: .22#/bushel
  200 bu = 44#
  Soybean K_2O: 1.2#/bushel
  60 bu = 72# (116)

2 Ton/Acre Application Rate, How close does it come to the crop need?

- 31#/Acre available N (140#?)
- 195#/Acre P_2O_5 (107#)
- 135#/Acre K_2O (116#)

Manure from a swine finishing unit

Parameters	Analysis as Received	Nutrients lbs/1000 gals	Est. First Year Availability lbs/1000 gals
Ammonium Nitrogen(N)	0.34 %	29.1	29
Organic Nitrogen(N)	0.12 %	10.0	4
Total Nitrogen(N)	0.46 %	39.1	33
Phosphorus(P2O5)	0.18 %	15.5	11
Potassium(K2O)	0.27 %	23.2	21
Sulfur(S)	0.05 %	4.0	2
Calcium(Ca)	0.11 %	9.0	6
Magnesium(Mg)	0.04 %	3.7	3
Sodium(Na)	0.06 %	5.3	4
Copper(Cu)	12 ppm	0.10	0.07
Iron(Fe)	58 ppm	0.49	0.35
Manganese(Mn)	9 ppm	0.07	0.05
Zinc(Zn)	28 ppm	0.24	0.16
Moisture	96.7 %		
Total Solids	3.3 %	278.8	
Total Salts		70.3	
pH	7.7		

First year availability of nitrogen is calculated based on preplant application with incorporation. Nitrogen available from previous years application not considered.

Total manure salts should not exceed 500 lbs/acre. Less than 500 lbs/acre if annual rainfall is less than 25 inches and/or the soil CEC is less than 12 meq/100g. Salt contributions from commercial fertilizer applications must also be considered. Soil test yearly to monitor phosphorus levels, organic pH, and micronutrients. Spring soil test for residual nitrate - make accurate sidedress recommendations! Nitrogen availabilty will vary with methods of a and field conditions. The nitrogen availability values used on a manure management plan must comply with state regulation. These regulations vary fr state to state.

Volatilization example -- liquid manure

You have liquid swine manure from a wean to finish operation that contains 39 lb N, 16 lb P_2O_5, and 23 lb K_2O per 1,000 gallons of manure. The manure will be broadcast and incorporated within 24 hours.

Volatilization correction:

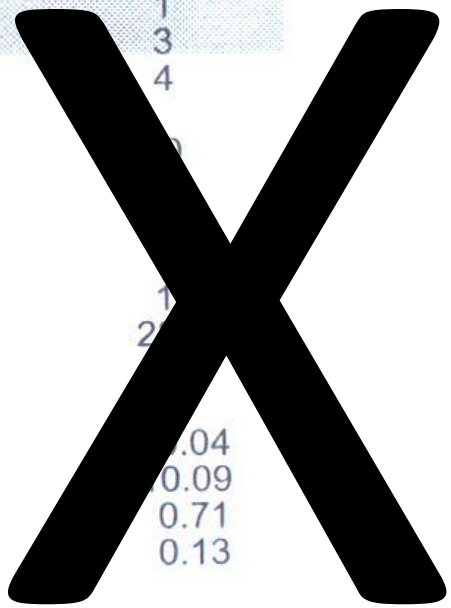
39 lb N x 0.95 = 37 lb N/1,000 gallons.

The amount of N available the year of application is 37 lb N. (remember that 90 to 100 percent of N in liquid swine manure is available, I used 100% here.)

Manure from a beef feedlot

Report Date:
Received Date:
Sampled Date:
P.O. Number:

Parameters	Analysis as Received	Nutrients lbs/ton	Est. First Year Availability lbs/ton
Ammonium Nitrogen(N)	0.08 %	1.6	1
Organic Nitrogen(N)	0.48 %	9.7	3
Total Nitrogen(N)	0.56 %	11.3	4
Phosphorus(P2O5)	0.72 %	14.4	
Potassium(K2O)	0.85 %	17.0	
Sulfur(S)	0.18 %	3.7	1
Calcium(Ca)	1.99 %	39.8	2
Magnesium(Mg)	0.58 %	11.7	
Sodium(Na)	0.13 %	2.6	
Copper(Cu)	30 ppm	0.06	.04
Iron(Fe)	7208 ppm	14.42	0.09
Manganese(Mn)	506 ppm	1.01	0.71
Zinc(Zn)	96 ppm	0.19	0.13
Moisture	27.8 %		
Total Solids	72.2 %	1444.0	
Total Salts		72.7	
pH	8.7		



First year availability of nitrogen is calculated based on preplant application with incorporation within one day. Nitrogen available from previous years application not considered.

Total manure salts should not exceed 500 lbs/acre. Less than 500 lbs/acre if annual rainfall is less than 25 inches and/or the soil CEC is less than 12 meq/100g. Salt contributions from commercial fertilizer applications must also be considered. Soil test yearly to monitor phosphorus levels, organic matter, pH, and micronutrients. Spring soil test for residual nitrate - make accurate sidedress recommendations! Nitrogen availabilty will vary with methods of applicati and field conditions. The nitrogen availability values used on a manure management plan must comply with state regulation. These regulations vary from state to state.

Example 2 -- solid beef feedlot manure

This manure contains 11.3 lb N, 14 lb P_2O_5, and 17 lb K_2O per ton. The manure will be broadcast onto the land; it will not be incorporated.

The amount of **N available the year of application** is:11.3 lb X 0.35 = 4.0 lb N/ton of manure.

Correction for **volatilization loss**:

4.0 lb N x 0.7 **= 2.8 lb N/acre**

44 Deep Bedded Beef Barns

Nutrient	Average (#/Ton)	Minimum (#/Ton)	Maximum (#/Ton)
N	21.4	12.7	33.5
P2O5	15.2	7.7	28.7
K2O	17.7	10.5	25.5

THANK YOU!

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