Using the Penn State Manure Analysis Report

MA-1

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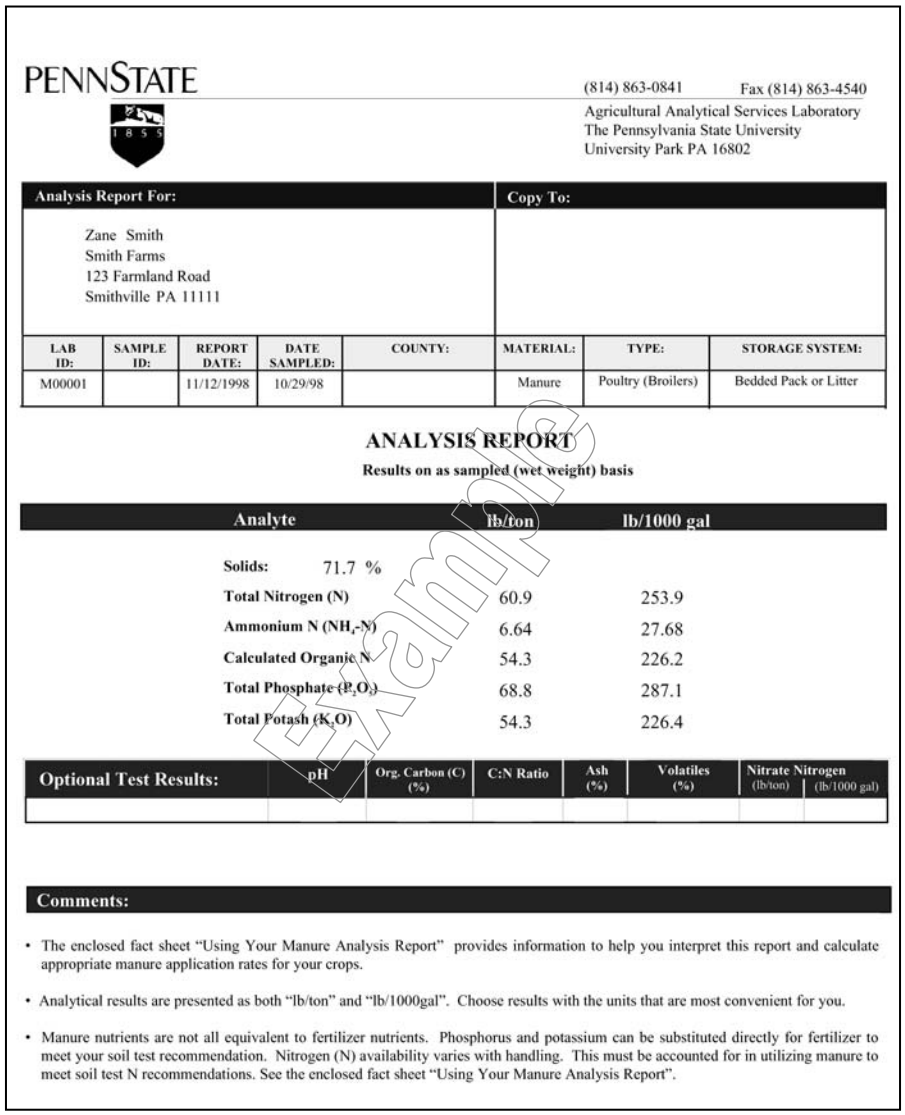

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Agricultural Analytical Services Laboratory
The Pennsylvania State University
University Park PA 16802

Analysis Report For:	Copy To:
Zane Smith Smith Farms 123 Farmland Road Smithville PA 11111	

LAB ID:	SAMPLE ID:	REPORT DATE:	DATE SAMPLED:	COUNTY:	MATERIAL:	TYPE:	STORAGE SYSTEM:
M00001		11/12/1998	10/29/98		Manure	Poultry (Broilers)	Bedded Pack or Litter

ANALYSIS REPORT

Results on as sampled (wet weight) basis

Analyte		lb/ton	lb/1000 gal
Solids:	71.7 %		
Total Nitrogen (N)		60.9	253.9
Ammonium N (NH_4-N)		6.64	27.68
Calculated Organic N		54.3	226.2
Total Phosphate (P_2O_5)		68.8	287.1
Total Potash (K_2O)		54.3	226.4

Optional Test Results:	pH	Org. Carbon (C) (%)	C:N Ratio	Ash (%)	Volatiles (%)	Nitrate Nitrogen (lb/ton)	Nitrate Nitrogen (lb/1000 gal)

Comments:

- The enclosed fact sheet "Using Your Manure Analysis Report" provides information to help you interpret this report and calculate appropriate manure application rates for your crops.
- Analytical results are presented as both "lb/ton" and "lb/1000gal". Choose results with the units that are most convenient for you.
- Manure nutrients are not all equivalent to fertilizer nutrients. Phosphorus and potassium can be substituted directly for fertilizer to meet your soil test recommendation. Nitrogen (N) availability varies with handling. This must be accounted for in utilizing manure to meet soil test N recommendations. See the enclosed fact sheet "Using Your Manure Analysis Report".

Example

Information on the Penn State manure analysis report

An example manure analysis report is shown at the left. The top of the report contains the identification information about the sample. The results for the standard test package that you requested are presented in the middle section. The results are on an "as sampled basis" so they can be used directly to calculate appropriate manure application rates. In all cases the results are given in units of both lb/ton and lb/1000 gal. These are the same analyses. Choose the analysis with units that are most convenient for you. For example, if you generally handle your manure as a liquid use the results presented in lb/1000 gal. Following the standard results are some comments about your results as appropriate. At the bottom of the report results of any optional tests that you requested are listed. Except as noted on the report, the results are for the total amount of the nutrient in the manure. The exception to this is that the total manure nitrogen (N) is broken down into ammonium-N and organic-N which is the difference between the total N and the ammonium-N.

Manure Application Rates

The main factors that must be considered when determining the amount of manure that can be applied to a field are: the crop nutrient requirement, the manure history of the field, the legume history of the field, any fertilizer that may be applied, the manure nutrient content, and the availability of the manure nutrient. Most nutrient management plans are based on balancing the N needs of the current crop with the manure application. This has been the primary approach because of the economic value of N for crops and because of the concern about nitrate pollution. However, when manure is applied based on N, excess P is often applied, which is a waste of P and also an environmental concern. In crop rotations where only some of the crops receive manure in a given year, manure can often be applied based on N because the excess P will be utilized by the unmanured crops in the rotation. In this situation P balance should be estimated for the rotation not just for a single year. In situations where manure is applied to a field almost every year, it is best to base the manure application rate on P to avoid applying excess nutrients. A P based manure rate will require more land over time to utilize the manure. Given these considerations you must decide which rate, N or P based, is most appropriate for your situation.

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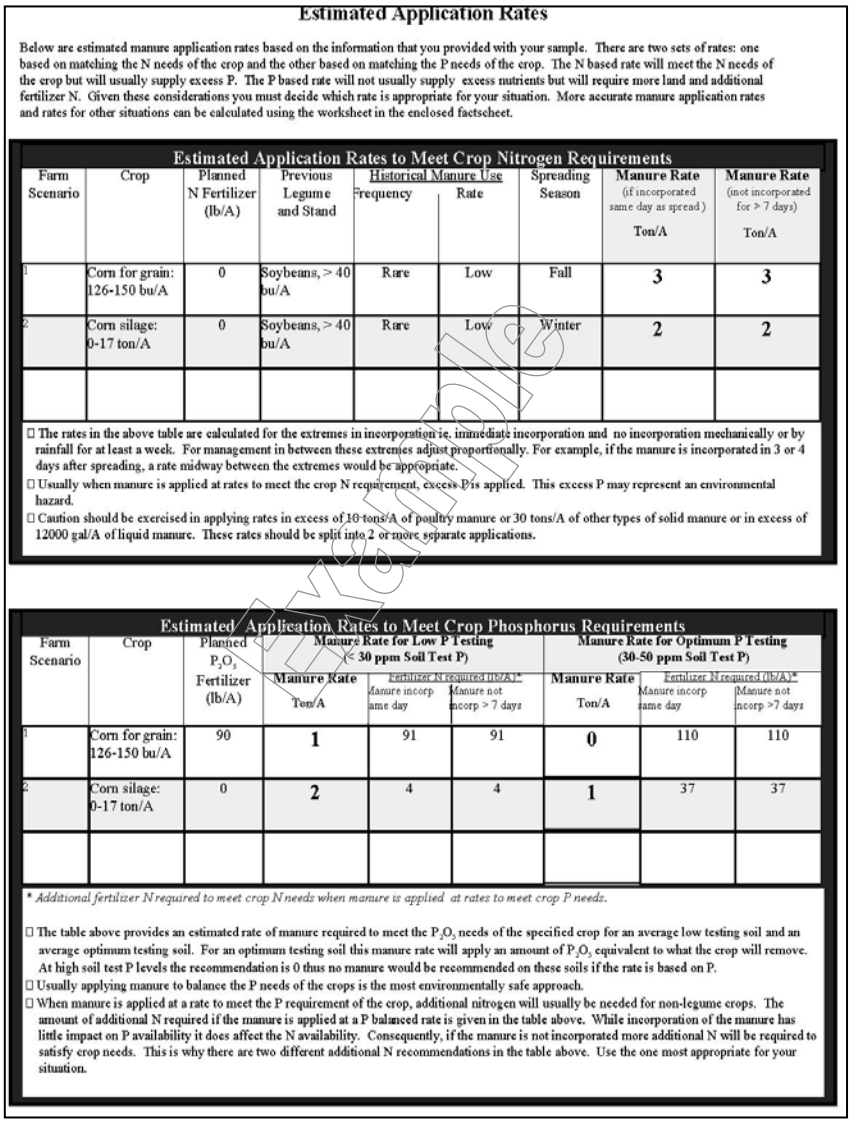

Estimated Application Rates

Below are estimated manure application rates based on the information that you provided with your sample. There are two sets of rates: one based on matching the N needs of the crop and the other based on matching the P needs of the crop. The N based rate will meet the N needs of the crop but will usually supply excess P. The P based rate will not usually supply excess nutrients but will require more land and additional fertilizer N. Given these considerations you must decide which rate is appropriate for your situation. More accurate manure application rates and rates for other situations can be calculated using the worksheet in the enclosed factsheet.

Estimated Application Rates to Meet Crop Nitrogen Requirements

Farm Scenario	Crop	Planned N Fertilizer (lb/A)	Previous Legume and Stand	Historical Manure Use: Frequency	Historical Manure Use: Rate	Spreading Season	Manure Rate (if incorporated same day as spread) Ton/A	Manure Rate (not incorporated for > 7 days) Ton/A
1	Corn for grain: 126-150 bu/A	0	Soybeans, > 40 bu/A	Rare	Low	Fall	3	3
2	Corn silage: 0-17 ton/A	0	Soybeans, > 40 bu/A	Rare	Low	Winter	2	2

- The rates in the above table are calculated for the extremes in incorporation ie. immediate incorporation and no incorporation mechanically or by rainfall for at least a week. For management in between these extremes adjust proportionally. For example, if the manure is incorporated in 3 or 4 days after spreading, a rate midway between the extremes would be appropriate.
- Usually when manure is applied at rates to meet the crop N requirement, excess P is applied. This excess P may represent an environmental hazard.
- Caution should be exercised in applying rates in excess of 10 tons/A of poultry manure or 30 tons/A of other types of solid manure or in excess of 12000 gal/A of liquid manure. These rates should be split into 2 or more separate applications.

Estimated Application Rates to Meet Crop Phosphorus Requirements

Farm Scenario	Crop	Planned P_2O_5 Fertilizer (lb/A)	Manure Rate for Low P Testing (< 30 ppm Soil Test P): Manure Rate Ton/A	Fertilizer N required (lb/A)*: Manure incorp same day	Fertilizer N required (lb/A)*: Manure not incorp > 7 days	Manure Rate for Optimum P Testing (30-50 ppm Soil Test P): Manure Rate Ton/A	Fertilizer N required (lb/A)*: Manure incorp same day	Fertilizer N required (lb/A)*: Manure not incorp >7 days
1	Corn for grain: 126-150 bu/A	90	1	91	91	0	110	110
2	Corn silage: 0-17 ton/A	0	2	4	4	1	37	37

** Additional fertilizer N required to meet crop N needs when manure is applied at rates to meet crop P needs.*

- The table above provides an estimated rate of manure required to meet the P_2O_5 needs of the specified crop for an average low testing soil and an average optimum testing soil. For an optimum testing soil this manure rate will apply an amount of P_2O_5 equivalent to what the crop will remove. At high soil test P levels the recommendation is 0 thus no manure would be recommended on these soils if the rate is based on P.
- Usually applying manure to balance the P needs of the crops is the most environmentally safe approach.
- When manure is applied at a rate to meet the P requirement of the crop, additional nitrogen will usually be needed for non-legume crops. The amount of additional N required if the manure is applied at a P balanced rate is given in the table above. While incorporation of the manure has little impact on P availability it does affect the N availability. Consequently, if the manure is not incorporated more additional N will be required to satisfy crop needs. This is why there are two different additional N recommendations in the table above. Use the one most appropriate for your situation.

Estimated Manure Application Rate

Estimated manure rates for up to three management scenarios are given on the back of the manure analysis report. (See example on the left) These rates are based on the manure analysis results and the information that you provided with your sample. There are several different rate options presented for each scenario. The first rates presented are based on meeting the crop N requirements. Because N availability is sensitive to when the manure is incorporated, two different rates are given. The first rate is the amount that would be needed if the manure is incorporated on the same day as it is spread. The represents the maximum availabiltiy of the manure N to the current crop. The second rate is the rate that would be needed if the manure is not incorporated for at least 7 days after application. Incorporation could be mechanical or by 1/2 inch of soaking rain. Without incorporation a significant amount of the N in the manure can be lost into the air. These two rates represent the extremes in application rates. If manure is incorporated after the day it is applied but before 7 days, a rate between these extremes should be choosen. For crops with high N requirements and the manure is not incorporated, the calculated manure application rate can be very high. Rates in excess of 10 ton/A of poultry manure, 30 ton/A of other solid manures, or 12000 gal/A of liquid manure should not be applied unless absolutely unavoidable and then these rates should be split into two or more separate applications.

The second set of rates calculated on the back of the report are based on meeting the P requirement of the crop. In the case of P the rate of manure required will depend on the level of P in the soil as determined by a soil test. Manure application rates are calculated based on recommendations for low testing soil and for an optimum testing soil. The manure application rate calculated for an optimum testing soil would supply P_2O_5 equal to what the crop will remove at the given yield level. For a high testing soil the P_2O_5 recommendation would be zero thus the manure rate would also be zero. Remember that a manure rate based on an actual soil test recommendation would be more accurate than these estimates based on average soil test levels. The worksheet in this factsheet can be used to make this calculation based on actual soil test recommendations. Manure application rates based on P will often not supply adequate N to meet crop needs. Thus additional fertilizer N will be necessary to supplement the manure. While incorporation of the manure has little impact on P availability it does affect the N availability. Consequently, if the manure is not incorporated more additional N will be required to supplement the manure N and thus satisfy crop needs. This is why there are two different additional N provided in each scenario. Use the one most appropriate for your situation.

Manure Rate Calculation Worksheet

The manure application rates on the manure analysis report are good estimates of appropriate manure application rates however, these can be refined and rates for other scenarios can be easily calculated. The following describes how manure rates are calculated and provides a worksheet that will enable you to refine the calculation of a manure application rate or determine the rate for other situations. The factors that go into determining an appropriate manure rate are discussed below and are included in the worksheet on the back. Numbers in parentheses refer to lines in the worksheet.

Crop nutrient Requirement (1) The soil test report provides a nutrient recommendation for the expected yield of the crop to be grown. This is the starting point for determining an appropriate manure application rate.

Fertilizer Applications (2) Any fertilizer nutrients that will be applied regardless of the manure application, such as starter fertilizer, or liquid N applied with the herbicide, should be deducted from the soil test recommendation before you calculate a manure rate.

Residual N from Previous Legume Crops (3) When the manure rate is based on N, the recommendation may need to be adjusted to account for residual nitrogen from previous legume crops in the rotation. Legume N credits can be found in Table 1. Note that if you are using a Penn State soil test and you provided the previous crop information, the legume credit is already deducted. If this is indicated on the soil test report do not make this adjustment again.

Table 1. Residual nitrogen contributions from previous legumes for corn production.

Previous crop	% Stand	Nitrogen credit (lb/A)
First year after alfalfa	>50% stand	80 – 120*
	25%-50% stand	60 - 80
	<25% stand	40
First year after clover or trefoil	>50% stand	60 - 90
	25%-50% stand	50 - 60
	<25% stand	40
First year after soybeans harvested for grain		1 lb N/bu soybeans

* Choose a based on the productivity of the field. ie use a higher number in the given range for more productive fields.

Residual N from Previous Manure Applications (4) When basing the manure rate on N, the basic N recommendation from the soil test may need to be adjusted to account for residual nitrogen from previous manure applications. Table 2 contains estimate of residual N from manure for some typical situations.

Table 2. Estimates of residual N from previous manure applications

Historical Manure Rate	Typical rates			Frequency of Manure Application		
	Dairy	Swine	Poultry	Rare or never	Frequent (4-8/10 yrs)	Continuous (>8/10yrs)
				Residual N (lb N/A)		
Low	15 ton or 6000 gal	5000 gal	3 ton	0	20	35
Medium	25 ton or 9000 gal	7500 gal	5 ton	0	35	60
High	35 ton or 12000 gal	10000 gal	7 ton	0	50	85

Select the historical rate that is similar to yours. For significantly higher or lower rates the residual N from the table can be adjusted proportionally.

This residual can also be estimated based on your actual manure history and analysis using the "Organic N decomposed from past applications" factors in Table 3. Multiply the appropriate factor in the table times the Organic N applied in past years and then sum these up. This method is most important when the amount and/or type of manure has varied significantly in the past.

Net Nutrient Requirement (6) The net nutrient requirement that can be met with the planned manure application is the crop requirement minus any fertilizer nutrient applications. For N also subtract the residual N from previous legume crops in the rotation or the residual N from past manure history.

Manure Nutrient Content (7) Because the manure analysis is on an "as sampled basis" you can take the analysis results directly from your manure analysis report.

Available Manure Nutrient Content (8-14) The manure analysis indicates the amount of total N, P_2O_5, and K_2O in the manure and the amount of ammonium N. For nutrient management plans based on P or K, it can be assumed that these nutrients are equivalent in availability to fertilizer. Not all of the N in manure is immediately available to the crop. The main factors that affect manure N availability are ammonium N content, season of application and incorporation. Table 3 provides factors to multiply times the ammonium N and organic N analysis to calculate the portion of the N in the manure that will be available to the planned crop. This calculation is only necessary for N.

Table 3. Factors for calculating manure nitrogen availability based on time of application, incorporation, field history, and manure analysis with ammonium and organic N fractions. Recommended for all manures, but required for atypical or treated manures. (Adapted from Klausner and Bouldin, Cornell University, Jokela, University of Vermont & Sims, University of Delaware)

TOTAL NITROGEN

AMMONIUM NITROGEN

Spring and Summer
For corn, grass hay, summer annuals

Days to Incorp.[1]	Poultry	Other	Swine
Immed.	.90	.80	.80
1	.80	.60	.60
2 - 4	.60	.40	.40
5 – 7	.40	.20	.20
>7	.20	.10	.10

Early Fall
For fall and spring use by grass hay and small grains

Days to Incorp.[1]	Poultry	Other	Swine
0 – 2	.50	.40	.40
3 – 7	.25	.20	.20
> 7	0	0	0

Late Fall and Winter
For summer use by corn or summer annuals with no cover crop or cover crop harvested for silage

	Poultry	Other	Swine
All	.20	0	0

For spring use by grass hay or small grains, or summer use by corn or summer annuals with green manure cover crop

All	.60	.50	.50

ORGANIC NITROGEN
(TOTAL N – AMMONIUM N)

Organic N decomposed during the year applied[2]

Dry Matter	Poultry	Swine	Other	Compost
< 18%	.60	.50	.35	.10
> 18%	.60	.50	.25	.10

Organic N decomposed from past applications[3]

Manure Applied	Manure	Compost
1 yr ago	.12	.05
2 yrs ago	.05	.02
3 yrs ago	.02	.01
4 yrs ago	.01	.01
5 yrs ago	.01	.01

[1] Mechanical incorporation or incorporation by ½ inch rain. Increase these factors by 0.2 after one day for very liquid manures (<5% solids) to account for soaking in on application.

[2] Use these factors for estimating organic N availability for current year.

[3] Use these factors as alternative to Table 2 for estimating residual N from previous manure applications.

Balanced manure application rate (15)
The calculated manure available N, P_2O_5 , or K_2O is divided into the net crop nutrient requirement for that element to determine the manure application rate that balances the needs of the crop for that nutrient. A different rate will be calculated for each nutrient.

Actual practical manure application rate (16) Choose the rate from the three that best fits your management objectives. This balanced rate is usually rounded to a practical application rate based on your manure spreader capabilities.

Net nutrient balance (18) If the actual practical rate to be applied is significantly less than the balanced rate, additional fertilizer nutrients will be required to meet the needs of the crop (positive numbers in 16). At a spreading rate greater than the balanced rate excess nutrients will be applied (negative numbers in 16) and can represent a potential environmental threat. Remember that using a balanced rate for one nutrient may result in a significant imbalance for another. As noted earlier, if manure is only applied to some crops in the crop rotation, annual excesses may be balanced out by nutrient use by other unmanured crops in the rotation. To check this, P balance should be estimated for the rotation.

Interpreting Additional Compost Analyses

Compost analysis can be used to determine the characteristics of raw materials and thus the appropriate mixtures to be used to make compost. The analysis is also useful for evaluating the quality of finished compost. Following are ranges in test levels desirable for rapid composting: C:N Ratio 25:1 to 35:1; Moisture 50 – 60 %; pH 5.5 – 8.5. Finished compost will have lower NH_4-N, C:N ratio and moisture levels than the starting mixture. Other tests can be interpreted similar to manure. For more information on making and using compost see the "Field Guide to On-Farm Composting" NRAES #114 available from: NRAES, 152 Riley-Robb Hall, Ithaca, NY 14853, (607) 255-7654.

Records

Records of manure applications should be kept both as a management tool and as verification that sound nutrient management practices are being followed in case of a complaint related to nutrient applications on the operation. It is difficult to make decisions about what practices to change in a nutrient management program with out having records such as soil tests, manure analysis, and crop yields. In addition, simple records of which fields manure was applied to, when manure was applied, how much was applied and any other nutrient applications will meet most needs.

Further Assistance

For more details on manure management and making these calculations to develop a nutrient management plan, see the current Penn State Agronomy Guide or the Manure Management Manual. Contact your local Penn State Extension office or Conservation District for assistance.

Prepared by: Douglas Beegle and Ann Wolf, Penn State University

Manure Rate Calculation worksheet

Field or Crop Group	Units	Example: Corn for grain 125 bu/A, Incorporated within 2-4 days in the spring					
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
1. Crop Nutrient Needs (Soil Test Recommendation)	[lb/A]	130	50	40			
2. Fertilizer Application (Other fertilizer to be applied regardless of manure applications)	[lb/A]	10	10	10			
3. Residual N from previous legume (Table 1)	[lb/A]	0					
4. Residual N from previous manure (Table 2)	[lb/A]	35					
5. Total Credits for fertilizer and residual N (line 2 + line 3 + line 4)	[lb/A]	45	10	10			
6. Net nutrient requirement (line 1 – line 5)	[lb/A]	85	40	30			
7. Manure nutrient content (Manure Analysis Report)	[lb/ton or lb/1000gal]	60.9	68.8	54.3			
8. Ammonium N (Manure Analysis Report)	[lb/ton or lb/1000gal]	6.64					
9. Ammonium N availability factor (Table 3)		.40					
10. Available ammonium N (line 8 x line 9)	[lb/ton or lb/1000gal]	2.7					
11. Organic N (Manure Analysis Report)	[lb/ton or lb/1000gal]	54.3					
12. Organic N Availability Factor (Table 3)		.60					
13. Available organic N (line 11 x line 12)	[lb/ton or lb/1000gal]	32.6					
14. Total available nutrients (N = line 10 + 13, P_2O_5 and K_2O = line 7)	[lb/ton or lb/1000gal]	35.3	68.8	54.3			
15. Balanced manure rates (line 6 ÷ line 14)	[ton/A or gal/A)	2.4	0.6	0.6			
16. Actual rate (Choose one from line 15 and round)	[ton/A or gal/A)	(N) 2.4 ton/acre					
17. Nutrients applied at the actual rate (line 16 x line 14)	[lb/A]	85	165	130			
18. Net Nutrient Balance (line 6 – line 17) (+ = need, - = excess)	[lb/A]	0	-125	-100			

Manure Rate Calculation worksheet

Field or Crop Group	Units						
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
1. Crop Nutrient Needs (Soil Test Recommendation)	[lb/A]						
2. Fertilizer Application (Other fertilizer to be applied regardless of manure applications)	[lb/A]						
3. Residual N from previous legume (Table 1)	[lb/A]						
4. Residual N from previous manure (Table 2)	[lb/A]						
5. Total Credits for fertilizer and residual N (line 2 + line 3 + line 4)	[lb/A]						
6. Net nutrient requirement (line 1 – line 5)	[lb/A]						
7. Manure nutrient content (Manure Analysis Report)	[lb/ton or lb/1000gal]						
8. Ammonium N (Manure Analysis Report)	[lb/ton or lb/1000gal]						
9. Ammonium N availability factor (Table 3)							
10. Available ammonium N (line 8 x line 9)	[lb/ton or lb/1000gal]						
11. Organic N (Manure Analysis Report)	[lb/ton or lb/1000gal]						
12. Organic N Availability Factor (Table 3)							
13. Available organic N (line 11 x line 12)	[lb/ton or lb/1000gal]						
14. Total available nutrients (N = line 10 + 13, P_2O_5 and K_2O = line 7)	[lb/ton or lb/1000gal]						
15. Balanced manure rates (line 6 ÷ line 14)	[ton/A or gal/A)						
16. Actual rate (Choose one from line 15 and round)	[ton/A or gal/A)						
17. Nutrients applied at the actual rate (line 16 x line 14)	[lb/A]						
18. Net Nutrient Balance (line 6 – line 17) (+ = need, - = excess)	[lb/A]						