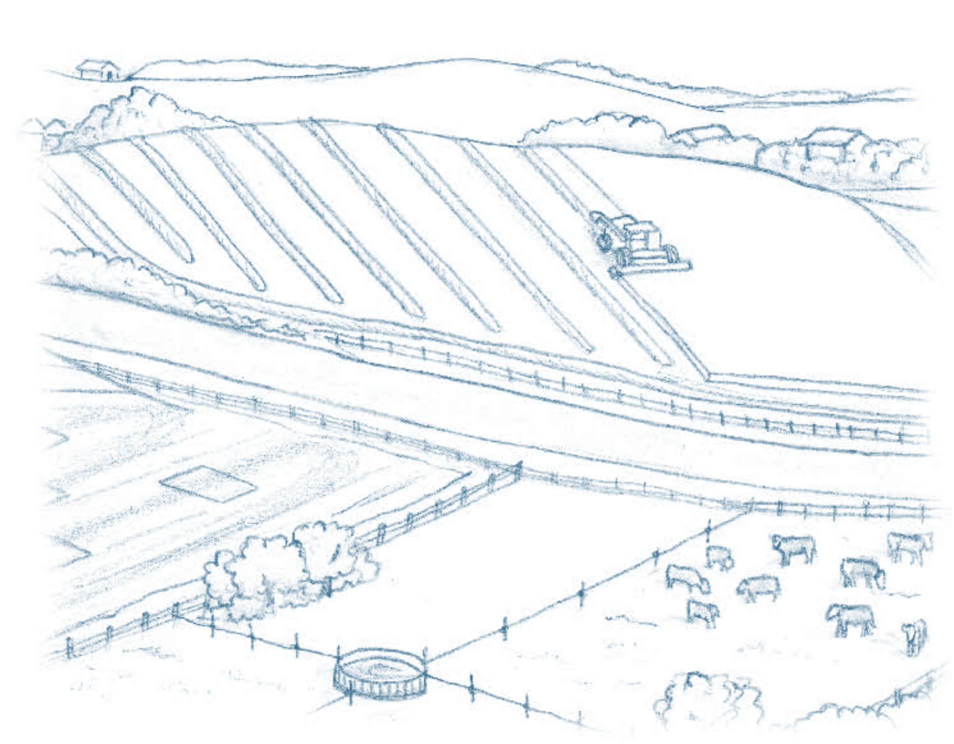
Chapter 6.1

Calculating Manure Application Rates and Fertilizer Requirements



learning objectives

- Calculate manure application rates.
- Calculate amounts of residual nitrogen and phosphorus applied.
- Determine whether available land base is sufficient.
- Determine additional fertilizer requirements.

Important Terms

Table 6.1.1 Key Terms and Definitions

Term	Definition
N-Based Application	A manure application rate calculated to meet the nitrogen (N) requirements of the crop.
P-Based Application	A manure application rate calculated to meet the phosphorus (P) requirements of the crop.
Reference Nutrient	The 'nutrient' on which the manure application rate was based or developed (e.g., nitrogen, phosphorus).
Threshold Application Rate	A simple calculation to determine whether the eligible land base will be sufficient to accommodate the total annual manure collected.

One of the most critical tasks in manure nutrient management planning is determining the appropriate manure application rates to get the desired crop productivity. It is also necessary in certain scenarios to determine fertilizer application rates to meet any nutrient requirements not met through manure application. These activities involve using information discussed in earlier chapters, including:

- available land base
- soil nutrient profile
- crop nutrient requirements
- nutrient content of manure
- application method and conditions

This chapter will work through the procedure for calculating manure application rates and determining fertilizer requirements. A hypothetical case study will be used to illustrate and reinforce the principles in each step.

Calculating Manure Application Rates

Calculating manure application rates involves four steps:

1. Estimate available nutrient content of manure
2. Determine crop nutrient requirements
3. Determine basis for application rate calculation
4. Calculate manure application rate

If manure is sampled during loading or application use "book values" or historical information on bulk density and manure nutrient content to calculate manure application rates. Once bulk density and manure analysis information is available repeat the calculations using this information to determine the correct manure and nutrient application rates and determine whether additional fertilizer is required.

Once the application rate has been determined, estimate the amount of nutrients that will become available in that year plus subsequent years, from that application. If a whole farm nutrient management plan is being developed determine whether additional area is required to apply all of the manure at agronomic rates.

Large surpluses of manure may suggest a need to:

- Build cooperative relationships with surrounding landowners to secure additional land for manure application.
- Consider alternative treatment measures, such as solid-liquid separation technologies or composting to increase the distance manure can be transported economically.
- Develop marketing options for the manure produced.

Estimate Available Nutrient Content of Manure

Chapter 4.2 described techniques for manure sampling. Once the results of the manure analysis are available the amount of crop available nutrients in the manure can be calculated, as illustrated in Chapter 4.3. Crop available nutrient content is a main factor that will influence manure application rate calculations.

» Crop Available Nutrient Calculations

Several equations used to estimate crop available nutrient content of manure, originally presented in Chapter 4.3, are presented here for reference purposes. For a more detailed discussion of estimating crop available nutrient content refer to Chapter 4.3.

Crop Available N Calculations

Organic N = Total N – NH_4-N

Available Organic N (year 1) = Organic N × 0.25

Available Organic N (year 2) = Organic N × 0.12

Available Organic N (year 3) = Organic N × 0.06

Retained NH_4-N = NH_4-N × Retention Factor (Table 4.3.4)

Estimated Crop Available N = Available Organic N (year 1) + Retained NH_4-N

Crop Available P Calculations:

Estimated Crop-Available P (year 1) = Total P × 0.7

Estimated Crop-Available P (year 2) = Total P × 0.2

Estimated Crop-Available P (year 3) = Total P × 0.06

Crop-Available K Calculations:

Estimated Crop-Available K = Total K × 0.9

Crop Availability of Other Nutrients in Manure

There is little need to be concerned about the crop availability of Ca, Mg and micronutrients (e.g., iron, zinc, copper) in manure. In Alberta soils deficient in nutrients other than N, P, K are rare, particularly if a field has received manure in recent memory.

Also due to the balance (or imbalance) of nutrients in manure, if application rate is based on either N or P, all other nutrients will likely be applied at rates several times higher than agronomic requirements.

Estimating Crop Available Nutrient Content

Lab analysis of liquid and solid manure sources yielded the following nutrient content information:

Source	Moisture	Total N (wet basis)	NH_4-N[1] (wet basis)	Total P (wet basis)	Total K (wet basis)
Liquid	92 %	3.8 g/L	1.9 g/L	1.0 g/L	4.3 g/L
Solid	50 %	8.3 kg/t	2.0 kg/t	2.3 kg/t	6.9 kg/t

[1] NH_4-N is Ammonium-Nitrogen

Crop Available N

Liquid manure source:

Organic N (g/L) = 3.8 g/L – 1.9 g/L

Organic N (g/L) = 1.9 g/L

Available Organic N, year 1 (g/L) = 1.9 g/L × 0.25

Available Organic N, year 1 (g/L) = 0.5 g/L

Since the intention is to inject manure during wet/cool spring conditions:

Retained NH_4-N (g/L) = 1.9 g/L × 1.00 (from Table 4.3.4)

Retained NH_4-N (g/L) = 1.9 g/L

Crop Available N (g/L) = 0.5 g/L + 1.9 g/L

Crop Available N (g/L) = 2.4 g/L

Solid manure source:

Organic N (g/kg) = 8.3 kg/t – 2.0 kg/t

Organic N (g/kg) = 6.3 kg/t

Available Organic N, year 1 (kg/t) = 6.3 kg/t × 0.25

Available Organic N, year 1 (kg/t) = 1.6 kg/t

Since the intention is to surface apply during wet/cool spring conditions and incorporate within 2 days:

Retained NH_4-N (g/kg) = 2.0 kg/t × 0.87 (from Table 4.3.4)

Retained NH_4-N (g/kg) = 1.7 kg/t

Crop Available N (g/kg) = 1.6 kg/t + 1.7 kg/t

Crop Available N (g/kg) = 3.3 kg/t

Crop Available P

Liquid manure source:

Crop Available P (year 1) (g/L) = 1.0 g/L × 0.7

Crop Available P (year 1) (g/L) = 0.7 g/L

Solid manure source:

Crop Available P (year 1) (g/kg) = 2.3 kg/t × 0.7

Crop Available P (year 1) (g/kg) = 1.6 kg/t

Crop Available K

Liquid manure source:

Crop Available K (g/L) = 4.3 g/L × 0.9

Crop Available K (g/L) = 3.9 g/L

Solid manure source:

Crop Available K (kg/t) = 6.9 kg/t × 0.9

Crop Available K (kg/t) = 6.2 kg/t

Summary of crop available nutrient content for the solid and liquid manure sources in the year of application:

Source	Crop Available N	Crop Available P	Crop Available K
Liquid	2.4 g/L	0.7 g/L	3.9 g/L
Solid	3.3 kg/t	1.6 kg/t	6.2 kg/t

It may be necessary to convert units appearing on the lab report, depending on testing facility and the units used in subsequent calculations. Many of the common conversions were presented in Table 4.3.3 (Chapter 4.3).

Determine Crop Nutrient Requirements

Use fertilizer recommendations generated by a testing facility based on representative soil samples to determine crop nutrient requirements. Remember that lab recommendations for P and K are reported as kg or lb of P_2O_5 and K_2O, respectively, which is not useful when applying manure. Available P and K content of manure must be converted to available P_2O_5 and K_2O in order to calculate manure application rate using fertilizer recommendations.

To convert P to P_2O_5, and K to K_2O, use the following equations:

$$P_2O_5 = P \times 2.29$$

$$K_2O = K \times 1.20$$

For situations where, for one reason or another, soil testing on an annual basis is either not possible or practical, an alternative strategy will need to be used. In order of preference, some alternatives are:

- Use fertilizer recommendations from comparable soil analysis results. This could include past recommendations for that field or recommendations for neighbouring fields under similar management.
- Use historical application rates, provided historical yield, quality (e.g., protein) and production factors (e.g., lodging, maturity) suggest that these rates were appropriate.
- Apply manure nutrients so as to replace nutrients removed by the crop at expected yields (Appendix 6). Information on historical yields can help estimate crop nutrient removal.

Note that none of these approaches are acceptable substitutes for soil testing in the long term but may be reasonable compromises if annual sampling of all fields is not possible. Remember that for a field to be eligible to receive manure AOPA requires soil analysis from within the last 3 years.

more info

A useful online calculator is available on Ropin' the Web, to estimate crop uptake and or removal for several crops at various yields. To access this calculator, visit Ropin' the Web and select the "Calculators" tab from the horizontal toolbar on the homepage. The calculator is called "Grains, Forage and Straw Nutrient Use".

Case Study: Determining Crop Nutrient Requirements

Based on the background information provided and results of the soil analysis the testing facility recommended the following fertilizer rates for a field:

Recommendations based on expected moisture conditions during growing season								
Dry (130 mm)			Average (200 mm)			Wet (270 mm)		
N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
22 kg/ha 20 lb/ac	22 kg/ha 20 lb/ac	-	44 kg/ha 40 lb/ac	28 kg/ha 25 lb/ac	-	78 kg/ha 70 lb/ac	39 kg/ha 35 lb/ac	-

Based on long-term weather patterns, expected crop prices and the fact that the manure has only a small cost associated with it (relative to fertilizer), manure application rate to be developed was based on the fertilizer recommendations for wet conditions.

Determine Basis for Application Rate

» N-Based Application

Current practice in Alberta is to base manure application on crop available N, which is the first limiting nutrient in most Alberta cropping scenarios. The impact this practice has on levels of other nutrients in the soil should be considered. By applying manure based on N, other nutrients including P and K will be simultaneously applied at rates that exceed crop removal. This is due to the typical nutrient content of most manure. This has three important implications:

- Applying nutrients above their agronomic requirement prevents the full economic value of manure to be realized.
- Research has clearly demonstrated that long-term application of P above agronomic rates is contributing to P build-up in surface soil layers to the point that the risk of runoff losses is increased. Loss of P to surface water is a significant environmental concern.
- High soil test levels of certain nutrients can impair the crop's ability to take up other essential nutrients (e.g., high soil test P can impair zinc uptake).

If manure is to be applied based on N, monitor soil test P levels regularly. Crops generally do not respond to soil test P levels above 112 kg/ha (100 lb/ac) in the top 15 cm of soil and higher levels increase the risk of runoff losses.

Due to equipment limitations it may be necessary to apply more than one-year's worth of manure, particularly if only small rates of manure application are suggested for a particular field.

» P-Based Application

One way of avoiding nutrient accumulation in soils is to apply manure based on P. At present, however, there is no one single prescribed strategy for applying manure on a P basis. One of the major constraints to P-based application is that current application technologies are not able to consistently apply manure at the low rates that would be required to meet agronomic P requirements for a single crop year. Even if technology allowed, it has been estimated that doing so would likely increase the area required for manure application by anywhere from 3 to 6 times compared to N-based application.

A logical P-based application strategy, if land base allows, would involve applying manure so as to supply three to four years worth of P in a single application. One consideration for using this approach is that while only 70 % of total manure P will be available in the year of application, much of the remaining P will come available over the subsequent two years.

A P-based application strategy that supplies three to four years worth of P will require supplemental N fertilizer applications to support subsequent crops. Annual soil sampling is recommended to determine N fertilization requirements and to monitor levels of soil test P. If soil test P remains high after the third year subsequent manure applications should be delayed. Whenever applying multiple years worth of P take precautions to minimize the risk of P losses in runoff by adopting suitable land management practices (see Chapters 8.2 and 8.3).

If land base relative to manure production is restricted, arrangements will likely need to be made with neighbouring landowners to secure additional area.

Calculate Manure Application Rate

Calculate application rate by dividing the recommendation for the nutrient being used as the basis for application (i.e., reference nutrient, N or P) by its concentration in the manure.

The generic calculation of manure application rate is:

Application rate =
Reference nutrient recommendation ÷ Reference manure nutrient concentration

Remember that if application is based on P, concentration of available P in the manure must be converted to a P_2O_5 basis in order to use the fertilizer recommendations from the soil analysis. In some instances, it may be also be necessary to convert factors in the equation so that the units are consistent.

Case Study: Calculating Manure Application Rate

Recall that manure application will take place under wet, cool conditions, liquid manure will be injected and solid manure is surface applied and incorporated within two days. Application rates will be calculated for the following scenarios:

1. Single-year application based on manure available N
2. One-time application of two years worth of manure available N
3. One time, three-year application based on manure available P

To review:

- The liquid manure source contains:
  2.4 g/L crop available N
  0.7 g/L crop available P
  3.9 g/L crop available K

- The solid manure source contains:
  3.3 kg/t crop available N
  1.6 kg/t crop available P
  6.2 kg/t crop available K

- The fertilizer recommendations for the field, based on soil test results were 78 kg/ha of N and 39 kg/ha of P_2O_5

Scenario 1: N-based; Single-Year Application Rate

Liquid manure:

The target application rate to supply one year's worth of available N is:

Application rate (metric units) = 78 kg/ha ÷ 2.4 kg/1,000 L* × 1,000

Application rate (metric units) = 32,500 L/ha

To convert this to imperial units:

Application rate (imperial units) = 32,500 L/ha × 0.089 (Table 4.3.3)

Application rate (imperial units) = 2,893 gal/ac

*Nutrient concentrations in g/L are the same as kg/1,000 L

Solid manure:

The target application rate to supply a single year's worth of available N is:

Application rate (metric units) = 78 kg/ha ÷ 3.3 kg/ t

Application rate (metric units) = 23.6 t/ha

To convert this to imperial units:

Application rate (imperial units) = 23.6 t/ha × 0.4461 (Table 4.3.3)

Application rate (imperial units) = 10.5 tn/ac

Scenario 2: N-based; One Time, Two-Year Application Rate

When applying multiple years' worth of N do not exceed AOPA NO_3-N limits for the soil zone (Chapter 4.4). In calculating available manure N be sure to account for mineralization of organic N in the year following the application. Since approximately 12% of the organic N fraction will become available in the year following application, the crop available N estimate must be adjusted for additional N:

Available Organic N (years 1 and 2) = Total Organic N × (0.25 + 0.12)

Crop Available N = Available Organic N (years 1 and 2) + Retained NH_4-N

Liquid manure

Available Organic N, years 1 and 2 (g/L) = 1.9 g/L × (0.25 + 0.12)
= 0.7 g/kg

Crop Available N (g/L) = 0.7 g/L + 1.9 g/L
= 2.6 g/L

The target application rate to supply 2 years worth of N would be:

Application rate (metric units) = 2 × 78 kg/ha ÷ 2.6 kg/1000 L* × 1000
= 60,000 L/ha

Application rate (imperial units) = 60,000 L/ha × 0.089 (Table 4.3.3)
= 5,340 gal/ac

*Nutrient concentrations in g/L are equivalent to kg/1000 L

Solid manure

Available Organic N, years 1 and 2 (g/kg) = 6.3 kg/t × (0.25 + 0.12)

Available Organic N, years 1 and 2 (g/kg) = 2.3 kg/t

Crop Available N (g/kg) = 2.3 g/kg + 1.7 g/kg

Crop Available N (g/kg) = 4.0 kg/t

The target application rate to supply 2 years worth of N would be:

Application rate (metric units) = 2 × 78 kg/ha ÷ 4.0 kg/t
= 39 t/ha

Application rate (imperial units) = 39 t/ha × 0.4461 (Table 4.3.3)
= 17.4 tn/ac

Scenario 3: P-based; One Time, Three-Year Application Rate

Since residual manure P will be mineralized in the years following application, the same procedure as in the previous scenario is followed to correct the estimated crop available P content:

Crop Available P (years 1, 2 and 3) = Total P × (0.7 + 0.2 + 0.06)

Crop Available P_2O_5 (years 1, 2 and 3) = Crop Available P × 2.29

Liquid manure:

Crop Available P; years 1, 2 and 3 (g/L)	= 1.0 g/L × (0.7 + 0.2 + 0.06)
	= 0.96 g/L
Crop Available P_2O_5, years 1, 2 and 3 (g/L)	= 0.96 g/L Available P × 2.29
	= 2.20 g/L

The target application rate to supply 3 years worth of P would be:

Application rate (metric units)	= 3 × 40 kg/ha ÷ 2.20 kg/1,000 L* × 1,000
	= 54,545 L/ha
Application rate (imperial units)	= 54,545 L/ha × 0.089 (Table 4.3.3)
	= 4,854 gal/ac

*Nutrient concentrations in g/L are equivalent to kg/1000 L

Solid manure:

Adjusted Crop Available P (kg/t)	= 2.3 g/kg × (0.7 + 0.2 + 0.06)
	= 2.21 kg/t
Crop Available P_2O_5, years 1,2 and 3 (kg/t)	= 2.21 kg/t Available P × 2.29
	= 5.06 kg/t

The target application rate to supply 3 years worth of P would be:

Application rate (metric units)	= 3 × 40 kg/ha ÷ 5.06 kg/t
	= 23.7 t/ha
Application rate (imperial units)	= 23.7 t/ha × 0.4461(Table 4.3.3)
	= 10.6 tn/ac

Calculating Amounts of Residual N and P Applied

There can be substantial excess application of certain nutrients depending on whether application rate is P-based or N-based. After calculating a target application rate, calculate the rates at which other nutrients will be applied.

Portions of residual organic N and P applied will become available in subsequent years. These will not be reflected in subsequent soil tests, but will impact fertilizer requirements.

Determining Application Rates of Other Manure Nutrients

Using the calculated application rates for solid and liquid manure from scenario 1 of the previous example, where manure application was based on a one-year supply of available N:

Solid application rate = 23.6 t/ha

Liquid Application rate = 32,500 L/ha

Available N applied in both situations = 78 kg/ha

The resulting application rates for total and available P and P_2O_5 are:

Liquid manure

Total P applied (kg/ha) = 32,500 L/ha ÷ 1,000 × 1.0 kg/1,000 L

Total P applied (kg/ha) = 32.6 kg/ha

Total P_2O_5 applied (kg/ha) = 32.6 kg/ha × 2.29

Total P_2O_5 applied (kg/ha) = 74.7 kg/ha

By using the factors presented earlier (Estimated crop available P in: year 1 = Total P x 0.7, year 2 = Total P x 0.2, and year 3 = Total P x 0.16), this translates to the following nutrient applied by the liquid manure application:

	Year 1	Year 2	Year 3
	kg/ha	kg/ha	kg/ha
Retained NH_4-N applied	61.8	N/A	N/A
Available organic N	16.3	7.4	3.7
Total crop available N	78	7.4	3.7
Available P	22.8	6.5	2.0
Available P_2O_5	52.2	14.9	4.6

Solid manure

Total P applied (kg/ha) = 23.6 t/ha × 2.3 kg/t

Total P applied (kg/ha) = 54.3 kg/ha

Total P_2O_5 applied (kg/ha) = 54.3 kg/ha × 2.29

Total P_2O_5 applied (kg/ha) = 124.3 kg/ha

By using the factors presented earlier (Estimated crop available P in: year 1 = Total P x 0.7, year 2 = Total P x 0.2, and year 3 = Total P x 0.16), this translates to the following nutrient applied by the solid manure application:

	Year 1	Year 2	Year 3
	kg/ha	kg/ha	kg/ha
Retained NH_4-N applied	40.1	n/a	n/a
Available organic N	37.2	17.8	8.9
Total crop available N	78	17.8	8.9
Available P	38.0	10.9	3.3
Available P_2O_5	87.0	24.9	7.5

sidebar

The rate at which other nutrients were applied can also be calculated, provided the concentrations of these in the manure were analyzed and reported, the application rate and availability estimates (if applicable) are known.

For the solid manure source in the above example, total P would be applied in excess of crop requirements. This means that if this manure was applied annually, based on a single year's requirement of available N, P would begin to accumulate in the soil.

This example illustrates the value of doing these calculations as well as the value of soil and manure testing. Depending on the natural risks (e.g., presence of neighbouring water bodies, high soil test phosphorus) associated with this field it might be advisable to consider basing application on P recommendations. Remember that if you choose a P-based application strategy soil N and P status needs to be monitored to ensure adequate nutrients for subsequent crops.

Manure Supply versus Available Land Base

If a farm-scale, multiple field nutrient management plan is being developed it is important to determine whether the supply of manure will exceed the available land base eligible to receive manure.

Calculating the land base required to apply stockpiled manure requires three pieces of information:

- manure application rate
- area eligible to receive manure
- total volume or weight of manure to be applied

The method for calculating manure application rates was described earlier in this chapter. The area eligible to receive manure is determined during the site assessment, taking into account physical limitations and legislated application setbacks.

Refer to Chapters 3.1 and 3.2 for more information on site assessment and determining the area of a field eligible to receive manure. Legislated constraints to manure application under the *Agricultural Operation Practices Act* (AOPA), which also impacts area available for application can be found in Chapter 4.4.

Use either standard estimates for manure production or estimate volume directly using the procedures and calculations outlined in Chapter 4.1 (preferred method). Solid manure is expressed in terms of weight, which requires that density of the material be considered. In the absence of a measured density average values for common livestock manures are presented in Table 6.1.2.

Table 6.1.2 Estimated Density of Selected Solid Manure Sources

	Manure Density	
Species/Class	kg/m³	lb/ft³
Beef, cows/finishers	655	40.9
Beef, feeders	641	40.0
Swine, farrow-to-finish	796	49.7
Swine, grow/finish	772	48.2
Poultry, broilers/pullets	320	20.0
Poultry, turkey toms	248	15.5
Sheep, ewes/rams	497	31.0
Goats, general	497	31.0
Horses, feeders	529	33.0

Derived from values presented in AOPA: Manure Characteristics and Land Base Code (2006).

In the event that manure supply exceeds eligible land base, additional land will need to be found in order to apply manure sustainably. This may require arrangements or formal agreements to be made with neighbouring landowners.

If eligible land base exceeds manure supply the issue then becomes how to prioritize fields for application to maximize economic benefit. Fields can be prioritized based on:

- distance to field from storage
- fertility requirements (e.g., high nutrient use crops, high fertilizer recommendations)
- value of the crop to be grown
- the presence of degraded soils (e.g., eroded areas, low organic matter, poor tilth) that would benefit from manure application
- the desire to minimize nuisance to neighbours or environmental risk
- accessibility or flexibility in crop management

Distance from the storage site to the application site is probably the biggest single factor influencing the economics of manure usage. In most situations, fields closest to the manure source are manured the most. For operations with a history of manure application, however, applying manure to fields further away may help to reduce nutrient build-up in fields closer to the manure source. In addition, this may help to extract greater economic benefit from manure nutrients since they will be used to support crop growth rather than contributing to nutrient surpluses in soil.

Crops with higher economic value (e.g., canola) may yield greater economic returns from the nutrients applied than lower value crops (e.g., oats). Degraded or poor quality soils can often benefit the most from manure application. This is due to soil building properties of manure as well as nutrient content, which help to improve the general productivity of these areas.

Fields may also be prioritized so as to minimize odour complaints from neighbours. Selecting fields with minimal natural environmental risk (e.g., slope or proximity to water bodies or other sensitive areas) is another strategy for prioritizing fields for application. Different cropping scenarios (e.g., silage production, fall cereals, forages) may offer potential for flexibility in manure allocation strategy. Fields that are drier earlier in the season may be given priority so manure application can begin earlier in the spring, reducing compaction issues and taking advantage of released nutrients.

» Determining Whether Land Base is Sufficient

A simple calculation can help a producer determine whether the eligible land base will be sufficient to accommodate annual manure production:

Threshold Application Rate =

Annual Manure Production ÷ Eligible Application Area

Based on the application strategy selected, if manure is applied at rates higher than this threshold, the eligible area will be sufficient. If manure is to be applied at a rate lower than this threshold, additional area will be required.

Determining Whether Available Land Base is Sufficient

From the earlier case study, the liquid manure source contained 3,200,000 L, while the solid manure source contained 984 t. The total area available for annual liquid manure application is 130 ha and the total area available to receive solid manure on an annual basis is 106 ha. The threshold annual application rates for these two manure sources and land bases are:

Threshold application rate for liquid manure (L/ha) = 3,200,000 ÷ 130 ha

= 24,600L/ha/yr

Threshold application rate for solid manure (t/ha) = 984 t÷ 106 ha

= 9.28 t/ha/yr

Compare these threshold application rates to the application rates calculated in the case study:

Manure Source	Application Scenario 1 (N-based, single year application)	Application Scenario 2 (N-based, two year application)	Application Scenario 3 (P-based, three-year application)
Liquid	32,500 L/ha/yr	60,000 L/ha/2 yrs (= 30,000 L/ha/yr)	54,545 L/ha/3 yrs (= 18,181 L/ha/yr)
Solid	23.6 t/ha/yr	39 t/ha/2 yrs (= 19.5 t/ha/yr)	23.7 t/ha/3 yrs (= 7.9 t/ha/yr)

The total area of 130 ha, for the annual liquid manure application, has a threshold application rate of 24,600 L/ha/year. Therefore, there is sufficient land base avaialble for the one-year and two-year N based application rates scenarios. Unfortunately, there is insufficient land base available for the liquid manure applied on a three-year P based application scenario. An additional 46 ha would be required to accommodate all the manure produced (3,200,000 L/year) if it was applied at the equivalent of 18,181 L/ha/year or 54,545 L/ha once every three years.

The total area of 106 ha, for the annual solid manure application, has a threshold application rate of 13.1 to/ha/year. Therefore, there is sufficient land base available for the one-year and two-year N based application rates scenarios. Unfortunately, there is insufficient land base available for the solid manure applied on a three-year P based application scenario. An additional 19 ha would be required to accommodate all the manure produced (984 t/year) if it was applied at the equivalent of 7.9 t/ha/yr or 23.7 t/ha once every three years.

» Estimating Additional Land Base Required

If it has been determined that the existing application area controlled by the operations is insufficient to accommodate annual manure production, the additional area can be estimated:

Additional Area Required = (Annual Manure Production ÷ Calculated Application Rate) - Current Eligible Area

Estimating Additional Land Base Required

The liquid manure source in the previous example had a total volume of 3,200,000 L and the intention is to apply this manure to meet the available P needs, three year application. The calculated application rate for this scenario is 18,181 L/ha, but the operation currently only has access to 130 ha. The additional land base required is:

Additional Area Required (ha)

= 3,200,000 L/yr ÷ 18,181 L/ha – 130 ha

= 176 ha/yr – 130 ha

= 46 ha/yr

The two examples above touch on some important calculations that CFO operators should consider. To apply manure at agronomic or sustainable rates many CFO's may require additional land to accommodate annual manure production. This issue is likely to become of greater concern to producers if legislation is introduced in the future that requires manure application to be based on phosphorus.

Estimating Remaining Fertilizer Requirements

Once manure nutrient application rates have been calculated (or verified after the fact) identify remaining nutrient deficits by subtracting nutrients applied (in manure) from fertility recommendations on the soil report. Fertilizer suppliers can typically develop a fertilizer blend customized to meet specific needs.

tip

Remember to account for nutrients that mineralize from manure with time when calculating fertilizer application rates for subsequent crops.

summary

- When calculating manure application rates consider the available nutrient content of manure, soil test results, crop nutrient recommendations and the application strategy (application method and basis for rate calculations).
- Once the basis for calculating application rates has been determined the application rates for N and P can be calculated by multiplying their estimated content in the manure by the application rate. If applying multiple years worth of manure, be sure to factor in mineralization of manure nutrients.
- There can be substantial excess application of certain nutrients depending on whether application rate is P-based or N-based. After calculating a target application rate, calculate the rates at which other nutrients will be applied. Portions of residual organic N and P applied will become available in subsequent years.
- Dividing the annual volume or weight of manure to be applied by the available land base will give the threshold application rate for an operation. By comparing this to the calculated application rate it is possible to determine whether the available land base will be sufficient.
- Estimating fertilizer requirements is easier because fertilizer recommendations are expressed on the same basis as fertilizer nutrient content, fertilizer nutrients are in crop-available forms and fertilizers can be custom blended to achieve a particular nutrient ratio.