5 Understanding the Soil Test & Manure Test Reports

5.1 The Soil Test Report and the Fertilizer Recommendation

The purpose of soil testing is to measure the amount of available nutrients in the soil in order to establish the amounts of additional nutrients that should be applied to meet the crop nutrient requirements. Soil testing and fertilizer recommendations have been used to enhance crop production, maximize economic return and minimize environmental impact on soil, water and air.

Most laboratories provide fertilizer recommendations on the soil test reports. The fertilizer recommendations are based on crop nutrient requirements, available soil nutrients and target yields for specific crops. In addition to the soil test results, there are several other factors that can be used to refine the fertilizer recommendation. These include: soil type, soil zone (Saskatchewan and Alberta), soil moisture, crop type, target yield, crop and fertilizer prices, whether the crop system is irrigated or dryland, and previous manure applications.

> The accuracy of the fertilizer recommendation relies on target yields that are realistic and based on expected moisture availability. In order to generate an accurate fertilizer recommendation, the laboratory must know which crop type will be grown and be given a realistic target yield. Target yields can be provided by customers based on recent yield data from their operations (such as a five-year average plus 10%). If the customer does not specify a target yield, most laboratories will base their fertilizer recommendations on regional average and optimum yield goals, which may not be representative of the operation's expected yield.

5.1.1 Why Fertilizer Recommendations May Differ

In developing fertilizer recommendations, each laboratory may consider several factors that will predict a targeted crop response at the most economic rate of fertilizer application. Factors such as target yield, soil moisture, crop price and the cost of fertilizer may be considered when developing a fertilizer recommendation. Laboratories may differ in their recommendations because they weigh the importance of the various factors differently. It is important to be confident in the recommendations of the laboratory. If a recommendation is given that does not appear reasonable, an explanation should be requested or a qualified agronomist consulted.

Some laboratories may give different recommendations for manure than for commercial fertilizer. This can occur if the laboratory considers the cost of fertilizer as a factor limiting the amount of fertilizer to be applied. Manure is often given free of charge to neighbouring landowners or sold at a fraction of its equivalent fertilizer value. As a result, the cost of manure is assumed to be lower and less limiting, and the recommendation may be less conservative.

5.2 Manure Test Reports: Unit Conversions

Laboratory reports use a variety of units to express the nutrient content of manure. In some instances, the results must be converted before they can be used to calculate a manure application rate.

Different laboratories report manure test results in different units. Scientists generally use metric units, but many producers are more comfortable using the imperial system of measurement.

Appendix A contains most of the conversion factors used for nutrient management planning. However, when there is no conversion table at hand, it is helpful to understand how the conversions are calculated. Below are various examples of conversion calculations that can be used with the manure test report results.

5.2.1 Conversions for Solid Manure Samples

The figures contained in table 5.1 are used in the following examples of solid manure conversions.

Table 5.1 Example of a Solid Beef Manure Test Report

Parameter	Lab Units[1] % and ppm		Metric Units kg/tonne
	Dry Basis	Wet Basis ("as received")	Wet Basis ("as received")
Moisture Content		69.5	
Total N	1.7	0.52	5.2
Ammonium N	2,243	684	0.684
Phosphorus	0.20	0.06	0.6
Potassium	1.08	0.33	3.3

[1] all analyses in this column are in % except for Ammonium N which is in ppm

Converting From a Dry-Weight to a Wet-Weight Basis

The nutrient content of the manure may be provided on a wet-weight (as-received) basis or a dry-weight basis. Since the manure is being land-applied "as-received", it is the wet-weight basis nutrient concentrations that are required. Laboratories report the manure analysis on a dry-weight basis simply because the sample is dried in the lab before many of the nutrient contents are determined.

If the results are expressed on a dry-weight basis, they must be converted to wet-weight in order to calculate a manure application rate. To convert back to a wet-weight or as-received value, the moisture content (%) must be known. This is usually provided in the manure test report. The conversion from a wet-weight value to a dry-weight value is as follows:

wet-weight value = dry-weight value x (1 – (% moisture/100))

Using total N as an example:
1.7% total N (on a dry-weight basis)
69.5% moisture content

To convert the total N value to a wet-weight basis:
wet-weight value = dry-weight value x (1 – (% moisture/100))
wet-weight value = 1.7 x (1 - (69.5/100))
wet-weight value = 1.7 x (1- 0.695)
wet-weight value = 1.7 x 0.305
wet-weight value = 0.52% total N

Converting From Percentage to kg/tonne

In the above example, the total N content of the solid beef manure is 0.52% total N on a wet-weight, or as-received, basis. This means that there is 0.52 kg of total N in every 100 kg of manure. There are 1,000 kg in a tonne. Therefore, there are 5.2 kg total N in 1,000 kg of manure.

kg/tonne = value (%) x 10
kg total N/tonne = 0.52 x 10
kg total N/tonne = 5.2

Converting From Percentage to lb/ton

In the above example, the total N content of the solid beef manure is 0.52% total N on a wet-weight, or as-received, basis. This means that there is 0.52 lbs of total N in every 100 lbs of manure. There are 2,000 lbs in a ton. Therefore the conversion factor from percentage to lb/ton is 20, as follows:

lb/ton = value (%) x 20
lb total N/ton = % Total N (wet-weight basis) x 20

For the solid beef manure:
lb total N/ton = % Total N (wet-weight basis) x 20
lb total N/ton = 0.52 x 20
lb total N/ton = 10.4

Therefore, the solid beef manure contains 10.4 lb total N in every ton.

Converting From kg/tonne to lb/ton

Some manure test reports list the nutrient contents of manure in kg/tonne, whereas many producers work in lb/ton. There are 2.2 lb per kg and there are 1.1 tons in a tonne. This means that there are 2 lb/ton for every kg/tonne.

lb/ton = value (kg/tonne) x 2
lb/ton = kg/tonne x 2.2 lb/kg x tonne/1.1 ton

In the above example, the solid beef manure contained 5.2 kg/tonne, or 10.4 lbs total N/ton manure.
5.2 kg total N/tonne x 2 = 10.4 lb/ton

Table 5.2 Example of a Liquid Swine Manure Test Report

Parameter	Lab Units[1] % and ppm		Metric Units kg/1,000 L
	Dry Basis	Wet Basis ("as received")	Wet Basis ("as received")
Moisture Content		96	
Total N	9.25	0.37	3.7
Ammonium N	58,375	2,335	2.3
Phosphorus	2.75	0.11	1.1
Potassium	3.75	0.15	1.5

[1] all analyses in this column are in % except for Ammonium N which is in ppm

5.2.2 Conversions for Liquid Manure Samples

The figures contained in table 5.2 are used in the following examples of liquid manure conversions.

Converting From a Dry-Weight to a Wet-Weight Basis

The conversion of nutrient concentrations in a liquid manure sample from a dry-weight basis to a wet-weight basis is the same as that for a solid manure sample (see Section 5.2.1)

Converting From Percentage to kg/m³

In the above example, the total N content of the liquid manure is 0.37% total N on a wet-weight, or as-received, basis. This means that there is 0.37 kg of total N in every 100 kg of manure; or 3.7 kg total N in 1,000 kg.

To convert liquid manure from a weight to a volume, you must estimate the density.

Density = mass/volume

The density of water is 1,000 kg/m³. However, the higher the dry matter content of the manure, the lower the density of the manure.

Since the liquid swine manure has a very low solids content, we can assume that the density of the liquid swine manure is very close to the density of water. For the purpose of this calculation, assume the density of the liquid swine manure is 1,000 kg/m³.

To calculate the volume of 1,000 kg of manure:
Density = Mass/Volume
1,000 kg/m³ = 1,000 kg/Volume (m³)
Volume = 1,000/1,000 m³
Volume = 1.0 m³

Since there are 3.7 kg total N in 1,000 kg of manure and 1,000 kg equals 1.0 m³ of manure, then there are 3.7 kg total N/m³ of manure.

Therefore, the simple factor from percentage to kg/m³ is 10, as follows:
kg/m³ = value (%) x 10

Converting From kg/m³ to kg/1,000 litres

In the above example, we calculated that the liquid swine manure contained 3.7 kg total N per m³ of manure. There are 1,000 litres in a m³.

Therefore, the total N content in the manure in kg/1,000 litres is:
3.7 kg total N/1,000 litres

Therefore,
kg/m³ = kg/1,000 litres

Converting From Percentage to lb/1,000 gallons

In the above example, the total N content of the liquid swine manure is 0.37% total N on a wet-weight, or as-received, basis. This means that there is 0.37 lb of total N in every 100 lb of manure. The density of water is 10 lb/imperial gallon. The density of the liquid swine manure is assumed to be very close to the density of water.

Therefore, in 100 lb of manure there are 10 imperial gallons as follows:
Density = Mass/Volume
10 = 100/ Volume
Volume = 10 gallons

This means that there is 0.37 lb total N in 10 gallons of manure; and 37 lb total N in 1,000 gallons of manure. The simple conversion from percentage to lb/1,000 gallons can be summarized as follows:

lb/1,000 gal = value (%) x 100

Converting From kg/1,000 litres to lb/1,000 gallons

Some manure test reports provide the nutrient contents of manure in kg/1,000 litres, whereas many producers work in lb/1,000 gallons. There are 2.2 lb per kg and there are 4.55 litres in an imperial gallon.

kg/1,000 litres x 2.2 lb/kg x 4.55 litres/gallon
kg/1,000 litres x 10 = lb/1,000 gallons

lb/1,000 gallons = value (kg/1,000 litres) x 10
Therefore, a lab analysis of 1.5 kg/1,000 L of K would represent
1.5 kg K/1,000 L x 10 = 15 lbs/1,000 gal

5.2.3 What is ppm (parts per million)?

Ammonium-N may be reported in parts per million (ppm), or mg/kg (equal to µg/g) for solid manure and mg/L for liquid manure.

ppm = mg/kg = µg/g
ppm = mg/L (assuming the density of water is 1,000 kg/m^3)

Converting mg/kg to kg/tonne for Solid Manure

There are 1,000,000 mg in a kg.
There are 1,000 kg in a tonne.

kg/tonne = mg/kg x kg/1,000,000 mg x 1,000 kg/tonne
kg/tonne = mg/kg / 1,000

kg/tonne = value (mg/kg) / 1,000

In the above example, the ammonium N content of the solid beef manure is 684 mg/kg on a wet-weight, or as-received, basis.

kg NH_4-N/tonne = 684 / 1000
kg NH_4-N /tonne = 0.7

Converting mg/kg to lb/ton for Solid Manure

There are 453,600 mg in a lb.
There are 907.2 kg in a ton.

lb/ton = mg/kg x lb/453,600 mg x 907.2 kg/ton
lb/ton = mg/kg / 500

lb/ton = value (mg/kg) / 500

In the above example, the ammonium N content of the solid beef manure is 684 mg/kg on a wet-weight, or as-received, basis.

lb NH_4-N /ton = 684/500
lb NH_4-N /ton = 1.4

The result can then be converted to imperial units using the conversion for kg/tonne to lb/ton as provided above (see Section 5.2.1).

Converting mg/L to kg/1,000 L for Liquid Manure

Since the density of liquid manure can be assumed to be the same as that of water, then mg/kg can also be reported as mg/L.

In one litre there is:
kg/L = mg/L x kg/1,000,000 mg

In 1,000 litres there are :
kg/1,000 L = mg/L x kg/1,000,000 mg x 1,000

kg/1,000 L = value (mg/kg) / 1,000

In the above example, the ammonium N content of the liquid swine manure is 2,335 mg/kg on a wet-weight, or as-received, basis.

kg NH_4-N/1,000 L = 2,335 / 1000
kg NH_4-N/1,000 L = 2.3

Converting mg/L to lb/1,000 gallons for Liquid Manure

There are 453,600 mg in a lb.
There are 4.55 L in an Imperial gallon.

In one gallon there is:
lb/gal = mg/L x lb/453,600 mg x 4.55 L/gal

In 1,000 gallons there are:
lb/1,000 gal = mg/L x lb/453,600 mg x 4.55 L/gal x 1,000

lb/1,000 gal = value (mg/kg) / 100

In the above example, the ammonium N content of the liquid swine manure is 2,335 mg/kg on a wet-weight, or as-received, basis.

lb NH_4-N/1,000 gal = 2,335 / 100
lb NH_4-N/1,000 gal = 23.4

5.2.4 Phosphorus versus P_2O_5

The manure test results may be expressed as total elemental P or P_2O_5.

To be consistent with the reporting of the P content of commercial inorganic fertilizers, P fertilizer recommendations are provided on the soil test report as P_2O_5. For this reason, it is helpful to be able to convert between the two.

To convert from P to P_2O_5 simply multiply the value for P by 2.3

Example:
Liquid swine manure contains 0.11% P
The manure will provide 1.1 kg P/1,000 L (see Section 5.2.2)
$P_2O_5 = 2.3 \times P$
$P_2O_5 = 2.3 \times 1.1$ kg P/1,000 L
Therefore, the liquid swine manure will provide 2.53 kg P_2O_5/1,000 L

5.2.5 Potassium versus K_2O

The manure test results may be expressed as total elemental K or K_2O.

To convert from K to K_2O, simply multiply the value for K by 1.2

To be consistent with the reporting of the K content of commercial inorganic fertilizers, K fertilizer recommendations are provided on the soil test report as K_2O. For this reason, it is helpful to be able to convert between the two.

Example:
Liquid swine manure contains 0.15% K
The manure will provide 1.5 kg K/1,000 L (see Sections 5.2.2)
$K_2O = 1.2 \times K$
$K_2O = 1.2 \times 1.5$ kg K/1,000 L
Therefore, the liquid swine manure will provide 1.8 kg K_2O/1,000 L