Soil and Nutrient Network

Helping farmers improve soil and nutrient management

Farm Advisory Service
National Advice Hub
T: 0300 323 0161
E: advice@fas.scot
W: www.fas.scot

A Report on Soil and Organic Materials Analysis from the Soil and Nutrient Network Farms 2016 – 2018

Scottish Government
Riaghaltas na h-Alba
gov.scot
SAC CONSULTING
The European Agricultural Fund for Rural Development
Europe investing in rural areas

For more information on the Soil and Nutrient Network see www.fas.scot. For dates of SNN events, find us on Facebook or follow us on Twitter @FASScot

Prepared by

Samantha Dolan, Chris McDonald and Bill Crooks for the Farm Advisory Service (March 2019)

Summary of Key Points

- A total of 273 soil samples, 14 slurry samples and 14 farm yard manure samples have been taken from the Soil and Nutrient Network farms.
- Farm yard manure and slurry analysis varied between samples in dry matter content and nutrient levels highlighting the need to test individual samples and obtain an analysis for effective nutrient management practice.
- The soil pH results showed that 47% of soil samples were less than pH 5.8, 35% were between pH 5.8 and 6.2 and 18% were above pH 6.2.
- The phosphorous (P) soil analysis showed that 33% of samples were Low or Very Low Status, 60% were Moderate(±) Status and 7% were High or Very High Status.
- The potassium (K) soil analysis showed that 11% of samples were Low or Very Low Status, 56% were Moderate(±) Status and 33% were High or Very High Status.
- The magnesium (Mg) soil analysis showed that 1% of samples were Low or Very Low Status, 66% were Moderate(±) Status and 33% were High or Very High Status.
- The individual PK levels of organic materials and soil samples varied and in order to implement an effective nutrient management strategy individual samples should be tested for nutrient concentrations.

Introduction

Improving soil and nutrient management on farm makes farm businesses more profitable by increasing nutrient use efficiency, and has other benefits including lowering the carbon footprint of the farm and reducing diffuse pollution risks. Even technically efficient farms can find small changes to current soil and nutrient management practices that will make a big difference. The aim of the Soil and Nutrient Network (SNN) is to improve farm soils by making the best use of both organic and inorganic fertilisers, saving money, benefitting yields and improving farm efficiency and resilience. This report on the Soil and Organic Materials Analysis from the Soil and Nutrient Network Farms (2016 – 2018) summarises the soil, farm yard manure and slurry data generated across the SNN farms. The aim of this report is to promote and encourage nutrient management and allow farmers to benchmark their test results against the results from the Soil and Nutrient Network farms.

1.1 Reference nutrient values for farm yard manure, slurry and soil samples

Farm yard manure and slurry

There are a range of FAS/SAC Technical Notes (TN) which provide fertiliser guidance and recommendations for nutrient management in Scotland. For farm yard manure and slurry, TN650 “Optimising the application of bulky organic fertilisers” provides a reference table of typical nutrient values for organic materials which can be used as a valuable source of nutrients and organic matter for soils. A summary of the guidance available in TN650 is outlined in **Table 1** which shows values for dry matter (DM) content (%), Total Nitrogen (N), Total Phosphate (P_2O_5) and Total Potash (K_2O) for some livestock manures.

Table 1. Reference nutrient values of organic materials

		kg/t (solid manures) or kg/m^3 (liquids and slurries)		
Organic Material	**DM (%)**	**Total N**	**Total P_2O_5**	**Total K_2O**
Cattle FYM (fresh/old)	25.0	6.00	3.20	8.00
Cattle Slurry	6.00	2.60	1.20	3.20
Horse FYM	30.0	7.00	5.00	6.00

Soil pH and nutrients

Soil pH levels are generally recommended to be maintained between pH 5.8 and 6.0 for grassland according to TN652 “Fertiliser recommendations for grassland” and between pH 6.0 and 6.2 for mineral soils according to TN714 “Liming materials and recommendations”. The concentrations of soil phosphorus (P), potassium (K) and magnesium (Mg) in soil samples are given an SAC Status depending on the level of nutrient in the soil and **Table 2** outlines the P, K and Mg ranges for each SAC Status classification. It is recommended that soils are sampled every 4 to 5 years and analysed for pH, and extractable P, K and Mg. Phosphorus and potassium fertiliser recommendations specific to four regions of Scotland are available for effective nutrient management in the Technical Notes for the Highlands and Islands (TN715), South West (TN716), North East (TN717) and South East (TN718). Magnesium recommendations can be found in TN714 “Liming materials and recommendations”.

Table 2. Soil P, K and Mg concentrations and the SAC Status classification ranges

	Concentration range (mg/L)		
SAC Status	**P**	**K**	**Mg**
Very Low (VL)	0 to 1.7	0 to 39	0 to 19
Low (L)	1.8 to 4.4	40 to 75	20 to 60
Moderate (M-)	4.5 to 9.4	76 to 140	61 to 200
Moderate (M+)	9.5 to 13.4	141 to 200	
High (H)	13.5 to 30.0	201 to 400	201 to 1000
Very High (VH)	> 30.0	> 400	> 1000

Soil and Nutrient Network Farms

There were 21 Soil and Nutrient Network Farms in operation between 2016 and 2018 which were evenly distributed across the four regions of Scotland; five in the North East, six in the Highlands & Islands, four in the South East and six in the South West (**Table 3**). The farm types consisted of nine Beef and/or Sheep, two Arable, three Dairy and seven Mixed, where the mixed farms included arable, beef and a dairy farm (**Table 4**). In total, 14 farm yard manure samples, 14 slurry samples and 273 soil samples were collected and processed through the SAC Commercial Ltd analytical laboratories. Soil samples were analysed for pH using standard operating procedures. The P, K and Mg in soil samples were extracted by Modified Morgan's.

Table 3. Number of Soil and Nutrient Network farms in each Region of Scotland

Region of Scotland	Number of Farms
North East	5
Highlands & Islands	6
South East	4
South West	6

Table 4. Number of Soil and Nutrient Network farms in each Farm Type

Farm Type	Number of Farms
Arable	2
Beef and/or Sheep	9
Dairy	3
Mixed	7

Results

1.2 Farm yard manure

The results of the farm yard manure (FYM) analysis of the 14 samples taken across the Soil and Nutrient Network farms are summarised in **Table 5**. The typical value for cattle FYM (TN650) is shown as a benchmark along with the average of the samples, plus maximum and minimum values to show the range of values across individual samples for comparison.

Table 5. Summary of Farm Yard Manure sample results from the Soil and Nutrient Network Farms compared to the typical farm yard manure analysis (fresh and/or old cattle manure) in TN650

	Dry Matter (%)	Total N (Kjeldahl) (kg/t)	Total Phosphate (P_2O_5) (kg/t)	Total Potash (K_2O) (kg/t)
Typical FYM Composition	25.0	6.00	3.20	8.00
Sample number				
1	24.3	3.54	2.53	10.5
2	19.1	4.10	1.70	4.00
3	21.7	3.69	1.20	8.10
4	17.5	5.04	4.29	7.21
5	22.5	6.41	4.52	4.93
6	38.9	5.56	4.99	5.44
7	37.7	4.00	4.16	2.54
8	21.8	11.0	3.77	10.9
9	20.2	4.99	2.56	7.93
10	18.0	5.53	4.27	11.5
11	21.9	5.51	3.22	8.30
12	23.6	5.70	4.27	11.0
13	18.9	5.19	3.02	2.50
14	21.3	5.45	2.96	1.50
Average	23.4	5.41	3.39	6.88
Maximum	38.9	11.0	4.99	11.5
Minimum	17.5	3.54	1.20	1.50

The results of the DM (%) analysis for the farm yard manure samples are shown in **Figure 1**. The average DM (%) of the samples was 23.4% which was close to the value of the TN650 typical value for fresh cattle FYM of 25.0% although most samples were below this value, to a minimum of 17.5%. Sample numbers 6 and 7 were greater than all samples and reference values at 38.9% and 37.7% because they were horse FYM with some cattle FYM mixed in. These results are greater than the TN650 value for horse FYM which was 30%. These results showed that although average values were similar to reference values, individual samples can vary from the Technical Note value and so testing of farm yard manures is important to ensure that effective nutrient management can be achieved. The source of the manure e.g. cattle or horses was also important.

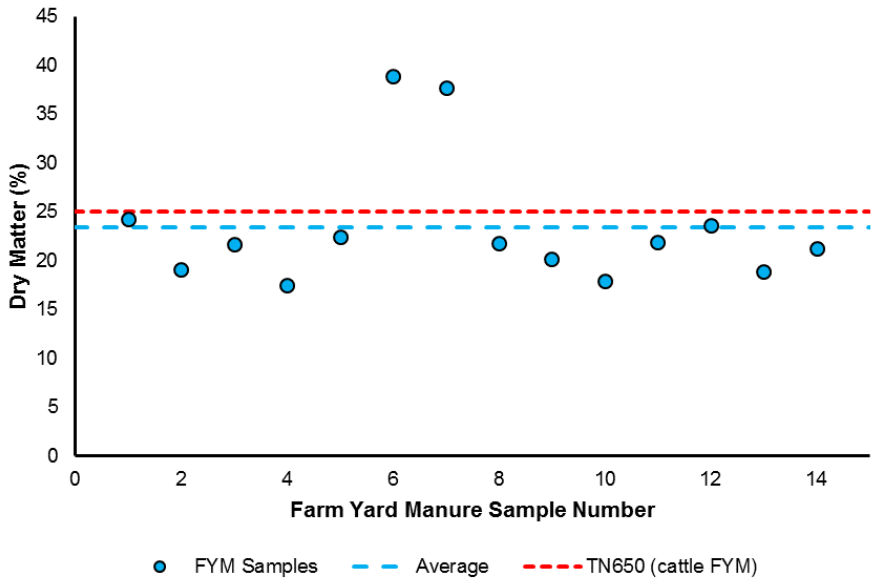

Figure 1. Dry Matter (%) content of the farm yard manure samples collected from the Soil and Nutrient Network Farms compared to the average of the samples and the TN650 typical value for cattle FYM

The Total N (kg/t) results of the FYM samples are shown in **Figure 2** and are compared to the average of the samples and the guideline value in TN650 for cattle FYM which is 6.00 kg/t. The average Total N was 5.41 kg/t which was almost 0.6 kg/t less than the typical cattle FYM value. Samples 6 and 7, which were horse FYM with some cattle FYM mixed in, showed Total N contents of 5.56 and 4.00 kg/t respectively, which was less than the TN650 value of 7.00 kg/t for horse manure. This could have been due to the addition of cattle FYM lowering the value. The variation in Total N across all samples was shown by the range of values from a minimum of 3.54 kg/t (sample 1) to 11.0 kg/t (sample 8) and highlights the need to test FYM for Total N so that N management can be more accurate.

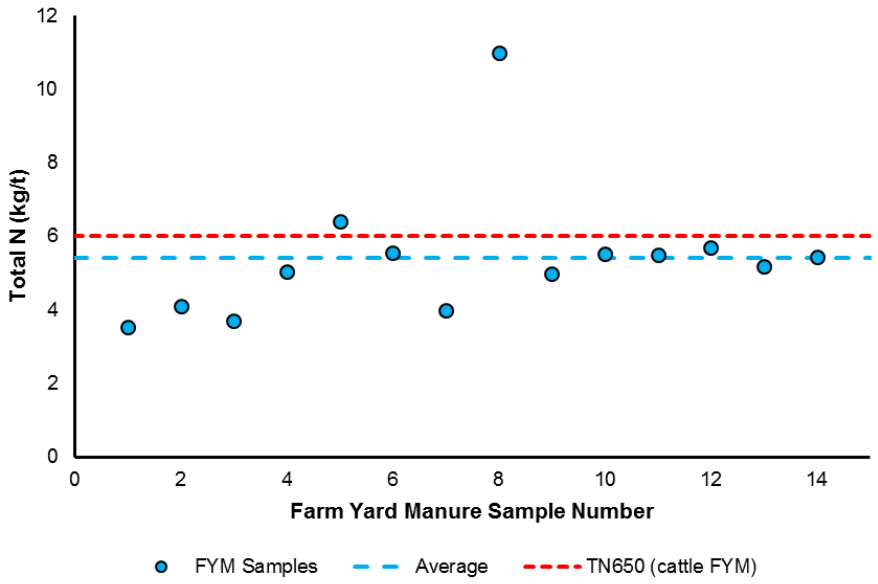

Figure 2. Total N (kg/t) of the samples collected from the Soil and Nutrient Network Farms compared to the average of the samples and the TN650 typical value for cattle FYM

The Total P_2O_5 (kg/t) results for the FYM samples are shown in **Figure 3** and are compared to the average of the samples and the guideline value in TN650 for cattle FYM (3.20 kg/t). The average Total P_2O_5 was 3.39 kg/t which was slightly greater than the guideline value of cattle FYM. There was variation in the Total P_2O_5 across the samples collected, with a minimum of 1.20 kg/t and maximum of 4.99 kg/t. This showed that individual samples varied, perhaps due to variations in feed compositions between the different farms, even though the average value was close to the typical value expected of cattle FYM. Therefore, this shows the importance of testing individual FYM samples when planning to utilise organic materials as a source of P_2O_5 (TN650).

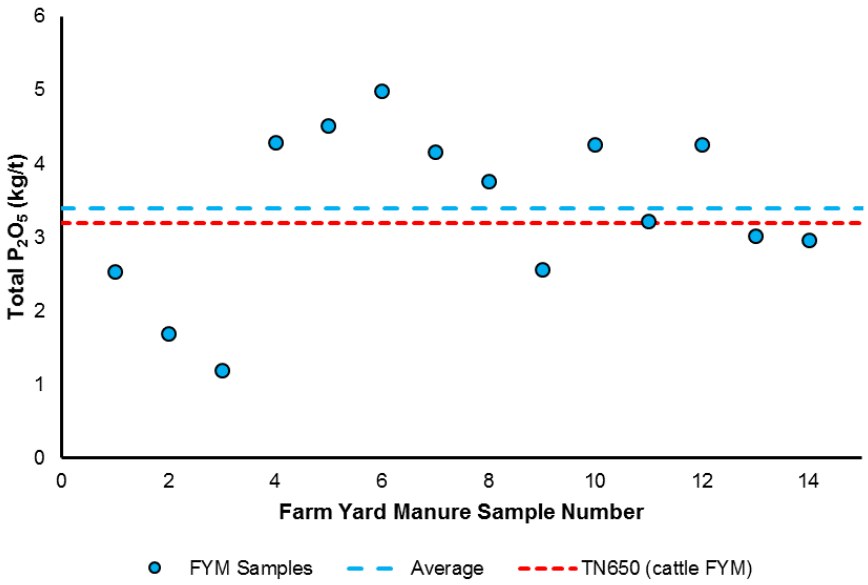

Figure 3. Total P_2O_5 (kg/t) of the samples collected from the Soil and Nutrient Network Farms compared to the average of the samples and the TN650 typical value for cattle FYM

The Total K_2O (kg/t) results in the FYM samples are shown in **Figure 4** and are compared to the average of the samples. The TN650 result for cattle FYM is also shown for reference (8.00 kg/t). The average Total K_2O for the samples was 6.88 kg/t and the variation across samples was large, ranging from 1.50 kg/t to 11.5 kg/t. The variation was likely to be a result of differences in feed nutrient concentrations and showed that individual samples should be tested for K_2O content.

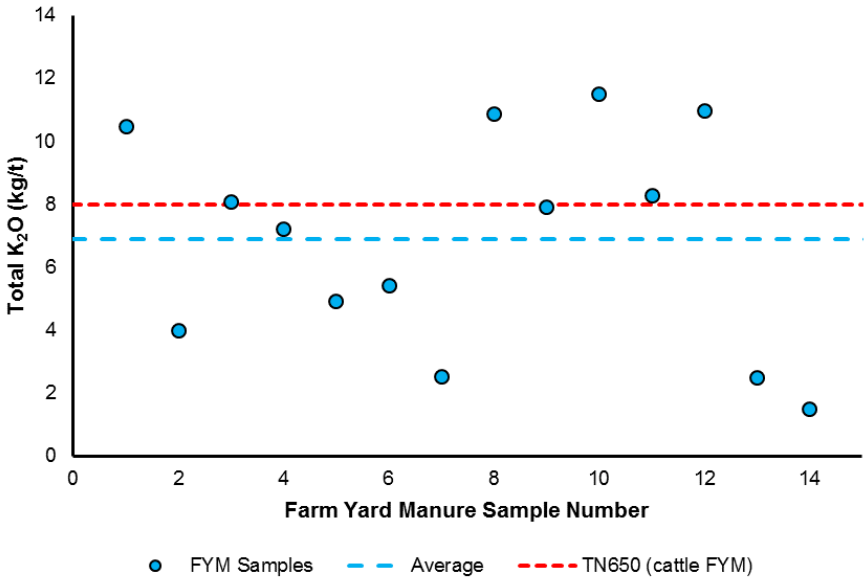

Figure 4. Total K_2O (kg/t) of the samples collected from the Soil and Nutrient Network Farms compared to the average of the samples and the TN650 typical value for cattle FYM

1.3 Slurry Analysis

The slurry analysis results of the 14 samples collected from the Soil and Nutrient Network farms are shown in **Table 6** and are compared to the typical composition of cattle slurry in TN650. The average, minimum and maximum results for each analysis are also shown for comparison. The average DM (%) for samples (6.09%) was close to the typical cattle slurry value in TN650 (6.00%). There were only 13 results for the Total N across the slurry samples and the average Total N of 2.62 kg/t was approximately equal to the guideline value of 2.60 kg/m^3. For Total P_2O_5, the sample average was 1.50 kg/m^3 which was slightly higher than the guideline of 1.20 kg/m^3. Finally, the average Total K_2O for the samples was 3.61 kg/m^3 which was greater than the typical Total K_2O in cattle slurry (3.20 kg/m^3).

Table 6. Summary of the slurry analysis for the samples collected from the Soil and Nutrient Network Farms compared to the typical composition of cattle slurry (TN650)

	Dry Matter (%)	Total N (kg/m^3)	Total P_2O_5 (kg/m^3)	Total K_2O (kg/m^3)
Cattle Slurry (TN650)	6.00	2.60	1.20	3.20
Sample Number				
1	9.06	2.01	1.21	3.35
2	8.79	4.70	1.99	6.15
3	7.10	2.3	1.28	5.25
4	3.75	4.61	1.31	2.16
5	3.14	3.95	1.33	2.36
6	6.38	2.37	1.28	3.86
7	8.77	-	1.39	2.35
8	4.19	1.93	4.88	8.30
9	7.29	2.40	1.45	4.30
10	3.38	1.21	1.10	0.39
11	2.29	1.53	0.52	2.30
12	5.39	1.99	1.16	2.50
13	8.13	3.31	1.21	4.70
14	7.62	1.79	0.85	2.60
Average	6.09	2.62	1.50	3.61
Minimum	2.29	1.21	0.52	0.39
Maximum	9.06	4.70	4.88	8.30

The Dry Matter (%) contents of the slurry samples collected from the Soil and Nutrient Network farms are shown in **Figure 5** and are compared to the sample average and the typical DM (%) content of cattle in TN650 (6.00%). The sample average (6.09%) and typical value were almost equal. However, there was variation across the samples which ranged from a minimum of 2.29 to 9.06%. This showed that individual samples could vary from the technical note values and further highlights the need to test individual samples for dry matter contents for effective management of organic materials.

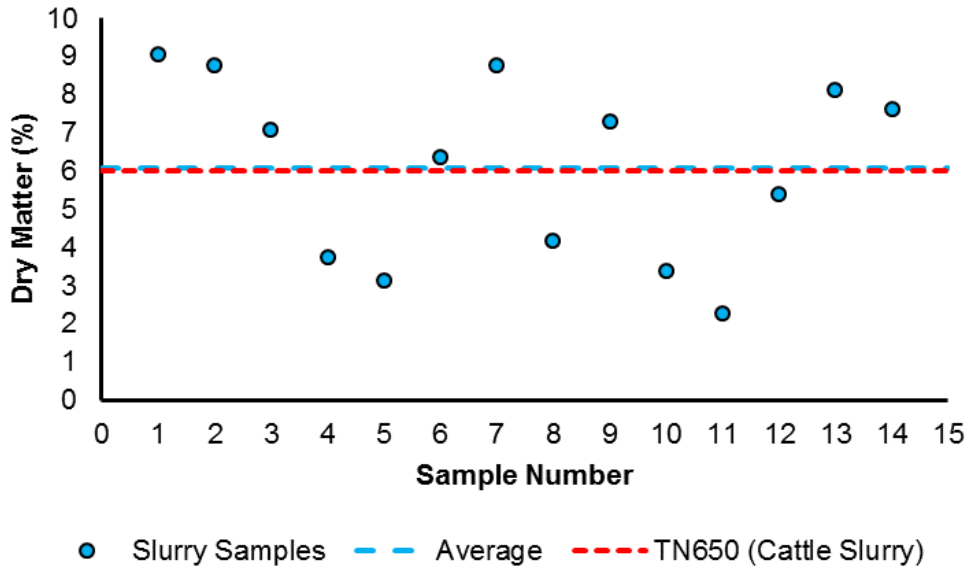

Figure 5. Dry Matter (%) of slurry samples collected from the Soil and Nutrient Network farms compared to the sample average and the guideline value for cattle slurry in TN650

The Total N (kg/m^3) results of the Soil and Nutrient Network slurry samples are shown in **Figure 6** and are compared to the average of the samples (2.62 kg/m^3) and the typical value of cattle slurry (2.60 kg/m^3) from TN650. The slurry sample average and the typical value were equal however the variation across the samples ranged from 1.21 to 4.70 kg/m^3. This is a result of differences in feed nutrient contents and DM content of the slurry samples. Differences were also observed on one farm between suckler cattle slurry (sample 1) and finishing cattle slurry (sample 2) with the latter showing double the amount of Total N at 4.70% than the former 2.01%. This demonstrates the importance of analysing slurry that is from different sources for nutrient contents as part of effective nutrient management planning.

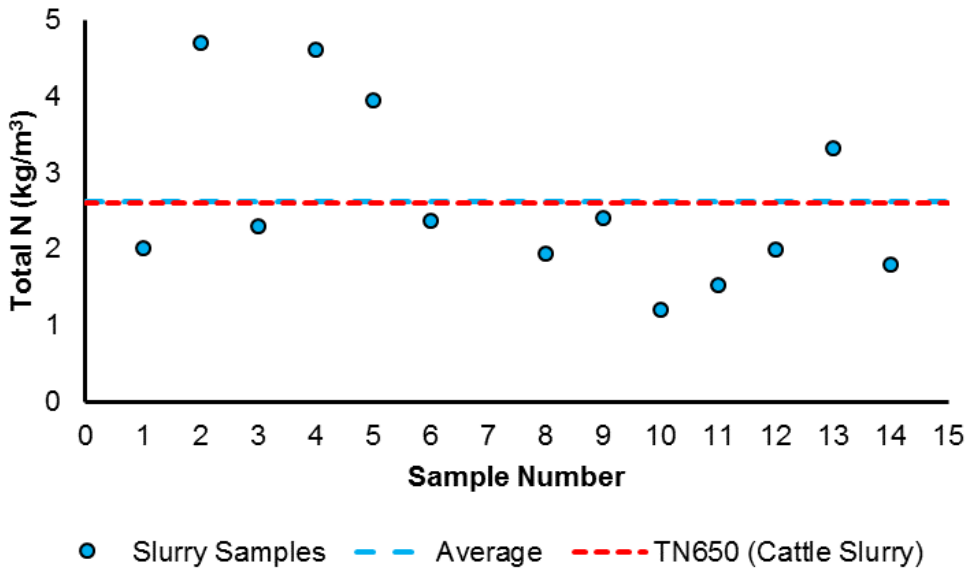

Figure 6. Total N (kg/m^3) of slurry samples collected from the Soil and Nutrient Network farms compared to the sample average and the guideline value for cattle slurry in TN650

The Total P_2O_5 (kg/m^3) results of the slurry samples from the Soil and Nutrient Network farms is shown in **Figure 7** and are compared to the average of the samples (1.50 kg/m^3) and the typical Total P_2O_5 of cattle slurry (1.20 kg/m^3) in TN650. The samples were close to the average and the typical value however sample 8 was much greater at 4.88 kg/m^3 which may reflect a diet high in phosphorus. Excluding sample 8, the Total P_2O_5 results ranged from 0.52 to 1.99 kg/m^3 and averaged around 1.24 kg/m^3 which was almost equal to the typical value in TN650. When results appear anomalous, such as the result for sample 8, the slurry should be re-tested as farm nutrient use efficiency would appear to be very low.

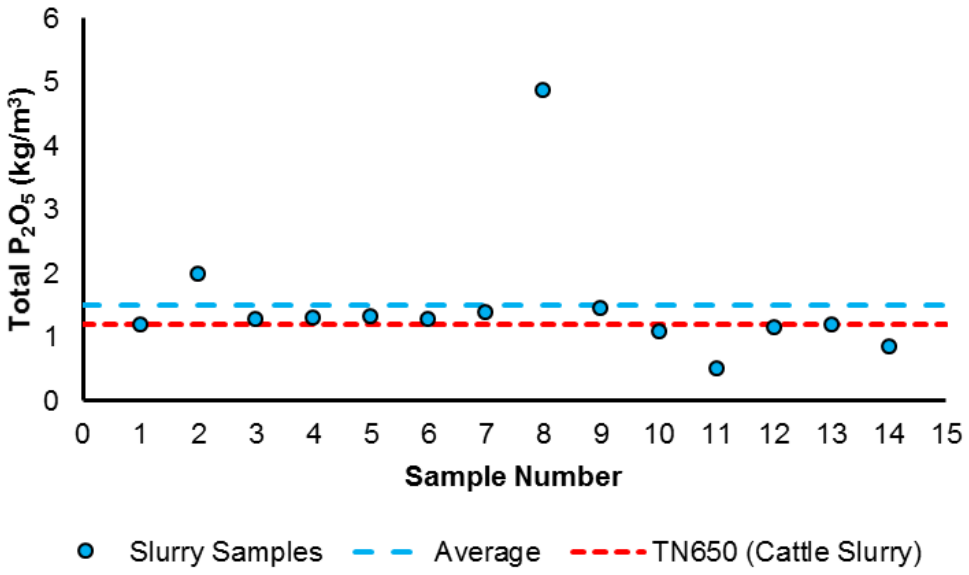

Figure 7. Total P_2O_5 (kg/m^3) of slurry samples collected from the Soil and Nutrient Network farms compared to the sample average and the guideline value for cattle slurry in TN650

The Total K_2O results for the slurry sample from the Soil and Nutrient Network farms are shown in **Figure 8** and are compared to the average of the samples (3.61 kg/m^3) and the TN650 typical Total K_2O for cattle slurry (3.20 kg/m^3). The slurry samples minimum Total K_2O was 0.39 kg/m^3 (sample 10) which was almost ten times less than the typical value in TN650. The maximum result was 8.30 kg/m^3 (sample 8) which was just over 2.5 times greater than the typical value. The variation across the samples may reflect differences in the nutrient content of the feed and the results showed that individual slurry samples could vary y from the technical note value for K_2O. These results highlight the need for testing slurry for nutrient content prior to application to land for effective K_2O management.

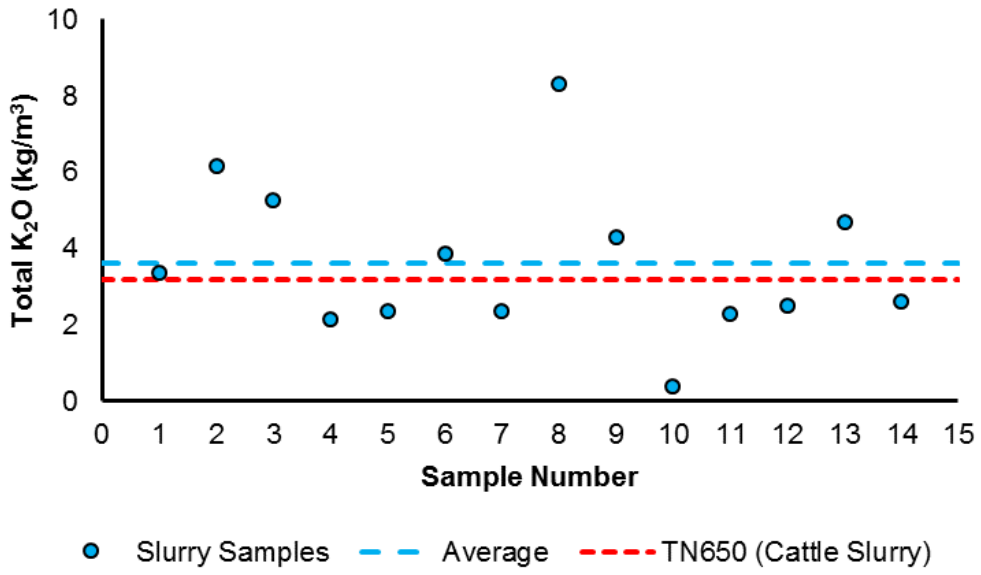

Figure 8. Total K_2O (kg/m^3) of slurry samples collected from the Soil and Nutrient Network farms compared to the sample average and the guideline value for cattle slurry in TN650

1.4 Soil Analysis

1.4.1 Soil pH

The results of the soil pH analysis are summarised in **Table 7** and shown in **Figure 9** for each farm type. For the soil samples taken from farms classed as arable only, the average soil pH was 6.0 and varied between pH 5.7 and 6.5. The optimum pH range for arable crops is between pH 6.0 and 6.2 and 50% of the soil samples were below target while 25% were on target and 25% were above target however the sample range was small at only 8 samples. The soil samples analysed from the beef and/or sheep farms had a lower pH with an average at pH 5.6 and showed a broader range of soil pH levels from pH 5.1 to 7.4. This indicated that some soils were below optimum pH levels while some were too high. Soil samples from the dairy farm types showed a narrower range compared to beef and/or sheep with an average soil pH of pH 5.6 ranging between pH 5.0 and 6.4. Ideally, grassland soil pH levels should be between pH 5.8 and 6.0 (TN652). These results showed that, out of 180 samples across the dairy and beef and/or sheep enterprises, 63% of the soils were below pH 5.8, 10% were above pH 6.0 and only 27% were within the target range of pH 5.8 to 6.0. Low soil pH levels limit nutrient availability to the grass and thus the growth of productive grasses and clovers, making fertiliser applications less efficient, particularly for N and P fertilisers. Where the aim is improved grassland production, the application of lime will improve the nutrient use efficiency of the farm, reduce the risk of nutrient loss, improve soil fertility and improve overall grassland production. Across all 273 soil samples regardless of farm type, the soil pH results showed that 47% of samples were less than pH 5.8, 35% were between pH 5.8 and 6.2 and 18% were above pH 6.2. Soils above pH 6.0 should not be limed in a grassland rotation. The mixed farm types showed an average soil pH level of 6.1 and ranged from pH 5.1 to 6.8 with a large variation in soil pH levels between soil samples. Soils at the lower end of the range would benefit from additional liming while those at the higher levels should avoid lime inputs and allow the soil pH to fall which will help save on liming costs.

Table 7. Summary of soil pH results for each farm type

Farm Type	Average*	Minimum	Maximum
Arable	6.0	5.7	6.5
Beef and/or Sheep	5.6	5.1	7.4
Dairy	5.6	5.0	6.4
Mixed	6.0	5.1	6.8

*The average soil pH value for each farm type was calculated by transforming the pH test results to the concentration of H+ ions using the equation 10^{-pH}. An average H+ concentration was then calculated for each farm type. This value was converted to the true average pH value using the equation –log10([H+]). The maximum and minimum values were obtained from the test results.

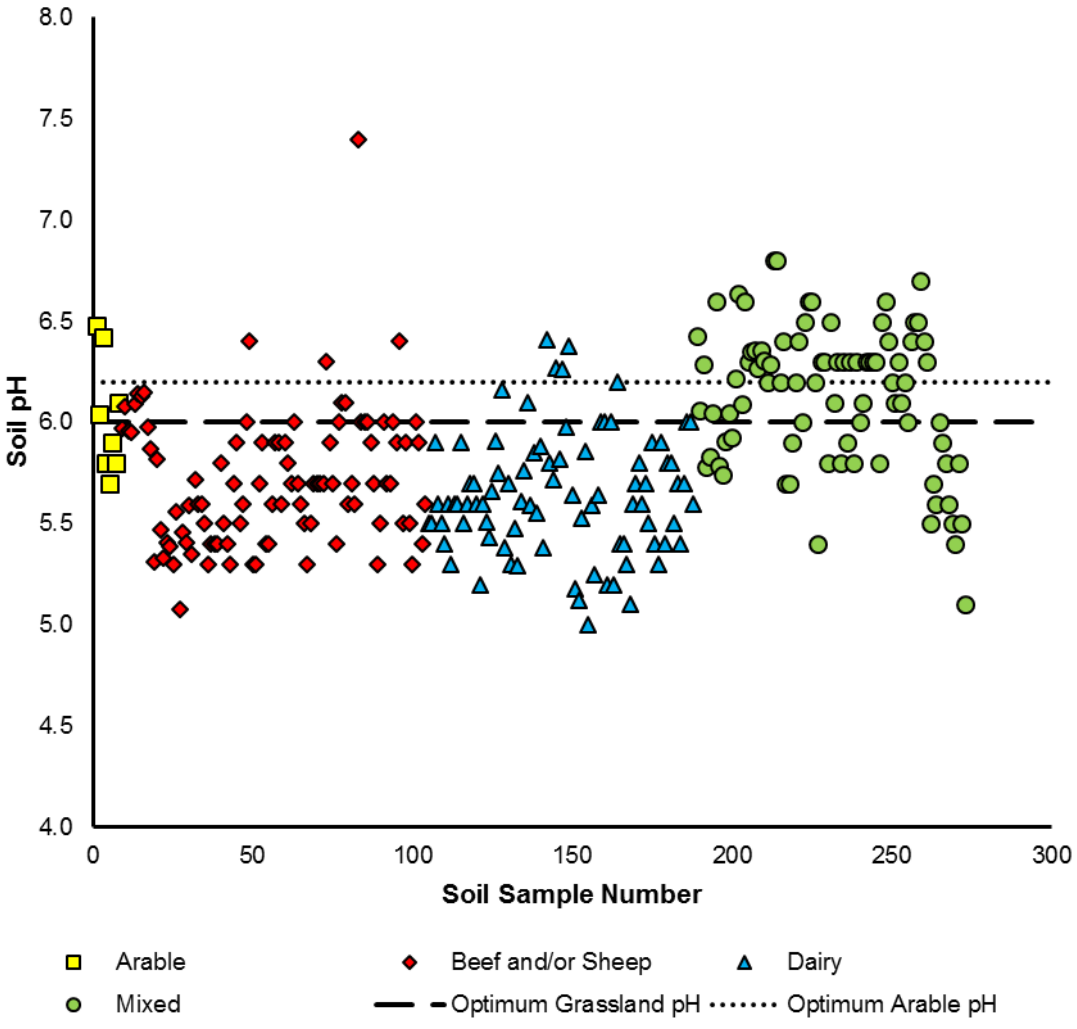

Figure 9. Soil pH levels for samples grouped by farm type including optimum pH values for grassland and arable soils

1.4.2 Phosphorus

The soil phosphorus (P) results for each farm type are summarised in **Table 8** and shown in **Figure 10**. The optimum concentration of soil P is either M- (4.50 and 9.40 mg/L) or t M+ Status (9.50 to 13.4 mg/L) depending on crop and soil P sorption capacity (PSC). The arable farms showed a P concentration range from 4.00 to 8.84 mg/L. A level of 4.00 mg/L is considered to be a Low (L) P Status and would require additional P fertiliser management. Overall, most of the soils were on average 5.97 ± 0.48 mg/L which showed most were within the optimum M- Status and would only require monitoring and maintenance of P levels unless the rotations contained potatoes or were PSC 3 soils. The soil samples collected for the Beef and/or Sheep farms showed large variations in the P levels from 0.90 to 50.9 mg/L which would be classed as Very Low (VL) to Very High (VH) respectively. However, these samples were likely to be outliers as the majority of the soils had P levels around 7.11 ± 0.64 mg/L giving a P Status of M- which is ideal for grassland on most soils. The high level found in one sample (50.9 mg/L) is likely the result of sampling too close to fertiliser application which will cause an artificially high reading. It is recommended that samples are not collected too soon after lime or fertiliser application as these can influence the result for up to 12 weeks after the application (TN668). Similarly, the dairy farms also showed some variation between 1.40 to 19.5 mg/L but the average was 6.73 ± 0.42 mg/L which is also ideal for this farm type. The P concentrations in the mixed farm types varied between 0.92 and 20.8 mg/L but, as with the other farm types, the optimum M- Status was achieved, with most soils having P levels around 6.20 ± 0.32 mg/L (M-). Those soils with P levels below 4.5 mg/L would be classed as Low (L), or Very Low (VL) if below 1.7 mg/L and so would require additions of P fertiliser to raise the concentration up for optimum grassland production. Soils with a P level above 13.4 mg/L would be classed as High (H) in P, or Very High (VH) if greater than 30.0 mg/L and would require restrictions of P fertiliser to reduce the levels. Across all soil samples regardless of farm type, the P results showed that 33% of samples were Low or Very Low Status, 60% were Moderate(±) Status and 7% were High or Very High Status. Excess P in soil can represent an economic loss as nutrients will be lost through soil erosion or leaching. The results show that most soils are on target for P for the farming system, except for arable, where more P may be required if the rotations contain potatoes. Individual soils and fields should be tested for P levels to check the Status but these results suggest that the phosphorus levels were on target as a third of soils were Low or Very Low Status.

Table 8. Summary of soil phosphorus (mg/L) levels for each farm type

Farm Type	Average	P Status	Minimum	Maximum
Arable	5.97 ± 0.48	M-	4.00	8.84
Beef and/or Sheep	7.11 ± 0.64	M-	0.90	50.9
Dairy	6.73 ± 0.42	M-	1.40	19.5
Mixed	6.20 ± 0.32	M-	0.92	20.8

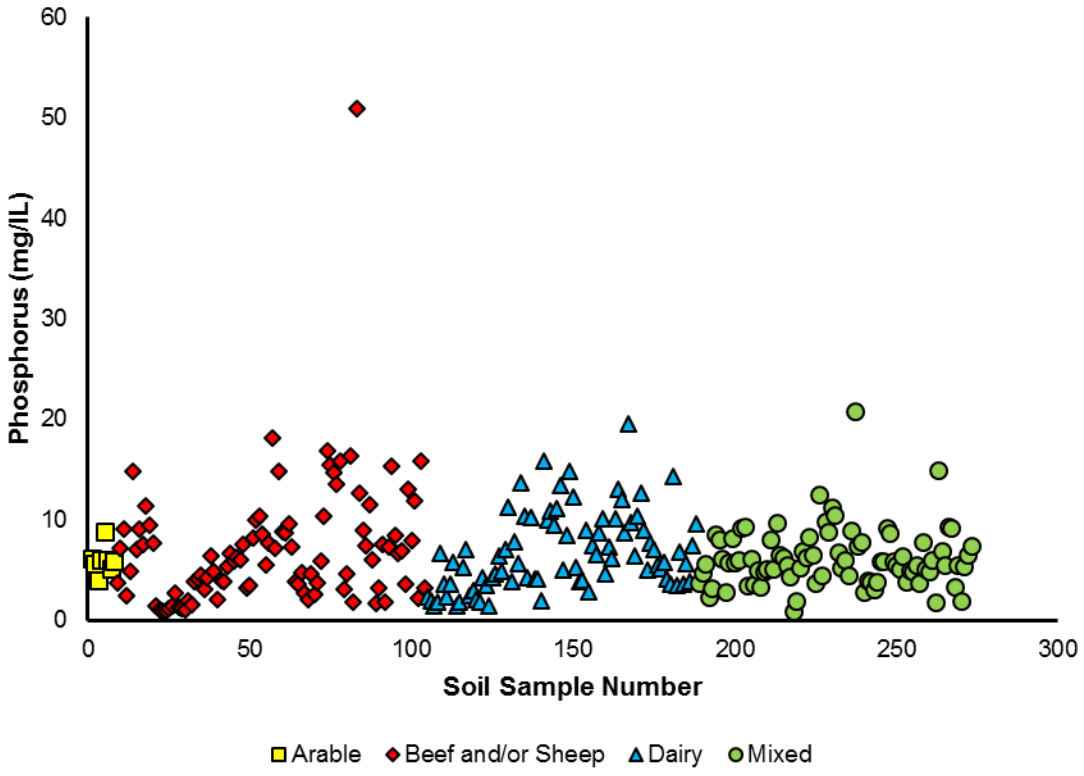

Figure 10. Phosphorus (mg/L) levels for soil samples grouped by farm type

1.4.3 Potassium

The soil potassium (mg/L) levels for each farm type are summarised in **Table 9** and shown in **Figure 11**. The ideal K levels were Moderate (M+) which requires no adjustments in established grasslands (TN652). Across all farm types, the K levels were, on average, on target, which was expected as potassium is typically well managed. The management of K depends on offtake amounts, and K balances should be calculated along with routine testing of the soil for K to ensure optimum levels for productive grasses and arable rotations. However, looking at the individual soil samples, there was a considerable range of K levels, particularly in the beef and/or sheep farms, with K levels at a minimum of 8.00 mg/L (VL) to 692 mg/L (VH). As with P, the single high K result (692 mg/L) is likely the result of sampling too close to application of fertiliser. The soil K levels can be influenced for up to 12 weeks of fertiliser or manure application (TN668). The maximum levels for dairy (449 mg/L) and mixed farm types (660 mg/L) were also classed as VH while the arable soils (281 mg/L) were given a K Status of H. The potassium soil analysis showed that, across all 273 soil samples, 11% of samples were Low or Very Low Status, 56% were Moderate(±) Status and 33% were High or Very High Status. Money could be saved on those soils which have a Status of H or VH by applying K fertiliser at a rate of 50% of the K offtake in the crop, and allowing the crops to use the K already present in the soil until a Status of M is achieved. Thereafter, only maintenance amounts of fertiliser are recommended to be applied to maintain M Status. In soils of VL or L Status, K fertiliser additions should be considered in order to raise the soil K level by applying fertilisers greater than the amount taken off by the crop grown on the soil.

Table 9. Summary of soil potassium (mg/L) levels for each farm type

Farm Type	Average	K Status	Minimum	Maximum
Arable	197 ± 22.1	M+	88.00	281
Beef and/or Sheep	192 ± 11.6	M+	8.00	692
Dairy	163 ± 9.17	M+	42.8	449
Mixed	187 ± 11.8	M+	44.1	660

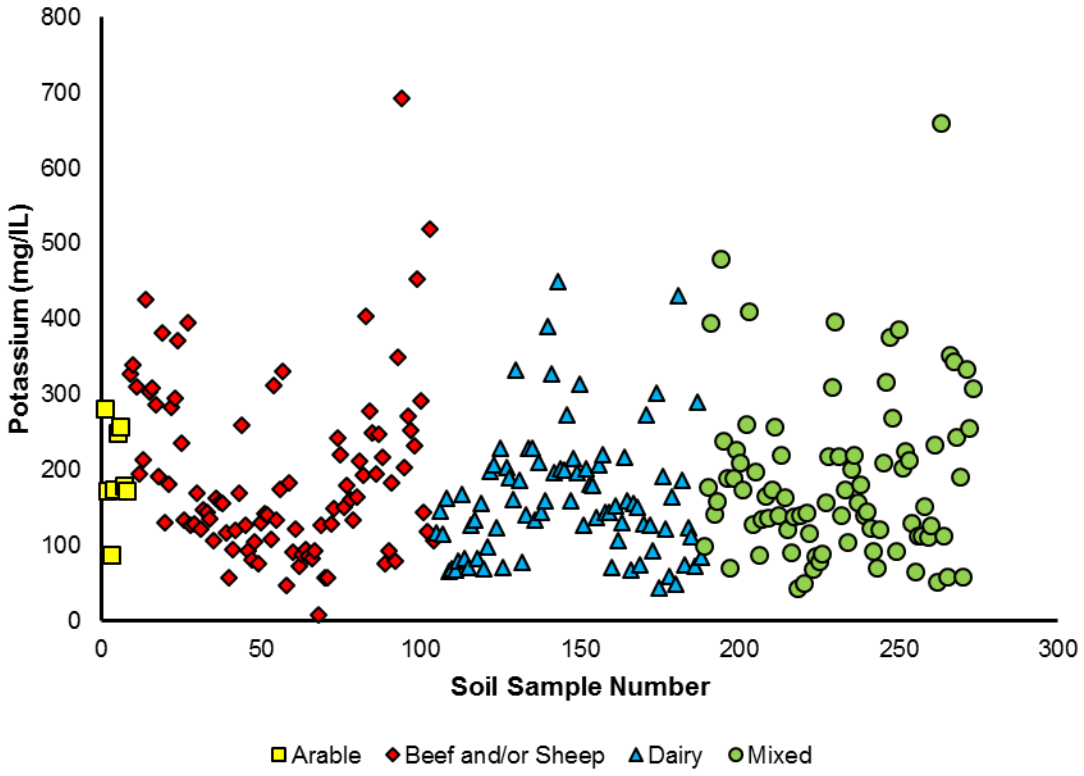

Figure 11. Potassium (mg/L) levels for soil samples grouped by farm type

1.4.4 Magnesium

The summary of the soil magnesium (mg/L) levels for each farm type are summarised in **Table 10** and shown in **Figure 12**. Soils across all four farm types had magnesium levels that were either Moderate (M) Status (arable and dairy) or High (H) Status (beef and/or sheep, and mixed farm types). There was a large range of magnesium (Mg) concentrations particularly for beef and/or sheep farms which ranged from 43.1 to 865 mg/L which would be classed as Low (L) to High (H) Status respectively although the average was restricted to 216 ± 16.9 mg/L (H). The mixed farms showed an almost identical spread of Mg at 222 ± 16.7 mg/L. For intensively managed grasslands, a soil Mg Status of H is considered ideal (TN652). However, soil pH levels should be above pH 6.0 for optimum grass growth and nutrient availability. The Mg levels in the arable farms ranged from 44.0 to 386 mg/L but were on average 122 ± 39.0 mg/L giving them an average status of M which are sufficient for crop rotations containing potatoes. As the arable soils were on target for pH 6.0, availability should not expected to be a limiting factor in these circumstances. The magnesium soil analysis showed that 1% of samples were Low or Very Low Status, 66% were Moderate(±) Status and 33% were High or Very High Status indicating that Mg deficiencies in soils are uncommon in the soil samples.

Table 10. Summary of soil magnesium (mg/L) levels for each farm type

Farm Type	Average	Mg Status	Minimum	Maximum
Arable	122 ± 39.0	M	44.00	386
Beef and/or Sheep	216 ± 16.9	H	43.10	865
Dairy	163 ± 7.36	M	66.70	339
Mixed	222 ± 16.7	H	46.00	605

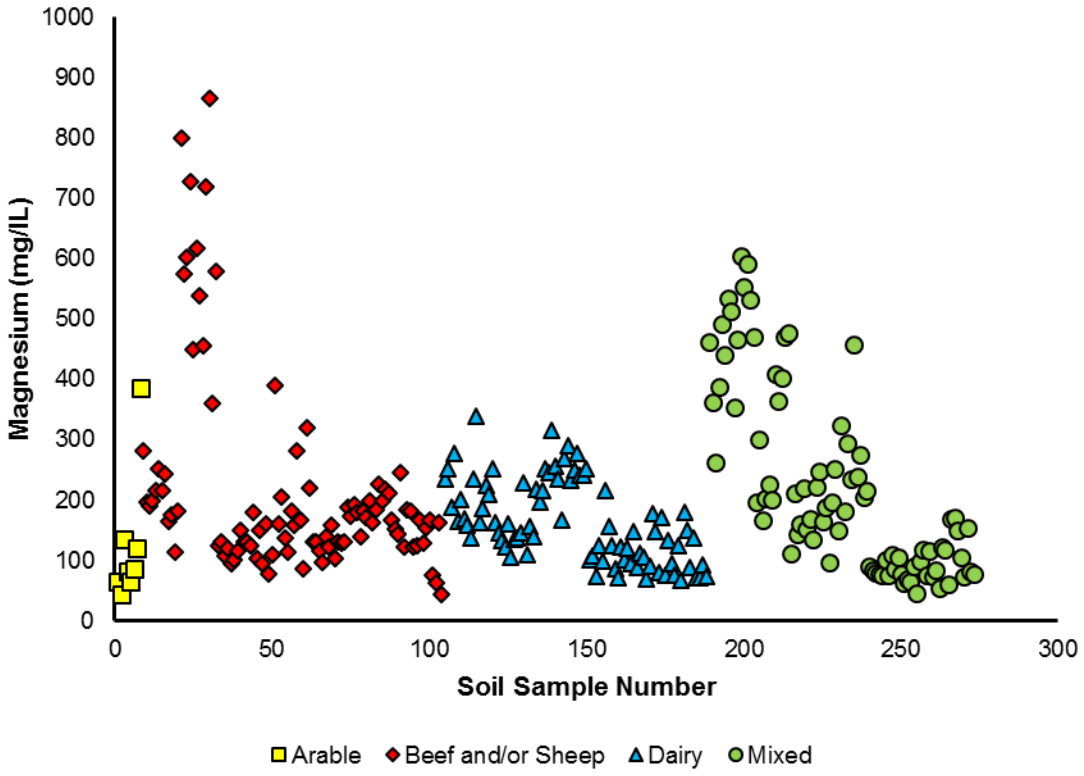

Figure 12. Magnesium (mg/L) levels for soil samples grouped by farm type

Summary

This report demonstrates the large variation in analysis results of soils, farm yard manures and slurries across different farm types. The key recommendation from this report is that testing is essential for accurate nutrient management.

In the farm yard manure analysis, the average dry matter content (DM) in the farm yard manures (23.4%) was similar to the TN650 for cattle farm yard manures (25.0%) but most samples were lower. The horse manure DM contents (38.9 and 37.7%) were greater than TN650 for typical horse manure (30.0%). The average Total N in FYM was 5.41 kg/t which was less than the typical Total N in cattle manures in TN650 (6.00 kg/t) and samples showed a range between 2.54 and 11.0 kg/t. The Total P_2O_5 of the FYM samples was on average 3.36 kg/t which was higher than the typical value of 3.20 kg/t for cattle FYM and samples showed large variations in results. The Total K_2O results also showed large variations (1.50 to 11.5 kg/t) and the average was lower at 6.88 kg/t compared to the TN650 value for cattle FYM of 8.00 kg/t. These results highlight the variation in nutrient content between individual FYM samples and although the average may be similar to the technical note, testing farm yard manure samples and knowing the source of the manure is important for effective nutrient planning, particularly for N and K.

The average DM content of the slurries (6.09%) was close to the typical composition for cattle slurry in TN650 (6.00%) but the individual samples ranged from 2.29 to 9.06%. The average Total N in the slurries (2.62 kg/t) was approximately equal to the technical note (2.60 kg/t) but with individual Total N results ranging between 1.21 and 4.70 kg/t. The P_2O_5 results showed an average 1.50 kg/t which was greater than the technical note for cattle slurry (1.20 kg/t) and samples ranged in P_2O_5 content between 0.52 and 4.88 kg/t. The Total K_2O results were on average 3.61 kg/t which was also higher than the technical note for cattle slurry of 3.20 kg/t. The results for the slurries showed large variations between samples which showed the need to test individual sample for nutrient content. The P and K varied between samples and the average nutrient content was also greater than the technical note and therefore highlights the need to rest slurry samples for effective nutrient management planning.

Soil samples were analysed according to four farm types (arable, beef and/or sheep, dairy, and mixed). Soil pH levels were on target for the arable samples (pH 6.0) and mixed (pH 6.0) but were slightly lower for dairy (pH 5.6) and beef and/or sheep farms (pH 5.6). The soil pH results across all farm types showed that 47% of soil samples were less than pH 5.8, 35% were between pH 5.8 and 6.2 and 18% were above pH 6.2. The P levels were classed as M- Status on average for all farms which is ideal in terms of laboratory testing. However, for managing soil phosphorus, other soil factors should be taken in to account including the Phosphorus Sorption Capacity (PSC) of the soil which influences the availability of P to crops (TN668). There were large variations between individual samples across all farm types ranging from Very Low to Very High Status. The K Status of the soils were all M+ Status however there was a considerable range of K levels between individual samples ranging from Very Low to Very High Status. Regional Technical Notes which take in to account crops grown in each Region of Scotland are available which provide P and K fertiliser recommendations for the Highlands and Islands (TN715), South West (TN716), North East (TN717) and South East (TN718). Finally, the average Mg levels in the soils were either M (arable and dairy) or H (beef and/or sheep, and mixed) with individual samples varying across the different Status levels. The results from the soil analysis highlight the need to test individual soil samples for nutrient concentrations to ensure that a nutrient management plan takes in to account any deficit or excess of nutrient in the soil for optimum fertiliser and organic material use efficiency.

References

The FAS/SAC Technical Notes can found at www.fas.scot/publication/technical-notes/

FAS/SRUC Technical Notes

Technical Note TN650 “Optimising the application of bulky organic fertilisers” (2013)

Technical Note TN652 “Fertiliser recommendations for grassland” (2013)

Technical Note TN668 “Managing soil phosphorus” (2015)

Technical Note TN714 “Liming materials and recommendations” (2019)

Technical Note TN715 “Phosphate and potash recommendations for crops grown in Highlands and Islands” (2019)

Technical Note TN716 “Phosphate and potash recommendations for crops grown in South West Scotland” (2019)

Technical Note TN717 “Phosphate and potash recommendations for crops grown in North East Scotland and Tayside” (2019)

Technical Note TN718 “Phosphate and potash recommendations for crops grown in Fife, Lothian and Scottish Borders” (2019)