Professional Agricultural Analysis Group

Collation of data from routine soil analysis in the UK

2018/2019

Contents

Summary

Results are reported for statistical collation of soil analytical data provided by participants in the Professional Agricultural Analysis Group. For the current year (June 1st 2018 to May 31st 2019) results for around 195,000 samples were available (different numbers for pH, P, K and Mg).

Some participants provided data that could be broken down by arable and grassland as the current crop and datasets were constructed to allow collation within this breakdown. Grassland samples formed 65% of all samples compared to 51% in 2016/17.

Conclusions should be drawn cautiously as the data were not necessarily representative of all UK fields and data collations were not statistically rigorous. However, some general points can be made:

- Soil pH was <6.0 in 19% of arable samples and <5.5 in 19% of grassland samples. During the period covered by PAAG reports, mean soil pH has decreased steadily in arable samples from around 7.0 to 6.6. There seems a need to address liming on significant proportions of arable and grassland areas.

- For both arable and grassland, around 30% of samples were at target P Index 2 and 29% (arable) and 26% (grassland) samples were at target K Index 2-. Just 9% of all samples were at target Indices for both P and K. There has been no evidence for convergence of P and K indices on target values since PAAG data were first collated. Some 90% of samples indicated the need for adjustment of P or K Index giving clear support for the need to base fertilizer use on regular soil analysis.

- Soil P index was lower than target in 22% of arable and 34% of grassland samples. K Index was lower than target in 24% of arable and 41% of grassland targets. Use of potash for grassland especially seems in need of attention.

- Soil P Index was higher than target in 50% of arable and 26% of grassland samples. During the period covered by PAAG reports, mean Olsen-P has increased in arable samples from around 27 mg/l to 31 mg/l but has remained fairly stable around 25 mg/l in grassland samples. The increase in Olsen-P in arable samples is surprising given the decrease in application of fertiliser phosphate over the same period even taking use of organic manures into account. However, other factors could be involved such as changes to cultivation methods. A move from ploughing to minimum cultivations, as occurred in England between 1995 and 2010, will tend to concentrate available P near the soil surface in the sampling zone.

- 11% of arable samples and 3% of grassland samples were in Mg Indices 0 or 1 where application of magnesium might be recommended for some crops.

1. **Background**

The Professional Agricultural Analysis Group (PAAG) was established in 2009 to help ensure a common quality standard amongst participating laboratories and to promote the benefits of soil analysis for efficient nutrient management. One of the early actions agreed by the PAAG was the collation of their UK soil analytical data to show breakdown by pH class and by P, K and Mg Indices.

This report covers the collation of analytical data provided by participants for the period 1st June 2018 to 31st May 2019. The same general format has been used for all annual reports since 2009/10.

2. Data provided

Data comprised results of soil analyses - Olsen method for P, ammonium nitrate extraction for K and Mg and 2.5:1 water:soil for pH. The amount and breakdown of data varied among participants. Data provided by some participants derived from several tens of thousands of samples, those from others derived from a few thousand samples. Some provided data that could be broken down by arable and grassland. Datasets were constructed for current year UK data and for data broken down into grassland and arable where this was possible. Where they could be identified, data from amenity trees, amenity grass of all kinds (including horse paddocks), perennial fruit crops, coppice, gardens, top-soil, protected crops and non-UK sites were excluded. Data for current arable crops following a ley were included in the arable dataset. Data for current arable crops and forage maize following permanent grassland or grazed grass were included in the grassland dataset. Where no other cropping details were available, data for maize were included in the arable dataset. Data from every participant were allocated to the various datasets to the greatest extent possible. Consequently, sample record numbers vary among datasets and the sums of identifiable grassland and arable sample records do not equal the total number for all samples.

3. Dataset classes

For every dataset, numbers of sample records in different pH classes and soil Indices (Table 1) were counted and expressed as percentages of the total number of samples in that dataset.

Table 1 Classes used for the collation

pH	P Index	K Index	Mg Index
<5.00	0	0	0
5.00-5.49	1	1	1
5.50-5.99	2	2-	2
6.00-6.49	3	2+	3
6.50-6.99	4	3	4
7.00-7.49	5	4	5
7.50-7.99	>5	5	6
>7.99		>5	>6

Only data that could be allocated to these classes, either directly or from concentrations in mg/l, were used in the analyses.

4. Interpretation of the data

Particular care is needed when drawing conclusions from the data. Firstly, soil samples submitted to laboratories are not randomly selected from the total population of fields. Technically aware farmers probably are more likely to use soil analysis in decision-making and their soils may be maintained at higher levels of available nutrients than are present in the population mean. Secondly, amounts and sources of data differed between the various datasets used. Several laboratories contributed to the collation of total samples for the UK. Fewer provided data for grassland and arable soils separately. The collation of the data therefore was not statistically rigorous. Nevertheless, broad trends can be identified and some conclusions drawn.

5. Collation of data

5.1 Datasets

The current year was June 1st 2018 to May 31st 2019. Data sets were established for:

- UK data across all crops and grassland
- UK data for arable samples
- UK data for grassland samples

5.2 UK data across all crops and grassland

Results for 196945 (pH), 186718 (P), 196482 (K) and 196416 (Mg) samples were available for the current year.

Mean soil pH was 6.26, 41% of samples were below 6.00 and 42% were between 6.00 and 7.00. The apparently large decrease in mean pH from 6.47 in 2017 is due partly to the greater proportion of grassland samples in 2019 (61% of total compared to 51% in 2017). However, soil pH has decreased during the period covered by PAAG reports from around 6.7.

Only 29% of samples were at target soil P index (2) and 27% at target soil K index (2-). Soil P was lower than target Index in 29% of samples and soil K was lower than target in 35% of samples. Soil Mg Index was lower than 2 in 6% of samples (Table 2, Fig 1).

The Mg/K ratio (both in mg/l) was greater than 2 in 9% of all samples. In 6% of samples, the ratio was greater than 2 and the K index was 0 or 1. These conditions have been associated with soil potassium supply or measurement issues though there appears to be no published scientific evidence for this.

Table 2 Soil pH and Indices - all samples

	Percentage of samples in class:							
Soil pH	**<5.0**	**5.00-5.49**	**5.50-5.99**	**6.00-6.49**	**6.50-6.99**	**7.00-7.49**	**7.50-7.99**	**>8**
	1	12	28	26	16	8	7	3
	Percentage of samples in class:							
P Index	**0**	**1**	**2**	**3**	**4**	**5**	**>5**	
	10	20	29	28	10	2	1	
	Percentage of samples in class:							
K Index	**0**	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
	6	30	27	17	16	4	1	0
	Percentage of samples in class:							
Mg Index	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
	0	8	33	34	13	6	5	1

Fig 1a Distribution of soil pH values
(All samples)

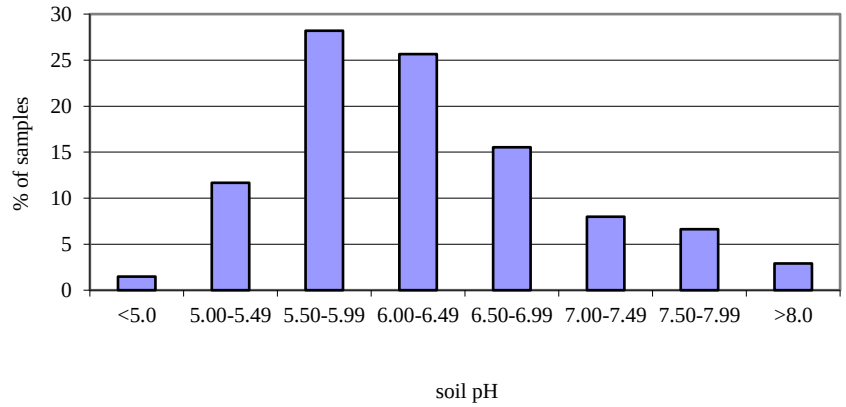


Fig 1b Distribution of soil P Index values
(All samples)

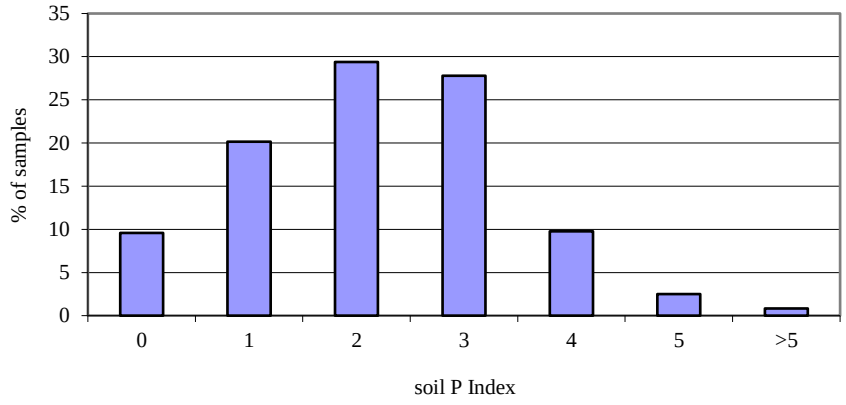
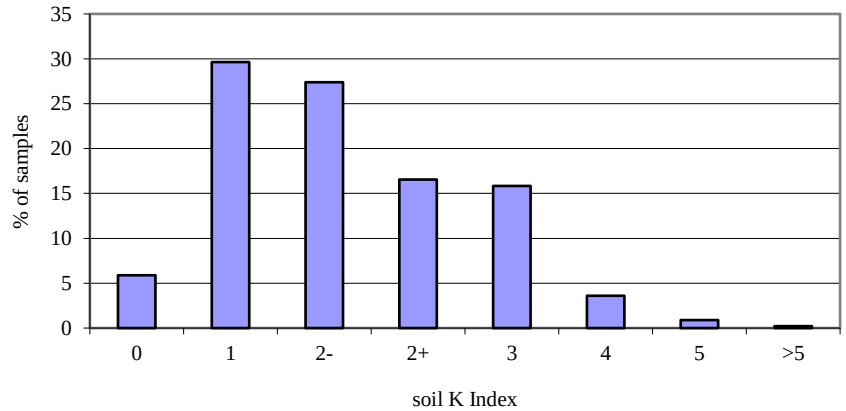
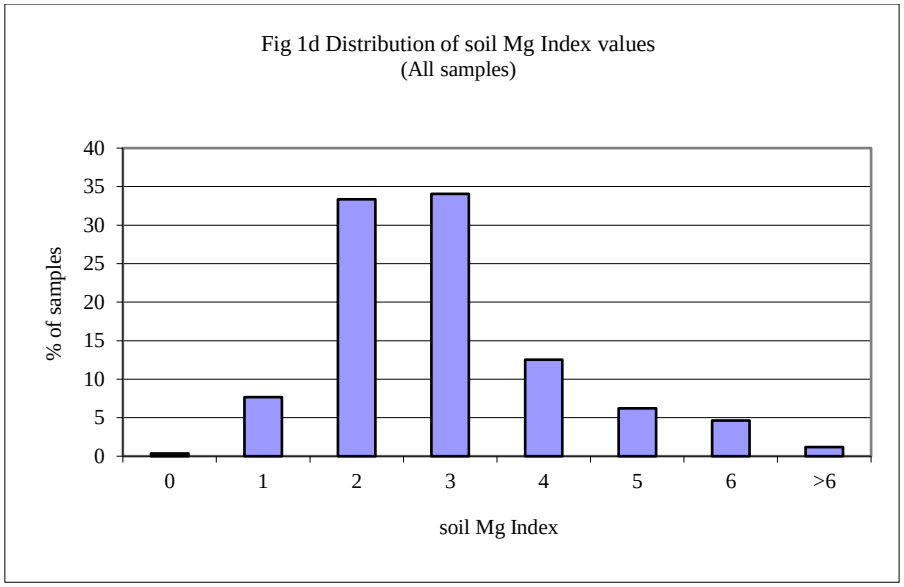


Fig 1c Distribution of soil K Index values
(All samples)





5.3 UK data by arable and grassland

Some participants provided data where the past crop could be identified as arable or agricultural grassland. These data (around 86000 samples for arable and 135000 for grassland) are summarised in Table 3 and Fig 2.

Mean pH for arable samples was 6.67 and for grassland 5.96. During the period covered by PAAG reports, pH has been fairly stable at around 6.0 in grassland but has decreased slowly but steadily in arable samples from around 6.8.

The distribution of soil P values was similar for arable and grassland with mean values of 31 mg/l (Index 3) for arable and 25 mg/l (Index 2) for grassland. Only 29-30% of arable and grassland samples were at target Index 2 with 22% (arable) and 35% (grassland) in Indices 0 or 1. During the period covered by PAAG reports, mean soil P has increased in arable samples from around 27 mg/l to 31 mg/l but has remained fairly stable at around 25 mg/l in grassland samples.

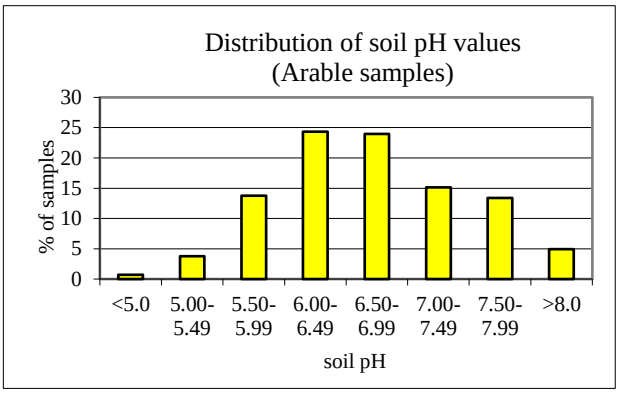
The distributions of soil K values also were somewhat similar with means of 197 mg/l (Index 2+) for arable and 162 mg/l (Index 2-) for grassland. Only 30% of arable and 26% of grassland samples were at target Index 2- and 26% (arable) and 41% (grassland) were in Indices 0 or 1. Mean soil K has increased in arable soils but has remained around 160 mg/l in grassland soils.

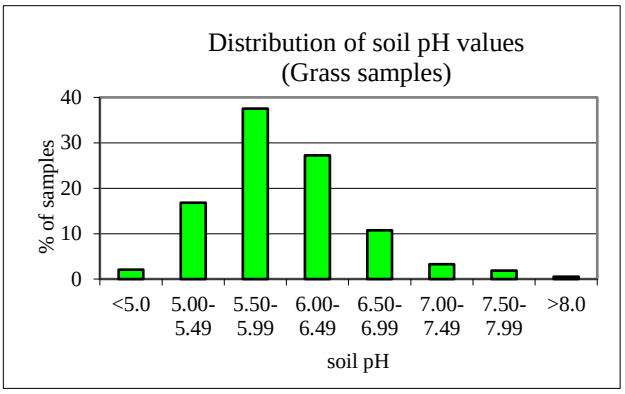
Mean soil Mg value was lower for arable (137 mg/l, Index 3) than for grassland (150 mg/l, Index 3). Only 3% of grassland, but 15% of arable, samples were in Mg Indices 0 or 1.

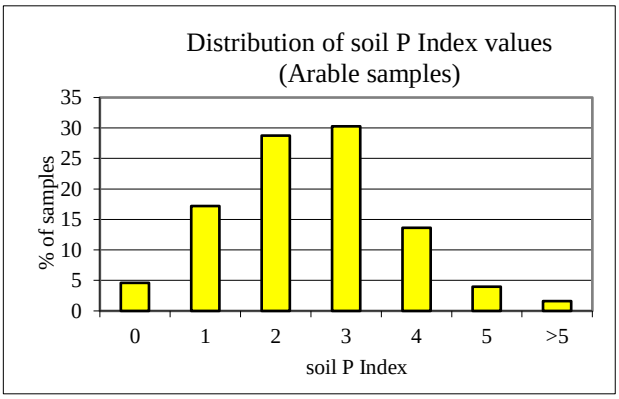
Table 3 Soil pH and Indices – arable and grassland

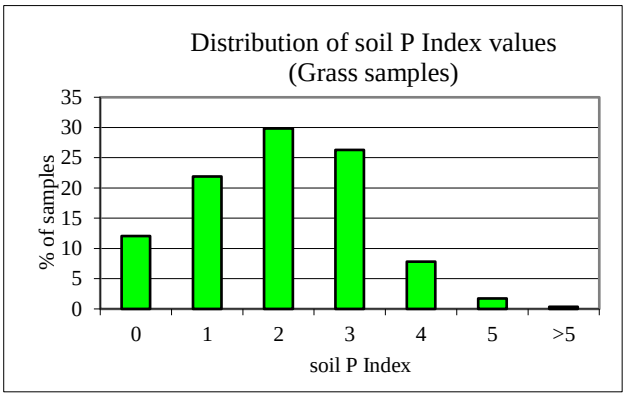
				Percentage of samples in class:				
Soil pH	**<5.0**	**5.00-5.49**	**5.50-5.99**	**6.00-6.49**	**6.50-6.99**	**7.00-7.49**	**7.50-7.99**	**>8**
Arable	1	4	13	23	23	16	14	6
Grassland	2	17	38	27	11	3	2	1
				Percentage of samples in class:				
P Index	**0**	**1**	**2**	**3**	**4**	**5**	**>5**	
Arable	5	17	29	30	13	4	1	
Grassland	13	22	30	26	8	2	0	
				Percentage of samples in class:				
K Index	**0**	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
Arable	3	23	30	20	19	4	1	0
Grassland	8	33	26	14	14	3	1	0
				Percentage of samples in class:				
Mg Index	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
Arable	1	14	37	27	10	6	4	1
Grassland	0	3	31	38	14	6	5	1

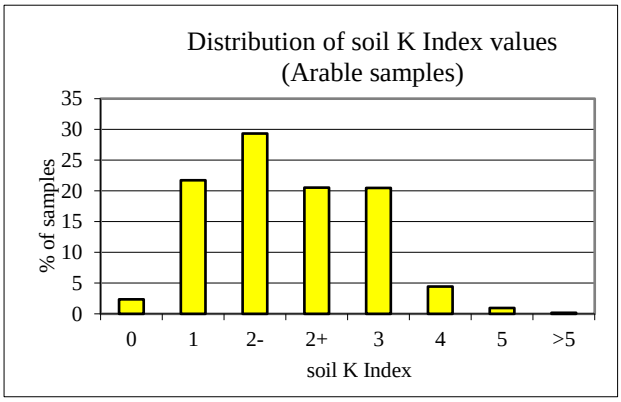
Fig 2 Distributions by arable and grassland

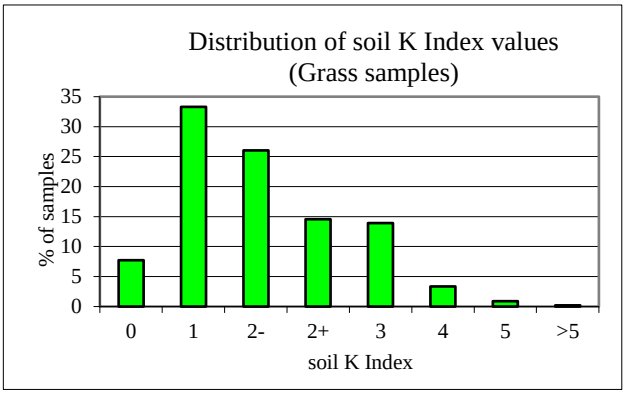


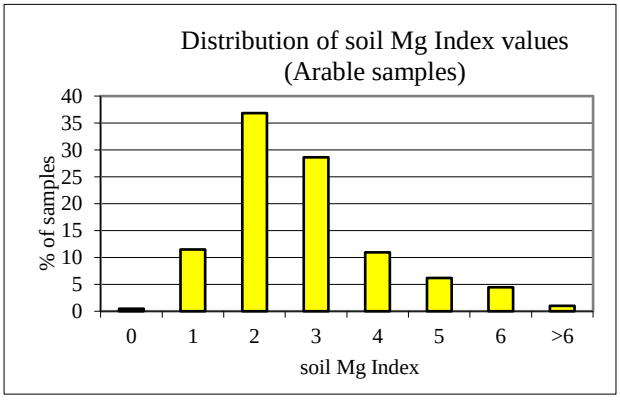


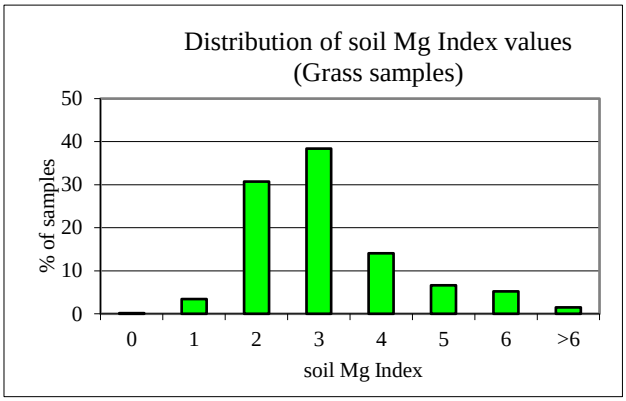












5.4 P x K Index matrix

A matrix was constructed showing percentages of all samples falling into different P and K Indices. A summary of results is shown in Table 4 and more detailed results are in Appendix 1.

Only 9% of samples were at target Indices for both P and K. This percentage has been almost unchanged since 2009. Not calculated at the time, the matrices for 2008/2009 and 1994/1995 (based on data for a small number of laboratories) data also show 10% of all samples at target indices for both P and K. Detailed results for 1994/95 and 2008/09 also are in Appendix 1 and look remarkably similar to those in 2016/17. It is a reasonable conclusion that the percentage of samples submitted to laboratories that are at target indices for both P and K has been around 9-10% for at least twenty-five years.

Table 4 Percentages of all samples in P and K Indices
(total 206959 samples)

	P index			
K index	<target	target	>target	
<target	16	10	10	36
target	8	9	10	27
>target	6	10	21	37
	30	29	41	100

Appendix 1 Percentages of samples in P x K Indices

All samples 2018/19 (206959 samples)

P Index

K Index	0	1	2	3	>3	Total
0	2	2	1	1	0	6
1	5	8	9	6	2	30
2-	2	6	9	8	3	27
2+	1	3	5	5	3	16
3	0	2	4	6	4	16
>3	0	0	1	2	2	5
Total	10	20	29	28	13	100

All samples 2008/09 (102324 samples)

P Index

K Index	0	1	2	3	>3	Total
0	1	2	2	1	0	6
1	3	8	10	8	3	33
2-	1	6	10	9	4	29
2+	1	2	5	6	3	16
3	0	1	3	4	3	13
>3	0	0	0	1	1	3
Total	6	19	30	29	15	100

All samples 1994/95 (18019 samples)

P Index

K Index	0	1	2	3	>3	Total
0	1	1	1	1	0	4
1	3	9	12	8	2	32
2-	1	6	10	10	3	30
2+	0	2	5	6	3	16
3	0	1	4	5	3	14
>3	0	0	1	2	2	4
Total	5	20	32	31	13	100