Professional Agricultural Analysis Group

Collation of data from routine soil analysis in the UK

2022/2023

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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 2022 to May 31st 2023) results for around 140,000 samples were available.

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 57% of all samples that could be identified as from arable or grass compared to 64% in 2021/22, 58% in 2019/20 and 65% in 2018/19.

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 9% of arable samples and <5.5 in 12% of grassland samples. During the period covered by PAAG reports, mean soil pH decreased steadily in arable samples from around 6.7 to 6.3 in 2018/19. Since then, mean pH for all samples has increased to 6.7. This increase occurred mainly in arable soils. The apparent improvement needs confirmation in later years.

- For both arable and grassland, 30-31% of samples were at target P Index 2 and 31% (arable) and 26% (grassland) samples were at target K Index 2-. 10% of all samples were at target Index for both P (2) and K (2-) as has been the case for nearly thirty years. This lack of convergence of P and K indices on target values is rather surprising and gives clear support for the need to base fertilizer use on regular soil analysis.

- Soil P Index was lower than target in 21% of arable and 36% of grassland samples. K Index was lower than target in 27% of arable and 39% of grassland soils. Use of phosphate and potash for grassland especially seem in need of attention.

- Soil P Index was higher than target in 48% of arable and 35% of grassland samples. During the period covered by PAAG reports, mean Olsen-P increased in arable samples from around 27 mg/l to 31 mg/l in 2014/15 but has decreased since to 29 mg/l. Mean Olsen-P has remained fairly stable around 25 mg/l in grassland samples.

- 23% 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. These percentages were similar in previous years.

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 2022 to 31st May 2023. The same general format has been used for all annual reports since 2009/10. Trends in data are shown from 1994/95 because one laboratory provided a large amount of data for the period before PAAG was established.

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, miscanthus, 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. Where current crop was permanent pasture but no past crop was recorded, data were included in the grass 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. 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 2022 to May 31st 2023. 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 139382 soil samples were available for the current year.

Mean soil pH was 6.75, 23% of samples were below 6.00 and 39% were between 6.00 and 7.00.

Only 30% of samples were at target soil P Index (2) and 29% were at target soil K Index (2-). Soil P was lower than target Index in 32% of samples and higher than target in 38% of samples. Soil K was lower than target in 33% of samples and higher

than target in 37% of samples. Soil Mg Index was lower than 2 in 16% of samples and higher than 2 in 46% of samples (Table 2, Fig 1).

The Mg/K ratio (both in mg/l) was greater than 2 in 9% of all samples (8% in 2021/22 and 9% in 2019/20). In 5% of samples, the ratio was greater than 2 and the K Index was 0 or 1 (5% in 2021/22 and 6% in 2019/20). 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	5	17	21	18	13	13	11
				Percentage of samples in class:				
P Index	**0**	**1**	**2**	**3**	**4**	**5**	**>5**	
	12	20	30	27	8	2	1	
				Percentage of samples in class:				
K Index	**0**	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
	6	27	29	17	15	3	1	1
				Percentage of samples in class:				
Mg Index	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
	1	15	38	26	8	5	5	2

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

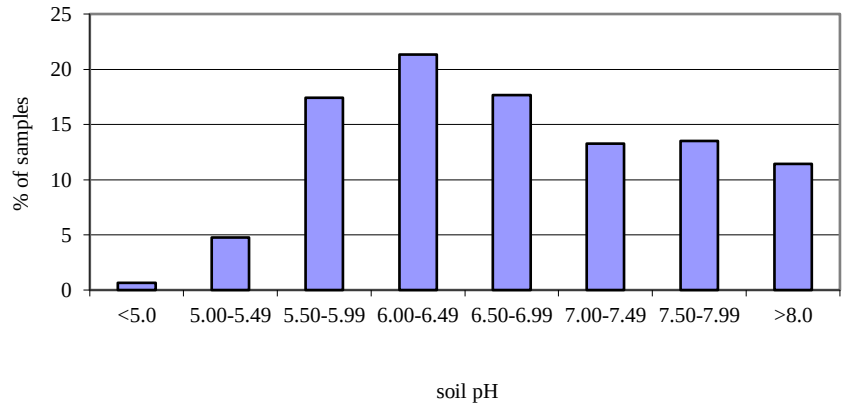


Fig 1b Distribution of soil P Index values
(All samples)

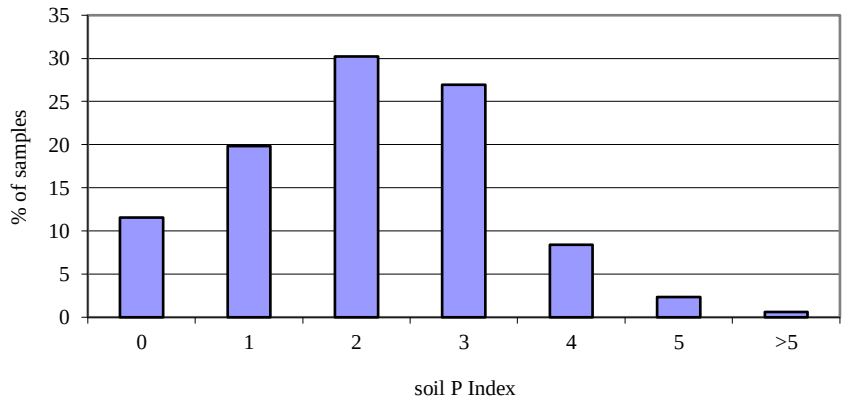
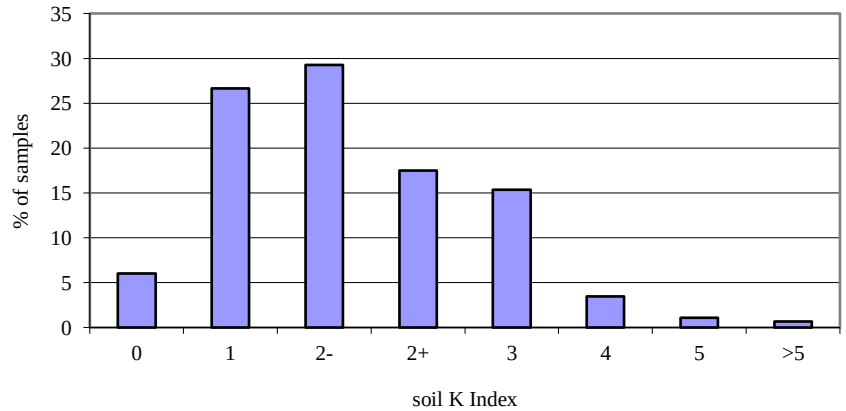
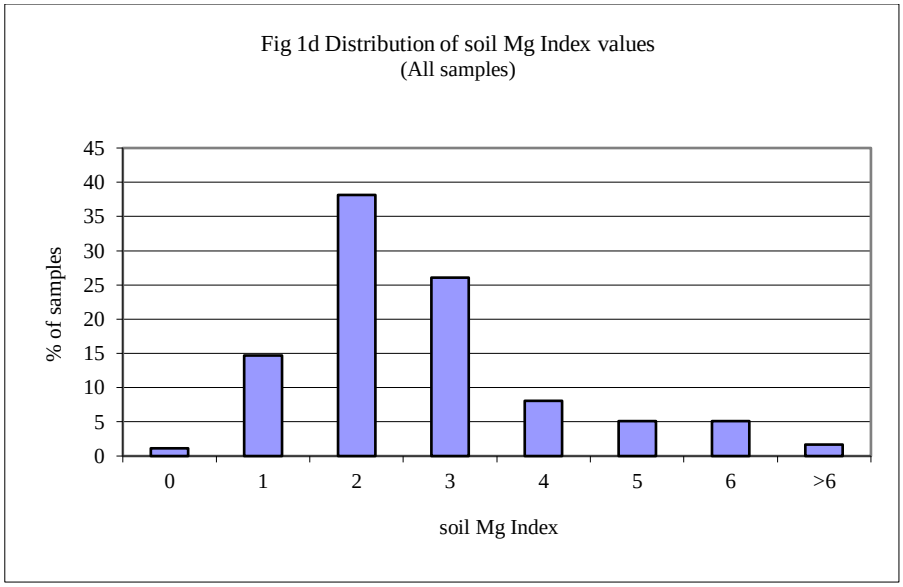


Fig 1c Distribution of soil K Index values
(All samples)





.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 (19115 samples for arable and 25417 for grassland) are summarised in Table 3 and Fig 2.

Mean pH for arable samples was 7.00 and for grassland 6.12. The mean for arable soils had increased to 7.07 in 2021/22 from 6.80 in 2019/20 which could be associated with the smaller number of laboratories that provided data in 2021/22. During the period covered by PAAG reports, pH has been fairly stable at around 6.0 in grassland samples.

Mean soil P value was 29 mg/l (Index 3) for arable samples and 24 mg/l (Index 2) for grassland samples. Only 30-31% of arable and grassland samples were at target Index 2 with 21% (arable) and 36% (grassland) in Indices 0 or 1. During the period covered by PAAG reports, mean soil P increased in arable samples from around 27 mg/l to 30 mg/l but remained fairly stable at around 25 mg/l in grassland samples.

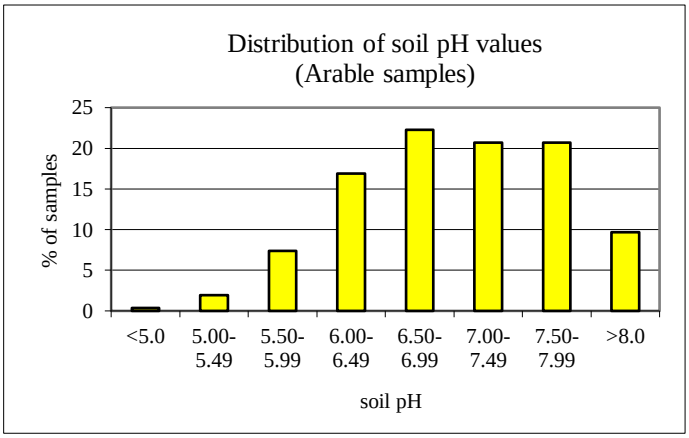
The distributions of soil K values also were somewhat similar with means of 189 mg/l (Index 2+) for arable and 175 mg/l (Index 2-) for grassland. Only 31% of arable and 26% of grassland samples were at target Index 2- and 27% (arable) and 39% (grassland) were in Indices 0 or 1. Mean soil K has increased in arable soils but has remained around 165-170 mg/l in grassland soils.

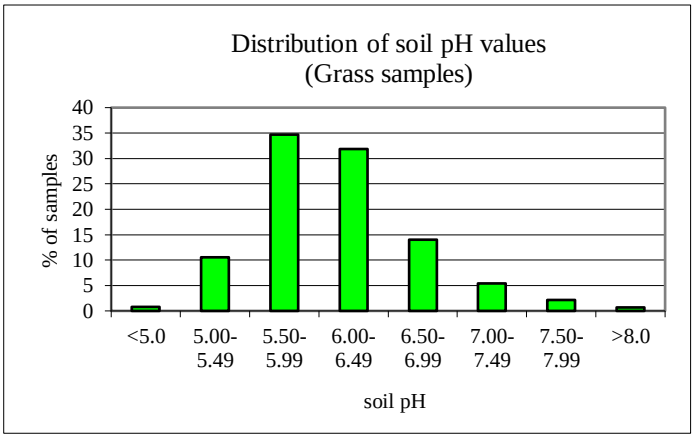
Mean soil Mg value was lower for arable (109 mg/l, Index 3) than for grassland (154 mg/l, Index 3). Only 3% of grassland, but 23% of arable, samples were in Mg Indices 0 or 1.

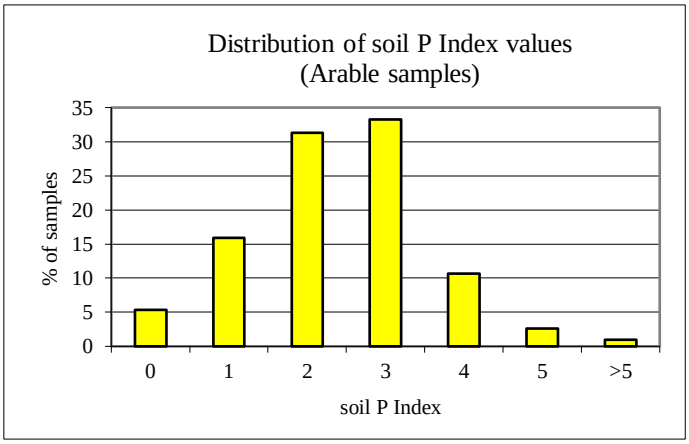
Table 3 Soil pH and Indices – arable and grassland

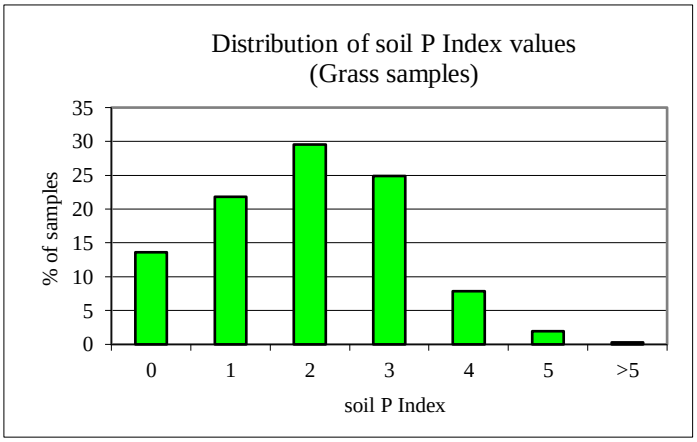
				Percentage of samples in class:				
Soil pH	**<5.0**	**5.00-5.49**	**5.50-5.99**	**6.00-6.49**	**6.50-6.99**	**7.00-7.49**	**7.50-7.99**	**>8**
Arable	0	2	7	17	22	21	21	10
Grassland	1	11	35	32	14	5	2	1
				Percentage of samples in class:				
P Index	**0**	**1**	**2**	**3**	**4**	**5**	**>5**	
Arable	5	16	31	33	11	3	1	
Grassland	14	22	30	25	8	2	0	
				Percentage of samples in class:				
K Index	**0**	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
Arable	3	24	31	20	18	3	1	0
Grassland	8	31	26	15	15	4	1	0
				Percentage of samples in class:				
Mg Index	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
Arable	1	22	41	21	7	4	2	1
Grassland	0	3	34	39	11	6	5	1

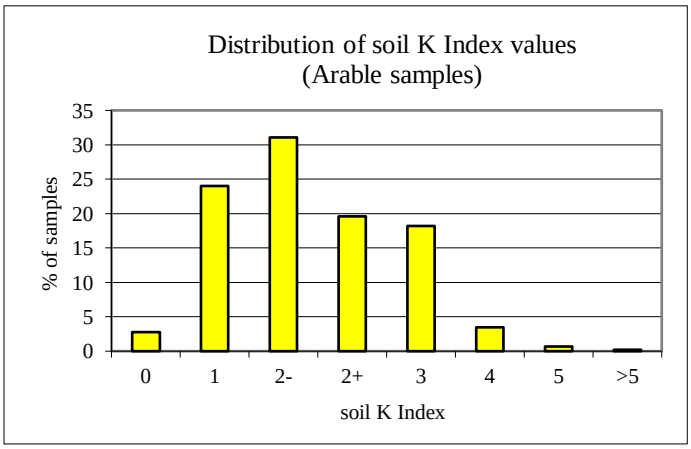
Fig 2 Distributions by arable and grassland

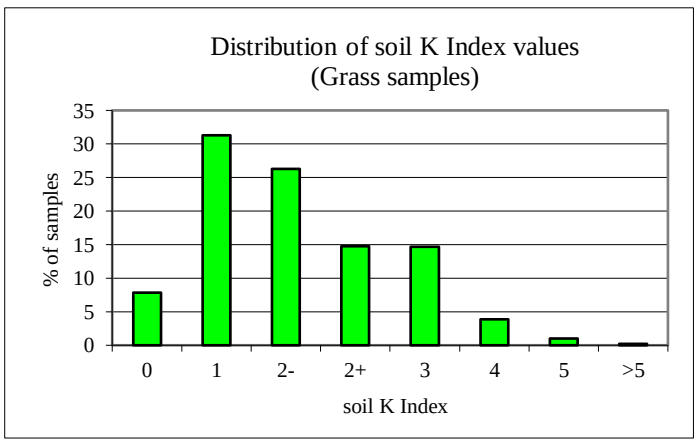


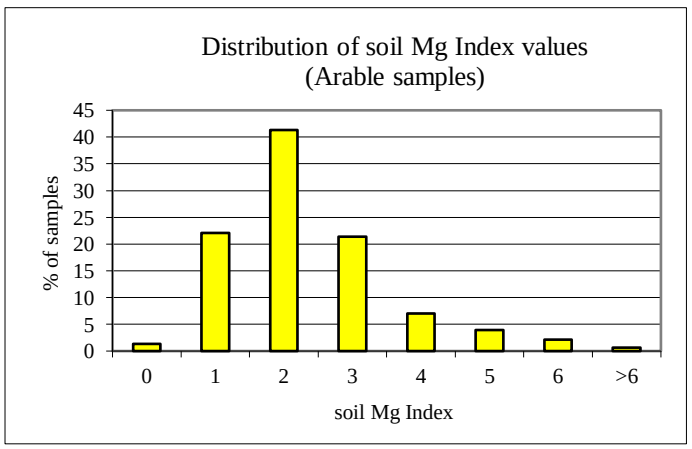


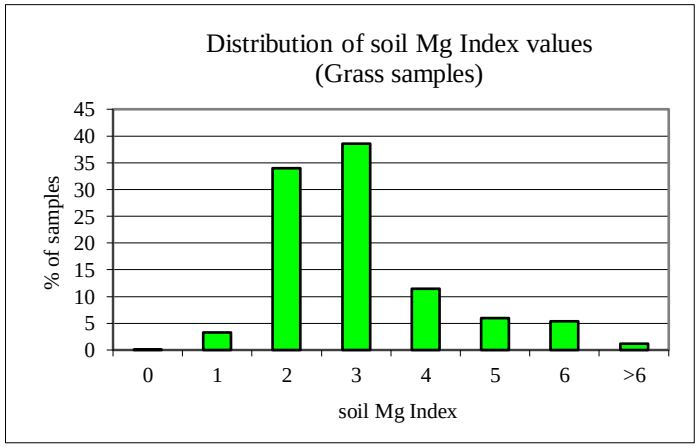












5.4 P x K Index matrix

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 10% of samples were at target Indices for both P and K. This percentage has been 9-11% 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 2022/23. 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 9-11% for at least twenty-five years.

Table 4 Percentages of all samples in P and K Indices
(total 139382 samples)

	P Index			
K Index	<target	target	>target	
<target	16	9	7	33
target	9	10	10	29
>target	6	11	21	38
	31	30	38	100

6. Previous years data

6.1 Datasets

The datasets established in previous years were extended by adding 2022/23 data. It is important to note that the number of laboratories providing data changed with years. The earliest data for 1994/95 were provided by one laboratory while the 2022/23 data were from three laboratories. In intermediate years, up to five laboratories contributed data. The apparent trends shown therefore could be anomalous and should be treated cautiously. The three datasets were:

- UK previous years data for all samples
- UK previous years data for fields identified as arable
- UK previous years data for fields identified as agricultural grassland

Trends were illustrated in two ways: firstly, development of pH or Indices in three classes each and secondly development of mean values for pH, P, K and Mg (last three expressed in mg/l).

6.2 UK past data across all crops and grassland

Percentages of samples in different classes are shown in tabular form in Appendix 3.

Soil pH

Since 1994/95, the percentage of samples with pH 6.00 to 7.00 has been around 40-45% apart from a temporary decrease to 35% in 2006/2007. From 1994/95, there was

some indication of a slight upward trend in the percentage with pH <6.00 (Fig 3) but this stabilized at around 30% by 2002/03. There was a large change in 2018/19 when the percentage of samples with pH <6 increased to 41% and that of soils with pH >7 decreased to 18% (Fig 4). However, these percentages have returned since to values typical until 2015. Mean pH showed a continued decline to 2018/19 but increased in 2021/22 (Fig 4).

Fig 3 Trends in soil pH
(all samples)

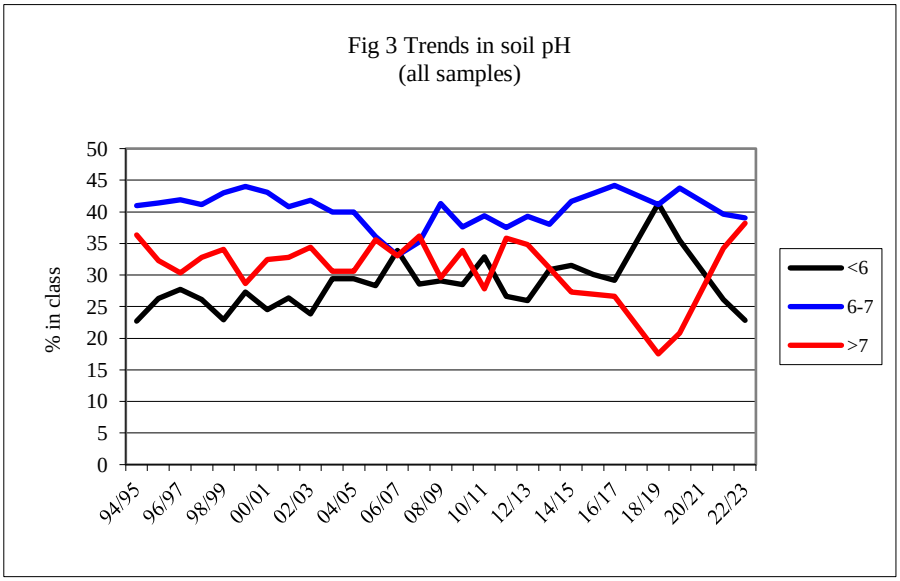
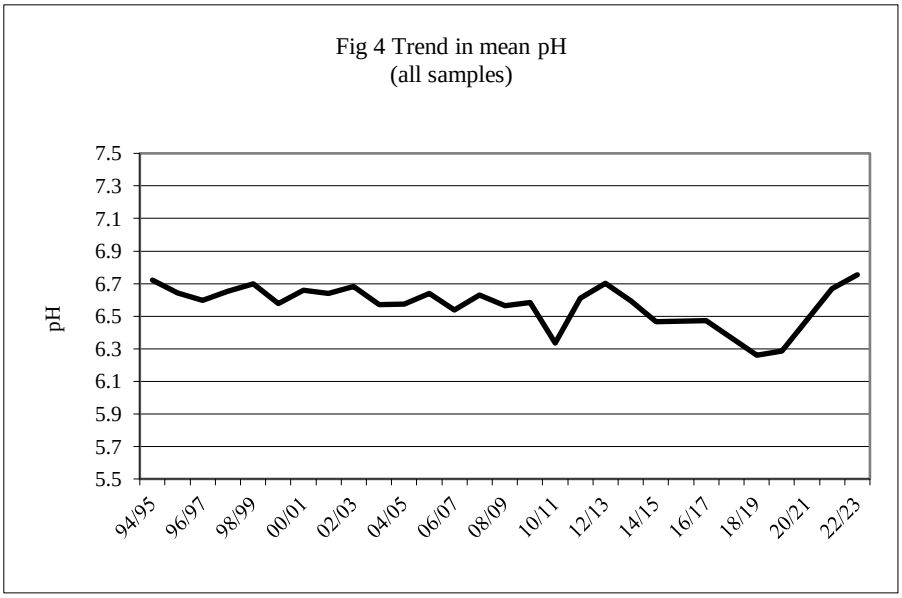


Fig 4 Trend in mean pH
(all samples)



Soil P Index

The percentage of samples below target Index 2 has been around 30% in recent years after a period around 25% to 2010. Percentage of samples at target Index also seems to have stabilised at 30% (Fig 5). There has been some decrease in mean Olsen-P since 2016/17 (Fig 6).

Fig 5 Trends in soil P Index
(all samples)

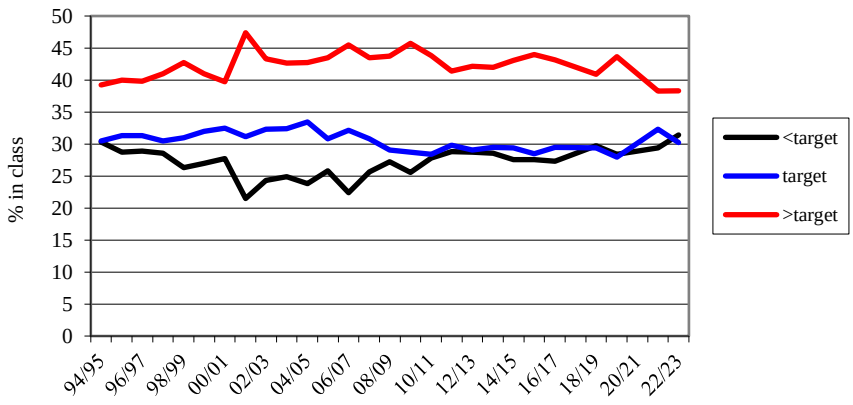
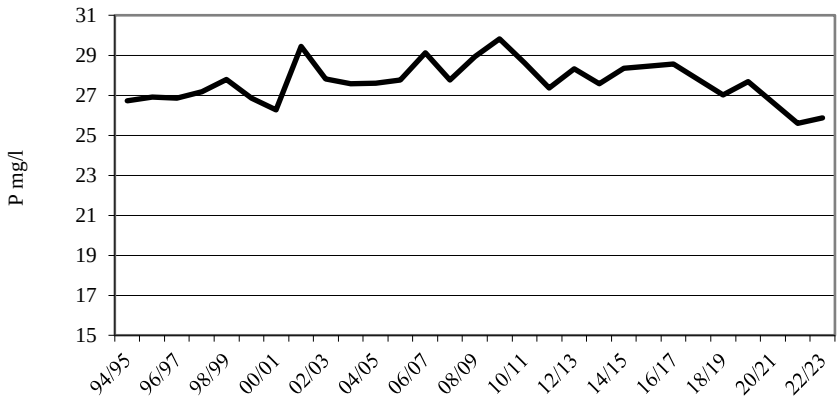


Fig 6 Trend in mean soil P
(all samples)



Soil K Index

The percentage of samples at target Index 2- has remained at around 30% during the period covered by PAAG reports (Fig 7). There has been a rather erratic upward trend in mean value since 2000 (Fig 8).

Fig 7 Trends in soil K Index
(all samples)

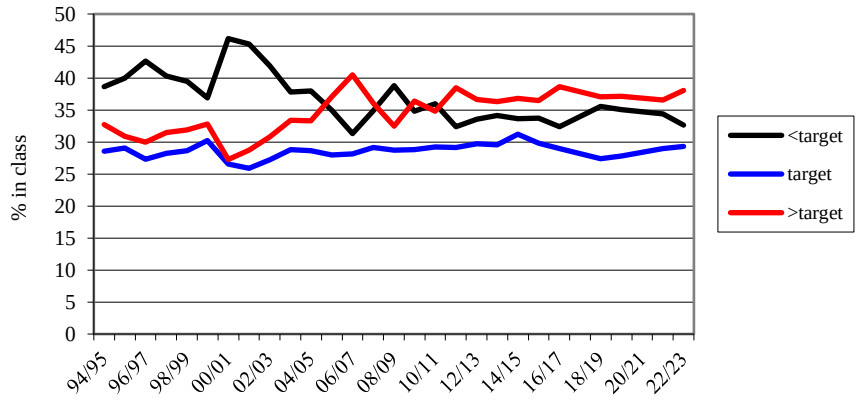
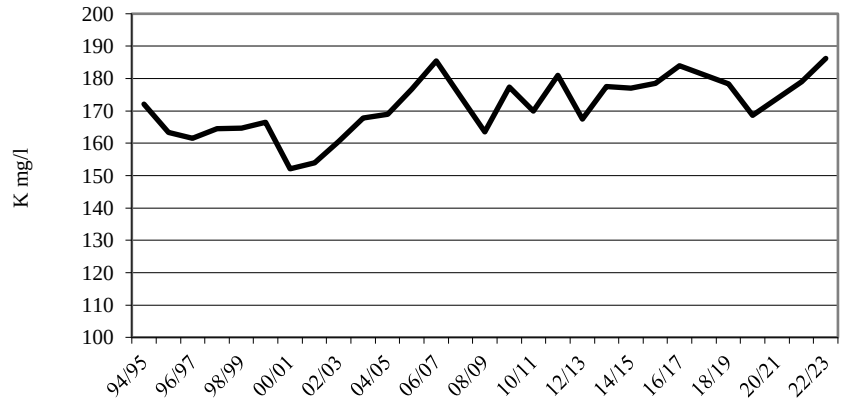


Fig 8 Trend in mean soil K
(all samples)



Soil Mg Index

The proportion of samples at Index 2 has remained fairly stable for twenty years at around 32% but with an apparent increase to 38% in 2021/22 and in 2022/23. 46% of all samples were above Index 2 in 2022/23 (Fig 9). Over the past ten years, there was a noticeable upward trend in percentage of samples above Index 2 and downward trend in percentage of samples below Index 2. These trends were reversed in 2021/22. Mean soil Mg value has remained around 140 mg/l over the past fifteen years but decreased temporarily to 129 mg/l in 2021/22 (Fig 10).

Fig 9 Trends in soil Mg Index
(all samples)

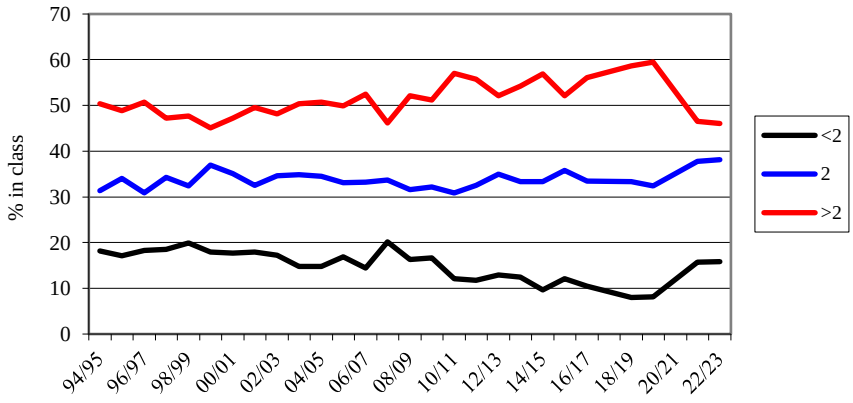
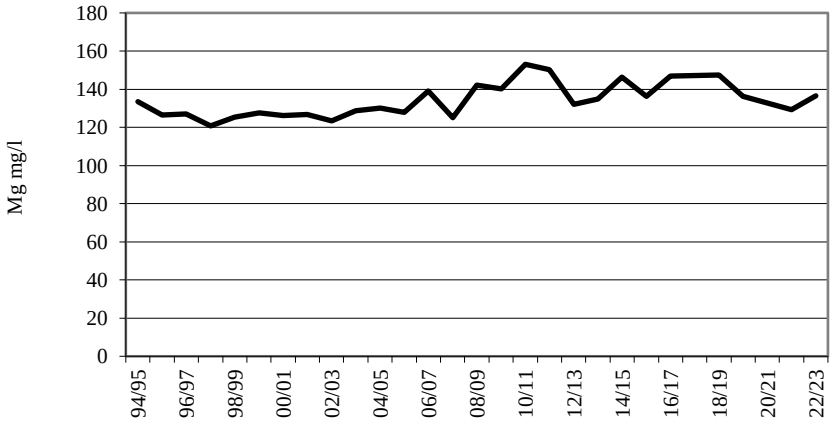


Fig 10 Trend in mean soil Mg
(all samples)



6.3 UK past data for arable and grassland

Percentages of samples in different classes are shown in tabular form in Appendix 4.

Soil pH

Until 2013/14, around 40% of arable samples were between pH 6 and pH 7. This increased to nearly 50% in 2015/16 but returned to around 40% in 2021/22 (Fig 11a). In 2021/22 there was a sharp increase in the percentage of arable samples with pH >7 and a corresponding decrease in the percentage with pH <6 (Fig 13a). This could be an anomaly associated with the smaller number of laboratories providing data in 2021/22. In grassland, there was a decrease in samples with pH <5.5 from around 20% in 2009/10 to 13% in 2021/22 (Fig 11b). In 2022/23, pH was 5.5-6.5 in 67% of grassland samples. The downward trend in mean pH in both arable and grassland samples from 1994/95 at an average rate of around 0.011 pH units/year was reversed in 2019/20 in arable samples and there was some increase in grassland samples (Fig 12).

Fig 11a Trends in soil pH
(arable samples)

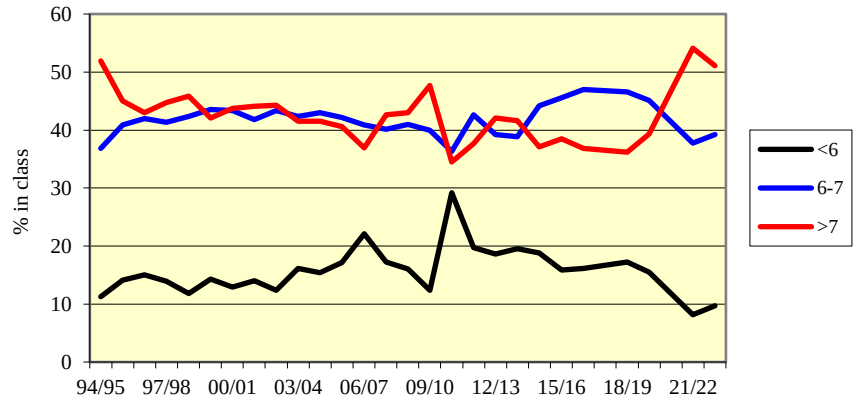


Fig 11b Trends in soil pH
(grass samples)

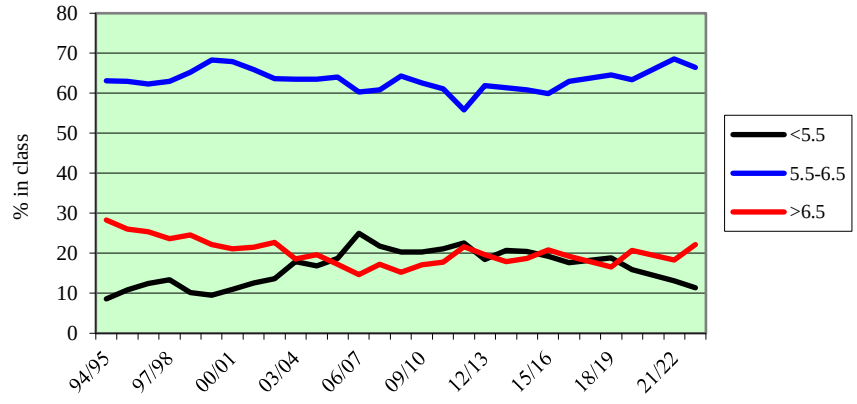
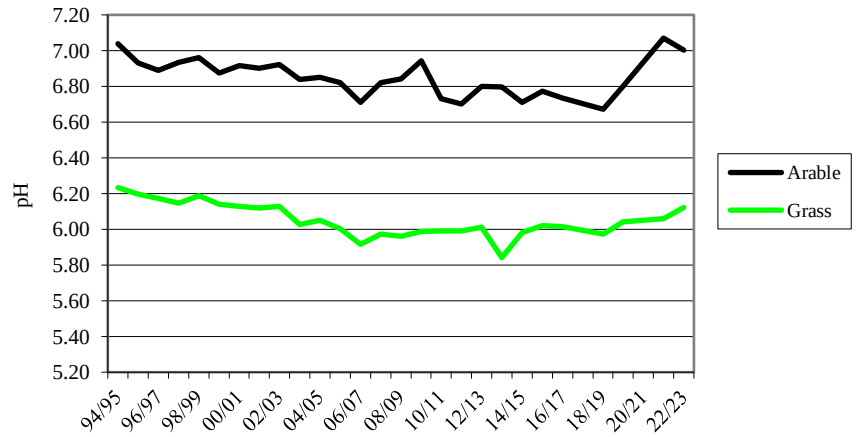


Fig 12 Trend in mean pH



Soil P Index

Since 1994/95, 29-35% of arable samples have been at target P Index 2. A larger percentage was at higher Indices and a smaller percentage at lower Indices (Fig 13a).

The percentage of arable samples with P Index above target has stabilised at around 50% after an upwards trend from 1994/95. A fairly stable 30% of grassland samples has remained at target P Index though there was a temporary increase to 34% in 2021/22. The percentage of grassland samples above target Index was around 40% in 2220/2010 but since has decreased to 30-35% (Fig 13b). Mean Olsen P tended to increase in arable samples from 1994/95 until stabilising since at around 31 mg/l. Linear regression of mg P/l in arable samples against time revealed a significant coefficient ($P<0.001$) of 0.11 mg P/l/year. This increase is surprising as, over the same period, fertiliser phosphate application has decreased. Other factors such as changes in cultivation practices could be involved. A change from ploughing to minimum cultivation can lead to concentration of available P near to the soil surface and in the sampling zone.

Fig 13a Trends in soil P Indices
(arable samples)

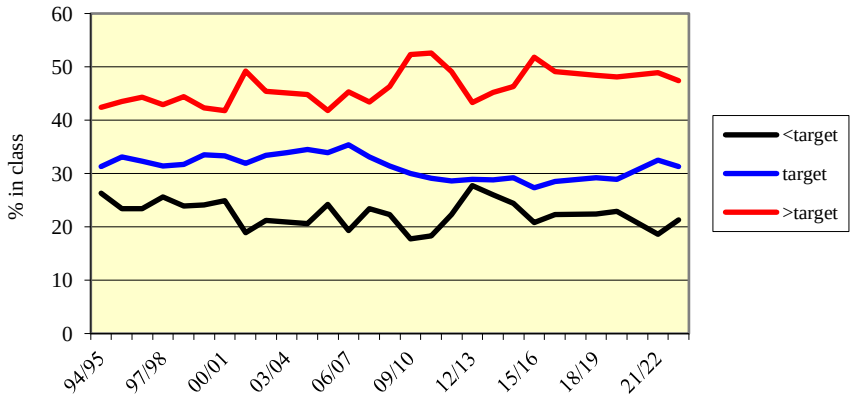
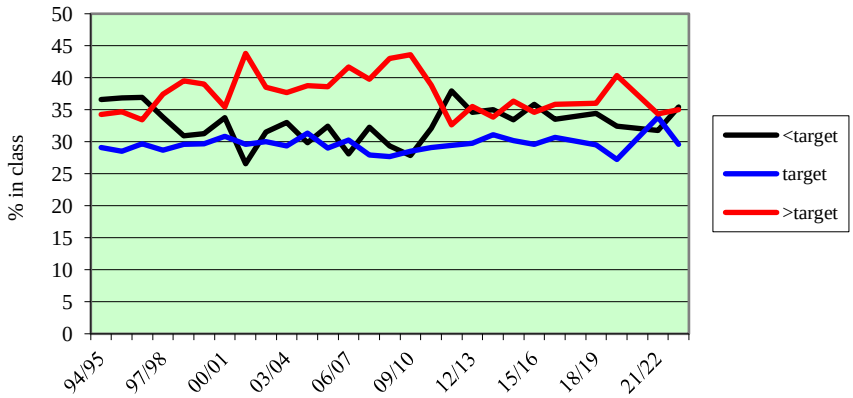
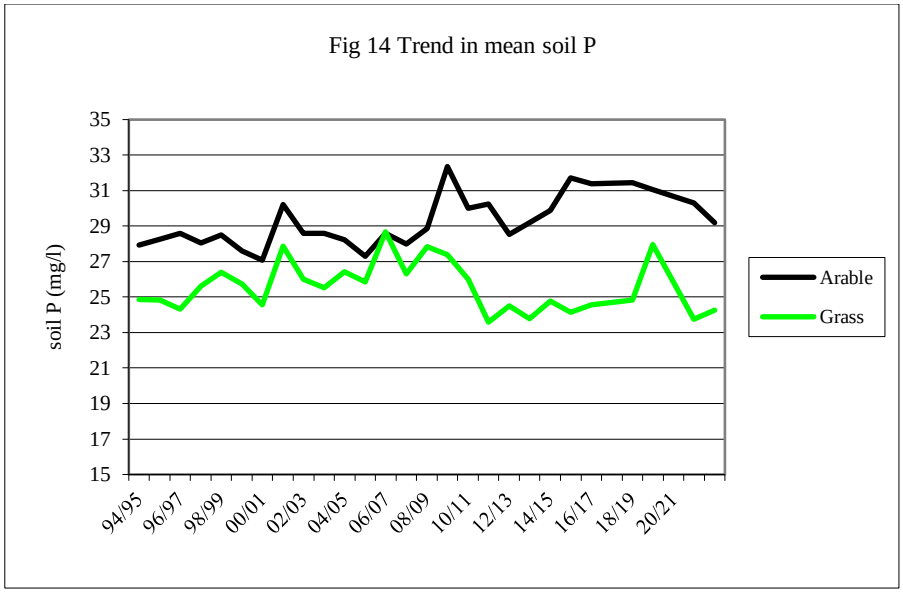


Fig 13b Trends in soil P Indices
(grass samples)





Soil K Index

Around 30% of arable samples have remained at target Index 2-. Over the period covered by PAAG reports, there has been an increase in the percentage of arable samples higher than target and a similar decrease in samples lower than target (Fig 15a). Around 27% of grassland samples were at target Index and there was no clear indication of an upward or downward trend (Fig 15b). Mean soil K trended upwards from 2000 in arable samples (Fig 16).

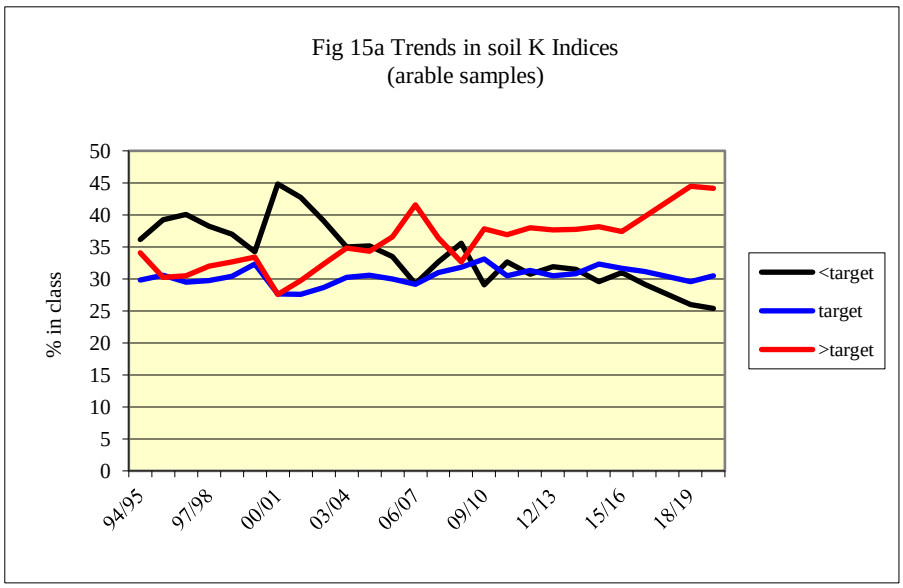


Fig 15b Trends in soil K Indices
(grass samples)

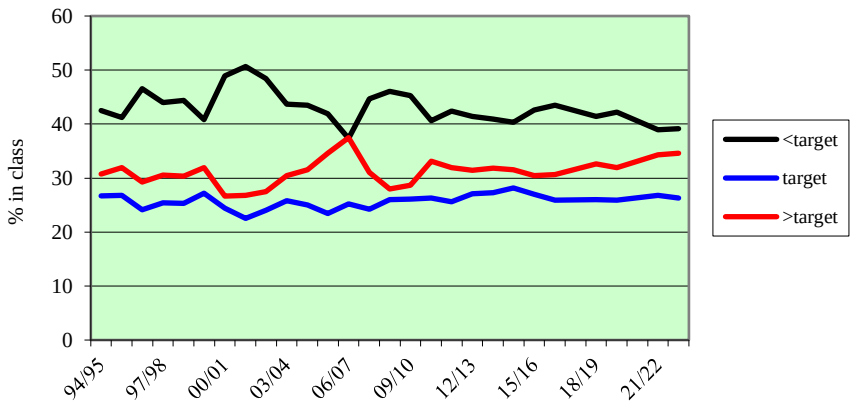
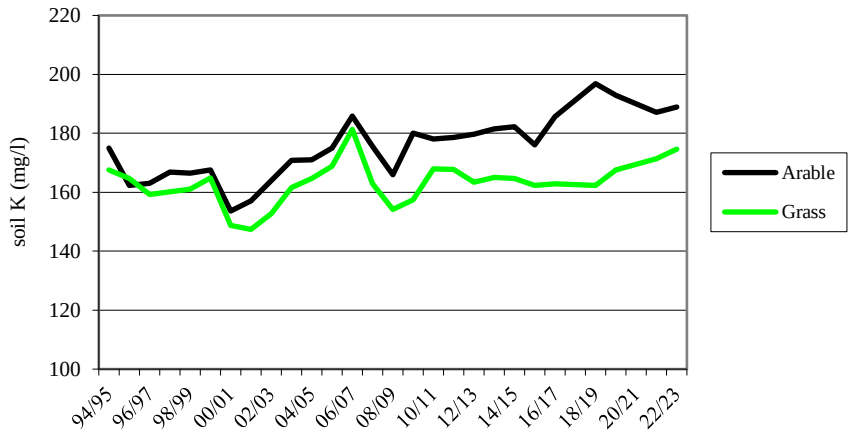


Fig 16 Trend in mean soil K



Soil Mg Index

The proportion of arable samples at Index 2 increased steadily from around 30% in 1994/95 to 42% in 2021/22 and 41% in 2022/23 (Fig 17a). In 2021/22, there was a sharp increase in percentage of arable samples with Index lower than 2 and a decrease in percentage with Index higher than 2. Percentage of grassland samples with Mg Index of 2 has been stable at around 30% (Fig 17b). Mg Index overall has been noticeably higher in grassland than in arable samples. This is due to the larger percentage of samples with Index greater than 2. Mean mg Mg/l has been rather erratic in both arable and grassland samples (Fig 18).

Fig 17a Trends in soil Mg Indices
(arable samples)

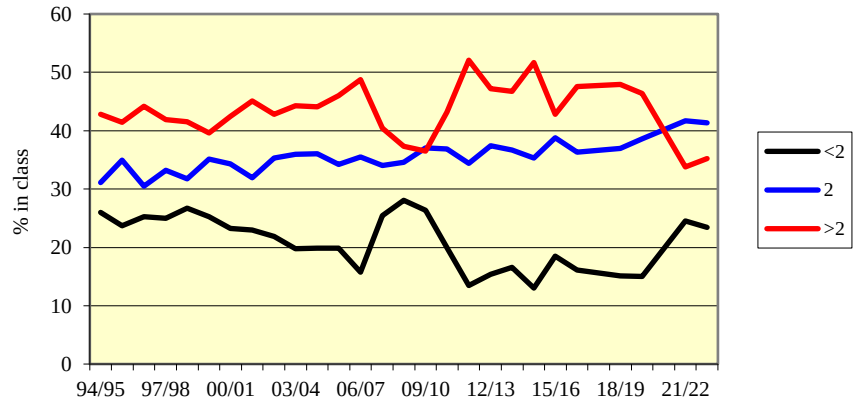


Fig 17b Trends in soil Mg Indices
(grass samples)

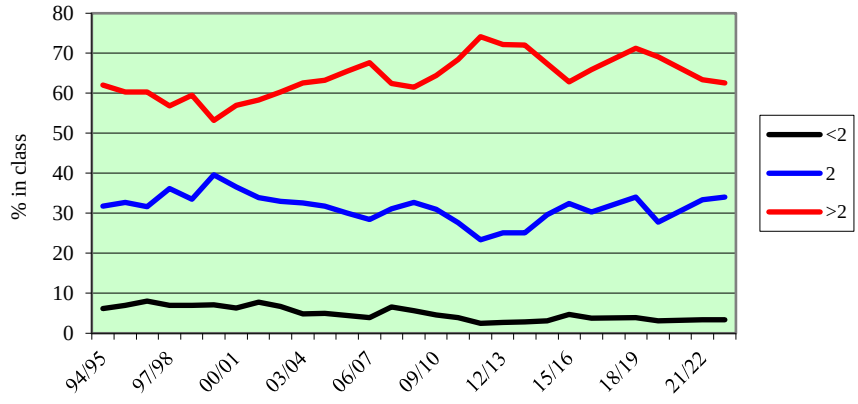
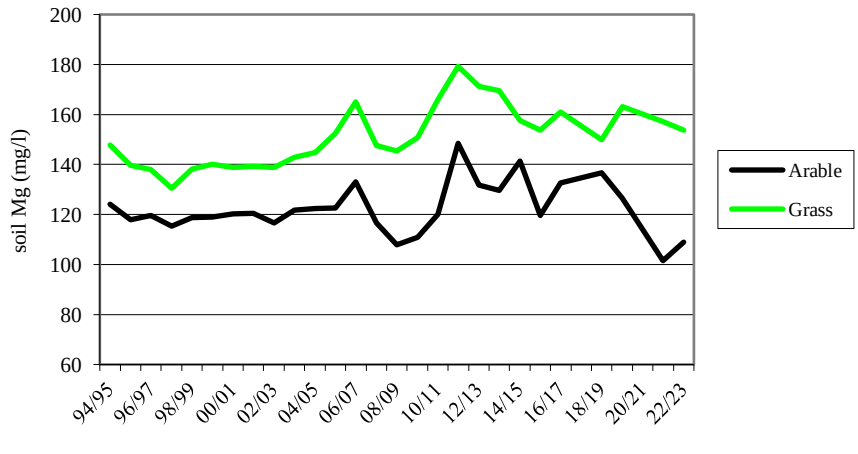


Fig 18 Trend in mean soil Mg



Appendix 1 Percentages of samples in P x K Indices

All samples 2022/23 (139382 samples)

P Index

K Index	0	1	2	3	>3	Total
0	2	1	1	1	0	6
1	5	7	8	5	1	27
2-	3	7	10	8	2	29
2+	1	3	6	6	2	17
3	0	1	4	6	3	15
>3	0	0	1	2	2	5
Total	10	19	32	28	10	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

Appendix 2 Previous years data – all samples

		Mean values			
	No. samples	**pH**	**P**	**K**	**Mg**
			mg/l	mg/l	mg/l
94/95	29753	6.72	27	172	133
95/96	35245	6.64	27	163	126
96/97	38518	6.60	27	161	127
97/98	36096	6.65	27	164	121
98/99	36877	6.70	28	165	125
99/00	40307	6.58	27	166	127
00/01	25869	6.66	26	152	126
01/02	31938	6.64	29	154	127
02/03	29456	6.68	28	161	123
03/04	31827	6.57	28	168	129
04/05	27756	6.58	28	169	130
05/06	39009	6.64	28	177	128
06/07	43622	6.54	29	185	139
07/08	50663	6.63	28	175	125
08/09	45461	6.56	29	163	142
09/10	189000-207000	6.58	30	177	140
10/11	178000-185000	6.32	29	170	154
11/12	171045	6.61	27	181	150
12/13	240000	6.70	28	167	132
13/14	197181	6.59	28	177	135
14/15	172186-173207	6.47	28	177	147
15/16	160332-170050	6.47	28	179	136
16/17	186703-188322	6.47	29	184	147
18/19	186794-197009	6.26	27	178	148
19/20	124825-126097	6.29	28	169	136
21/22	144060	6.67	26	179	169
22/23	139382	6.75	26	186	136

Appendix 2 (continued)

pH data

Percentage of samples

	<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	>8.0
94/95	0	4	18	23	18	13	11	12
95/96	1	6	20	23	18	12	10	10
96/97	1	6	21	24	18	12	10	9
97/98	1	6	19	23	18	12	11	10
98/99	0	4	18	24	19	13	11	11
99/00	0	5	22	25	19	13	9	7
00/01	0	5	19	23	20	13	10	9
01/02	1	5	20	22	19	13	11	8
02/03	0	5	18	22	20	14	12	9
03/04	1	8	21	22	18	12	12	7
04/05	1	7	21	22	18	12	11	7
05/06	1	7	20	20	16	13	15	7
06/07	1	11	22	19	15	13	14	6
07/08	1	8	19	19	17	15	15	6
08/09	1	9	21	22	18	15	16	7
09/10	1	8	19	20	17	13	14	7
10/11	1	10	22	22	17	11	10	6
11/12	1	8	17	20	17	13	16	8
12/13	1	7	18	22	18	14	14	8
13/14	1	9	21	21	17	12	13	6
14/15	1	9	21	24	18	11	10	6
15/16	1	9	20	24	19	12	10	5
16/17	1	8	20	25	19	12	10	5
18/19	1	12	28	26	16	8	7	3
19/20	1	10	25	26	17	9	7	5
21/22	1	6	20	23	17	12	12	10
22/23	1	5	17	21	18	13	13	11

Appendix 2 (continued)

Soil P data

	Percentage of samples						
	Index						
	0	**1**	**2**	**3**	**4**	**5**	**>5**
94/95	9	21	30	27	9	2	1
95/96	8	21	31	28	9	2	1
96/97	8	21	31	28	9	2	1
97/98	8	20	30	29	10	2	1
98/99	7	19	31	30	10	3	0
99/00	7	20	32	29	9	2	0
00/01	7	21	33	29	9	2	0
01/02	4	17	31	33	12	3	1
02/03	5	19	32	31	10	2	0
03/04	5	19	32	30	10	2	1
04/05	5	19	33	31	10	2	0
05/06	6	20	31	30	11	2	0
06/07	5	18	32	32	11	2	0
07/08	6	19	31	31	10	2	0
08/09	7	19	32	34	12	3	1
09/10	8	18	29	29	11	3	2
10/11	8	20	28	28	11	3	2
11/12	7	21	30	28	10	3	1
12/13	8	20	29	28	11	3	1
13/14	9	20	29	28	10	3	1
14/15	8	20	29	29	10	3	1
15/16	8	20	28	29	11	3	1
16/17	7	20	30	28	11	3	1
18/19	10	20	29	28	10	2	1
19/20	9	20	28	28	11	4	2
21/22	10	19	32	28	8	2	1
22/23	12	20	30	27	8	2	1

Appendix 2 (continued)

Soil K data

	Index							
	0	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
94/95	5	34	29	15	13	3	1	0
95/96	5	35	29	15	13	3	0	0
96/97	8	34	27	14	12	3	1	0
97/98	7	34	28	15	13	3	1	0
98/99	7	33	29	16	13	3	1	0
99/00	5	32	30	17	13	3	0	0
00/01	12	35	27	13	11	3	0	0
01/02	12	33	26	14	12	2	0	0
02/03	9	33	27	15	13	3	0	0
03/04	6	32	29	16	14	3	0	0
04/05	7	31	29	16	14	3	1	0
05/06	6	29	28	17	16	3	1	0
06/07	5	26	28	18	18	4	1	0
07/08	6	29	29	17	15	3	1	0
08/09	6	35	33	17	14	2	0	0
09/10	6	29	29	17	15	3	1	0
10/11	6	30	29	17	14	3	1	0
11/12	5	28	29	18	16	3	1	0
12/13	5	29	30	18	15	3	1	0
13/14	5	29	29	17	15	3	1	0
14/15	4	29	31	17	15	3	1	0
15/16	5	29	30	17	15	3	1	0
16/17	5	28	29	18	16	4	1	0
18/19	6	30	27	17	16	4	1	0
19/20	6	30	28	17	14	4	1	0
21/22	7	28	29	17	15	3	1	0
22/23	6	29	29	17	15	3	1	1

Appendix 2 (continued)

Soil Mg data

	Percentage of samples							
	Index							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
94/95	3	16	31	25	12	9	3	1
95/96	2	15	34	27	12	8	2	0
96/97	2	16	31	29	11	8	2	0
97/98	2	16	34	28	10	7	2	0
98/99	2	18	32	27	10	7	2	1
99/00	1	16	37	22	12	8	2	0
00/01	2	16	35	26	11	7	2	1
01/02	2	16	33	28	12	7	2	0
02/03	2	15	35	27	12	7	2	0
03/04	2	13	35	28	13	8	2	0
04/05	2	13	35	29	13	7	2	1
05/06	2	15	33	29	12	6	3	1
06/07	1	13	33	28	13	7	4	1
07/08	2	18	34	25	11	6	4	0
08/09	2	21	37	28	11	6	3	1
09/10	1	15	32	26	12	7	5	1
10/11	1	11	31	29	13	8	6	1
11/12	0	11	33	29	13	8	5	1
12/13	1	13	35	28	12	6	4	1
13/14	1	12	33	30	12	6	4	1
14/15	0	9	33	31	13	7	4	1
15/16	1	12	36	30	11	6	4	1
16/17	0	10	33	31	12	7	5	1
18/19	0	8	33	34	13	6	5	1
19/20	0	8	32	34	13	7	4	1
21/22	1	15	38	28	9	5	4	1
22/23	1	15	38	26	8	5	5	2

Appendix 3 Previous years data – arable and grassland

Arable samples

		Mean values			
	No. samples	**pH**	**P**	**K**	**Mg**
			mg/l	mg/l	mg/l
94/95	18019	7.04	28	175	124
95/96	21370	6.93	28	162	118
96/97	22845	6.89	29	163	120
97/98	23277	6.93	28	167	115
98/99	24282	6.96	29	166	119
99/00	24078	6.87	28	168	119
00/01	17429	6.92	27	154	120
01/02	21298	6.90	30	157	120
02/03	20555	6.92	29	164	117
03/04	21363	6.84	29	171	122
04/05	18180	6.85	28	171	122
05/06	21768	6.82	27	175	123
06/07	23038	6.71	29	186	133
07/08	30590	6.82	28	175	117
08/09	30842	6.84	29	166	108
09/10	30055	6.94	32	180	111
10/11	32052-38811	6.73	30	178	120
11/12	61027-68565	6.70	30	179	148
12/13	190000	6.80	29	180	132
13/14	129918-137676	6.80	29	182	130
14/15	108136-109444	6.71	30	182	141
15/16	60756-68780	6.77	32	176	120
16/17	63554-64356	6.73	31	186	133
18/19	78305-81427	6.67	31	197	137
19/20	52350-53469	6.80	31	193	126
21/22	18668	7.07	30	187	102
22/23	19115	7.00	29	189	109

Appendix 3 (continued)

Grassland samples

		Mean values			
	No. samples	**pH**	**P**	**K**	**Mg**
			mg/l	mg/l	mg/l
94/95	11734	6.23	25	168	148
95/96	13875	6.20	25	165	140
96/97	15673	6.17	24	159	138
97/98	12819	6.14	26	160	131
98/99	12595	6.19	26	161	138
99/00	16229	6.14	26	165	140
00/01	8440	6.13	25	149	139
01/02	10640	6.12	28	147	139
02/03	8901	6.13	26	153	139
03/04	10464	6.03	26	162	143
04/05	9576	6.05	26	165	145
05/06	12435	6.00	26	169	152
06/07	14970	5.92	29	181	165
07/08	15264	5.97	26	163	148
08/09	14619	5.96	28	154	145
09/10	18468	5.99	27	157	151
10/11	18721	5.87	22	139	130
11/12	38272	5.99	24	168	179
12/13	49000	6.01	24	163	171
13/14	59500	5.84	24	165	169
14/15	59558-59695	5.98	25	165	158
15/16	59720-59912	6.02	24	162	154
16/17	67240-67429	6.02	25	163	161
18/19	117228-124321	5.97	25	162	150
19/20	72475-72638	6.04	28	167	163
21/22	33835	6.06	24	171	157
22/23	25417	6.12	24	175	154

Appendix 3 (continued)

Arable soil pH data

Percentage of samples

	<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	>8.0
94/95	0	2	9	17	20	17	16	19
95/96	0	3	11	20	21	16	14	15
96/97	0	3	12	21	21	16	14	13
97/98	0	3	11	20	21	16	15	14
98/99	0	2	10	20	22	17	14	15
99/00	0	2	12	20	23	18	14	11
00/01	0	3	10	19	24	18	13	13
01/02	0	2	11	20	22	17	15	12
02/03	0	2	10	20	23	17	15	12
03/04	1	4	12	21	21	16	16	10
04/05	0	3	12	21	23	16	15	10
05/06	0	3	13	20	22	16	16	9
06/07	0	6	16	21	20	15	15	7
07/08	1	4	13	19	21	18	17	7
08/09	0	4	12	20	21	17	19	7
09/10	1	3	9	18	22	18	21	9
10/11	1	9	19	20	17	13	14	7
11/12	1	5	14	21	21	16	16	6
12/13	1	4	14	20	19	16	17	10
13/14	1	5	14	19	20	15	17	9
14/15	1	4	14	23	21	15	14	8
15/16	1	4	12	22	24	16	14	8
16/17	1	3	12	24	23	16	14	6
18/19	1	4	13	23	23	16	14	6
19/20	0	3	12	22	23	15	14	10
21/22	0	2	6	16	22	20	24	10
22/23	0	2	7	17	22	21	21	10

Appendix 3 (continued)

Grassland soil pH data

Percentage of samples

	<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	>8.0
94/95	1	8	32	31	16	6	4	3
95/96	1	10	34	29	13	6	4	3
96/97	1	11	34	29	13	6	4	2
97/98	1	12	35	28	13	5	4	2
98/99	1	9	34	31	13	5	4	2
99/00	1	9	37	31	13	5	3	1
00/01	1	10	37	30	12	4	3	2
01/02	1	12	39	27	11	4	4	2
02/03	1	13	37	27	11	5	4	2
03/04	2	16	39	25	10	4	3	1
04/05	2	15	39	24	10	5	4	2
05/06	2	17	39	25	9	4	3	1
06/07	2	23	39	21	8	3	3	1
07/08	2	19	38	23	9	4	3	1
08/09	2	19	41	23	8	3	3	1
09/10	2	19	39	24	9	4	3	1
10/11	2	19	38	24	9	4	3	1
11/12	3	19	31	24	12	5	3	1
12/13	2	17	35	27	12	5	3	1
13/14	2	19	36	26	11	4	3	1
14/15	2	19	35	26	11	4	3	1
15/16	2	17	33	27	12	5	3	1
16/17	2	16	35	28	12	4	2	1
18/19	2	17	38	27	11	3	2	1
19/20	2	14	34	29	13	4	2	1
21/22	1	12	37	31	13	4	1	1
22/23	1	11	35	32	14	5	2	1

Appendix 3 (continued)

Arable soil P data

	Percentage of samples						
	Index						
	0	**1**	**2**	**3**	**4**	**5**	**>5**
94/95	6	20	31	30	10	2	1
95/96	4	19	33	30	10	2	1
96/97	5	18	32	31	10	3	1
97/98	6	20	31	30	10	3	1
98/99	5	19	32	31	11	3	0
99/00	5	20	34	30	10	2	0
00/01	5	20	33	31	9	2	0
01/02	3	16	32	34	12	3	1
02/03	3	18	33	32	10	2	0
03/04	3	18	34	32	10	2	1
04/05	3	18	35	32	10	2	0
05/06	4	20	34	30	10	2	0
06/07	2	17	35	32	10	2	0
07/08	4	20	33	31	10	2	0
08/09	5	18	31	32	11	3	0
09/10	3	14	30	34	14	4	2
10/11	4	14	29	35	13	3	1
11/12	5	18	29	32	12	3	1
12/13	8	20	29	28	11	3	1
13/14	8	18	29	30	11	3	1
14/15	6	19	29	30	12	3	1
15/16	5	16	27	32	14	4	2
16/17	5	17	29	30	13	4	2
18/19	5	17	29	30	13	4	1
19/20	5	18	29	30	12	4	2
21/22	4	14	33	34	11	3	1
22/23	5	16	31	33	11	3	1

Appendix 3 (continued)

Grassland soil P data

	Percentage of samples						
	Index						
	0	**1**	**2**	**3**	**4**	**5**	**>5**
94/95	13	23	29	24	8	2	1
95/96	13	24	28	24	8	2	0
96/97	12	25	30	24	8	2	0
97/98	13	21	29	27	8	2	1
98/99	10	21	30	28	9	2	0
99/00	10	21	30	29	8	2	0
00/01	11	22	31	26	8	1	0
01/02	8	19	30	30	11	2	0
02/03	9	22	30	27	9	2	0
03/04	10	23	29	27	9	2	0
04/05	9	21	31	27	9	2	1
05/06	10	22	29	27	10	2	0
06/07	7	21	30	29	10	3	0
07/08	11	21	28	28	10	2	0
08/09	10	19	28	29	11	3	1
09/10	9	19	29	31	10	2	0
10/11	11	21	29	28	9	2	1
11/12	12	26	29	24	7	2	0
12/13	11	23	30	26	8	2	0
13/14	11	24	31	26	7	1	0
14/15	11	23	30	27	8	1	0
15/16	12	24	30	25	7	2	0
16/17	11	23	31	26	8	2	0
18/19	13	22	30	26	8	2	0
19/20	11	21	27	26	9	3	2
21/22	11	21	34	27	6	1	0
22/23	14	22	30	25	8	2	0

Appendix 3 (continued)

Arable soil K data

	Percentage of samples							
	Index							
	0	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
94/95	4	33	30	16	14	3	1	0
95/96	4	35	31	15	12	2	0	0
96/97	6	34	29	15	12	3	1	0
97/98	5	33	30	16	13	3	1	0
98/99	5	32	30	16	13	2	0	0
99/00	4	30	32	18	13	2	0	0
00/01	10	35	28	14	11	2	0	0
01/02	10	33	28	15	12	2	0	0
02/03	7	32	29	16	14	2	0	0
03/04	5	30	30	17	14	3	0	0
04/05	5	30	31	17	14	3	1	0
05/06	5	29	30	18	15	3	1	0
06/07	4	26	29	19	18	4	1	0
07/08	4	28	31	18	15	3	1	0
08/09	4	31	32	17	13	2	0	0
09/10	3	26	33	19	15	3	1	0
10/11	4	28	30	18	15	3	1	0
11/12	3	28	31	19	16	3	1	0
12/13	4	28	30	18	15	3	1	0
13/14	4	27	31	18	15	3	1	0
14/15	3	27	32	19	16	3	1	0
15/16	3	28	32	19	16	3	0	0
16/17	3	26	31	19	17	3	1	0
18/19	3	23	30	20	19	4	1	0
19/20	2	23	30	21	19	4	1	0
21/22	3	24	32	19	17	3	1	0
22/23	3	24	31	20	18	3	1	0

Appendix 3 (continued)
Grassland soil K data

	Percentage of samples							
	Index							
	0	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
94/95	7	35	27	14	13	3	1	0
95/96	7	34	27	15	13	3	1	0
96/97	12	35	24	13	12	3	1	0
97/98	9	35	25	15	13	3	1	0
98/99	10	34	25	14	12	3	1	0
99/00	7	33	27	15	13	3	1	0
00/01	15	33	24	13	11	3	0	0
01/02	18	33	23	12	12	3	0	0
02/03	14	35	24	12	12	3	1	0
03/04	9	34	26	14	13	3	1	0
04/05	11	33	25	14	13	3	1	0
05/06	11	31	23	15	15	4	1	0
06/07	8	29	25	15	16	5	1	0
07/08	11	34	24	14	13	3	1	0
08/09	10	36	26	14	11	2	1	0
09/10	8	37	26	14	12	3	0	0
10/11	7	33	26	15	14	3	1	0
11/12	7	35	26	14	14	3	1	0
12/13	7	35	27	15	13	3	1	0
13/14	6	35	27	15	14	3	1	0
14/15	6	34	28	15	13	3	1	0
15/16	7	35	27	14	12	3	1	0
16/17	8	35	26	14	12	3	1	0
18/19	8	33	26	14	14	3	1	0
19/20	8	34	26	14	14	3	1	0
21/22	8	31	27	15	15	3	1	0
22/23	8	31	26	15	15	4	1	0

Appendix 3 (continued)

Arable soil Mg data

	Percentage of samples							
	Index							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
94/95	4	22	31	21	10	8	3	1
95/96	3	20	35	22	10	7	2	0
96/97	3	22	30	24	10	8	2	0
97/98	3	22	33	23	9	7	2	0
98/99	3	24	32	23	9	7	2	1
99/00	2	23	35	18	11	8	2	0
00/01	2	21	34	23	10	7	2	1
01/02	3	20	32	25	11	7	2	0
02/03	2	19	35	23	11	7	1	0
03/04	2	18	36	23	11	7	2	0
04/05	2	18	36	24	11	7	2	1
05/06	2	18	34	26	11	6	2	1
06/07	1	15	35	25	12	7	4	1
07/08	3	23	34	21	9	6	4	0
08/09	3	25	35	22	8	5	2	0
09/10	2	24	37	20	8	5	3	0
10/11	1	19	37	24	9	5	3	1
11/12	0	13	34	26	12	8	5	1
12/13	1	15	37	26	10	6	4	1
13/14	1	15	37	26	10	6	4	1
14/15	1	13	35	27	12	7	4	1
15/16	1	18	39	25	9	5	4	1
16/17	1	15	36	27	10	6	4	1
18/19	1	14	37	27	10	6	4	1
19/20	1	14	39	27	10	5	3	1
21/22	1	23	42	21	7	3	2	0
22/23	1	22	41	21	7	4	2	1

Appendix 3 (continued)
Grassland soil Mg data

Percentage of samples

Index

	0	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
94/95	1	6	32	33	16	10	2	0
95/96	1	6	33	36	14	8	2	0
96/97	1	7	32	37	14	8	2	0
97/98	1	6	36	37	12	6	1	0
98/99	0	7	34	37	13	8	2	0
99/00	0	7	40	28	13	9	2	1
00/01	0	6	37	34	13	7	2	1
01/02	0	7	34	34	14	8	2	0
02/03	1	6	33	37	14	8	2	0
03/04	0	4	33	37	15	8	2	0
04/05	0	5	32	37	16	8	1	1
05/06	0	4	30	38	15	8	3	1
06/07	0	4	28	36	16	9	5	1
07/08	1	6	31	35	15	8	4	0
08/09	0	5	33	37	14	7	3	1
09/10	0	4	31	38	15	8	3	1
10/11	0	4	28	38	15	8	6	2
11/12	0	2	23	38	18	10	7	2
12/13	0	3	25	40	17	9	5	2
13/14	0	3	25	40	17	8	6	1
14/15	0	3	30	40	15	7	4	1
15/16	0	5	32	37	13	7	5	1
16/17	0	4	30	37	14	7	5	2
18/19	0	3	31	38	14	6	5	1
19/20	0	3	28	39	16	8	5	1
21/22	0	3	33	38	12	6	6	1
22/23	0	3	34	39	11	6	5	1