PAAG
Professional Agricultural Analysis Group

Professional Agricultural Analysis Group

Collation of data from routine soil analysis in the UK

2019/2020

TRIED & TESTED

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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 2019 to May 31st 2020) results for around 125,000 samples were available (slightly 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 58% of all samples compared to 65% in 2018/19 and 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 15% of arable samples and <5.5 in 16% of grassland samples. During the period covered by PAAG reports, mean soil pH has decreased steadily in arable samples from around 7.0 to 6.8. 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 30% (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 23% of arable and 34% of grassland samples. K Index was lower than target in 25% of arable and 42% of grassland targets. Use of potash for grassland especially seems in need of attention.

- Soil P Index was higher than target in 48% of arable and 40% 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.

- 15% 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 2019 to 31st May 2020. 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 2019 to May 31st 2020. 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 124825 (pH), 126097 (P), 126091 (K) and 126089 (Mg) samples were available for the current year.

Mean soil pH was 6.29, 36% of samples were below 6.00 and 43% were between 6.00 and 7.00. Soil pH has decreased during the period covered by PAAG reports from around 6.7.

Only 28% of samples were at target soil P index (2) and 28% were at target soil K index (2-). Soil P was lower than target Index in 28% of samples and higher than target in 44% of samples. Soil K was lower than target in 35% of samples and higher than target in 37% of samples. Soil Mg Index was lower than 2 in 8% of samples and higher than 2 in 59% 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 are the same percentages calculated using 2018/2019 data. 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	10	25	26	17	9	7	5
				Percentage of samples in class:				
P Index	**0**	**1**	**2**	**3**	**4**	**5**	**>5**	
	9	20	28	28	11	4	2	
				Percentage of samples in class:				
K Index	**0**	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
	6	30	28	17	16	4	1	0
				Percentage of samples in class:				
Mg Index	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
	0	8	32	34	13	7	4	1

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

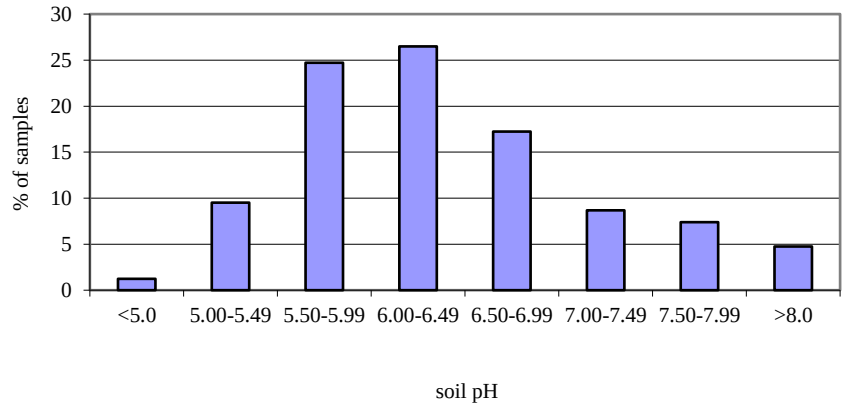


Fig 1b Distribution of soil P Index values
(All samples)

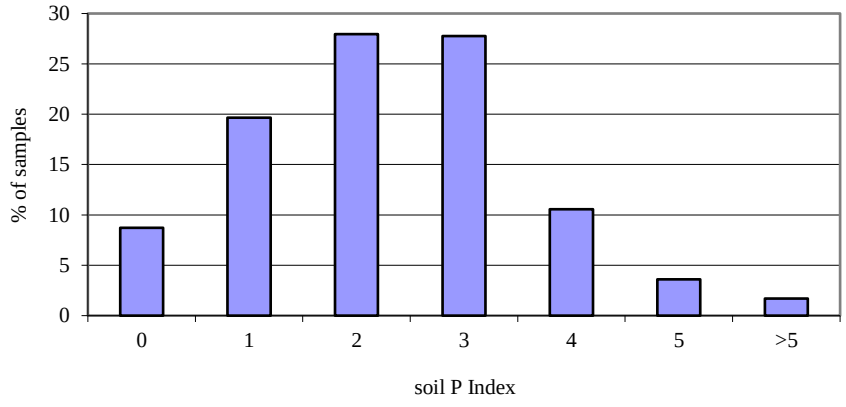
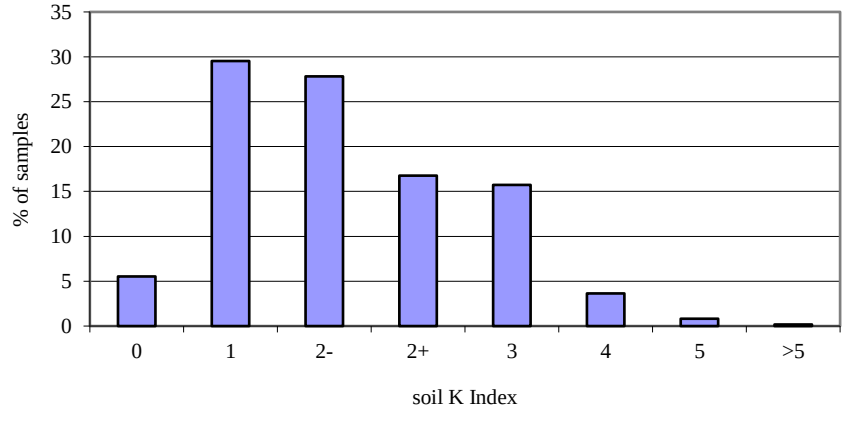
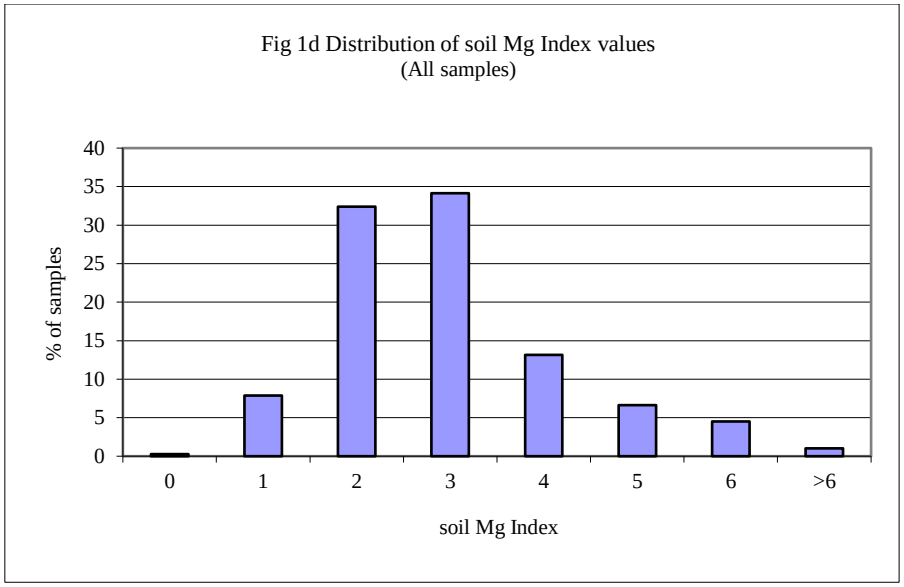


Fig 1c Distribution of soil K Index values
(All samples)





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 53000 samples for arable and 73000 for grassland) are summarised in Table 3 and Fig 2.

Mean pH for arable samples was 6.80 and for grassland 6.04. During the period covered by PAAG reports, pH has been fairly stable at around 6.0 in grassland and, after a slight decline for several years, has returned to the 2009 value of 6.8 in arable samples.

The distribution of soil P values was similar for arable and grassland with mean values of 31 mg/l (Index 3) for arable and 28 mg/l (Index 3) for grassland. Only 27-29% of arable and grassland samples were at target Index 2 with 23% (arable) and 32% (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.

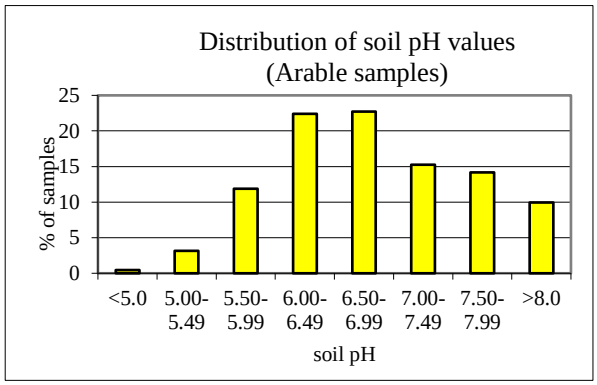
The distributions of soil K values also were somewhat similar with means of 193 mg/l (Index 2+) for arable and 167 mg/l (Index 2-) for grassland. Only 30% of arable and 26% of grassland samples were at target Index 2- and 25% (arable) and 42% (grassland) were in Indices 0 or 1. Mean soil K has increased in arable soils but has remained around 160 mg/l in grassland soils.

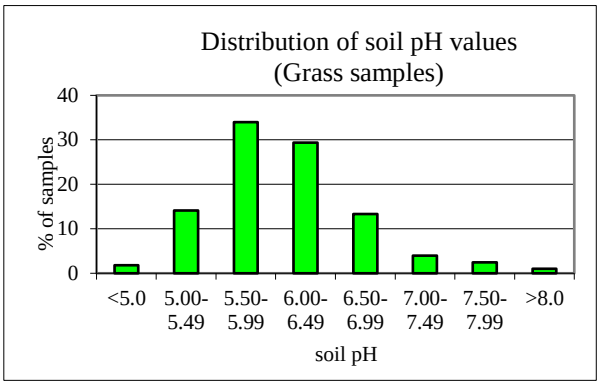
Mean soil Mg value was lower for arable (126 mg/l, Index 3) than for grassland (163 mg/l, Index 3). Only 3% of grassland, but 15% of arable, samples were in Mg Indices 0 or 1.

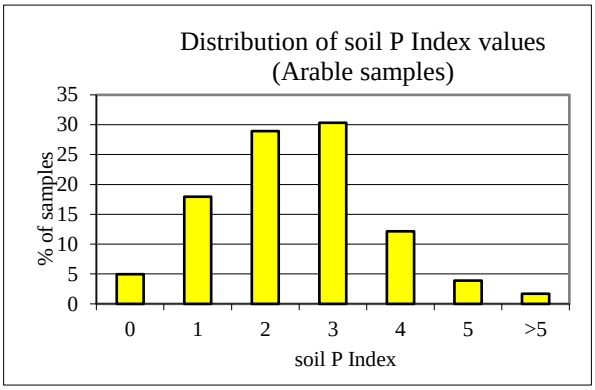
Table 3 Soil pH and Indices – arable and grassland

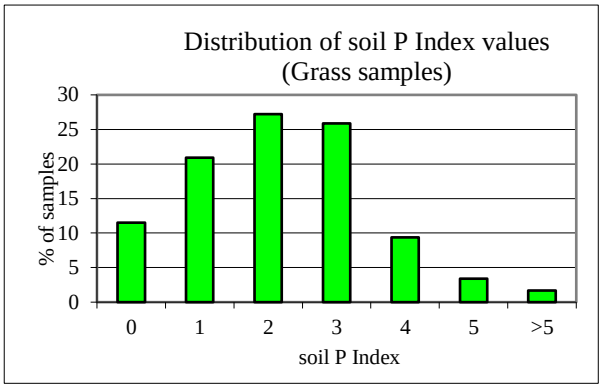
				Percentage of samples in class:				
Soil pH	**<5.0**	**5.00-5.49**	**5.50-5.99**	**6.00-6.49**	**6.50-6.99**	**7.00-7.49**	**7.50-7.99**	**>8**
Arable	0	3	12	22	23	15	14	10
Grassland	2	14	34	29	13	4	2	1
				Percentage of samples in class:				
P Index	**0**	**1**	**2**	**3**	**4**	**5**	**>5**	
Arable	5	18	29	30	12	4	2	
Grassland	11	21	27	26	9	3	2	
				Percentage of samples in class:				
K Index	**0**	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
Arable	2	23	30	21	19	4	1	0
Grassland	8	34	26	14	14	3	1	0
				Percentage of samples in class:				
Mg Index	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
Arable	1	14	39	27	10	5	3	1
Grassland	0	3	28	39	16	8	5	1

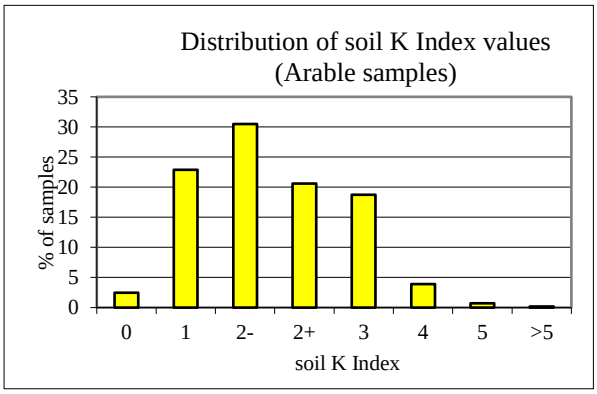
Fig 2 Distributions by arable and grassland

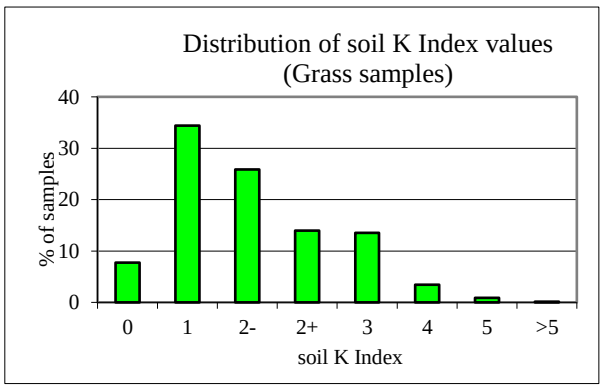


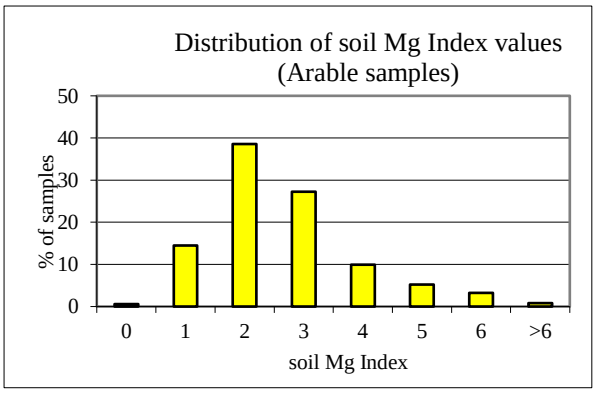


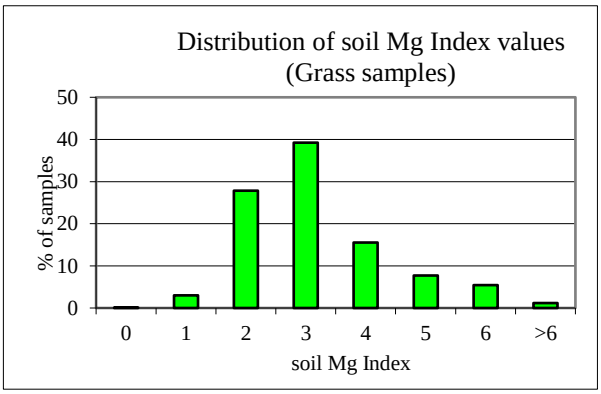












5.4 P x K Index matrix

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 2019/20. 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 12608 samples)

	P index			
K index	<target	target	>target	
<target	14	10	11	35
target	8	9	11	28
>target	6	10	21	37
	28	28	44	100

Appendix 1 Percentages of samples in P x K Indices

All samples 2019/20 (126089 samples)

P Index

K Index	0	1	2	3	>3	Total
0	1	1	1	1	0	6
1	4	8	8	7	3	30
2-	2	6	9	8	4	28
2+	1	3	5	5	3	17
3	1	2	4	5	4	16
>3	0	0	1	1	2	5
Total	9	20	28	28	16	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

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

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

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

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

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

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

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

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

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

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

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

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

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

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	58	85	1