PAAG

Professional Agricultural Analysis Group

Collation of data from routine soil analysis in the UK

2014/2015

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 2014 to May 31st 2015) results for around 170,000 samples were available (different numbers for pH, P, K and Mg).

Some participants provided data that could be broken down by arable and grass as the current crop and datasets were constructed to allow collation within this breakdown.

Conclusions should be drawn cautiously as the data were not necessarily representative of all UK fields and data collations were not statistically rigorous.

Soil pH was <6.0 in 19% of arable samples (20% in 2013/14) and <5.5 in 21% of grass samples (19% in 2013/14). This supports the need for regular soil analysis to maintain pH.

As in previous years, only around 30% of all samples were at target Index of 2 for P and 30% were at target Index of 2- for K. Just 10% of samples were at target Indices for both P and K. 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.

In the current year 14% of arable samples and 3% of grass samples were in Mg Indices 0 or 1 where application of magnesium might be recommended for some crops. These percentages were similar to those in 2013/14.

Breakdown of data by regions showed similar geographical patterns in soil pH, P, K and Mg to those found in 2009. Only in North West England were there noticeable changes, soil P having decreased and soil Mg increased since 2009. There was clear regional variation in mean soil pH, P, K and Mg.

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 2014 to 31st May 2015.

2. Data provided

Data comprised results of soil analyses - Olsen 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 hundred samples. Some provided data that could be broken down by arable and grass. Datasets were constructed for current year UK data and for data broken down into grass and arable where this was possible. Where they could be identified, data from Christmas trees, top fruit, coppice, forage maize after grass and non-UK sites were excluded from the arable dataset. Data for amenity grass

of all kinds (including horsed paddocks) were excluded from the grassland dataset. 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 current crop and past were not identified, data 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 grass 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 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 grass 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 2014 to May 31st 2015. Data sets were established for:

- UK data across all crops and grass
- UK data for arable samples
- UK data for grass samples
- Regional data across all crops and grass and separately for arable crops and grass

5.2 UK data across all crops and grass

Results for 173207 (pH), 172857 (P), 172186 (K) and 172780 (Mg) samples were available for the current year.

Mean soil pH was 6.47, 31% of samples were below 6.00 and 42% were between 6.00 and 7.00.

Only 29-31% of samples were at target soil P or K Index (2 and 2- respectively). Soil P was lower than target Index in 28% of samples and soil K was lower than target in 33% of samples. Soil Mg Index was lower than 2 in 9% of samples (Table 2, Fig 1).

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	9	21	24	18	11	10	6
	Percentage of samples in class:							
P Index	**0**	**1**	**2**	**3**	**4**	**5**	**>5**	
	8	20	29	29	10	3	1	
	Percentage of samples in class:							
K Index	**0**	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
	4	29	31	17	15	3	1	0
	Percentage of samples in class:							
Mg Index	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
	0	9	33	31	13	7	4	1

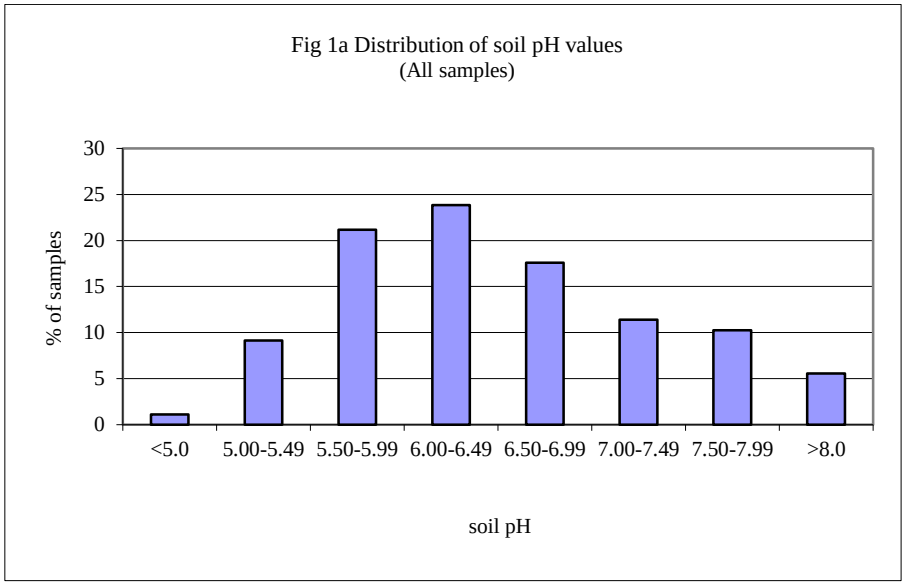


Fig 1b Distribution of soil P Index values
(All samples)

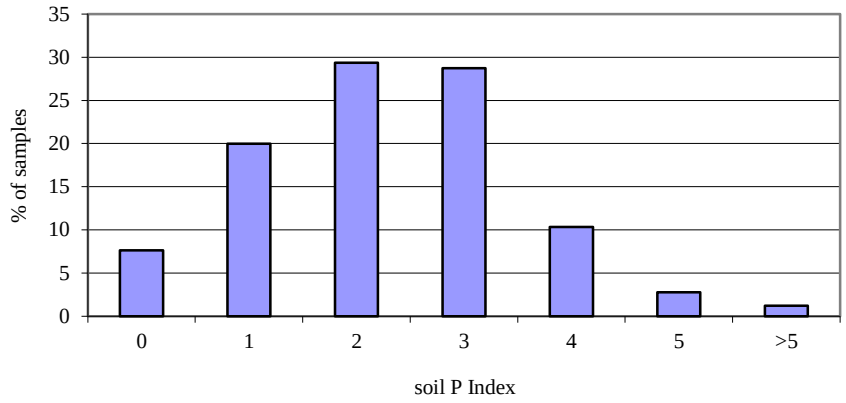


Fig 1c Distribution of soil K Index values
(All samples)

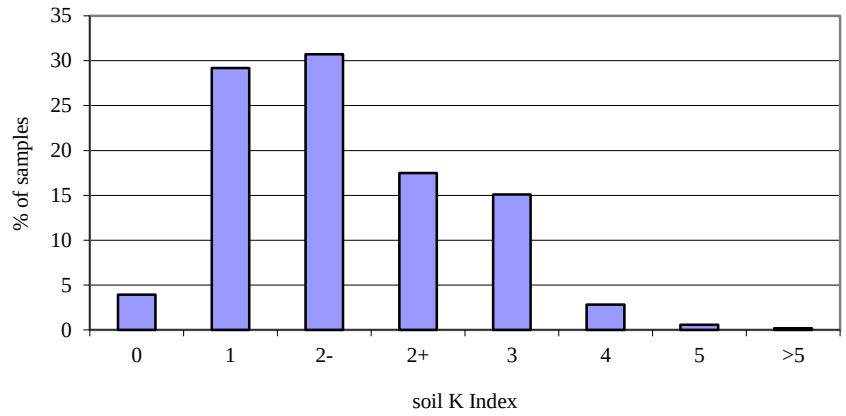
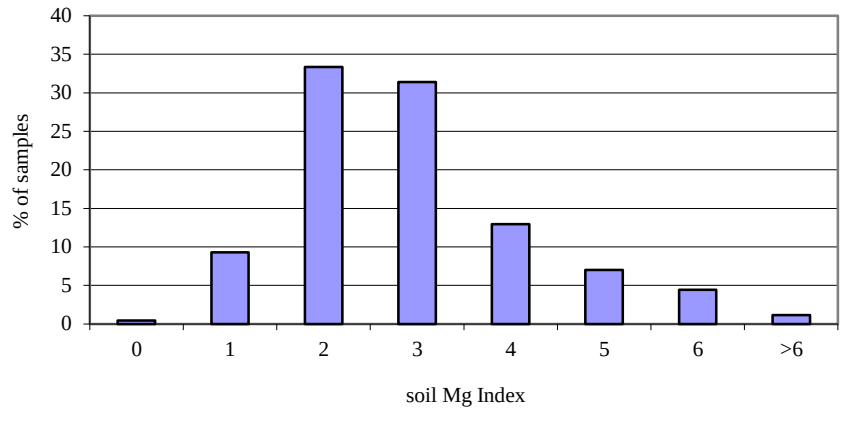


Fig 1d Distribution of soil Mg Index values
(All samples)



5.3 UK data by arable and grass

Some participants provided data where the past crop could be identified as arable or agricultural grass. These data (around 108000 samples for arable and 60000 for grass) are summarised in Table 3 and Fig 2.

Mean pH for arable was 6.71 and for grass 5.98.
The distribution of soil P values was similar for arable and grass with mean values of 30 mg/l (Index 3) for arable and 25 mg/l (Index 2) for grass. Only 29-30% of arable and grass samples were at target Index 2 with 25% (arable) and 34% (grass) in Indices 0 or 1.

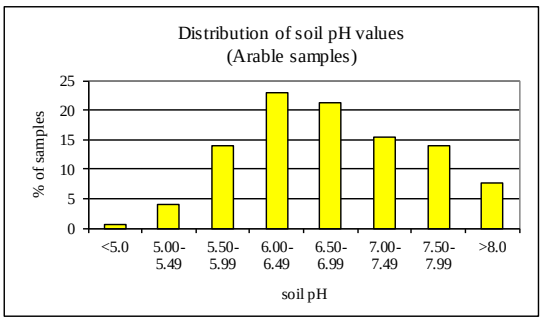
The distribution of soil K values also were somewhat similar with means of 182 mg/l (just Index 2+) for arable and 165 mg/l (Index 2-) for grass. Only 32% of arable and 28% of grass samples were at target Index 2- and 30% (arable) and 40% (grass) were in Indices 0 or 1.

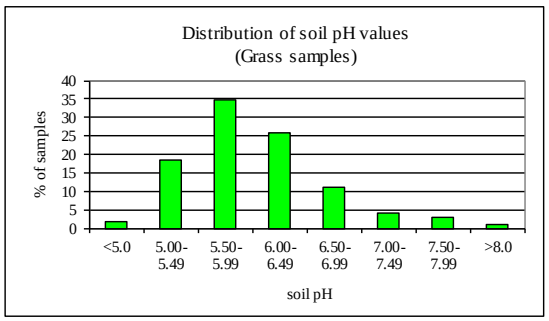
There was a more noticeable difference between arable and grass in soil Mg. Mean value was lower for arable (141 mg/l, Index 3) than for grass (158 mg/l, Index 3). Only 3% of grass, but 14% of arable, samples were in Mg Indices 0 or 1.

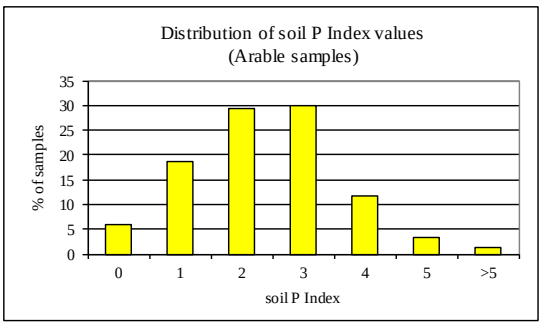
Table 3 Soil pH and Indices – arable and grass

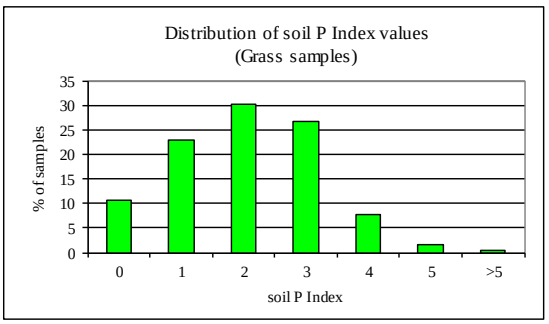
	Percentage of samples in class:							
Soil pH	**<5.0**	**5.00-5.49**	**5.50-5.99**	**6.00-6.49**	**6.50-6.99**	**7.00-7.49**	**7.50-7.99**	**>8**
Arable	1	4	14	23	21	15	14	8
Grass	2	19	35	26	11	4	3	1
	Percentage of samples in class:							
P Index	**0**	**1**	**2**	**3**	**4**	**5**	**>5**	
Arable	6	19	29	30	12	3	1	
Grass	11	23	30	27	8	1	0	
	Percentage of samples in class:							
K Index	**0**	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
Arable	3	27	32	19	16	3	1	0
Grass	6	34	28	15	13	3	1	0
	Percentage of samples in class:							
Mg Index	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
Arable	1	13	35	27	12	7	4	1
Grass	0	3	30	40	15	7	4	1

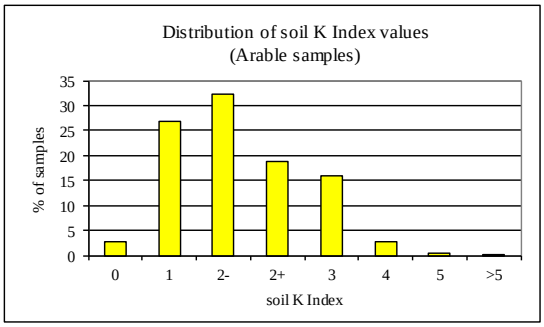
Fig 2 Distributions by arable and grass

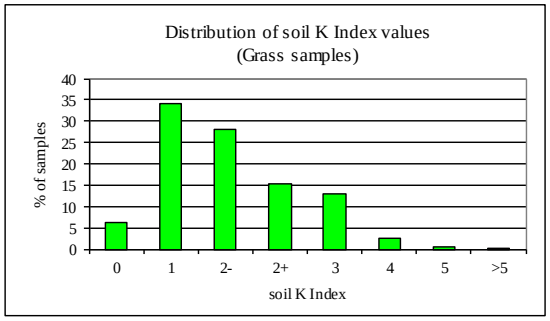


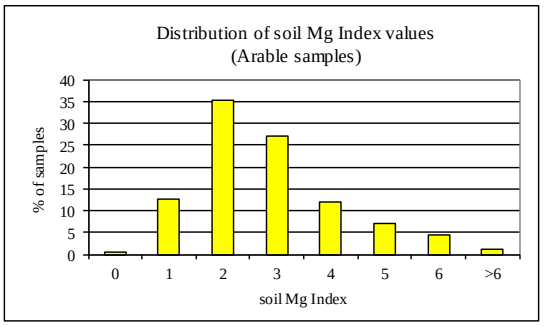


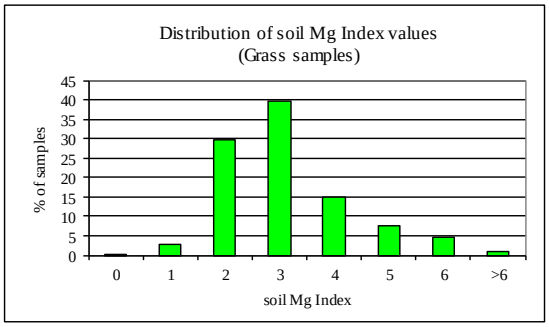












5.4 P x K Index matrix

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 full results are in Appendix 1.

Only 10% of samples were at target Indices for both P and K. This percentage has been almost unchanged since the matrix was calculated first in 2010.

Table 4 Percentages of all samples in P and K Indices

K Index	P Index <target	target	>target
<target	13	10	10
target	8	10	13
>target	6	10	21

(total 129806 samples)

6. Data by region

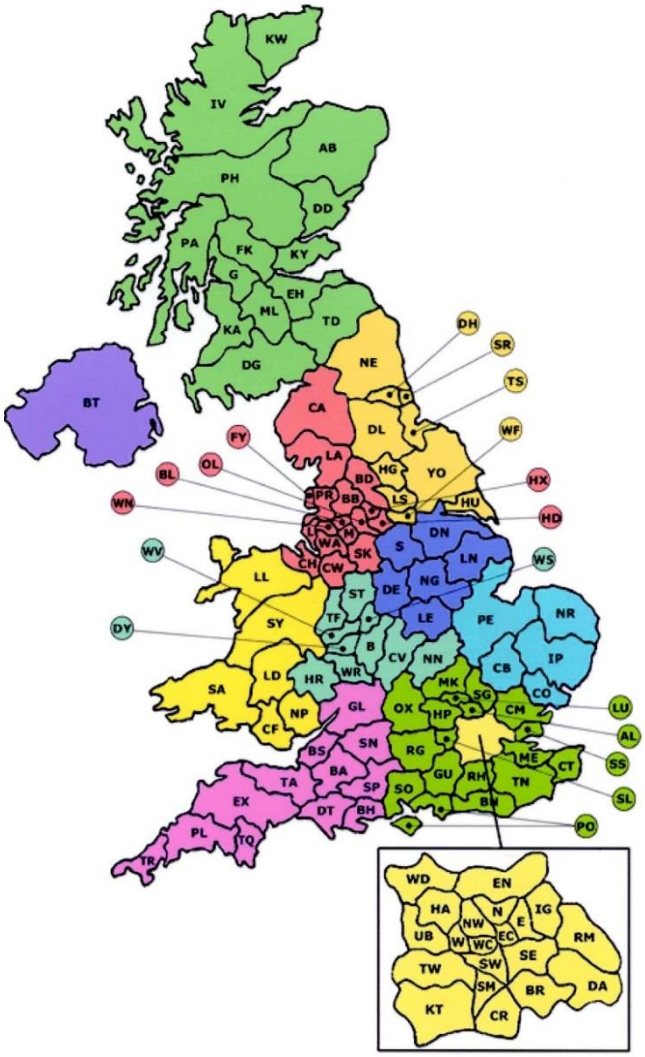
6.1 Regions

Some laboratories provided data that included a post code, parish name or county name for sample records. The procedure for allocating sample records to defined geographical regions was the same as that used in 2009.

Ten regions were defined for the collation:

Wales
Northern Ireland
Scotland
North East
North West
East Midlands
West Midlands
East Anglia
South East
South West

Regional boundaries were by postal code (map below).



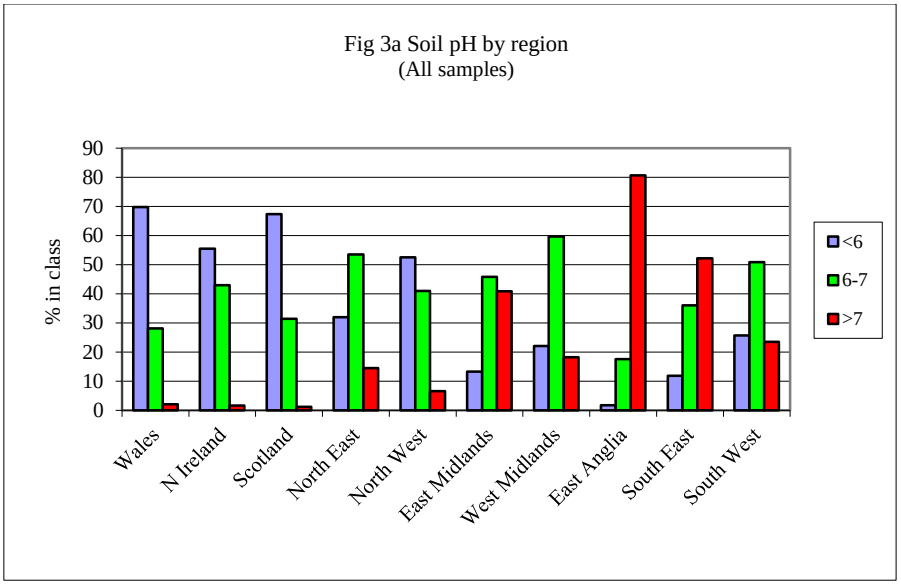
Proportions of samples in different pH and Index classes are summarised below for all samples. Tables and diagrams for arable and grassland separately are shown in Appendix 2.

6.2 Soil pH

There were clear differences in soil pH between Scotland, Northern Ireland, Wales and northern England, and the rest of England (Table 5, Fig 3a). The proportion of samples with pH <6 was smaller in the Midlands and southern England.

Table 5 Soil pH by region
Percentage of samples in pH band:

	<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**
Wales	3	25	42	21	7	2	0	0
N Ireland	1	13	42	32	11	1	0	0
Scotland	2	20	45	26	6	1	0	0
North East	1	8	23	32	21	8	5	2
North West	1	15	36	28	13	4	2	0
East Midlands	0	3	10	20	26	21	13	6
West Midlands	1	4	18	32	27	11	6	2
East Anglia	0	0	1	4	13	25	34	22
South East	1	2	9	16	20	16	19	17
South West	1	5	20	30	21	10	9	5

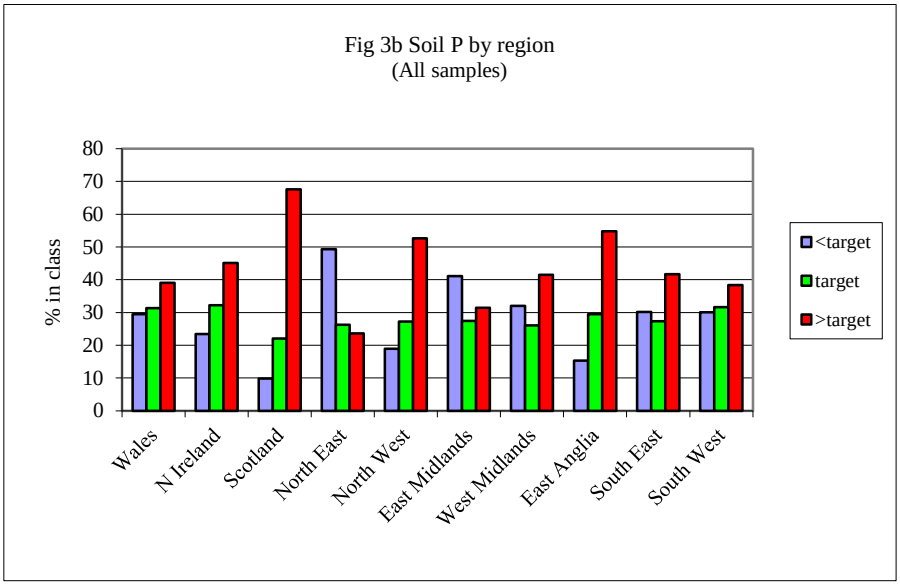


6.3 Soil P Index

Fewer than 40% of samples (just 22% in Scotland) were at target Index in any region (Table 6, Fig 3b). In all regions except north-east England, a greater proportion of samples was above than was below target Index. The proportion of samples above target Index was especially large in Northern Ireland, Scotland, north-west England and East Anglia.

Table 6 Soil P Index by region

	Percentage of samples in P Index:						
	0	**1**	**2**	**3**	**4**	**5**	**>5**
Wales	9	21	31	30	8	1	0
N Ireland	6	17	32	33	10	1	0
Scotland	2	7	22	42	21	4	1
North East	21	28	26	17	5	1	1
North West	5	14	27	35	14	3	2
East Midlands	14	27	27	24	6	1	0
West Midlands	12	20	26	28	10	3	1
East Anglia	3	12	29	39	13	3	1
South East	12	18	27	28	10	4	1
South West	10	20	32	28	8	2	1

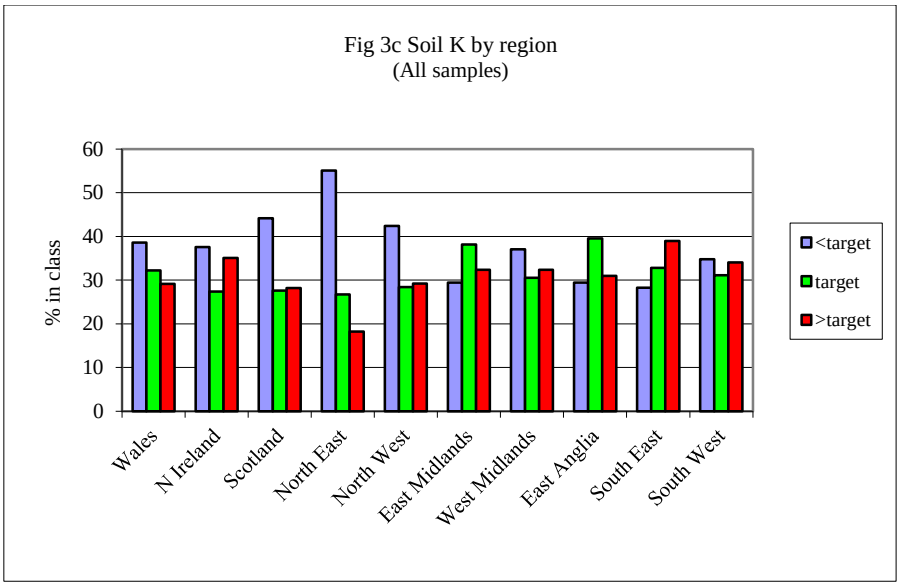


6.4 Soil K Index

Generally, higher proportions of samples were below target K Index than were below target P Index (Table 7, Fig 3c). Larger proportions of arable samples were above target Index than below it in East Midlands, South East England and East Anglia. The proportion below target Index was larger in all regions for grass samples than it was for arable samples (Appendix 2).

Table 7 Soil K Index by region

	Percentage of samples in K Index							
	0	**1**	**2-**	**2+**	**3**	**4**	**5**	**>5**
Wales	5	34	32	17	11	1	0	0
N Ireland	6	31	27	16	14	3	1	0
Scotland	11	33	28	15	11	2	0	0
North East	10	45	27	10	6	2	0	0
North West	7	35	28	15	11	3	0	0
East Midlands	4	26	38	18	12	2	0	0
West Midlands	4	33	31	16	14	2	0	0
East Anglia	2	27	40	17	11	2	0	0
South East	4	24	33	19	17	3	1	0
South West	6	29	31	16	14	3	1	0



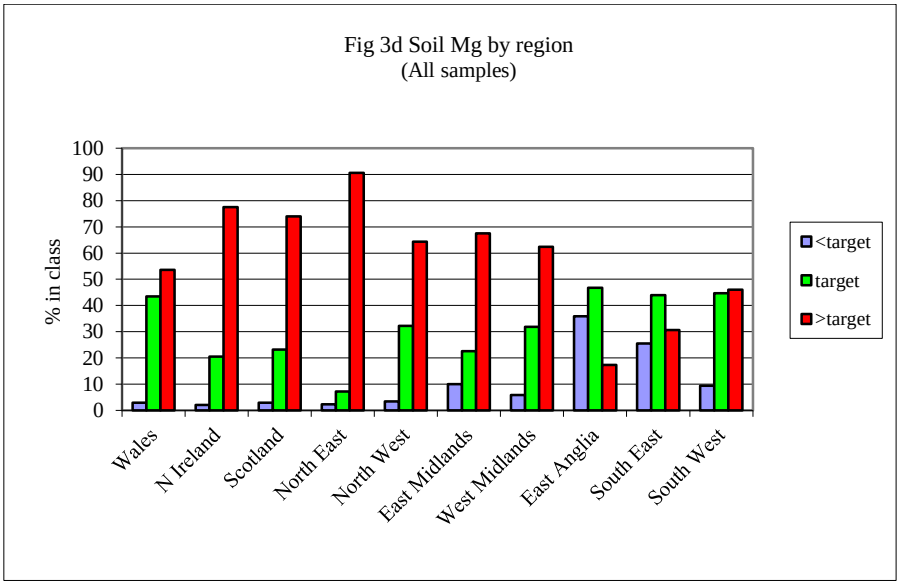
6.5 Soil Mg Index

Magnesium application is recommended for some arable crops where the soil Index is 0 or 1. The proportion of all samples in these Indices exceeded 10% only in East Anglia and South East England (Table 8, Fig 3d).

The proportion of grass samples in Index 0 or 1 exceeded 10% only in East Anglia and South East England. In the main grassland regions, very small proportions of samples were below Index 2.

Table 8 Soil Mg Index by region

	Percentage of samples							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**>6**
Wales	1	2	44	43	9	2	0	0
N Ireland	0	2	20	33	14	12	13	5
Scotland	1	2	23	42	23	8	1	0
North East	0	2	7	33	33	19	6	0
North West	0	3	32	45	13	4	2	0
East Midlands	1	9	23	31	18	12	6	1
West Midlands	1	5	32	38	13	7	3	1
East Anglia	2	34	47	9	4	3	1	0
South East	2	23	44	21	5	3	1	0
South West	1	9	45	32	8	4	2	1



6.6 Comparison with 2009

Mean values for soil pH, P, K and Mg were calculated for every region in 2009 and 2015. With the exception of North West England, there was remarkable similarity in these means between 2009 and 2015 (Fig 4a – 4d).
In North West England, soil pH increased slightly, soil P decreased and soil Mg increased. The similarity between 2009 and 2015 in other regions indicates that real geographical patterns of soil pH and nutrients were identified.

Fig 4a Mean soil pH in regions

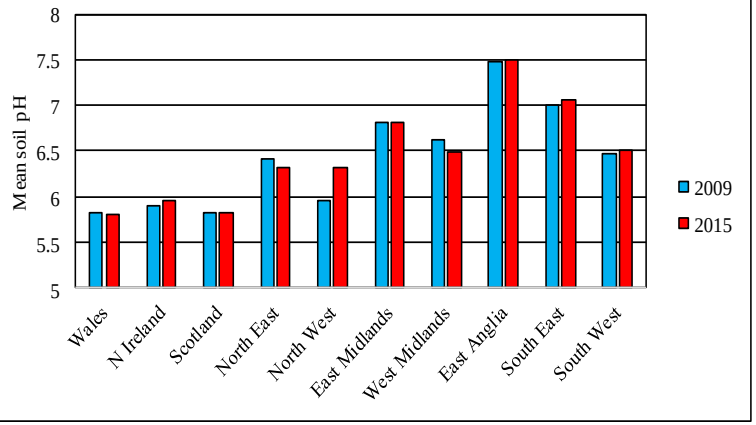


Fig 4b Mean soil P in regions

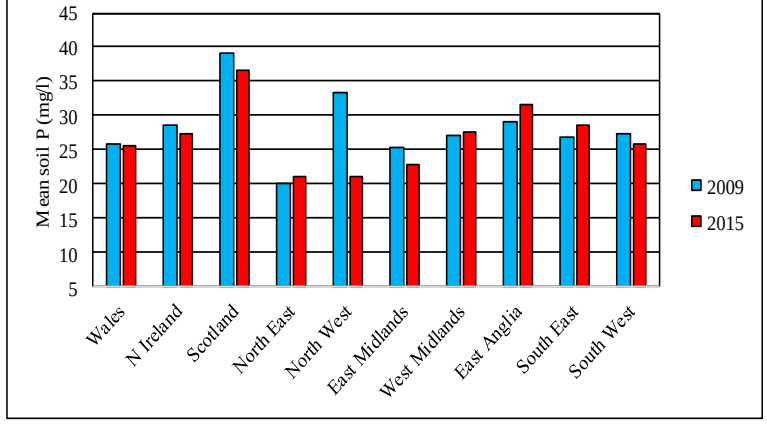


Fig 4c Mean soil K in regions

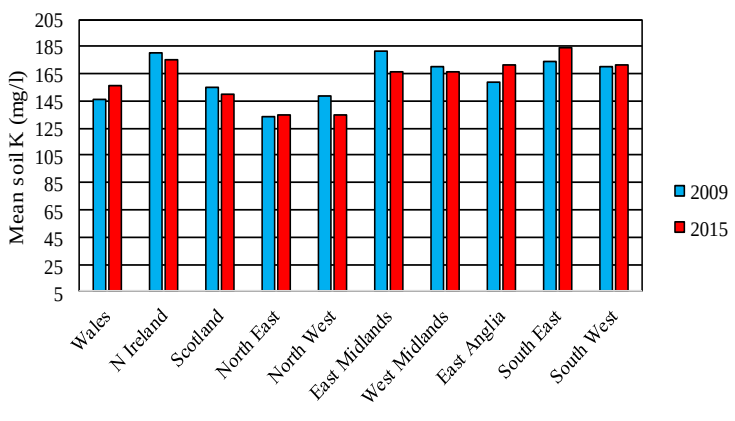
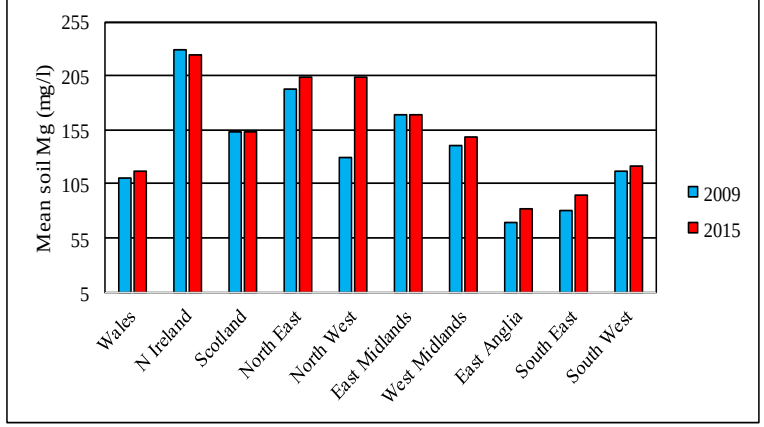


Fig 4d Mean soil Mg in regions



Appendix 1 – Percentages of sample in P x K Indices

All samples

	P Index				
K Index	**0**	**1**	**2**	**3**	**>3**
0	1	1	1	1	0
1	3	7	9	7	2
2-	2	6	10	9	4
2+	1	3	5	6	3
3	1	2	4	5	3
>3	0	0	1	2	1

Appendix 2 – Regional breakdown for arable and grassland

Numbers of samples

	Arable	Grassland
Wales	878	7824
N Ireland	998	4182
Scotland	536	2141
North East	571	843
North West	627	2448
East Midlands	873	437
West Midlands	1477	1014
East Anglia	5991	124
South East	2590	917
South West	2281	2686

Tables

Arable soil pH

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
Wales	2	7	22	31	26	8	3	1
N Ireland	0	6	29	41	21	3	0	0
Scotland	1	6	36	44	10	1	1	0
North East	0	2	7	29	32	14	10	5
North West	1	4	18	28	29	12	6	1
East Midlands	0	1	6	17	24	26	18	8
West Midlands	0	1	9	31	34	14	6	3
East Anglia	0	0	1	4	14	27	34	19
South East	0	1	5	14	22	17	21	19
South West	0	3	12	28	23	13	13	8

Arable soil P

Percentage of samples

	0	1	2	3	4	5	>5
Wales	6	18	34	33	8	2	0
N Ireland	2	11	28	41	15	2	1
Scotland	1	5	20	45	24	5	1
North East	11	29	32	16	7	3	3
North West	2	6	20	39	21	6	7
East Midlands	9	26	31	25	7	2	0
West Midlands	6	16	29	32	13	4	1
East Anglia	3	12	30	39	13	3	1
South East	8	18	29	30	10	4	1
South West	4	15	32	34	11	3	1

Arable soil K

Percentage of samples

	0	1	2-	2+	3	4	5	>5
Wales	4	33	34	15	12	2	0	0
N Ireland	4	21	31	22	17	4	1	0
Scotland	6	36	32	15	9	2	0	0
North East	4	42	33	13	5	1	0	0
North West	4	37	27	13	12	4	2	0
East Midlands	1	23	41	22	12	1	0	0
West Midlands	2	27	36	19	14	1	0	0
East Anglia	1	29	41	16	10	2	0	0
South East	3	21	34	20	18	3	0	0
South West	2	24	34	19	17	3	1	0

Arable soil Mg

Percentage of samples

	0	1	2	3	4	5	6	>6
Wales	0	5	52	32	9	1	1	0
N Ireland	0	5	37	29	11	10	7	2
Scotland	1	5	27	38	20	8	2	0
North East	1	5	8	29	31	20	6	0
North West	0	10	38	35	8	4	5	0
East Midlands	1	10	27	29	14	10	7	2
West Midlands	0	6	36	35	12	6	3	1
East Anglia	2	34	48	8	4	3	1	0
South East	2	27	47	18	4	2	1	0
South West	1	13	54	23	5	2	2	0

Grassland soil pH

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
Wales	2	28	44	20	5	1	0	0
N Ireland	1	14	45	30	8	1	0	0
Scotland	3	23	48	21	4	0	0	0
North East	1	12	35	35	12	3	1	0
North West	1	18	41	28	9	2	1	0
East Midlands	0	6	20	26	30	12	4	2
West Midlands	1	7	31	35	16	5	4	0
East Anglia	0	5	3	15	19	25	23	10
South East	1	6	22	25	19	11	12	5
South West	1	8	29	30	16	8	5	2

Grassland soil P

Percentage of samples

	0	1	2	3	4	5	>5
Wales	8	21	32	30	7	1	0
N Ireland	7	19	33	31	8	1	0
Scotland	3	8	22	42	21	4	1
North East	22	28	25	20	4	0	0
North West	5	17	29	34	13	2	0
East Midlands	26	29	20	18	6	1	0
West Midlands	22	25	24	22	6	1	0
East Anglia	10	13	23	33	15	3	2
South East	26	22	24	19	7	1	1
South West	14	22	31	25	6	1	0

Grassland soil K

Percentage of samples

	0	1	2-	2+	3	4	5	>5
Wales	5	34	32	17	11	1	0	0
N Ireland	7	34	26	15	14	3	1	0
Scotland	12	33	26	15	12	2	0	0
North East	14	44	23	8	7	3	0	0
North West	8	35	29	16	11	2	0	0
East Midlands	5	32	34	12	13	3	0	0
West Midlands	6	41	23	13	15	2	0	0
East Anglia	1	32	30	19	11	4	2	0
South East	8	37	26	13	11	2	1	0
South West	9	32	28	15	13	3	1	0

Grassland soil Mg

Percentage of samples

	0	1	2	3	4	5	6	>6
Wales	1	2	44	43	8	2	0	0
N Ireland	0	1	17	34	15	13	14	5
Scotland	1	2	22	43	23	8	1	0
North East	0	0	8	33	34	19	5	0
North West	0	2	31	48	14	4	1	0
East Midlands	0	3	13	37	27	16	3	0
West Midlands	1	2	26	44	15	8	4	0
East Anglia	2	19	42	25	6	2	5	1
South East	1	9	39	34	9	6	2	0
South West	1	3	35	41	10	6	3	1

Fig A2a Soil pH by region
(Arable samples)

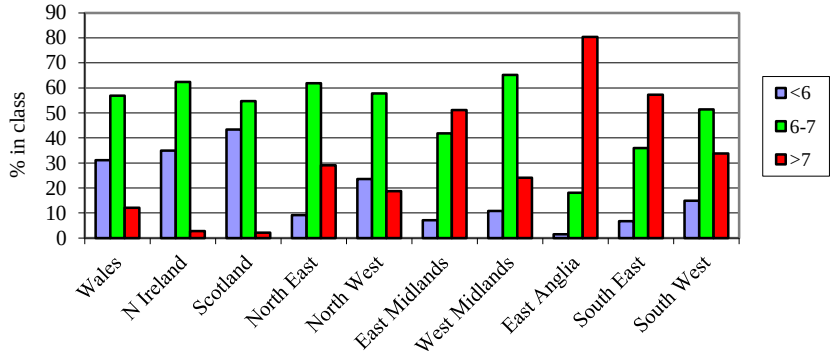


Fig A2b Soil P by region
(Arable samples)

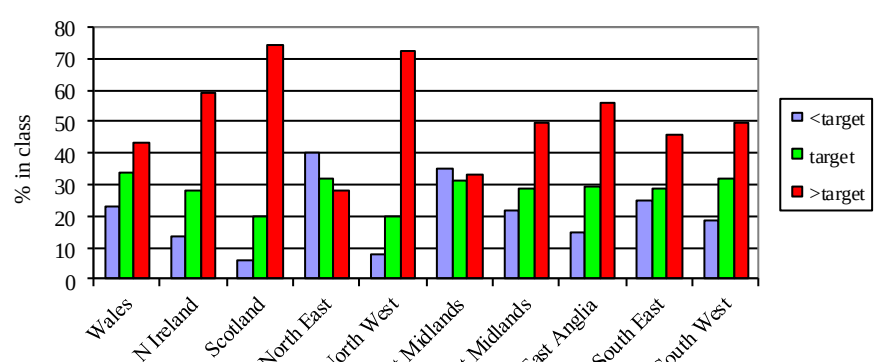


Fig A2c Soil K by region
(Arable samples)

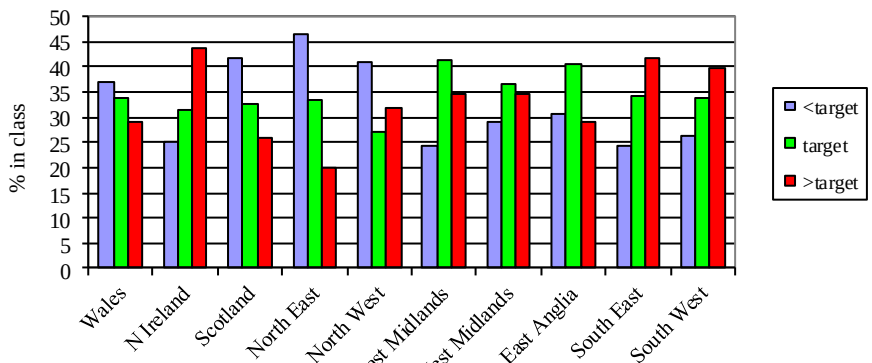


Fig A2d Soil Mg by region
(Arable samples)

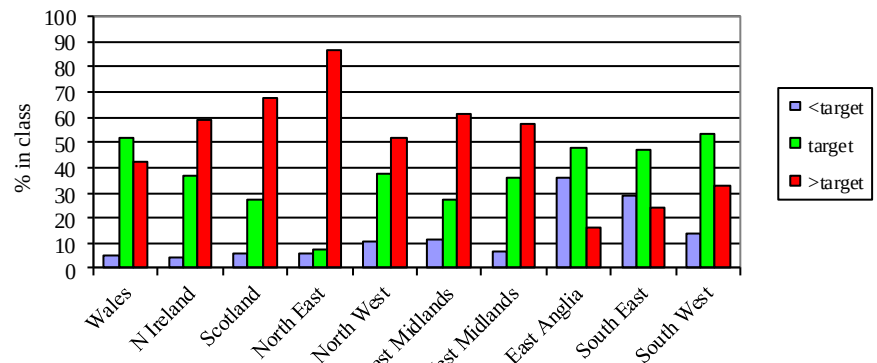


Fig A2e Soil pH by region
(Grass samples)

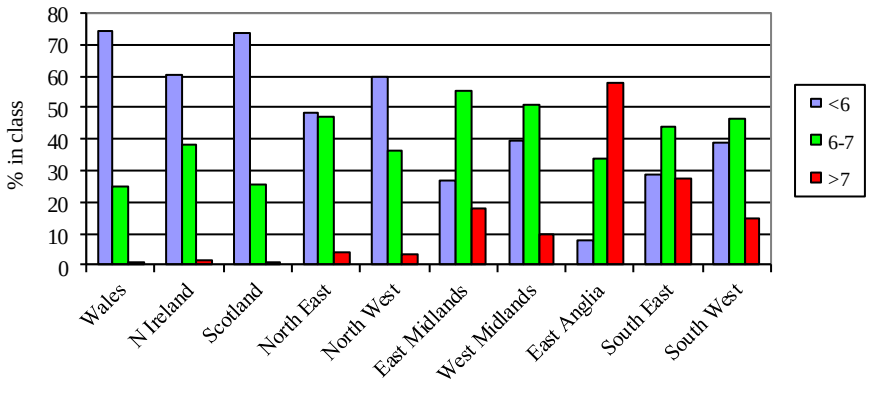


Fig A2f Soil P by region
(Grass samples)

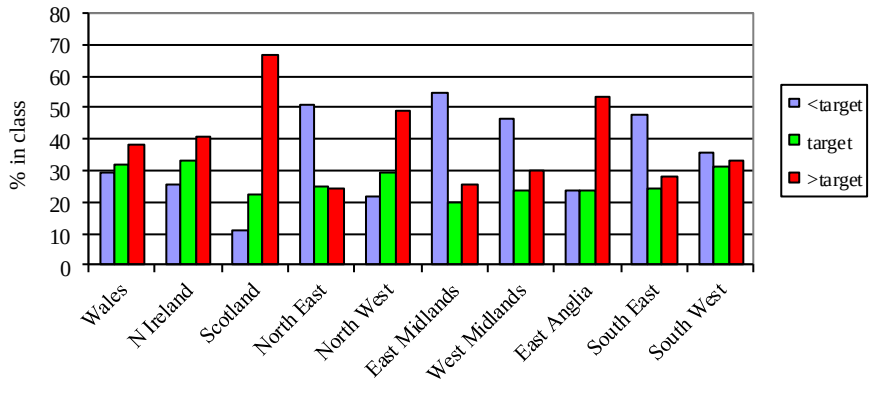


Fig A2g Soil K by region
(Grass samples)

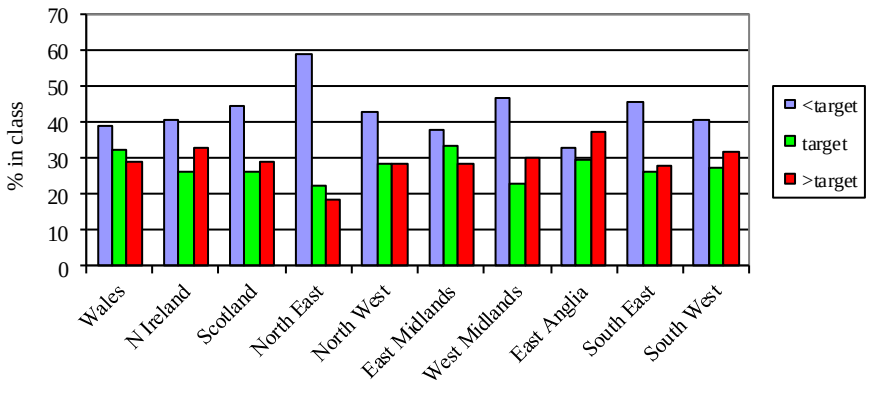
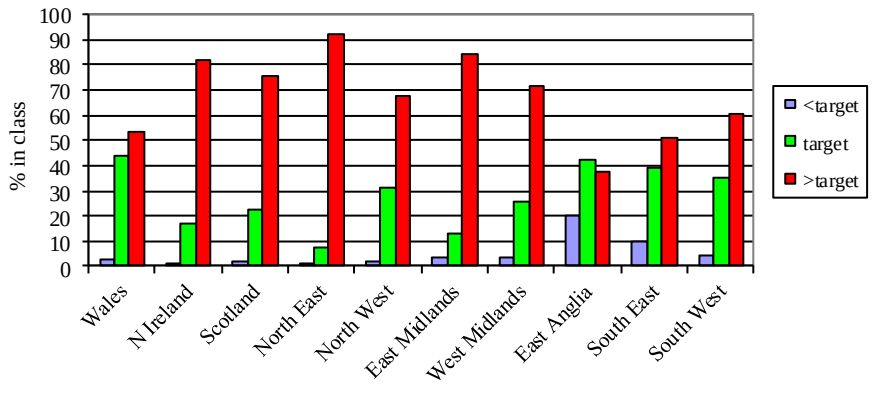


Fig A2h Soil Mg by region
(Grass samples)



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Whilst the production of this publication was part-funded by the Catchment Sensitive Farming project, the content does not necessarily reflect the agreed policy of Natural England, Environment Agency or Defra.