A report summarising the findings from soil samples collected by farmers in the South West and analysed through the Soils for Profit Project

Introduction

The South West Agricultural Resource Management (SWARM) Initiative is a Rural Development Programme for England (RDPE) funded initiative tasked with helping farmers and growers to use resources more efficiently, providing both economic and environmental benefits.

The Soils for Profit (S4P) project, delivered by Natural England in partnership with the Environment Agency and as part of the SWARM Initiative, has operated a scheme since 2011 giving farmers the opportunity to collect soil samples from up to five fields of their choice and to have the samples analysed free of charge to the farmer. The results from the soil analysis were then used by the S4P farm advisers to support advice specific to the farm as part of the S4P 'On-Farm Resource Review of Soils, Manures and Nutrients', and in particular, to help demonstrate nutrient budgeting.

The SWARM Hub, also part of the SWARM Initiative, has collated and analysed the data from 3,447 samples to produce this report in association with S4P staff.

The aim of this report is to summarise the findings of the samples taken in terms of:

- Soil pH;
- Soil Organic Matter (SOM) status; and
- Key nutrients *i.e.,* Phosphate (P), Potash (K) and Magnesium (Mg).

Methodology

Upon registration to the Soils for Profit project farmers were sent packs with instructions on how to take the samples. The soil samples were then collected and sent to the appointed laboratory by the farmers themselves. Standardised analysis was carried out by NRM (Natural Resource Management Ltd.) and the results for each farmer returned to the S4P Project which assigned them to a farm adviser who interpreted the results and demonstrated nutrient budgeting for the farmer whilst on farm. The results obtained between September 2011 and August 2013 were aggregated and supplied by the Natural England's S4P project team (anonymised) to the SWARM Hub for this report.

Results from a total of 3,447 soil samples (usually from different fields) were included in the dataset, from 699 participating farmers, spread across the six counties of the South West Region. Figure S1 in the appendix shows the spread of samples and farms by county.
Each sample was analysed for pH, SOM, and key nutrients P, K and Mg. Farmers were also asked to specify the current cropping. For the purpose of this report the crop types have been grouped into arable (including cereals, vegetables and bulbs) and grassland (including permanent pasture, short-term leys and silage crops).

When reading this report it should be remembered that soil samples are often taken by farmers from their more challenging fields. If this was the case it could influence the data. However there is no indication that this happened, therefore for the purpose of this analysis, it is assumed that the samples were taken across a representative area of the farms by those farmers who participated.

Results and conclusions

Of the samples analysed 771 soil samples were from arable land, whilst 2,578 soil samples were from grassland and 98 soil samples did not specify the cropping. The latter were not included in this preliminary analysis.

The number of soil samples that were either under, met or above the recommended pH, SOM and key nutrient targets, as set out in Defra publication RB209, are shown in Table S1.

The number of soil samples that were under the recommended pH, SOM and key nutrient targets, as set out in Defra publication RB209, are shown in Table S2 and S3 in the appendix.

Soil pH

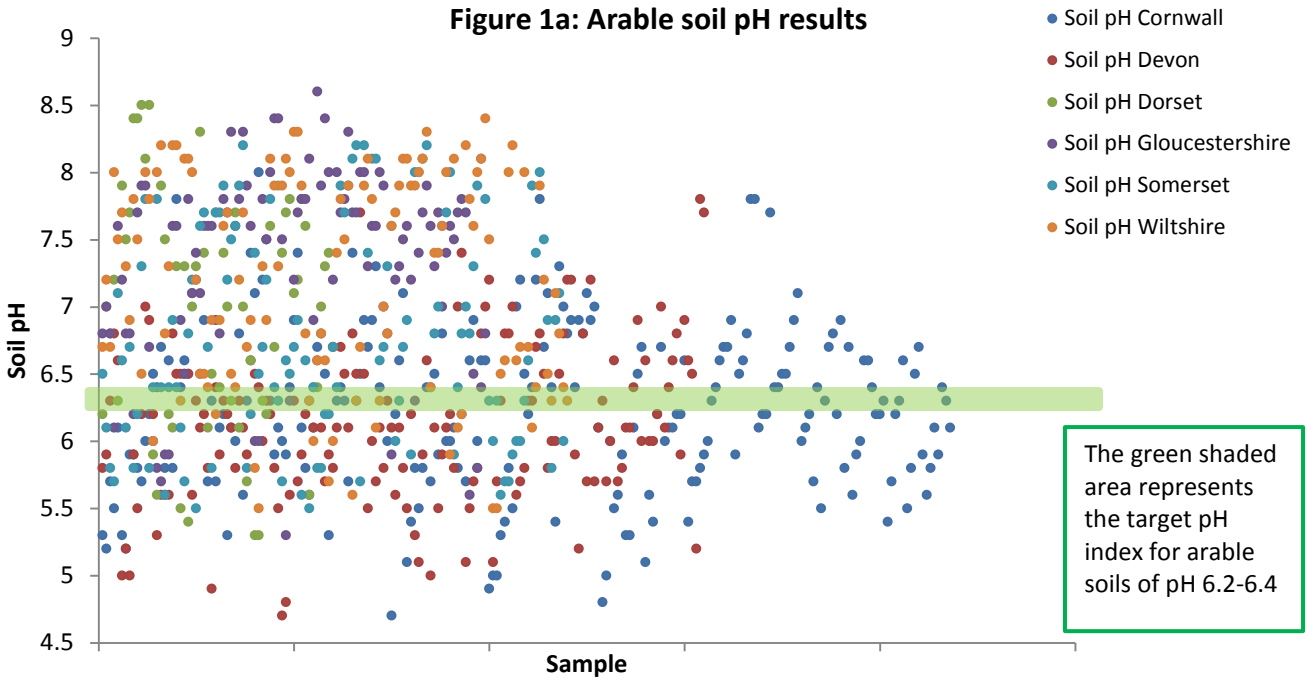
The pH is a measure of acidity or alkalinity, with agricultural soils typically ranging from a pH of around 4.5 (termed 'very acid') to around 8.5 (termed 'alkaline'). The availability of plant nutrients will vary depending on the soil pH and the optimum availability will occur over a small range of pH values, termed the target pH range. The table below specifies the target pH range for both arable and grass cropping.

Cropping	Target pH Range
Arable	6.2 - 6.4
Grass	6.0 - 6.2

Source: RB209 Fertiliser Manual, Defra 2010

Of the 3347 soil samples tested for pH, only 14.3 % (110) of all the arable field samples and 16.8% (432) of grassland samples were within the target pH range (Figure 1a and 1b).

47% of all samples were under the target pH. This included 31.8% (245) of the arable samples and 51.6% (1,329) of the grassland samples.



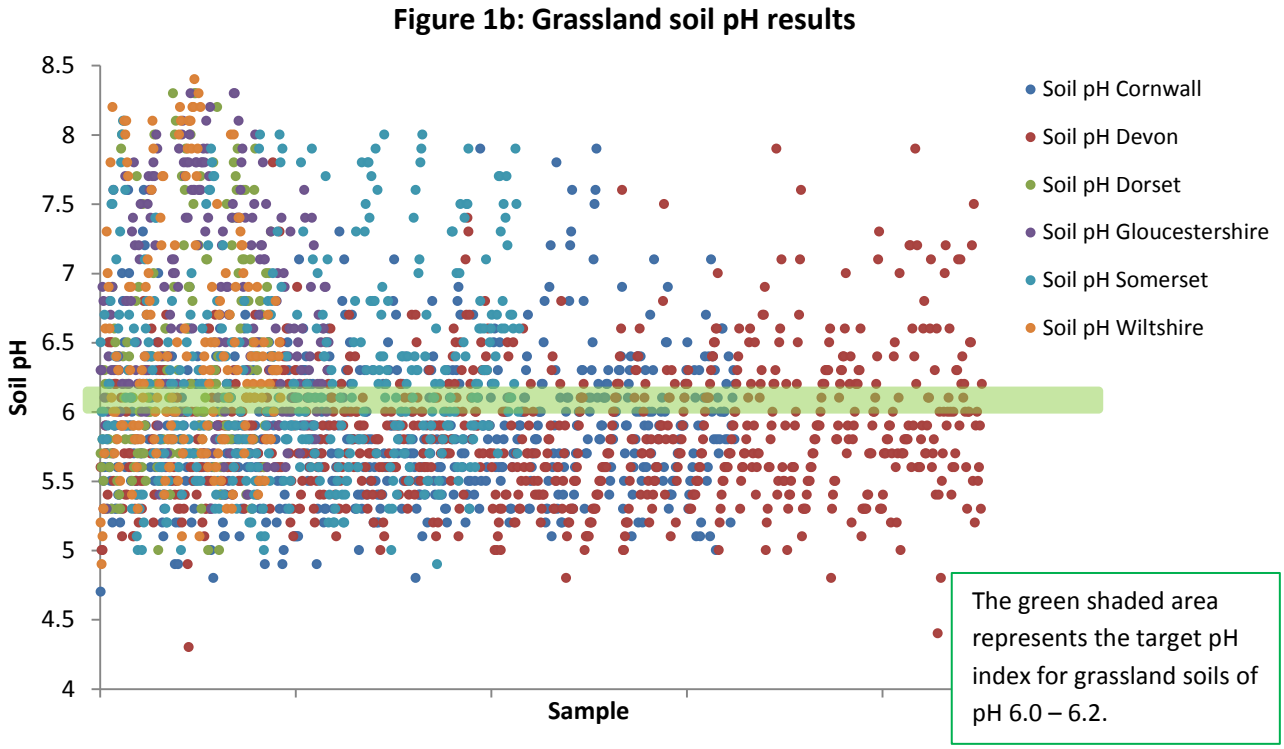


Figure 1: Each arable (a) and grassland (b) sample has been plotted against its pH level. Each dot represents an individual soil sample. The dots are colour-coded according to county. Those that lie within the green shaded area are within the target pH range. Those that fall outside the green shaded area are not within the target pH range. See Figure S3 and Table S1 in the appendix to see the percentages of samples that fall outside of the target pH range as set out in the Defra RB209 Fertiliser Manual.

Just under one third of all grassland soil samples taken in the South West fell within the pH range of 5.5 – 5.9 (See Figure S2 in the appendix). Soils with pH lower than the recommended values will have significantly reduced nutrient availability to the crop, especially in the case of phosphate. Micro nutrients are also significantly affected by pH and decisions to apply additional nutrients should only be made after underlying pH issues are remedied. Although it is important to remember that some plants and habitats favour acid conditions, these are unique cases. To learn more about the benefits of optimal soil pH and tips on how to accomplish a good soil pH click here.

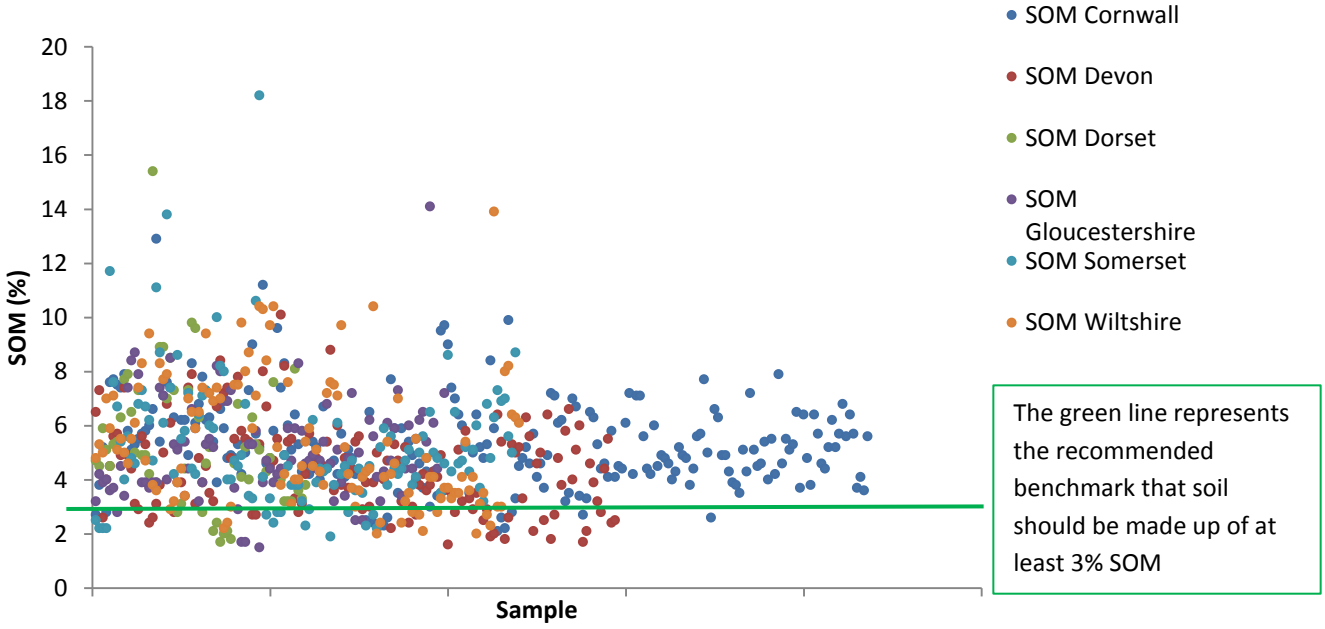
Soil Organic Matter (SOM)

SOM helps bind soil mineral particles together and is important for providing crops with a number of essential nutrients in available forms. Maintaining a good SOM is important as it is essential for chemical interactions within the soil and also helps to strengthen soil structure. SOM is expressed in this report as a percentage of soil volume.

There are no specific targets for SOM, as the amount of organic matter in a soil is highly dependent on factors such as soil type, climate and farming system. However, the general recommendation is to at least maintain, and where possible increase SOM levels. An organic matter of below 3% is recognised by many advisers as being a catalyst for long-term soil problems.

Figures 2a and 2b show that SOM is much lower in arable fields than grassland as more than 11.3% of arable soil samples were below the 3% SOM benchmark as opposed to only 1.5% of grassland soil samples. National findings indicate that declining SOM is a growing problem particularly in arable situations and especially where grass has been ploughed for arable cropping. If you would like to read more about enhancing your soil biology click here.

Figure 2a: Soil Organic Matter (%) from Arable Farms by county



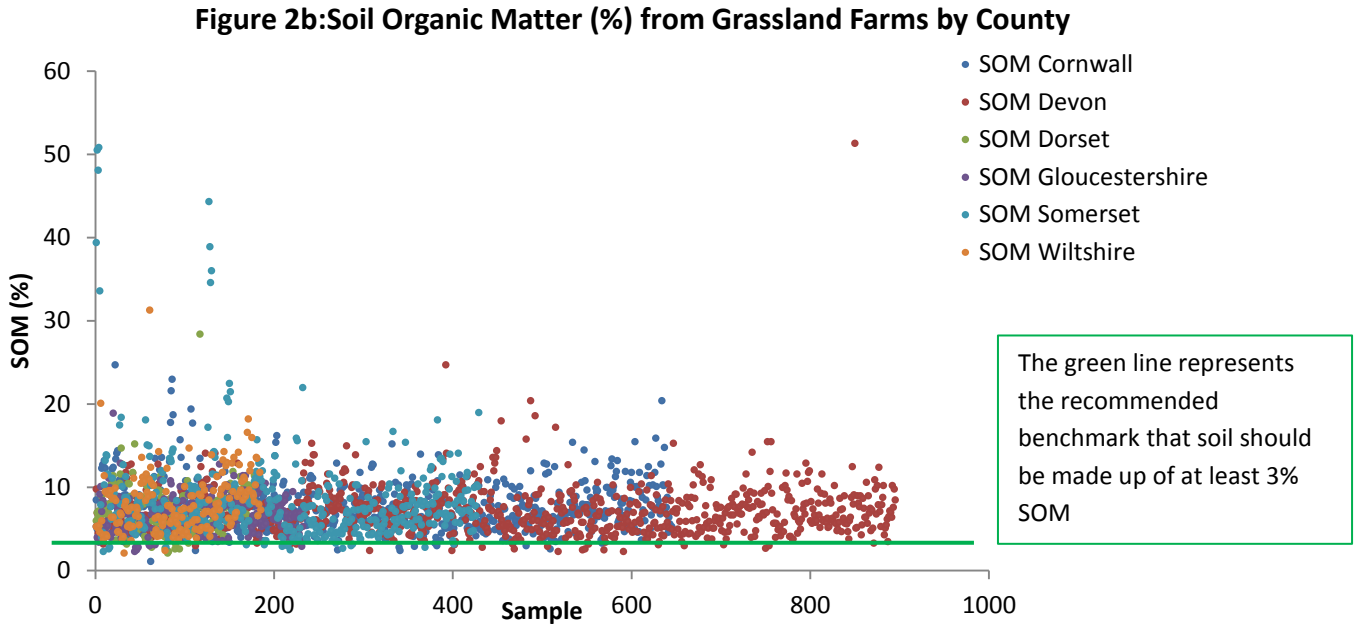


Figure 2: Each arable (a) and grassland (b) sample has been plotted against soil organic matter percentage volume. Each dot represents an individual soil sample. The dots are colour-coded according to county. Those that lie on or below the line are thought to be at risk of long-term problems and those that lie above the green line are above the recommended 3% benchmark.

Key Nutrients

Phosphate (P), Potash (K) and Magnesium (Mg) indices were analysed in all soil samples. The target indices for all crops are as follows:

Nutrient	Target Indices
Phosphate	2
Potash	2-
Magnesium	2

Source: RB209 Fertiliser Manual, Defra 2010

P and K levels over or under the target index will impact on crop productivity as well as how the crop utilises other applied nutrients. If the index is too high there is a risk of economic and environmental loss through applying nutrients that are not required, and if the indices are too low there is likely to be yield consequences.

Being over the target index for Mg typically will not limit crop production and grass growth is unlikely to respond to applications; nevertheless, it is important to maintain levels in order to prevent Mg deficiency in cattle which causes the metabolic disorder known as grass staggers. This analysis revealed only a small percentage of samples that were under the target index for Mg, the majority were within or above it.

This analysis revealed that 29.2% (225) arable samples and 44.8% (1,156) of grassland samples which were taken from farms across the South West region were under target for Phosphate (P) index (see figures 3a and 3b). These percentages did not vary much between counties.

When testing for Potash (K) values, the analysis revealed that 23.2% (179) of the arable samples and 43.5% (1,121) grassland samples were not meeting the target index (see figures 4a and 4b). Cornwall showed the highest proportion of arable (44.7%) soil samples below the target index for K and Devon had the highest proportion of grassland soil samples (16.6%) below the target index for K.

It should be noted that for both key nutrients i.e. Phosphate & Potash the grassland samples showed lower levels than the arable samples.

In terms of Magnesium (Mg) this was the contrary, a higher percentage of arable samples (5.9%) were below the target index whereas the grassland samples only 1.5% were below target (see figures 5a and 5b).

Figure 3a: Arable farms - P indices by county

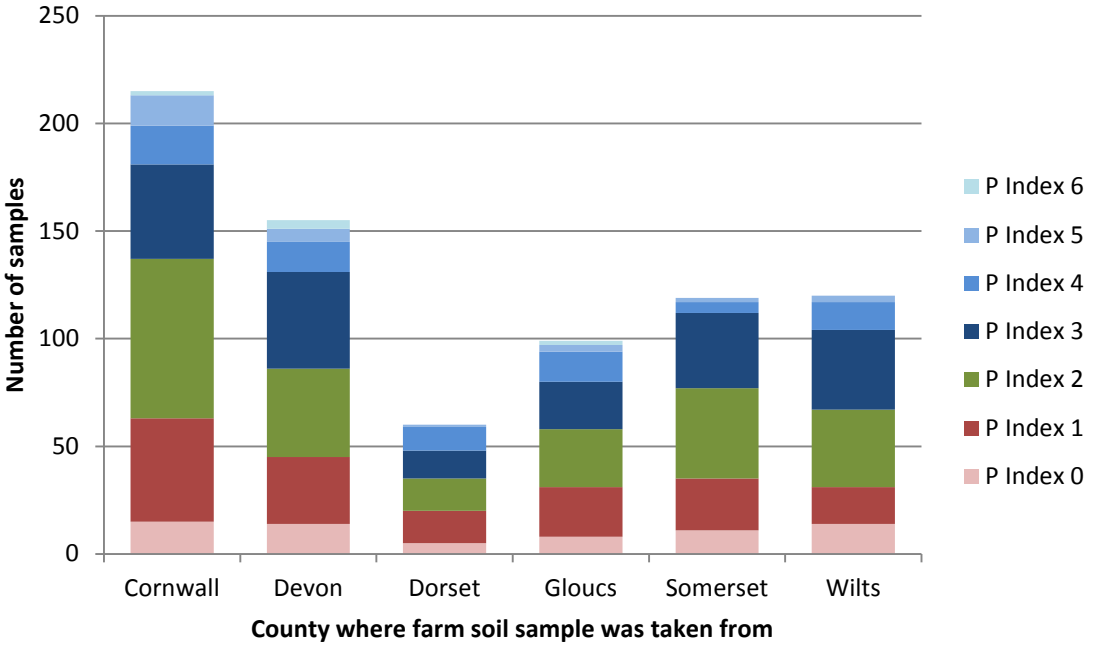


Figure 3b: Grassland farms - P Indices by county

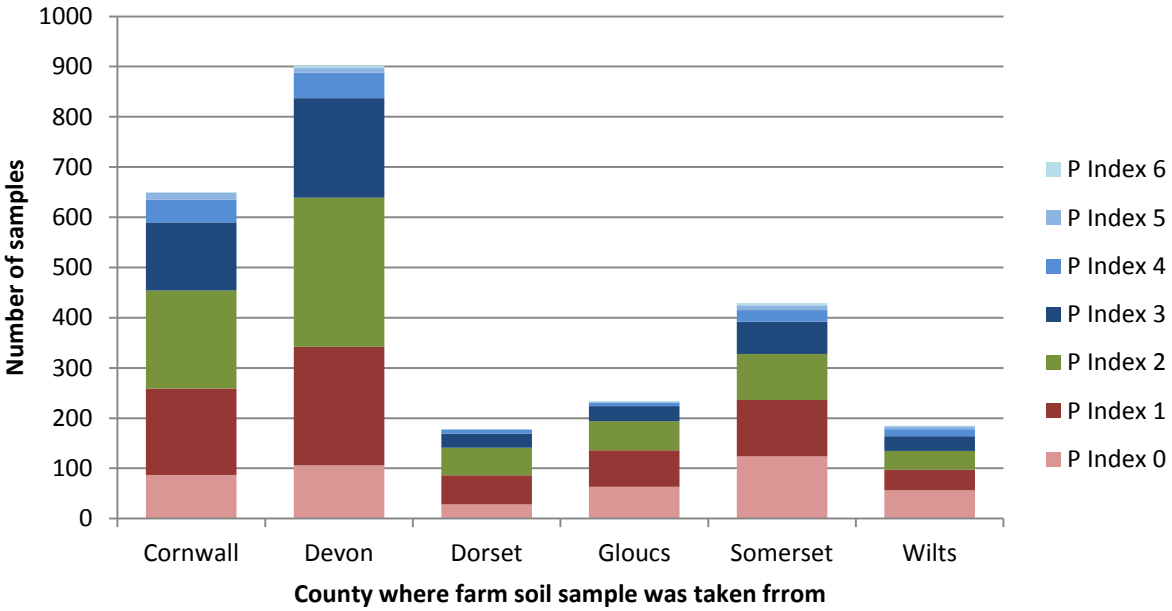


Figure 3: The graphs shows the number of arable (a) and grassland (b) farms soil samples that scored each of the P index values categorised by county. The index scales ranges from 0 – 6 and the target index for P is 2. The area of the bar that is red or pink represents the samples which were under the target index, the areas which are green met the target index, and the areas which are blue exceed the target index.

Fig 4a: Arable farms - K indices by county

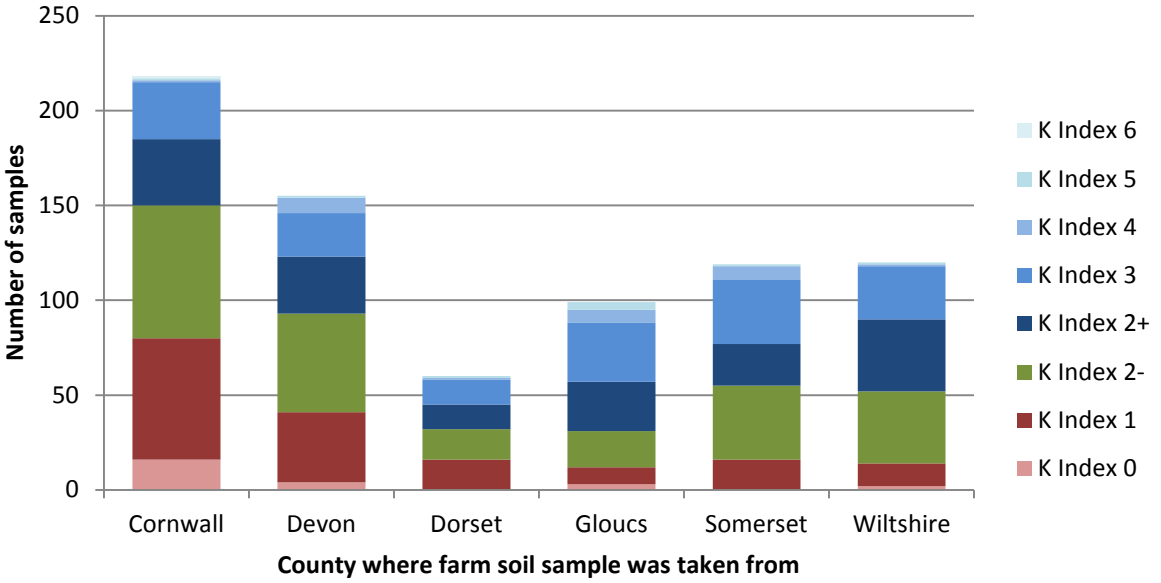


Figure 4b: Grassland farms - K Indices by county

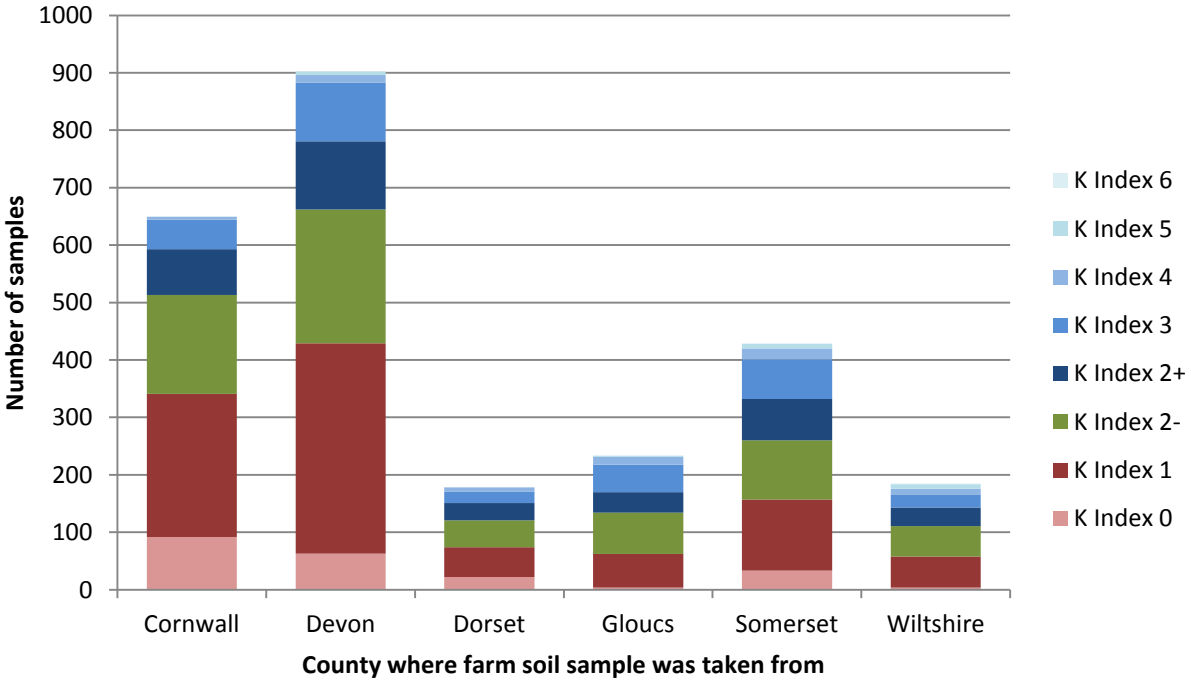


Figure 4: The graphs shows the number of arable (a) and grassland (b) farms soil samples that scored each of the K index values categorised by county. The index scale is 0, 1, 2-, 2+, 3, 4, 5, and 6, and the target index for K is 2-. The area of the bar that is red or pink represents the samples which were under the target index, the areas which are green met the target index, and the areas which are blue exceed the target index.

Figure 5a: Arable farms - Mg indices by county

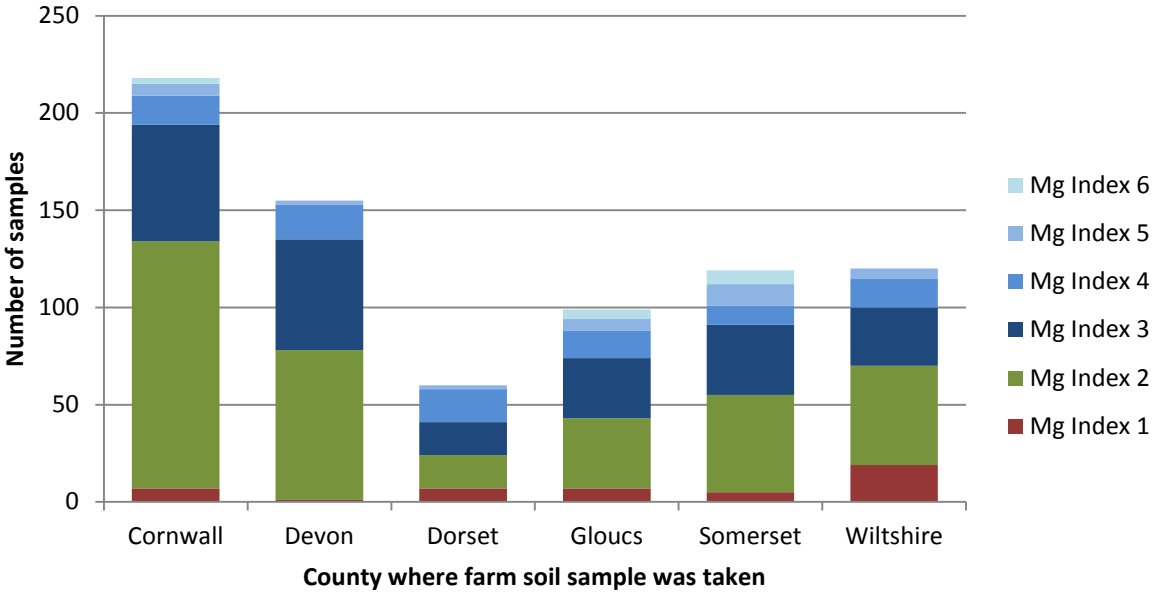


Figure 5b: Grassland farms - Mg Indices by county

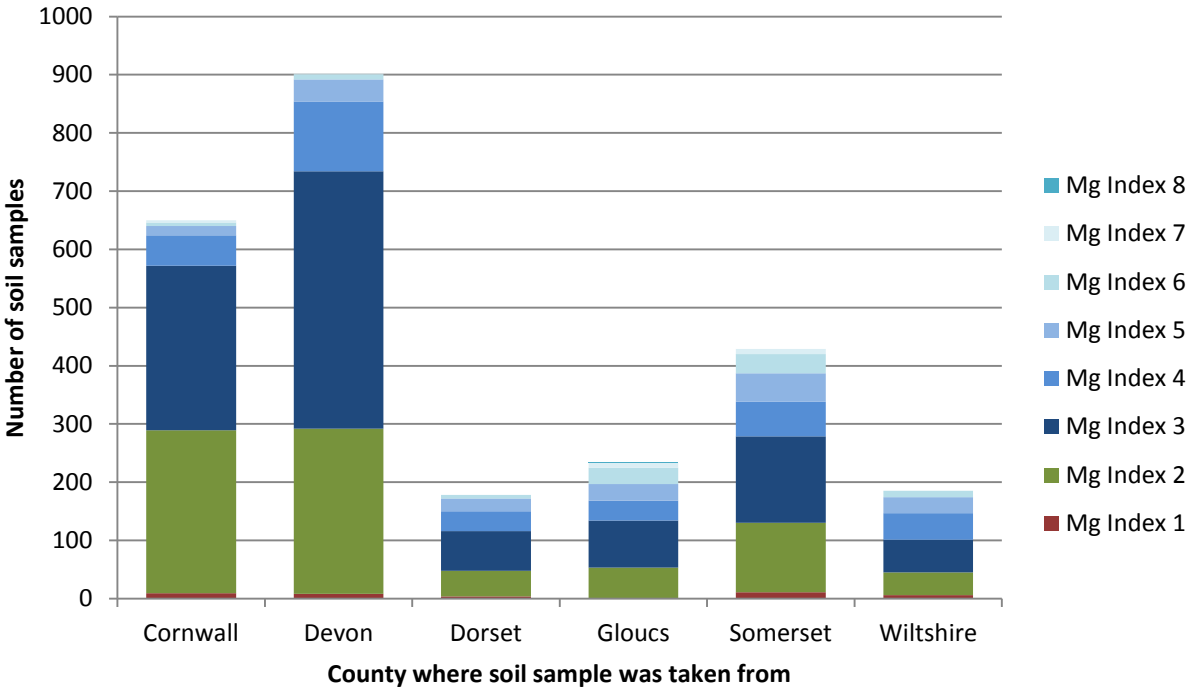


Figure 5: The graphs shows the number of arable (a) and grassland (b) farms soil samples that scored each of the Mg index values categorised by county. The index scale ranges from 1 – 8 and the target index for Mg is 2. The area of the bar that is red represents the samples which were under the target index, the areas which are green met the target index, and the areas which are blue exceed the target index.

In summary the findings suggest that:

- Approximately one third of all samples met the target index for P, K or Mg
- Samples below the target index were as follows:-
    - 41.2% - P ,
    - 38.8% - K,
    - 2.5% - Mg
- Samples on target were as follows:-
    - 29% - P
    - 27.3% - K
    - 35.1% - Mg
- Soil samples above target were as follows:_
    - 29.7% - P
    - 33.9% - K
    - 62.3% - Mg
- Cornwall has the highest proportion of soil samples from arable fields (>40%) below the target index for K
- Overall a much higher proportion of grassland soil samples are below the target index for P and K than arable soils
- Only a small number of both arable and grassland samples are below the target index for Mg

Key Conclusions

Soil pH

- 47% of samples taken were below the target pH as specified in the Defra RB209 fertiliser manual
- Devon has the highest proportion of arable (53.5%) and grassland (64%) soil samples below target pH
- Cornwall had the second highest proportion of arable (44%) and grassland (63%) soil samples that were below target pH
- Gloucestershire has a high proportion (83.8%) of arable soil samples that were above the target pH
- Dorset and Wiltshire had a high percentage of samples (both arable and grassland) which were above the target pH

Soil Organic Status

- From the soil samples taken from arable farms in Gloucestershire only seven were below the 3% benchmark
- Only two grassland samples from farms in Wiltshire, five from Gloucestershire and six from Dorset were below the 3% SOM benchmark
- The analysis showed that 22.6% of samples from arable fields and 3% from grasslands had an organic matter percentage below the 3% benchmark

Key Nutrients

- In four of the six counties approximately 50% of grassland soils sampled were below the target P index (Dorset, Gloucestershire, Somerset and Wiltshire). In Cornwall and Devon approximately 38% of grassland samples were below
- Arable farms in Cornwall were particularly K depleted compared with the other counties in this study
- Between 30 – 55% of grassland soil samples taken from Cornwall, Devon, Dorset, Somerset and Wiltshire were below the target K index
- More arable samples had P and K indices which were above target than grass samples
- Generally Mg levels appear to be good with the majority of samples being within or above the target index for both arable and grass crop type samples

Reference

- The target indices are taken from page 104 (arable)and page 179 (grassland) of the RB209 Fertiliser Manual, Defra 2010

Appendix

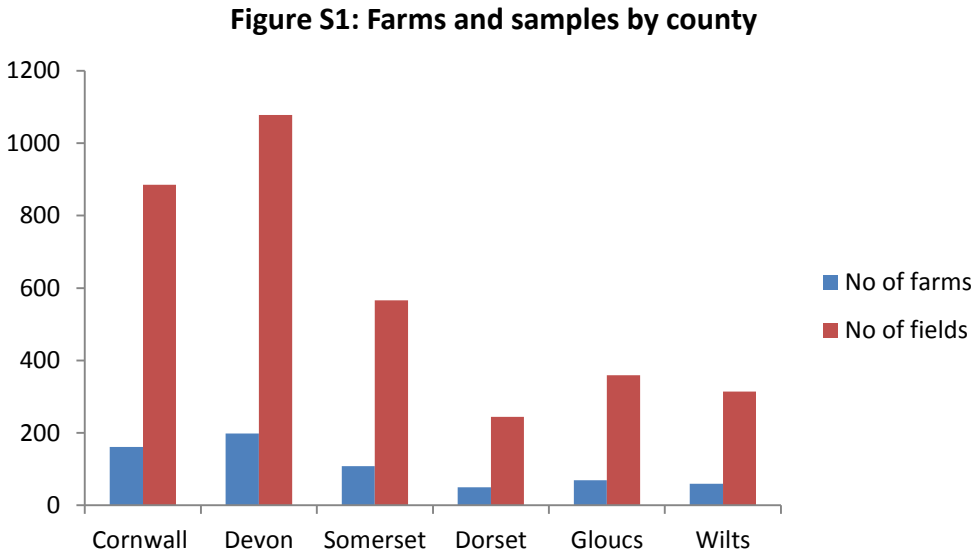


Figure S1: The number of farms participating and samples analysed per county.

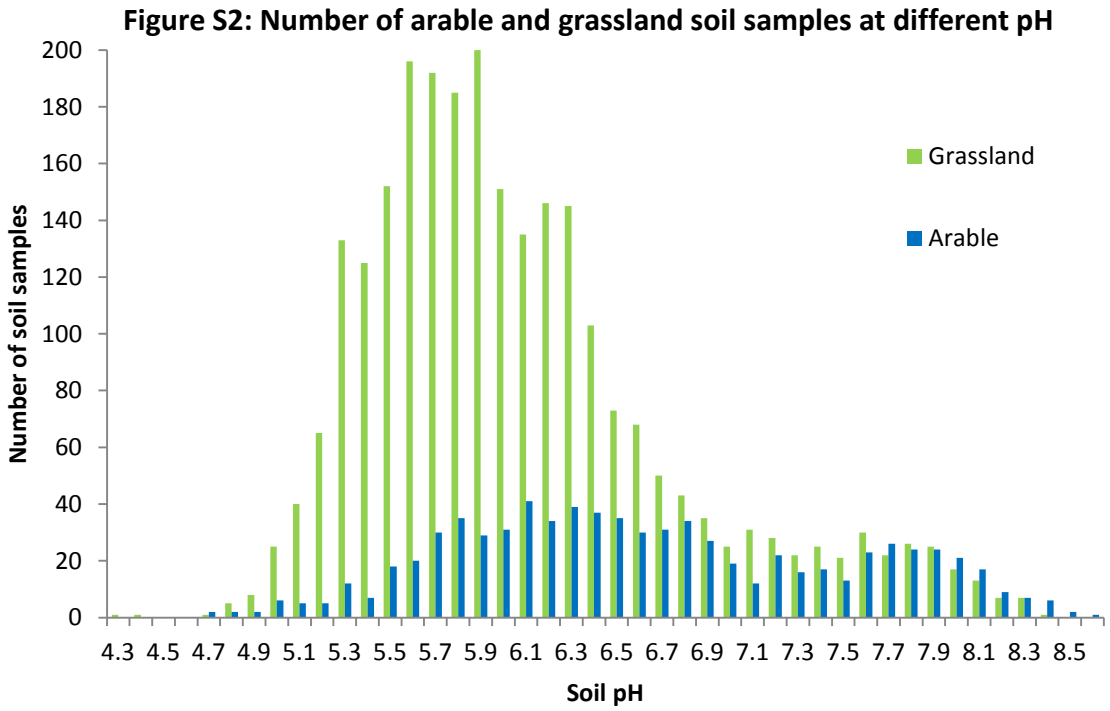


Figure S2: This graph shows the number of arable and grassland soil samples with particular pH values. It should be noted that the modal pH of the grassland (green bars) samples from the South West are within the pH range of 5.5 – 5.9. For arable (blue bars) samples, the modal pH is within the range of 5.8 – 6.1.

Figure S3a: Proportion of arable soil samples compared to target pH per county

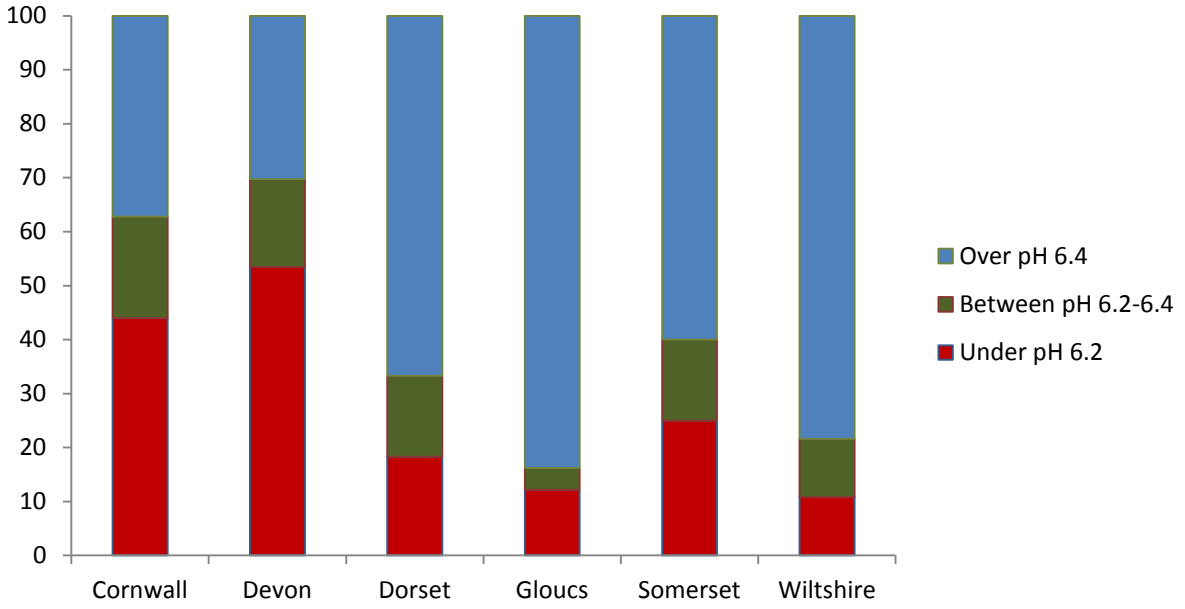


Figure S3b: Proportion of grassland soil samples compared to target pH per county

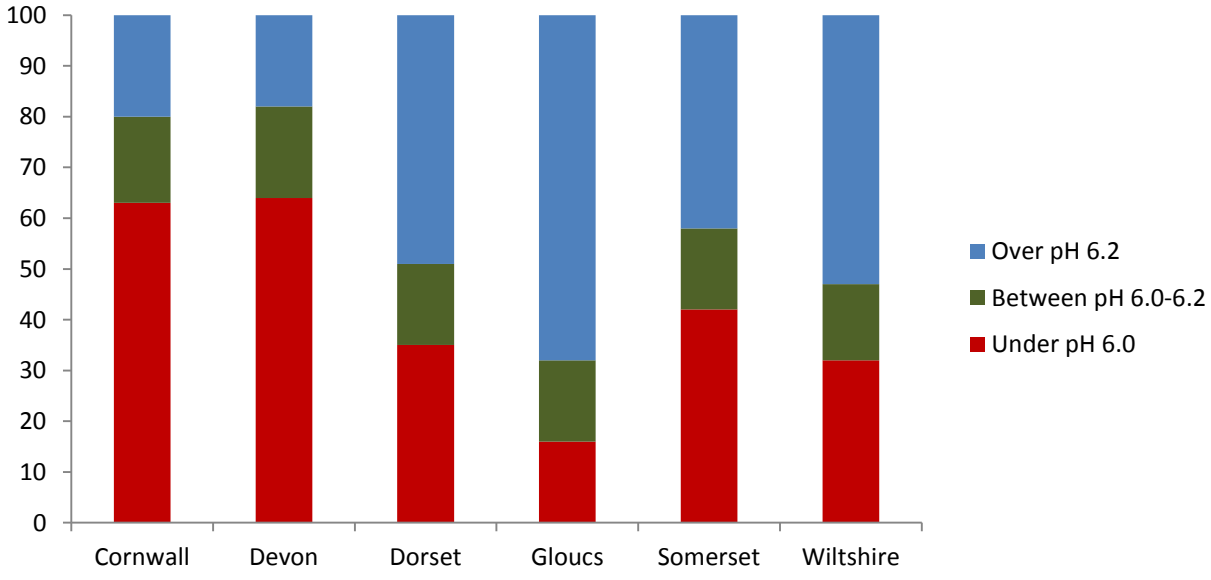


Figure S3: These graphs show the percentage of arable (a) and grassland (b) soil samples that fell outside the target pH for the particular cropping systems. The red areas represent those soils samples that were too acidic, the green areas are those soils samples that met the target pH and the blue areas represent the soil samples that are more alkaline than recommended. The values used in this figure can be seen in Table S1 below.

Table S1: The percentage of arable and grassland soil samples that were under, met or above the target pH range compared by county in the South West.

	Arable			Grassland		
County	**Under target pH**	**Met target pH**	**Above target pH**	**Under target pH**	**Met target pH**	**Above target pH**
Cornwall	44	18.8	37.2	63	17	20
Devon	53.5	16.2	30.3	44	18	18
Dorset	18.3	15	66.7	35	16	49
Gloucs	12.2	4	83.8	16	16	68
Somerset	25	15	60	42	16	42
Wiltshire	10.8	10.8	78.4	32	15	53

Table S2: The number of **arable** soil samples that were below the recommended SOM benchmark or key nutrient index compared by county.

		Number of arable soil samples **below** indices			
County	Total number of arable soil samples	3% SOM	P index	K index	Mg index
Cornwall	218	14	63	80	7
Devon	155	30	45	41	1
Dorset	60	8	20	16	7
Gloucestershire	99	7	31	12	7
Somerset	119	15	35	16	5
Wiltshire	120	13	31	14	19
Total	771	87	225	179	46

Table S3: The number of **grassland** soil samples that were below the recommended SOM benchmark or key nutrient index compared by county.

		Number of grassland soil samples **below** indices			
County	Total number of grassland soil samples	3% SOM	P index	K index	Mg index
Cornwall	650	7	259	341	9
Devon	902	11	342	429	8
Dorset	178	6	86	74	4
Gloucestershire	234	5	136	62	1
Somerset	429	8	236	157	11
Wiltshire	185	2	97	58	6
Total	2578	39	1156	1121	39