Soil and Nutrient Network

Helping farmers improve soil and nutrient management

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Case study -
Girrick Farm, Roxburghsire

Girrick is an owner occupied mixed arable, beef and sheep unit farmed by Andrew Forster and his family. Girrick lies around 450ft above sea level and extends to 242ha, all of which is Non-Less Favoured Area and within the Lothian and Borders Nitrate Vulnerable Zone (NVZ). The farm is roughly split 50:50 between crop and grassland, with some short term leys used as an arable break and 69ha of permanent pasture. Winter wheat, winter oats and winter and spring barley are grown at Girrick. All straw is baled and kept for bedding and feed for the beef enterprise. This consists of 150 Simmental and Angus cross cows and followers. All stock not kept for breeding are finished on farm. The Forsters also run a flock of 200 commercial Easy Care ewes

Assessing Soil Health

The Forsters already GPS soil sample their fields on a hectare grid for pH, P and K. Lime, P and K are then applied at variable rate using application maps based on the soil analysis results. Prior to the first Soil & Nutrient Network Farm meeting, around half of the farm was also conventionally soil sampled and analysed for pH, major nutrients, trace elements and organic matter. On the whole, the analysis results were very good. None of the fields (including the permanent pasture) had a pH of below 6.1, and the majority of major nutrients and trace elements were found to be at a 'moderate' level. The only consistently low nutrient across the farm was sulphur. Organic matter levels were also acceptable at between 4 and 6% on the rotational fields.

Having confirmed the nutrient content of the soil, it is important to also consider soil structure. At Girrick, Dr Audrey Litterick of Earthcare Technical dug several soil pits to assess the soil structure. The soil structure was generally found to be good, but there was some evidence of compaction. Poor soil structure is characterised by solid soil with little porosity. Plant roots will travel horizontally and the soil will crack in horizontal 'plates' when broken apart. Layers of wetness can be found due to compaction and the soil can have an unpleasant odour as crop remains rot in wet soil.

It is important to assess soil structure **BEFORE** taking any action to improve it. Many problems can be easily worsened by subsoiling or taking action in unfavourable conditions

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Organic Fertilisers & Soil

Audrey also spoke at Girrick about the different bulky organic products available and the benefits they provide as fertilisers and soil conditioners. With AD plants now becoming more common, there is growing interest in anaerobic digestate as it becomes more widely availabile. Audrey explained that whole digestates can be excellent fertilisers but they typically contain a high percentage of readily available nitrogen, so storing and applying them requires a lot of thought. Digestate is typically bulky in relation to its nutrient value, so consideration should be given to separating the material (into liquid and fibre) for easier storage and application and to reduce haulage and spreading costs. Whole, separated and fibre digestates vary widely in their nutritional value so testing those available to you regularly is crucial if their use is to be optimised!

Key Findings

- Maintaining and enhancing soil organic matter levels is key to improving soil health. Applying organic materials like green compost or cattle FYM is an effective way to add fresh soil organic matter which boosts worm activity, worm numbers and other soil microbial life.
- GPS soil sampling enables targeted applications of lime and P&K fertiliser. Sampling at 1/4ha grids removes pH variation faster and more accurately than 1 ha grids. GPS sampling can be more cost-effective than the traditional soil sampling method when taking into account lime application requirements. There are various methods of GPS sampling so monitoring crop performance within your fields can help to determine if you are using the most appropriate method on your farm.
- A fertiliser spreader properly maintained, set up and operated over 100 ha in one year will apply £10,000 worth of fertiliser, generating additional crop yield worth around £80,000. It therefore makes good sense to spend less than £250 to ensure that the spreader is spreading accurately.

The Importance of Sulphur

As atmospheric deposition of sulphur from industry continues to decline, it is likely that the risk of sulphur deficiency will affect an increasingly wide range of crops grown on many different soil types. SAC Consulting's Donald Dunbar explained that when crops are deficient in sulphur, they do not respond as efficiently to applied nitrogen. Sulphur deficiency is most common in sandy or shallow soils and soils of low organic matter as it is soluble, so easily leached from the soil in the same way as nitrate. Symptoms of sulphur deficiency are seen in the young leaf/new growth in cereals and grass. These tend to be pale, with interveinal yellowing in the middle and upper leaves. In oilseed rape, pale flower petals are found.

To confirm sulphur deficiency, several forms of analysis are available. Soil analysis can be useful for identifying very deficient soils. However, plants sometimes do not show signs of deficiency when grown in soil low in sulphur. Plant tissue analysis of the nitrogen:sulphur ratio will confirm if the crop itself is deficient. The table below provides parameters for the N:S ratio and when a response to applied sulphur is likely.

Total N: Total S	Response to applied Sulphur
Less than 13:1	Unlikely
13:1 to 16:1	Insurance dressing required
Greater than 16:1	Response highly likely

Applications in several fields have been split between straight urea and urea + sulphur at Girrick to assess the effect of sulphur application on both grassland and arable crops. Samples of plant tissue, fermented silage and grain will be taken and analysed to see what impact this has on silage and grain quality.

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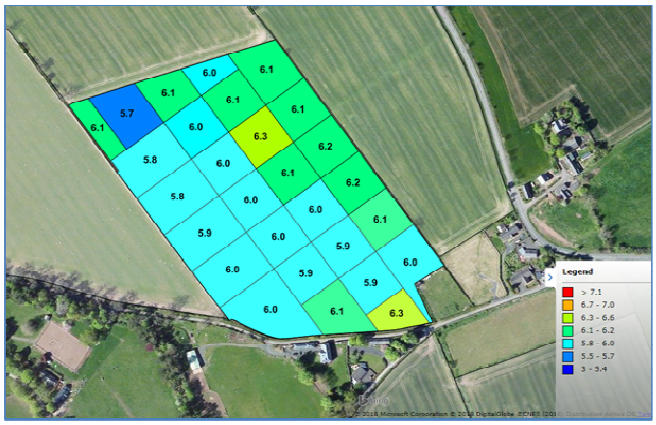
Organic Fertilisers & Soil

The Forsters already GPS soil sample their fields at Girrick on a hectare grid for pH, P and K. Lime, P and K are then applied at variable rate using application maps based on the soil analysis results. Over the winter, one of the fields at Girrick was GPS sampled on both a hectare grid and a ¼ hectare grid for pH to assess the pros and cons of a smaller sampling grid.

pH at 1 ha grid

pH at 1/4 ha grid



Visually you can immediately see that at the top of the field, the ¼ grid sampling has picked up areas with 5.7 and 5.8 pH in an area that averaged 6.1 pH on the 1 hectare grid. At the bottom of the field, it has identified an area of 6.3 pH where the average of the 1 hectare grid was 5.9 pH. Senior agricultural consultant Donald Dunbar said in this situation the under application of lime in a spring barley crop is likely to have a detrimental impact on yield crop and performance. The take home message is sampling at a 1/4ha grid for pH will accurately identify variation and allow a more targeted application of lime than 1ha grids. The resulting removal of pH variation within the field will be faster and more accurate.

Ideally, yield maps should be used alongside GPS soil analysis maps to establish if the sampling method being used is also evening out yield variation and improving performance across the field.

Whilst GPS soil sampling costs more than a traditional 'W-pattern' soil sample, it is important to recognise that savings that can be made in the following lime applications. Based on the Girrick field it was estimated that the combined cost of soil sampling and applying lime using the conventional 'W-pattern'in the 7.5 ha field would be around £789. Based on the GPS analysis results, Donald suggested a net saving of £435 could be achieved using the hectare grid, and a net saving of £262 on the ¼ hectare grid, when compared to the conventional sampling approach.

Fertiliser Spreading Testing

It is estimated that only around a third of fertiliser spreaders in the UK receive an annual tray test, with a similar number not being checked at all. Uneven spreading of nitrogen affects both crop yield and quality. Coefficient of Variation (CV) is used to measure the accuracy of the spread pattern. At a CV of above 20%, you are likely to see visual striping in cereal crops.

Coefficient of Variation	Rating
< 10%	Excellent
10-15%	Good
15-20%	Poor
> 20%	Unacceptable

The fertiliser spreader at Girrick was tested prior to the 2018 season by SCS Spreader & Sprayer Testing Ltd.. During the initial inspection of the spreader, two of the vanes were found to be worn and were replaced. When the spreader was taken into the field for the tray-test, it was found to have a CV of 12% (good). Following some adjustments, this was reduced by 3%, when a CV of under 9% was attained (excellent). For straight nitrogen-based products with wheat at £140/t, reducing the CV by 3% could result in a saving close to £3/ha.

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Organic Matter

At the final meeting of the Roxburghshire Nutrient Network Farm, Dr Audrey Litterick of Earthcare Technical explained the role of soil organic matter in determining soil health. Fresh organic matter (such as crop residues and dung) provides food for larger organisms (e.g. earthworms) and soil-micro-organisms, both of which are generally present in large numbers in healthy soils. Without regular additions of fresh organic matter, the life in the soil will decline, as will natural nutrient cycling (e.g. mineralisation). This will result in an overall decline in soil health.

There is no "ideal" soil organic matter level as this will differ depending on a range of factors, including soil type, climate and rotation. In very broad terms, soil organic matter levels of below 2% would be extremely low. From 4 - 7% is generally fine for arable rotations, with a higher figure better. Over 7% is usually very good, but this depends on the situation. Fields in permanent pasture in Scotland will have higher percentages of soil organic matter levels than those in arable crops. Soil organic matter levels were analysed at Girrick and found to range from 8-11% in the permanent pasture fields, and 4-6% in fields in arable rotation.

Dr Litterick concluded that conserving and increasing the soil organic matter levels we have in our soils is vital in order to maintain and enhance soil health. She outlined the main methods for maintaining and enhancing soil organic matter, which are:

- Organic amendments (e.g. composts, manures, paper crumble, biosolids, fibre digestates)
- Green manures and cover crops (inter-cropping or partial or full-year leys)
- Return of crop residues
- No-till and min-till
- Reduce losses by minimising intensive cultivations and choosing not to grow crops where cultivations or harvest are likely to result in soil damage

The table below outlines various sources of bulky organic matter available in different organic materials.

Organic Material	Dry Matter	Organic Matter Content (%)	Application Rate (t/ha) NVZ 250kg N/ha	Organic Matter Applied (t/ha)
Cattle FYM	25%	13.1	42	5.5
Broiler Litter	60%	31.2	8	2.5
Green Compost	58%	24.7	38	9.4
Green/Food Compost	51%	19.0	22	4.2
Biosolids (lime cake)	19%	70.0	4*	2.8

* Rate dependent on phosphate content rather than N content.