Technical Note TN656

November 2013 • All

Soils information, texture and liming recommendations.

SUMMARY

- Web based access to information on your soils on your farm is described.
- Soil texture classes of mineral soils are described and identified by hand texturing.
- Liming recommendations for different soils and managements are tabulated.

1. Introduction

Scotland's soils have been comprehensively surveyed, classified, and studied over the past 75 years. Understanding and using this information at the farm level has up till now been difficult due to its complexity and the accessibility of information. The development of web based tools has changed this and The James Hutton Institute, who hold the National Soils Database for Scotland, have created the SIFSS (Soil Indicators for Scottish Soils) website which allows you to access information on your soils. SIFSS is also available as a free iPhone app for you to find out what soil type is in your area, discover the differences in soil characteristics between cultivated and uncultivated soils, and also to examine a range of key indicators of soil quality.

In this technical note the influence of soil texture on target soil pH values and liming requirements of crops and grass is described. Regular soil testing is required every 4 - 5 years in order to monitor success in maintaining targeted levels of lime. This note can be used along with PLANET Scotland, a software tool designed for routine use by Scottish farmers and advisers to plan and manage lime and nutrient use on individual fields.

There is also on-going work that will make the information relevant to how we manage our soils on a daily basis. Further technical notes are planned linking trace element status with soil parent material, texture and pedological drainage status; and rates of phosphate fertiliser to build up and run down soil P status with a different set of soil properties.

2. Soil classification

One key step in making use of soils information on your farm is to be able to understand how soils are classified and mapped at the field level. The Soil Survey of Scotland classifies soils within a hierarchy.

- At the top level is the Soil Division, in which the soils are grouped according to the dominant soil forming processes – examples of divisions include leached soils and gleys.
- These soils are then classified into Major Soil Groups where soils are formed by similar processes (examples include brown earths and surface water gleys).

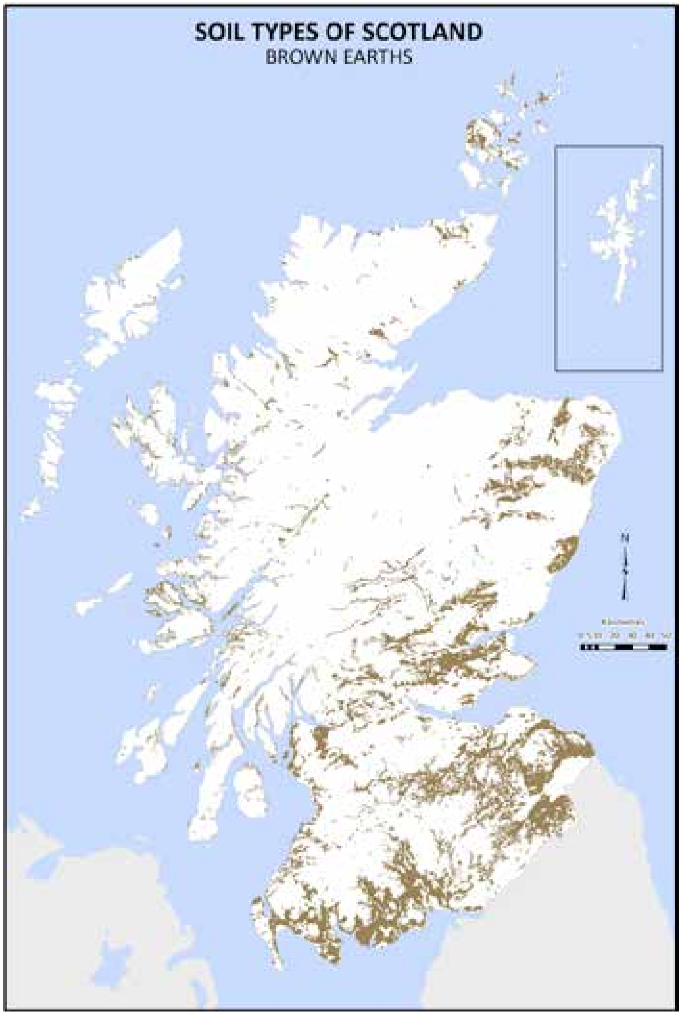
- These are then classified into Major Soil Sub-groups where the sequences of soil horizons are generally found in the same arrangement – examples are brown forest soils and non-calcareous gleys. Examples are given below of two contrasting soil types: a brown forest soil and a non-calcareous gley, as well as maps of their distribution across Scotland.

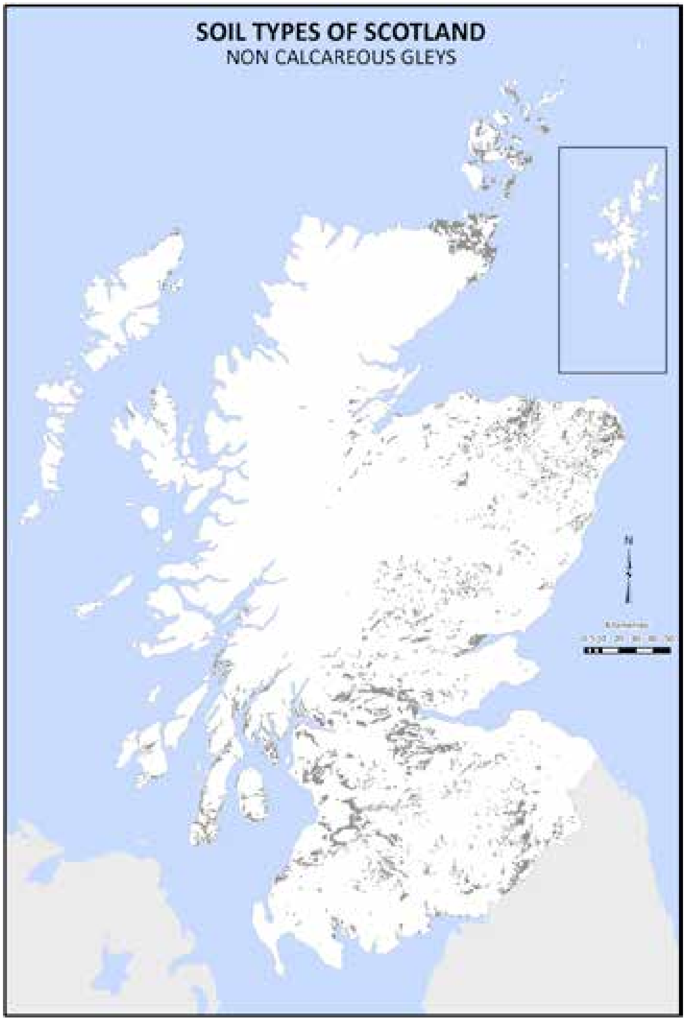
- At the lowest level is the soil Series – soils with the same arrangement of horizons formed on the same parent material. Series names are typically associated with the area in which the soil was first surveyed e.g. Forfar series or Monaughty series, and there are over 1000 separate series described in Scotland. Soils in a given series are very similar in terms of texture, depth, and mineralogy.

For more information on these, and other soil types, see the James Hutton Institute website.

Brown forest soils are generally free draining, with a brown or reddish brown colour. A dark-coloured surface A horizon (or Ah where h denotes enriched with humus) overlies subsoil (B) horizon(s) with distinctive brown colours which gradually lighten as the organic matter and iron contents decrease with depth. Brown forest soils are amongst the most fertile soils in Scotland and are used extensively for agriculture. Significant growth rates of trees can be obtained within sheltered sites.

Non calcareous gleys are poorly draining soils where, due to waterlogging, the subsoil is deprived of oxygen causing iron compounds which normally give soils yellow or reddish-brown colours to change to ones which give the soil a grey or bluish-grey colour. In their natural state, non calcareous gleys support a range of plant species often used for rough grazing or forestry. Drainage allows many non calcareous (and other) gleys to be developed for agricultural, often as productive grassland for cattle.





At the national level, soils are often mapped by Major Soil Group or sub-group, but at the farm level, soil series is the mapping unit and there are between 3 and 4 different soil series on a typical farm. Identifying different soils on your farm and linking them to knowledge of the soil characteristics is the first step to help you manage them more sustainably and profitably.

The SIFSS system identifies a soil 'map unit', a collection of one or more soils typically found together in the landscape, for the area you are interested in – you can specify a postcode, grid reference, or select using the interactive map - and returns a menu with the soil series that make up that map unit. The description of the series includes whether the topsoil is mineral or organic and the predominant soil texture.

Soil properties influence soil fertility through direct effects on soil structure, drainage, acidity, availability of nutrients, and ultimately plant rooting depth. Compaction of the upper soil layers arising from poaching, trafficking and excessive rainfall resulting in ponding of surface water limits root development, restricts nutrient uptake and reduces growth potential. Excess soil moisture limits the length of the effective growing season and requires correction before the use of moderate to high levels of nutrient inputs can be fully justified. Soil compaction should be addressed when identified using a combination of cultivation, ploughing and changes to land management practices. An SRUC field guide to identifying soil compaction is available.

3. PLANET Scotland software tool

In the PLANET Scotland software tool a simplified approach to soil types is taken (Table 1), where mineral soils (<15% organic matter) are grouped into shallow; sands; sandy loams; and 'other mineral soils'. 'Other mineral soil' textures include sandy silt loam, silt loam and clay soils (>18% clay content). In farming practice light soil is a term used to describe sands and sandy loams; medium soils include sandy silt loam and silt loam; while heavy soils are the clay soils. These soil texture classes are described in section 4 in this technical note.

Organic soils are grouped into humose (between 15 and 35% organic matter) and peaty soils (more than 35% organic matter) which can be confirmed by laboratory analysis.

Table 1. Description of soil types based on soil texture and organic matter

Shallow soils	All mineral soils which are less than 40cm deep.
Sands	Soils which are sand (S) and loamy sand (LS) textures to a depth more than 40cm.
Sandy loams	Soils which are sandy loam texture to a depth of more than 40cm.
Other mineral soils	Soils with less than 15 percent organic matter that do not fall into the sandy or shallow soil category i.e. silty and clay soils.
Humose soils	Soils with between 15 and 35 percent organic matter. These soils are darker in colour, stain the fingers black or grey, and have a silky feel.
Peaty soils	Soils that contain more than 35 percent organic matter.

4. Soil texture

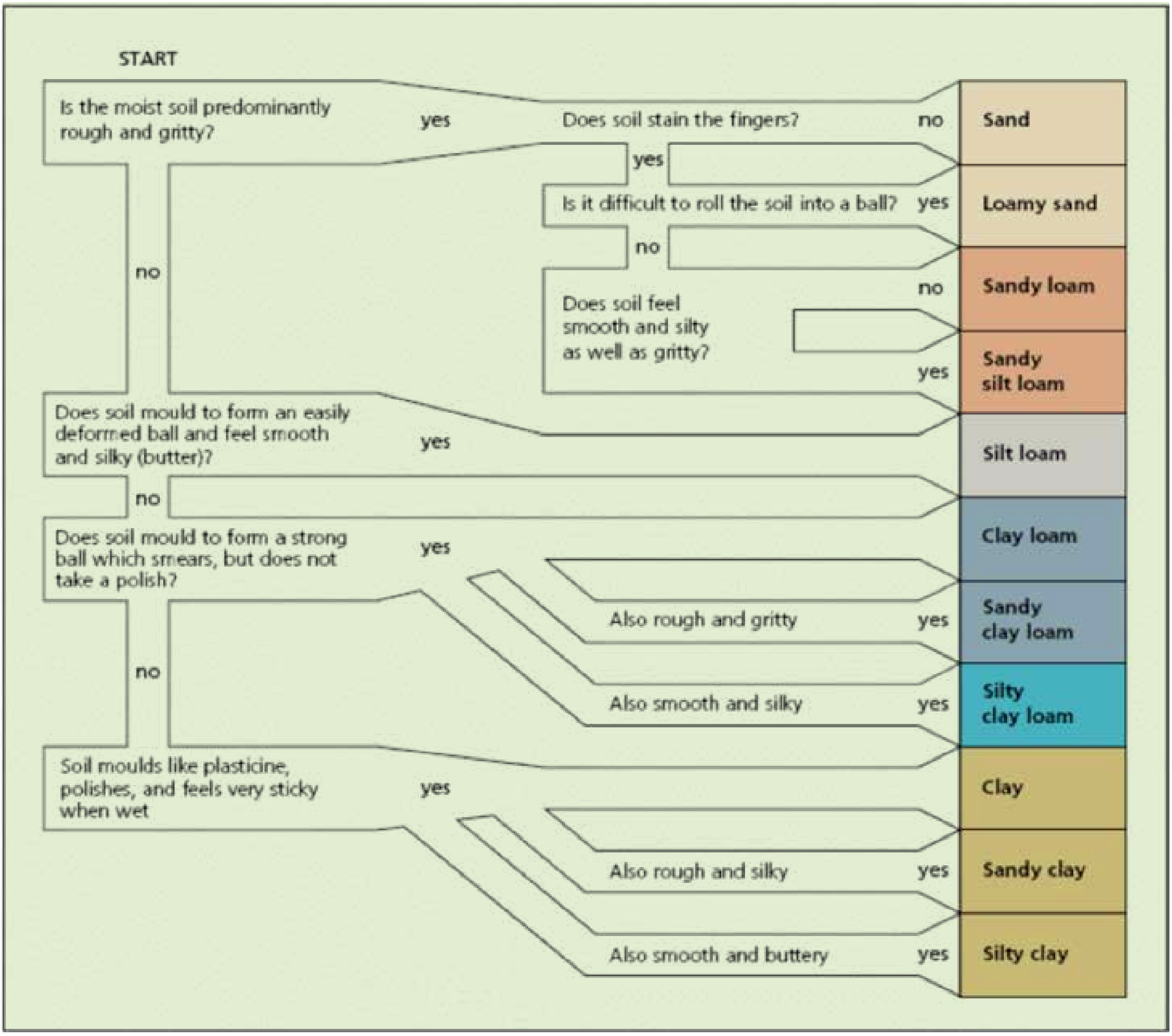
Soil texture, which is defined by the proportion of sand, silt and clay sized particles in mineral soils, cuts across major soil groups and sub-groups. For example, a cultivated podzol and a brown earth can both appear in the 'sandy loams' class. Soil texture can be determined in a number of ways:

- Laboratory analysis followed by classification using the texture triangular diagram. This diagram can be found in the [FSP Farm Soils Plan – Protecting soils and income in Scotland.]()
- For most practical purposes texture classes of mineral soils can be identified by hand texturing by the following method:

Assessment of Soil Texture

Accurate measurement of soil texture requires laboratory analysis, but for practical purposes texture can be assessed by hand using the following method:

Take about a dessert spoonful of soil. If dry, wet up gradually, kneading thoroughly between finger and thumb until soil crumbs are broken down. Enough moisture is needed to hold the soil together and to show its maximum stickiness. Follow the paths in the diagram to get the texture class.



5. Lime recommendations for different soils

Soil pH is a measure of acidity and alkalinity. The natural pH of a soil depends on the nature of the material from which it was developed. It ranges from about pH 4 (very acid), when most crops will fail, to about pH 8 for soils naturally rich in calcium or magnesium carbonate. For soils with a pH lower than 7, natural processes (e.g. rainfall, crop growth and leaching in drainage water) and some farming practices (e.g. use of some nitrogen fertilisers) tend to acidify soil. Acidifying processes can cause soil pH to fall quite quickly, particularly in sandy soils, and regular pH checks every 4 to 5 years are advisable. If problems are suspected, soil pH should be checked.

At soil pH values below 5.6 in mineral soils in Scotland soluble aluminium inhibits cereal root growth and reduces yield. Organic soils contain less aluminium and for this reason can be maintained at lower pH values than for mineral soils for any given crop. The aim should be to apply liming material to avoid patches with pH below 5.6 in all parts of the field on mineral soils. For each field the amount of lime to apply will depend on the current soil pH, soil texture, soil organic matter and the optimum pH needed. Clay and organic soils need more lime than sandy soils to increase pH by one unit. A lime recommendation is usually for a 20 cm depth of cultivated soil or a 7 cm depth of grassland soil. The SRUC soil testing laboratory measures dry soil bulk density along with soil pH in order to assess the lime requirement for each soil sample. Table 2 gives examples of the recommended amounts of lime (based on a neutralising value (NV) of 50% CaO) required to raise the pH of different soil types to achieve the optimum pH level.

Liming materials should be purchased on the basis of the price relative to the neutralising value and fineness of the products on offer. The fineness will usually include the maximum size of particles and the amount passing a 150 micron sieve. The finer the grinding of the product the more rapid the rate at which neutralisation occurs.

One common question is if there is a detrimental impact on the structure of clay soils from applying extra magnesium to the soil that is already high in magnesium? Calcium can improve soil structure by causing the soil particles to move apart for aeration and drainage. Magnesium makes the particles stick together. The role of these cations on soil structure is described in terms of the calcium to magnesium ratio (Ca:Mg) of the soil as it is the balance of the two that has an impact on soil structure. In low calcium, clay soils the magnesium will have a more dominate effect on structure and can cause them to bind together. It is the balance between the two that results in a good structured clay soil. In general if your soil test is showing high magnesium levels there is no need to apply more and doing so may also impact soil structure.

It must be noted that most clay soils with severe structural problems that are not due to physical compaction will typically have high amounts of sodium cations attached to the clay as well, causing clay particles to disperse when wet and set like concrete when dry. Sodium is deposited on soils near coasts with predominantly onshore winds. However, sodium is usually washed out of course textured soils within 12 months.

The main source of magnesium application to soil is magnesian ground limestone. A magnesian limestone with the minimum amount of magnesium carbonate will contain 10% magnesium and 26% calcium i.e. a tonne of this magnesian lime will apply 100 kg magnesium and 260 kg calcium, a ratio of Ca:Mg of 2.6:1. There has been much research done world-wide on trying to identify soil structural problems with cation ratios, most of which does not definitely show benefits to having the "right ratio" of Ca:Mg. Rather than total Ca:Mg ratio in a soil, a better way would be to measure the extractable Ca and Mg in the soil and take plant tissue samples. It is also important to point out that using Ca:Mg ratios in isolation can lead to erroneous interpretations as calcium and magnesium levels can both be low, yet have an ideal ratio; or both can be high, yet have an ideal ratio. Although there is no definitive ratio, a ratio of extractable Ca:Mg in clay soils of 4:1 to 7:1 is expected to ensure that magnesium is not excessive and detrimental to soil structure and aeration.

High magnesium status soil in the SAC soil test starts at an extractable Mg value above 200 mg/l. The extractable Ca level in a heavy soil limed to a target pH value of 6.0 to 6.2 is typically between 1600 and 2400 mg/l i.e. a Ca:Mg ratio of between 8:1 and 12:1. Even where extractable Mg is 400 mg/l, the Ca:Mg ratio is expected to be in the range 4:1 and 8:1.

Soil pH can vary considerably metre by metre, especially if there is a range in soil textures within fields. GPS sampling for soil pH at 4 samples/ha, each sample containing a number of cores bulked together, and variable lime application can be cost-effective in many fields. Identifying major soil types and yield variation in the field is a key step in establishing the need for GPS sampling. Before embarking on GPS sampling within fields for soil pH

- Compare crop and variety performances between fields
- Identify and calculate financial loss to the farm of poor output areas
- Identify and remedy soil structural and wetness problems

Where soil is acid below 20 cm, and soils are ploughed for arable crops, a proportionately larger quantity of lime should be applied. However, if more than 10 t/ha is needed, half should be deeply cultivated into the soil and ploughed down with the remainder applied to the surface and worked in. For established grassland or other situations where there is no, or only minimal, soil cultivation, no more than 7.5 t/ha should be applied in one application. In these situations, applications of lime change the soil pH below the surface very slowly. Consequently the underlying soil should not be allowed to become too acid because this will affect root growth and thus limit nutrient uptake and water, which will adversely affect yield. Lime should be applied at least 6 months prior to reseeding in order to allow soil pH to increase before sowing, and prior to applying phosphate fertiliser. Applying phosphate and lime in close proximity can lead to phosphate being locked up due to precipitation as calcium phosphate.

Table 2. Lime requirement values (t/ha of product with NV 50% CaO) for arable and rotational grassland; and permanent grassland that is ploughed at reseeding.

Soil pH	Sands (S, LS)		Sandy loams		Other mineral soils		Humose soils		Peaty soils	
	Arable & rot. grass	Perm. grass	Arable & rot. grass	Perm. grass	Arable & rot. grass	Perm. grass	Arable & rot. grass	Perm. grass	Arable & rot. grass	Perm. grass
6.3	0	0	0	0	0	0	0	0	0	0
6.2	0	0	0	0	2	0	0	0	0	0
6.1	0	0	2	0	3	0	0	0	0	0
6.0	2	0	3	0	4	0	0	0	0	0
5.9	2	0	4	0	5	0	2	0	0	0
5.8	3	0	4	0	5	2	3	0	0	0
5.7	4	2	5	2	6	2	4	0	0	0
5.6	4	2	6	3	7	3	5	0	2	0
5.5	5	3	6	4	8	4	6	2	4	0
5.4	5	4	7	4	9	5	7	2	5	0
5.3	6	4	8	5	10	6	8	3	6	0
5.2	7	5	8	6	10	6	9	4	7	0
5.1	7	5	9	6	11	7	10	5	8	2
5.0	8	6	10	7	12	8	11	7	10	4
4.9	8	7	10	8	13	9	12	8	11	5
4.8	9	7	11	8	14	10	13	9	12	6

Lime requirements for shallow mineral soils which are less than 40cm deep should be based on the soil texture groups in Table 2. Where permanent grass is reseeded without ploughing lime requirements may be further reduced.

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