



Higher National Unit specification

General information for centres

Unit title: Soils and Plant Nutrition

Unit code: F1JL 35

Unit purpose: On completion of the Unit the candidate should be able to explain the scientific principles underlying soil properties, soil processes and soil fertility. This is essential for anyone involved in managing soils: techniques and methods change over time and an understanding of the underpinning scientific principles enables candidates to adapt to these changes.

On completion of the Unit the candidate should be able to:

- 1 Explain the function of the soil biomass in determining soil fertility.
- 2 Explain the influence of soil physical properties and processes on soil fertility.
- 3 Explain the role of essential nutrients in crop nutrition.
- 4 Explain the influence of soil chemical properties and processes on soil fertility.

Credit points and level: 1 HN credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Recommended prior knowledge and skills: It is recommended that candidates take the Soil Management Unit prior to this one as it gives a good basic introduction to the subject. However, good candidates should not be disadvantaged unduly if they do not have this Unit.

Core Skills: There are opportunities to develop the Core Skills of *Problem Solving* at SCQF level 6 level in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Assessment: The Unit could be assessed with restricted response questions set either as individual tests for each Outcome or as roll up tests. Assessment should be carried out in controlled conditions lasting 45 minutes each if individually assessed, or a 2 hour paper in total.

Higher National Unit specification: statement of standards

Unit title: Soils and Plant Nutrition

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The sections of the Unit stating the Outcomes, Knowledge and/or Skills, and Evidence Requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Explain the function of the soil biomass in determining soil fertility

Knowledge and/or Skills

- ◆ Nutrient cycling
- ◆ Decomposition
- ◆ Humification
- ◆ Symbioses
- ◆ Population dynamics

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the functioning of the soil biomass
- ◆ describe at least four out of five of the above knowledge/skills

Assessment Guidelines

Evidence could be generated through a set of 10 in-class, closed-book, restricted response questions. The test should last 45 minutes. To ensure that the candidates will not be able to foresee which situations will be assessed, a different sample of knowledge/skills is required each time the Outcome is assessed. The assessment for this Outcome could be combined with Outcomes 2, 3 and 4 as part of a single examination. If this is the case then the time limit could be reduced.

Higher National Unit specification: statement of standards (cont)

Unit title: Soils and Plant Nutrition

Outcome 2

Explain the influence of soil physical properties and processes on soil fertility

Knowledge and/or Skills

- ◆ Texture
- ◆ Structure
- ◆ Organic matter
- ◆ Air
- ◆ Water
- ◆ Water movement
- ◆ Diffusion
- ◆ Structure formation

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain the following physical soil properties:
 - texture
 - structure
 - organic matter
 - air
 - water
- ◆ explain the following soil processes:
 - water movement
 - diffusion
 - structure formation

Evidence for this Outcome can be assessed on a sample basis.

To ensure that the candidates will not be able to foresee which situations will be assessed, a different sample of knowledge/skills is required each time the Outcome is assessed.

Assessment Guidelines

Evidence could be generated through an in-class, closed-book, restricted response test comprised of ten questions, lasting at least 45 minutes. Candidates will need to demonstrate that they can accurately describe at least 75% of the above knowledge/skills. These will be sampled under supervised conditions.

The assessment for this Outcome could be combined with Outcomes 1, 3 and 4 as part of a single examination. If this is the case then the time limit could be reduced.

Higher National Unit specification: statement of standards (cont)

Unit title: Soils and Plant Nutrition

Outcome 3

Explain the role of essential nutrients in crop nutrition

Knowledge and/or Skills

- ◆ Macro-nutrients
- ◆ Micro-nutrients
- ◆ Effect on crop physiology
- ◆ Effect on pests and diseases
- ◆ Effect on crop yield
- ◆ Effect on crop quality

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can explain the:

- ◆ role of macro-nutrients in crop nutrition
- ◆ role of micro-nutrients in crop nutrition
- ◆ effect of crop nutrients on crop physiology
- ◆ effect of crop nutrients on pests and diseases
- ◆ effect of crop nutrients on crop yield
- ◆ effect of crop nutrients on crop quality

Evidence will be generated through an in-class, closed-book, restricted response test comprised of ten questions, lasting at least 45 minutes. Candidates will need to demonstrate that they can accurately describe at least 66% of the above knowledge/skills. These will be sampled under supervised conditions.

To ensure that the candidates will not be able to foresee which situations will be assessed, a different sample of knowledge/skills is required each time the Outcome is assessed.

Assessment Guidelines

Evidence will be generated through an in-class, closed-book, restricted response test comprised of ten questions, lasting at least 45 minutes.

The assessment for this Outcome could be combined with Outcomes 1, 2, and 4 as part of a single examination. If this is the case then the time limit could be reduced.

Higher National Unit specification: statement of standards (cont)

Unit title: Soils and Plant Nutrition

Outcome 4

Explain the influence of soil chemical properties and processes on soil fertility

Knowledge and/or Skills

- ◆ Cation Exchange Capacity
- ◆ pH
- ◆ Nutrient availability
- ◆ Redox potential
- ◆ Nutrient cycling
- ◆ Potential toxins

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can explain the influence of:

- ◆ soil chemical properties on soil fertility
- ◆ soil chemical processes on soil fertility

Candidates will need to demonstrate that they can accurately describe at least 66% of the above knowledge/skills. These will be sampled under supervised conditions.

To ensure that the candidates will not be able to foresee which situations will be assessed, a different sample of knowledge/skills is required each time the Outcome is assessed.

Assessment Guidelines

Evidence could be generated through an in-class, closed-book, restricted response test comprised of ten questions, lasting at least 45 minutes.

The assessment for this Outcome could be combined with Outcomes 1, 2 and 3 as part of a single examination. If this is the case then the time limit could be reduced.

Administrative Information

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Unit title: Soils and Plant Nutrition
Superclass category: RF
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History of changes:

| Version | Description of change | Date |
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Higher National Unit specification: support notes

Unit title: Soils and Plant Nutrition

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This Unit is aimed at any person with responsibility for managing soils correctly including those involved in agriculture (crop production and livestock enterprises), intensive horticulture, and environmental protection (eg pollution control and carbon sequestration). Ideally the candidates should have the *Soil Management* Unit before they undertake this one.

The main aim is to explain 'soil fertility' ie the ability of soils to support sustainable crop production. 'Sustainable' means continued production over a substantial period of time without significant decrease in yield or the need for significant increases in inputs. 'Inputs' include chemicals (fertilisers, herbicides etc), capital, equipment, time and labour. Soil fertility is a measure of the soil's ability to provide all the growth requirements of crops that are supplied by soils ie nutrients, oxygen, water, heat, anchorage, and the absence of detrimental levels of toxins, weeds, pests and diseases.

Whereas introductory soil management Units emphasise practical management of soils, this Unit aims to explain why modern soil management methods work and why some techniques are more appropriate than others in particular situations. The Outcomes are essentially stand-alone since they cover different components of soil fertility (ie soil biology, physics, nutrients and chemistry) and therefore there is not so much a progression of ideas but rather a development of knowledge and understanding of soils as a whole.

Although there is a lot of cross over between these elements (eg soil organic matter can be considered as a component of soil biology, physics or chemistry), because of the complexity of the subject there is no other way that the influence of soils on plant growth and crop production can be sensibly delivered. On the other hand, it is important to emphasise throughout the delivery of the Unit the dynamic and interactive nature of all the soil's components.

Outcome 1. This Outcome stresses the importance of the soil biotic component in affecting plant growth and development. The complexity of the soil ecosystem and diversity of species (in terms of their structure and function) should be emphasised. The subject could be placed within the context of organic husbandry (and perhaps be compared to the role of soil fauna and flora in conventional systems of production). Obvious symbionts would include mycorrhizae and nitrogen fixing bacteria. The role of the soil biotic and abiotic components and other environmental factors on diseases could be stressed (the former in terms of eg competitive exclusion). Population dynamics are important in pest/predator interactions and disease control.

Higher National Unit specification: support notes (cont)

Unit title: Soils and Plant Nutrition

Outcome 2. The concept of soil fertility is often reduced to the availability of nutrients or the pH of the soil. This gives an incomplete picture of the effect of soil characteristics on crop (and livestock) production. It is important therefore to also include *physical* soil properties in any discussion of soil fertility. Earlier Units (eg *Soil Management*) will introduce concepts such as soil texture, drainage and irrigation. This Unit explains eg *why* sandy soils have lower available water than silts; *why* waterlogging reduces crop growth (through the effect of lower Eh increasing toxin availability and reducing nitrogen supply); *why* stones do not automatically help with drainage; *why* silty soils are prone to capping.

Outcome 3. Nutrients obviously have a major effect on crops. Students should be aware of the role of macro- and micro-nutrients in plant physiology (eg enzyme function, chlorophyll structure, respiration) and pest and disease control (especially the effect of, and interaction between, N and K). Nutrient disorders ('rugby striping' and Mn deficiency in cereals) should be explained (eg iron deficiency causing chlorosis because of the role of Fe in chlorophyll production). The effect of nutrients on yield can easily be illustrated by reference to yield response curves (including harvestable yield), and the effect on quality can be seen through disorders such as blossom end rot, raan (B deficiency), and malting quality (excess N).

Outcome 4. Discussion of the nature of soil chemical fertility centres on the main properties and processes. Processes involved in nutrient cycling might include desorption/adsorption reactions (eg phosphate sorption, pesticides, radio-nuclides (eg Caesium from the fallout from Chernobyl) and cation exchange), precipitation/dissolution, leaching, and denitrification. Toxin availability also depends on similar processes.

Guidance on the delivery and assessment of this Unit

This Unit ideally follows on from the *Soil Management* Unit which introduces methods for manipulating the soil in order to optimise soil fertility. The module also links with other crop production and plant physiology modules.

The Outcomes follow each other logically. It is best to start with soil biology because (a) this is a subject that candidates like the most (and therefore they are immediately engaged), (b) it's the subject which *surprises* them the most (ie they don't expect to see so much life, and such diversity of life-forms, in the soil), and (c) it's the subject that so many land managers forget to address when planning or managing their soils. Likewise, soil physical properties are usually overlooked by land managers' emphasis on crop nutrition when in actuality no matter how rich the soil is in nutrients, if the soil is waterlogged, compact or droughty, the crops will under-perform or even fail.

This is not a practical Unit and therefore field visits are would not constitute a major part of the delivery of the syllabus. Lectures, lab practicals and computer programs would be the main form of delivery.

Higher National Unit specification: support notes (cont)

Unit title: Soils and Plant Nutrition

Practicals could consist of hand texturing (using keys), lab experiments (eg to analyse for nutrients and soil pH, or leaching), greenhouse trials (eg looking at the effect of treatments on plant germination and growth) and microscope work (eg identifying soil organisms after extraction from soils using Baermann and Tullgren funnels). Demonstrations can also be set up showing eg the effects of organism activity (eg vermiforms, ant colonies, compost bins), salinity, or NPK interactions. Other practicals could look at mechanical analysis (for particle size distribution), water tension (eg using a sponge to demonstrate water distribution and air filled porosity in pots), and lime requirement.

Computer programs are readily available to guide the students through, for example, the nitrogen cycle, carbon cycling and water dynamics. These can be used to supplement lectures, for self-guided learning, and for formative assessment.

Assessment will be by closed-book, in-class, restricted response questions. A minimum of ten questions per test for each of the Outcomes. The students could be shown a longer list of questions prior to the test to give them an idea of the level of response expected and the areas required to revise. By 'explaining' the principles of the properties and the processes the candidates will demonstrate understanding of cause and effect and fundamental chemical, biological/ecological and physical principles.

Opportunities for developing Core Skills

There are opportunities to develop the Core Skills of *Problem Solving* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Open learning

This Unit is highly compatible with delivery via Distance Learning since the main thrust is understanding the theoretical aspects of soil fertility. All Outcomes could be delivered via a combination of real-time lectures delivered over the internet, material posted on a VLE platform, CD-ROMs (eg computer programs), and paper-based material.

Candidates with disabilities and/or additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (www.sqa.org.uk).

General information for candidates

Unit title: Soils and Plant Nutrition

The Unit is designed to explain the scientific principles underpinning soil processes and properties, and soil management operations. For example, why is nitrate leached whilst ammonium and phosphate aren't? Why does over-liming cause iron deficiency and chlorosis in many plants? Why is it useful to inoculate plants with fungi (mycorrhizae) and bacteria (eg *Rhizobia*) in some situations; what benefits do plants derive from these associations? Why does placing broken crockery at the bottom of pots actually make drainage *worse* rather than improve it? Why does waterlogging actually *increase* soil pH rather than make soils more acidic?

There are many misconceptions about soils and the reason is that people don't fully understand what's going on within them. This Unit aims to demystify soils and in the process endow you with the knowledge to manage them more effectively and sustainably.

On completion of this Unit you should be able to:

- 1 Explain the function of the soil biomass in determining soil fertility.
- 2 Explain the influence of soil physical properties and processes on soil fertility.
- 3 Explain the role of essential nutrients in crop nutrition.
- 4 Explain the influence of soil chemical properties and processes on soil fertility.