



Higher National Unit specification

General information for centres

Unit title: Crop Physiology and Breeding

Unit code: F2AX 35

Unit purpose: This Unit is designed to enable candidates to gain an understanding of the physiological basis of crop yields, how this is influenced by environmental and management factors and how plant breeding methods can be used to improve crops. It is suitable for candidates seeking employment in agriculture, horticulture or agricultural science.

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

- 1 Explain the physiological basis of crop yield production.
- 2 Explain how environmental factors affect the physiology of crop yield.
- 3 Explain how variations in crop management influence the physiology of yield in a selected crop.
- 4 Explain the principles of plant breeding.

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: Access to this Unit will be at the discretion of the centre, and there is no prerequisite but it would be an advantage if the candidate had prior experience of studying one or more Units in plant science, crop production or genetics at SCQF level 7.

Core Skills: There are opportunities to develop the Core Skills of Communication (Written Communication), Numeracy (Using Graphical Information) and Problem Solving (Critical Thinking) at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: This Unit is included in the framework of the Group Awards HND Applied Bioscience, HND Agricultural Science, HND Agriculture, HND Horticulture and HND Green Technology. It is recommended that it should be taught and assessed within the subject area of the particular Group Award to which it contributes.

Assessment: Suggested assessment methods are a closed-book test of restricted response questions for Outcomes 1 and 2, followed by one or two written reports covering Outcomes 3 and 4. Alternatively, Outcome 4 could be assessed by a supervised, closed-book test containing restricted response questions.

Higher National Unit specification: statement of standards

Unit title: Crop Physiology and Breeding

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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 physiological basis of crop yield production

Knowledge and/or Skills

- ◆ Canopy light interception
- ◆ Conversion of light energy into crop biomass
- ◆ Harvest index
- ◆ Leaf area index
- ◆ Canopy photosynthesis
- ◆ Crop development and components of yield
- ◆ Root functions and interactions with canopy

Evidence Requirements

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

- ◆ outline the physiological basis of crop yield production in terms of canopy light interception, the conversion of light energy into crop biomass and harvest index
- ◆ explain how crop leaf area index affects light interception
- ◆ explain how canopy photosynthesis affects biomass production
- ◆ explain how crop development determines the components of yield
- ◆ explain how the root system interacts with shoots to affect crop yields

On every assessment occasion, evidence must be provided to satisfy the first bullet point in the Evidence Requirements above, as well as three out of four of the other Evidence Requirements. A different sample should be chosen on each occasion. Evidence will be generated using an assessment in which candidates must obtain at least 60% of the marks available in order to pass.

Assessment Guidelines

Evidence for this Outcome could be generated through a supervised, closed-book assessment of 45 minutes duration. It could take the form of a set of structured questions and restricted responses.

The assessment of this Outcome could stand alone or be combined with that for Outcome 2 into a test of 90 minutes duration.

Higher National Unit specification: statement of standards (cont)

Unit title: Crop Physiology and Breeding

Outcome 2

Explain how environmental factors affect the physiology of crop yield

Knowledge and/or Skills

- ◆ Effects of environmental factors on canopy expansion and senescence
- ◆ Effects of environmental factors on canopy photosynthesis
- ◆ Effects of environmental factors on reproductive development
- ◆ Effects of temperature
- ◆ Effects of light (daylength and irradiance)
- ◆ Effects of carbon dioxide concentration
- ◆ Effects of soil water availability
- ◆ Effects of nitrogen availability

Evidence Requirements

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

- ◆ explain the effects of two environmental factors on the rate of canopy expansion
- ◆ explain the effects of two environmental factors on the rate of canopy photosynthesis
- ◆ explain the effects of one environmental factor on the reproductive development of crops

Evidence for this Outcome will be generated through an assessment involving sampling of the environmental factors listed in the knowledge and skills above. In order to ensure that candidates will not be able to foresee the sample, the whole of the content listed must be taught and available for assessment, and a different sample chosen on each assessment occasion.

Evidence will be generated using an assessment in which candidates must obtain at least 60% of the marks available in order to pass.

Assessment Guidelines

This assessment could be a supervised closed-book assessment of 45 minutes duration. It could take the form of a set of structured questions and restricted responses. The assessment of this Outcome could stand alone or be combined with that for Outcome 1 into a test of 90 minutes duration.

Outcome 3

Explain how variations in crop management influence the physiology of yield in a selected crop

Knowledge and/or Skills

- ◆ Choice of variety
- ◆ Sowing/planting date
- ◆ Plant population density
- ◆ Crop nutrition
- ◆ Crop protection

Higher National Unit specification: statement of standards (cont)

Unit title: Crop Physiology and Breeding

Evidence Requirements

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

- ◆ explain how variations in crop management influence the physiology of crop yield in a selected crop with regard to:
 - choice of variety
 - variation in sowing or planting date,
 - plant population density,
 - crop nutrition
 - crop protection

Assessment Guidelines

Evidence for this Outcome could be gathered in the form of a written assignment of approximately 1,500 words covering all the bullet points in the knowledge and skills.

Assessment of this Outcome could be combined with that for Outcome 4 to take the form of a written assignment of approximately 2,500 words.

Outcome 4

Explain the principles of plant breeding

Knowledge and/or Skills

- ◆ Crop plant origins
- ◆ Plant breeding objectives
- ◆ Plant breeding methods
- ◆ Testing and registration of new varieties

Evidence Requirements

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

- ◆ for a minimum of one named crop:
 - describe crop origins
 - explain plant breeding objectives
 - explain at least one plant breeding method
 - describe the testing and registration of new varieties

Higher National Unit specification: statement of standards (cont)

Unit title: Crop Physiology and Breeding

Assessment guidelines

This Outcome could be assessed by a supervised, closed-book test taking the form of a set of restricted response questions, covering all of the Evidence Requirements above.

Alternatively, a written assignment of approximately 1,000 words on the origins, breeding objectives, breeding method(s) and testing and registration of new varieties for a selected crop species could provide the evidence required.

The assessment of this Outcome could be combined with that for Outcome 3 to take the form of a written assignment of approximately 2,500 words.

Administrative Information

Unit code: F2AX 35

Unit title: Crop Physiology and Breeding

Superclass category: SB

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History of changes:

Version	Description of change	Date

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Higher National Unit specification: support notes

Unit title: Crop Physiology and Breeding

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

The aim of the Unit is to provide a thorough understanding of the physiological basis of crop yield production. This framework can be applied to a wide range of agricultural, horticultural, energy and industrial crops, to explain how variation in environmental and management factors affects growth and yield, and to consider practical approaches to improving crop yield and quality. The understanding developed in this Unit provides the foundation for a range of subsequent Units examining crop breeding, plant-environment interactions and agronomy at a more advanced level. The concepts of crop physiology are also important tools for candidates aiming for a career in the production of field or protected crops.

This Unit is applicable to a wide range of different crop production systems, including agricultural and horticultural field crops, grassland and forage crops, protected crops, energy and industrial crops, as well as the production of ornamentals and nursery stock.

Corresponding to Outcomes:

1 Explain the physiological basis of crop yield production

This Outcome introduces the concept of considering crop canopies on the basis of Unit ground area. The physiological basis of crop yield will be explained in terms of light interception, the conversion of light energy into the chemical potential energy of biomass and the partitioning of dry matter to harvested parts. The relationship between leaf (green) area index and light interception will be explained, and the influence of leaf angle and canopy structure explored. The importance of root systems and their interactions with crop canopies will also be examined. The yield components of selected crops will be related to phases of development and harvest index.

2 Explain how environmental factors affect the physiology of crop yield

The concepts and principles from the first Outcome are used to examine how environmental factors affect leaf canopy development and senescence, light interception, canopy photosynthesis, plant development, and the establishment of yield components and harvest index. The effects of stress factors on the physiology of crop yield will also be covered.

3 Explain how variations in crop management influence the physiology of yield in a selected crop.

The concepts and principles developed in the first two Outcomes are used to examine how variations in crop management influence crop production, yield and quality, using diverse crop types as examples. Candidates are required to select a crop, and to apply their physiological knowledge to consider the management of their chosen crop. The relevant management factors will be crop-specific, but might include the following: choice of variety; date of sowing or planting; plant population density; crop nutrition and crop protection. The effects of management practices on the quality of the harvested product will also be considered.

Higher National Unit specification: support notes (cont)

Unit title: Crop Physiology and Breeding

4 Explain the principles of plant breeding

The significance and methodologies of plant breeding for the production of food and other products such as drugs, medicines and raw materials for industry, relevant to the Group Award are examined. Candidates are introduced to the general principles of crop improvement including breeding objectives and selection. Systems and regulations for the testing and registration of new varieties are also described.

The following texts provide information relevant to the Unit:

- ◆ Biotol (1995), *'Crop Physiology'* Butterworth-Heinemann
- ◆ Hay, RKM & Walker, AJ (1989), *'Introduction to the Physiology of Crop Yield'* Longman
- ◆ Hay, RKM, Porter, JR (2005), *'The Physiology of Crop Yield'* Blackwell

Additional information and exemplar material is contained within the following texts/equivalents:

- ◆ Galletta, GJ & Himelrick, DG [Eds] (1990), *'Small fruit crop management'* Chapter 2: Factors that influence small fruit production. Prentice-Hall
- ◆ HGCA (1997), *'The Wheat Growth Guide — to improve management decisions'*
- ◆ Kalloo, G, Bergh, BO (1997), *'Genetic Improvement of Vegetable Crops'* Pergamon Press
- ◆ Kamp, AMP, PGH & Timmerman, GJ (1996), *'Computerized environmental control in greenhouses — a step by step guide'* Chapter 3: Physiology IPC-Plant, Ede, The Netherlands
- ◆ Luddington Experimental Horticulture Station (1985; 1986) Report: *'Ornamental Nursery Stock Open Day'*
- ◆ MAFF (1980) Leaflet, *'Tree trials: The effects of spacing; Feather removal'*
- ◆ Simmonds, NW, Smart, TJ (1999), *'Principles of Crop Improvement'* Blackwell Science Ltd
- ◆ Stokes, DT, Sylvester-Bradley, R, Scott, RK, Clare, R, Hopkinson, J, Milford, GFJ & Salmon, SE [Eds] (1998) HGCA Project Report 159, *'An integrated approach to nitrogen nutrition for wheat'*.
- ◆ Smith, WK & Hinckley, TM [Eds] (1995), *'Ecophysiology of Coniferous Forests'* Chapters 4, 7 and 8 Academic Press

Guidance on the delivery and assessment of this Unit

This Unit is designed to form part of the HND Group Awards in Applied Bioscience, Agricultural Science, Green Technology, Agriculture and Horticulture. Candidates should already have completed the first year of these awards. The Unit builds on issues introduced in the level 7 HN Units *'Arable Crop Production'* and *'Plant Physiology'*. It complements the SCQF level 8 Unit *'Specialised Field crops'*.

Higher National Unit specification: support notes (cont)

Unit title: Crop Physiology and Breeding

It is suggested that candidate's knowledge and understanding of Outcomes 1 and 2 are assessed by means of a test, whereas reports are more appropriate for the assessment of Outcomes 3 and 4 where a student applies the principles to a crop of their choice.

Opportunities for developing Core Skills

The report assessing Outcome 3 develops the Core Skills of Communication (Written Communication) and Problem Solving (Critical Thinking) at SCQF level 6. Aspects covered in Outcome 1 involve the interpretation of many graphs, thereby developing Numeracy (Using Graphical Information) in this Unit. There is no automatic certification of Core Skills or Core Skills components.

Open learning

Since this Unit introduces a theoretical framework which is then applied to different crops, and methods of crop improvement, this Unit is highly compatible with delivery via Distance Learning. All Outcomes could be delivered via a combination of real-time lectures delivered over the internet, material posted on a VLE platform, CD-ROMs and paper-based study resources.

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: Crop Physiology and Breeding

This is a 1 credit SCQF level 8 Unit, intended to be delivered as part of an Applied Bioscience, Agricultural Science, Agriculture, Horticulture or Green Technology HND qualification. It is designed to enable you to understand the physiological functioning of crops that determines harvested yields, how this is influenced by environmental and management factors and how plant breeding methods can be used to improve crops. The Unit is applicable to a wide range of different crop production systems, including agricultural and horticultural field crops, grassland and forage crops, protected crops, energy and industrial crops, as well as the production of ornamentals and nursery stock. It will provide you with knowledge and understanding relevant for a career in agriculture, horticulture or agricultural science, or in preparation for progression to a degree course.

On completion of the Unit you should be able to:

- 1 Explain the physiological basis of crop yield production.
- 2 Explain how environmental factors affect the physiology of crop yield.
- 3 Explain how variations in crop management influence the physiology of yield in a selected crop.
- 4 Explain the principles of plant breeding.

Corresponding to Outcomes:

- 1 Explain the physiological basis of yield production by crop canopies
You will be introduced to the concept of considering crops on the basis of Unit ground area. You will learn how crop yields are determined by canopy light capture, the efficiency with which this light energy is converted into crop of biomass and the distribution of this to the harvested parts. The importance of leaf angle, canopy structure, the interactions between roots and canopies and the importance of yield components will also be examined.
- 2 Explain how environmental factors influence the physiology of crop yield.
Having studied the functioning of crops in the first Outcome, you will now examine how environmental factors and stress factors affect crop physiology and yield.
- 3 Explain how variations in crop management influence the physiology of yield in a named crop.
The concepts and principles developed in the first two Outcomes are used to explore how variations in crop management influence crop production, yield and quality. You will apply your physiological knowledge to consider the effects of crop management on a crop of your choice. The relevant management factors will be crop-specific, but might include the following: choice of variety, date of sowing or planting, plant population density, crop nutrition and crop protection. The effects of management practices on the quality of the harvested product will also be considered.
- 4 Explain the principles of plant breeding.
The final part of the Unit considers how plant breeding methods can be used to produce new improved varieties of crops for food, energy, drugs, medicines and raw materials for industry. The systems and regulations for the testing and registration of new varieties are also described.

Outcomes 1 and 2 will be assessed by means of short answer tests. These might be taken separately or combined into one test. Outcome 3 will be assessed by means of a written assignment, perhaps combined with the assessment of Outcome 4. Alternatively Outcome 4 could be assessed by means of a short answer test.