



An Roinn Oideachais
agus Scileanna

Agricultural Science

Curriculum Specification

LEAVING CERTIFICATE
Ordinary and Higher Level

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Senior cycle

Students in senior cycle are approaching the end of their time in school and are focusing on the directions they would like to take in their future lives. Senior cycle plays a vital role in helping students to address their current needs as young adults and in preparing them for life in a changing economic and social context.

Senior cycle is founded on a commitment to educational achievement of the highest standard for all students, commensurate with their individual abilities. To support students as they shape their own future there is an emphasis on the development of knowledge and deep understanding; on students taking responsibility for their own learning; on the acquisition of key skills; and on the processes of learning. The broad curriculum, with some opportunities for specialisation, supports continuity from junior cycle and sets out to meet the needs of students, some of whom have special educational needs, but who all share a wide range of learning interests, aptitudes and talents.

Curriculum components at senior cycle promote a balance between knowledge and skills, and the kinds of learning strategies relevant to participation in, and contribution to, a changing world where the future is uncertain.

Assessment in senior cycle involves gathering, interpreting and using information about the processes and outcomes of learning. It takes different forms and is used for a variety of purposes. It is used to determine the appropriate route for students through a differentiated curriculum, to identify specific areas of difficulty or strength for a given learner, and to test and certify achievement. Assessment supports and improves learning by helping students and teachers to identify next steps in the teaching and learning process.

The experience of senior cycle

The vision of senior cycle sees the learner at the centre of the educational experience. That experience will enable students to be resourceful, to be confident, to participate actively in society, to build an interest in learning, and to develop an ability to learn throughout their lives.

This vision of the learner is underpinned by the values on which senior cycle is based and it is realised through the principles that inform the curriculum as it is experienced by students in schools. The curriculum, made up of subjects and courses, embedded key skills, clearly expressed learning outcomes, and supported by a range of approaches to assessment, is the vehicle through which the vision becomes a reality for the learner.

At a practical level, the provision of a high-quality educational experience in senior cycle is supported by

- ▶ effective curriculum planning, development, organisation and evaluation
- ▶ teaching and learning approaches that motivate and interest students, that enable them to progress, that deepen and apply their learning, and that develop their capacity to reflect on their learning
- ▶ professional development for teachers and school management that enables them to lead curriculum development and change in their schools
- ▶ a school culture that respects students, that encourages them to take responsibility for their own learning over time, and that promotes a love of learning.

Senior cycle education is situated in the context of a broader education policy that focuses on the contribution that education can make to the development of the learner as a person and as a citizen. It is an education policy that emphasises the promotion of social cohesion, the growth of society and the economy, and the principle of sustainability in all aspects of development.

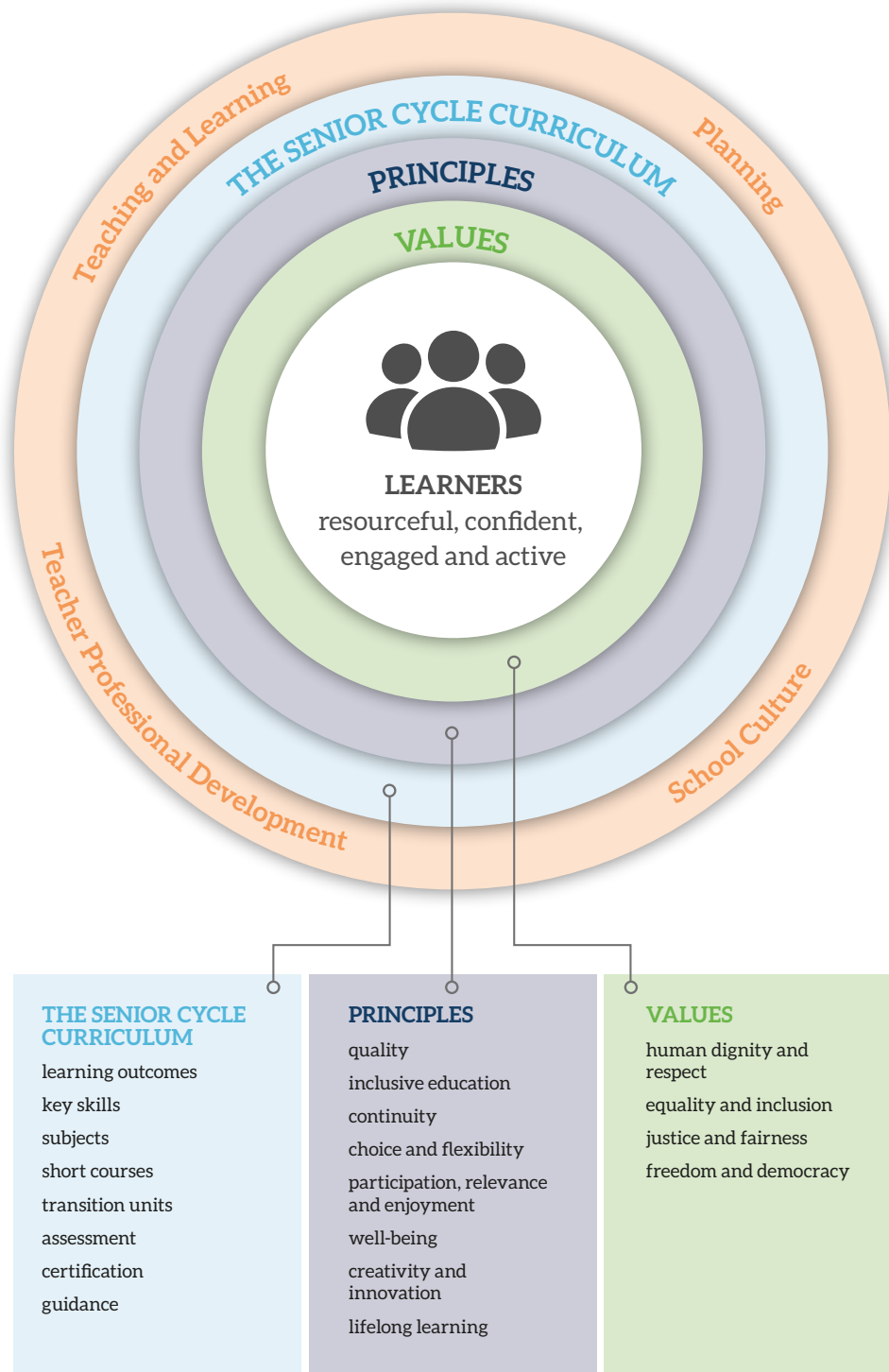


Figure 1: Overview of senior cycle

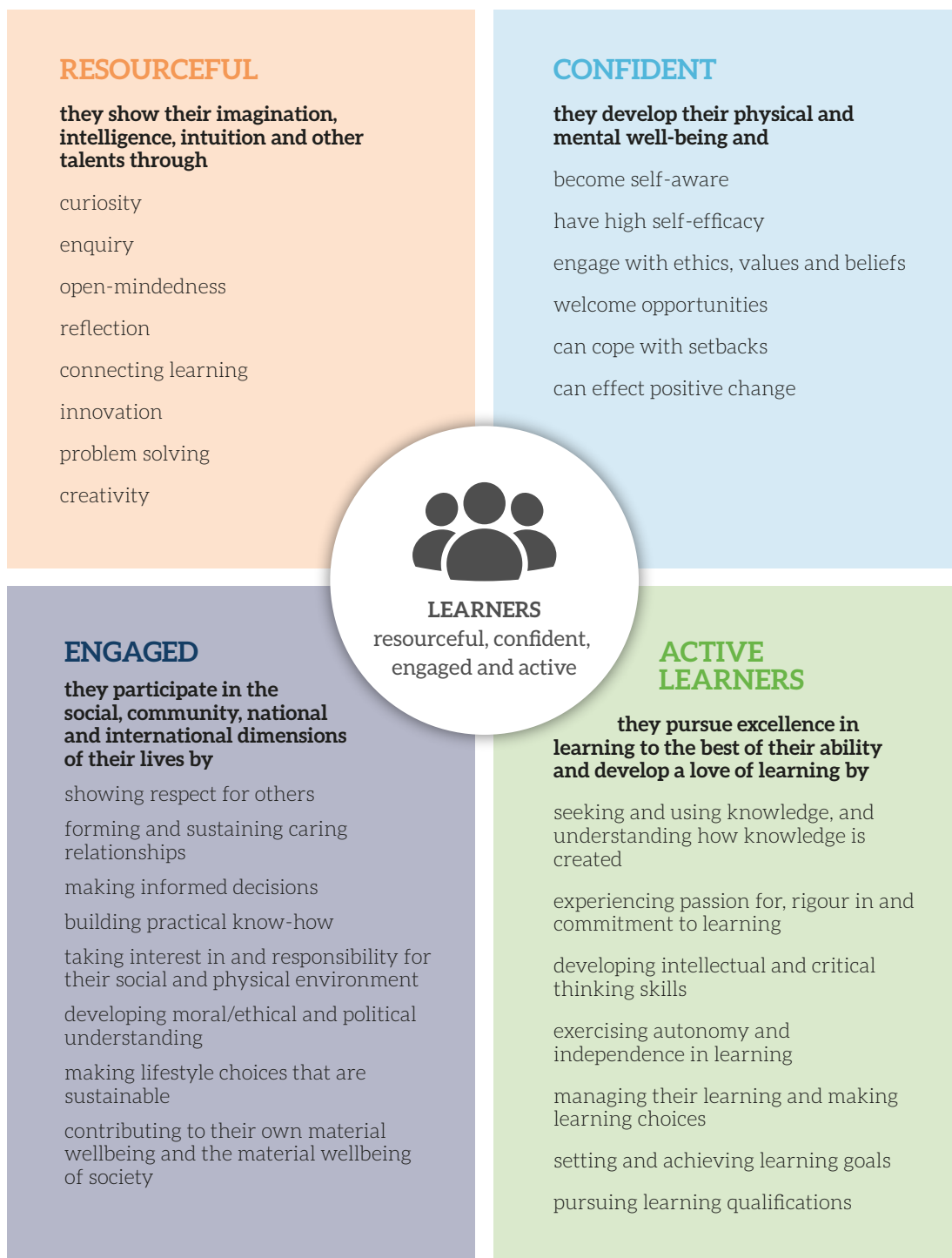


Figure 2: The vision of the learner

2

Leaving Certificate Agricultural Science

Introduction

Science education provides a means by which students can interact with the world around them and understand how scientific concepts can be used to interpret the natural and physical world. As students' scientific literacy grows, they are able to make sense of the various ways in which scientific knowledge is communicated. Scientific knowledge is constructed by the sharing of ideas and by developing, refining, and rejecting or accepting these ideas. Through engagement with science, students will acquire the knowledge, skills, attitudes and values that will allow them to take informed positions on scientific issues. As well as developing a knowledge of science, they will also develop a knowledge about the nature of science, including its moral and ethical dimensions.

Rationale

Leaving Certificate Agricultural Science is the study of the science and technology underlying the principles and practices of modern agriculture. It is a scientific approach to the knowledge and understanding, skills and attitudes that affect the long-term sustainability of natural resources—the land, plants, and animals—and places particular emphasis on the sustainable use of these resources for the economic and social benefit of humankind.

Through agricultural science, an understanding of human use of the Earth's natural resources and environment for the production of food and non-food materials is developed. The science and technology employed is identified and explored, and an awareness of the need to enhance environmental quality through greater scientific understanding of agricultural principles and practices is promoted. The role and importance of strategies and policies for the continued sustainable development and growth of the agri-food industry are recognised, whilst understanding the importance of biodiversity, animal welfare and care of the environment.

Agricultural science can make a significant contribution to the scientific, aesthetic and moral education of young people through its focus on knowledge, processes, methods and context, and through its investigative laboratory and field-based activities, independent and guided research and study, projects and assignments. The scientific concepts in Leaving Certificate Agricultural Science arise from the basic investigative nature of the subject and an integrated approach to teaching it. Scientific principles are applied to testing stated hypotheses, which in turn leads to the solving of identified problems arising from the learner's own observations and perceptions of agricultural situations.

Through a study of agricultural science, students develop many practical skills when handling, observing and investigating plants and animals and through the range of other practical activities encountered. Similarly, they learn skills of analysis and interpretation of data, hypothesis formulation, and the designing and planning of investigations. Through individual or group investigations students are given the opportunity for scientific research. In undertaking collaborative group work, they gain experience of communicating, interacting and working with others. Therefore, the progressive development of scientific inquiry, problem-solving, curiosity and self-confidence in the learner will be facilitated through guided discovery, laboratory and field work, experimental investigations, and field-based assignments.

The study of agricultural science involves personal involvement of the student with the scientific world by acknowledging the daily application of science to the life and work of those engaged in the agricultural and food sectors. Students are involved in making value judgements when they apply scientific knowledge to modern agri-food practices, to crop and animal husbandry, and to the care of their natural environment. Students gain a key understanding of the central contribution of the agri-food industry to the national economy and the importance of agri-food policies to the sustainable development of rural communities. Opportunities are also provided for the integration of knowledge and skills through the interplay of scientifically-supported theory and practice.

Opportunities for the development of motivation and interest continually arise through the need to exercise concern and care for living things, either in the school laboratory or garden, or through observations or the collection of data in the local environment. This concern with care enables students to develop a positive and healthy attitude, which helps them in their future working lives and leisure-time activities. Much of the subject is self-evidently meaningful, and it is one of the areas of the school curriculum where students are enabled and encouraged to show a creative and caring concern for the responsibilities placed in their charge, to make judgements based on evidence, and to appreciate the culture of enterprise. It enables the students to develop an increased environmental awareness and a sense of scientific and social responsibility. Consequently, it produces a firm framework for the learner in their future life.

Aims

Leaving Certificate Agricultural Science aims to enable students to:

- ▶ appreciate the natural environment and human interactions with it and the sustainable use of its resources, recognising the need for a rational and balanced approach to the exploitation of these resources in a local and global context
- ▶ recognise the need for, and global importance of, relevant strategies and policies to promote the agri-food industry while insulating it from future challenges (e.g. climate change, novel crop and animal diseases) and identify opportunities for innovation and entrepreneurship in the context of local, regional and world markets
- ▶ develop their scientific knowledge and skills, in the context of agricultural practices, and increase their awareness of health and safety issues associated with these practices.

Objectives

Students should:

- ▶ develop an ecological awareness in the context of the provision of food and non-food materials
- ▶ recognise the impact of various agricultural practices on the environment and appreciate how the application of science and technology affects the individual, the community and the environment
- ▶ become aware of the contribution of agriculture to the economy of the locality and the nation and its importance in EU and world contexts
- ▶ make informed evaluations of contemporary agricultural science issues locally and globally
- ▶ understand that the study and practice of science are primarily co-operative activities which are subject to social, economic, technological, ethical and cultural influences, and legislative and economic considerations
- ▶ develop independent thinking, problem-solving and self-directed learning skills through active engagement in their own learning and through project work

understand the need for safety in conducting laboratory and field investigations.

Related learning

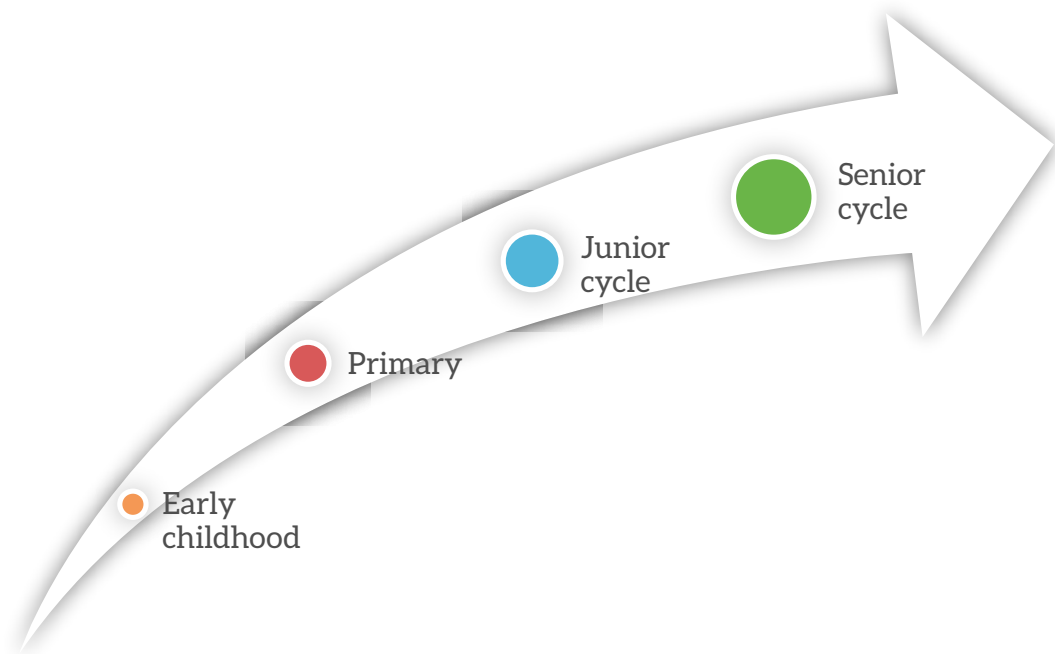


Figure 3: Related learning

EARLY CHILDHOOD

Learning from experiences as they unfold, children make sense of the things, places and people in their world by interacting with others, playing, investigating, questioning, and forming, testing and refining ideas. This lays a healthy foundation for working scientifically in primary school.

PRIMARY

Children's inventive and creative capacities are nurtured as they construct, modify and develop a broad range of scientific concepts and skills through practical investigation, designing and making activities, and problem-solving tasks. Children develop a personal sense of responsibility for the environment and an appreciation of all living things and the Earth in which they live.

JUNIOR CYCLE

Students further develop their ability to explain phenomena scientifically, their understanding of scientific inquiry and their ability to interpret and analyse scientific evidence and data to draw justified conclusions. As part of this process students develop as thoughtful and active citizens who appreciate the values of science. There is a particular focus on the concepts of sustainability and energy. This supports students to make informed decisions about many local, national and global challenges and opportunities they encounter. Students also develop their scientific literacy and their capacity to engage in discussion about the cultural and ethical aspects of science.

SENIOR CYCLE

For students taking Leaving Certificate Agricultural Science, knowledge of junior cycle science is assumed. Students build on the scientific literacy and the scientific concepts, processes and practices developed at junior cycle as they progress through the two years of study of Leaving Certificate Agricultural Science. They develop a deeper understanding of scientific concepts and processes, with particular reference to their application in an agricultural context. Students develop their ability to make informed decisions about many of the local, national and global challenges and opportunities they will encounter in a world which is increasingly shaped by science and its applications. Many senior cycle subjects have close links with agricultural science: the knowledge and understanding gained in agricultural science can be used in conjunction with that developed in these other subjects to enrich overall learning.

FURTHER STUDY AND CAREERS

The Leaving Certificate Agricultural Science specification is designed to prepare students for immediate entry into society and the world of work, or to further education and training, through a well-designed study of knowledge-based, experimental, investigative and practical agricultural science activities. The study of agricultural science can lead to many exciting and rewarding careers across the agriculture and food sectors, which offer a vast array of opportunities for those with vision, leadership and entrepreneurial skills.

COMMUNITY AND SOCIETY

Students develop an appreciation of the social and cultural perspectives of involvement in agriculture and food production, together with an appreciation of the impact of science and technology on people, nature and the environment. A thriving agri-food industry can contribute significantly to developing and sustaining rural communities. World market trends and agri-food policies at local and European level also have an impact on rural communities.

EDUCATION FOR SUSTAINABLE DEVELOPMENT

The *National Strategy on Education for Sustainable Development 2014 -2020* highlights the need to integrate education for sustainable development (ESD) in the curriculum from pre-school up to senior cycle. The national strategy aims to ensure that education contributes to sustainable development by equipping students with the relevant knowledge (the 'what'), the key dispositions and skills (the 'how') and the values (the 'why') that will motivate and empower them throughout their lives to become informed active citizens who take action for a more sustainable future.

This Leaving Certificate Agricultural Science specification supports education for sustainable development by integrating the key skills of senior cycle throughout the strands. *Sustainability* is one of the cross-cutting themes in the four strands of the specification: Scientific practices, Soils, Crops, and Animals. By linking and integrating the learning across the four strands, the interdependence of the scientific, economic and social dimensions of agricultural science is reinforced. By considering the impact of human activity and the importance of responsible management in relation to soils (Section 2.3), crops (Section 3.3) and animals (Section 4.3), students develop awareness of the need for sustainable development and use of natural resources at local, national and global levels.

3

Overview of the specification

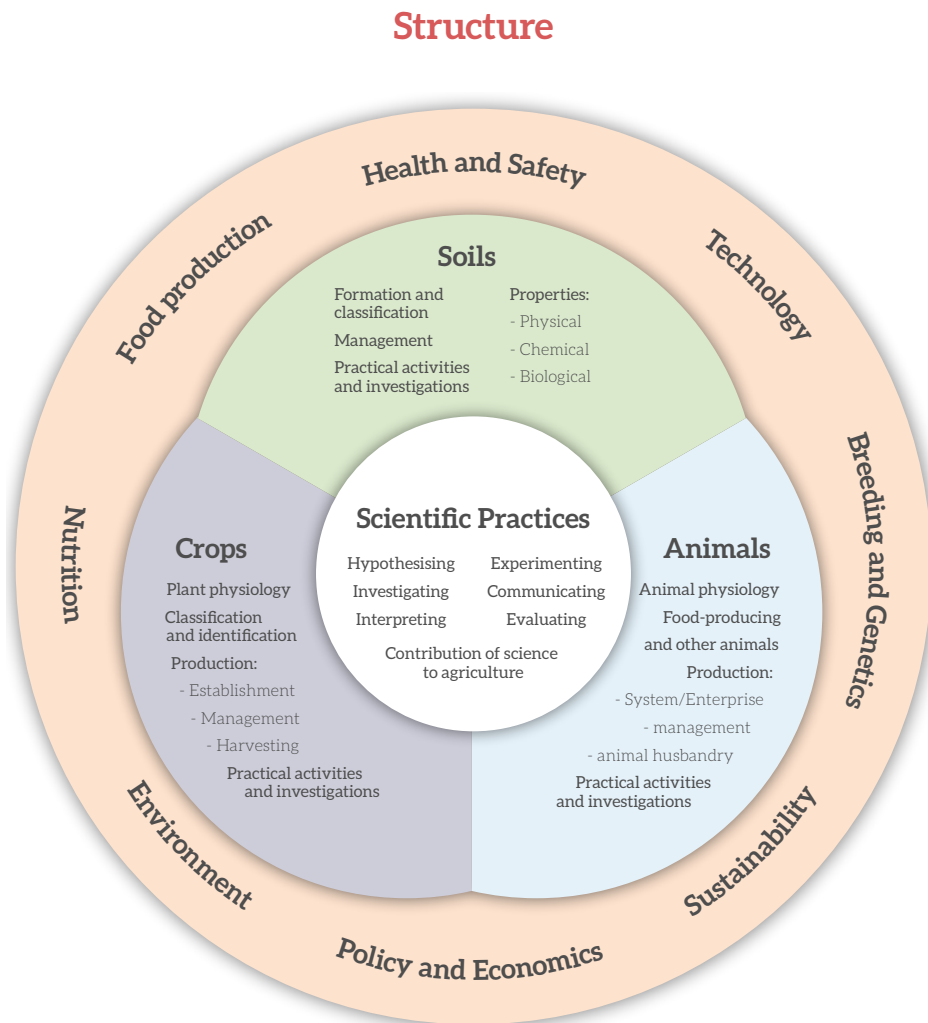


Figure 4: Structure of the specification

Strands of study

The specification for Leaving Certificate Agricultural Science is set out in four strands of study and eight cross-cutting themes that permeate these strands (see Figure 4). The first strand, Scientific practices, is an overarching strand which underpins and finds expression in the context of each of the other strands. It provides a strong focus on how science works; on scientific investigation: hypothesising, experimenting, evaluating, interpreting, communicating; and on the role and contribution of science to agriculture. It also emphasises the importance of health and safety. The cross-cutting themes, which are illustrated as surrounding the strands, permeate and provide appropriate contexts for the study of the four strands.

Each of the four strands is presented in the form of learning outcomes: these are statements of what the learner should be able to do having completed the strand of study. The sequence in which the strands and learning outcomes are presented does not imply any particular order of teaching and/or learning, although it should follow a logical and coherent approach. Appropriate links should be made between the strands, incorporating the cross-cutting themes and scientific practices where relevant. Such linkages and integration will assist students in realising the holistic dimension and interdependence of the scientific, economic and social aspects of agricultural science. The selection of subject matter and teaching strategies should at all times reflect the aims and objectives of the specification and should strive towards the development of knowledge and understanding, practical skills, and the promotion of the range of attitudinal skills outlined.

The student investigative study also provides an integrating aspect to the learner's engagement with the strands and cross-cutting themes. Through this investigative study, students develop a deeper understanding of the science underpinning agricultural practice in an integrated way, while also developing and refining their practical science skills.

Time allocation

The Leaving Certificate Agricultural Science specification is designed for a minimum of 180 hours of class contact time. It is recommended that some class periods should be timetabled consecutively, at least once per week, to facilitate meaningful learner engagement in practical activities. Students will also devote time individually to an investigative study of a topic which is based on a thematic brief specified for each examination cohort by the State Examinations Commission. This is undertaken over the full two years of the course and must be submitted for assessment by the State Examinations Commission as part of the Leaving Certificate examination.

Literacy and numeracy

Literacy and numeracy skills are embedded in the learning outcomes across each of the four strands in agricultural science. The students' oral literacy skills are supported through the emphasis on discussion, debate and communication throughout the learning. They develop their reading, comprehension and writing skills when they research, examine, record, compare and critique different agricultural practices, contexts and information. Their digital and media literacy skills are developed as they use information and communications technology (ICT) for research and presentation purposes. Agricultural science also helps students develop literacy as they gain the vocabulary and expressive skills to articulate informed views on events and issues affecting the agriculture and food sectors at local, national and global levels.

Agricultural science facilitates students in using mathematical understanding and skills to help analyse complex issues and factors related to agricultural development and production, including the interpretation of data and the economics of different production systems. Over the course of their studies, students engage with both qualitative and quantitative data. They develop numeracy skills as they access and interpret research data, examine evidence and reach conclusions. Students also use mathematical reasoning as they examine the patterns and trends in, and the impact of scientific and technological developments on, crop and animal production.

Key skills

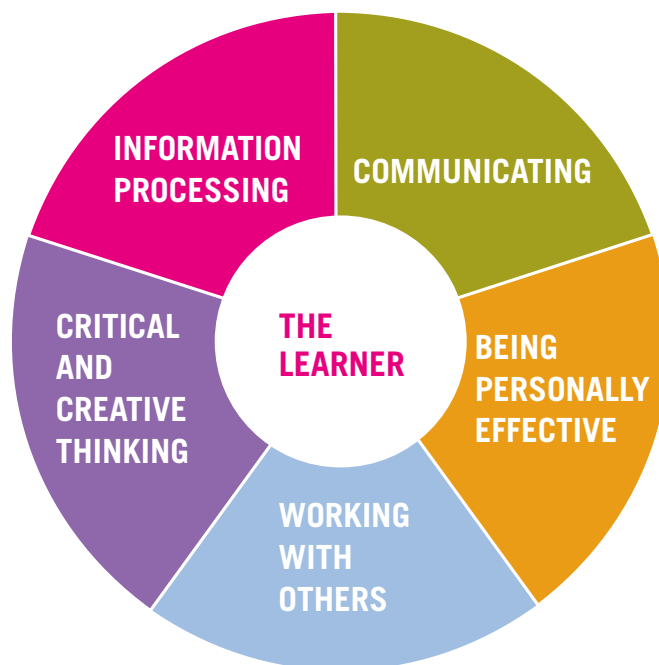


Figure 5: Key skills of senior cycle

There are five skills identified as central to teaching and learning across the curriculum at senior cycle: *information processing*; *being personally effective*; *communicating*; *critical and creative thinking*; and *working with others*. It is important for all students to develop these key skills in order to achieve their full potential, both during their time in school and into the future. This will allow them to participate fully in society, including family life, the world of work and lifelong learning. The specification is designed to help students develop skills as they build on their knowledge and understanding of agricultural science and form positive attitudes to learning. The key skills are embedded within the learning outcomes of the specification and will be assessed in the context of the assessment of the learning outcomes.

Students will develop their key skills as they engage with the fundamental principles and concepts of agricultural science through participation in a wide range of activities. They will build on their scientific knowledge constructed initially through their investigations in science in the primary school curriculum and in junior cycle science. They will develop critical and creative thinking skills by examining relationships, developing and testing hypotheses, designing experimental tests to prove or disprove assumptions, exploring options, solving problems, and applying those solutions to new contexts. They will develop skills in working with others and communicating as they collaborate on investigations and present their findings. In solving relevant problems, students will develop their information processing skills by using careful observation, managing data, thoughtful analysis and clarity of expression to evaluate evidence, and make a clear presentation of their proposed solution. They will learn to research up-to-date and balanced information that they can use to develop a critical approach to accepted scientific theories and, in so doing, come to understand the limitations of science. Students will develop the skill of being personally effective as they develop strategies for managing, monitoring and evaluating their learning.



4

Teaching and learning

Senior cycle students are encouraged to develop the knowledge, skills, attitudes and values that will enable them to become independent students and to develop a lifelong commitment to improving their learning.

Leaving Certificate Agricultural Science supports the use of a wide range of teaching and learning approaches, emphasises practical experience of science for each learner. The importance of the processes of science as well as knowledge and understanding is reflected throughout the learning outcomes. As students progress they develop learning strategies that are transferable across different tasks and different disciplines, enabling them to make connections between agricultural science, other subjects, and their everyday experiences. Through engaging in self-directed activities and reflection, students assume responsibility for planning, monitoring, and evaluating their own learning and, in so doing, develop a positive sense of their own capacity to learn. By engaging in group work students develop skills in reasoned argument, listening to each other, informing one another about what they are doing, and reflecting on their own work and that of others.

Students integrate their knowledge and understanding of agricultural science with its ethical, social, economic and environmental implications and applications. Increasingly, arguments between scientists extend into the public domain. By critically evaluating scientific texts and debating public statements about science, students engage with contemporary issues in agricultural science that affect their everyday lives. They learn to interrogate and interpret data—a skill which has a value far beyond agricultural science, useful wherever data are used as evidence to support argument. By examining and debating reports about contemporary issues in science students develop an appreciation of the social context of science. They develop skills in scientific communication by collaborating to generate reports and present them to their peers.

The variety of activities that students engage in will enable them to take charge of their own learning by setting goals, developing action plans, and receiving and responding to assessment feedback. Students vary in the amount and type of support they need to be successful. Levels of demand in any learning activity will differ as students bring different ideas and levels of understanding to it. The use of strategies for differentiated learning such as adjusting the level of skills required, varying the amount and the nature of teacher intervention, and varying the pace and sequence of learning will allow students to interact at their own level.

Use of technology should be included to enhance student learning, for example by enabling students to work more efficiently or to complete work that otherwise could not be done. The portability of laboratory sensor systems makes them useful for work outside as well as inside the classroom, and ICT should be used to collect, record, analyse and display data and information. The increasing use of technology in agriculture and modern farming practice should be reflected in the study of agricultural science.

Coursework

Scientific methods, research, interpretation of data and use of evidence and argument in evaluating information are central to both the practical work and the theoretical concepts in the Leaving Certificate Agricultural Science specification. Access to laboratory facilities is required so that students can conduct practical investigations. Engagement in practical activities enables the learner to develop their skills in independent thinking and self-directed learning.

Practical laboratory and field investigative and experimental activities provide opportunities for the promotion of scientific methodology. Students will learn to ask questions about and seek to find evidence as answers to their observations. The process will involve them in formulating and testing hypotheses. Students will appreciate the need for investigative and experimental controls and other measures intended to minimise errors.

All investigations and experimental activities must be conducted in a manner that promotes safe working conditions. Students, either individually or working in small groups, are expected to engage in the investigative or experimental activities prescribed in the specification.

SPECIFIED PRACTICAL ACTIVITIES

Over the two years of the course, each learner is required to complete and prepare reports on the specified practical activities which are included as learning outcomes in the specification (these are marked with an *). The reports will not be externally assessed, but must be available for inspection and retained until the end of the assessment process.

There is no particular method prescribed for these activities, which may be planned and carried out in small groups but must be reported on individually. These reports can be completed using any suitable media. The skills and understanding developed in these activities will prepare students for the individual investigative study.

Teachers are encouraged to extend and enrich the learning experience of the learner by further involving them in teacher-led demonstrations, field and/or industrial visits and other activities appropriate to the specification.

INDIVIDUAL INVESTIGATIVE STUDY (IIS)

As well as the specified practical activities, each student is required to carry out an individual investigative study related to a topic in agricultural science, including any research that might be appropriate. The individual study is an investigative activity which is based on and draws from a thematic brief set annually by the State Examinations Commission at the commencement of the two-year course. It is conducted over the two years of the course and facilitates study of particular areas in greater depth and which may be of local or regional agricultural significance. It enables students to see at a practical level how science underpins and supports agricultural practices, processes and research.

Assessment to support learning

As well as varied teaching strategies, varied assessment strategies will support learning and provide information that can be used as feedback so that teaching and learning activities can be modified in ways that best suit individual students. By setting appropriate and engaging tasks, asking higher-order questions and giving feedback that promotes learner autonomy, assessment supports learning as well as summarising achievement.

Through the monitoring of their work during the course, ongoing support can be given to students to ensure that progress is made in achieving the learning outcomes and in completing the specified activities and other practical work.

Strand 1: Scientific practices

In addition to the ability to understand and rigorously apply the concepts, laws and theories of science, students will understand the purposes and principles underpinning the practice of science. Through studying Leaving Certificate Agricultural Science, students will gain an understanding of the ideas which underpin the collection, analysis and interpretation of data so that they can handle scientific evidence accurately and effectively. In justifying their conclusions, they will consider the validity and reliability of their data and appreciate the limitations of scientific evidence. As they present their work they will develop skills in scientific communication and argumentation. While the scientific practices outlined in this strand permeate the other strands, thus facilitating and promoting an integrated approach to teaching and learning, they are also associated with particular learning outcomes.

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
1.1 Hypothesising	<ul style="list-style-type: none"> ▶ use observations as the basis for formulating a hypothesis ▶ apply their knowledge and understanding of Agricultural Science to develop arguments or draw conclusions related to both familiar and unfamiliar situations ▶ compile and interpret data or other information gathered from print, laboratory, and electronic sources (including websites), to research a topic or solve a problem ▶ make a prediction based on the hypothesis
1.2 Experimenting	<ul style="list-style-type: none"> ▶ design, manage and conduct practical investigations ▶ identify variables and select appropriate controls ▶ collect, organise, interpret, present and analyse primary and secondary data with and without the use of technology ▶ describe relationships (qualitatively and/or quantitatively) between sets of data, recognising the difference between causation and correlation ▶ distinguish between statistical and systematic uncertainty and identify appropriate methods to reduce these ▶ recognise uncertainty as a limitation of the process of measurement ▶ appreciate the difference between accuracy and precision ▶ conduct an open-ended investigation

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
1.3 Evaluating evidence	<ul style="list-style-type: none"> ▶ critically examine the scientific process that was used to present a scientific claim ▶ appreciate the limitations of scientific evidence ▶ make judgements and draw informed conclusions arising from the result of the investigation—their own and those of others—and consider the reliability and validity of data ▶ make predictions on the behaviours of systems based upon interpretation of numeric, graphic and symbolic representations ▶ evaluate ethical issues related to agricultural practices
1.4 Communicating	<ul style="list-style-type: none"> ▶ communicate the procedures and results of investigations by displaying evidence and information in various forms, including flow charts, tables, graphs, and laboratory reports ▶ discuss, debate, reflect on and critically evaluate the outcomes of investigations, their own and those of others ▶ read and evaluate scientific information related to agriculture, drawing on a variety of sources: media, websites, agri-food events and other agricultural resources—including people involved in the agri-food industry
1.5 Working safely	<ul style="list-style-type: none"> ▶ identify health and safety hazards associated with agricultural practices and discuss controls and precautions necessary to prevent accidents, injury and ill health ▶ discuss the health and safety considerations of using agricultural machinery and equipment ▶ recognise the need for safe work practices in all agricultural activities

Strand 2: Soils

Soil is a natural resource and a medium for the growth of plants, as well as a habitat in its own right. The study of Leaving Certificate Agricultural Science enables students to develop an understanding of the role and function of soil and to appreciate its importance in providing for the growth of grass and other crops. The management of soil must also take into account the ecosystem services provided by soils, e.g. the provisioning of food, fibre and fuel, its significance as a natural biological filter to protect water quality, its role in regulating the hydrologic cycle, its potential to sequester carbon from the atmosphere and regulate climate, its role as a store for cultural artefacts and archaeology, and its role in supporting biodiversity.

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
2.1 Formation and classification	<ul style="list-style-type: none"> ▶ describe the factors involved in soil formation ▶ describe the different soil types/groups and soil profiles and their distribution in Ireland ▶ compare soils with respect to their varied properties and land use potentials
2.2 Properties 2.2.1 Chemical	<ul style="list-style-type: none"> ▶ examine the chemical features of soil including plant-available nutrients, pH and liming, cation exchange, and flocculation ▶ conduct an investigation into the chemical properties of soil to <ul style="list-style-type: none"> • demonstrate cation exchange capacity (CEC) * • show flocculation * • determine the pH *
2.2.2 Physical	<ul style="list-style-type: none"> ▶ examine the physical features of soil, including structure, particle size, texture, drainage, temperature, and the impact of compaction, organic matter loss, erosion, sedimentation and weathering ▶ determine and compare the total pore space in a compacted soil and an uncompacted soil ▶ investigate the texture of soil by <ul style="list-style-type: none"> • sedimentation * • using a soil sieve * • hand testing * ▶ compare the capillarity and infiltration rate of a compacted soil and an uncompacted soil * ▶ calculate the percentage water content of a soil sample *

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
<p>2.2.3 Biological</p>	<ul style="list-style-type: none"> ▶ examine the biological features of soils including microbiome, earthworm activity, organic matter, the nitrogen cycle and the carbon cycle ▶ isolate and grow bacteria from clover root nodules * ▶ appreciate the importance of the rhizosphere and the relationship between soil fungi and roots and the impact of that relationship on productivity ▶ determine the percentage organic matter in a soil sample and convert that to organic carbon * ▶ relate organic matter content to soil structure and other physical and chemical properties in soils of differing management (for example, conventional continuous tillage vs. permanent grassland) ▶ show the activity of earthworms in a soil and estimate the number of earthworms in a pasture *
<p>2.3 Management</p>	<ul style="list-style-type: none"> ▶ discuss the importance of good soil management in terms of drainage, soil health and fertility, soil sampling, testing and analysis of results, fertiliser or slurry/manure application, sustainable land use and management, impact of animals on the chemical, physical and biological properties of soil, soil compaction, pollution and conservation, maintenance of soil organic matter and soil carbon sequestration, and impact on water quality, air quality and greenhouse gas emissions ▶ identify health and safety hazards associated with soil management and discuss controls and precautions necessary to prevent accidents, injury and ill health ▶ appreciate the need for safe work practices, including the safe handling, use and storage of chemicals, slurry/farmyard manure and machinery

Strand 3: Crops

In their study of Leaving Certificate Agricultural Science, students develop an understanding of the role and importance of a variety of crops, including crops as forage and crops for human consumption, their management and production, and their contribution to future sustainable development. In Ireland, our location and climate are conducive to a predominantly grass-based system for beef and dairy production. National sustainability programmes unite stakeholders in promoting and supporting efficient and sustainable production into the future.

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
3.1 Plant physiology	<ul style="list-style-type: none"> ▶ relate the main structures of the plant to its fundamental processes: photosynthesis, respiration, transpiration and nutrient absorption ▶ describe the principles of genetic improvement and selection: <ul style="list-style-type: none"> • performance testing • physical traits • progeny testing • genotyping and genomic selection • natural selection ▶ understand the principles of genetic engineering, identifying genes in characterised crop genomes and understanding how they produce proteins to tackle specific crop diseases
3.2 Classification/ identification	<ul style="list-style-type: none"> ▶ apply their knowledge of structure and function to identify a variety of grasses, cultivated crops and weeds ▶ distinguish between annual, biennial and perennial lifecycles ▶ explain the importance of plant breeding and seed variety
3.3 Production	<ul style="list-style-type: none"> ▶ describe the growth cycle of grass and of another food crop (forage or for human consumption) and of an energy or catch crop ▶ discuss strategies for crop protection against diseases (fungal, bacterial or viral)
3.3.1 Establishment	<ul style="list-style-type: none"> ▶ discuss the effect of soil quality, seedbed preparation, seed selection and sowing on the productivity of a crop ▶ understand how a variety of soil factors influence productivity ▶ investigate the effect of weather and soil conditions on the percentage germination of an agricultural seed * ▶ compare plant uniformity from certified and uncertified seed* ▶ compare establishment for grass with that of one other crop *

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
<p>3.3.2 Management</p>	<ul style="list-style-type: none"> ▶ evaluate the impact of different crop management practices on food-producing and other animals ▶ identify farm health and safety hazards associated with the management of crops, and discuss the controls and precautions necessary to prevent accidents, injury and ill health on the farm ▶ compare conventional and organic food production ▶ investigate the botanical composition of an old permanent pasture or a new ley* ▶ recognise the purpose of crop rotation and the benefits of, and alternatives to, crop rotation as a means of indirect disease control ▶ appreciate the role of innovation and biotechnological applications in crop development and management ▶ discuss the various factors involved in crop management, including application of nutrients to match crop requirements ▶ investigate the effect of nutrients on the growth of a sample of different plants and measure the biomass of these plants above and below ground * ▶ measure the dry matter (DM) content of a named crop * ▶ evaluate the ethical and economic considerations and arguments arising from biotechnological applications as applied to crop management, for example the genetic enhancement of crop varieties against pests and diseases using traditional biotechnology and more recent technologies such as genome editing ▶ investigate the complexity associated with the genetic inheritance of traits by hybridising two varieties to determine the rate of transfer of the required trait (e.g. petal colour) to the next progeny* ▶ discuss the implications of sustainable development for crop production ▶ appreciate the need for compliance in relation to notifiable diseases ▶ evaluate the use of chemicals for controlling disease in crops
<p>3.3.3 Harvesting</p>	<ul style="list-style-type: none"> ▶ discuss harvesting techniques and storage methods for grass and another food crop (forage or for human consumption) and an energy or catch crop ▶ investigate two factors which affect crop preservation ▶ recognise the need for safe work practices, including the safe handling, harvesting and storage of crops

Strand 4: Animals

In Leaving Certificate Agricultural Science, the study of animals includes traditional farm animals such as cattle, sheep and pigs, but also allows for the inclusion of other animals of agricultural importance and interest, for example horses and poultry.

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
4.1 Animal physiology	<ul style="list-style-type: none">▶ compare the ruminant and monogastric digestive systems, including the role of microorganisms▶ describe the mammalian reproductive cycle and methods of fertilisation of any two farm animals▶ explain the importance of genetics in food-producing and other animals▶ describe the principles of genetic improvement and selection:<ul style="list-style-type: none">• performance testing• physical traits• progeny testing• genotyping and genomic selection• natural selection• genetic engineering
4.2 Classification/ identification	<ul style="list-style-type: none">▶ describe the characteristics of common types, breeds and crosses of cattle, sheep, and one of the following farm animals: pigs, poultry, horses

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
<p>4.3 Production</p>	<ul style="list-style-type: none"> ▶ discuss the importance of nutrition and ration formulation to meet the protein, energy and performance requirements at different growth/development stages of cattle, sheep, and one of the following farm animals: pigs, poultry, horses ▶ describe the nutritive properties of food constituents and their function in growth and development ▶ compare two different systems of animal production for a chosen enterprise ▶ discuss the attributes of Irish food based on grass-fed animals ▶ investigate the factors that determine the output and quality of produce from a chosen enterprise (breed variety, nutrition, housing, management) ▶ use secondary data to determine the daily live-weight gain (DLG) and the feed conversion rate (FCR) of a selected animal ▶ Interpret secondary data relating to (DLG) and (FCR) ▶ investigate the quality of a sample of milk over time * ▶ using secondary data, compare the percentage of water and solids in two different milk samples (a.m./p.m.) ▶ recognise the role and importance of innovation and biotechnological applications in animal science ▶ appreciate the challenges of sustainable intensification ▶ discuss the environmental implications of animal production ▶ identify the potential hazards (physical, biological, health) associated with working with farm animals, and safe work practices/controls
<p>4.3.1 System/enterprise</p>	<ul style="list-style-type: none"> ▶ describe the scientific principles underlying the management of the lifecycle of a selected farm animal, including the dietary requirements at different growth/development stages ▶ recognise the importance of market trends and requirements, including value-added/niche markets/artisan produce/export markets ▶ use secondary data to discuss the impact of milk quality on milk price ▶ appreciate the impact on farm economics of different animal production systems

STUDENTS LEARN ABOUT:	STUDENTS SHOULD BE ABLE TO:
4.3.2 Management	<ul style="list-style-type: none"> ▶ discuss management practices for <ul style="list-style-type: none"> • handling and housing farm animals • optimal animal health and welfare • slurry/farmyard manure • delivering sustainable and environmentally friendly production systems • ensuring quality, safe and traceable food for the consumer ▶ appreciate the role of policies related to traceability and animal welfare, and their connection with the food-supply chain
4.3.3 Animal husbandry and health	<ul style="list-style-type: none"> ▶ discuss the factors to be taken into account when considering the welfare of farm animals ▶ describe a farm that they have studied in terms of: * <ul style="list-style-type: none"> • farmyard layout (sketch) in which they identify and discuss potential hazards on the farm and how they may be managed • best layout practice, encompassing economic, health and safety, social, and environmental sustainability aspects ▶ recognise the potential hazards to humans of animal diseases ▶ identify the main diseases that can affect ruminant and monogastric farm animals, and discuss their transmission and control ▶ appreciate the need for compliance in relation to notifiable diseases

5

Assessment

Assessment of Leaving Certificate Agricultural Science for certification is based on the aims, objectives and learning outcomes of this specification. Differentiation at the point of assessment is achieved through examinations at two levels – Ordinary level and Higher level.

Differentiation

The Leaving Certificate Agricultural Science specification is differentiated in three ways: through the learning outcomes of the specification, in the process of teaching and learning, and through assessment. Coursework is assessed at a common level.

ORDINARY LEVEL

The learning outcomes that are presented in normal type apply at Ordinary level. Students engage with a broad range of knowledge, mainly factual in nature, but with some elements of abstraction or theory. Students at Ordinary level will be expected to demonstrate and use a moderate range of practical and cognitive skills and tools, select from a range of procedures, and apply known solutions to problems in both familiar and unfamiliar contexts.

HIGHER LEVEL

All learning outcomes, **including those in bold type**, apply at Higher level. Students engage with a broad range of knowledge including theoretical concepts and abstract thinking with significant depth in some areas. Students at Higher level will be expected to demonstrate and use a broad range of specialised skills and tools to evaluate and use information, to plan and develop investigative strategies, and to determine solutions to varied, unfamiliar problems, and to identify and apply skills and knowledge in a wide variety of both familiar and unfamiliar contexts.

Assessment components

There are two assessment components at each level:

ASSESSMENT COMPONENT	PERCENTAGE
Written <ul style="list-style-type: none">▶ short answer questions▶ structured questions▶ synoptic questions	75
Coursework <ul style="list-style-type: none">▶ Individual investigative study	25

Both components of assessment reflect the relationship between practical activities and the theoretical content of the specification.

Written assessment

The written component of assessment is an examination paper of two and a half hours duration taken at the end of the two-year course. There will be separate Ordinary level and Higher level examination papers. At each level, the examination paper will assess students' knowledge, understanding and skills in relation to the learning outcomes in the specification. At Higher level, all of the learning outcomes will be subject to assessment, including those presented in **bold type**. At Ordinary level, only those learning outcomes that are presented in normal type will be subject to assessment. Examination questions will require candidates to demonstrate knowledge, understanding, application, analysis and evaluation appropriate to each level.

The written examination paper will assess:

- ▶ knowledge and recall of facts related to the principles and practices of agricultural science
- ▶ application of knowledge and understanding from different areas of the specification to familiar and unfamiliar situations
- ▶ scientific inquiry, formulation of hypotheses and design and evaluation of investigations
- ▶ critical thinking, the ability to analyse and evaluate information and to form reasonable and logical argument, based on evidence
- ▶ problem solving based on integration, analysis and evaluation of qualitative and quantitative information and data
- ▶ understanding of the ethical, historical, environmental and technological aspects of agricultural science, and how it contributes to the social and economic development of society.

The written examination paper will have a combination of question types, in which there will be some choice. The question types are described below:

Short questions: these address core topics across the entire specification. The short questions are made up of both multiple choice and short answer questions and focus on concepts and skills.

Structured questions: each structured question will be drawn from one area of the specification; each structured question may include a variety of scientific ideas in the context of one agricultural science topic.

Synoptic questions: these questions will require students to collate knowledge across a number of agricultural science topics. The questions are based on a context but draw from across different areas of the specification.

Coursework

PORTFOLIO OF SPECIFIED PRACTICAL ACTIVITIES

Students must complete the range of specified practical activities set out in the learning outcomes of the specification, including laboratory and field investigations, and other appropriate activities. Over the two years of the course, each student will be required to maintain a portfolio in which a record of all activities is kept. There is no particular method specified for these activities. The activities are planned and carried out in groups and reported on individually. Where appropriate, these reports should include video, audio and electronic graphical analysis. The skills developed in the specified practical activities will be used by the student to successfully complete the individual investigative study.

INDIVIDUAL INVESTIGATIVE STUDY

In addition to the specified practical activities, each student must complete an individual investigative study during the course, through which a topic of agricultural significance is investigated in greater depth. This study, incorporating any appropriate research, will be based on a thematic brief which is set by the State Examinations Commission at the commencement of the course for each examination cohort. As part of their investigation students gather and process data, evaluate evidence, and develop arguments. They read about current research and developments in science and relate their learning to the applications and implications of science for society and the environment. Students prepare and present a scientific communication describing the research question, methodology, results and conclusions. The reports on these practical activities are directly assessed by the State Examinations Commission. In addition, some of the skills developed during the individual investigative study will also be assessed in the written examination.

Assessment criteria

WRITTEN ASSESSMENT

A high level of achievement in this component is characterised by a thorough knowledge and understanding of facts, principles, concepts and practices from the whole specification, with few significant omissions. Candidates consistently apply their knowledge and understanding of agricultural science to problem solving in both familiar and new contexts using appropriate scientific terminology. They accurately analyse and evaluate qualitative and quantitative data from different sources; manipulation of data is almost flawless. Candidates present logical arguments and ideas that are clearly based on evidence.

A moderate level of achievement in this component is characterised by a good knowledge and understanding of facts, principles, concepts and practices from many parts of the specification. Candidates apply their knowledge and understanding of agricultural science to problem solving in familiar contexts and in some new contexts using appropriate scientific terminology. They carry out adequate levels of analysis and evaluation on qualitative and quantitative data from different sources; much of their manipulation of data is correct. Candidates present arguments and ideas which, in the main, are based on evidence.

A low level of achievement in this component is characterised by a limited knowledge and understanding of facts, principles, concepts and practices set out in the specification. Candidates select appropriate facts and principles to solve problems concerning familiar material using a limited range of scientific terminology. They carry out basic manipulation of data using straightforward mathematics. Candidates present some explanations based on evidence from familiar contexts, though they may include irrelevant material.

COURSEWORK

INDIVIDUAL INVESTIGATIVE STUDY

A high level of achievement in this component is characterised by demonstration of a comprehensive range of substantive and procedural understanding of the chosen topic throughout the investigation. Students generate valid, testable hypotheses and apply ideas, concepts and theories to make links between complex aspects of the task. They make predictions and generalisations based on available evidence, and evaluate the relevance of known information within a theoretical context. They apply knowledge and understanding of science to develop arguments and to draw conclusions based on the collected evidence.

A moderate level of achievement in this component is characterised by demonstration of a range of substantive and procedural understanding of the chosen topic throughout the investigation. Students generate hypotheses, but in some cases they fail to apply ideas, concepts and theories to make links between aspects of the task. They make predictions and generalisations that are not well supported by available evidence, and show limited evaluation of the relevance of known information within a theoretical context. They apply knowledge and understanding of science to develop poorly-constructed arguments and to draw conclusions based on the collected evidence. In some cases, the arguments are not directly linked to evidence.

A low level of achievement in this component is characterised by demonstration of a lack of substantive and procedural understanding of the chosen topic throughout the investigation. Students fail to generate a testable, valid hypothesis and do not link aspects of the task. They fail to make predictions or generalisations supported by available evidence, and do not use known information within a theoretical context. They fail to apply knowledge and understanding of science to develop arguments and fail to draw conclusions that are consistent with the collected evidence. Their arguments are not directly linked to evidence.

Reasonable accommodations

This agricultural science specification requires that students engage with practical science activities on an ongoing basis throughout the course. In addition, it involves assessment of practical work, with an emphasis on practical activities, which may have implications for students with physical/medical/sensory and/or specific learning difficulties. In this context, the scheme of Reasonable Accommodations, operated by the State Examinations Commission, is designed to assist candidates in the Leaving Certificate who have physical/medical/sensory and/or specific learning difficulties.

Reasonable accommodations are designed to remove as far as possible the impact of a disability on a candidate's performance, so that he or she can demonstrate in an examination his or her level of achievement—they are not designed to compensate for a possible lack of achievement arising from a disability.

Appendix

Glossary of action verbs

This glossary is designed to clarify the learning outcomes throughout the specification. The action verb is described in terms of what the learner should be able to do. This glossary will be aligned with the command words used in the assessment.

ACTION VERB	STUDENTS SHOULD BE ABLE TO
Analyse	study or examine something in detail, break down in order to bring out the essential elements or structure; identify parts and relationships, and interpret information to reach conclusions
Annotate	add brief notes of explanation to a diagram or graph
Apply	select and use information and/or knowledge and understanding to explain a given situation or real circumstances
Appraise	evaluate, judge or consider text or a piece of work
Appreciate	recognise the meaning of, have a practical understanding of
Briefly describe/ explain	provide a short statement of only the main points
Argue	challenge or debate an issue or idea with the purpose of persuading or committing someone else to a particular stance or action
Calculate	obtain a numerical answer showing the relevant stages in the working
Classify	group things based on common characteristics
Comment	give an opinion based on a given statement or result of a calculation
Compare	give an account of the similarities and (or) differences between two (or more) items or situations, referring to both (all) of them throughout
Consider	describe patterns in data; use knowledge and understanding to interpret patterns, make predictions and check reliability
Construct	develop information in a diagrammatic or logical form; not by factual recall but by analogy or by using and putting together information
Convert	change to another form
Criticise	state, giving reasons the faults/shortcomings of, for example, an experiment or a process
Deduce	reach a conclusion from the information given
Define	give the precise meaning of a word, phrase, concept or physical quantity
Demonstrate	prove or make clear by reasoning or evidence, illustrating with examples or practical application

ACTION VERB	STUDENTS SHOULD BE ABLE TO
Derive	arrive at a statement or formula through a process of logical deduction; manipulate a mathematical relationship to give a new equation or relationship
Describe	develop a detailed picture or image of, for example a structure or a process, using words or diagrams where appropriate; produce a plan, simulation or model
Determine	obtain the only possible answer by calculation, substituting measured or known values of other quantities into a standard formula
Discuss	offer a considered, balanced review that includes a range of arguments, factors or hypotheses; opinions or conclusions should be presented clearly and supported by appropriate evidence
Distinguish	make the differences between two or more concepts or items clear
Estimate	give a reasoned order of magnitude statement or calculation of a quantity
Evaluate (data)	collect and examine data to make judgements and appraisals; describe how evidence supports or does not support a conclusion in an inquiry or investigation; identify the limitations of data in conclusions; make judgements about the ideas, solutions or methods
Evaluate (ethical judgement)	collect and examine evidence to make judgements and appraisals; describe how evidence supports or does not support a judgement; identify the limitations of evidence in conclusions; make judgements about the ideas, solutions or methods
Explain	give a detailed account including reasons or causes
Examine	consider an argument or concept in a way that uncovers the assumptions and relationships of the issue
Find	general term that may variously be interpreted as calculate, measure, determine etc.
Formulate	express the relevant concept(s) or argument(s) precisely and systematically
Group	identify objects according to characteristics
Identify	recognise patterns, facts, or details; provide an answer from a number of possibilities; recognise and state briefly a distinguishing fact or feature
Illustrate	use examples to describe something
Infer	use the results of an investigation based on a premise; read beyond what has been literally expressed
Investigate	observe, study, or make a detailed and systematic examination, in order to establish facts and reach new conclusions
Interpret	use knowledge and understanding to recognise trends and draw conclusions from given information
Justify	give valid reasons or evidence to support an answer or conclusion
List	provide a number of points, with no elaboration

ACTION VERB	STUDENTS SHOULD BE ABLE TO
Measure	quantify changes in systems by reading a measuring tool
Model	generate a mathematical representation (e.g., number, graph, equation, geometric figure) for real-world or mathematical objects, properties, actions, or relationships
Order	describe items/ systems based on complexity and/or order
Outline	give the main points; restrict to essentials
Predict	give an expected result of an event; explain a new event based on observations or information using logical connections between pieces of information
Prove	use a sequence of logical steps to obtain the required result in a formal way
Provide evidence	provide data and documentation that support inferences or conclusions
Recognise	identify facts, characteristics or concepts that are critical (relevant/ appropriate) to the understanding of a situation, event, process or phenomenon
Recall	remember or recognise from prior learning experiences
Relate	associate, giving reasons
Sketch	represent by means of a diagram or graph (labelled as appropriate); the sketch should give a general idea of the required shape or relationship, and should include relevant features
Solve	find an answer through reasoning
State	provide a concise statement with little or no supporting argument
Suggest	propose a solution, hypothesis or other possible answer
Synthesise	combine different ideas in order to create new understanding
Understand	have and apply a well-organised body of knowledge
Use	apply knowledge or rules to put theory into practice
Verify	give evidence to support the truth of a statement

