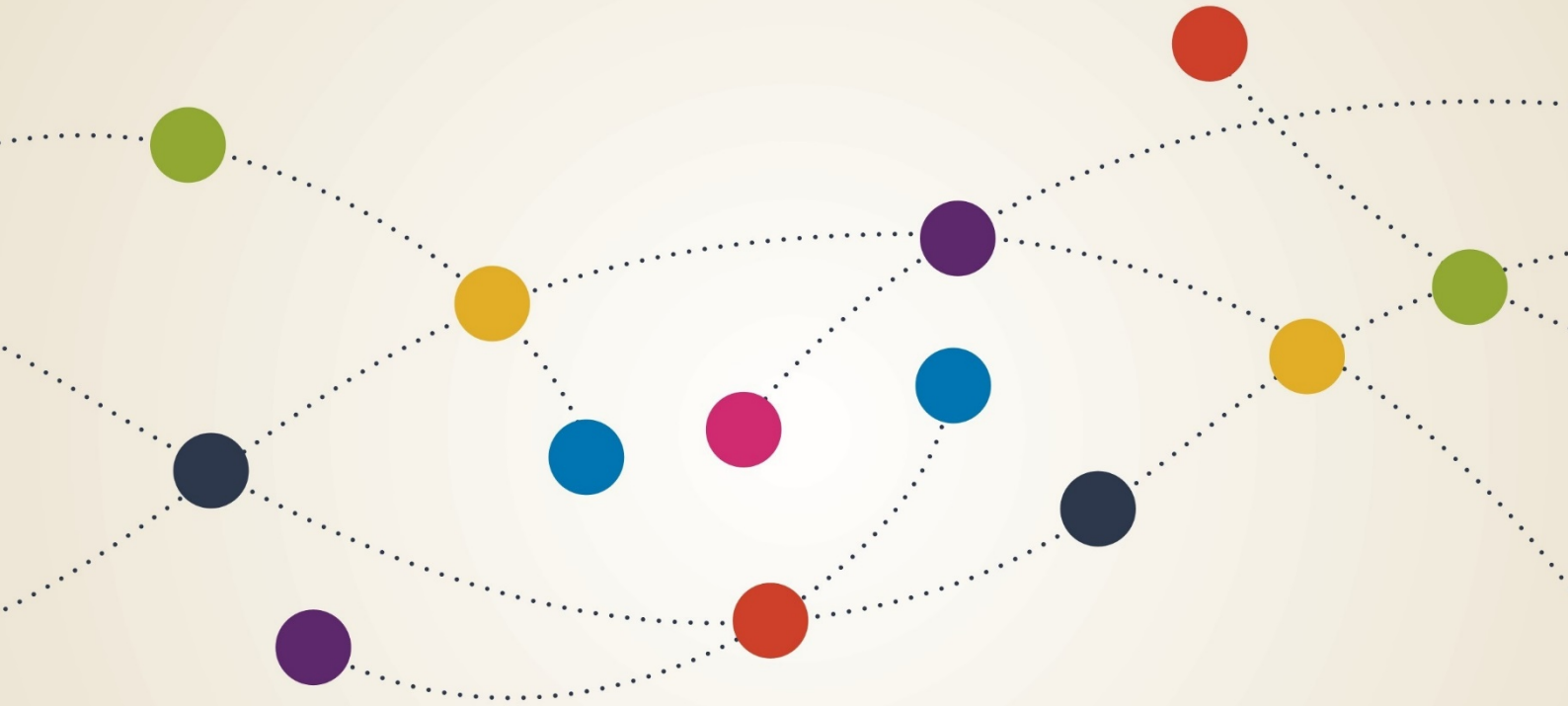


Leaving Certificate Agricultural Science
Draft Specification

For consultation

NCCA
An Chomhairle Náisiúnta Curaclaim agus Measúnachta
National Council for Curriculum and Assessment

January 2016

Contents

Senior cycle

Learners 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 learners 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 learners, commensurate with their individual abilities. To support learners as they shape their own future there is an emphasis on the development of knowledge and deep understanding; on learners 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 learners, 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 learners 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 learners 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 learners 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.

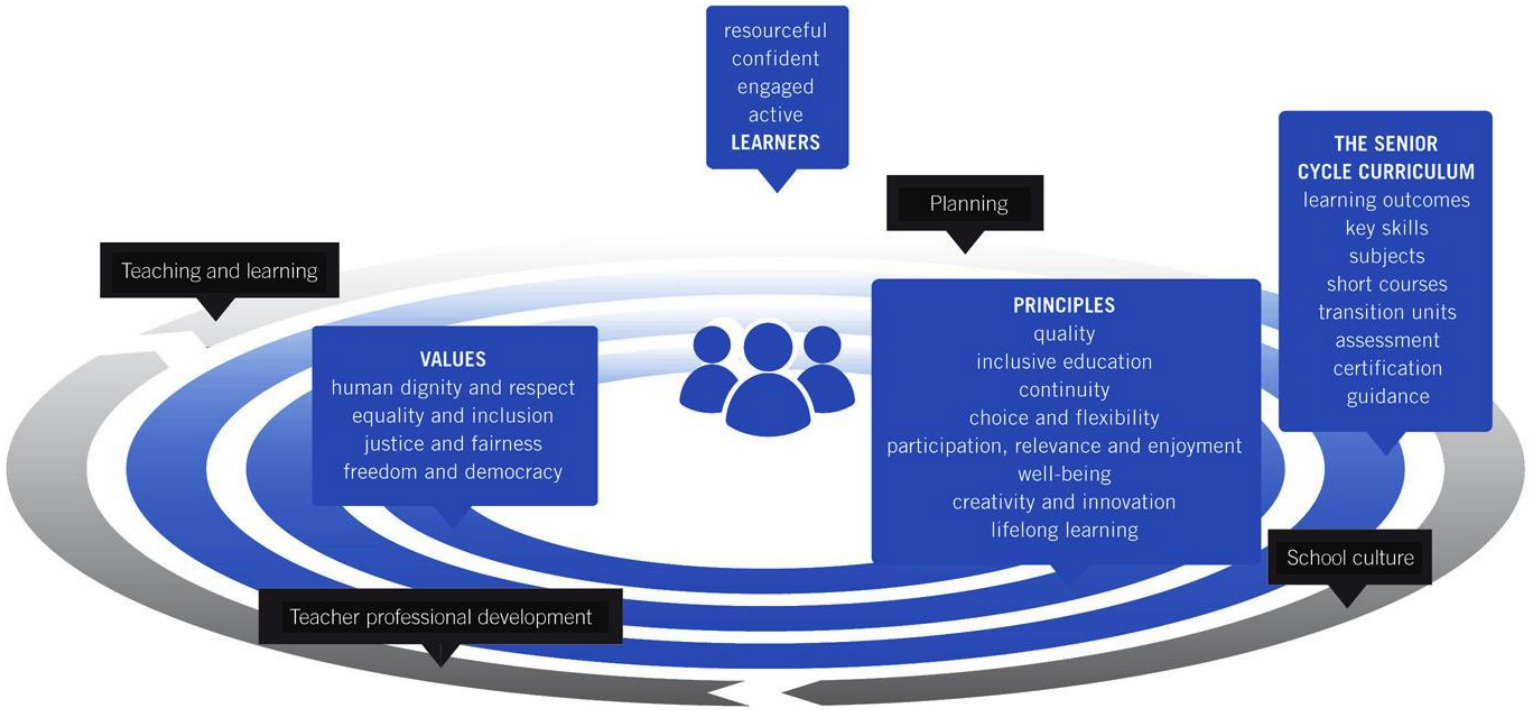
This vision of the learner is underpinned by the values on which senior cycle is based and it is realised through the principles that inform the curriculum as it is experienced by learners in schools. The curriculum, made up of subjects and courses, embedded key skills, clearly expressed learning outcomes, 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

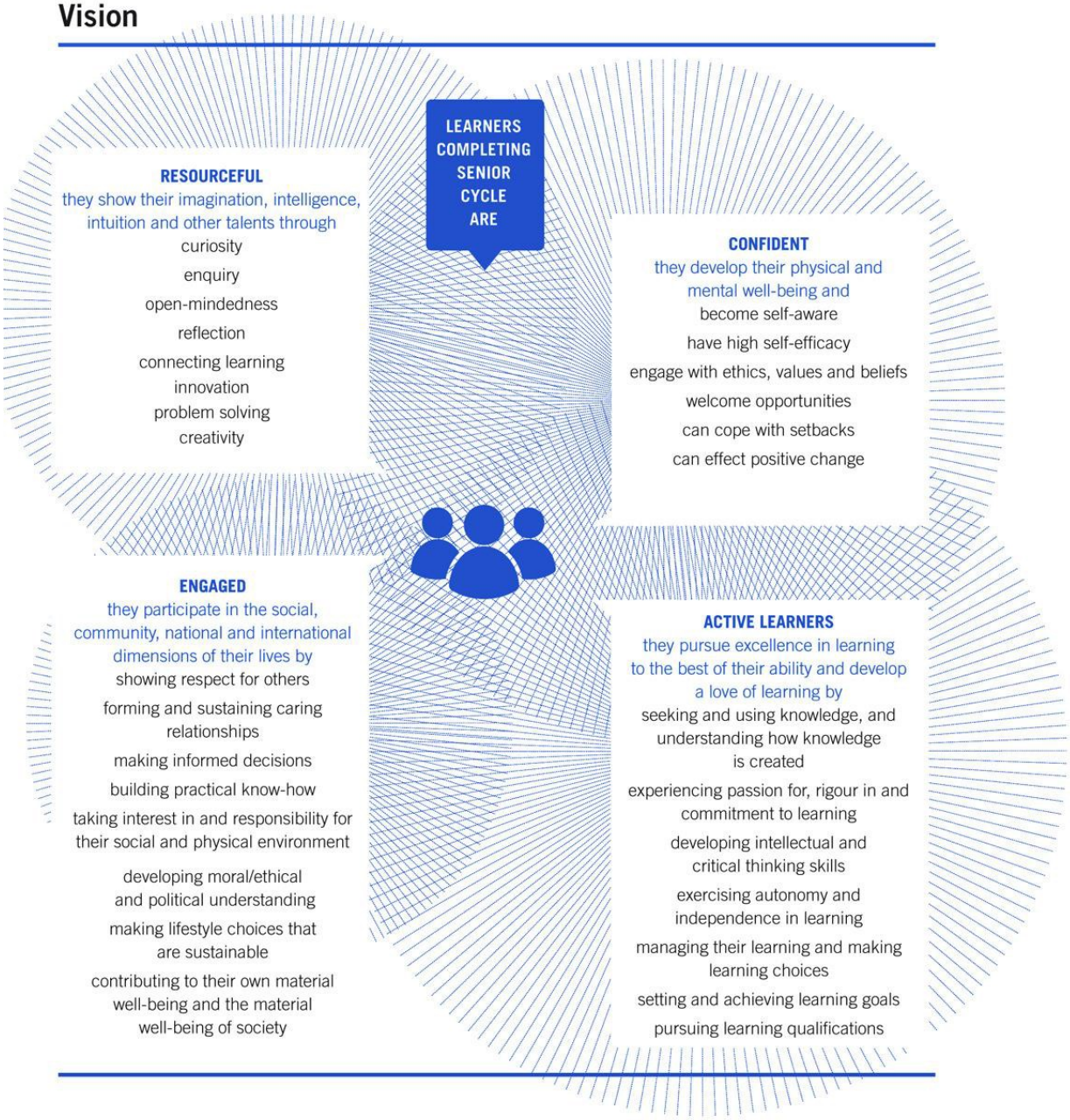
- effective curriculum planning, development, organisation and evaluation
- teaching and learning approaches that motivate and interest learners, that enable them to progress, that deepen and apply their learning, and that develop their capacity to reflect on their learning
- professional development for teachers and school management that enables them to lead curriculum development and change in their schools
- a school culture that respects learners, 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.

Overview of senior cycle



Vision


LEARNERS COMPLETING SENIOR CYCLE ARE
RESOURCEFUL
they show their imagination, intelligence, intuition and other talents through
curiosity
enquiry
open-mindedness
reflection
connecting learning
innovation
problem solving
creativity
CONFIDENT
they develop their physical and mental well-being and
become self-aware
have high self-efficacy
engage with ethics, values and beliefs
welcome opportunities
can cope with setbacks
can effect positive change
ENGAGED
they participate in the social, community, national and international dimensions of their lives by
showing respect for others
forming and sustaining caring relationships
making informed decisions
building practical know-how
taking interest in and responsibility for their social and physical environment
developing moral/ethical and political understanding
making lifestyle choices that are sustainable
contributing to their own material well-being and the material well-being of society
ACTIVE LEARNERS
they pursue excellence in learning to the best of their ability and develop a love of learning by
seeking and using knowledge, and understanding how knowledge is created
experiencing passion for, rigour in and commitment to learning
developing intellectual and critical thinking skills
exercising autonomy and independence in learning
managing their learning and making learning choices
setting and achieving learning goals
pursuing learning qualifications

Leaving Certificate Agricultural Science

Introduction

Science education provides a means by which learners can interact with the world around them, and understand how scientific concepts can be used to interpret the physical world. As learners' scientific literacy grows, they will be 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, learners 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 managed 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. 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 the solving of identified problems arising from the learner's own observations and perceptions of agricultural situations.

Through a study of Agricultural Science, learners develop many practical skills when handling, observing and investigating plants and animals and in 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 project work they are given the opportunity for scientific research. In undertaking project work as a group member, they gain the experience of communicating, interacting and co-operating in and through the group. Therefore, the progressive development of scientific inquiry, curiosity and self-confidence in the learner will be facilitated through guided discovery, laboratory and field work, independently conducted and group project work, and field-based assignments.

The study of Agricultural Science involves the learner with the scientific world in a personal way as a farmer and scientist by acknowledging the daily application of science to the life and work of the farmer. Learners are involved in making value judgments when they apply scientific knowledge to modern farming practices, to the maintenance and care of farm animals, and to the care of their natural environment. Learners will research and appreciate the key contribution of farming and the agri-food industry to the Irish economy and the importance of agri-food policies to the sustainable development of farming at both the local and global level. 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 learners 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 helpful, and it is one of the areas of the school curriculum where learners are enabled and encouraged to show a creative and caring concern for the responsibilities placed in their charge, to make judgments based on evidence, and to appreciate the culture of enterprise. It enables the learners to develop an increased awareness of responsibility in both the scientific and social senses. Consequently, it produces a firm framework for future life in which the learner will operate.

Aims

Leaving Certificate Agricultural Science aims to enable learners to

(a) 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

(b) recognise the need for, and global importance of, relevant strategies and policies for the agri-food industry and identify opportunities for innovation and entrepreneurship in the context of local, regional and world markets

(c) 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

Learners should

(a) develop an ecological sense of the role and place of humans in the provision of food and non-food materials

(b) recognise the impact of the environment on various agricultural practices and appreciate how the application of science and technology may be both beneficial and detrimental to the individual, the community and the environment

(c) become aware of the contribution of agriculture to the economy of the locality and the nation and its importance in EU and world contexts

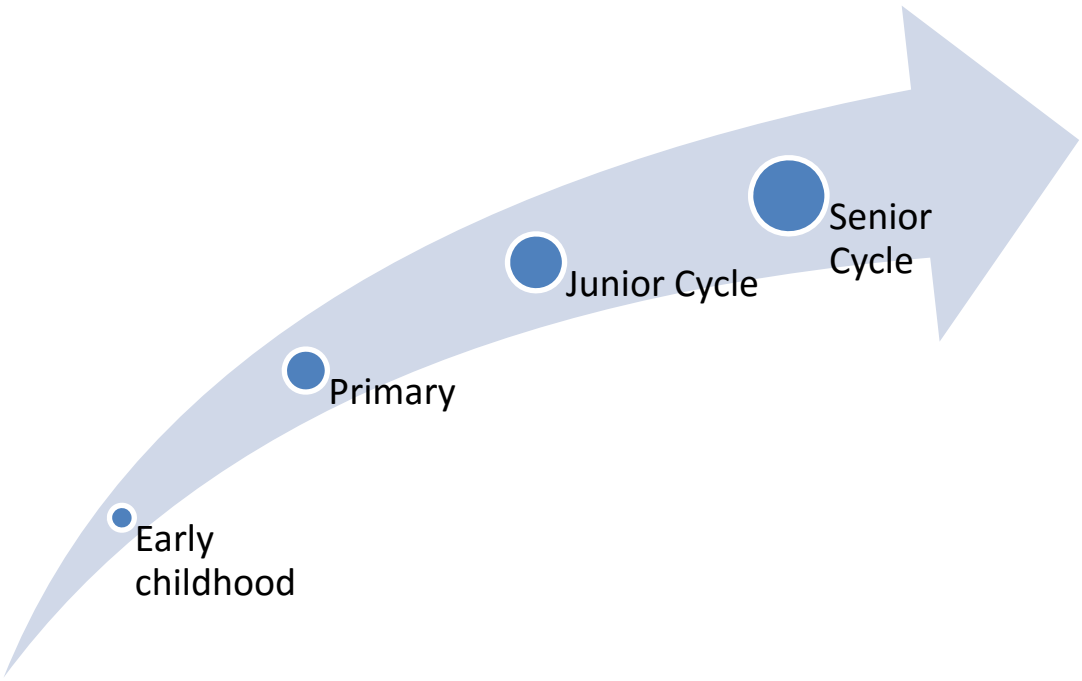
(d) make informed evaluations of contemporary agricultural science issues locally and globally

(e) understand that the study and practice of science are co-operative and cumulative activities which are subject to social, economic, technological, ethical and cultural influences and limitations

(f) develop independent thinking and self-directed learning skills through active engagement in their own learning and through project work

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

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

Learners 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 learners 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 learners to make informed decisions about many local, national, and global challenges and opportunities they encounter.

Senior cycle

For learners taking Leaving Certificate Agricultural Science, knowledge of Junior Cycle Science is assumed. Learners build on the scientific concepts, processes and practices developed at junior cycle as they progress through the two years of study of Leaving Certificate Agricultural Science and use them to develop deeper understanding of scientific concepts and processes, with particular reference to their application in an agricultural context. Many senior cycle subjects have close links with Agricultural Science: Biology, Chemistry, Geography, Mathematics and Home Economics—scientific and social. 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

The Leaving Certificate Agricultural Science specification is designed to prepare learners 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, from direct engagement in farming to research in environmental, agricultural and food-related areas of industry. For students of Agricultural Science, there are many interesting career pathways to the agri-food industry, encompassing areas such as marketing, accounting, sales, politics, law, and nutrition. The increasing use and importance of developments in technology in the agri-food sector also provide potential directions for students of Agricultural Science. Veterinary medicine and environmental science are other career areas in which interest can be generated through the study of Agricultural Science at Leaving Certificate. Farming and the agri-food industry offer opportunities for those with vision, leadership and entrepreneurial skills.

Community and society

Learners 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

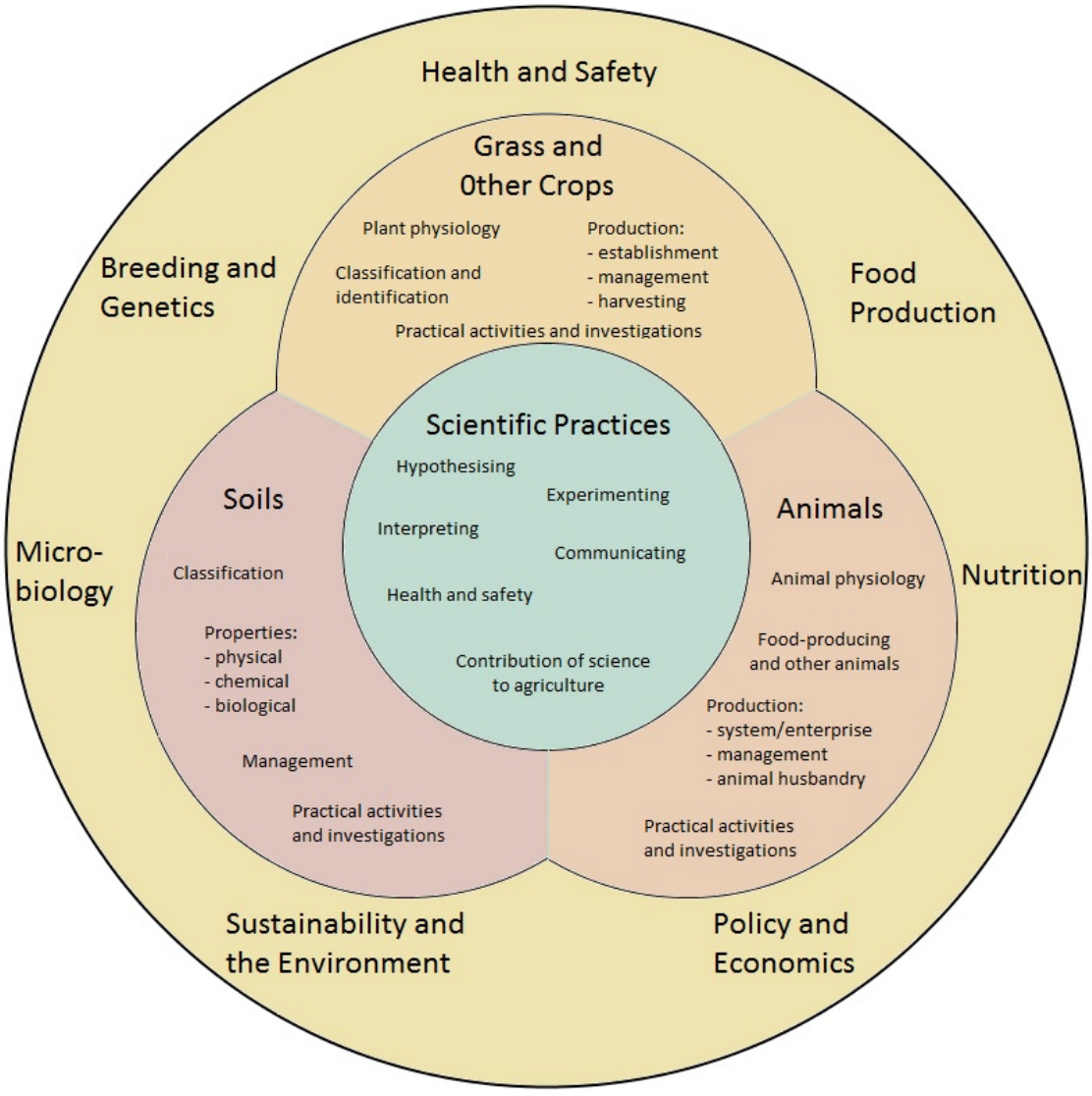
The *National Strategy on Education for Sustainable Development 2014 -2020* highlights the need to integrate Education for Sustainable Development (ESD) in the curriculum from pre-school up to senior cycle. The National Strategy aims to ensure that education contributes to sustainable development by equipping learners 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 Agricultural Science specification supports education for sustainable development by integrating the key skills of senior cycle throughout the strands. *Sustainability and the environment* is one of the cross-cutting themes in the four strands of the specification: scientific practices, soils, grass and other 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 (Section3.3) and animals (Section 4.3), learners develop awareness of the need for sustainable development and use of natural resources at local, national and global levels.

Overview of the specification

Structure

The specification for Leaving Certificate Agricultural Science is set out in four strands of study and seven cross-cutting themes that permeate these strands, as illustrated below. The first strand, Scientific Practices, is an integrating 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 learners 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 project also provides an integrating aspect to the learner's engagement with the strands and cross-cutting themes. Through this investigative study, learners 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. Learners will also devote time individually to the student project – an investigative study of a topic which is based on a brief or theme specified for each examination cohort by the State Examinations Commission. This is undertaken during the two years of the course and is a mandatory part of the coursework which is 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 learners' oral literacy skills are supported through the strong 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 technology for research and presentation purposes. Agricultural Science also helps learners develop literacy as they gain the vocabulary and expressive skills to articulate informed views on events and issues affecting agriculture at local, national and global levels.

Agricultural Science facilitates learners in using mathematical understanding and skills to help analyse complex issues and factors related to agricultural development and production, including the interpretation of secondary data and the economics of different production systems. Over the course of their studies, learners engage with both qualitative and quantitative data. They develop numeracy skills as they access and interpret research data, examine evidence and reach conclusions. Learners 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.

The written examination also promotes the development of literacy and numeracy through its focus, not only on assessing knowledge and understanding, but also on assessing skills of analysis and interpretation of qualitative and quantitative data and the capacity to form reasonable argument and to draw relevant and justified conclusions.

Key skills

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 learners 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 learners 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.

Learners 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, analysing hypotheses, 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, learners 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. Learners will develop the skill of *being personally effective* as they develop strategies for managing, monitoring and evaluating their learning.

Practical activities

Scientific methods, research, interpretation of data and use of evidence and argument in evaluating information are central to both the practical activities and the theoretical concepts in the Agricultural Science specification. Access to laboratory facilities is required so that learners 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 until some results and conclusions are reached. Learners 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. Learners, either individually or working in small groups, are expected to engage in the investigative or experimental activities prescribed in the specification. Over the two years of the course, each learner will be required to maintain a record of these activities. This must be available for inspection and must be retained until the end of the assessment process.

As a minimum, learners are required to complete and prepare reports on the mandatory practical activities which are included as learning outcomes in the specification. 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. Where appropriate, these reports could include video, audio and graphical files, etc.

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

Student project

As well as the mandatory practical activities, students are required to carry out an independent student project related to a topic in Agricultural Science, including any research that might be appropriate. A brief or theme will be set annually by the State Examinations Commission. The project should be an investigative activity, conducted over time (typically for a full growth cycle), which facilitates study 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.

Teaching and learning

Senior cycle learners are encouraged to develop the knowledge, skills, attitudes and values that will enable them to become independent learners 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. It is inquiry-based in its design and 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 learners progress they develop learning strategies that are transferable across different tasks and different subjects, enabling them to make connections between Agricultural Science, other subjects, and their everyday experiences. Through engaging in self-directed activities and reflection, learners assume much of the 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 learners 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.

Learners 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, learners 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 wherever data are used as evidence to support argument. By examining and debating reports about contemporary issues in science learners 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 learners engage in will enable them to take charge of their own learning by setting goals, developing action plans, receiving and responding to assessment feedback. Learners vary in the amount and type of support they need to be successful. Levels of demand in any learning activity will differ as learners 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 learners to interact at their own level. Supporting documentation for teachers will be provided on www.curriculumonline.ie.

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.

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.

Ordinary level

The learning outcomes that are presented in **normal type** apply at Ordinary level. Learners engage with a broad range of knowledge, mainly concrete in nature, but with some elements of abstraction or theory. They 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. Learners engage with a broad range of knowledge including theoretical concepts and abstract thinking with significant depth in some areas. They 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. They will be expected to identify and apply skills and knowledge in a wide variety of both familiar and unfamiliar contexts.

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 learners. 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.

Strands of Study

Strand 1. Scientific practices

Strand 2. Soils

Strand 3. Grass and other crops

Strand 4. Animals

Strand 1: Scientific practices

In addition to the ability to understand and rigorously apply the concepts, laws and theories of science, learners will understand the purposes and principles underpinning the practice of science. Through studying Leaving Certificate Agricultural Science, learners 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	▪ use observations as the basis for formulating a hypothesis ▪ apply their knowledge and understanding of science and nature 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	▪ design, manage and conduct practical investigations to test the prediction and also investigations based on secondary data ▪ 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

Students learn about	Students should be able to
1.2 Experimenting (continued)	▪ distinguish between statistical and systematic uncertainty and identify appropriate methods to reduce this ▪ recognise uncertainty as a limitation of the process of measurement ▪ appreciate the difference between accuracy and precision ▪ conduct an open-ended investigation
1.3 Evaluating evidence	▪ critically examine the scientific process that was used to present a scientific claim ▪ appreciate the limitations of scientific evidence (see supporting document) ▪ make judgments 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 any ethical issues
1.4 Communicating	▪ 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

Students learn about	Students should be able to
1.5 Working safely	▪ 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 learners 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 its significance as a natural biological filter and the contribution that it makes to the care of the environment through its interaction with water, plant life and the earth's atmosphere.

Students learn about	**Students should be able to**
2.1 Classification	▪ describe the different soil types and soil profiles and their distribution in Ireland ▪ describe the factors involved in soil formation ▪ compare productive and non-productive soils with respect to their properties
2.2 Properties	
2.2.1 Chemical	▪ examine the chemical features of soils including nutrients; pH; cation exchange; liming and flocculation ▪ conduct an investigation into the chemical properties of a soil to - **demonstrate cation exchange capacity (CEC)** - show flocculation - determine the pH
2.2.2 Physical	▪ examine the physical features of soils, including structure, particle size, texture, drainage, temperature, and the impact of erosion, sedimentation and weathering ▪ determine and compare the total pore space in a structured soil and a structureless soil ▪ investigate the texture of a soil by - sedimentation - using a soil sieve - how it feels ▪ compare the capillarity and infiltration rate of two contrasting soil types ▪ calculate the percentage water in a soil sample

Students learn about	Students should be able to
2.2.3 Biological	▪ examine the biological features of soils including microbiome, earthworm activity, organic matter and the nitrogen cycle ▪ isolate and grow bacteria from clover root nodules ▪ appreciate the relationship between soil fungi and roots and the impact of the relationship on productivity ▪ show the percentage organic matter in a soil sample ▪ show the activity of earthworms in a soil and estimate the number of earthworms in a pasture
2.3 Management	▪ 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 application, sustainable land use and management, impact of animals on the chemical, physical and biological properties of soil, soil compaction, pollution and conservation ▪ 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 and machinery

Strand 3: Grass and other crops

In their study of Leaving Certificate Agricultural Science, learners develop an understanding of the role and importance of grass as an animal food crop. Irish agriculture is predominantly grass-based, which provides a unique selling point for Irish agricultural produce; for example, the beta-carotene in grass gives Irish butter its distinctive yellow colour. Apart from its role as a food crop, the cultivation of grassland can make a contribution to carbon sequestration, which is increasingly a factor in climate change and control.

Students learn about	**Students should be able to**
3.1 Plant physiology	▪ relate the main structures of the plant to its fundamental processes: photosynthesis, respiration, transpiration and nutrient absorption
3.2 Classification/ identification	▪ apply their knowledge of structure and function to identify a variety of grasses, cultivated crops and weeds ▪ list the major food and energy crops grown in Ireland ▪ explain the importance of plant breeding and seed variety
3.3 Production	▪ describe the lifecycle (annual, biennial, perennial) of grass, as a food crop **and an energy crop**
3.3.1 Establishment	▪ discuss the effect of soil quality, seedbed preparation and seed selection on productivity ▪ investigate how a variety of soil factors influence productivity ▪ investigate the effect of climate and soil conditions on the percentage germination of an agricultural seed ▪ **compare establishment for grass with that of one other crop**

Students learn about	Students should be able to
3.3.2 Management	▪ appreciate the importance of optimal grassland management for food-producing and other animals ▪ identify farm health and safety hazards associated with the management of grass and other crops, and discuss the controls and precautions necessary to prevent accidents, injury and ill health on the farm ▪ compare conventional and organic farming ▪ compare the botanical composition of an old permanent pasture versus a new lay (not line transect or percentage cover) ▪ recognise the purpose of crop rotation and the role of innovation and biotechnological applications in crop development and management ▪ recognise the benefits of, and alternatives to, crop rotation ▪ 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 plants and compare the pigment content of this sample of plants ▪ measure the dry matter (DM) content of a crop ▪ evaluate the ethical and economic considerations and arguments arising from biotechnological applications as applied to crop management, for example genetic modification of organisms ▪ debate the arguments for and against high energy crops vs sustainable management ▪ recognise the importance of controlling disease in crops and evaluate the benefits and disadvantages of using chemicals for this purpose
3.3.3. Harvesting	▪ discuss harvesting techniques and conservation methods, for grass, and for one food crop **and one energy crop** ▪ find the percentage sugar in a sample of grass or silage ▪ show the effect on ensiled grass of - an additive - soil - air ▪ recognise the need for safe work practices, including the safe handling, harvesting and storage of grass and other 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 and other animals of agricultural importance and interest, for example horses and poultry.

Students learn about	Students should be able to
4.1 Animal physiology	▪ compare the ruminant and monogastric digestive systems, including the role of microorganisms ▪ describe the animal reproductive cycle, methods of fertilisation, and the importance of genetics for food-producing and other animals ▪ describe the principles of genetic improvement and selection: - performance testing - progeny testing - pedigree selection - natural selection - genetic engineering
4.2 Classification/ identification	▪ describe the characteristics of common types, breeds and crosses of cattle, sheep and one non-ruminant animal
4.3 Production	▪ discuss the importance of nutrition and ration formulation to meet the protein and energy requirements at different growth stages of cattle, sheep and one non-ruminant animal ▪ describe the nutritive properties of food constituents and their function in growth and development ▪ compare two different systems of animal production ▪ discuss why grass-fed Irish food is so unique ▪ investigate the factors that determine the output and quality of produce from a chosen enterprise (seed variety, nutrition, housing, management) ▪ use **and interpret** secondary data to determine the live weight gain and the feed conversion rate (FCR) of a selected animal ▪ investigate the quality of a sample of milk over time using the methylene blue test ▪ compare the percentage of water and solids in two different milk samples (a.m./p.m.)

Students learn about	Students should be able to
	▪ recognise the role and importance of innovation and biotechnological applications in animal science ▪ appreciate the need for sustainable intensification ▪ discuss the environmental and health and safety considerations associated with animal production and processing ▪ identify the potential hazards (physical, biological, health) associated with working with animals, and safe work practices/controls
4.3.1 System/enterprise	▪ describe the scientific principles underlying the lifecycle of a selected animal, including the dietary requirements at different growth stages ▪ recognise the importance of market trends and requirements, including value-added/niche markets/artisan produce ▪ use secondary data to discuss the impact of milk quality on farm income ▪ appreciate the impact on farm economics of different animal production systems
4.3.2 Management	▪ discuss management practices for - handling and housing animals - optimal animal health and welfare - slurry - delivering sustainable and environmentally friendly production systems - ensuring quality, safe and traceable food for the consumer ▪ evaluate the role of policies related to traceability, animal welfare and its connection with the food chain
4.3.3. Animal husbandry and health	▪ discuss the factors to be considered when caring for animals ▪ based on a farm that they have studied, - sketch a farmyard layout, and identify and discuss potential hazards on the farm and how they may be prevented - identify best practice in terms of farmyard layout, 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 animals, and discuss how they may be spread and their control

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.

There are two assessment components, coursework and an examination paper, as illustrated below. Both components of assessment reflect the relationship between practical activities and the theoretical content of the specification.

Coursework	Examination Paper
(i) Portfolio of activities and investigations specified in the learning outcomes (ii) A student project [Current weighting is 25%]	Question Paper to be completed in 2½ hours [Current weighting is 75%]

Coursework assessment

Students must complete the range of mandatory practical activities set out in the learning outcomes of the specification, including laboratory and field investigations, farm visits 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, according to criteria specified by the State Examinations Commission. This record must be available for inspection during the course and be submitted for assessment at the end of the course.

In addition, a student project is undertaken during the course, through which a topic of agricultural significance is investigated in greater depth. This individually completed project, incorporating any appropriate research, will be based on a theme that is set annually by the State Examinations Commission.

Common criteria will be applied at Higher level and Ordinary level to the assessment of coursework, which complements the assessment conducted through the examination paper.

Examination paper

The examination paper of 2½ hours duration is 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 and skills in relation to the learning outcomes in the specification. At Higher level all of the learning outcomes will be assessed, including those presented in **bold type**. At Ordinary level only those learning outcomes that are presented in normal type will be assessed. 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 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 science, and how it contributes to the social and economic development of society.

Assessment criteria for the written examination

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.

Reasonable Accommodations

This Agricultural Science specification requires that learners engage with practical science activities on an ongoing basis throughout the course. In addition, the assessment involves a coursework component, with emphasis on practical activities, which may have implications for learners 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.

Applications for reasonable accommodations are considered within a published framework of principles (Expert Advisory Group Report, January 2000) and are submitted by the school which a candidate attends on prescribed application forms. Applications are normally invited one year in advance of the examination concerned.

Appendix 1: Glossary of terms

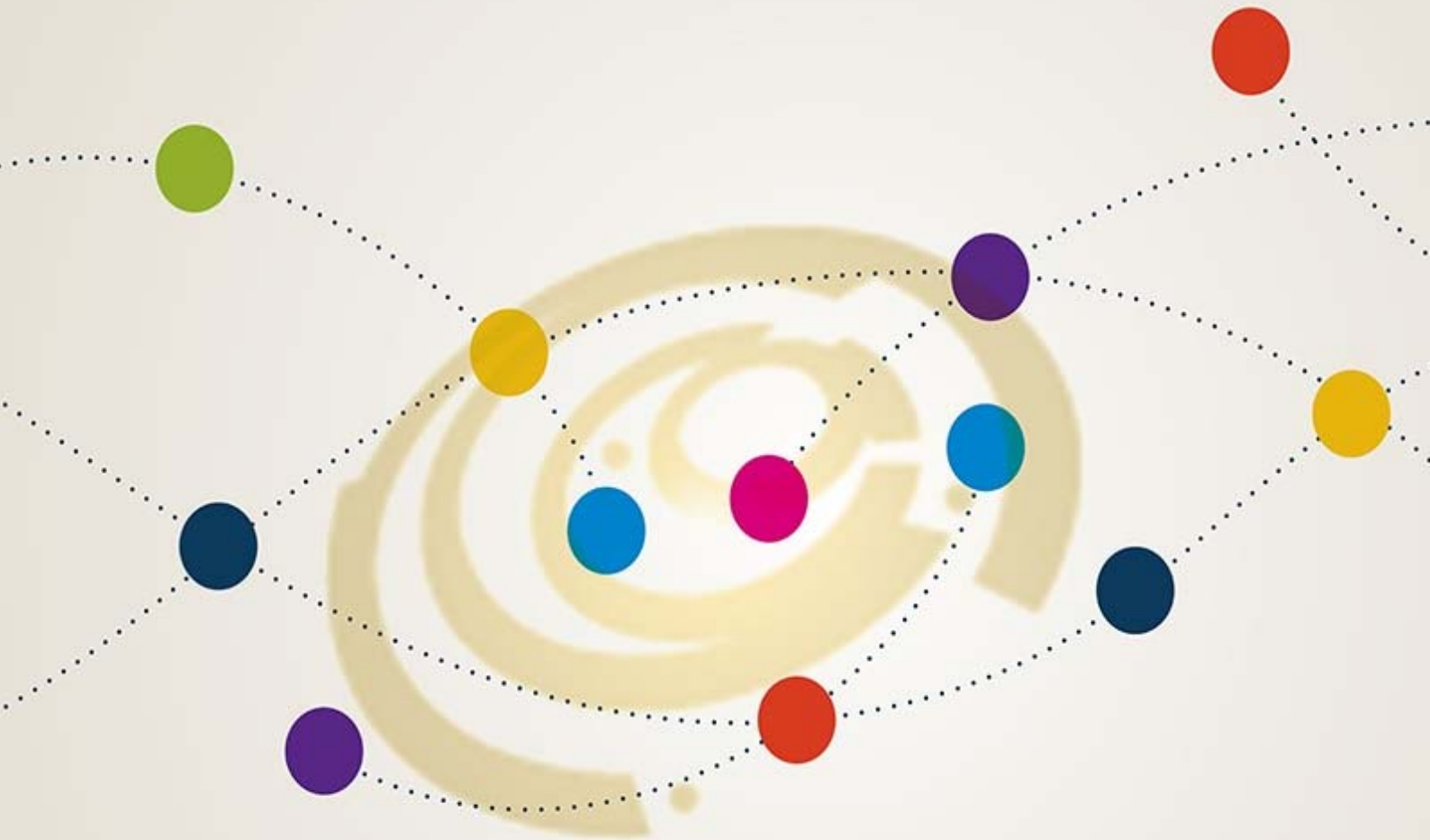
This glossary is designed to clarify the learning outcomes throughout the specification. The action verb is described in terms of what the learner should be able to do. This glossary will be aligned with the command words used in the assessment.

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
Brief description/explanation	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

Action verb	Students should be able to
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
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 judgments 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 judgments about the ideas, solutions or methods

Action verb	Students should be able to
Evaluate (ethical judgement)	collect and examine evidence to make judgments and appraisals; describe how evidence supports or does not support a judgement; identify the limitations of evidence in conclusions; make judgments 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; recognize 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 recognize 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
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

Action verb	Students should be able to
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 recognize 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-organized body of knowledge
Use	apply knowledge or rules to put theory into practice
Verify	give evidence to support the truth of a statement



NCCA

35 Cearnóg Mhic Liam, BÁC 2 | 35 Fitzwilliam Square, Dublin 2