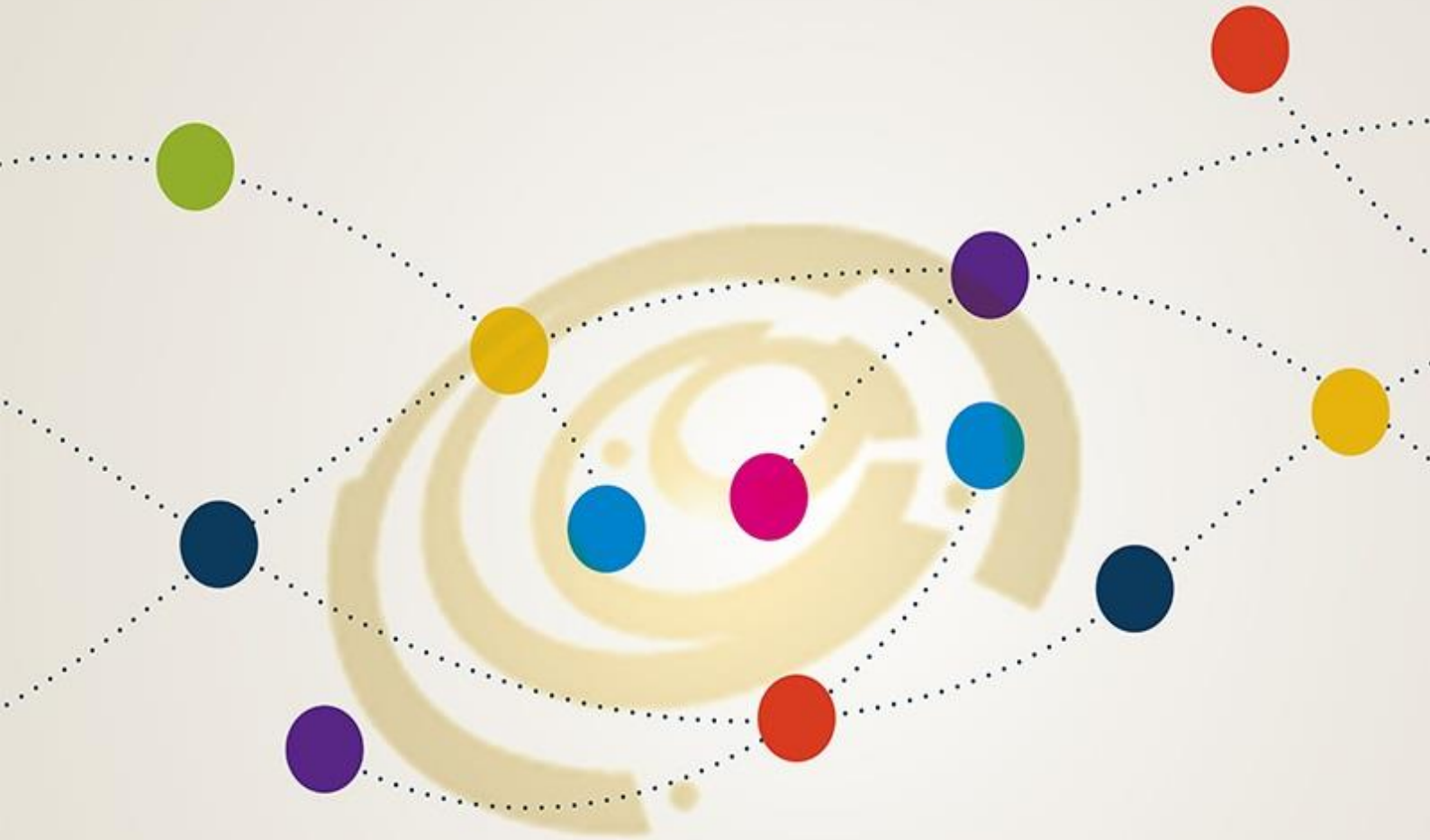

Background Paper and Brief for the review of Leaving Certificate Agricultural Science

For consultation

NCCA

November 2014

Contents

1. Introduction

This background paper signals the beginning of the work in developing a revised specification for LC Agricultural Science, which is one of 33 subjects examined annually in the Leaving Certificate examination.

The study of agricultural science in post-primary schools is a development of the study of Rural Science both at primary level and as part of the Day Vocational (Group) Certificate programme at second level. It is also a progression from the traditional training programmes which were conducted by agricultural instructors in registered Agricultural Colleges for young, aspiring farmers – with a focus on training in farm practice, rather than on the scientific study of agriculture. Agricultural Science was first introduced in post-primary schools in 1943, at both Intermediate Certificate and Leaving Certificate, and was initially offered in a restricted number of second-level schools/colleges. There was a requirement for the school or college to have a garden or farm attached so that the practical elements of the subject could be catered for (Mangan, 1994). The subject was discontinued at Intermediate Certificate in 1968.

The syllabus for LC Agricultural Science was revised in 1969 and first examined in 1971; it is published in *Rules and programme for Secondary Schools* (see Appendix 1). Due to the extent of overlap between LC Agricultural Science and LC Biology, students were not permitted to take both subjects in the Leaving Certificate examination. While the requirement for schools to have a garden or farm attached was subsequently lifted and the number of schools offering Agricultural Science increased, the bar on students taking both Agricultural Science and Biology at Leaving Certificate continued to act as a disincentive to increased take-up the subject. This bar was removed in 2004, following the introduction of the revised syllabus for LC Biology.

Table 1 shows the growing number of candidates sitting the subject in the Leaving Certificate examinations over recent years. By comparison with the latest figures, in 2000 the total number of candidates was just under 3,000.

Year	Higher level	Ordinary level	Total
2011	5286	1186	6472
2012	5587	1302	6889
2013	5951	1463	7414
2014	6329	1597	7926

Table 1. LC Agricultural Science candidates

There has also been a growth in the number studying related subjects in higher education. While this growth in the uptake of the subject is welcomed by the agriculture and agricultural science communities, a number of factors need to be taken into consideration:

- A revised syllabus for LC Biology was introduced in 2002 for first examination in 2004; although a revised syllabus for LC Agricultural Science was developed in 2006 (see Appendix 3), it was not introduced in schools—pending the outcome of developments in the Leaving Certificate science subjects more generally and the assessment arrangements in particular.

- The removal in 2004 of the bar on candidates taking both Agricultural Science and Biology in the Leaving Certificate examination is viewed as having had an effect on candidate numbers in Agricultural Science (cf. Chief Examiner's report, 2010) which, as Table 1 above indicates, have grown significantly since then. The table below shows that, in recent years, approximately half of all candidates taking Agricultural Science also take Biology.

Year	2011	2012	2013	2014
% of LC Ag Science candidates also taking LC Biology	47.9%	49.3%	51.48%	49.26

- The most recent Chief Examiner's report for LC Agricultural Science (2010) draws attention to a reducing range of topics in the practical coursework element of the examination, as well as a noticeable lack of recorded evidence of work done—including *a continuing incidence of candidates, during interview, demonstrating poor knowledge of the contents of their own projects* (p. 8).

  The report goes on to state that *evidence continues to indicate that the practical coursework is not being given the prominence ascribed to it in the syllabus* (p. 8).

In light of the concerns about the reduction in the extent and quality of p***r***actical coursework being submitted by candidates, updated guidelines for the conduct and examination of practical coursework in LC Agricultural Science (current syllabus) came into effect in the examinations of 2014 and thereafter (see Appendix 2).

2. Context

2.1 Science developments at senior cycle

Introduction of revised science syllabuses

Revised Leaving Certificate syllabuses in Chemistry and Physics were introduced in 2000 and first examined in 2002; a revised syllabus in Biology was introduced in 2002 and first examined in 2004. While no provision was made for a second assessment component in these syllabuses, consideration was given to the possibility of introducing an assessment of practical work at a later date. The revised Junior Certificate Science syllabus was introduced in 2003 and included a second component assessment in the form of student coursework.

Revision of the LC Agricultural Science syllabus

A review process for the Agricultural Science syllabus began in 1992, more than twenty years after its initial introduction, and a draft syllabus (together with an initial draft of Teacher Guidelines) was the subject of consultation in early 1995. However, agreement could not be reached on a number of outstanding issues, most notably that of an appropriate arrangement for the assessment of the practical coursework elements of Agricultural Science. In particular, the existing arrangement—which involved the teacher marking the students' work, with moderation by an external examiner following an interview with a random sample of students—was seen as unsatisfactory from a number of perspectives and there was strong opposition from teachers to retaining this form of assessment for the revised Agricultural Science syllabus. They were of the view that all candidates should be interviewed, and have their marks awarded, by an external examiner.

In autumn 2004 a proposal on assessment was considered by the committee (see Appendix 4). This involved a broad description of the assessment arrangements—for both the coursework and written examination—being included in the syllabus, with further details to be set out in teacher guidelines. An updated draft syllabus was completed and submitted to Council in 2006 (see Appendix 3). It presented Agricultural Science as the study of the science and technology underlying the principles and practices of modern-day agriculture, placing particular emphasis on the managed use of these resources for the economic and social benefit of humankind. It focussed on developing an understanding of human use of the natural resources of the environment for the production of food and non-food materials while, at the same time, promoting awareness of

the need to enhance environmental quality through increased scientific understanding of agricultural principles and practices.

Syllabus content was set out under three main headings:

1. Natural resources science
2. Food science and technology, incorporating animal enterprise science and crop enterprise science
3. The agricultural industry in context.

Under the revised syllabus, students would engage in experimental, investigative and practical agricultural science activities, including the scientific study of

- Two productive animal enterprises of national agricultural importance, one of which is a ruminant animal enterprise
- Two productive crop enterprises of national agricultural importance, one of which is a grass crop.

The 25% weighting for second component assessment proposed by the committee differed from the emerging weighting (20%) in the other three science subjects at Leaving Certificate. In forwarding the Agricultural Science syllabus to the Department in November 2006, this difference in weighting was noted. As indicated previously, the syllabus was not introduced, pending the outcome of deliberations around practical assessment in the senior-cycle sciences more generally.

Removal of the bar on taking both Agricultural Science and Biology

Despite the fact that a revised syllabus for Agricultural Science had not been introduced at the same time as the other Leaving Certificate science syllabuses, the bar on candidates taking both Agricultural Science and Biology in the Leaving Certificate examination was removed with effect from 2004. As noted earlier, there has been a steady increase in the number of candidates taking Agricultural Science in the Leaving Certificate examination which is attributed, at least in part, to the removal of the bar on candidates taking both of these subjects.

Developments in senior cycle education

By 2004, the NCCA had developed proposals for senior cycle education which were designed to maintain the strengths of the existing experience and improve on them in terms of the rate and quality of participation for all. These proposals envisaged a wider range of curriculum components which would allow for a better balance between knowledge and skills and which would promote the kinds of learning strategies associated with participation in the knowledge society. They also provided for improved access to a greater variety of assessment methods.

An integral element of the proposed developments is a strong emphasis across all subjects on Key Skills, which are essential for all students to achieve their full potential both in school and in their future lives. The key skills should be embedded in the learning outcomes of all curriculum components.

Senior cycle science subjects revisited

As part of the senior cycle developments, a Board of Studies for Science was established to oversee and progress the work of modernising the science syllabuses to take into account changes and developments which had occurred in science practice and in science education internationally and revising them to reflect the new emphasis on key skills and on the presentation of syllabuses to a common template, including the specification of student learning outcomes.

Building on the proposals for senior cycle education, and in particular the desirability of broadening the assessment methods, consideration was given to the introduction of a second assessment component in the science subjects which would reinforce and reward practical and investigative work. Given that there was already an assessment of coursework in LC Agricultural Science, the focus of initial discussion was on LC Biology, LC Chemistry and LC Physics.

As possible scenarios for the assessment of practical work in these subjects emerged, it became clear that the syllabuses were in need of further revision in order to reflect the importance of adopting an investigative approach in teaching and learning. The work of finalising specifications and the proposals for a second assessment component in these three subjects is now complete and a trialling of practical assessment will take place in 2015.

2.2 Other developments

Apart from the developments in science education outlined above and curriculum contexts more generally, the development of a specification in LC Agricultural Science will need to take account of developments in agriculture in Ireland and internationally, as well as issues associated with it such as the agriculture and food industries, the environment, sustainable development, and legislation. Increasingly, issues associated with agriculture and food production arise at an international level and are significantly impacted by global policies and trade agreements.

Food Harvest 2020

In line with Government policy of economic renewal, the agri-food industry *must invest in ideas, knowledge and skills, encourage innovation and creativity, and recognise new opportunities for collaboration across the food supply chain and with other competitors* (DAFF, p.4). The renewal also involves making the most of opportunities to adapt and refine agricultural practices to reflect a 'green' agenda which includes a commitment to the principles of sustainability and concern for the environment.

The role of farming in the stewardship of the natural and cultural landscapes has become far more visible over the last decade and provides a robust platform for the future development of a rural Ireland that is economically viable, socially inclusive and environmentally sustainable. The biodiversity of the natural landscape must also be preserved and supported.

In the Food Harvest 2020 vision for Irish agriculture and food production (DAFF, p. 22), areas of action include:

- Promoting sustainable pasture-based farming and soil management.
- Contributing to sustainable energy requirements.
- Developing new green technologies that improve water quality.
- Reducing the carbon intensity of agricultural activities and enhancing carbon sinks.
- Contributing to protecting biodiversity and achieving biodiversity targets.

Other aspects of agriculture which will need to be considered are land use; land and soil management; water management; factors affecting climate change and the adaptations to agricultural practice required to minimise the impact of climate change. The plentiful availability of water is one of Ireland's major natural advantages, but it is a resource which must be carefully

managed so that water quality is both improved and sustained. Effective measures, including more efficient use of fertilisers and management of farm waste, will be required to reduce water pollution resulting from agricultural activity.

Genomics can potentially help to identify desirable product qualities that will add value in the marketplace. In the dairy and beef sectors, primary producers must be encouraged to optimise efficiency by adopting new technology and a best practice approach to animal health while, at the same time, ensuring that farming provides a viable means of income.

Horticulture is also an aspect of farming which makes an important economic contribution and generates additional entrepreneurial and employment opportunities in domestic retail and food services. Organic production is an area of growth which is particularly suited to small-scale production and offers real opportunities for Irish farmers and food processors. Other areas for consideration include forestry, marine and aquaculture.

The challenge in developing a specification for LC Agricultural Science will be to ensure that students engage in a science-based study that enables them to develop scientific knowledge and science process skills in the context of current agricultural practice, while at the same time taking into account the potential for developments in both scientific and agricultural practice and the increased focus on the critical role played by agriculture in food production. The need to recognise and accommodate concerns and constraints related to the environment and sustainability, including regulation at national and European level, will also prove challenging. Policy decisions that affect agricultural development are increasingly taken at global level.

Education for Sustainable Development

The National Strategy on Education for Sustainable Development 2014-2020, launched in July of this year, provides a framework to support the contribution that the education sector can make towards a more sustainable future at individual, community, local, national and international levels. It 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. (ESD objective)*

The emphasis is on education for sustainable development, rather than education about sustainable development and the strategy is informed by a set of key principles (p. 4):

ESD in Ireland will aim to

- balance environmental , social and economic considerations;
- promote lifelong learning;
- be locally relevant while also linking the local to the national and international;
- engage all sectors of the education system, as well as the non-formal education sector;
- be interdisciplinary and recognise interdependence and interconnectivities across other sectors;
- use a variety of pedagogical techniques that promote active and participatory learning and the development of key dispositions and skills;
- emphasise social justice and equity;
- focus on values and promote active democratic citizenship and inclusion as a means of empowering the individual and the community.
- be an agent for positive change in reorienting societies towards sustainable development.

The strategy accepts that the development of learners' key skills, dispositions, knowledge and values is largely facilitated through the existing curriculum, as well as through the manner in which the curriculum is delivered in the classroom or other educational setting. It recognises that the integration of ESD at post-primary level is more difficult due to the individual subject nature of the curriculum. However, a number of the core principles and the statements of learning in the Framework for Junior Cycle are relevant to ESD, as are the five key skills which have been identified for senior cycle education. The development of a specification for LC Agricultural Science will take place in the context of these broader initiatives.

Science and the key skills at senior cycle

In the NCCA consultation report on the draft Leaving Certificate specifications for biology, chemistry and physics (NCCA, 2012b), there was a welcome for the move to inquiry and practical-based learning in the sciences, which are seen as contributing significantly to the key skills that students should develop through their learning at senior cycle:

- Information processing
- Critical and creative thinking
- Working with others

- Communicating
- Being personally effective

These skills are seen as prerequisites for living and working in the 21st century. In common with all specifications, detailed information on the key skills and how they are embedded in the learning outcomes will be included in the revised specification for Agricultural Science. The revised specification should also encourage innovation and creativity, which are fundamental to developing a culture of entrepreneurship that will contribute to economic and social progress.

2.3 International curriculum context

While many countries provide for the study of agricultural science and/or agricultural research as part of further or higher education, a much smaller number of countries include agricultural science as a standalone subject or area of study at second level. The curriculum provision in three such countries/regions is described below.

(a) CCEA GCSE specification in Agriculture and Land Use[1]

This recently introduced specification (September 2013) is designed for 120 -140 hours of learning, within the broad objectives of the Northern Ireland Curriculum. The GCSE *Agriculture and Land Use* is an applied qualification in which students develop knowledge, understanding and skills through practical demonstration and/or in a context related to employability.

The specification aims to encourage students to

- Develop their scientific knowledge in relevant, enjoyable and work-based contexts
- Appreciate how knowledge of science can enhance productivity in the land-based and environmental sector
- Develop their awareness of complex relationships between humans and the environment in which they engage in agricultural activity
- Acquire core knowledge about the land-based and environmental sector and the skills required to work in it
- Develop a critical and analytical approach to problem solving within the context of work-related scenarios
- Make informed decisions about further learning opportunities and career choices in the land-based and environmental sector.

The specification is unitised, comprising

- Unit 1: Soils, crops and habitats
- Unit 2: Animals on the land

[1] The specification is available for download at http://www.rewardinglearning.org.uk/microsites/agriculture_and_land_use/gcse/specification/index.asp. At present, it is not planned to develop a specification at A level.

- Unit 3: Controlled Assessment – contemporary issues in agriculture and land use.

In Unit 1, with a focus on an understanding of plants and their key role in the food chain, students engage in practical work and fieldwork and develop knowledge of how plants contribute to maintaining a healthy and balanced environment. Student awareness is raised of the diverse types of farming in Northern Ireland and they consider how modern farming can limit the impact that agricultural practices have on the natural environment, while enhancing biodiversity and promoting sustainability.

The learning outcomes in Unit 1 are set out under the following content headings:

- Composition of soils
- Horticulture
- Plant biology
- Crop production
- Care and management of the countryside
- Renewable energy and climate change
- Careers.

Unit 2 involves the main animal species that are kept commercially in Northern Ireland, with a focus on key aspects of cow, sheep, pig and poultry husbandry, including health, welfare and breeding. Students learn how farming is responding to increased environmental concerns about land use and they also consider sustainability at farm level, including diversification. The learning outcomes of Unit 2 are set out under the following content headings:

- Livestock farming
- Breeding and reproduction (cows, sheep, pigs, poultry)
- Health and welfare (cows)
- Nutrition
- Food production and processing
- Farm economics
- Farm health and safety

- Pollution and farm waste.

In Unit 3, taken at the end of the course of study, students carry out a practical investigation (Task 1) and a research project (Task 2) into topics relevant to contemporary issues in Agriculture and Land Use. For each task, students select one of three task titles. Each task is carried out under specified headings, with associated learning outcomes.

Task 1, which represents one-third of the marks available for the unit, provides students with an opportunity to apply their skills, knowledge and understanding as they

- Plan an investigation and develop a risk assessment
- Carry out an investigation
- Present a report.

Task 2, which represents two-thirds of the marks available for the unit, provides students with opportunities to apply knowledge and understanding to a realistic context as they

- Plan research into a contemporary issue in Agriculture and Land Use
- Carry out research using primary and secondary sources
- Present a report.

(b) New Zealand: Agricultural and horticultural science[2]

Agricultural and horticultural science in the New Zealand Curriculum (at senior secondary level) adopts a practical, production-focused approach, involving students in problem solving and the use of appropriate management practices. Through purposeful learning in agricultural and horticultural science, students engage in future and creative thinking and develop problem-solving strategies and lifelong skills. They build knowledge of practical techniques, and are encouraged to find innovative solutions to challenging production issues. They also learn to appreciate the economic, historical, social, and cultural influences on primary production and the interrelationships of science, technology, society, and the environment.

The study of agricultural and horticultural science has a production and marketing emphasis and is built around four **key concepts**:

[2] More detailed information is available in a guide which can be downloaded from http://seniorsecondary.tki.org.nz/index.php/Science/Ag-and-hort-science

- Primary producers produce for a market
- Producers systematically manage life processes
- Production systems must be sustainable
- Producers must make a profit.

The learning objectives for agricultural and horticultural science are structured in four strands that mirror the key concepts:

- Markets
- Life processes
- Sustainability
- Profitability

Programmes are based around realistic and practical contexts. Students learn to explore agricultural and horticultural issues and to communicate their ideas to others. They develop the skills of planning, investigating, designing, drawing, and model-making and capabilities in using digital tools and processes. They use creativity, logic, and knowledge to find innovative solutions to real-life problems. In agricultural and horticultural science, students will find themselves dealing with contexts, issues, and problem solving drawn from a broad agenda that includes, for example:

- Products (for example, pork, poultry, avocados, honey, timber, milk, wool, apples, grapes)
- Environments (for example, waterways, erosion, landscape, soil, shelter, glasshouses, effluent, pollution; environmental modification and sustainable management practices)
- Solutions for particular management issues (for example, irrigation, cropping, harvesting and milking equipment, data, information and communication digital technologies, shelter and shade construction, and cultivation technologies).

Agricultural and horticultural science is an applied science. As such, programmes can integrate concepts and achievement objectives from a range of learning areas including science, technology, social sciences, and mathematics and statistics. Programmes should take account of the particular needs and interests of the students and the particular opportunities that are available in the community.

Contexts for learning are chosen for their relevance and utility, and teaching focuses on long-term, valued outcomes rather than the learning of discrete and possibly isolated pieces of content. The

curriculum does not specify achievement objectives for agricultural and horticultural science. Since agricultural and horticultural science programmes can integrate concepts and learning from achievement objectives in biology, science, economics, geography, and technology, learning can be assessed using standards from a range of other subjects as achievement standards for agricultural and horticultural science.

The applied nature of agricultural and horticultural science is reflected in learning outcomes that allow for a broader range of assessment possibilities. Teachers use both diagnostic and formative assessments which include class or individual activities, student interviews, and effective questioning. They provide students with feedback that will enhance their learning, identify next steps in the learning process, address gaps in understanding and build a picture of student progress. Students also engage in peer- and self-assessment using agreed frameworks and exemplars. Although summative assessment tasks are usually in the form of written tests, other approaches – such as portfolios, practical investigations or end-of-unit presentations – can provide valid evidence of student understanding and application.

(c) Agricultural Science in Caribbean Secondary Education[3]

Agricultural science is one of 6 science subjects at second level in the Caribbean region. The Agricultural Science syllabus is designed to allow students to develop knowledge and understanding of the interaction between the component parts of agriculture and the scientific principles that explain the processes which take place when inputs are transformed into outputs. It caters for a broad range of abilities and interests among students in the region. The syllabus requires students to engage with certain conceptual and theoretical issues associated with the discipline, while at the same time providing them with the opportunity to develop a wide range of practical skills and an awareness of the technologies associated with agriculture.

The Agricultural Science syllabus is arranged in five sections, each of which consists of general and specific objectives, content and suggested practical activities:

- Section A – The business of farming
- Section B – Crop production
- Section C – Animal production

[3] The syllabus can be accessed at http://www.cxc.org/SiteAssets/syllabusses/CSEC/CSEC%20Agricultural%20Science.pdf

- Section D – Horticulture
- Section E – Animal management

Candidates for the Single Award examination must complete Sections A, B and C only. Candidates for the Double Award examination must complete all five sections. A minimum allocation of five forty-minute class periods per week is recommended for the single award, and a minimum eight class periods per week for the double award.

Each section of the syllabus is set out using general objectives, specific objectives, content and suggested practical activities. It is suggested that the laboratory exercises for the syllabus should be done in conjunction with those of the allied subjects of Biology, Chemistry, Physics, Integrated Science and Home Economics. The syllabus has a tie-in with Economics insofar as it includes objectives related to economic factors of production, trade agreements, and farm financing.

Examinations consist of written papers and a school-based assessment (SBA). Single Award candidates complete two examination papers and the SBA; candidates for the Double Award complete three examination papers and the SBA. The SBA is an integral part of student assessment and the suggested practical activities form part of the learning experience to enable students to achieve the objectives of the syllabus. It facilitates the development of essential investigative and practical skills that allow the student to function more effectively in his or her chosen vocation. It also provides an instrument for testing students and rewarding them for their achievements (Caribbean Examinations Council, Agricultural Science syllabus, p.38). In the assessment of skills (SBA) the student is credited for performances on each of ten identified skills on which he or she is examined.

As an intrinsic part of their study of farm production systems, students produce at least four crops (fruit, root, leaf and flower vegetable crop) during the course and rear a batch of broiler chicks—bred for meat production—(and, for the double award, a batch of layer chicks) each term. For the SBA, each student must record all activities associated with the cultivation of the crop from the planning stage to marketing of the crop, including all cultural practices, harvesting and post-harvesting techniques and marketing. They also rear a batch of broiler chicks (and, for the double award, a batch of layer chicks) from day-old to slaughter, carrying out all the necessary practices associated with broiler production. All activities are documented in a portfolio for presentation. Students also prepare a cost-analysis of one crop, and a cost-analysis of one batch of broilers (and, for the double award, one batch of layers) for presentation as part of their school-based assessment. In addition to the skills assessment and the study of farm production systems, students completing the double award are required to do a research project in which they apply

experimental techniques, technologies, research methods and data presentation and analysis techniques in the context of a particular agricultural issue or problem.

The difference in emphasis and scope of the specifications in these countries offers some points for discussion in developing a specification for Leaving Certificate Agricultural Science. These are considered in next section of the paper.

3. Issues for consideration

This section sets out a number of issues for consideration and resolution in the development of a specification for Leaving Certificate Agricultural Science. These arise from the nature of the subject itself and its inclusion among the sciences, as well as from its association with and impact on a wide range of social, cultural and economic factors.

Science investigation skills

In the revision of specifications in senior cycle sciences, a more investigative approach is taken to the study of science. As well as constructing knowledge of science and developing their science skills, students construct knowledge about the nature of science, including its moral and ethical dimensions. Investigative practices which involve *hypothesizing*, *experimenting*, *evaluating evidence* and *communicating* also facilitate the development of the key skills of senior cycle education. Through their engagement with science in the senior cycle, students acquire attitudes and values that will allow them to take informed positions on scientific issues.

Given the practical nature of agricultural activity and the emphasis on investigative activities in the rest of the sciences, it can be expected that the new specification will give appropriate emphasis to students engaging in experimental and investigative activities in laboratory and field situations. The nature and range of such activities will need to be considered, as will the potential contribution that they can make to encouraging creativity and innovation and the development of key skills. Unlike the Caribbean curriculum arrangement, given the individualised nature of subjects in the Leaving Certificate, opportunities do not necessarily arise for students to engage in laboratory-based investigative activities in conjunction with other subjects. Nonetheless, the extent of any overlap between Agricultural Science and the other Leaving Certificate sciences, particularly Biology, will need to be considered.

It will therefore be important to consider the balance which is desirable in the new specification between an emphasis on developing science knowledge and skills in and of themselves through the study of agriculture and its practices, and a focus on the agricultural practices and processes and the role which science and technology play in their operation and development. In addition, the specification will need to include broader issues associated with agriculture, such as its impact on the environment and its contribution to economic development through food production, which feature in the specification in both the Northern Ireland curriculum and the New Zealand curriculum.

Scope of the subject

Given the diverse nature of agricultural practice and the ever-changing developments in both science and technology that underpin and contribute to that practice, consideration will need to be given to the range of areas in agriculture that ought to be included in the specification. The feasibility of facilitating student interest in a wide range of agricultural contexts while at the same time maintaining a focus on the scientific principles and processes involved in the specification will also need careful consideration.

In the revised Agricultural Science specification, opportunities should be provided for integrating knowledge, skills, attitudes and values in the context of using and sustaining agricultural resources. Challenges related to sustainability, climate change and the environment in the context of increasing demand on agriculture for greater productivity in globalised economic systems must also be considered (IAASTD, 2009). These feature explicitly in the agricultural science specifications of New Zealand and Northern Ireland.

The increasing impact of economics on agriculture and food production and their contribution to economic activity will need to be reflected in the revised specification. In this regard, consideration will need to be given to elements of LC Agricultural Economics which are directly related to the agricultural industry in a general sense, as well as to individual farms and the farming industry. These could include

- agricultural production and income; the contribution of agriculture to gross national product
- value of trade in agricultural products and agricultural exports
- the farm as a business unit; costs, margins, record keeping, farm accounts, planning and budgeting, etc.

With the inclusion of elements such as these in the new specification for LC Agricultural Science it is expected that LC Agricultural Economics will be discontinued – as had been planned when the revision to LC Agricultural Science re-commenced in 2004. A new specification is also being developed in LC Economics.

Agriculture and the food economy

Developments in agriculture and associated food production in recent years highlight the significant contribution that agriculture makes to our economy. Consideration will need to be given to whether the focus of study in Agricultural Science should be on the supply role of farming to the food chain in terms of animal and crop production, or whether it should continue to focus

on such aspects as the general structure and function of plants and animals, and specific study of soils, farm crops and farm animals.

Other issues associated with agriculture and food production

Quite apart from the direct study of agricultural practices and the role played by science and technology in these, a range of associated topics also arises:

- Sustainability and the use of natural resources
- Profitability and its influence on traditional agricultural practice
- Health and safety in agricultural practice and food production
- Genomics, genetic engineering and ethical considerations
- Environmental issues, including water quality
- Impact on—and from—climate change
- Effect of European and global economic policies, regulation and funding, and the increasing contribution of agri-business to the economy

This is by no means an exhaustive list of issues which will merit consideration in the development of the specification for LC Agricultural Science.

Assessment of Agricultural Science

With the introduction of a second component of assessment in the sciences generally, the emerging consensus around the relative weighting of the two components and the focus of each can inform decisions in relation appropriate arrangements for the assessment of LC Agricultural Science. While the assessment should reflect and reinforce the practical nature of the subject, it must also accommodate the potentially diverse aspects of the subject and the kind of practical/coursework activities that these will involve.

Consideration will need to be given to elements of the current assessment model which can benefit the assessment of the new specification. Over time, and guided by specific criteria and the moderation process to provide quality assurance, teachers have developed expertise in the assessment of student practical work. The distinctive nature of this practical work in Agricultural Science will need to be recognized when decisions are being made around the 'fit' with the other senior-cycle sciences.

4. Brief for the review of LC Agricultural Science

In line with current developments and the new structures (NCCA, 2012a) the specification will be prepared by the Agricultural Science Development Group. It will be student-centred and outcomes-based, and follow the format of other senior cycle specifications:

- Introduction and rationale
- Aim
- Objectives
- Structure
- Key skills
- Learning outcomes
- Assessment
    - Assessment components
    - Assessment criteria.

In general terms, the specification should be aligned with levels 4 and 5 of the National Framework of Qualifications.

More specifically, the development of the new/revised specification will address

- how the development of key skills will be facilitated
- how to embrace technology and collaboration in the learning, teaching and assessment associated with the specification
- the scope and range of topics to be included, and whether options should be considered as a means of accommodating these
- agricultural practice as grounded in scientific reasoning, appropriate investigation, and the development of science process skills
- how student work will be assessed; the provision of multiple, diverse and appropriate opportunities available for students to achieve.

The work of the Agricultural Science Development Group will be based, in the first instance, on this brief. In the course of its work and discussions, elaborations on some of these points and additional points may be included in the brief.

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Appendix 1: Current LC Agricultural Science syllabus

AGRICULTURAL SCIENCE
Ordinary and Higher Level courses

An assessment, to which 100 marks will be allotted, will be made of students options.

Soils
The formation of soils.
Principal rock groups.
Weathering of rocks.
Origin of soils: glaciation, derived soils, soils formed in situ, formation of peats.

Soil Texture
Size of particles as determined by mechanical analysis. Classification of soils.
Humus.

Use of geological maps.
Map study of soils in Ireland.
Local soil surveys.

Physical properties of soils.
Soil structure; soil air; soil density; soil temperature; soil water and soil water control.
Principles of soil cultivation with reference to tillage crops and grassland.

Chemical properties of soils.
Colloidal properties, pH and flocculation in relation to clay fraction and humus.
Base exchange.
Major and minor elements. Fertilisers and liming.

Living organisms and their effects.
Macro and micro organisms. Interdependence of animals and plants.
Decomposition of organic matter; carbon and nitrogen cycles.
Improving soil fertility.

The General Structure and Function of Plants

Elementary structure and life cycle of a bacterium, mould, fern, pine and flowering plant.

The plant cell – types of cells in different plant tissues as seen in roots, stems, leaves.

Cell division – mitosis, meiosis.

Parts of the flowering plant – function of each part.

The flower and seed production.

Structure of seed – monocot and dicot.

Germination and establishment.

Propagation of plants by vegetative means.

Plant physiology: osmosis, respiration, photosynthesis, transpiration, translocation, food storage.

Tests for food constituents.

Essential elements for normal growth.

Identification of plants of agricultural importance in the school environment and study of characteristics and habitat.

Principles of classification of plants. Ability to classify plants in at least six natural orders.

Farm Crops – Cereal and Roots

Cultivation of one cereal and one root crop or potatoes in order to illustrate the agricultural importance of the following:

Rotation.
Soil suitability.
Preparation of seed bed.
Nutrition.
Choice of variety.
Seed dressing.
Time, rate and method of seed sowing.
Establishment.
Diseases, pests, weed control, health.
Harvesting, yield, storage, food value and final use.

At least one scientific investigation should be carried out in both cases.

Farm Crops – Grassland

Study of inflorescence and vegetative system of the following grasses and clovers: Perennial Ryegrass, Cocksfoot, Timothy, Meadow Fescue, Crested Dogstail, Bent Grass, a Meadow Grass, Red Clover, White Clover.

Study of pastures (permanent and temporary leys) under the following headings:
Establishment – soil, seed bed, manuring, seeds mixtures.
Management.

Measurement of output of grassland in terms of total weight, dry matter, meat and milk.
Conservation of grassland products.
Factors influencing the feeding value of pasture, hay and silage.
Maintaining fertility.

Tree and Shelter

Hedgerow trees and shelterbelts in relation to farm animals and crops. Effects of shelter on early growth and total yield of farm crops.

Principles of Genetics

The cell – structure; mitosis; meiosis.

Mendel's laws.

Sex determination, sex linkage.

Mutations.

Heritable characters and selection for breeding – see plant and animal sections.

Structure and Function of the Animal Body

Diversity in animal life. Principles of classification.

Brief study of one representative of each of the following phyla:
Protozoa, Platyhelminthes, Nematoda, Annelida, Mollusca, Arthropoda (insect species), Chordata (mammalian species).

Classification of parasites studied elsewhere in the course.

Skeleton and muscle – simple anatomical treatment; composition of the bone; the skeleton as a storage organ.

Growth – bone, muscle and fat deposition in relation to age; composition of muscle and fat.

Circulation: the heart and blood vessels: composition and functions of the blood.

Respiration: mechanism of breathing; respiratory function of the blood.

Ingestion: structure of the mouth of a ruminant and non-ruminant – relevance to feeding habits.

Digestion: study of the digestive system of the ruminant, horse, pig and fowl; the digestive juices; the digestive enzymes.

Function of the kidney. Excretion.

Regulation of body temperature; normal temperature; heat production and body temperature in relation to microclimatic control; critical temperature of the pig and ox; consideration of farm buildings in relation to environmental temperature and humidity.

Nervous system and reflex mechanisms: the brain, nerve cells, reflexes.

The reproductive system: dissection of the rabbit – male and female.

The endocrine system: simple treatment of the pituitary, thyroid, parathyroid, thymus, pancreas, adrenals and gonads.

Transport and storage.

(a) The blood and lymphatic systems.
(b) Liver, adipose tissue and skeleton as storage organs.

The Cow

Common breeds, general characteristics.
Breeding principles.

The cow in production – feeding standards for maintenance, milk production and reproduction with special reference to winter feeding and grassland utilisation.

The common diseases – cause, symptoms, prevention and control – for oral examination.

Milk production – the udder; measurement of yield; composition of milk, factors influencing yield and composition; bacteriology in relation to clean milk production. Milk products.

The calf – rearing for beef and herd replacement. General study of nutrition, growth, health and housing from birth to at least 12 months.

The Sheep

Common breeds, general characteristics. Breeding principles.

Nutrition, growth, care and health of lambs from birth to sixteen months.

Study of wool – types, growth, principal features, use.

Horse

Study of the horse (or pony) as a farm animal – for school assessment only.

Pig

Nutrition, management, environmental conditions, health
Sow – during pregnancy and lactation.
Bonham – birth to weaning.
Pig – weaning to slaughter.

Selection for breeding – based on genetical and visual assessment.
Factors affecting production costs.

Farm Buildings – *for school assessment only*

Ability to discuss farm buildings and to illustrate how they provide the environmental conditions required on the farm e.g. in regard to cattle and pigs. Emphasis on temperature, ventilation, insulation, planning for economy of labour.

Farm-House Environment – *for school assessment only*

The physical/aesthetic layout of the house in relation to the farm, farmyard and general surroundings.

NOTE: The examination in Agricultural Science will consist of (a) a written examination and (b) an assessment of the work of the candidate during the course. The assessment will be based on material set out in the syllabus and marks, to a total of 100, will be awarded under the headings set out hereunder.

(1) Identification of plant and animal types associated with agriculture.
(2) Practical experience with crops, livestock, house and farmyard layouts.
(3) Investigations carried out relating to ecology, soil science, animal physiology, plant physiology, genetics and microbiology.

Appendix 2: Updated guidelines for the assessment of LC Agricultural Science

Coimisiún na Scrúduithe Stáit
State Examinations Commission
Corr na Madadh, Baile Átha Luain, Co. na hIarmhí
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S89/12

To: Management Authorities of Second Level Schools

Leaving Certificate Examination in Agricultural Science 2014 and thereafter

Following a review of arrangements for the assessment of Agricultural Science at Leaving Certificate level, the updated guidelines attached are issued

(i) to assist teachers in the direction of candidates in the completion and presentation of their coursework and
(ii) to assist teachers in their assessment of the work of candidates during the course.

The updated guidelines involve changes to both the detail of the coursework specification and to the way in which marks are allocated.

The attached guidelines supersede the guidelines previously issued and are effective for candidates commencing the two-year programme in Leaving Certificate Agricultural Science in September 2012 and presenting for assessment in the Leaving Certificate examination of 2014 and thereafter.

Please bring this circular and the attached guidelines to the attention of all teachers of the Leaving Certificate Agricultural Science syllabus in your school.

If you have any queries please contact the State Examinations Commission at 090 644 2700.

Yours sincerely

Phil Mulvihill,
Staff Officer,
November,2012

LEAVING CERTIFICATE AGRICULTURAL SCIENCE

PRACTICAL COURSEWORK ASSESSMENT

GUIDELINES FOR TEACHERS

Applicable to candidates presenting for the Leaving Certificate examination in 2014 and thereafter.

The government publication *Rules and Programmes for Secondary Schools* sets out the syllabus in Agricultural Science.
It states:

"The examination in Agricultural Science will consist of
(a) a written examination and
(b) an assessment of the work of the candidate during the course.

The assessment will be based on material set out in the syllabus, and marks, to a total of 100, will be awarded under the headings set out hereunder.

(1) Identification of plant and animal types associated with agriculture.

(2) Practical experience with crops, livestock, house and farmyard layouts.

(3) Investigations carried out relating to ecology, soil science, animal physiology, plant physiology, genetics and microbiology."

Agricultural Science at Leaving Certificate level is marked out of a total of 400 marks.
A total of 300 marks (75%) is allocated to the terminal written examination and 100 marks (25%) to the coursework component. The breakdown of marks is summarised in the table below.

Allocation of marks			
Written paper	Coursework		
	(1) Identification	(2) Practical experience	(3) Scientific investigations
300	20	35	45

The detailed allocation of marks is given below in the relevant sections.

These guidelines are issued to assist teachers in the direction of candidates in the completion and presentation of their coursework and to assist teachers in their assessment of the work of candidates during the course. Examples or suggestions given in the guidelines are for illustrative purposes and are not intended to be exhaustive or limiting.

Candidates will present their coursework in the normal way. Monitors, appointed and trained by the SEC in the national standards, will monitor the teachers' assessments by review of the coursework and by interviewing a sample of candidates.

Teachers are reminded that in the Agricultural Science practical coursework component all work is assessed at a Common level.

1. Identification of plant and animal types associated with agriculture **(20 marks)**

Candidates are required to demonstrate their ability to:

- identify five common plants related to their experience of agriculture
- name the families to which the identified plants belong.

Identify plants: 5 × 1 mark
Name families: 5 × 1 mark
} = 10 marks

Candidates are required to demonstrate their ability to:

- identify four common food-producing animals by the bodily characteristics specific to their breed
- identify six other animals related to agriculture and state their agricultural importance (Suitable animals might include e.g. parasites, disease vectors, soil-borne organisms).

Identify and state bodily characteristics of food-producing animals: 4 × 1 mark
Identify and state agricultural importance of other animals: 6 × 1 mark
} = 10 marks

2. Practical Experience **(35 marks)**

Candidates are required to demonstrate that they have gained practical experience in the areas of crops, livestock and farm layout as outlined below.

(a) **Crops** – 15 marks

Two crops must be chosen from the following list, with only one crop to be chosen from each line:
(i) A cereal
(ii) Potatoes **or** a root crop
(iii) Grassland
(iv) Any other crop.

Both chosen crops must be treated under the headings given in the syllabus.

(b) **Livestock** – 10 marks

Any **one** type of livestock of which the candidate has practical experience is acceptable. Suitable headings might include e.g. types of enterprise, breeds, breeding principles, nutrition, husbandry, disease control, housing.

(c) **Farm layout** – 10 marks

Candidates are required to present a sketch plan indicating

- the farmhouse and buildings
- the farm

and to demonstrate their ability to discuss the farm buildings and how they provide the environmental conditions required on the farm and to demonstrate the physical/ aesthetic layout of the house in relation to the farm, farmyard and general surroundings. Suitable information/ discussion points might include e.g. planning for economy of labour, aspect, roadways, fencing, shelter, grazing methods, crops grown.

Candidates must maintain a record their practical experience, which may be gained through one or more of the following:

- experience on a family farm
- experience on an adopted farm
- suitable farm-based or garden-based investigations.

3. Scientific Investigations **(45 marks)**

These scientific investigations are intended to be carried out over the full two years of the course. Candidates should be reminded that high marks can only be expected when as complete a range as possible of such work is presented that fulfils the criteria set out below and is consistent with laboratory work and fieldwork performed over the duration of the course.

Each candidate must maintain a written record of all scientific investigations carried out, under the following headings:

- Date
- Aim
- Method – to include relevant controls
- Diagram(s)
- Result
- Discussion
- Conclusion.

Work should be of an appropriate standard and must include evidence from enquiry-based laboratory or field investigations in each of the main areas of study listed below.

(a) **Ecology** – 10 marks

A detailed study of a named habitat to include at least three distinct lines of investigation e.g. drawing a map, qualitative survey, quantitative survey, field techniques used, biotic factors, abiotic factors, edaphic factors.

(b) **Soil Science** – 10 marks

An investigation to include at least three distinct aspects of soils e.g. soil texture, soil structure, soil composition, physical and chemical properties of soil, soil organisms.

(c) **Plant Physiology** – 10 marks

An investigation to include at least three distinct aspects of plant physiology e.g. plant structure in relation to function, plant-water relationships, plant nutrition, plant growth regulators, plant reproduction.

(d) **Animal Physiology** – 5 marks

An investigation to include at least two distinct aspects of animal physiology e.g. the structure and function of some of the principal body systems of a farm animal.

(e) **Genetics** – 5 marks

An investigation to include at least two distinct aspects of genetics e.g. any aspects of breeding or variation in agriculturally relevant plants or animals.

(f) **Microbiology** – 5 marks

An investigation to include at least two distinct aspects of microbiology in agricultural contexts e.g. presence and/ or effect of microorganisms in silage, milk, soil, water, feed.

Appendix 3: Extracts from the 2006 draft syllabus for LC Agricultural Science

Contents

Leaving Certificate Agricultural Science – Draft syllabus (2006)

1.0 Introduction

1.1 Rationale

Agricultural science is the study of the science and technology underlying the principles and practices of modern-day agriculture.

It is a scientific approach to the knowledge and understanding, skills and attitudes that affect the long-term sustainability of agricultural resources – the land, plants, and animals. This scientific approach 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 natural resources of the 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.

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 agricultural science arise from the basic investigative nature of the subject and a holistic approach to its teaching. Scientific and agribusiness principles are applied to the solving of identified problems arising from the student'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 in the range of other practical activities encountered. Similarly, they learn skills of analysis and interpretation of data, hypothesis formulation, and the testing 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 enquiry, curiosity and self-confidence in the student 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 student in a personal way with the scientific world by being placed in the social and historical context of a young scientist at work and by exploring such things as the production of a food product or the analysis of the effect of shelter on crop growth. Students are involved with the formulation of 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. 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 greater motivation and interest continually arise through the need to exercise concern and care for living things (plant or animal), 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 helpful, 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 those responsibilities placed in their charge, to make judgments based on evidence, and to appreciate the culture of enterprise. It enables the students 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 student will operate.

1.2 Aims

The Leaving Certificate agricultural science syllabus is designed to prepare students for immediate entry into open society, or to further education and training, through well-designed studies of knowledge-based, experimental, investigative and practical agricultural science activities.

The syllabus aims to enable students to

a. appreciate the natural environment and human interactions with it and the use of its resources for the production of food and non-food materials, leisure and amenity activities

b. become confident citizens in a technological world, able to take or develop an informed interest in matters of scientific and agricultural importance

c. recognise the usefulness and limitations of the scientific method and appreciate its applicability in other disciplines and in everyday life

d. recognise the importance of scientific principles and their application to modern techniques and practices in the utilisation of our natural resources for productive purposes

e. provide a suitable basis for the formation of the careers of school leavers with a wide variety of interests and aspirations

f. develop an appreciation of the significance of the agricultural industry to the Irish economy in the context of European and world dimensions

g. develop an understanding of the nature of food and the global limits to its production

h. encourage an appreciation of the need for safe laboratory and field investigation practice

i. develop an interest in working with plants and animals in the context of the working environment and as a leisure-time pursuit

j. recognise the need for a rational and balanced approach to the exploitation of natural resources in harmony with the environment.

1.3 Objectives

1.3.1 Knowledge and understanding

Students should

a. develop an understanding of the scientific facts and principles underlying the nature and practices of agricultural science

b. develop an ecological sense of the role and place of humans in the provision of food and non-food materials

c. develop an understanding of the origin and distribution of soils and their physical, chemical and biological properties

d. understand the scientific principles underlying the primary production of food and food products

e. understand the scientific and management principles of crop and animal production

f. understand the nature, growth and importance of micro-organisms in food production

g. be aware of the environmental impact of weather and of various agricultural practices

h. be aware of the effects of pollution, its causes and methods of prevention

i. understand the general structure and function of plants and animals of agricultural importance

j. apply scientific principles to the understanding of suitable environmental conditions in respect of the welfare of farm animals

k. understand the scientific principles of animal and plant breeding

l. understand the scientific principles, ethical issues and economic importance of biotechnological applications in agricultural science

m. become aware of the contribution of agriculture to the economy of the locality and the nation and its importance in EU and world contexts and be able to make informed evaluations of contemporary agricultural science issues.

1.3.2 Attitudes

Students should

a) develop an attitude of curiosity and scientific enquiry involving accurate observation and deduction through first-hand experimentation, investigation and practical work
b) appreciate how the application of science and technology may be both beneficial and detrimental to the individual, the community and the environment
c) appreciate that the study and practice of science are co-operative and cumulative activities and are subject to social, economic, technological, ethical and cultural influences and limitations
d) develop informed attitudes towards the wise use of our natural resources and environment
e) develop an awareness of the need for safe practice.

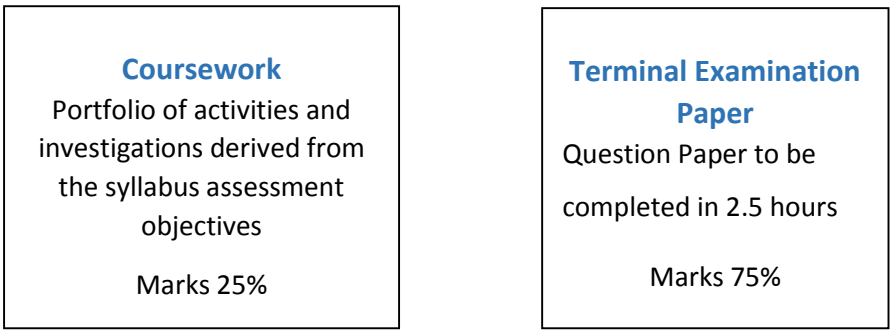
1.3.3 Skills

The agricultural science syllabus should promote the development of the following skills:

a) the ability to plan, design and implement scientific investigations and experiments
b) the use of scientific methodology in problem-solving
c) observation through laboratory and field work
d) the selection, recording, analysis, interpretation and use of data
e) independent thinking and self-directed learning abilities in students through active engagement in their own learning and through project work
f) logical thinking and inductive and deductive reasoning
g) the presentation and communication of information
h) the care and maintenance of plant and animal stock.

Appendix 4: Assessment proposal for LC Agricultural Science (2006)

Leaving Certificate Agricultural Science will be assessed at two levels, Higher and Ordinary. At each level, assessment will be by means of a terminal examination paper and coursework. The assessment arrangements are illustrated below.



Coursework assessment

Students must complete a range of investigative and experimental work, in laboratory and field situations, including demonstrations, field or industrial visits and other appropriate activities. These activities will be prescribed within broad syllabus content areas and will be assessed under generic skills-based parameters.

Over the two years of the course, each student will be required to maintain a portfolio in which a record of this work will be kept, according to specified criteria. This record must be available for inspection during the course and must be presented by the student in the school for external assessment.

Common criteria will be applied to the assessment of coursework at Higher level and Ordinary level (ref. syllabus 1.8.3). Different weighting will apply at each level.

Terminal examination paper

There will be separate Ordinary level and Higher level examination papers. At each level the examination paper will consist of four sections, which will assess students' knowledge and skills in relation to syllabus material under the headings of Natural Resources Science, Food Science and Technology (including Animal Enterprise Science and Crop Enterprise Science) and The Agricultural Industry in Context.