



Leaving Certificate Agricultural Science

Guidelines for completing the Individual Investigative Study

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Introduction

The Individual Investigative Study provides an opportunity for students to develop a deeper understanding of the science underpinning agricultural practice in an integrated way, while also developing and refining their practical science skills. The development and interplay of skills of research, experimentation, communication and application of knowledge to contemporary agricultural issues is at the heart of Agricultural Science. The Individual Investigative Study is designed to allow students opportunities to develop these skills further. It is therefore an integral part of the learning in Agricultural Science and is directly related to the aims and learning outcomes of the subject.

The Individual Investigative Study affords students the opportunity to connect learning from their local experience to the Agricultural Science course and expand their thinking to the wider agri-food sector in Ireland and the world. While connecting with learning across the specification, it directly addresses the learning outcomes of Strand 1, Scientific Practices. This strand focuses on developing students' abilities to understand the purposes and principles underpinning the practice of science. The scientific practices in this strand permeate the other strands and are experienced through the learning outcomes and cross-cutting themes.

This document, *Leaving Certificate Agricultural Science: Guidelines for completing the Individual Investigative Study*, provides

- an overview of the coursework assessment for Agricultural Science
- guidelines on the process for conducting the Individual Investigative Study
- information on the role of teachers in supporting students in the process of completing the Individual Investigative Study
- information on the evidence of learning required.

These guidelines should be used in conjunction with the curriculum specification for Leaving Certificate Agricultural Science, which can be accessed at

<https://www.curriculumonline.ie/Senior-cycle/Senior-Cycle-Subjects/Agricultural-Science>.

The State Examinations Commission (SEC) will issue a thematic brief, which contains instructions and clarification to all examination candidates of the procedures for completion and submission of the Individual Investigative Study, available on the SEC website at www.examinations.ie.

Overview of coursework assessment

The coursework assessment of Leaving Certificate Agricultural Science includes:

- a portfolio of specified practical activities
- an Individual Investigative Study.

Portfolio of specified practical activities

Students must complete the range of specified practical activities set out in the learning outcomes of the specification, including laboratory and field investigations, and other appropriate activities. Over the two years of the course, each student will be required to maintain a portfolio in which a record of all activities is kept. There is no particular method specified for these activities. The activities are planned and carried out in groups and reported on individually. Where appropriate, these reports should include video, audio and electronic graphical analysis. The reports will not be externally assessed but must be available for inspection and retained until the end of the assessment process. The skills developed in the specified practical activities will be used by the student to successfully complete the Individual Investigative Study.

Individual Investigative Study

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

The brief for the Individual Investigative Study will be issued by the SEC early in year 1 of the course for each examination cohort and will be a common thematic brief for both Ordinary and Higher level. The brief will provide a topic of agricultural significance which should be used as a “lens” whenever appropriate to look through while engaging with the learning outcomes and cross-cutting themes of the specification.

The form and requirements of the Individual Investigative Study will be the same at both Higher and Ordinary levels. Upon completion of the Individual Investigative Study, students will be required to present a report. The format of the report, a digital booklet, and means of submission will be specified by the SEC.

it is important to note that students are not assessed on the study itself but on their report of the study. The report on the study accounts for 25% of the total marks for Leaving Certificate Agricultural Science.

Timeframe

The brief for the Individual Investigative Study will be issued by the SEC early in Year 1 of the course. Given the integral and interconnected nature of the Individual Investigative Study with students’ progression through the course, there is no set time period specified during the two years within which the study must take place. Students may begin work on their Individual Investigative Study as soon as the brief has issued and continue in parallel with their studies over the duration of the course. As they encounter aspects of the course which are of interest to them and of relevance to the brief students may, with the support and guidance of their teachers, pursue these aspects as part of their study. Students will thus engage with aspects of the Individual Investigative Study throughout the Agricultural Science course as relevant and appropriate to their school context. The SEC will specify a date towards the end of Year 2 by which the report is to be submitted.

Overview of the study

The brief will relate to an area of agricultural significance and be relevant to the cross-cutting themes of the course. The brief will require students to conduct a study involving research, experimentation and communication. This is in keeping with the learning outcomes of Strand 1 of the specification, *Scientific Practices*.

Students will conduct research in response to a research question of their design. They will form justified opinions based on an evaluation of contemporary and relevant evidence from the field of agricultural science. They will demonstrate practical skills in conducting laboratory and/or field experiments of their choosing and design. Throughout the process communication in various forms will be central, as they convey the process and outcomes of their study in a report.

The process of conducting the Individual Investigate Study and completion of the final report must be the work and responsibility of the individual student. Whilst students may collaborate to share ideas and evidence from common areas of study, they must individually pursue their own research question in conducting their study. The report must be authenticated by the agricultural science student, teacher and school authorities. The SEC will provide guidelines on authentication and submission.

Conducting the study

While it is acknowledged there may be overlap and various iterations as students engage with the investigative process, the Individual Investigative Study will broadly consist of a number of phases. These phases, outlined below, suggest different aspects of the process of completing the study and are not to be misconstrued with section headings for a report.

Getting started

Informed by the brief, students will develop an outline for the study which speaks to the brief but also their experiences of the Agricultural Science course. In developing an outline for the study, students should clarify:

- the topic they wish to investigate
- how it connects to the brief
- a plan for conducting the study.

Great care is needed in the selection of a topic to investigate and the choice should be made in consultation with the teacher. Students will need to be able to justify and defend their research, experimentation and communication choices as aligned with the brief. It is suggested that students do not undertake substantive work on the project until the teacher has approved a submitted plan (Appendix 1). It is anticipated the plan should be submitted within a month of considering the SEC brief.

Students may have specific interests in relevant agricultural science practices that extend beyond the classroom. Given the need for the study to be an original piece of work, students should be encouraged to pursue those areas they have interest in. Where the chosen topic derives from something of genuine interest to the students, the study can help to link student experience with the theory and practice of agriculture and empower them to be inquiring, self-confident and reflective learners.

It is suggested that students provide a background to the setting for the study, including details on the agricultural enterprise involved (e.g. if the study is taking place in a farm setting – provide an overview of the farm). In considering an overview of the study, students may wish to consider the following questions:

- why choose this study? Students may wish to present a rationale based on personal and/or agricultural significance
- where is the study being conducted and over what time period?
- how is the study organised? Provide an outline of activities and milestones over the course of the study
- what are the different aspects of the study – pose the research question to be investigated for the topic chosen, provide an outline of the research and experiments conducted and how they respond to the research question.

Clarifying and understanding the topic under investigation

Students will be expected to show evidence of initial research on the brief, including consideration of existing solutions or ideas. They will also be expected to research the background and context of the brief.

Once students have familiarised themselves with the brief and relevant information, they will then clarify a topic to investigate and develop a research question. Students should ensure their research question:

- relates to the brief and the topic under investigation
- is based in an agri-scientific background
- can be engaged with through considering evidence from different viewpoints
- requires students to form a justified opinion based on the evidence
- lends itself to investigation by research and experimentation.

An example of prompts for evaluating the suitability of a topic is suggested in Appendix 2.

Research

Students will conduct research in response to their research question. They will gather evidence in the form of information/data from a variety of sources including the internet, newspapers, science journals/magazines, or any other appropriate source e.g. findings from reports, commentary from people involved in the agri-food industry, field observations from farms, secondary data and observations taken from agri-food events and field trips. It is important for students to record the sources of all the information gathered in order to assess its reliability and quality (relevance, accuracy and bias) and to ensure the sources of information used can be appropriately referenced in their report. Good research practice involves reviewing, summarising and evaluating evidence from different viewpoints. This allows an informed and justified opinion to be made in response to the research question. Students are expected to conduct their research in a responsible, safe and ethical manner and to avoid plagiarism. The role of the teacher is central here. Teachers should support students in understanding plagiarism and steps to avoid it through various experiences throughout the Agricultural Science course. This is best achieved when students, from an early stage of embarking on the course, gain frequent and progressive opportunities to develop their research skills through the ongoing and appropriate use of learning intentions and success criteria.

Experimentation

To further enable students to take an informed position in relation to their research question, they will generate evidence through conducting laboratory and/or field experiments. Students will collect primary data through experimentation and will use this data to draw conclusions informing their response to the research question. Students may choose to conduct more than one experiment and replicate this across different points during their study (e.g. across different seasons). Depending on the nature of the topic, aspects of this work may also need to take place beyond classroom settings. It is important to note it is the quality of experimentation that is being assessed, not the quantity. Students should be given ample time over the course of their studies to have hands-on experience in planning, conducting and reporting on their own experiments. This will support students in developing the appropriate knowledge and skills to conduct their Individual Investigative Study.

For each experiment that students conduct, it is expected they will generate a hypothesis which fits the following criteria:

- it defines and links the variables under investigation
- it is testable
- its testing is manageable.

If the investigation is more of a *trial and error* nature, then students may choose a more general statement, a prediction, rather than a hypothesis.

Students collect data in a safe and responsible manner with guidance from their teachers. To support student planning for conducting their experiments, it is suggested they provide their teacher with an experimental plan (See Appendix 3 for example template). Any safety concerns and steps taken to minimise the concerns should be outlined. Accurate use of equipment and reliable collection of a sufficient amount of good quality data are expected. Data should be recorded and presented using appropriate representations (e.g. tables, graphs, formulae, models) and relevant scientific terminology. Any calculations should be completed to a high degree of accuracy. Descriptions of trends, patterns and/or anomalies should be outlined where necessary. Conclusions drawn should be justified by the analysis of the data and the strengths and/or weaknesses of the experimental approach taken should be described in detail.

Students may wish to consider some or all of the following aspects for each experiment:

- setting for experiment
- equipment
- safety considerations
- variables and controls
- hypothesis
- method
- data collection, representation and analysis
- conclusions and reflection on the experimental approach
- significance of the conclusions in helping to answer the research question.

Communication

Throughout the process of conducting the study, communication will be central. Students will communicate with their teachers on an ongoing basis as they develop and refine their study. They may communicate with classmates and experts in the field as they investigate their research question. They will also communicate the outcomes of their study in a report, submitted in the format of a digital booklet as prescribed by the SEC.

The Individual Investigative Study is completed digitally using the template, file format type and instructions specified by the State Examinations Commission (SEC). The completed report will comprise of some or all of the following elements: written text, data tables, diagrams, digital images and photographs. All images must be captured, edited and published in accordance with the requirements of the school's AUP and Data Protection Policy, and GDPR. Effective science communication involves synthesising information on the topic using relevant and appropriate scientific terminology. Clear and precise knowledge, understanding and application of scientific ideas and theories relevant to the study is recommended.

Good scientific practice involves keeping research records throughout the investigative process. Examples of items students might include in their research records are:

- sources and summaries of background information
- initial and refined questions and hypotheses
- data collection methods used

- details of any trials carried out, raw data collected, any interesting or anomalous observations
- note of any key decisions and actions
- mistakes made and decisions for improvement.

Research records capture ongoing investigative activity and cognitive work. They provide primary sources of data and show ongoing progression of the investigation. While the research records will not be submitted to the SEC, aspects of these records can be distilled into the final report. This will help to enhance the overall authenticity and quality of the final report

Students may adjust their original outline plan for the study. This could be for various reasons, such as emerging opportunities in the field, changing conditions over the period of study, new insights from research and/or data collection which lead to other avenues they wish to pursue. Any decisions made to change from the original plan should be documented and reflected in the students' research records. To support students in reviewing, refining and reflecting on their investigative process, it is suggested they complete progress reports (Appendix 4) with their teacher at strategic intervals throughout the duration of the study. Whilst there is no specified timeline for the study, it is suggested that students would complete a progress report for at least three points in time, such as:

- during their research phase
- during their experimentation phase
- during their preparation for final write up.

The student is best placed, with the support and guidance of their teacher, to decide when would be appropriate to complete a progress report and should not feel restricted by the phases suggested above. For example, a study may involve seasonal data collection and students may wish to complete progress reports across the season. The important point is that students are encouraged to reflect upon the progress of their study and to clarify, and justify, any key decisions they have made. This may include a rationale for any significant changes to the original plan.

Students should reflect on the outcomes of their study in relation to the topic and requirements of the brief. Combining knowledge and understanding gained from research and experimentation, they should take an evidence-based position in response to the research question. They will reflect upon the study and comment on:

- the degree to which the research question was answered
- improvements in the research and experimental approaches chosen
- future directions and areas of further investigation
- significance of the outcomes of the study for the agri-food sector and/or the study of agricultural science.

Whilst students will follow an investigative process for the study, the assessment will be of their final report alone. Students should take care to ensure the communication of their work in the final report is sufficient to allow a judgement to be made on the quality of all the study rather than just aspects.

Conducting aspects of the study in settings beyond the Agricultural Science classroom

Any work completed beyond school settings and away from the supervision of the teacher can be authenticated by the teacher through ongoing review of student work in combination with direct oversight of the aspects of the work done in school. This review can take various forms, such as conversations with the student, check in on research records, pictures and video¹ from experiences in the field and more structured review through progress reports.

If students are collecting data beyond classroom settings and away from the supervision of their teacher, they must provide sufficient evidence to their teacher that the work is their own and was conducted in a responsible, safe and ethical manner. Students can choose to share this information using a variety of media such as photos, audio/video or diary entries in their research records. The SEC will provide clarification as to the format and types of media to be submitted in the final report.

The Individual Investigative Study allows students to design their own investigations, stemming from their areas of interest and/or experience in the field. They can also choose to adapt, modify and extend specified practical activities from the course. For example, depending on the brief issued in any given year, a student may base their study on a farm engaging with mechanical weeding practices and may choose an experimental design around these practices. Likewise, a student may choose to extend the specified practical activity of investigating the botanical composition of an old permanent pasture or new ley (learning outcome 3.3.2) by investigating botanical composition before and after different mechanical weeding practices and compare the results.

¹ Note – videos may not be submitted in the report to the SEC

The teacher's role

The teacher has an important role to play in supporting and supervising the student. The most crucial role a teacher can play in preparation for the Individual Investigative Study is to ensure students are facilitated in realising the learning outcomes of all four strands of the specification. This should be done in as many contexts as possible over the duration of the course and through consistent engagement with the crosscutting themes. Engagement with the scientific practices of Strand 1 is pivotal to students' readiness to carry out their study.

Getting started with the study

Teachers should, at an early point in the course, communicate to students the various assessment components for Agricultural Science, including all coursework components. They should clarify the requirements of the Individual Investigative Study and, when the brief is released, create opportunities for students to consider the relevance of the brief for their current and upcoming learning in Agricultural Science, including specified practical activities. Students should be reminded to centralise their own circumstances and interests when considering a topic of agricultural significance to pursue in response to the brief. They should be encouraged to consider evidence from local, national and international contexts and from a variety of reliable sources as part of their background research. Once students have had time to conduct background research in relation to the brief, they should develop an outline plan for the study. It is anticipated this should take place within one month of considering the brief. Teachers should consider the implications of students' proposed studies in their planning for teaching and learning.

Supporting formative assessment in the classroom

Teachers should ensure that, as part of the ongoing formative assessment in the classroom, students gain frequent opportunities for authentic engagement with the processes of scientific investigation. Students should be empowered in realising that research and experimentation is more about engaging with and learning from the process, rather than seeking a seamless trajectory or *perfect answer*. Authenticity is key and students should not be penalised for giving an honest representation of how their investigative work unfolds. To promote a scientific habit of mind within students, teachers are encouraged to promote student reflection on their investigative work throughout the Agricultural Science course.

Students' knowledge and understanding should be enhanced by engaging in the Individual Investigative Study and learning from it. This could include learning that something did work, but also that something did not work, and in either case understanding why. Teachers should provide students with opportunities to talk about the SEC brief throughout the Agricultural Science course, allowing for a balanced consideration of the Individual Investigative Study across the course. This will require teachers to consider the brief at the point of planning for engagement with the learning outcomes of the specification. In advance of the brief being shared with schools, teachers can engage students with the scientific practices of Strand 1 to help them in their ongoing knowledge and skills development as they progressively improve their capacity to carry out their own investigations. This will help them in their preparations for engaging with the brief.

The role of formative feedback on students' investigative work is crucial in supporting their development as agricultural scientists. Effective feedback goes beyond acknowledging the achievements in the work and should promote student thinking – strengths of the work and areas for improvement should be highlighted, and student reflection should be encouraged. Feedback should be in reference to an agreed and shared standard. Students are best served in understanding the standards of expectation for their work when they are involved in conversations around those standards. This is best achieved through the ongoing and appropriate use of learning intentions and success criteria, effective questioning and formative feedback throughout the students' course of studies.

Supporting student reflection

Student reflection on the process is supported by the teacher through encouraging the ongoing use of research records and through the completion of staged progress reports. The purpose of completing progress reports is to show the evolution of the investigative process, promote reflection and support students in their decision-making process. If completing a progress report with students, the following practices are encouraged:

- the teacher could mediate a progress report in conversation with the student. This should not be considered an onerous task, and it would not be expected of teachers to review drafts of reports, full experiments or excerpts from research. The progress report should simply serve as a 'check in' with the student on how the process is going, any key milestones, decisions taken and rationale for any changes made. Where possible, the student should be encouraged to complete the report themselves.
- set goals with the student and check in on these goals regularly through ongoing classwork.

- encourage students to communicate the learning from positive and negative outcomes of investigative work. Failure is a valuable part of the process and encouraging students to reflect upon this helps to promote resilience and a scientific habit of mind. This is best achieved through promoting a culture of productive/safe failure in the classroom.

Authentication

The SEC has detailed guidance as to the conditions for acceptance and authentication of coursework. Additional information as to how this applies in the case of the Individual Investigative Study will be provided in the documentation accompanying the brief, including the requirements for adequate oversight of any activities not directly observed by the teacher.

Evidence of learning

Students present evidence of learning in the form of a report, submitted as a digital booklet in a format specified by the SEC. Students should present their report in a structured and coherent fashion. Students must acknowledge the source of any research or the use of the work of others, including any images or photographs. **The report can be completed at the end of the study and submitted in line with instructions provided by the SEC in the brief.** It is expected the report would be no more than 2500 words in length (including titles of diagrams and other images but excluding the list of references at the end of the report). Care should be taken to not exceed this word count.

Assessment criteria for the Individual Investigative Study

The assessment criteria for the Individual Investigative Study are set out in the Curriculum Specification for Agricultural Science (DES/NCCA, 2018, p.28). They are described at three levels of achievement: high, moderate and low.

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

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

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

Inclusive practice and access arrangements

Leaving Certificate Agricultural Science is designed to be accessible to every student. Any access arrangements that a school considers necessary for a particular student to carry out the course work component should be processed between the school and SEC as early as possible. These are known as *reasonable accommodations*. They are designed to enable the student to show what they know and what they can do without changing the demands of the assessment. It is important that, in order to make an informed decision before undertaking the course, any prospective learner who has a disability that might affect their capacity to engage with the standard assessment arrangements be made aware of the accommodations that are possible. Equally important is that the student be made aware, where relevant, of those access arrangements that are *not* possible. Further details as to the arrangements that are possible are available on the SEC's website, www.examinations.ie, or available from the Reasonable Accommodations Section of the SEC directly.

Appendix 1: Suggested student plan for the study

Student name:	Date:
	Class:
The topic I wish to investigate:	
How it connects to the brief:	
My plan for conducting the study	
Areas of the study	Timeline
Research	
Experimentation	
Communication	
Approved by:	Date:
Feedback:	

Appendix 2: Suggested prompts for evaluating the suitability of a topic in response to the brief

SEC Brief	
Topic selected by student in response to the brief:	
Research question:	
Is this topic relevant to the brief?	
Does it provide opportunities to engage with the themes and learning outcomes of the specification?	
Are there a number of viewpoints that can be researched?	
Can the research question be investigated through research and experimentation?	
Can primary data be collected safely in laboratory and/or field settings which support the formation of conclusion?	
Can the research question be pursued over an appropriate period of time (e.g. a season of production) in laboratory and/or field settings?	

Appendix 3: Suggested experimental plan

Student name:	Date:
	Class:
Experiment:	
How it connects to the brief:	
Equipment and materials request:	
Safety:	
Proposed method:	
Approved by:	Date:
Feedback:	

Appendix 4: Suggested template for progress report

Student name:	Date:
	Class:
Progress Report number:	
What stage is the study at?	
Main achievements and milestones so far:	
Key decisions made and why:	
Next steps:	
Approved by:	Date:

