

LEAVING CERTIFICATE
AGRICULTURAL SCIENCE



Agricultural Science – Individual Investigative Study
Supportive Information for Report Writing



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Individual Investigative Study – Report Writing

Agricultural Science students must design and complete an Individual Investigative Study and write a report on the process, in response to a brief issued by the State Examinations Commission (SEC) in Autumn of 5th year. It is worth 100 marks or 25% of the student's overall grade. The report must be completed by a deadline (April 21st for 2023) in 6th year and submitted via the School Portal shortly afterwards (April 25th-28th for 2023). From 2023 onwards reports must be submitted in pdf format. ***Please note*** It must be completed using the template booklet provided annually by the SEC called a digital reporting booklet so it is advisable to download this and get your students to work with it as their project progresses.

The report must not exceed 2500 words (excluding references, equations, diagrams, graphs, etc.) and must not include more than 20 images. An image can be any relevant table, graph, chart, diagram or photograph. The total file size of your digital report including all embedded images must not exceed 100 MB. One teacher gives their overview of the IIS in this video. A breakdown of the sections and marks are found in Appendix A and B.



Understand the brief!
The most important step is to unpack the brief you have been given and understand exactly what the purpose of your project will be.

The SEC have published an Information Note reviewing the coursework components of recent subjects that have new specifications. It offers an insight into good practice observed by examiners of student work as well as advice on engaging with the coursework. Below are some key examples of these.

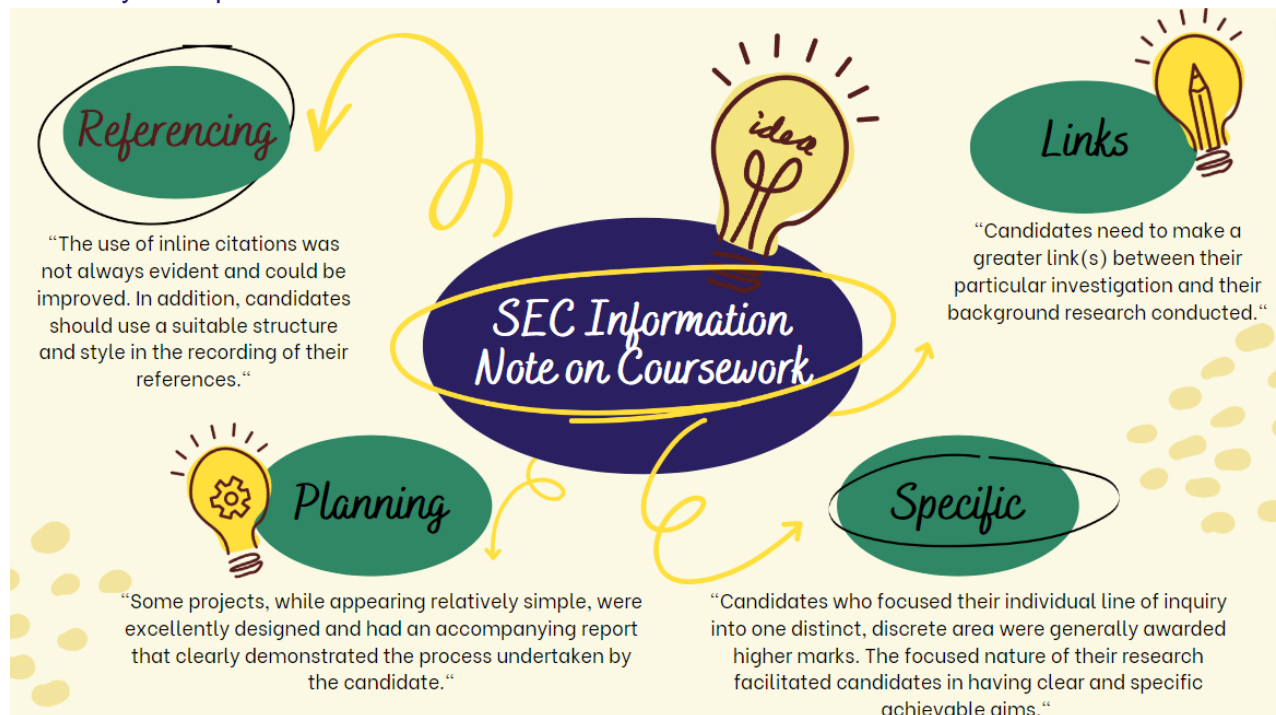


Figure 1: Information note for four Leaving Certificate subjects with new subject specifications (SEC, 2021)

There will be five sections to this document to reflect the sections of the IIS:

1. Background Research and Introduction (& Referencing)
2. The Investigative Process
3. Results, analysis and conclusions
4. Reflection on the study
5. Communication and Innovation

Each section is covered in the following pages.

1. Background Research and Introduction (& Referencing)



Researching for your investigation

When engaging with research to find out more about a certain area of interest, it is important to be aware of what are reputable sources and what are not. While the use of search engines and YouTube may be an obvious place to start, you must be careful of whether the information is reliable and suitable for your project.

Determining the credibility of a source:

- There is a vast amount of information available online so it is important to be able to judge what content is accurate and reliable and what is not. Not all information available online is correct or from a reliable source (Chat forums or Wikipedia may not be reviewed for credibility).
- Information that is peer reviewed (checked by others for accuracy) has high reliability as it has been approved by experienced people in that area.
- Check other sources: Can you find the same information on other reputable websites? Do they provide their sources? If similar information can be found from different independent sources then there is a better chance that it is reliable.
- False information often contains incorrect dates or altered timelines. It is also a good idea to check when the article was published, is it current or old? Check when an article was written or last updated. If you can't tell when a source was written, then keep looking until you find a good source about the topic that does have a recent date, so you can see if anything has changed.
- Are your own views or beliefs affecting your judgement of how accurate or reliable a piece of information is? In general, we are all drawn to information that confirms our own beliefs or biases. Online algorithms that are designed to give us news and information based on our personalised searches and interests make it harder to see beyond our own world view.



Top Tip!

Remember to constantly refer to the theme of the brief and ask yourself, if and how the information fits with the brief and with your research question

Researching online:

- When looking at online search results, don't just use the first result in the list. This can be sponsored or optimised for other reasons resulting in them not being the best quality for your search.
- When you find some interesting information, it can be helpful to bookmark it so that it is easily accessed at a later date.

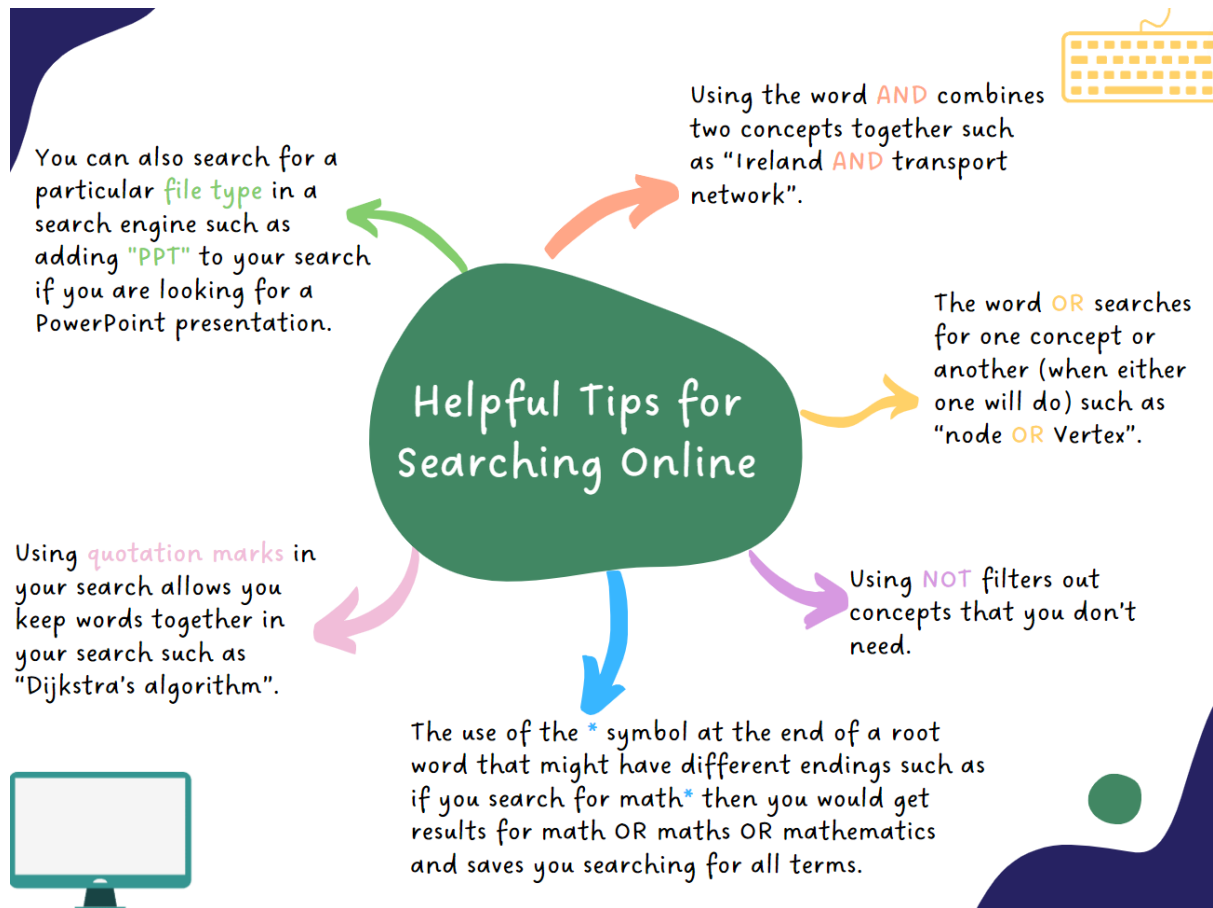
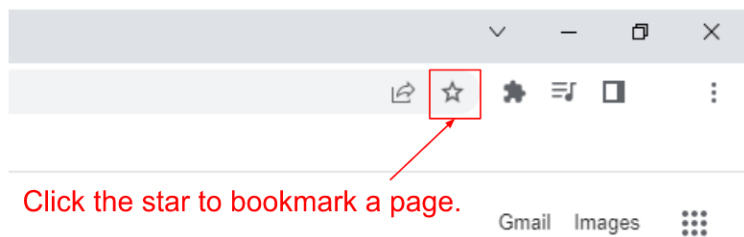


Figure 2: Helpful Tips for Searching Online

Online Research: Tips for Students: <https://youtu.be/LTJyqQwYV84>

Helpful Resources:

- [Webwise Connected](#) (Information regarding Online Wellbeing; News, Information and Problems of False Information; Big Data and the Data Economy; and My Rights Online).
- [Internet Safety and Information Videos](#) (Videos about Big Data, False Information, Safety and the connectedness of the internet).
- [Snopes](#) (Website about fact checking and misinformation).
- [All about Explorers](#) (Website about searching better on the internet).
- [Internet Literacy Handbook](#) (Council of Europe, 2017)

Referencing:

Any information used in your report that you gathered from a secondary source must be referenced whether it be direct quotations adapting someone else's ideas/work in your writing. There is no problem using information that isn't your own but you must acknowledge the source and also allow readers to find the material that you have mentioned. Information could come from various sources such as books, professional journals, government reports, online sources or relevant individuals.

Referencing the work of other people involves two distinct elements:

- An in-text citation
- A reference list

In-text citations are inserted in the main body of your text and indicate that you are using or directly quoting someone else's work. It usually just involves the author's name and date that the work was published with full reference details found in your reference list.

When giving further details in the reference list you may need to include a selection of the following details:

- Author
- Year of publication
- Title of article or chapter
- Title of the publication
- Issue and volume numbers
- Place of publication
- Publisher
- Edition
- Page numbers
- URL
- Date you accessed the material

Resources for Referencing:

- ["How to use Harvard Referencing"](#) and many more IIS related videos from Philip Ryan, Kilkenny College
- [Mybib.com](#) – helps students generate their bibliography
- <https://www.citethisforme.com/> - helps students generate references
- [Neil's Toolbox](#) - helps students generate references



Example of Referencing a Website:

In-text Citation: Ireland's population rose by 7.6% since 2016 (Central Statistics Office, 2022)

Your Reference List: Central Statistics Office. 2022. Central Statistics Office website. [online] Available at: <https://www.cso.ie/en/releasesandpublications/ep/p-cpr/censusofpopulation2022-preliminaryresults/> [Accessed 26 September 2022].

Comprehension



As you research and gather information relevant to the specific problem that you are modelling it is important to synthesise all of the information that you have gathered into effective paragraphs. Don't just start writing as soon as you begin researching for your project, think about the overall report and plan its structure. Consider how you will communicate your work as effectively as possible and ensure that there is a logical flow to your writing. While writing, consider using transitions which connect the last sentences/ideas you wrote and what you're going to say next.

Creating an initial outline of the report may be helpful to organise your research and writing as well as give you a guide to follow as you write. When writing about the research that you have conducted for your project it is not simply 'copying and pasting' but using your research to show an understanding of the information and how it is applicable to and enhances your project. Your background research should be relevant to your specific model and strong links should be made between research and the problem that you are modelling.

Supporting all learners

If a student experiences difficulty in any of the following areas try some of these supports:

- Doing basic research, try [Britannica Education](#) to search reliably away from the distractions of the internet.
- Reading complicated comprehensions/scientific text, try [Immersive Reader](#) to read aloud the text.
- Understanding complicated comprehensions, try some [Comprehension Strategies](#) or [Rewordify](#) to simplify text.
- Spotting spelling and grammar errors or proof reading, try [Grammarly](#).
- Understanding English, try [Google Translate](#) or [Microsoft Translator](#).

Introducing your study

The function of the introduction is to set the scene for your investigation. Answering questions that include why did you choose this investigation? What do you hope to find out? What is the context of the study? Is it linked to a problem on a family farm or local agricultural enterprise? Will the investigation occur there or be modelled in a laboratory? How is this linked to the theme of the brief? What is the specific research question you will answer? It is important to use your word count effectively so ensure that each of the following items are engaged with appropriately in a "contextualisation paragraph":

- Provide a title of your investigation
- Explain the purpose of your investigation
- Outline the setting of your investigation (Agricultural Enterprise chosen)
- What is your Research Question?
- Explain how this question is linked to the theme of the brief

Once you have set the scene for your investigation you can then provide a research context to your study, by interrogating a broad range of credible and relevant sources. It is important to understand the purpose of your research and if certain research is more relevant to your specific research question than others. Remember to provide citations as mentioned earlier.

2. The Investigative Process

Central to this section is to follow the scientific process. It is divided into two subsections for marking purposes. (a) Details of the action undertaken in response to stated hypothesis (b) Data collection undertaken

(a) Details of the action undertaken in response to stated hypothesis

Did you start with an observation? Form a hypothesis? Make a prediction? Identify variables? Decide on a control? Design an experiment? Consider health and safety? Are you adapting, extending or modifying an SPA? If so, explain how?

Can you supplement your description with clear images here?

Can you use some of the language of Strand 1 Learning Outcomes here (**See Appendix D**) e.g. LO 1.1 a, 1.1 d, 1.2 a and 1.2 b.



Top Tip!

The webinar "Thinking and Working Like a Scientist - Supporting IIS" takes a glimpse into the work of a Teagasc post-doctoral researcher using the same scientific method steps as students completing an IIS

Click here for ["Thinking and Working Like a Scientist - Supporting IIS"](#). It follows Dr. Ben Lahart as he leads a research study on methane production by dairy cows in Teagasc, Moorepark.

(b) Data collection undertaken

What piece of equipment will you use?

Do you have to clean it? Calibrate it?

How many repeats will you do? Why?

What other efforts do you make to ensure accuracy? Precision?

What are the likely errors and what are you doing to minimise them?

Can you use some of the language of Strand 1 Learning Outcomes here (See Appendix D) e.g. LO 1.1 a, 1.1 d, 1.2 a, 1.2b



Top Tip!

This section is worth 13 marks so ensure to give it the focus it deserves. Have a look at the Experiments Collage below to see some ways researchers ensure accuracy when they collect primary data

Click here for [VT4-Experiments Collage](#) to see how researchers calibrate and accurately record measurements.

3. Results, analysis and conclusions

This section is divided into three subsections for marking purposes (**See Appendix A**).

(a) Appropriate presentation of data (b) Informed judgement and conclusions following analysis and (c) Limitations of study considered and clear linkage of conclusions to research question



This section is worth 35% of the overall IIS grade so give it due focus. Ensure you give adequate attention to each subheading Results, Analysis and Conclusions

(a) Appropriate presentation of data

It is important when working with data to understand the various types of data, what they mean and how best to represent data. **Primary data** is data that is gathered by the person who is going to use the data while **secondary data** refers to data that has already been collected by someone else previously.



When working with data, both qualitative (categorical) data and quantitative (numerical) data can be used. Long lists of data can be difficult to interpret so suitable graphical representations can be helpful to summarise the data and understand its meaning. Data representations can be useful in determining the trend in data over time, if there is a relationship between two variables or how much data falls in a specific category or range of values.

Gathering and Representing Data

Not all of your modelling/results needs to be represented using just mathematical calculations; the use of graphs, tables or other suitable representational forms may be more suitable depending on the results or the message that you are trying to convey. Overusing one format of representing data should be avoided. Choose the format that best suits the data and what you are trying to highlight. Where appropriate, you should use titles, legends for the presentation of data and information. Images should be labelled properly (Figure 1, Figure 2, etc.) as well referred to by their figure name in body of the report. Tables can be referred to as Table 1, Table 2, etc. Also, if images/graphs are from a secondary source then they must be referenced.

If you are presenting calculations in your report then make sure that they are easy to read and assigned the correct unit (if applicable). Discuss what your calculations mean in the context of what you're modelling and how your model is progressing compared to previous iterations.

Choosing the Most Suitable Method of Representing your Data

There are many ways of representing data and while a certain method may look good it may not be the most appropriate for what you are trying to show. It's important that whoever is reading your project is able to understand it and any method of representing data is easy to follow.

When choosing your visual representation, think about its purpose and what message you want to communicate. Is it to show the relationship between different variables or is it to compare certain items over a certain period of time? Figure 3 below may be helpful in determining the most suitable data representation type.

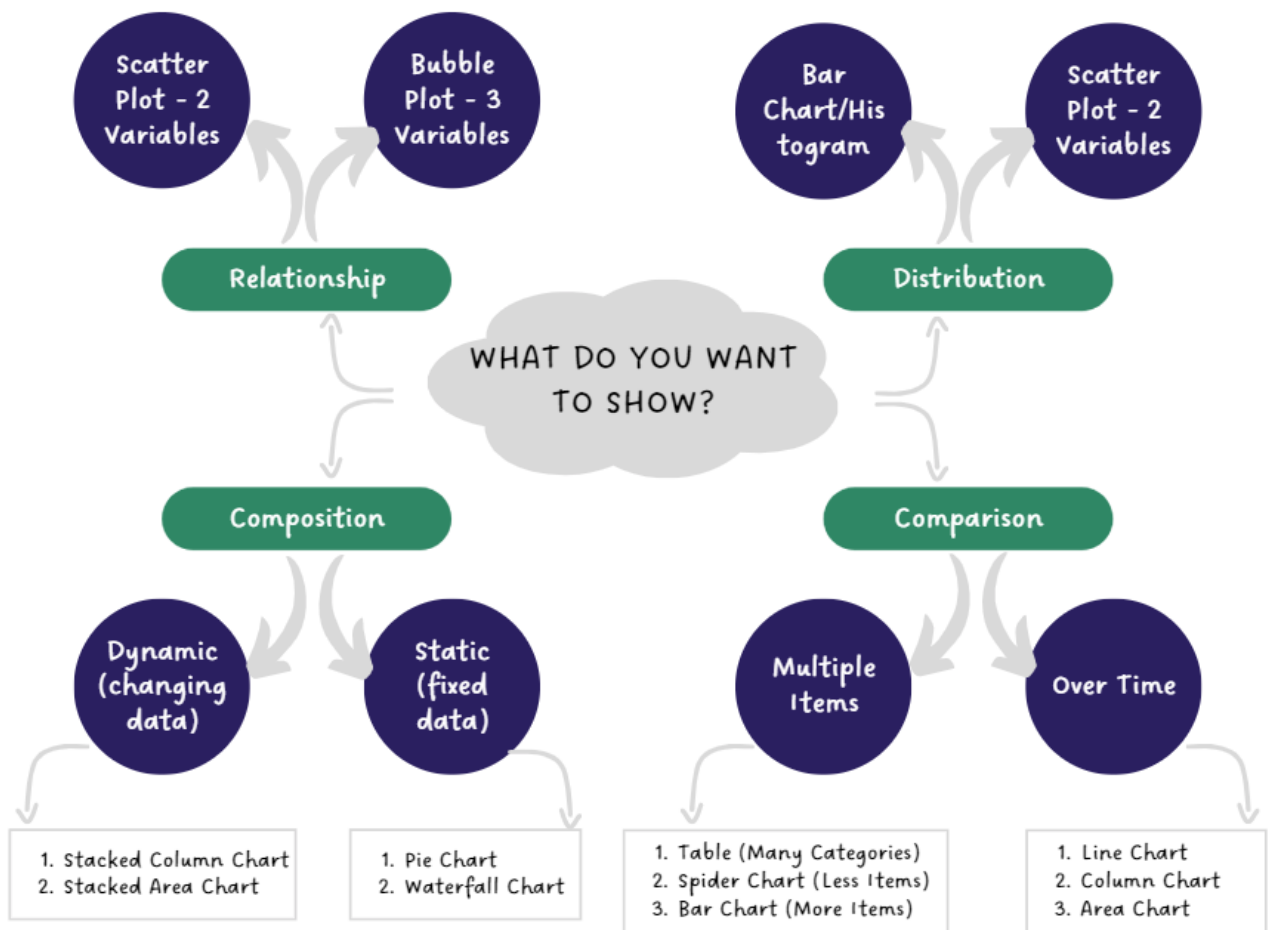


Figure 3: Choosing the Right Data Representation Type

Every project/report is different resulting in different data representation types suiting varying goals, aims or topics. If you are looking to communicate a particular trend over a certain period of time then a line chart, column chart or area chart could be the most suitable. If you are comparing two or more sets of information then the choices could be a bubble chart, spider graph or scatter plot.

To summarise, here are a number of data representation types and their uses that may be helpful:

1. Number Chart - gives an instant overview of a specific value.
2. Line Chart - demonstrates trends and changes in data over a period of time.
3. Maps - visualises data by geographical location.
4. Waterfall Chart - demonstrates the static composition of data.
5. Bar Graphs / Histograms - used to compare data of many items.
6. Pie Chart - expresses a part-to-whole relationship in your data.
7. Gauge Chart - used to display a single value within a quantitative context.
8. Scatter Plot - applied to express relations and distribution of large sets of data.
9. Spider Chart - comparative charts great for rankings, reviews, and appraisals.
10. Tables - shows a large number of precise dimensions and measures.
11. Area Chart - portrays a part-to-whole relationship over time.
12. Bubble Plots - visualises 2 or more variables with multiple dimensions.

General Rules for Representing Data:

1. Keep it simple. Huge amounts of data and graphs can result in readers becoming lost and struggle to see the key information.
2. Begin general and then move to more specific. Start with the bigger picture and wider information and then focus on key findings and relevant analyses.
3. Data should be related to and answer the goal of the modelling project (the problem statement).
4. Always use the past tense when describing results.
5. Do not repeat the same information in more than one format. Select the best method and communicate the information.
6. Whether the graph was created by you or a secondary source, you should reference it in your report to demonstrate its relevance for your project and its impact on your mathematical model.



Top Tip!

Have you used the "how-to tutorial guide to Excel" to help you sort, analyse and present data in graphical format specifically designed for Ag Science students

Click here to access the ["how-to tutorial guide to Excel"](#) for Ag Science students.

(b) Informed judgement and conclusions following analysis

Remember a conclusion is a statement based on experimental measurements and observations. Be sure to state a conclusion clearly. When writing a conclusion, it is important to make connections with other parts of your project such as background research and any other relevant data.

Consider some of the following. Can you identify trends? (“say what you see happening”), what might be causing these trends? Have you analysed all of your primary data? Can you supplement this analysis with qualitative data? Or secondary data? Or how does your data compare with what your research had found? Can you use some of the language of Strand 1 Learning Outcomes here (**See Appendix D**) e.g. 1.2 c, 1.2d?

Top Tip!



It is not enough to present data/information, you should analyse it and draw conclusions from it. Relate the information to your research question

(c) Limitations of study considered and clear linkage of conclusions to research question

What were the limitations of the study? Time of year? Access to equipment? Sensitivity/accuracy of equipment? Sample Size? And how did these limitations impact your study?

Your conclusion should directly relate to the hypothesis? Are you accepting/rejecting/amending it? How does your conclusion relate to the research question?

Top Tip!



Here you revisit what you set out to achieve in Section 1. Given your primary data, the limitations of your study and secondary data you accessed through research do you accept, reject or amend your initial hypothesis?

4. Reflection on the study

The purpose of the reflection is to interpret the meaning of the conclusion of your study in a real-world context. It allows you to summarise all of the work that you have done and make statements based on your findings and reflect on the outcomes of your model and the process itself. Consider the following: To what degree was your research question answered? How reliable and valid were the study? Were there any refinements or alternative approaches to improve the study? Are there future directions or possibility of further studies? What is the significance for your chosen enterprise? Or for the Agri food sector?

Top Tip!



This section allows space for you to reflect on the entire process and what it means to you, your chosen enterprise and the agri-science sector. Consider reliability, validity, relevance and ways to improve the study

5. Communication and Innovation

Communication

The language you use will affect how clearly you communicate your study. Wherever possible can you demonstrate scientific literacy skills by incorporating the language of Strand 1 Learning Outcomes (*see Appendix D*).

Top Tip!



Coherence is really important: your independent and dependent variable become a thread that weaves through the entire report. The relationship between these appears in every section!

To support literacy skills, you can access multiple [sentence starter stems](#) here. Sentence stems can be useful when writing as they avoid the overuse of certain phrases and can help communicate your work better. Below are some possible sentence stems that may be helpful for different aspects of your report:

Introduction

The aim / intention / purpose of this report is to outline / present / discuss / sum up ...
This involved visiting / looking at / investigating ... / The data was obtained by ...

Introducing Points

First(ly) ... / In the first place ... / First of all ... / The first aspect / thing to consider is ...

Moreover ... / Furthermore ... / Another aspect to consider ... / Yet another aspect / consideration is ... Besides that, ... / Apart from that ... / In addition to this ... / On top of that ...

To Cite an Idea

According to...As explained by...As seen by...

Based on the ideas of.....showed that.....explored the idea.....wrote that...

...disputed/claimed/suggested that...Similarly, ...stated that...

Giving Examples

For example, / instance ... This can be shown / illustrated / demonstrated / clarified by ...

The picture / diagram shows / illustrates ...

Comparing

One of the main / biggest / most significant / ... differences between ... and ... is ...

Unlike ..., ... is ... / While / Whereas / Although ... is, ... is ...

To Evaluate

Based on... I evaluated...on the following criteria... I assessed that...My interpretation of...was...When ranking its importance...I felt that...because...When I compared..., I discovered that...

To Analyse

The fact that...shows that...because...Based on..., I can conclude...because...

All of this goes to show that...because...This is significant because...My interpretation of...was...After careful examination of...it appeared that...

Taken together, the fact that... It...clearly demonstrated that...because...

Concluding

It can be seen from the data / reactions / information above that ...

All things considered, I believe that ... / In general / On the whole I found that ...

In conclusion ... / To conclude ... / To sum up ... / In summary ...

Innovation

Some studies are clearly original, novel or innovative but not every study can be.

You can get marks here by writing about the curiosity that lead you to this study, the unique research you carried out, the innovative and resourceful experimental design you developed or the different ways you analysed and reported on the study.



Appendix A: Instructions to Examiners

This is a summary of the instructions and marking criteria examiners work to:

- Before commencing marking read the entire Individual Investigative Study to familiarise yourself with the content presented for marking.
- To assist in the awarding of marks 'indicative content' has been stated for each section (see table below).
- To finalise the marks, review the criteria descriptors against the marked work.
- These descriptors should be interpreted in the context of the challenges and demands of the investigation the candidate has chosen.
- Be careful not to penalise skilful brevity, nor to reward unwarranted length.

Section	Subsections	Indicative Content	Marks
1. Introduction and background research	Introduction	<i>Context for the IIS</i>	10
	Background research	<i>Research, sources and knowledge</i>	10
2. The investigative process	Hypothesising & experimenting	<i>Details of the actions undertaken in response to stated hypothesis</i>	12
	Collecting data	<i>Data collection undertaken</i>	13
3. Results, analysis and conclusions,	Results	<i>Appropriate presentation of data</i>	10
	Analysis	<i>Informed judgement and conclusions following analysis</i>	15
	Conclusions	<i>Limitations of study considered and clear linkage of conclusions to research question</i>	10
4. Reflections on the Study	-	<i>Knowledge and insights arrived at as a result of the study</i>	10
5. Communication and Innovation	-	<i>The report has an overall coherence, quality and clarity with the inclusion of individual innovative thinking by the candidate</i>	10
6. References	-		0

Source: Adapted from State Examinations Commission Leaving Certificate Agricultural Science Higher Level Marking Scheme, September 2022 (pgs. 6-11)

Appendix B: Report structure and mark allocations

Report structure and mark allocations		
Section	Indicative content to be included	Marks
Introduction and background research Suggested range between 300 and 500 words	<ul style="list-style-type: none"> ▪ Give a title to your Individual Investigative Study. ▪ Identify the agricultural enterprise chosen as the context for the study and state the topic selected for investigation. ▪ State the research question, and make clear how it relates to the theme of the brief and the chosen enterprise. ▪ Outline what the initial research you carried out tells you about the topic and the research question. Include references. (Use short in-line citations here, with full references at the end of the report.) 	20
The investigative process Suggested range between 500 and 800 words	<ul style="list-style-type: none"> ▪ Describe the specific experiments and other relevant investigative activities undertaken, stating clearly the purpose of each and describing how it was carried out. ▪ Make clear what specific hypotheses were developed and tested. ▪ Describe in detail how you gathered the data. 	25
Results, analysis, and conclusions Suggested range between 600 and 1000 words	<ul style="list-style-type: none"> ▪ Present the data and results from your investigation. Use tables, graphs, and photographs as appropriate. ▪ Analyse and interpret the data, results, and other information. ▪ Make judgements and draw conclusions from your analysis. ▪ Take due account of any relevant limitations of your study. ▪ Link the conclusions clearly to the research question. 	35
Reflection on the study Suggested range between 150 and 200 words	<ul style="list-style-type: none"> ▪ Reflect on the insights gained from engagement with the study and comment on: <ul style="list-style-type: none"> ○ The degree to which the research question was answered ○ Possible changes or alternative approaches that might have made the investigation better ○ Future directions and possible areas of further investigation ○ Significance of the outcomes of the study for the agri-food sector and/or the study of agricultural science. 	10
References	<ul style="list-style-type: none"> ▪ Full references for all sources used during the study and/or referred to in the report. <p>This section will not attract a separate mark. Any deficiencies in referencing will be taken account of when marking the relevant section of the report.</p>	-
Communication and innovation	<p>This is not a distinct section of the report.</p> <p>Marks will be awarded for evidence of taking an individual approach, for coherence and for innovative thinking.</p>	10

Source: State Examinations Commission Brief, September 2022, pg. 6.

Appendix C: Thematic Briefs Provided by State Examinations Commission

You will find the brief for each examination year posted on the SEC website www.examinations.ie

All material pertaining to the IIS can be found in: “Examination Information” > “Project and “Practical Coursework” > “Agricultural Science”

Each year it states the theme for the YEAR brief is “THEME OF BRIEF”.

Use the theme, “THEME OF BRIEF”, as a “lens” to look through while undertaking the learning contained in the specification’s strands and crosscutting themes.

2021: “Improving Sustainability in Irish Agriculture”

2022: “Supporting conservation of the environment through Irish Agricultural practice”

2023: “Exploring nutrition and nutrients - the importance to Irish Agriculture of their effective use and management”

2024: “The role of food production in maintaining natural resources in Irish Agriculture”

Appendix D: Learning Outcomes of Strand 1- Scientific Practices

Strand 1: Scientific practices

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

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

Source: Leaving Certificate Agricultural Science Specification (NCCA, 2019) p16

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

Source: Leaving Certificate Agricultural Science Specification (NCCA, 2019) p17