EDUCATING KIDS ABOUT AGRICULTURE

SCIENCE INVESTIGATION AWARDS

Experimental Design and Research Methodology

Primary school

STUDENT HANDBOOK

PPSA Primary Producers SA
Australian Government Department of Agriculture, Water and the Environment
DELIVERED BY: AL2100 Food & Fibre Education SA

Contents

Disclaimer:

We love seeing all types of science investigation posters, but to ensure best practice science, there are a few safety and ethical requirements which all schools must adhere to.

1. Please ensure the experiment topic is approved by the supervising teacher. Topics MUST adhere to each schools safety and ethics policies.
2. Students must check any chemicals or equipment with the teacher PRIOR to using them – safety is the first priority. No hazardous or toxic substances are to be used
3. All experiments MUST have a safety plan, which is approved by the teacher prior to starting. This plan must include the personal protective equipment (PPE) plus the actions and processes required to manage and mitigate risk.
4. If the project involves animals, they must not under any circumstance be harmed in the experimental process. It is suggested that the teacher/student seek advice from a local vet or animal professional to ensure that the approach is safe and adheres to the required animal ethics as defined in your school policies.
5. Implementation of any science experiment must be taken with appropriate supervision, following all safety precautions of all materials used in a project.
6. It is the responsibility of the school and teacher to approve content and the best practice approach to safety.

Welcome to the 2022 Science Investigation Awards.

We are excited to have you on board this year and look forward to showcasing the best of what South Australian schools can achieve in the fields of science, experimental design, and research methodology. Every year we are blown away by the great experiments the competitors present, and this year we are sure will be no different!

The PRIMARY Science Investigation Awards are for students from Years 7 to 12 to complete a science, food or fibre research project. This competition involves students researching a chosen topic and producing a scientific investigation report. Students then present their results in a poster form.

Schools hold an in-school competition where posters are judged against the set criteria. The top THREE posters are selected from each class. These students move through to compete at the State Finals at the Royal Adelaide Show. Certificates, ribbons and prizes are awarded to winning students.

We are excited to work with you through our school visits and online webinars and look forward to seeing the research in action!

Please contact our team if you would like more information and support, we are always happy to help.

Kind regards,

Belinda Cay - 0423 295 576

The Science Investigation Awards: Information for Teachers

Background

The Science Investigation Awards is a state-wide competition which engage students in experimental design and scientific inquiry. The awards are for students in years 5 to 12 who are studying science. The awards program maps neatly against the national curriculum's Science as a Human Endeavour content descriptor (view appendix 1).

- The competition involves students selecting a research topic of interest (can be anything) and design an appropriate experiment to test their hypothesis
- Competitors keep a science journal, recording observations, findings and collecting data
- Students then present their findings as a poster which is judged by industry representatives
- School finalists are selected, and they more through to an inter-school Grand Final
- The Grand Final will be hosted at the Royal Adelaide Show for the finalists and their teachers on **Monday *5th* September.**

What we offer:

- Virtual and in-school presentations from passionate real-life scientists / science educators on experimental design and research methodology. We present on experimental design and research methodology–then it's up to the students to design and complete their experiments with teacher assistance. We are available for added support if required noting correspondence will be via the teacher.
- Ongoing support throughout the entire competition, which must be organised through the teacher i.e. help choosing their project topic, designing the experimental protocol.
- Support to judge the school competition i.e. selecting the top posters to move through to the Grand Final.
- This year we have added extra categories and have
- Prizes for winners in the following categories:
  - Best Food and Fibre Based Project Primary
  - Best Food and Fibre Based Project Middle
  - Best Food and Fibre Based Project Senior
  - Year 5: First, second and third place
  - Year 6: First, second and third place
  - Year 7: First, second and third place
  - Year 8/9: First, second and third place
  - Year 10/11/12: First, second and third place

Our team can deliver a presentation on experimental design anytime in term *1 or* 2. We recommend your students work on this program throughout the term.

Key dates

- Term 1 / 2. Students start working on their poster. Note: contact AgCommunicators to arrange a school visit where we present on research methodology / experimental design. We also highlight key dates and poster design.
- ALL entries need to be completed by 19 August 2022.
- School finalists will need to be selected and entered into the Royal Adelaide Show online schedule by 19 August 2022.
- Contact us to help register your finalists as each student will receive ONE FREE entry ticket to the Show plus ONE ticket for a parent/care giver / guardian / teacher (max tickets = 2 per entry). Tickets will be picked up at the Rose Terrace gate on the morning of the Royal Show judging day.
- The Grand Final will be held on MONDAY 5th SEPTEMBER, at the Royal Adelaide Show (in the Goyder Mezzanine) from 9:00am - 1:00 pm.

FAQs

We are often asked the following questions - we hope this information is useful. Please contact us with any questions.

Can I enter as a team?

We recommend entering as an individual or pair only. Work should be equal between any pairs.

Can you visit our school?

Yes, we can visit your school and deliver a single lesson presentation on experimental design. We cover how to design an experiment, hypothesis, replications, variables, methodology, results and discussion. We also go over key dates and information on the awards.

Is the report judged?

No. The report may be marked / assessed by the teachers for their class assessment, however, it is not judged by the Science Awards judges. The report should contain your comprehensive findings and results. This is used to prepare the poster.

How do we enter our school?

To be involved in the awards you firstly need to register with Belinda Cay. You will then receive the information booklet and arrange your onboarding presentation.

How do we enter our winning students in the Royal Adelaide Show? How do we receive our prize money?

Once your class has selected its top three posters, these students will need to be registered by their teacher as competitors in the Royal Adelaide Show online competitors portal (in the Science Investigation Awards category). Entires are done on-line by visiting www.theshow.com.au/technology

Online registration is essential to ensure your students receive their certificate and award payments. Note that this year all payments will be made through the Royal Adelaide Show, and will be paid to the Show. Schools will then distribute cash awards to their students. Payments are made in late October.

What times do I need to be at the Grand Final?

The Grand Final will be held on Monday 5 September 2022. The judging occurs in the Goyder Mezzanine. Students can set their posters up from 9:00 am to 10:30 am. Each student will be allocated a table in their year level. You place your poster on the table and stand by the poster during the judging.

The official opening occurs at 10:30 am. Judging is from 11:00-12:30. Winners are announced at 12:30. The day concludes at 1:00.

How many free tickets do we get?

Each finalist student will receive ONE free entry ticket to the Royal Adelaide Show. ONE adult entry ticket will also be provided per student, this is for a caregiver / parent / teacher or guardian to attend and supervise the student during the competition.

Where do we get our tickets from?

Tickets will be picked up by each finialist and their caregiver at the Rose Terrace Gate on the morning of the Royal Show Grand Final day. We do not post tickets out any more.

What happens with the winning posters?

Winning posters will be placed on display in the Goyder Pavilion. Students / teachers / caregivers will need to arrange pick up of these posters from the Goyder Pavilion the day after Show finishes.

What prizes are on offer this year?

Prizes will be awarded for the following:
Best Food & Fibre Based Project Primary ($300) Best Food & Fibre Based Project Middle ($300)
Best Food & Fibre Based Project Senior ($300)

Year 10/11/12 Projects: First = $250, Second = $150, Third = $100

Year 8/9 Project: First = $250, Second = $150, Third = $100

Year 7 Project: First = $250, Second = $150, Third = $100

Year 6 Project: First = $250, Second = $150, Third = $100

Year 5 Project: First = $250, Second = $150, Third = $100

Important safety and ethics information for teachers

As mentioned earlier in this handbook, we love seeing all types of science investigation posters and look forward to seeing the results! However, it's very important that all students / schools adhere to the safety and ethical requirements.

1. Please ensure the experiment topic is firstly approved by the teacher. It MUST adhere to your school's safety and ethics policies.
2. Check any chemicals or equipment your students will be working with PRIOR to using them. They must not be hazardous or toxic - yours and your student's safety is the first priority.
3. Ensure all experiments have a safety plan, which you approve for your students prior to starting. You must ensure their plan is viewed and approved by you as their teacher to ensure all personal protective equipment (PPE) plus the actions and processes.
4. If students are working with animals, the animal(s) must not under any circumstance be harmed in the process. We suggest that you seek advice from a local vet or animal professional to ensure that your approach is sound, and that all safety and ethics policies are adhered to.
5. Implementation of any science experiment must be taken with appropriate supervision, following all safety precautions of all materials used in a project.
6. For experiments involving humans - students need to work with teachers to ensure the experiment is safe prior to commencement, has parent approval and that all practices are safe. Confidentiality must also be maintained (i.e. you cannot name the students in your report - instead use person A, B and C. You must treat the results with respect and confidentiality). For experiments involving animals - any experiment involving animals must follow your school's ethics guidelines. No animal can be harmed in any experiment. If you are testing feeding regimes, they must be nutritious and we recommend calling a vet to check the approach is safe and sound.
7. It is the responsibility of the school, teacher and parent to approve student projects to ensure all practices are safe.

Risk assessment and management

The following table can be used to identify any possible hazards associated with the student experiments, and to allow them to find safe ways of conducting their science. It must be approved by the teacher as part of the topic approval. Students are also given access to this tool later in the handbook.

Possible hazard	*Risk Score*	Safe Operating Procedure	PPE & other safety equipment required
EXAMPLE ONLY: Testing the impact of different soil types on plant growth	4	• Don't eat or drink while working with soil • Wash hands thoroughly with soap when finished • Work outside / good ventilation • Do not use potting mix use soil	• Sturdy shoes • Hand wash station • PPE: Dust mask / goggles / lab coat • Gloves

Risk assessment matrix

The following Risk Assessment Matrix (adapted from smartsheet.com) provides a generic framework for assessing and managing risk. This provides a guide for helping students to assess the severity of the risk, and the likelihood of the risk occurring. It is a good science workplace process to get them learning about assessing risk, understanding the likelihood of a risk occurring and how to mitigate risk.

RISK MATRIX Adapted from smartsheet.com

RISK RATING KEY	LOW	MEDIUM	HIGH	EXTREME
	0 – ACCEPTABLE	1 – ALARM as low as reasonably practicable	2 – GENERALLY UNACCEPTABLE	3 – UNACCEPTABLE
	OK TO PROCEED	TAKE MITIGATION EFFORTS	SEEK SUPPORT AND REDUCE RISKS	DO NOT PROCEED

LIKELIHOOD OF RISK OCCURRING ↓ / SEVERITY OF LIKELY IMPACTS →	ACCEPTABLE LITTLE TO NO EFFECT ON EVENT	TOLERABLE EFFECTS ARE FELT, BUT NOT CRITICAL TO OUTCOME	UNDESIRABLE SERIOUS IMPACT ON SAFETY	UNACCEPTABLE COULD RESULT IN DISASTER AND CATASTROPHIC INJURY OR WORSE
UNLIKELY RISK IS UNLIKELY TO OCCUR	LOW – 1 –	MEDIUM – 4 –	MEDIUM – 6 –	HIGH – 10 –
POSSIBLE RISK WILL LIKELY OCCUR	LOW – 2 –	MEDIUM – 5 –	HIGH – 8 –	EXTREME – 11 –
HIGHLY LIKELY RISK WILL OCCUR	MEDIUM – 3 –	HIGH – 7 –	HIGH – 9 –	EXTREME – 12 –

Assessment

The Science Investigation Awards provide a range of assessment opportunities. We have provided a guide below. You can adapt this assessment to suit your teaching work plan and needs. For your reference, we have also provided our judging score sheet so you can see how student poster entries will be assessed at both the class competition and the Grand Final. Note that we do not judge the report, only the poster. The report however, is an important tool in getting students to keep a lab manual and recording their results.

Example report assessment guide

Criteria for report assessment	Weighting	Mark obtained	Comment
Experimental design • background information/relevance (3) • define the aim of the experiment (3) • formulate a hypothesis (1) • identify independent and dependent variables, and control (3) • design and describe methods (3) and materials (2)	15		
Data collection • record data accurately • work safely • manage time and equipment	5		
Results • data presented correctly in diagrams, tables and/or graphs; select appropriate format for data to be presented • construct appropriate headings, units, axis, scale etc • Regular photo diary of experiment included – showing progress and comparisons	5		
Evaluate (analysis, discussion, and conclusion) • discuss the pattern of results • analyse data using logical explanations • assess strengths and weaknesses of the experiment, and reliability of data • suggest improvements to the experiment • communicate conclusion, relate to hypothesis, and implications for agriculture	10		
Reporting • report neatly presented with title page and headings for each section • bibliography • use correct grammar and spelling	5		
Total	**40**		

Example poster assessment guide

Criteria for poster assessment	Weighting	Mark obtained	Comment
Experimental design • background information/relevance (3) • define the aim of the experiment (2) • formulate a hypothesis (2) • identify independent and dependent variables, and control (3) • design and describe methods and materials (2) • Ethics and safety plan (PPE) (3)	15		
Data collection • record data accurately • work safely • manage time and equipment	5		
Results • data presented correctly in diagrams, tables and/or graphs; select appropriate format for data to be presented • construct appropriate headings, units, axis, scale etc • regular photo diary of experiment included – showing progress and comparisons	5		
Evaluate (analysis, discussion, and conclusion) • discuss the pattern of results • analyse data using logical explanations • assess strengths and weaknesses of the experiment, and reliability of data • suggest improvements to the experiment • communicate conclusion, relate to hypothesis, and implications for agriculture	10		
Poster design and execution • poster neatly presented with title page, headings for each section • simplified results presented, and easy to read and understand • use correct grammar and spelling	5		
Total	**40**		

Student support guide

Welcome to the 2022 Science Investigation Awards! This project includes you designing and testing your very own research experiment.

There are two main parts to the Scientific Investigation Awards:

- a two page report, AND a poster.
- This handbook will help you understand what needs to go in each the report and the poster.
-

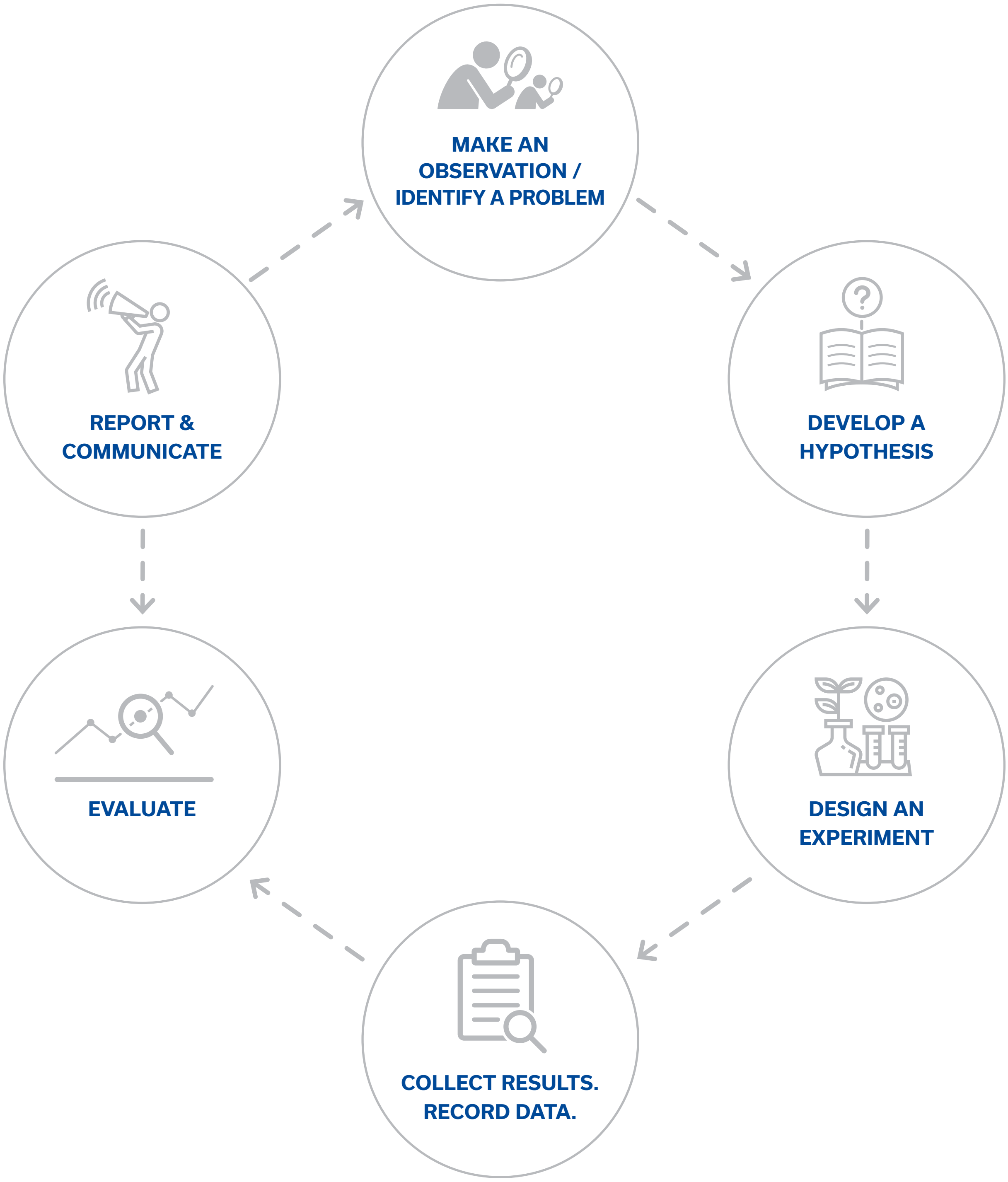
NOTE: that the report and poster will both be assessed by your teacher. A representative from the Food and Fibre team will judge and assess your poster only. We will select the top THREE entries from each class and provide FREE tickets for these students to compete in the Grand Final at the Royal Adelaide Show.

Important things to know	Notes
Experimental design	Work with your teacher to choose a topic and design an experiment. You can look up 'science investigation' or 'science fair' ideas for a few helpful hints.
Develop your hypothesis	Construct your 'if' and 'then' statement.
Design your experiment	Design a credible experiment using the process of experimental design - you will need to think about replications, variables, controls and equipment.
Safety	You MUST have your teacher's approval before you start your experiment. Safety notes are provided in your handbook so you can develop your safety plan. Ensur you have the right PPE and safety measures in place to protect you and your classmates. Your report and poster will both be assessed on this aspect.
Results	You will need to collect and record your results. Make sure you keep all results in a lab book (hard copy or electronic is fine). Be sure to date and time all points of data collection. Take pictures along the way.
Evaluate	You will need to analyse your results. Think of ways you can calculate averages, present trends and then consider what the results mean. You then evaluate if your findings support or not-support your hypothesis. Note: just because your results or findings did NOT support your hypothesis, this does not mean you have failed! It means the process of science is working and that you have found something out! Did your results support your hypothesis? Why/why not?
Report and communicate	Write up your experimental design, results and discussion into a formal science report. THEN present your KEY findings, images, graphs etc in a poster. Make sure you refer to our guides for what sections must be included in each. Two page report AND a poster. Tips for great posters are included in your handbook.
FRIDAY *19* AUGUST	Make sure your entries are completed. Your teacher will let you know when your school / class judging day will be held. The top three from each class will move into the Grand Final inter school competition, which is held at the Royal Adelaide Show.
FRIDAY *19* AUGUST	Finalists registered with Royal Adelaide Show (your teachers will do this with AgCommunicators and the Royal Show Team).
MONDAY *5* SEPTEMBER	Grand Final: Royal Adelaide Show State winners will be announced!

What is Experimental Design?

Experimental design is a process that scientists use to test an observation or problem.

The process includes the following steps, which are explored in the booklet. When designing an experiment you can be as creative as you like and choose a topic which interests you, then research – investigate – explore and report!



Step 1: Choose Your Topic

Your first task is to select your research topic. This is what you are going to explore in your work as a junior scientist.

A research topic can be based on an observation you have made (i.e. wheat seems to grow well in the paddock on the eastern aspect of the hill, but not the western aspect. Or you may identify a problem i.e. my bread is going mouldy too quickly, or I am not sure what soap to buy to kill germs? You then need to think about this observation or problem and consider:

- Why and how is this a problem?
- Where in the world is it a problem?
- How much does this problem cost to manage?

Finalise your topic (see appendix 2 for ideas) considering:

- It is something you can research and gain answers too in the time you have?
- Approval from your teacher i.e. does it meet the schools standards for risks, ethics and safety. Can you manage this appropriately to protect your self and others?
- IF you have the equipment to do what you are after.

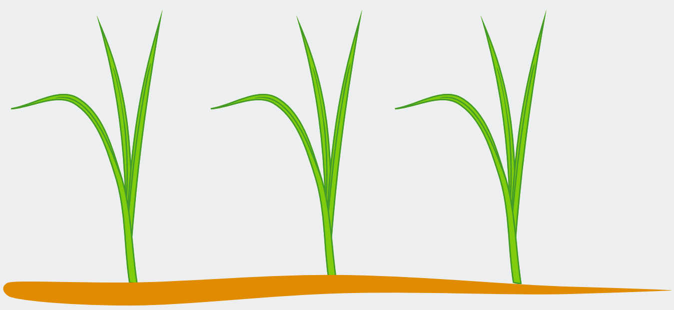
TIP: While you can choose any topic you like, remember we have a category for the BEST FOOD AND FIBRE project! Can you think of a topic which considers how to produce more food more sustainably?

Observation

We need more healthy food per meter of soil – per mm of rainfall to feed out population in lock down.

Problem

Some plants don't grow as well as others? If plants don't grow well they won't produce as much fruit, seed or vegetables...



Step 2: Develop a Hypothesis

All research scientists design a hypothesis at the beginning of their experiment. A hypothesis is a statement of what you are testing in your research. It enables you to test or compare two or more things. It is a statement about what you predict you might find.

'Your Dictionary' states that: *A **hypothesis** is an educated guess or proposition that attempts to explain a set of facts or natural phenomenon. In a **hypothesis** statement, students make a prediction about what they think will happen or is happening in their experiment.*

A hypothesis often takes the shape of "If ___then ___" statements.

An example may include:

> *If leaf colour change is related to temperature, then exposing plants to low temperatures will result in changes in leaf colour.*

OR

> *If plant growth is related to the amount of fertilizer in the soil, then increasing the amount of fertilizer will increase plant growth.*

The first part of the sentence states the independent variable and the second part states the dependent variable.

Alternatively, you can also phrase your hypothesis in a way that states what difference you expect to find between two things. For example:

> *Plants which receive 50 kg/per hectare of nitrogen fertilizer will have better growth that plants which receive 25 kg/per hectare.*

OR, you may choose to pose a NULL hypothesis. This takes a default position that you will see no change or association between the variables.

> *The amount of fertilizer applied to the plant has no effect on plant growth.*

Your experiment can then either support or refute your hypothesis. Either is fine – note it is not a failure if you dispute your hypothesis! That just shows the process of science is working!

2a. Variables

A hypothesis proposes a relationship between two or more variables. A variable is defined as 'something likely to, or able to, be changed'.

In science, a hypothesis contains two variables. One is "independent" and the other is "dependent."

> **The independent variable is the one you, the "scientist" control (i.e. temperature)**

> **The dependent variable is the change that you observe and/or measure because of the independent variable (leaf colour, height, number, weight).**

> **Controlled variables are factors that you want to stay the same throughout the experiment. They are controlled all throughout the experiment so scientists can see how the independent variable affects the dependent variable.**

To test the effect of the independent variable, you must now design a scientifically sound experiment.

Step 3. *Design your experiment*

Once you have selected your independent variables, you need to consider how many treatments you test.

You must also have a control. In this experiment, the control is what happens when you add NO fertiliser. Without the control, how could you measure what the impact of fertiliser actually is!

For example:

In this experiment, the scientist is testing the hypothesis:

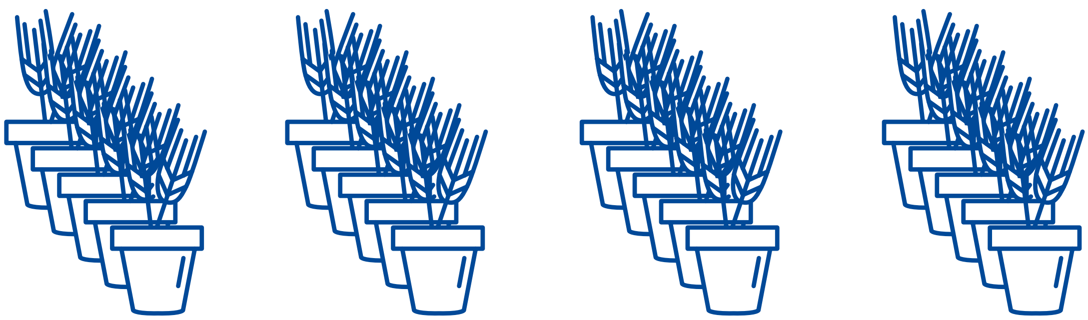
- *If **plant growth** is related to the amount of fertilizer in the soil, then increasing the **amount of fertilizer** will increase plant growth.*

CONTROL | HALF RATE | RECOMMENDED RATE | DOUBLE RATE

- *The constants include: the type of pots, type of soil, amount of light, temperature, type of seed (bean), the watering can (i.e. consistent measurements)*
- *The independent variable is the amount of water.*
- *The dependent variables are the growth of the plant as a result of the amount of water.*

The above experiment is looking good ... BUT what happens if an insect ate the plant? You would have no experiment left! Any good experiment MUST have replications of the treatments. Replications ensure you not only minimise risks but you increase the reliability of the results i.e. what you are seeing as a result of your independent variable is not just happening by chance.

*If **plant growth** is related to the amount of fertilizer in the soil, then increasing the **amount of fertilizer** will increase plant growth.*



CONTROL | HALF RATE | RECOMMENDED RATE | DOUBLE RATE

It can help to place these in a table to help you keep track.

TIP: Make sure you clearly label all treatments / replications in your experiment. Use a waterproof pen if possible. Judges will expect to see at least THREE replications in all experiments.

Here is an example of how you can present your rates, variables and how you will control it.
Ensure you have this table in your report and on your poster.

Experiment	Rates	Controlled variables (these need to be controlled to minimise risk)	How to control for it
Control	ZERO fertiliser	• Type of soil • Soil temperature • Size of pot (affects water distribution) • Sunlight • Wind • Type of water used • Measuring vessel • Insect or disease risk	• Use the same soil for all • Use the same pots for all • Water with a consistent water source for all • Use the same type / brand of fertiliser for all • Keep in the same place • Apply fertiliser at same time • Measure growth of all using the same measuring tape / ruler on the same day / time. • Ensure many replicants to minimise risk
Treatment 1	Rate of fertiliser recommended on packet label		
Treatment 2	Half of recommended label rate		
Treatment 3	Double recommended label rate		

Step 4: Identify your materials

Develop a list of materials you need for the experiments, including any safety equipment. This should include costs, how many of each unit, where you source them from.

Step 5: Develop a safety plan

Part of being a good scientist is managing risks and ensuring the safety of both yourself and others.

EVERY EXPERIMENT NEEDS ITS OWN RISK EVALUATION PLAN WHICH MUST BE APPROVED BY YOUR TEACHER PRIOR TO COMMENCING.

To develop your plan, you need to consider:

- What are the risks involved in your experiment?
    - Am I using chemicals that are dangerous and allowed? Can I use an alternative product? Can I manage this risk by wearing gloves, a mask and lab coat? Or is the risk too great – and therefore choose another experiment.
    - Is there anything that I could be breathing in (fumes, dust, spores). If so, will I need a fume hood, a well-ventilated space, or a mask?
    - Is there anything that I could hurt myself with? Boiling water, sharp knives, scalpels etc? How can I reduce this risk?
- We have provided a risk management check list which you must complete (page 16). This helps you think about your risks and what mitigation efforts are you going to put in place to stop these risks becoming hazards or accidents?

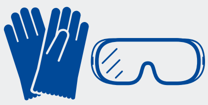
The key risk points to consider are:

- **Risk:** a situation that involves exposure to danger
- **Risk Mitigation:** a measure you put in place to reduce the chance of or prevent a risk from becoming a hazard
- **Hazard:** anything that has the potential to harm the health or safety of a person.

HAS my experiment been approved?

Do you require a lab partner, teacher or parent supervision?

Do you have access to eyewash or first aid in case of emergencies?



Do you need gloves, masks, safety glasses, protective clothing?

Do you have any allergies? If so, is what you are testing a risk to these allergies?

Safety:

One really important part of any experiment is to consider the safety aspects. You will also be judged on how well you've considered your own safety, safety to others, and to any animals you may be including in your experiment.

The things you'll need to consider are mostly the same for the report and the poster, but they are different in the way you communicate on each. This booklet will assist you in producing each.

Important Safety and Ethics Information for Students

As mentioned earlier in this handbook, we love seeing all types of science investigation posters and look forward to see your results! However, it's very important that you adhere to a few safety and ethical requirements.

1. Please ensure the experiment topic is firstly approved by your teacher. It MUST adhere to your school's safety and ethics policies.
2. Check any chemicals or equipment you'll be working with PRIOR to using them. They must not be hazardous or toxic - yours and your student's safety is the first priority.
3. Ensure your experiment has a safety plan approved by your teacher prior to starting. You must ensure your plan is viewed and approved by your teacher to ensure all personal protective equipment (PPE) plus the actions and processes.
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7. It is the responsibility of the school, teacher and parent to approve student projects to ensure all practices are safe.

Risk assessment and management

The following table can be used to identify any possible hazards associated with your experiment, and to allow you to find safe ways of conducting your science. It must be approved by your teacher as part of the topic approval. You are also given access to this tool later in the handbook in the 'Safety plan' section.

Possible hazard	***Risk Rating***	**Safe Operating Procedure**	**PPE & other safety equipment required**
EXAMPLE ONLY: Testing the impact of different soil types on plant growth		• Don't eat or drink while working with soil • Wash hands thoroughly when finished • Work outside where possible • Wear a mask (especially if asthmatic) • Wear gloves	• Sturdy shoes • Hand wash station • Lab coat • Dust mask • Gloves

Step 6: Carry out experiment, Collect and record data

Once approved by your teacher, carry out your experiment.

You need to collect and measure your results in a meaningful and precise way. Many scientists keep a lab book and record information daily.

You might decide to take measurements at other times, just keep them consistent. A table is provided to help you record data and plan your experiment.

Tips on collecting data:

- Use a notebook, journal, word document or excel spreadsheet for collecting results so they are stored all together
- Decide on a plan for how often you take measurements and keep it consistent e.g. 3 times a week, on the same days each week, at the same time of day
- Take plenty of clear photos with labels during your experiments; photos will aid in your presentation and support your findings with evidence
- Record plenty of notes, this will make it much easier to remember what happened throughout your experiment when it comes to making your presentation

Step 6: Evaluate

After completing your research, you must analyse and evaluate your results. Evaluating means you need to not just report your results, but have a think about what the results mean. What was the impact of the different fertiliser rates on plant growth? Did you see any trends? If so, why do you think that is? If not, what might that mean for the treatments you applied?

The next step is to think more broadly about what your results might mean. For example, if you noticed stronger growth in your treatment with the recommended fertiliser rate, but some of your plants died when you doubled the recommended rate, what might this mean if you were farming on a larger scale?

You can present your results as graphs, in tables and as images. A few things to think about:

- Can you come up with an average using your treatment replications?
- What difference do you see between the control and treatments?

Step 7: Report and Communicate

With the Science Investigation Awards you are required to present your research as a poster and report write up.

REPORT

- Your report can be in the form of the template provided.

POSTER

The following guide should assist in your poster development:

- The poster, and experiment, can be done as a pair or individual only. No groups of three or more.
- The poster must be your own work.
- You must reference information you source from google or books.
- The poster must include:
  - A background
  - Aim / hypothesis
  - Variables summary
  - Materials and methods
  - Risk assessment
  - Results – including tables and graphs, images to demonstrate the work is your own
  - Discussion and findings
  - References
- Tips for great posters
  - Size can be a standard sheet of cardboard – we will accept A2 or A1 (we recongise it can be hard to get supplies in some places, so note the below as a guide).
  - Your poster must be able to stand on a tabletop – see example so it can be judged.
  - We do allow props on the judging day to help tell your story – but note this alone will not win you first place! We are interested in the quality of the science.

- Judging
- Your posters will be judged on the
  - Quality of the science
  - Experimental deign
  - How you have controlled your variables
  - Risk management
  - Data analysis
  - Quality of results and discussions
  - Presentation
  - Number of replications
  - Interpretation of your results and findings, what does this mean for others?

Tips for great posters

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Step 6.1 Experiment Plan

Courtesy of D. Brookes, Experimental Design, Urrbrae Agricultural School 2019

Use the below to guide the development of your report and poster.

What problem have you identified?

Provide a short (500 word) summary of the background of the issue, providing references. i.e. where is it a problem, why is it a problem etc.

Write your experiment aim – what you are hoping to achieve

Hypothesis – what you predict will happen

(If and then statement)

Your Experimental variables

Control:

Dependent variable(s):

Independent variable(s):

Controlled variables:

Modify the below table to help you keep track of how you will manage your experiment:

Experiment	Rates	Controlled variables (these need to be controlled to minimise risk)	How to control for it
Control			
Treatment 1			
Treatment 2			
Treatment 3			

Materials – everything you need to conduct the experiment

Method – what you need to do to conduct the experiment

A step by step plan of how it is going to run

Safety plan

- What are the risks involved in your experiment? List them.
- How are you going to mitigate or prevent each of your risks from becoming hazards?
- Once you have considered these 2 things, you can carry out your experiment safely following the methods you chose to prevent hazards occurring.

RISK	MITIGATION

Results – the data you collect during your experiment

Think about how you want to collect your data using qualitative and/or quantitative measurements.

Tips on collecting data:

- Use a notebook, journal, word document or spreadsheet for collecting results so they are stored all together
- Decide on a plan for how often you take measurements and keep it consistent e.g. 3 times a week, on the same days each week, at the same time of day
- Take plenty of clear photos with labels during your experiments; photos will aid in your presentation and support your findings with evidence
- Record plenty of notes, this will make it much easier to remember what happened throughout your experiment when it comes to making your presentation

Conclusion – summarise your results, did it support your hypothesis?

Presentation: either a PowerPoint presentation or a poster covering everything you did during your experiment and what results you achieved!

Appendix 1:
Curriculum Links

This program delivers against the national curriculum. We have provided examples of the linkage to the 9 curriculum as a guide:

YEAR 9

Activity	Curriculum links
Presentation from the Food and Fibre Team Introduction to experimental design and research methodology **Conducting their own experiment** Developing a hypothesis, designing an experiment and collecting / analysing data. **Writing up a research report and poster** Writing up the experimental protocol, research findings and a discussion in a poster and research report.	• Formulate questions or hypotheses that can be investigated scientifically (ACSIS164) • Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165) • Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACSIS166) • Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSIS169) • Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170) • Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data. • Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems (ACSIS172) • Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)

Appendix 2:
Investigation Ideas

What are the benefits of organic fertilisers vs inorganic fertilisers on plants?

- Does one result in higher yields than the other?
- What effects do each fertiliser type have on the soil?
- Is one more sustainable than the other?
- What are the economics of using one vs the other?

What is the effect of different coloured light on plant growth?

- Which colour cellophane affects plant growth?
- What is the significance of each of the light spectrums on plant growth?
- How could this be translated into a real-life farming technology innovation?

What is the optimum amount of nitrogen fertiliser to apply to plants?

- What rate achieves the best yield?
- What is the relationship between rate and timing of fertiliser?
- What is the toxicity limit of adding nitrogen to plants?
- What would be a real-life economic fertiliser plan that a farmer could use on his crops?

How much do plants rely on water?

- What level of water (i.e. rainfall) can different plants survive on as a bare minimum?
- What is the relationship between water absorbed by the plant roots vs the leaves?
- What would an irrigation plan for a real-life cropping scenario look like?
- What is the optimum water required for plants to achieve the best growth?

What brand of bread / jam (etc) goes mouldy quickest?

- What causes mould growth?
- What ingredients cause / inhibit mould growth?

Do all sugars taste the same? Can you taste the difference between the different types of sugars?

- What are the most commonly used sugars e.g. glucose, sucrose, etc.
- Who will be used as testers for the investigation? Justify your choice of testers.
- Will the sugars be dissolved or used in powder form?
- How will testers rate the different sugars?
- Why are different sugars used in different food products?

Many food products use acidic or alkaline solutions as a preservative. Develop a set of natural indicators to test a range of pH solutions.

- Which fruits and vegetables contain dyes that can be extracted easily?
- Do the colours need to be preserved so they remain stable?
- What pH range does each indicator test?
- What safety precautions need to be considered in the investigation?

Are waters in urban area more polluted than in rural areas?

- Test macro and micro invertebrate populations in different creeks?
- What are the signs of a healthy vs unhealthy water way?

What sort of fabric should fire fighters wear?

- Investigate the flammability of different fabrics
- What are different fabrics made form and what contributes to their burn rate.

Effects of disinfectants on various bacteria

- Use algar plates swabbed with germs (i.e. toilet floor, kitchen floor, door handle) and see which disinfectant works best

Are we washing our hands effectively?

- Wash hands with different soaps and hand sanitisers and then test (using 'Glitter Bug') the effectiveness of germ kill.

Reaction time in left and right hands.

- Test reaction time when blindfolded / not blindfolded. Compare boys vs girls or age groups.

Does the shape of something affect how fast it falls?

Compare fall rates of different shapes with same weight.

Other ideas...

- Do different types of soil hold different amounts of water?
- The effect of music on the heart rate
- Do the surrounding colours affect a bird's eating habit?
- Hearing test of boys vs girls / over 50's vs under 10's etc.
- What is the best way to get rid of stains? i.e. test effectiveness of detergents at removing stain.
- The effect of exercise on heart rate.
- Does wheat grow differently using different water sources?
- Synthetic fibre vs natural fibre
- The effect of different food on eggshell strength, colour and shape.
- Does grooming affect a horse heart rate after exercise?
- Does chilli affect metabolism?
- Do different types of soil change the pH of water?
- Which product minimises apple oxidation (i.e. lemon juice, vinegar, sugar syrup, other)
- How much vitamin C is in your vegetables?

If you have another idea in mind for what you could test for your experiment, consult your teacher for permission to use one not on this list along with a list of materials you will need for this, including a full safety plan.

Appendix 3:

Finalist judging criteria for posters

Criteria	Description	Score
Hypothesis	How thoughtful, interesting and worthwhile is the **question** that the student(s) investigated?	0 1 2 3 4 5
Safety / PPE / ethics	Was there a safety plan in place? Did the student have a safety plan in place i.e. risks managed / PPE? Or was the animal / human ethics appropriate.	0 1 2 3 4 5
Control of variables / *replications*	Were the variables controlled? Were there appropriate replications.	0 1 2 3 4 5
Independent and dependent variables	How well did they change one variable (independent) to see how it affected another variable (dependent)?	0 1 2 3 4 5
Display of data	Has data been displayed thoughtfully, clearly and scientifically in tables and/or labelled graphs?	0 1 2 3 4 5
Accuracy of data	Establish how or if they ensured accuracy of their collected data (average of repeated or many readings)	0 1 2 3 4 5
Diagram/Image	What is the quality of the labelled diagram of assembled equipment used?	0 1 2 3 4 5
Discussion, thinking and analysis	How well have the results been **interpreted and discussed?** (Eg. implications arising, examination of possible real-life applications of the research, mention of further questions suggested by their results, links to other studies etc.)	0 1 2 3 4 5
Conclusion	How clearly have the students stated their conclusion(s)?	0 1 2 3 4 5
Visual Communication	How clearly have the aim and the method been **communicated** on the display board?	0 1 2 3 4 5
Verbal Communication	In your **discussion** with the student(s), was their understanding of the Scientific Method apparent?	0 1 2 3 4 5
Judges' overall impression	You have asked the questions and looked at the display details. What is your overall impression of this project?	0 1 2 3 4 5
	Total Score /60	