Rooting for Knowledge

LEAVING CERTIFICATE AGRICULTURAL SCIENCE

TEACHER BOOK

A new way to learn

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CONTENTS

Chapter One
NATURE OF SCIENCE

NATURE OF SCIENCE

LEARNING OUTCOMES

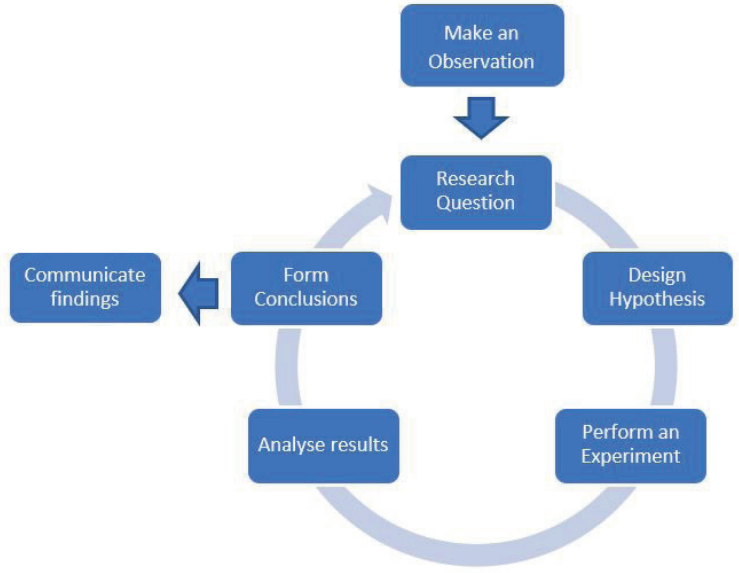
You should be able to:	✓
Outline the steps involved in experiments and understand experimentation as a cyclical process	
Differentiate between variables and explain fair testing	
Explain the terms: Statistical and systematic uncertainty, precision, accuracy, causation, correlation	
Identify and interpret graphs	
Draw a graph from results	
Assess the reliability and validity of a source	
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	

KEY TERMS

Hypothesis: A proposed explanation for a phenomenon.

Variable: Any factor or condition that may influence an experiment.

Control: Designed to minimise the effects of variables to allow for a fair comparison.



SCIENTIFIC METHOD

1. An OBSERVATION is made or an idea is formed.
2. This is used to develop a RESEARCH QUESTION and a hypothesis. This hypothesis must be testable.
3. An experiment should be designed to test the HYPOTHESIS.
4. The EXPERIMENT should be performed and data should be collected and analysed.
5. From the ANALYSIS a conclusion should be formed.
6. The hypothesis can be altered and/or retested.

OR

The findings should be published.

VARIABLES

There are three types of variables:

- Variables you change (INDEPENDENT variable)
- Variables you record (DEPENDENT variable)
- Variables that are kept constant during an experiment (CONTROLLED variables)

An experiment will often look at how an independent variable affects the dependent variable.

E.g. If investigating the effect of fertiliser on yield

- Independent variable: FERTILISER
- Dependent variable: YIELD

FAIR TESTING

In order to make sure an experiment is fair only one variable should be changed.

This ensures that only the INDEPENDENT variable could lead to the effect that is recorded.

E.g. If investigating the effect of fertiliser on yield

Controlled variables: SOIL TYPE, MOISTURE, CROP, VARIETY, SEEDING RATE etc.

DATA

PRIMARY DATA is collected by the user.

E.g. Performing an experiment, collecting and analysing the results.

SECONDARY DATA is collected by someone other than the user.

E.g. Analysing data collected by Teagasc.

QUANTITATIVE DATA is numerical data that can be recorded using numbers.

E.g. the yield of a crop

QUALITATIVE DATA is data that can be recorded using words.

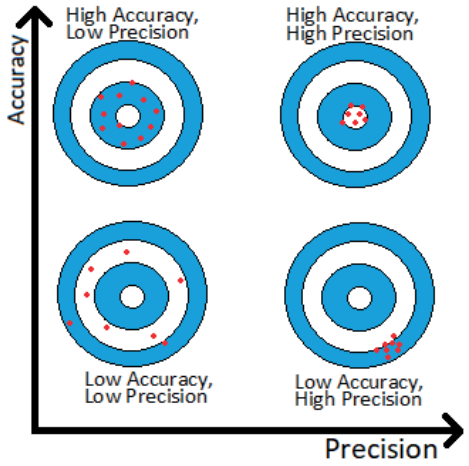
E.g. the colour of leaves

PRECISION VS. ACCURACY

PRECISION means that each piece of recorded data is close together.

ACCURACY means that each piece of recorded data is close to the true value.

Scientists should aim to be both precise and accurate.



ERRORS IN DATA

SYSTEMATIC uncertainty is when we are constantly over or under the accurate values by a set amount.

Caused by misuse or incorrect calibration of equipment.

Can be reduced by ensuring correct use of equipment.

STATISTICAL errors are random errors. These can occur in either direction.

Can be caused by random fluctuations in measurement.

Can be reduced by increasing the sample size and finding the average of the results.

ANALYSIS OF RESULTS

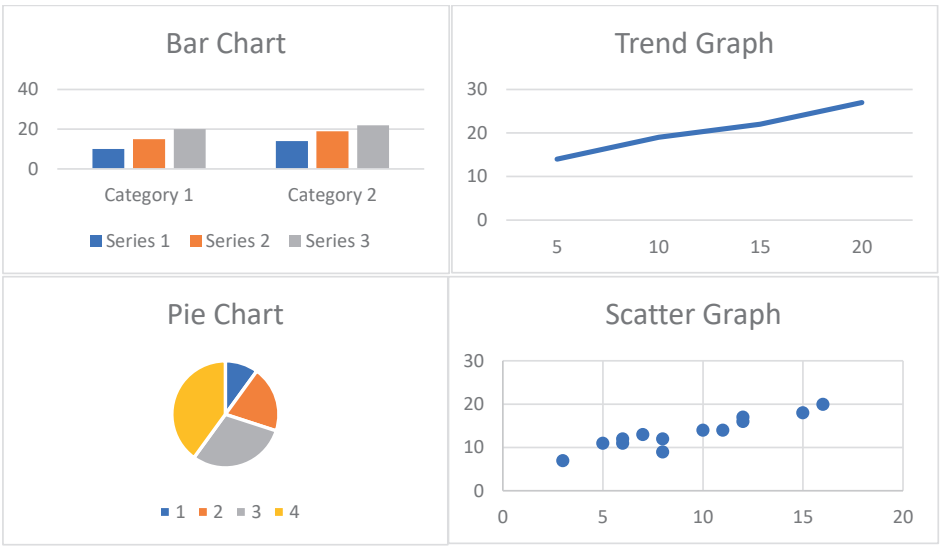
Experiments should be repeated to ensure ACCURACY.

To calculate the mean (average) of a set of data:

$$\text{Mean:} \quad \frac{\text{Sum of values}}{\text{Number of values}}$$

REPRESENTING DATA

Data can be represented in the following ways:



Bar Chart

- Comparing two variables (two quantitative or one quantitative and one qualitative)

Pie Chart

- Representing proportions

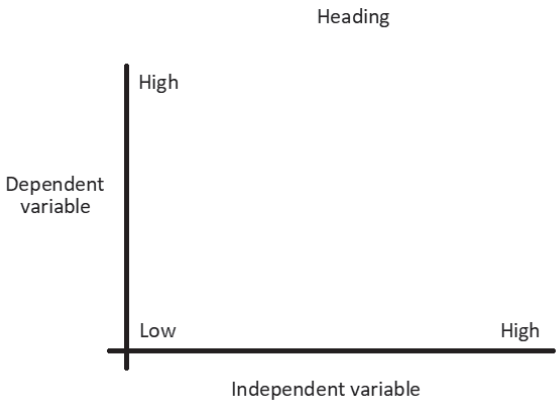
Trend Graph/Scatter Graph

- Comparing two quantitative variables

DRAWING A GRAPH

Following **GRAPH** rules:

- Use **G**raph Paper
- Use a **R**uler
- Label your **A**xes
- Use a **P**encil
- Give your graph a **H**eading



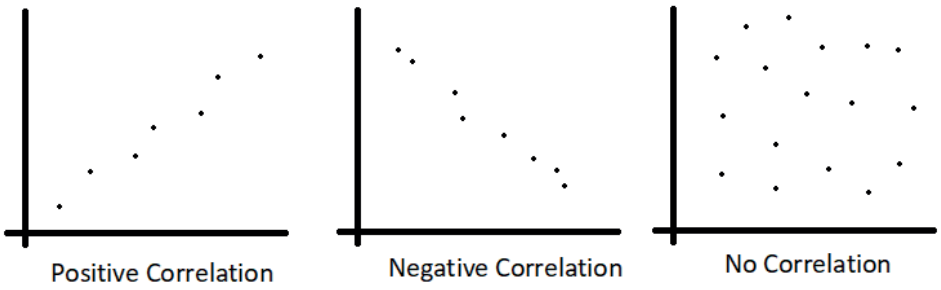
CORRELATION

Correlation refers to the relationship between TWO VARIABLES.

If there is a positive correlation then as the independent variable increases the dependent variables increases as well.

If there is a negative correlation then as the independent variable increases the dependent variables decreases.

If there is no correlation then there is no set relationship between the variables.



CORRELATION VS. CAUSATION

CORRELATION indicates a relationship between the two variables.

CAUSATION means that the change in one variable has caused the change in the other.

A randomised controlled experiment should be carried out to determine causation.

RELIABILITY

When researching, it is important to evaluate evidence to ensure it comes from a reliable source.

- Could the experiment be repeated?
- Was it repeated to increase accuracy?
- Was the sample size large enough to account for statistical uncertainty?
- Has the research been peer-reviewed?

If it is not an experiment report, information should still be assessed for reliability. Anybody can put information on the internet and so it should be assessed carefully.

- Is the information accurate? Are there disclaimers? Are there references? Should you double check the information against a source you know is reliable?
- Is the information coming from a recognised, experienced and trustworthy source? Is there potential bias?
- How recent is the information? Does this affect it's reliability?

VALIDITY

It is important to assess if an experiment is valid.

- Does the experiment test the stated hypothesis?
- Does the method allow for accurate collection of results?

ETHICS

The moral principles that guide behaviour/research.

Ethical considerations include:

- The risk of harm to participants should be minimised
- Animals should be treated correctly
- The impact of a study on the environment (chemicals, biodiversity etc.)
- The impact of a study on organisms

Ethics should be taken into account:

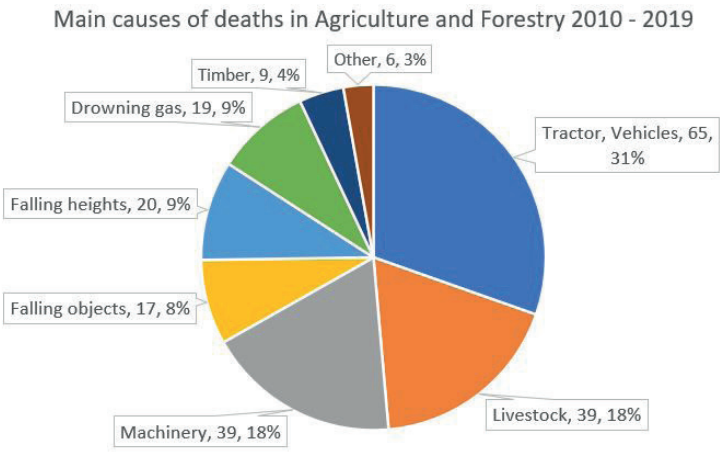
- During agricultural work
- During agricultural research

SAFETY IN AGRICULTURE

Agriculture has higher workplace fatalities than any other industry. There were 18 fatalities in Ireland in 2019.

Care should be taken at all times.

The following are some areas where farmers should take care.



MACHINERY

Risks:

- Being caught in a MACHINE MECHANISM
- Failing handbrakes
- Power Take-Off (PTO) shafts
- Overhead or buried ESB lines

Precautions:

- Check HANDBRAKES
- Suitable GUARDS in place
- Loose clothing should be not be worn
- Operate machinery from the correct position

LIVESTOCK

Risks:

- Animals with YOUNG OFFSPRING
- Being knocked over
- Being kicked

Precautions:

- Good handling facilities for livestock
- Proper CRUSH for handling livestock
- Use a ring and chain on a stock bull

HEIGHTS/FALLING OBJECTS

Risks:

- Work on roofs
- Work on ladders
- Loading trailers and stacking

Precautions:

- Use appropriate SCAFFOLDING
- Suitable platforms/covers if fragile material
- Secure LADDERS
- Trailers should be in good condition and loads should be secure
- Do not stack bales more than TWO HIGH

CHEMICALS

Risks:

- Skin irritation
- Unplanned reactions
- INHALATION
- INGESTION

Precautions:

- Read labels carefully
- Store safely in locked CHEMICAL STORES
- Use appropriate PPE (PERSONAL PROTECTIVE EQUIPMENT)
- Do not mix chemicals without knowing if they will react

SLURRY

After storage over the winter months a CRUST forms on the top of the slurry.

Gases such as HYDROGEN SULPHIDE, METHANE, ammonia and carbon dioxide build up under the crust.

The crust should be broken, the gases released and the slurry should be AGITATED.

This agitation gives the slurry a uniform consistency.

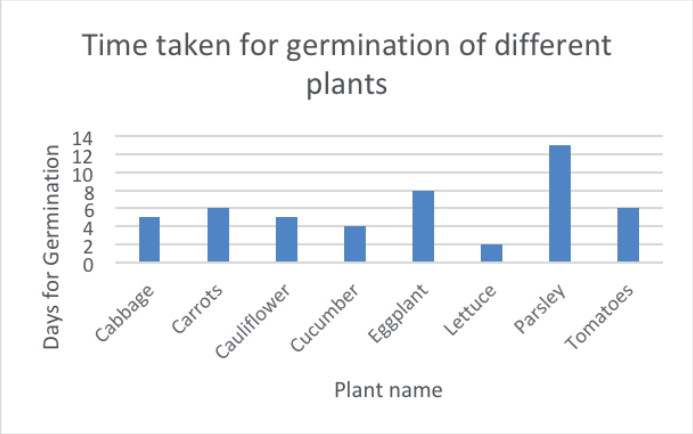
Unsafe practices can lead to drowning and asphyxiation.

PRECAUTIONS:

- Evacuate shed of all LIVESTOCK and people.
- Open all doors and ensure adequate ventilation.
- Agitation points should be outside the building.
- Do not allow anyone to enter the building.
- AT LEAST TWO people should be present and using appropriate equipment.
- Nobody should enter the shed within 30-60 MINUTES of agitation.

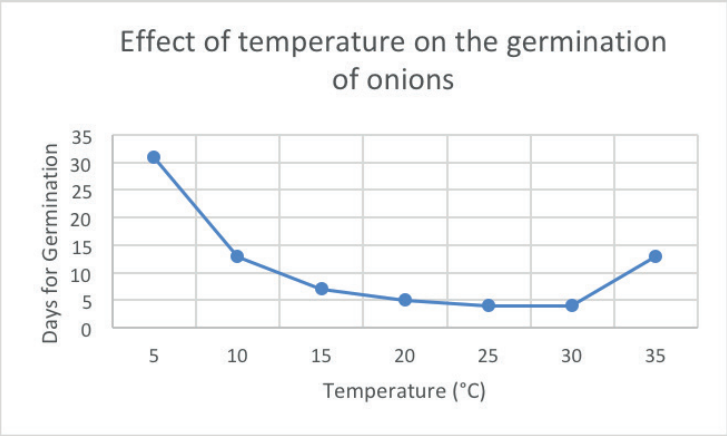
LEARNING CHECK

1. Describe the steps involved in the experimental process.
2. What is a variable?
3. Name and describe the three types of variables in an experiment.
4. You are completing an experiment to investigate "The effect of grazing strategy on tillering".
   (a) What is the independent variable?
   (b) What is the dependent variable?
   (c) Name two controlled variables.
5. What makes an experiment a fair test?
6. Distinguish clearly between the members of the following pairs of terms:
   (a) *Statistical uncertainty* and *systematic uncertainty*
   (b) *Precision* and *Accuracy*
   (c) *Causation* and *Correlation*
7. Study the following graph and answer the questions.



   (a) Name the type of graph shown.
   (b) What plant takes the longest to germinate?
   (c) What plant germinates the fastest?
   (d) How long does it take for eggplant seeds to germinate?
   (e) Identify a plant that can germinate in 5 days.
   (f) What is the independent variable?
   (g) What is the dependent variable?

8. Study the following graph and answer the questions.



(a) Name the type of graph shown.

(b) Describe the trend observed as the temperature increases.

(c) At what temperature do the onions germinate the fastest?

(d) How does the trend change between 30°C and 35°C?

(e) How many days does it take to germinate onions at 20°C?

(f) What is the independent variable?

(g) What is the dependent variable?

(h) Name a controlled variable for this experiment.

9. Study the following table of results.

Investigating the effect of fertiliser concentration on plant height.

Concentration of fertiliser (mg L^{-1})	Plant height (cm)
50	29
100	33
300	32
600	29
900	23

(a) What is the independent variable?

(b) What is the dependent variable?

(c) What fertiliser concentration gives the greatest plant height?

(d) Draw a trend graph of the results (Be sure to follow your GRAPH rules)

10. Find three sources discussing the use of GMO foods for human comsumption. Assess the validity of these sources.
11. Find three sources discussing the pros and cons of vaccinations . Assess the validity of these sources.
12. Identify two risks on a farm. Discuss how these risks can be reduced.
13. Why does slurry need to be agitated before spreading?
14. What risk is associated with agitating slurry?
15. What precautions should be followed when agitating slurry?