Agricultural Science subject report

2023 cohort

February 2024

Queensland Government | QCAA Queensland Curriculum & Assessment Authority

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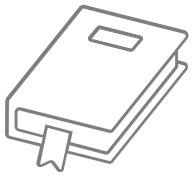
Introduction



Throughout 2023, schools and the Queensland Curriculum and Assessment Authority (QCAA) continued to improve outcomes for students in the Queensland Certificate of Education (QCE) system. These efforts were consolidated by the cumulative experience in teaching, learning and assessment of the current General and General (Extension) senior syllabuses, and school engagement in QCAA endorsement and confirmation processes and external assessment marking. The current evaluation of the QCE system will further enhance understanding of the summative assessment cycle and will inform future QCAA subject reports.

The annual subject reports seek to identify strengths and opportunities for improvement of internal and external assessment processes for all Queensland schools. The 2023 subject report is the culmination of the partnership between schools and the QCAA. It addresses school-based assessment design and judgments, and student responses to external assessment for this subject. In acknowledging effective practices and areas for refinement, it offers schools timely and evidence-based guidance to further develop student learning and assessment experiences for 2024.

The report also includes information about:

- how schools have applied syllabus objectives in the design and marking of internal assessments
- how syllabus objectives have been applied in the marking of external assessments
- patterns of student achievement.

The report promotes continuous improvement by:

- identifying effective practices in the design and marking of valid, accessible and reliable assessments
- recommending where and how to enhance the design and marking of valid, accessible and reliable assessment instruments
- providing examples that demonstrate best practice.

Schools are encouraged to reflect on the effective practices identified for each assessment, consider the recommendations to strengthen assessment design and explore the authentic student work samples provided.

Audience and use

This report should be read by school leaders, subject leaders and teachers to:

- inform teaching and learning and assessment preparation
- assist in assessment design practice
- assist in making assessment decisions
- help prepare students for internal and external assessment.

The report is publicly available to promote transparency and accountability. Students, parents, community members and other education stakeholders can use it to learn about the assessment practices and outcomes for senior subjects.

Report preparation

The report includes analyses of data and other information from endorsement, confirmation and external assessment processes. It also includes advice from the chief confirmer, chief endorser and chief marker, developed in consultation with and support from QCAA subject matter experts.

Subject highlights

47
schools offered Agricultural Science

83.57%
of students completed 4 units

98.56%
of students received a C or higher

Subject data summary

Subject completion

The following data includes students who completed the General subject or Alternative Sequence (AS).

Note: All data is correct as at January 2024. Where percentages are provided, these are rounded to two decimal places and, therefore, may not add up to 100%.

Number of schools that offered Agricultural Science: 47.

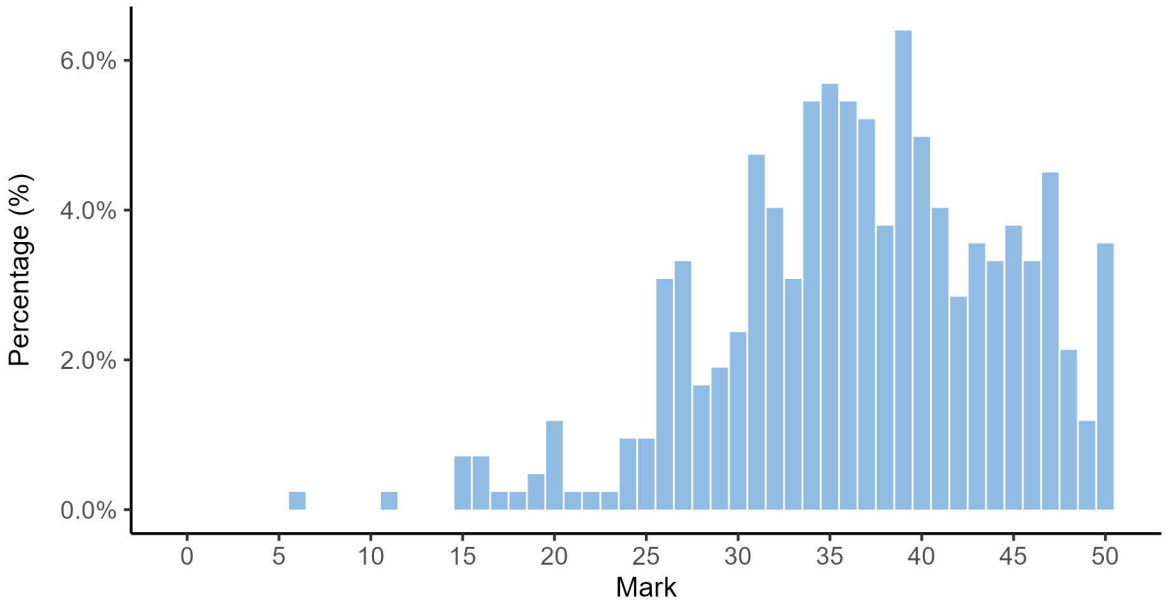
Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	499	478	417

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory
Unit 1	466	33
Unit 2	437	41

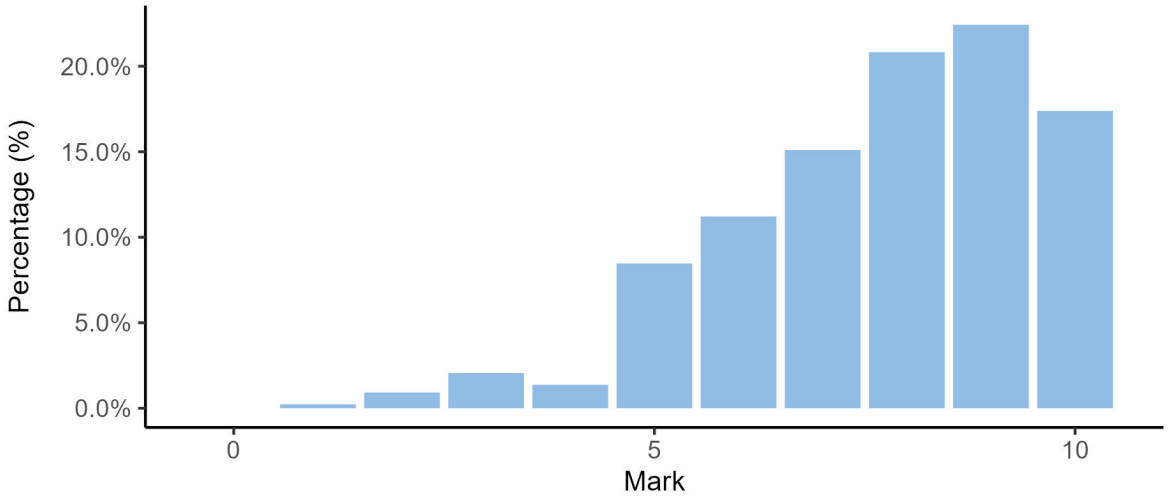
Units 3 and 4 internal assessment (IA) results

Total marks for IA

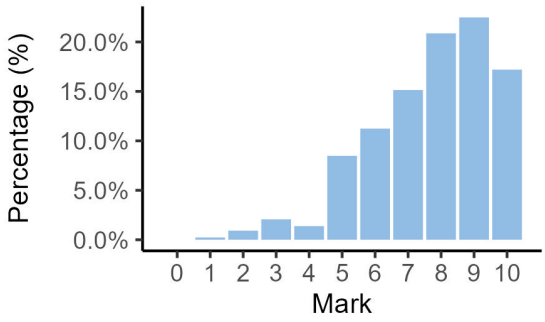


IA1 marks

IA1 total

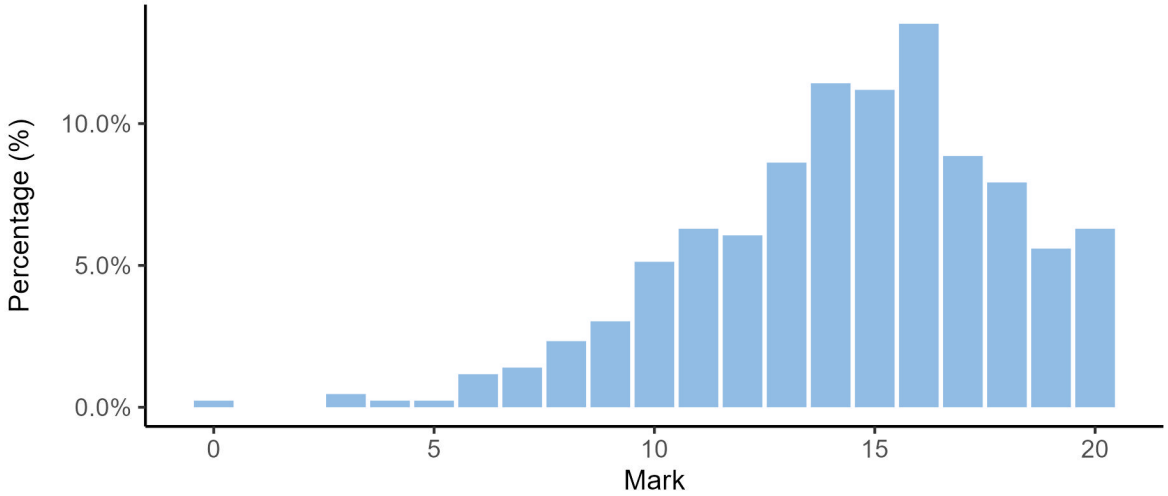


IA1 Criterion: Data test

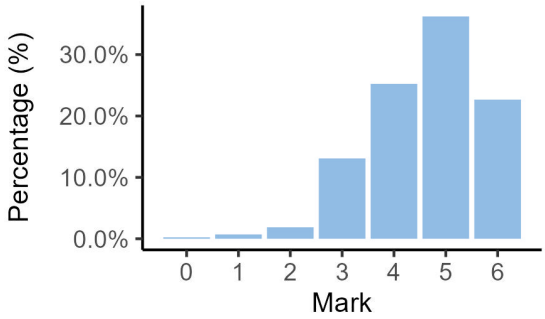


IA2 marks

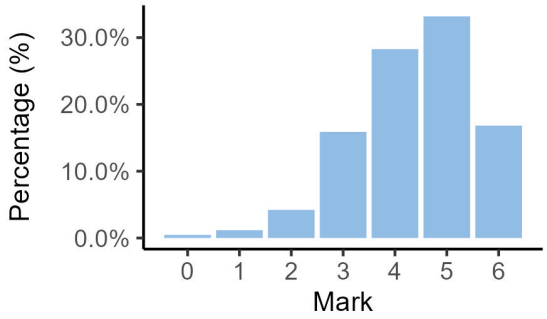
IA2 total



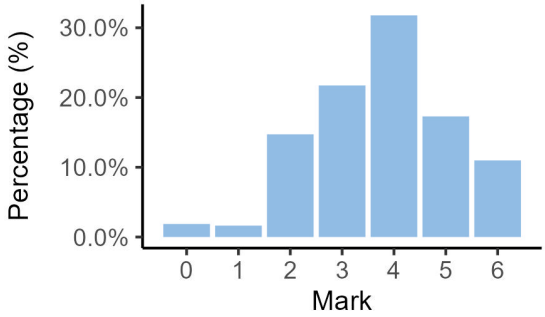
IA2 Criterion: Research and planning



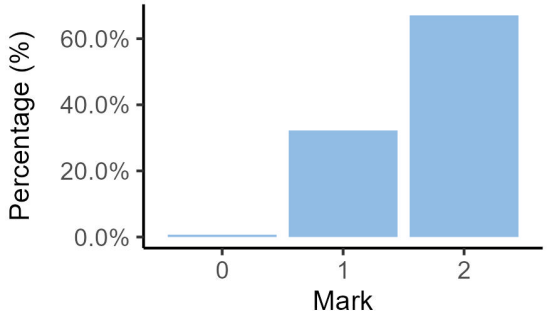
IA2 Criterion: Analysis of evidence



IA2 Criterion: Interpretation and evaluation

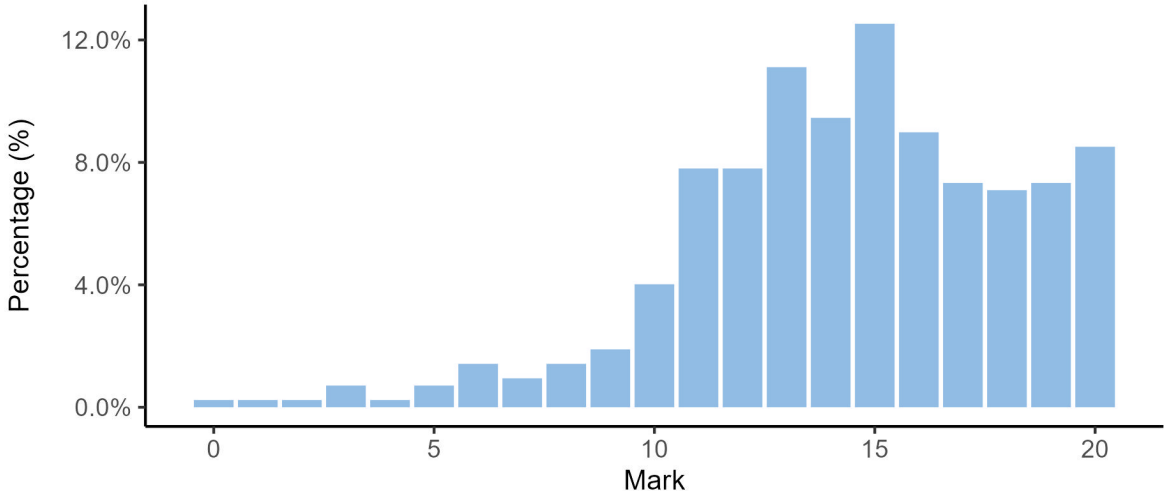


IA2 Criterion: Communication

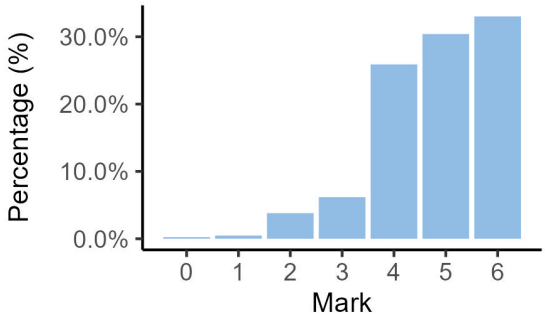


IA3 marks

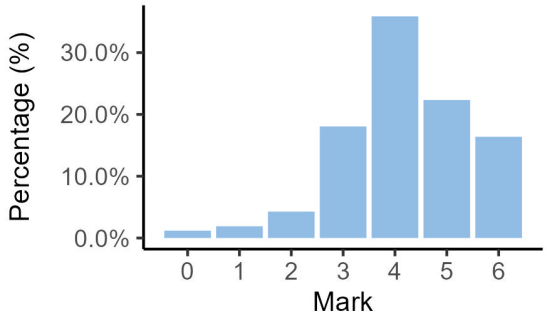
IA3 total



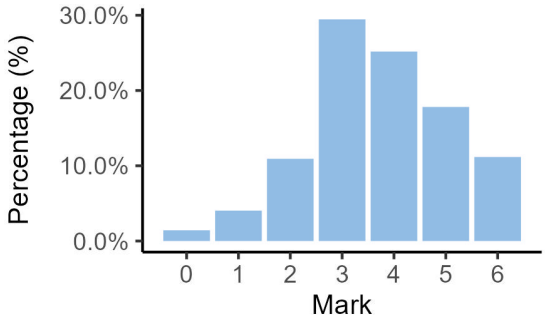
IA3 Criterion: Research and planning



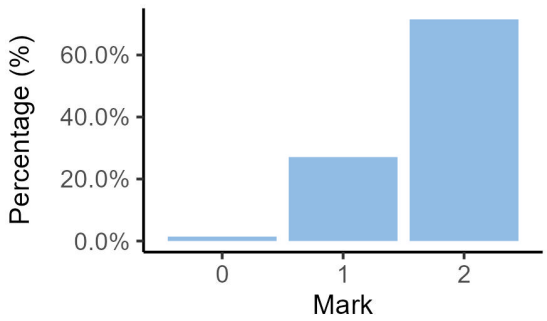
IA3 Criterion: Analysis and interpretation



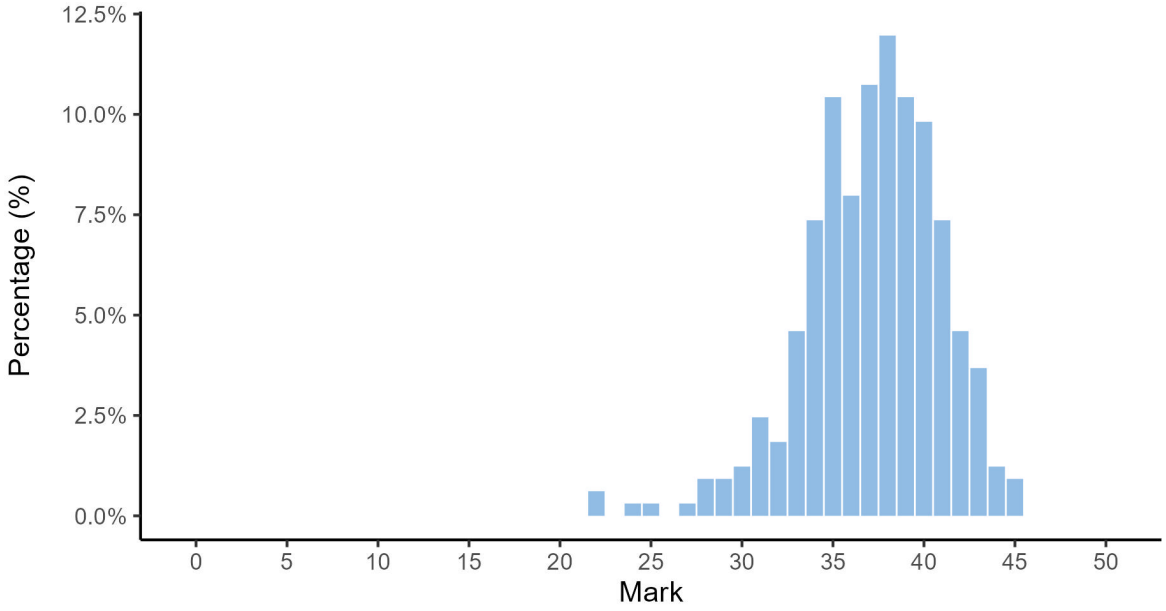
IA3 Criterion: Conclusion and evaluation



IA3 Criterion: Communication

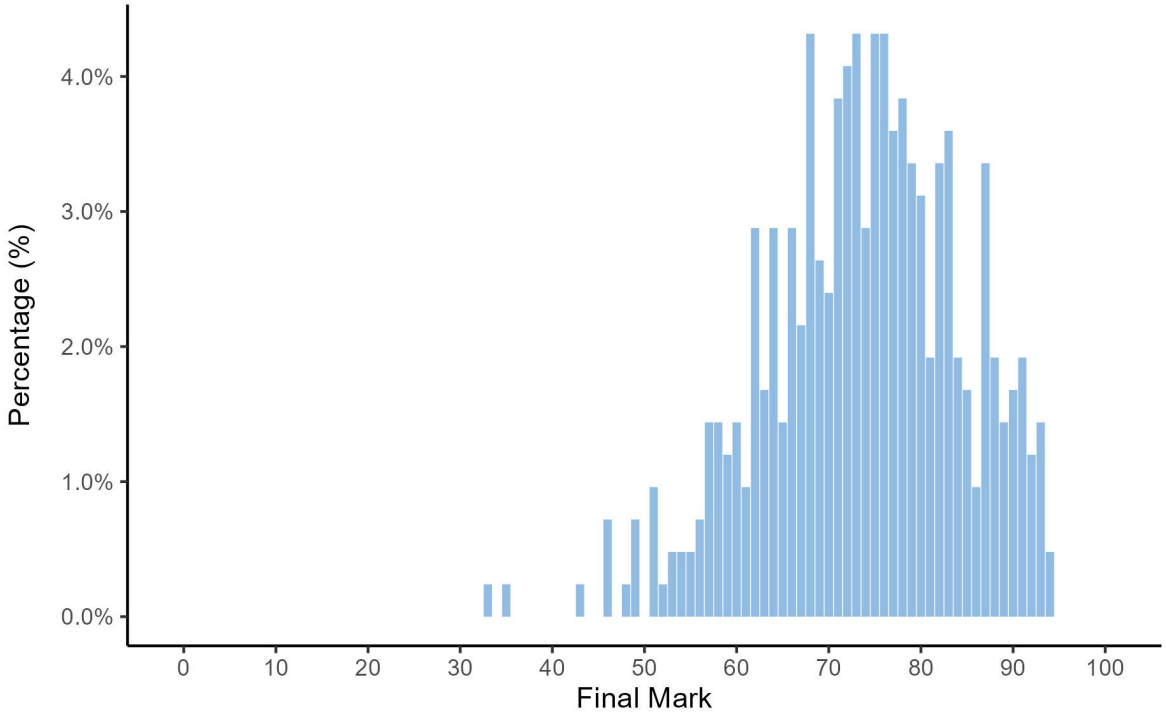


External assessment (EA) marks



Final subject results

Final marks for IA and EA



Grade boundaries

The grade boundaries are determined using a process to compare results on a numeric scale to the reporting standards.

Standard	A	B	C	D	E
Marks achieved	100–83	82–67	66–47	46–20	19–0

Distribution of standards

The number of students who achieved each standard across the state is as follows.

Standard	A	B	C	D	E
Number of students	90	227	94	6	0

Internal assessment

The following information and advice relate to the assessment design and assessment decisions for each IA in Units 3 and 4. These instruments have undergone quality assurance processes informed by the attributes of quality assessment (validity, accessibility and reliability).

Endorsement

Endorsement is the quality assurance process based on the attributes of validity and accessibility. These attributes are categorised further as priorities for assessment, and each priority can be further broken down into assessment practices.

Data presented in the Assessment design section identifies the reasons why IA instruments were not endorsed at Application 1, by the priority for assessments. An IA may have been identified more than once for a priority for assessment, e.g. it may have demonstrated a misalignment to both the subject matter and the assessment objective/s.

Refer to *QCE and QCIA policy and procedures handbook v5.0*, Section 9.6.

Percentage of instruments endorsed in Application

Number of instruments submitted	IA1	IA2	IA3
Total number of instruments	47	47	47
Percentage endorsed in Application 1	63%	91%	87%

Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. The QCAA uses provisional criterion marks determined by teachers to identify the samples of student responses that schools are required to submit for confirmation.

Confirmation samples are representative of the school's decisions about the quality of student work in relation to the instrument-specific marking guide (ISMG), and are used to make decisions about the cohort's results.

Refer to *QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.

The following table includes the percentage agreement between the provisional marks and confirmed marks by assessment instrument. The Assessment decisions section of this report for each assessment instrument identifies the agreement trends between provisional and confirmed marks by criterion.

Number of samples reviewed and percentage agreement

IA	Number of schools	Number of samples requested	Number of additional samples requested	Percentage agreement with provisional marks
1	45	209	0	97.78%
2	45	266	12	75.56%
3	45	266	0	86.67%

Internal assessment 1 (IA1)

Data test (10%)

This assessment focuses on the application of a range of cognitions to multiple provided items.

Student responses must be completed individually, under supervised conditions, and in a set timeframe.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment

Validity priority	Number of times priority was identified in decisions*
Alignment	10
Authentication	0
Authenticity	0
Item construction	0
Scope and scale	1

*Each priority might contain up to four assessment practices.

Total number of submissions: 47.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- aligned the cognition and the nature of the expected response as indicated in the Mark allocations table (Syllabus section 4.6.1, AS section 4.6.1), e.g. items that used the cognitive verb
  - *compare*, which requires students to identify similarities, differences and the significance of the recognised similarities or differences
  - *deduce*, which requires students to analyse and interpret items
- used a variety of cognitive verbs from each objective
- avoided repetition of question types and calculations, e.g. asking students to determine the most appropriate bull for a given scenario by calculating one dressing percentage, not four.

Practices to strengthen

It is recommended that assessment instruments:

- include prompts that
  - indicate the cognition and nature of the expected response, e.g. ‘justify your response’

  - do not include scaffolding that informs students how to perform the cognition in the question, e.g. do not include ‘quantify the differences’ if a question requires students to contrast

- have a marking guide that matches the items in the data test and clearly indicates how marks are awarded for each valued feature of the expected response
- avoid items that assess communication (Assessment objective 7), e.g. if instructions in the scaffolding indicate ‘give your answer as a percentage to one decimal place’, students should not be penalised for answering to a different number of decimal places.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	1
Language	6
Layout	0
Transparency	4

*Each priority might contain up to four assessment practices.

Total number of submissions: 47.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- contained clear instructions aligning with the specifications, objectives and/or ISMG (Syllabus section 4.6.1, AS section 4.6.1)
- used datasets containing only the information required to answer the question.

Practices to strengthen

It is recommended that assessment instruments:

- contain images and tables in datasets that are legible, clear, relevant and of appropriate scope and scale
- use consistent language in questions and datasets
- provide formulas that are required for calculations
- use appropriate cues to support responses, e.g. ‘use evidence from Dataset 1 to justify your conclusion’.

Additional advice

- Use cognitive verbs and terminology in ways that reflect their glossary explanations (Syllabus section 6) to ensure the validity of the marking guide and to support students to prepare for subsequent assessments.
- Ensure that items demonstrate a correct understanding of any statistical terminology used, e.g. r^2 values and p values.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Data test	97.78%	0%	2.22%	0%

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

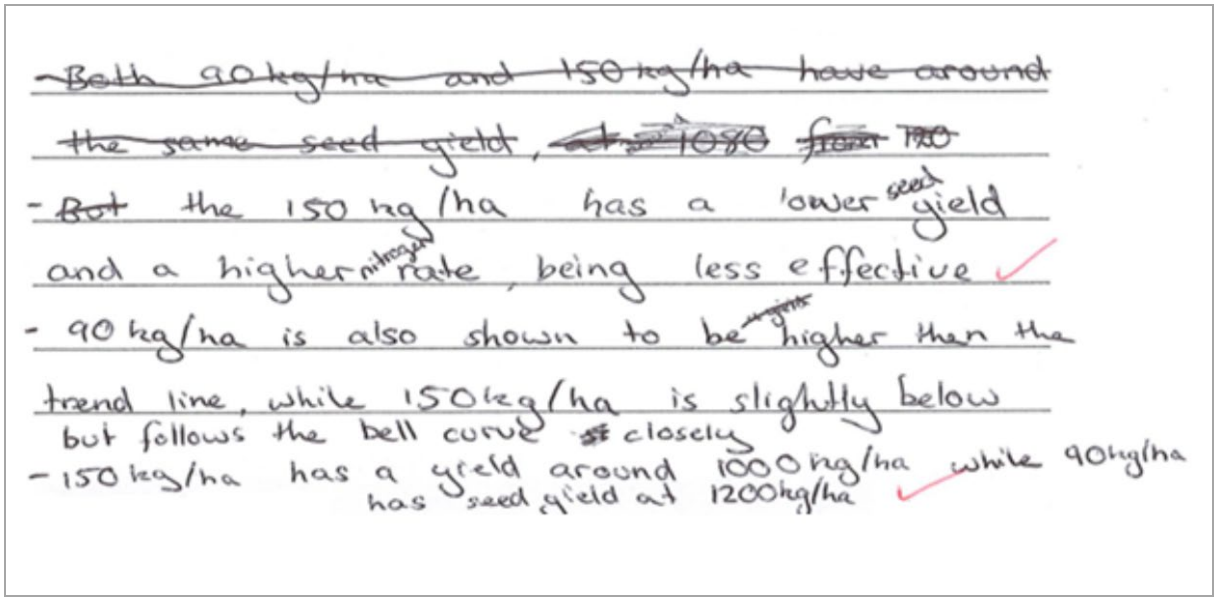
- the marking scheme provided an accepted range for a valid quantitative response, e.g. when reading the value of 130 from a graph, an accepted range between 125 and 135 inclusive (125–135) was indicated
- the marking scheme clearly indicated where marks were allocated in the student response
- the sample response and mark allocation provided in the marking scheme consistently aligned to the cognition required in the question.

Samples of effective practices

The following excerpt demonstrates the use of annotations (ticks) on the student response to indicate where evidence matches to the marking scheme in an Objective 3 item. The item required students to use evidence from the dataset to contrast values for the dependent variable.

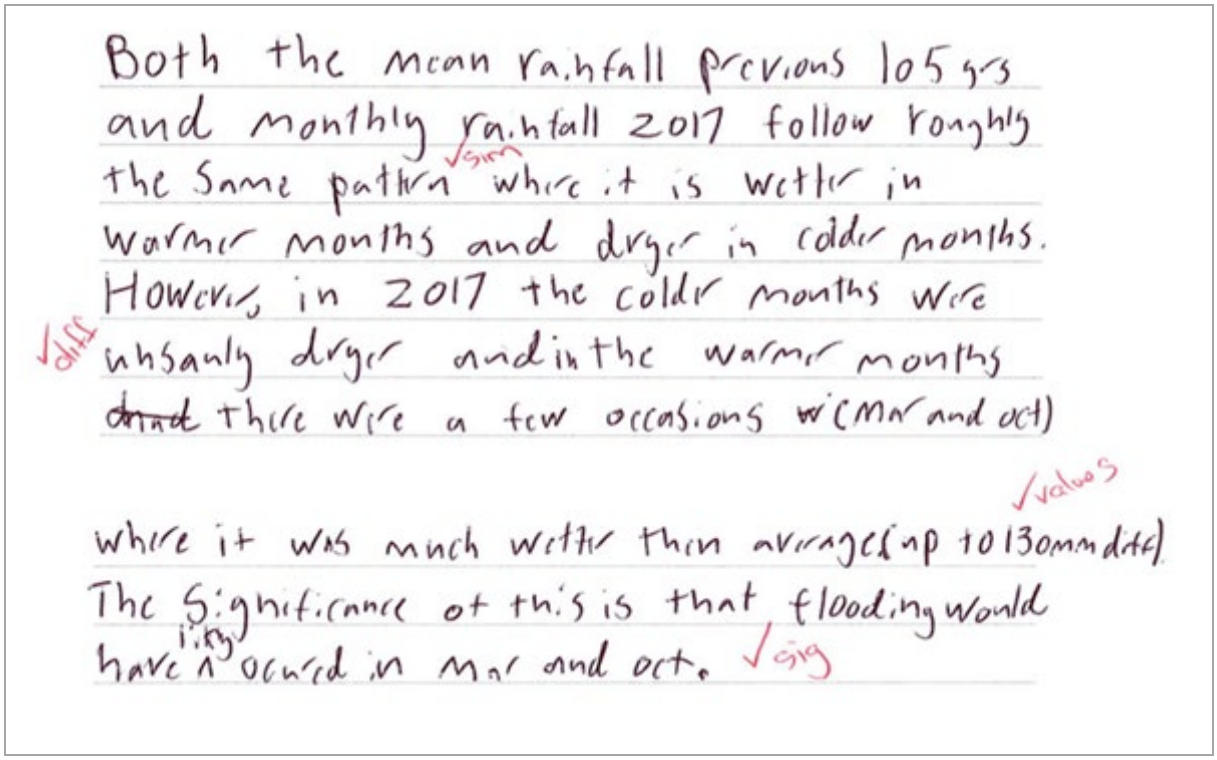
Marks could be clearly awarded as the marking guide explicitly stated the range of the acceptable values for the response.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



The following excerpt demonstrates a student response that clearly indicates the aspects of the cognitive verb *compare* required in the response (i.e. similarity, difference and significance) for an Objective 4 item.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- schools upload an updated marking scheme at confirmation that reflects any changes made to the original marking scheme submitted at endorsement
- the marks within the ISMG are correctly applied to the overall percentage achieved on the data test, e.g. a mark of 10 can only be awarded where the percentage achieved on the data test is greater than 90%
- marking schemes are clear, accurate, complete and match the endorsed assessment instrument.

Additional advice

- When comparable assessments are administered, schools are encouraged to ensure that an appropriate marking scheme specific to that instrument is uploaded at confirmation. Comparable assessments should be developed in the Endorsement application (app) to ensure the correct examination and its matching marking scheme are available for the confirmation review (*QCE and QCIA policy and procedures handbook v5.0,* Section 7.4).
- The labelling of questions within the marking scheme must accurately reflect those in the endorsed instrument, e.g. Question 7 in the instrument is labelled as Question 7 in the marking scheme.

Internal assessment 2 (IA2)

Student experiment (20%)

This assessment requires students to research a question or hypothesis through collection, analysis and synthesis of primary data. A student experiment uses investigative practices to assess a range of cognitions in a particular context. Investigative practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment

Validity priority	Number of times priority was identified in decisions*
Alignment	1
Authentication	0
Authenticity	0
Item construction	3
Scope and scale	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 47.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- provided practicals for modification aligned to the appropriate unit's subject matter, e.g.
  - 'conduct an investigation into either respiration or photosynthesis' (AS Unit 1)
  - 'design and conduct a plant trial to collect and analyse primary data on a factor that affects plant production' (Unit 3)
- contained scaffolding appropriate to supporting completion of the task, e.g. guidance on developing a research question
- included a statement indicating that students cannot use any example research question/s provided in the scaffolding to develop a response.

Practices to strengthen

It is recommended that assessment instruments:

- contain consistent information in the Conditions and Context sections of the task sheet, i.e. the practical listed must align to the topics identified in the assessment objectives (Syllabus section 4.6.2, AS section 2.6.2)
- contain all the requirements listed in the assessment specifications (Syllabus section 4.6.2, AS section 2.6.2)
- clearly indicate (e.g. using asterisks) the sections of the assessment that can be completed in a group, as listed in the assessment conditions (Syllabus section 4.6.2, AS section 2.6.2)
- ensure unique student responses can be achieved, i.e. the task should not provide guidance on how students should modify a particular listed practice.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	0
Language	0
Layout	0
Transparency	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 47.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided clear instructions that align with the specifications of the syllabus, the assessment objectives and the ISMG (Syllabus section 4.6.2, AS section 2.6.2)
- included clear communication of task elements, using succinct language and accurate spelling and grammar
- used relevant formatting features (e.g. bold, italics) in a consistent manner.

Practices to strengthen

There were no significant issues identified for improvement.

Additional advice

- Ensure practicals listed in the assessment instrument support the development of a research question that considers
  - the difference between groups, e.g. ‘does the type of feed provided affect the growth rate of meat chickens?’
    or

  - a correlation between variables, e.g. ‘does gibberellic acid concentration affect the growth (height) of tomatoes?’.
- Also ensure listed practicals support investigations of one independent and one dependent variable to allow students to demonstrate all the assessment objectives within the specified response length.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Research and planning	84.44%	15.56%	0%	0%
2	Analysis of evidence	82.22%	15.56%	2.22%	0%
3	Interpretation and evaluation	88.89%	11.11%	0%	0%
4	Communication	97.78%	2.22%	0%	0%

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- for the Interpretation and evaluation criterion,
  - *relevant* suggested improvements and extensions were listed separately and were clearly *considered* based on the analysis of evidence. Refinements focused on improving the validity and reliability of the experiment, and extensions were based upon other, related variables or modifications to the methodology to better replicate real-life applications
  - the conclusion of the report explicitly answered the research question in full, rather than just restated the results of the experiment. *Insightful* conclusions showed an application of understanding by referring to limitations of the experiment and/or background scientific information.

Samples of effective practices

The following excerpt has been included to demonstrate identified risks to both humans and the environment through an explanation of the potential pollution to natural watercourses.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Risk Assessment:

Table 1: Risks and Management Strategies

Ethical and Environmental Risks:	Management Strategy:
Fertilizer poses environmental risks to watercourses, due to pollution of natural environments (Queensland Government Department of Environment and Science, N.D.).	Isolate fertilizer from water sources and dispose of appropriately.
Potting soil can contain Legionella longbeachae bacteria, which can cause pneumonia (Diemen, 2020).	Do not inhale soil, wear PPE and wash hands to minimise contamination.
Seedlings are organisms that should not be disposed of after usage.	At conclusion, seedlings were replanted in an agricultural environment.
Bags of potting soil are heavy, and equipment can be hazardous, which can injure persons.	Handle with appropriate lifting techniques and caution.
Fertilizer eye-contact, repeated skin contact and consumption could cause serious physical reactions, due to nitrogen levels (Healthline, N.D.).	Wear appropriate PPE, handle responsibly, wash contaminated equipment.

The following excerpts have been included to demonstrate the identification of uncertainty

- through the statistical calculations of standard error and standard deviation of all three treatment levels (temperature) for both dependent variables measured (mass and sugar content), as well as *p* values for each pairing of treatment levels
- in graphical form by the inclusion of error bars.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1

Processed data:

Percentage mass change:

	Mean	standard error	Standard deviation
-18°C	-0.26	0.07	0.15
4°C	-3.73	0.46	1.04
20°C	-2.92	0.28	0.63

Percentage Brix change:

	Mean	standard error	standard deviation
-18°C	5.76	2.42	5.40
4°C	19.66	4.04	9.03
20°C	29.72	7.70	17.22

	p-value	
Temperature	*mass*	*Sugar content*
-18 and 4°C	0.002	0.021
-18 and 20°C	0.001	0.031
20 and 4°C	0.179	0.291

Excerpt 2

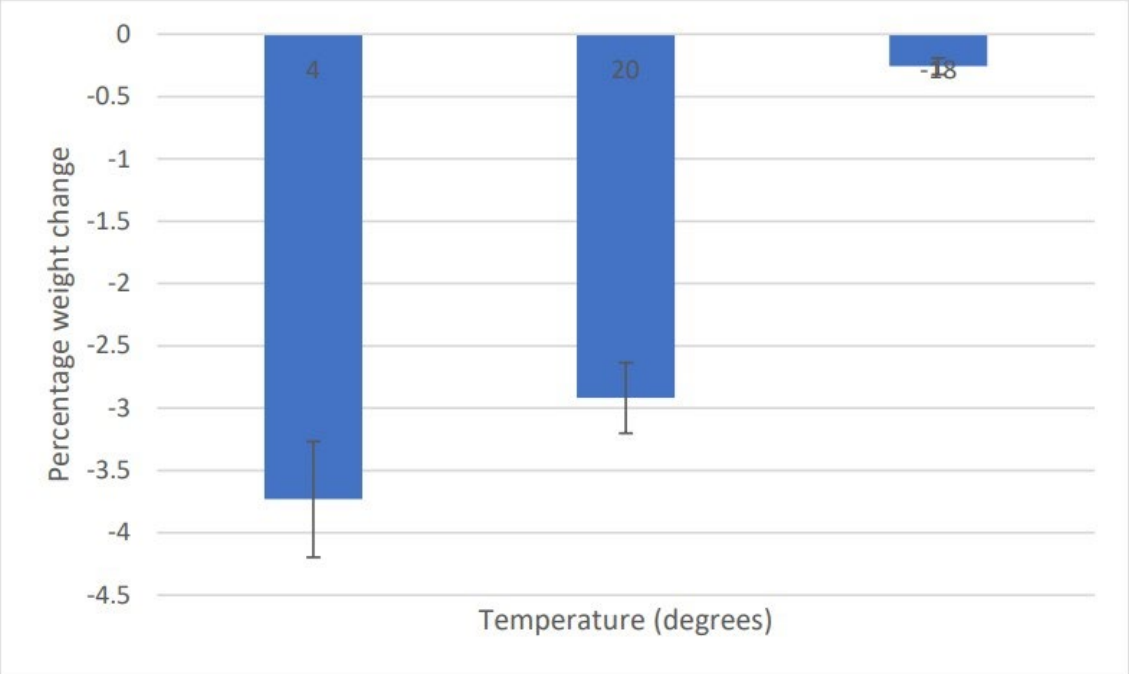


Figure 1: The percentage mass change of Keitt mangoes

The following excerpt demonstrates how a response has addressed improvements and extensions separately, with improvements focused on methodological changes that would reduce the variability in the data collected, thereby reducing uncertainty that was identified earlier in the response. Extensions are justified through reference to research and are focused on expanding on this experiment to gather data that would have further real-life applications.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Improvements and Extensions

Improvements

The experiment could be improved by:

- Ensuring each experimental group has the same number of chicks to improve accuracy with the average weight of the chicks over time.
- Increasing the size of the box where the chicks were housed would increase validity as it could reduce pecking order behaviour. This should ultimately increase or equalise the food intake of individual animals within the same feed group.
- Increasing the total sample size and length of the experiment would likely lower the standard error and standard deviation values and make the data more accurate, thus improving reliability.
- Implementing heat lamps to control temperature to a greater extent which would eliminate the possibility of varying temperatures affecting weight gain.
- Using printed labels rather than written to ensure the numbers remain readable and are less likely to fall off throughout the experiment.

Extensions

The experiment could be extended by:

- Researching additional information into which feed is more cost-effective in comparison to the growth rate which could then be applied to real-life chicken-farming situations.
- Experimenting on the effects of differing protein intakes when the chickens are placed in different housing methods such as free range compared to caged farming. Zhao, 2014 found that more active chickens in a free-range environment had significantly lower weekly weight gain (Zhao, 2014).
- Comparing the impact of alternative abiotic factors on weight gain such as light colours or intensity. A 2015 report by Bradley Hogshead found that broiler chickens exposed to blue and green light had an increased weight gain (Hogshead, 2015)

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- for the Research and planning criterion,
  - the impacts of risks associated with the experiment and their subsequent management are *considered* with regard to how the methodology was carried out
  - environmental issues (e.g. waste or nutrient run-off) are identified in addition to risks associated with human safety when conducting plant trials
  - a specific and relevant research question
    - is clearly aligned with the subject matter specific to the relevant unit, i.e. Unit 3 dependent variables are focused on production parameters (e.g. yield or biomass); AS Unit 1 experiments are based on measurements of plant establishment (e.g. germination rate) and growth (e.g. height or internodal length)

        - focuses on independent variables that have relevance to real-world applications (e.g. gibberellic acid)
    - the response clearly outlines the original experiment to justify modifications
- for the Analysis of evidence criterion, responses thoroughly identify appropriate measures of uncertainty and limitations of evidence, e.g.
    - uncertainty may be presented in tabular or graphical form and includes calculation of statistical measures of uncertainty (e.g. standard error, standard deviation, confidence intervals or error bars)
    - limitations may include outliers, flaws or errors in methodology or unexpected environmental impacts specific to the context of the experiment.

Additional advice

- When determining best fit on an ISMG, the higher mark in the performance level should only be awarded if there is evidence of all the characteristics in the performance-level descriptor (see *Using ISMGs For General Science syllabuses* under Resources in the Syllabuses app on the QCAA Portal).
- The quality descriptor 'does not meet any of the descriptors above' on the ISMGs should only be selected if the response does not contain evidence that matches any of the quality descriptors (*QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.1).
- Responses must adhere to the response length requirements outlined in the syllabus (Section 4.6.2, AS section 2.6.2) and the *QCE and QCIA policies and procedures handbook v5.0* (Section 8.2.6).

Internal assessment 3 (IA3)

Research investigation (20%)

This assessment requires students to evaluate a claim. They will do this by researching, analysing and interpreting secondary evidence from scientific texts to form the basis for a justified conclusion about the claim. A research investigation uses research practices to assess a range of cognitions in a particular context. Research practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment

Validity priority	Number of times priority was identified in decisions*
Alignment	1
Authentication	0
Authenticity	3
Item construction	1
Scope and scale	1

*Each priority might contain up to four assessment practices.

Total number of submissions: 47.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- contained claims directly aligned with the appropriate subject matter, e.g.
  - 'soil degradation cannot be controlled with sustainable farming practices' (Unit 4)
  - 'the adoption of technology is vital to meet future food and fibre demands' (AS Unit 2)
- contained claims that allowed the generation of multiple research questions, e.g. 'animal welfare in agricultural production systems is improving'
- contained a complete list of the task description requirements as outlined in the syllabus specifications (Syllabus section 5.5.1, AS section 3.5.1).

Practices to strengthen

It is recommended that assessment instruments:

- include consistent information across the Conditions and Context sections of the task sheet, i.e. the claims listed must align with the topics identified in the assessment objectives (Syllabus section 5.5.1, AS section 3.6.1)
- include claims that allow for a variety of unique student responses, e.g. 'grazing management is an essential component of animal production' is likely to elicit a wider range of research questions from students than the narrowly focused claim 'rotational grazing is an essential component of sustainable cattle grazing management'
- ensure the scale of information, knowledge and skills that students are required to demonstrate when completing the task is appropriate for the syllabus conditions (Syllabus section 5.5.1, AS section 3.6.1).

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	0
Language	1
Layout	0
Transparency	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 47.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided clear instructions that allowed students to understand the task requirements as per the syllabus specifications and produce a response within the syllabus conditions (Syllabus section 5.5.1, AS section 3.6.1)
- included claims that were clear and concise
- used appropriate language and avoided unnecessary jargon, specialist language and/or colloquial language
- were free from errors and modelled accurate spelling, grammar, punctuation and other textual features.

Practices to strengthen

There were no significant issues identified for improvement.

Additional advice

- Where a claim contains more than one variable to be considered (e.g. the claim 'sustainable management of the physical, chemical and biological properties of soils is essential for agricultural production') students should be encouraged to develop a research question that focuses on one aspect of the claim. This will enable the development of a response within the specified syllabus conditions.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Research and planning	88.89%	6.67%	4.44%	0%
2	Analysis and interpretation	91.11%	6.67%	2.22%	0%
3	Conclusion and evaluation	88.89%	8.89%	2.22%	0%
4	Communication	100%	0%	0%	0%

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- for the Research and planning criterion, a *considered* rationale for the investigation identified key aspects of the claim and linked them to the background scientific information. This further supported the development of a *specific* and *relevant* research question
- for the Analysis and interpretation criterion,
  - *insightful* interpretation of evidence demonstrated linking of different pieces of evidence and/or background scientific information presented in the rationale to develop *justified* scientific arguments. This meant that the scientific argument used sound reasoning by drawing on valid and reasonable evidence
  - *thorough* and *appropriate* identification of limitations involved discussion of potential factors (e.g. size, age, methodology and/or statistical significance) related to the evidence used and the potential effects of that limitation on the overall findings of the investigation.

Samples of effective practices

The following excerpt demonstrates a rationale that shows clear identification of the key aspects of the claim and evidence of relevant background scientific research. The excerpt also demonstrates effective narrowing of a broad claim topic (i.e. application of sustainable

environmental management practices) to a focused research question, which addresses practices for improving water efficiency within a specific agricultural industry (rice production).

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Claim-

Australian agricultural industries do not use sustainable environmental management practices.

Rationale-

With our rapidly increasing population, the growing demand for produce is pushing for greater supply from the Agricultural Industry. Although resource availability is decreasing, this is leading the Agricultural Industry to exercise more sustainable management practices, in an attempt to decrease their impact on the environment.
One of the major depleting available resources is water. Irrigation is the main water user, with 40 % of our total world food produced using irrigation due to its ability to increase the output per unit when used. Although as water availability decreases, farmers are seeking to find more efficient management practices (The World Bank, 2022).

The largest water-consuming industry in Australia, considering the water used per hectare of the crop, is rice (Groat, 2020). Australian rice is a small industry, mainly growing medium grain varieties. Rice is only grown when there is enough available water. Australia is one of the leading countries for water sustainability, using 50 per cent less water than the international average (Department of Agriculture, Fisheries and Forestry, 2019). SunRice-Ricegrowers Ltd trading as SunRice encompasses 99% of the whole Australian Rice industry, allowing for the management industry to be easily analysed (Groat, 2020). SunRice is a part of the organisation of the Rice Growers Association (RGA). RGA implements strategies to ensure the industry's sustainability including factors like soil health, water usage, greenhouse gas emissions, and chemical handling (Ricegrowers' Association of Australia Inc., 2023). By 2026 the Australian Rice industry aims to improve water efficiency by 75 per cent (Calver, 2022).

Traditionally rice is grown in Asia, where rice crops have permanent flooding after germination to protect the rice from high temperatures. The rice industry has now expanded to every continent of the world. Australia's main rice growing areas are in the Riverina in southern New South Wales, due to level ground, correct soil types, and available water for irrigation. The high-yielding medium-grain rice is leading the world to greater water sustainability (Ricegrowers Ltd, n.d.).

Water management practices that are used in Australia to result in more efficient water usage, include: Raised Beds, Saturated Soil Culture(SSC) (Borrell, et al., 1997), Direct Seeded Rice(DSR), Delayed Permanent Water(DPW), Alternative Wetting and Drying(AWD), and more water-efficient varieties of rice including japonica (Groat, 2020)

The following excerpts demonstrate a response that:

- evaluates the quality of each piece of evidence used to construct arguments by referring to
  - any potential biases
  - the relevance of data collected to current practices
  - the intention of the original authors of the evidence
  - the evidence's relevance to answering the research question

- recommends improvements and extensions separately, with improvements aimed at strategies that would enhance the evidence of the current investigation through more supportive data, and extensions that go beyond the current investigation to address other related industries and global impact.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1

The First data set, Table 1, was shown to have a high quality of evidence. This was a result of the table being published, and written by the Australian Government Department of Agriculture, Fisheries and Forestry. This meant that the report had to go through numerous different checkpoints and editing stages helping to improves the data's accuracy. The report also had a purpose to inform the public on the current live export situation, meaning there was minimal need for any bias. Figure 1 was a graph used from a report released by Mecardo LTD, which is a company that provides market analyses for wool, livestock, and grain. The data released for Figure 1's specific report was gathered from 2022, meaning that the data from the report is the most current data available, including current trends and relationships. The source is also relevant to the research question as it directionally demonstrates how a decline in export numbers result in a decrease in mortality rates, which is an improvement in animal welfare. The final figure's used (figure 2 and 3) were graphs published by Mecardo LTD, which is an independent company from the government. As the company is independent from the government, this eliminates any chance of biases which might relate with government organisations. As the purpose of the document is to simply just inform the nature of the live sheep export market, the company doesn't gain any advantages from falsifying their documents. Due to the minimal bias and the use of current statistics, it can be stated that all evidence and data collected had a high quality of evidence.

Excerpt 2

Improvement and extensions:

Improvements – The following three improvements for the data sets are:

- More current data for figure 2, which extends up to the end to the 2023 financial year. This would allow the investigation the current position of the market.
- Increased data relating to components of live export such as voyage length. Demonstrating if longer voyages of live export have more an effect on animal welfare.
- Data that specifically focused on animal welfare. With data concentrated on more what might have happened to drive the Australian government to change legislation.

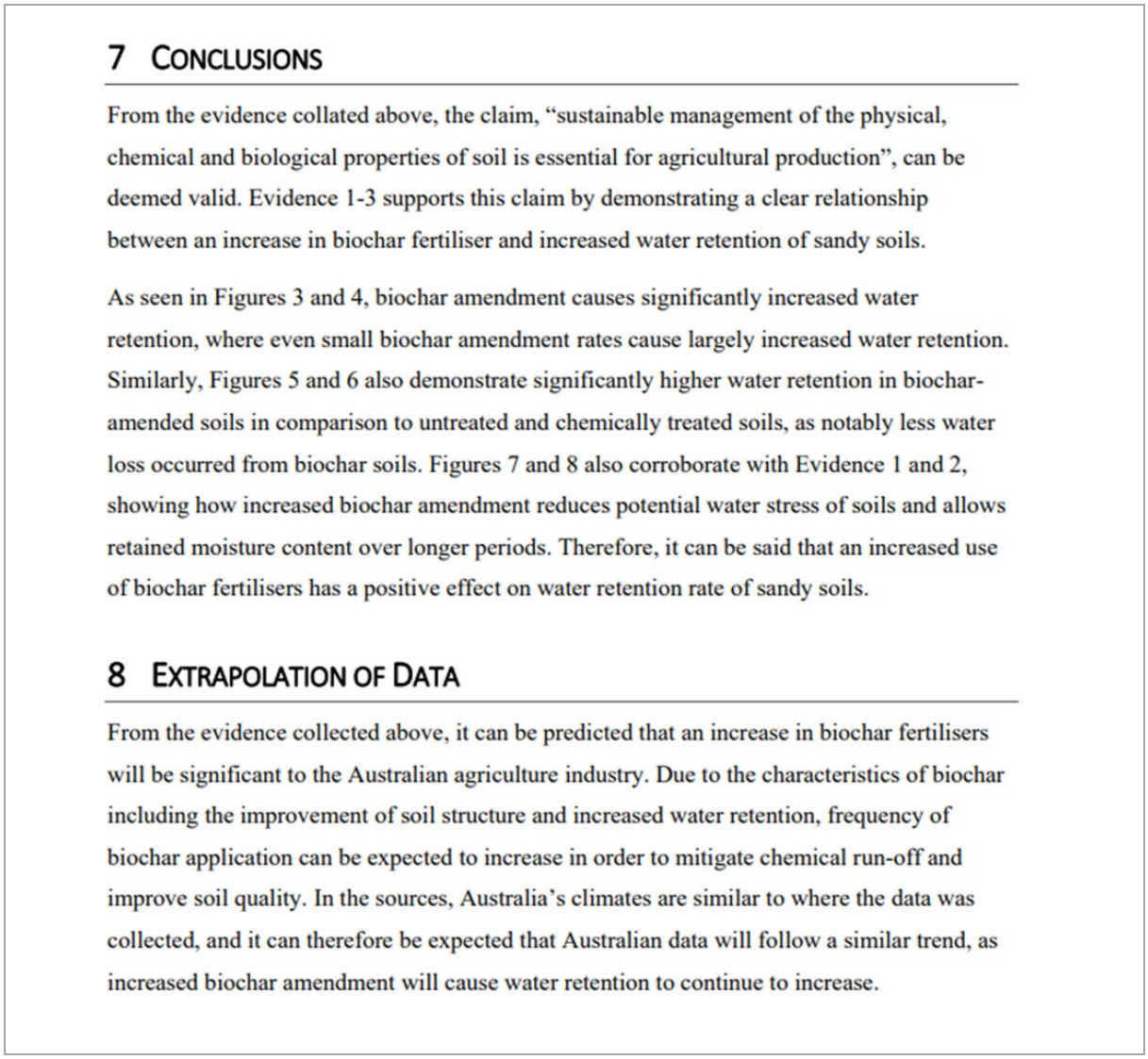
Extensions – Three extensions that could be made were:

- Investigate specific countries, and if Australia had stopped live export trading with some countries rather than others. This would allow countries with high mortality rates to be identified and excluded.
- Incorporate and research other live export markets. This could be other trade markets such as cattle, chickens or goats. To demonstrates how certain markets might have different mortality rates.

The following excerpt demonstrates a response that draws upon background scientific information about the effects of biochar on soil properties. It contains justified conclusions that were cited earlier in the response to extrapolate the findings into an Australian context and

consider the future implications of this method of soil conditioning for sustainable farming practices.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



7 CONCLUSIONS

From the evidence collated above, the claim, "sustainable management of the physical, chemical and biological properties of soil is essential for agricultural production", can be deemed valid. Evidence 1-3 supports this claim by demonstrating a clear relationship between an increase in biochar fertiliser and increased water retention of sandy soils.

As seen in Figures 3 and 4, biochar amendment causes significantly increased water retention, where even small biochar amendment rates cause largely increased water retention. Similarly, Figures 5 and 6 also demonstrate significantly higher water retention in biochar-amended soils in comparison to untreated and chemically treated soils, as notably less water loss occurred from biochar soils. Figures 7 and 8 also corroborate with Evidence 1 and 2, showing how increased biochar amendment reduces potential water stress of soils and allows retained moisture content over longer periods. Therefore, it can be said that an increased use of biochar fertilisers has a positive effect on water retention rate of sandy soils.

8 EXTRAPOLATION OF DATA

From the evidence collected above, it can be predicted that an increase in biochar fertilisers will be significant to the Australian agriculture industry. Due to the characteristics of biochar including the improvement of soil structure and increased water retention, frequency of biochar application can be expected to increase in order to mitigate chemical run-off and improve soil quality. In the sources, Australia's climates are similar to where the data was collected, and it can therefore be expected that Australian data will follow a similar trend, as increased biochar amendment will cause water retention to continue to increase.

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

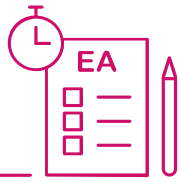
- for the Conclusion and evaluation criterion,
  - *critical* evaluation of the quality of evidence is demonstrated through a discussion of the aspects that may affect reliability and validity of the sources used, e.g. consideration of bias, the author's credentials, currency of data and relevance to the research question
  - *credible* findings to the claim are extrapolated by linking conclusions to the investigation of real-life applications or future implications that are relevant to Unit 4 subject matter, e.g. drawing on relevant resource management techniques to support the claim
  - suggested improvements are distinguished from proposed extensions, with

- *considered* improvements related to the reliability and validity of the evidence used in the investigation
- *relevant* extensions addressing alternative aspects of the claim not investigated in the student response pointing to further investigation of agricultural practices where it is likely to improve outcomes.

Additional advice

Research questions should be refined to ensure that they are clear and focused. (e.g. ‘what is the relationship between …’ or ‘how does __ compare …’). The research question stem ‘to what extent does …’ can result in a student response that is too broad and lacks sufficient secondary data to draw a justified conclusion. For further guidance, see the *IA3 effective processes and practices* resources and *IA3 sample assessment instrument: Research investigation v1.3* under Resources in the Syllabuses app on the QCAA Portal.

External assessment



External assessment (EA) is developed and marked by the QCAA. The external assessment for a subject is common to all schools and administered under the same conditions, at the same time, on the same day.

Examination (50%)

Assessment design

The assessment instrument was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the relevant syllabus.

For both syllabuses, the assessment required students to respond to multiple choice and short response questions and an extended response question.

General syllabus

The examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (20 marks)
- Paper 1, Section 2 consisted of short response questions (27 marks)
- Paper 2, Section 1 consisted of short response questions (39 marks)
- Paper 2, Section 2 consisted of an extended response question (18 marks).

The examination assessed subject matter from Units 3 and 4. Questions were derived from the contexts of Animal production B, Plant production B, Agricultural enterprises B, Enterprise management, Evaluation of an agricultural enterprise's sustainability.

Alternative Sequence (AS)

The AS examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (20 marks)
- Paper 1, Section 2 consisted of short response questions (35 marks)
- Paper 2, Section 1 consisted of short response questions (35 marks)
- Paper 2, Section 2 consisted of an extended response question (13 marks).

The AS examination assessed subject matter from AS Units 1 and 2. Questions were derived from the contexts of Agricultural enterprises A, Animal production A, Plant production A, Management of renewable resources, Physical resource management, Agricultural management, research and innovation.

Assessment decisions

Assessment decisions are made by markers by matching student responses to the external assessment marking guide (EAMG). The external assessment papers and the EAMG are published in the year after they are administered.

Multiple choice question responses

There were 20 multiple choice questions in Paper 1.

Percentage of student responses to each option

Note:

- The correct answer is **bold** and in a blue shaded table cell.
- Some students may not have responded to every question.

Agricultural Science General: Paper 1

Question	A	B	C	D
1	22.91	11.15	**63.16**	2.17
2	11.15	1.86	37.46	**48.92**
3	7.43	**24.15**	49.54	18.27
4	**71.21**	2.48	0.62	25.08
5	4.02	40.56	5.57	**49.23**
6	**46.44**	1.55	8.05	43.34
7	**66.87**	9.91	14.86	7.43
8	3.41	**91.64**	0.62	3.72
9	68.73	7.43	10.53	**12.38**
10	**67.18**	20.74	3.1	8.36
11	13	5.88	**57.89**	22.6
12	5.26	12.07	**73.07**	8.67
13	**11.46**	35.91	10.53	41.49
14	5.88	58.51	**9.91**	25.08
15	**70.9**	12.07	11.46	4.95
16	4.64	45.2	**24.15**	25.39
17	2.48	**59.13**	13	24.46
18	9.91	8.05	22.6	**58.2**
19	3.1	10.53	14.24	**71.21**
20	1.55	**68.73**	25.7	3.41

Agricultural Science AS: Paper 1

Question	A	B	C	D
1	4.3	1.08	7.53	**87.1**
2	33.33	**22.58**	30.11	13.98
3	**53.76**	18.28	7.53	20.43
4	**32.26**	16.13	37.63	13.98
5	3.23	34.41	2.15	**60.22**
6	1.08	10.75	**78.49**	9.68
7	3.23	**70.97**	6.45	19.35
8	2.15	**37.63**	18.28	41.94
9	9.68	27.96	17.2	**45.16**
10	19.35	16.13	32.26	**32.26**
11	**44.09**	32.26	11.83	11.83
12	16.13	1.08	5.38	**77.42**
13	6.45	19.35	**72.04**	2.15
14	6.45	12.9	**68.82**	11.83
15	9.68	**61.29**	13.98	15.05
16	11.83	**8.6**	39.78	39.78
17	55.91	2.15	**41.94**	0
18	**90.32**	6.45	3.23	0
19	1.08	2.15	1.08	**95.7**
20	**80.65**	6.45	7.53	5.38

Effective practices

Overall, students responded well when they:

- described and explained risk avoidance strategies for management of agricultural enterprises
- performed calculations to determine animal utilisation of feed and market value
- identified a simple linear relationship between two variables presented in graphical form
- interpreted tabulated data to decide which crop should be grown for identified environmental conditions.

Samples of effective practices

Short response

The following excerpt is from Question 21 in Paper 1. It required students to explain the post-harvest processes for an agricultural plant product of their choice.

Effective student responses:

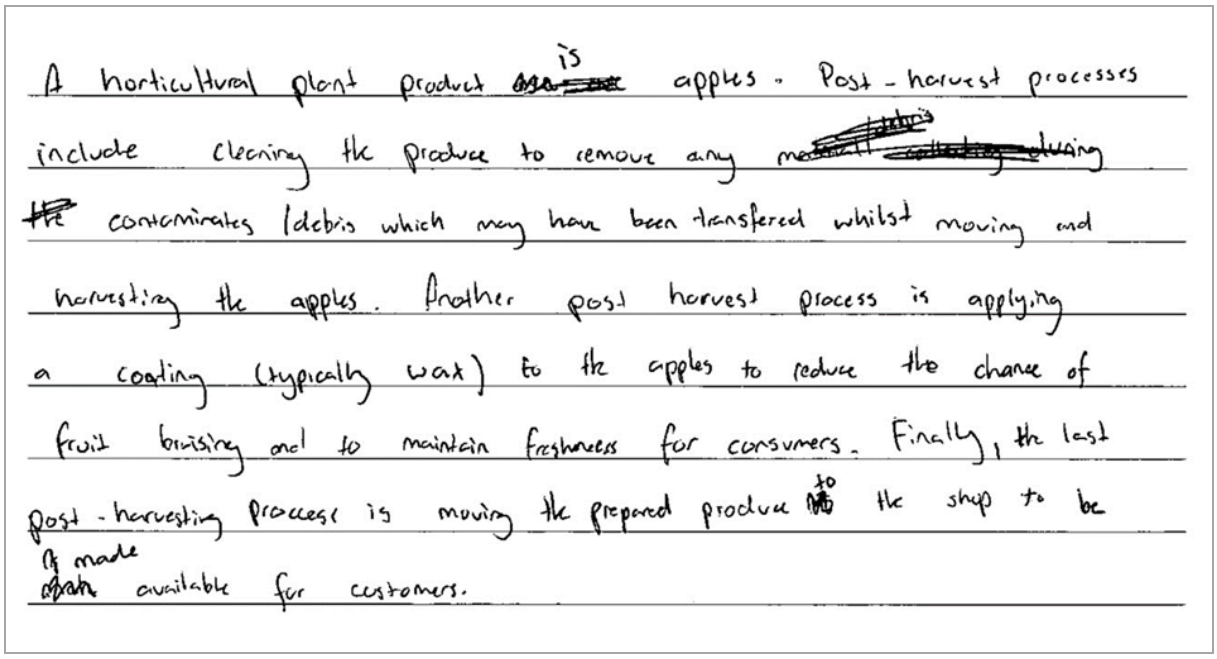
- identified an example of a horticultural plant product
- described the post-harvest process of transportation to a packhouse/storage facility

- explained the post-harvest process of handling, packaging or grading required for that product
- explained the post-harvest process of controlling the ripening process.

This excerpt has been included:

- to demonstrate an effective explanation of the post-harvest process for an identified horticultural product from the time of harvest until it reaches the consumer.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.


A horticultural plant product is apples. Post-harvest processes include cleaning the produce to remove any debris contaminates/debris which may have been transfered whilst moving and harvesting the apples. Another post harvest process is applying a coating (typically wax) to the apples to reduce the chance of fruit bruising and to maintain freshness for consumers. Finally, the last post-harvesting process is moving the prepared product to the shop to be made available for customers.

The following excerpt is from Question 25 in Paper 1. It required students to interpret data from two graphs to draw two justified conclusions about the social sustainability of organic farming enterprises.

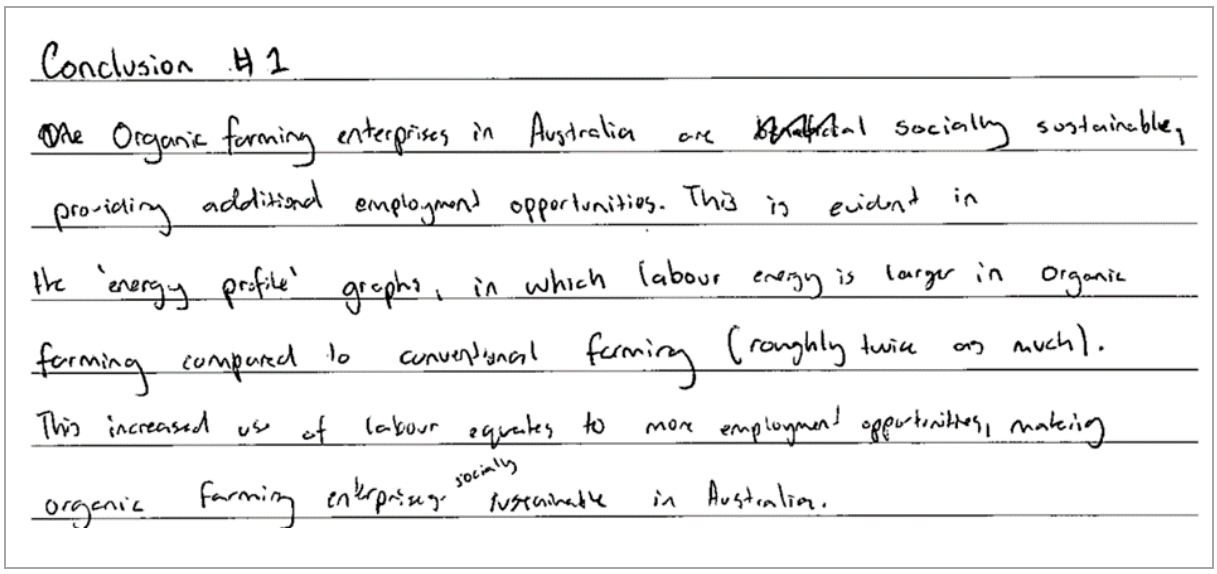
Effective student responses:

- concluded that organic farming enterprises are socially sustainable under the employment criteria
- concluded that organic farming enterprises are socially sustainable under the income criteria
- used the graph to justify the employment conclusion
- used the graph to justify the employment conclusion.

This excerpt has been included:

- to demonstrate a justified conclusion that organic farming enterprises are socially sustainable under the employment criteria.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.


Conclusion H 1

The Organic farming enterprises in Australia are ~~fundamental~~ socially sustainable, providing additional employment opportunities. This is evident in the 'energy profile' graphs, in which labour energy is larger in Organic farming compared to conventional farming (roughly twice as much). This increased use of labour equates to more employment opportunities, making organic farming enterprises socially sustainable in Australia.

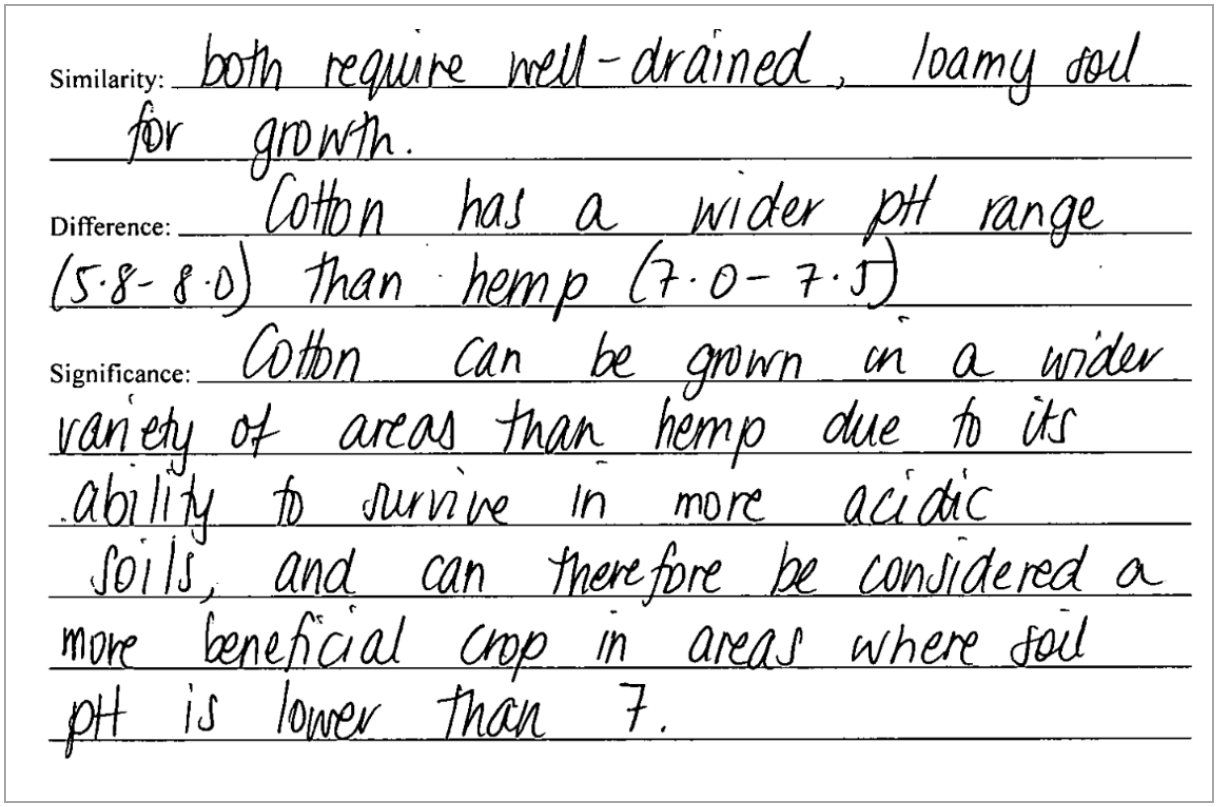
The following excerpt is from Question 28 in AS Paper 1. It required students to interpret data to compare the soil requirements of two crops.

Effective student responses:

- identified a similarity, a difference and the significance of the comparison between the two crops soil requirements.

This excerpt has been included:

- to demonstrate the clear identification of a similarity, and difference with reference to the pH, structure and texture of soil. The significance of the comparison is relevant to the context of the crop selection.


Similarity: both require well-drained, loamy soil for growth.

Difference: Cotton has a wider pH range (5.8-8.0) than hemp (7.0-7.5)

Significance: Cotton can be grown in a wider variety of areas than hemp due to its ability to survive in more acidic soils, and can therefore be considered a more beneficial crop in areas where soil pH is lower than 7.

The following excerpt is from Question 9 in Paper 2. It required students to interpret a graph to describe the trend between two variables: Nitrogen use efficiency (NUE) and fertiliser applied.

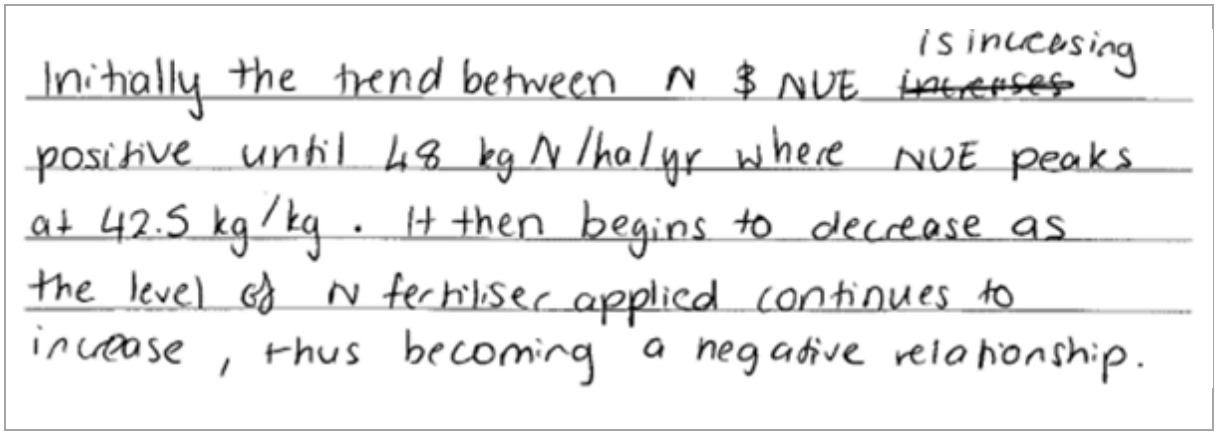
Effective student responses:

- identified the initial increase in NUE
- identified the decline in NUE.

This excerpt has been included:

- to demonstrate a response that describes the complex relationship between NUE and fertiliser application.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.


Initially the trend between N & NUE is increasing ~~increases~~ positive until 48 kg N/ha/yr where NUE peaks at 42.5 kg/kg. It then begins to decrease as the level of N fertiliser applied continues to increase, thus becoming a negative relationship.

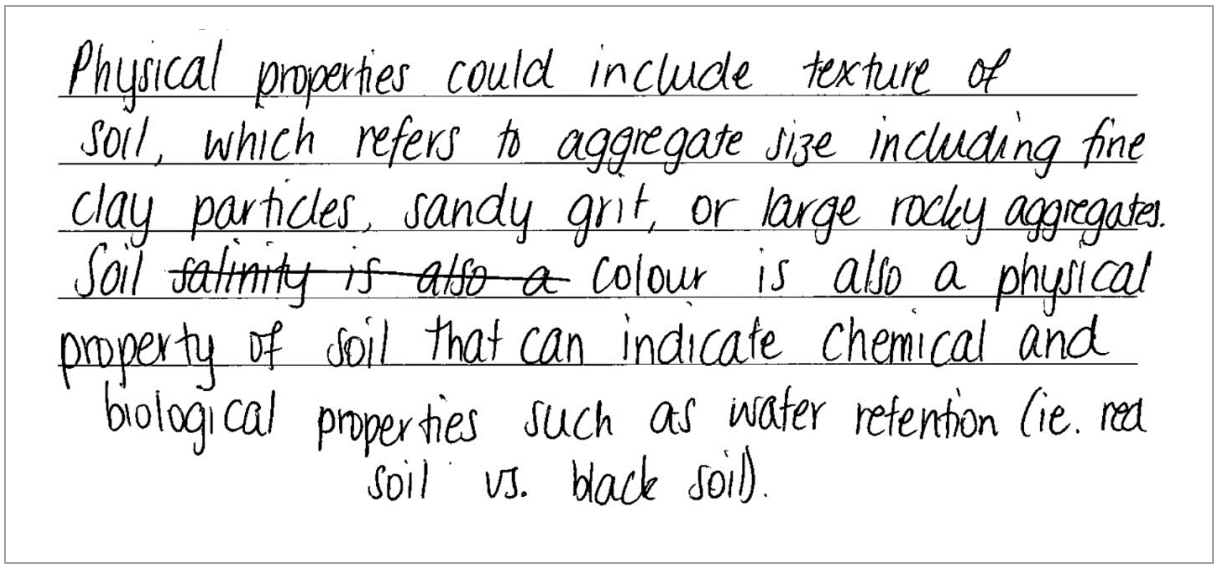
The following excerpt is from Question 1 in AS Paper 2. It required students to describe two physical properties of soil.

Effective student responses:

- identified two physical characteristics of soil
- described each of the identified physical characteristics.

This excerpt has been included:

- to demonstrate the accurate identification and description of two physical properties of soil.


Physical properties could include texture of soil, which refers to aggregate size including fine clay particles, sandy grit, or large rocky aggregates. Soil ~~salinity is also a~~ colour is also a physical property of soil that can indicate chemical and biological properties such as water retention (ie. red soil vs. black soil).

Extended response

The following excerpt is from Question 11 in Paper 2. It required students to assess the environmental sustainability of an enterprise using three criteria.

Effective student responses:

- identified three environmental criteria for enterprise sustainability
- analysed physical resource management, biological resource management and waste management
- drew a conclusion about the environmental sustainability of the enterprise.

This excerpt has been included:

- to demonstrate the clear identification of one criterion for environmental sustainability and the drawing of conclusions about the strengths and weaknesses of the practices used, based on the analysis of evidence.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Biological

A strength of the system in relation to the biological criteria is that crops are rotated throughout winter. This allows for the soil nutrients and health to recover over-time and not be over used additionally, as chickpea's which are a legume is used nitrogen levels will be further replenished. Another benefit of the system is the rotational grazing of the cattle. This allows for time in-which the soil can recover, as no cattle traffic is present the soil wont be compacted or muddy, buffel grass can regrow as well to make sure cattle have feed. This benefits soil microbes, nutrients, health and overall biodiversity. Another strength is the use of Bt cotton, this allows for increased quality and yield of the harvested corn while also reducing the populations of the Helicoverpa sp pest, therefore, benefiting the crops while also reducing losses.

Practices to strengthen

When preparing students for external assessment, it is recommended that teachers consider:

- reviewing the multiple choice items that students answered incorrectly to ensure that subject matter is sufficiently covered, e.g. analyse data about the nutritional content of animal food (including crude protein (CP), metabolisable energy (ME) and dry matter (DM)) to make decisions about animal rations
- providing opportunities for students to
  - identify complex relationships between two variables presented in graphical form
  - apply their understanding of concepts, theories, models and systems to unseen stimulus under examination conditions
- reviewing all agricultural concepts within subject matter statements that have multiple parts, e.g. describe and explain the following properties of soil: *biological*, *chemical* and *physical*, including soil texture, soil structure, porosity, infiltration, water-holding capacity and compaction.

Additional advice

- Teachers should provide opportunities for students to practise responding to multiple choice questions.