Agricultural Science subject report

2024 cohort

January 2025

Queensland Government | QCAA Queensland Curriculum & Assessment Authority

250032

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Contents

Introduction

The annual subject reports seek to identify strengths and opportunities for improvement of internal and external assessment processes for all Queensland schools. The 2024 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 General and General (Extension) subjects. 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 2025.

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.

Subject highlights

78.57%
agreement with provisional marks for IA3

98.66%
of students received a C or higher

7.43%
increase in enrolment since 2023

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 2025. 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: 44.

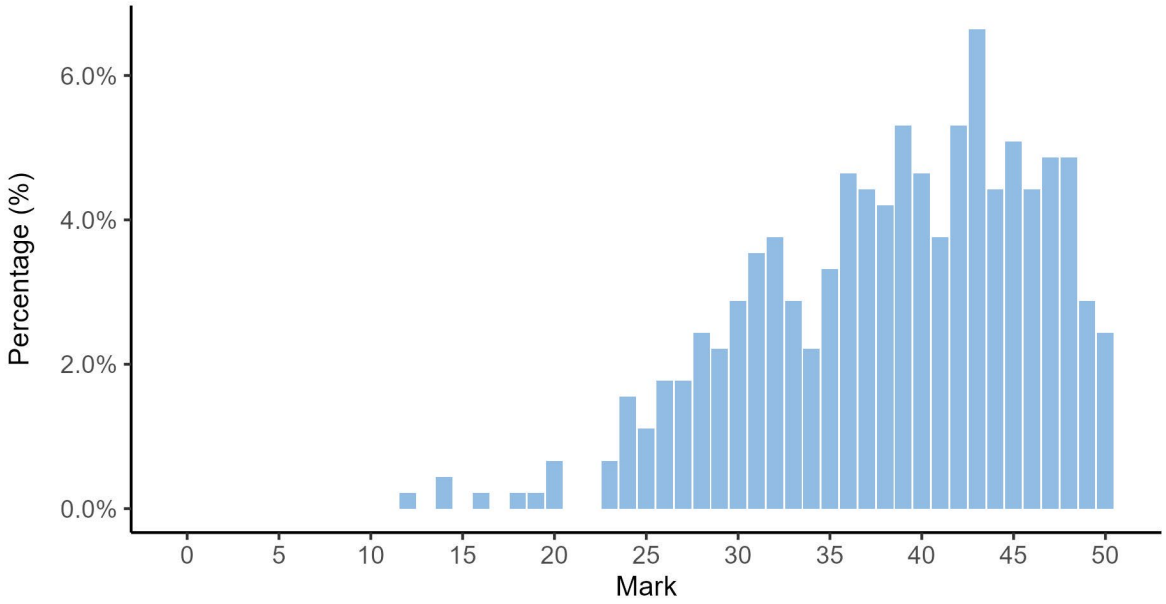
Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	531	489	448

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory
Unit 1	489	42
Unit 2	460	29

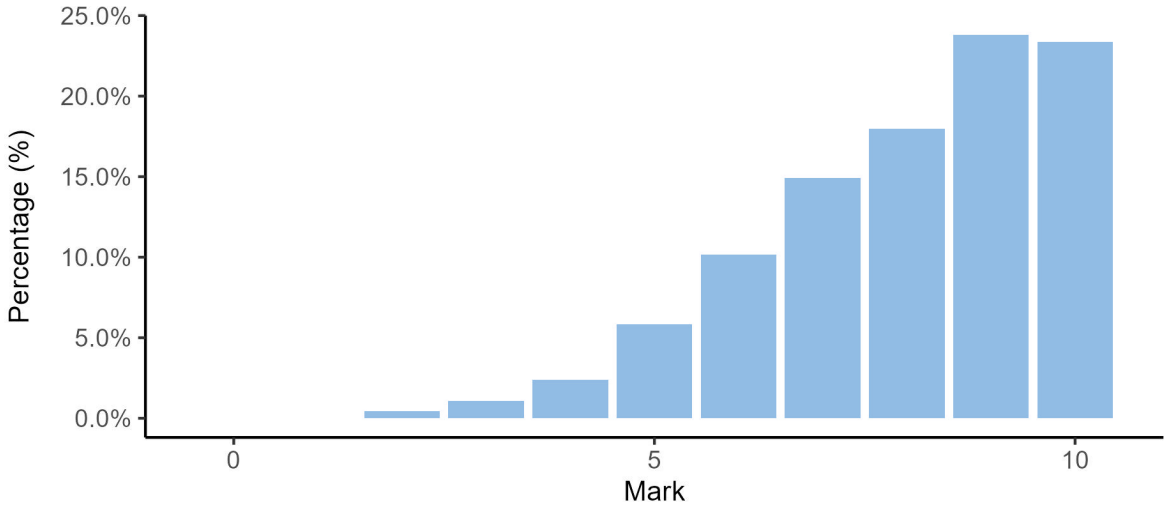
Units 3 and 4 internal assessment (IA) results

Total marks for IA

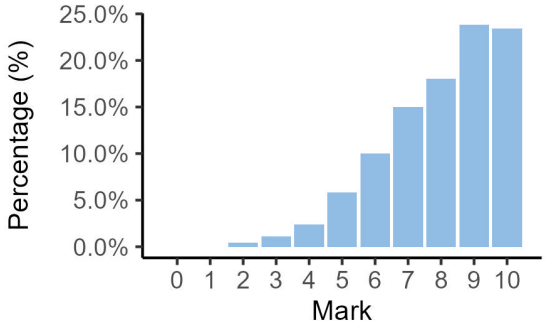


IA1 marks

IA1 total

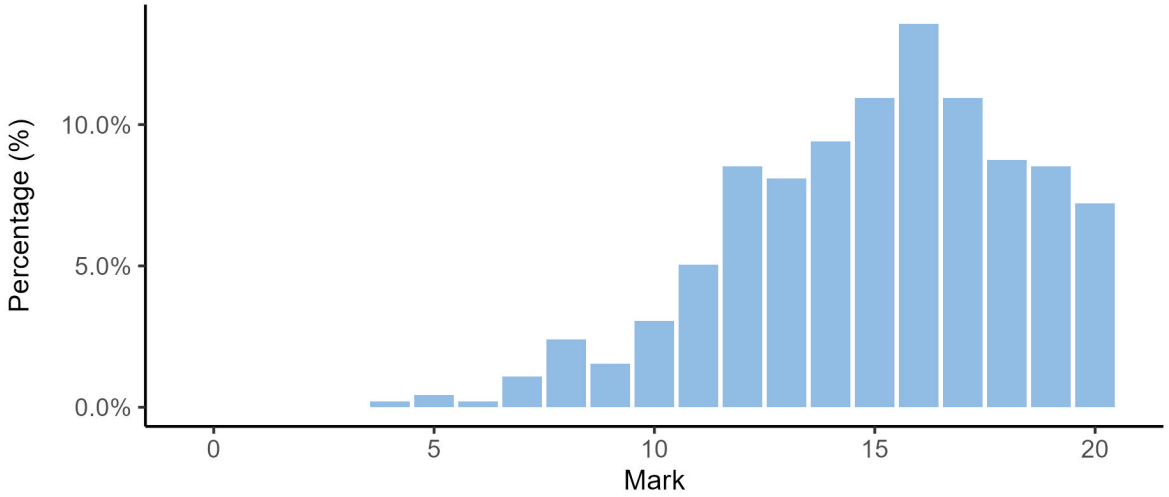


IA1 Criterion: Data test

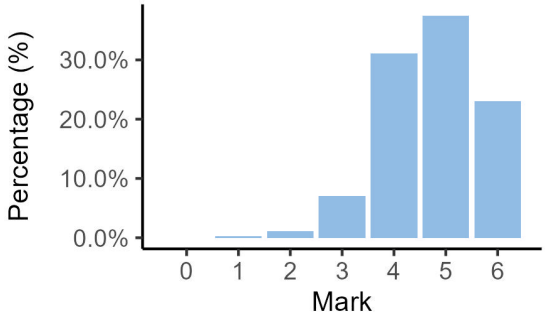


IA2 marks

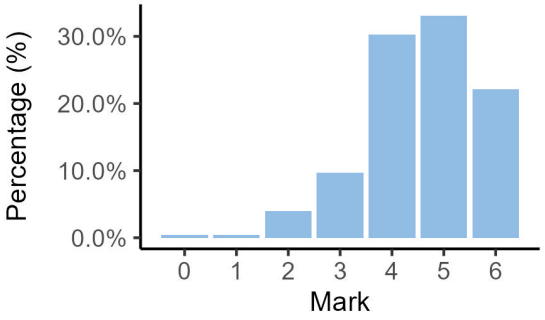
IA2 total



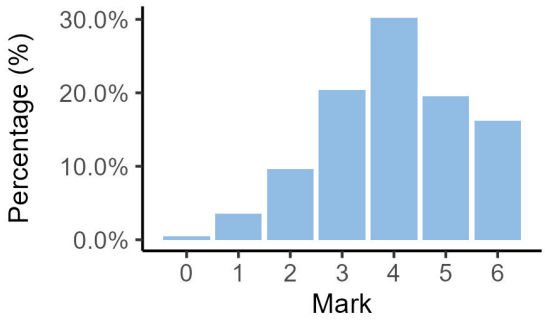
IA2 Criterion: Research and planning



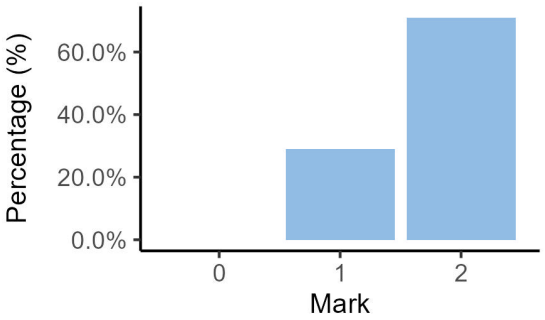
IA2 Criterion: Analysis of evidence



IA2 Criterion: Interpretation and evaluation

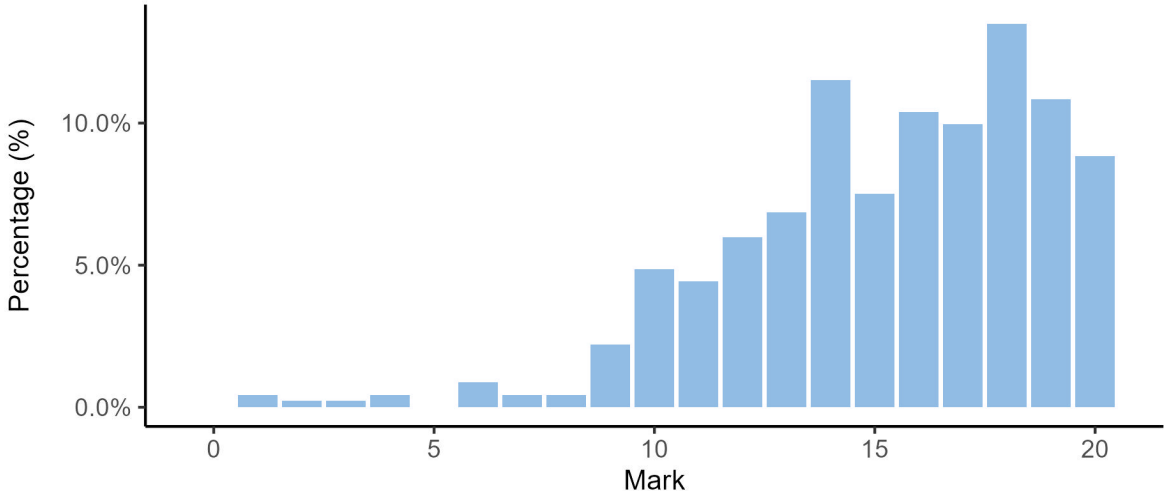


IA2 Criterion: Communication

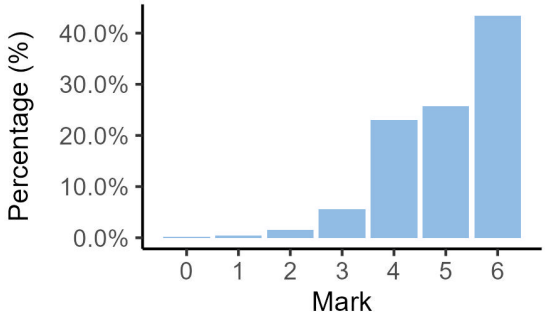


IA3 marks

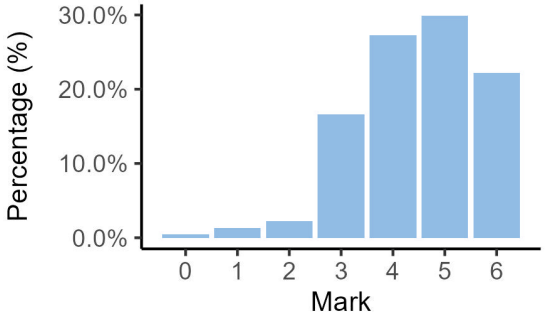
IA3 total



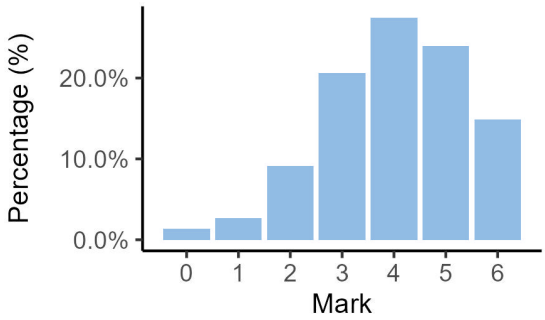
IA3 Criterion: Research and planning



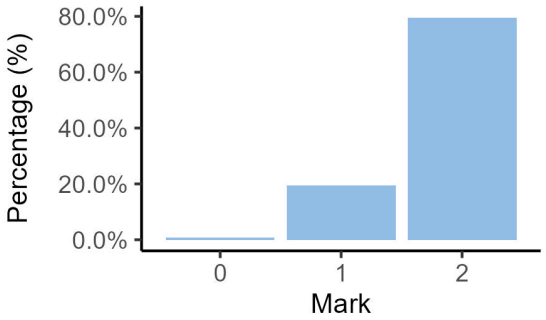
IA3 Criterion: Analysis and interpretation



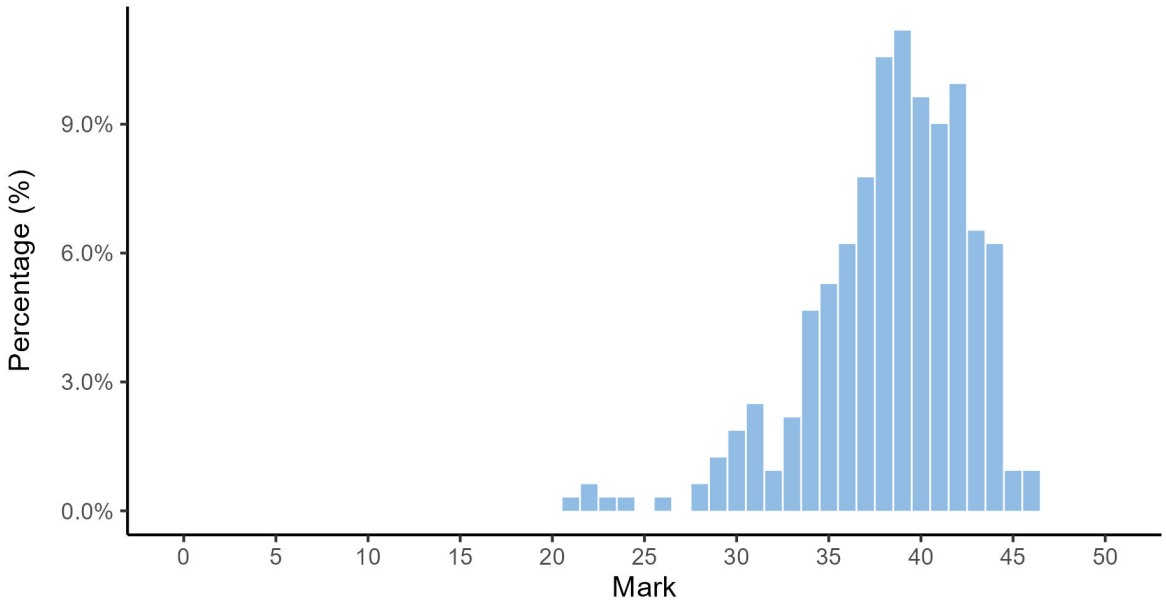
IA3 Criterion: Conclusion and evaluation



IA3 Criterion: Communication

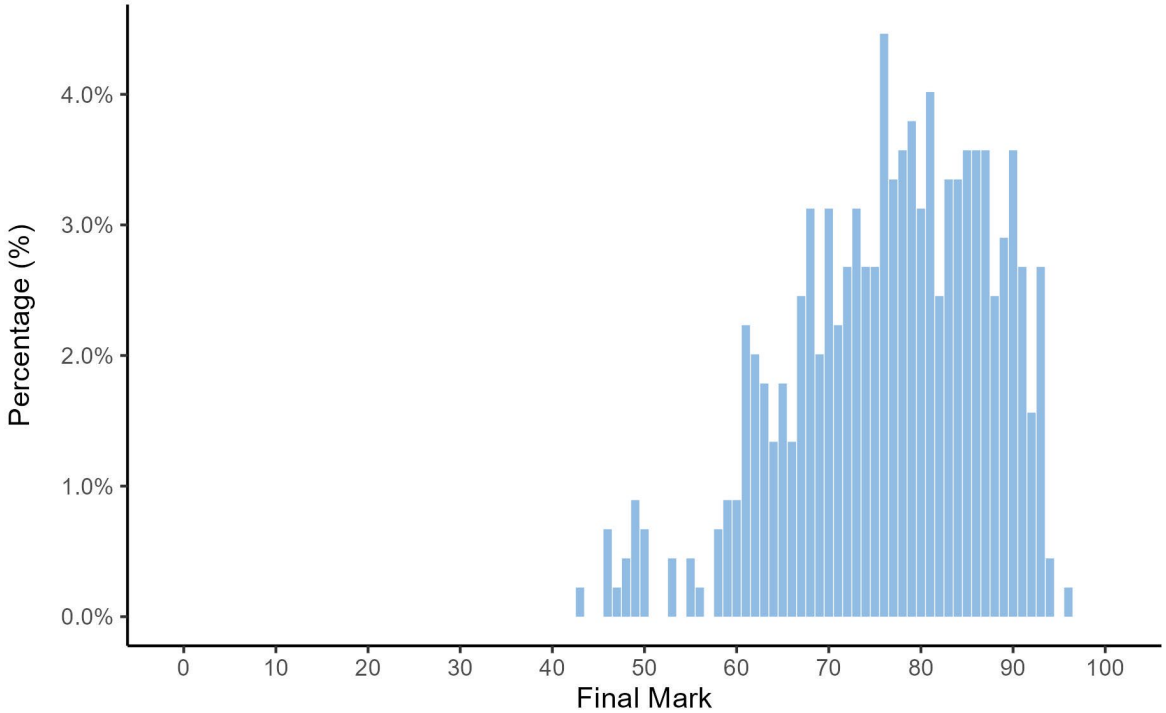


External assessment (EA) marks



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	100–84	83–67	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	137	234	73	4	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 assessment. 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 v6.0*, Section 9.5.

Percentage of instruments endorsed in Application 1

Instruments submitted	IA1	IA2	IA3
Total number of instruments	44	44	43
Percentage endorsed in Application 1	52	81	72

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 v6.0*, Section 9.6.

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	42	273	0	100.00
2	42	273	2	52.38
3	42	270	0	78.57

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	12
Authentication	0
Authenticity	3
Item construction	0
Scope and scale	0

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- used datasets and questions that matched Objectives 2–4 for Unit 3
- aligned the cognition and the nature of the expected response as indicated in the mark allocations table (Syllabus section 4.6.1), e.g. items that used the cognitive verb *contrast* required students to identify the differences between two or more items
- contained one cognitive verb per question and the cognitive verb matched the objective that the marks allocation table indicated was being assessed (Syllabus section 4.6.1)
- contained questions that could be answered from the information, i.e. provided dataset and context.

Practices to strengthen

It is recommended that assessment instruments:

- contain consistent information in the conditions and the datasets used (Syllabus section 4.6.1), e.g. datasets that match Topic 3 where it appears in the conditions section.
- include questions that are written without scaffolding that informs students how to perform the cognition, e.g. ‘Contrast the metabolisable energy requirements of animals A and B’, not: ‘Contrast the differences in metabolisable energy requirements of animals A and B’.

- ensure the marking guide aligns to the questions in the data test and contains correct answers that clearly indicate how marks are allocated for each valued feature of the expected response, aligning to the objective and cognition being assessed
- avoid items that assess Communication (Assessment objective 7), e.g. questions indicating that the answer should be written to one decimal place, should not penalise student responses written 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	4
Language	8
Layout	0
Transparency	5

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
- included all evidence required to answer the question in the dataset
- clarified any abbreviations used in the dataset, e.g. ‘ADG’ means ‘average daily gain’.

Practices to strengthen

It is recommended that assessment instruments:

- use appropriate language and avoid unnecessary jargon, specialist language and/or colloquial language
- have sequentially numbered tables and/or graphs, e.g. not three Table ones or a Table 6.3
- use consistent language in the questions and dataset, e.g. the table heading should not refer to average fat (mm) if the question requires the student to identify P8 fat depth (mm)
- contain questions that are concise and specific with minimal options so that students spend less time interpreting what the question requires, e.g. ‘Draw a conclusion about the liveweight of beef cattle and the water required (L) for lactating cows or mature bulls’, not: ‘Draw a conclusion about the liveweight of beef cattle and the water required (L) for growing heifers, steers and bulls or finishing beef cattle or lactating cows or mature bulls’ (2 marks).

Additional advice

- Schools should ensure that
  - the marking scheme submitted matches the data test being endorsed and the correct responses submitted match the objective being tested to avoid endorsement decisions

identifying ‘possible errors in the marking scheme’, e.g. items that use the cognitive verb *contrast* should match to a correct response that identifies the differences between the specified data

- questions align with subject matter specific to the relevant unit, e.g. Unit 1 subject matter (plant growth and questions on plant growth parameters, such as plant height and growth rate) should not be included in a data test assessing Unit 3 subject matter.

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	100	0	0	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 150 mm from a graph, an accepted range between 145 mm and 155 mm inclusive (145–155) was indicated
- the sample response and mark allocation provided in the marking scheme consistently and specifically aligned to the cognition required in the question, e.g. for a *compare* question, the sample response should include a similarity, difference and significance
- follow-through error was allowed in questions where more than two steps were required, and this was clearly indicated in the marking scheme
- annotations on the student response clearly indicate where evidence matches the marking scheme when awarding part marks.

Practices to strengthen

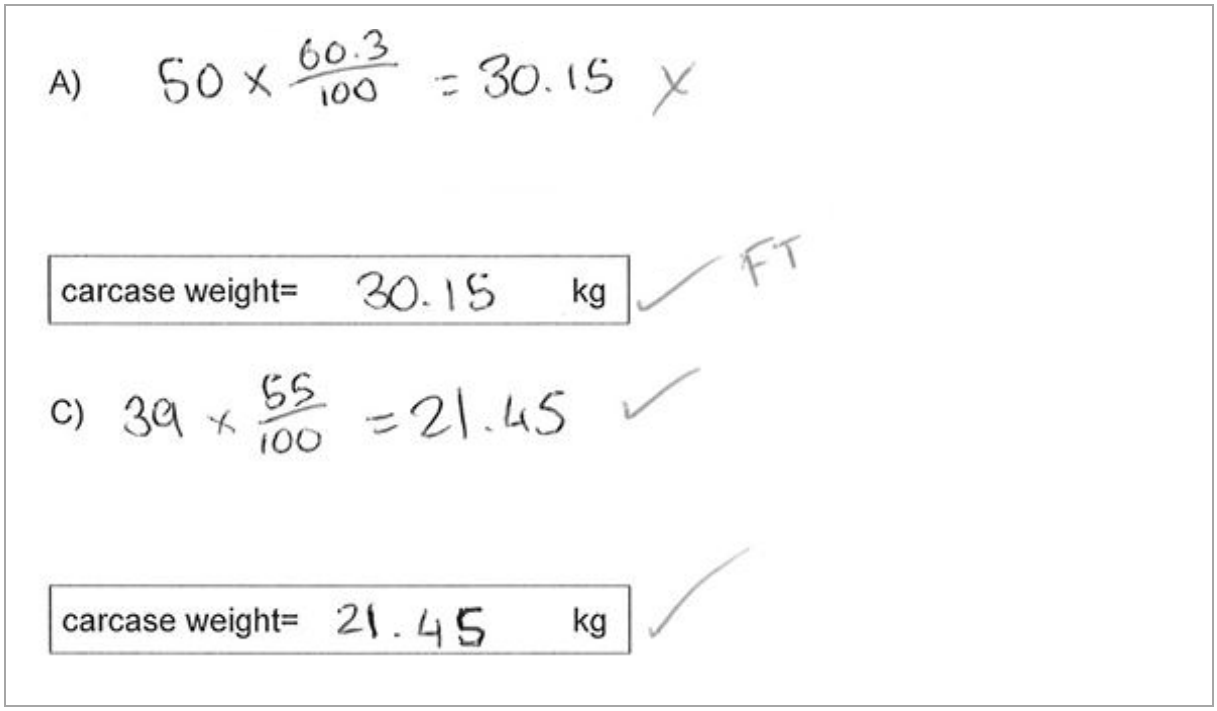
To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- if a handwritten marking scheme is used, this should be based on the final endorsed version of the instrument to ensure any updates made to the instrument after the first application for endorsement are reflected accurately in the marking scheme
- the marking scheme be updated during and after marking student work to ensure that it is clear, accurate, complete and matches the endorsed instrument precisely.

Samples

The following excerpt demonstrates where follow-through error is appropriately applied for an Objective 2 item. The question requires students to use a provided equation to calculate average carcase weight. A mark is awarded for correct substitution of values into the equation as well as a mark for the correct answer. As indicated by the marking scheme, annotations on the student response indicate where this provision was allowed.

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



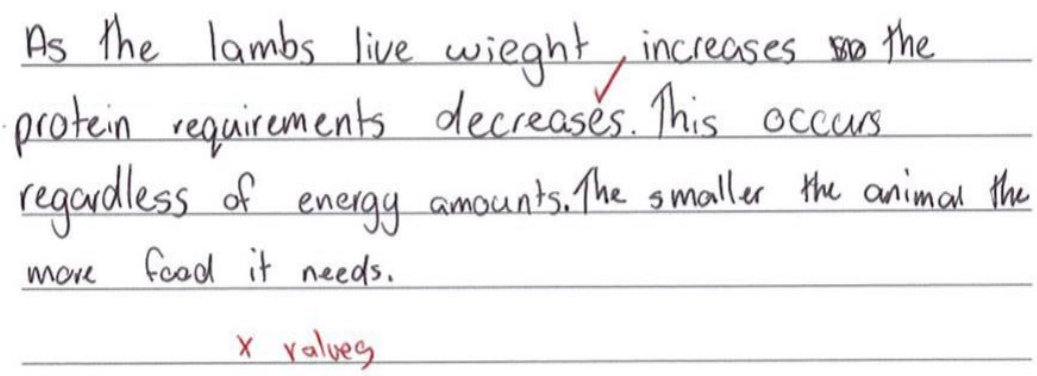
The following excerpt has been included to demonstrate a mark being awarded for identifying a range of values related to the fat depth for a specific cattle market. Students used the graph provided, and the additional information for accepted values provided by the marking scheme.

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

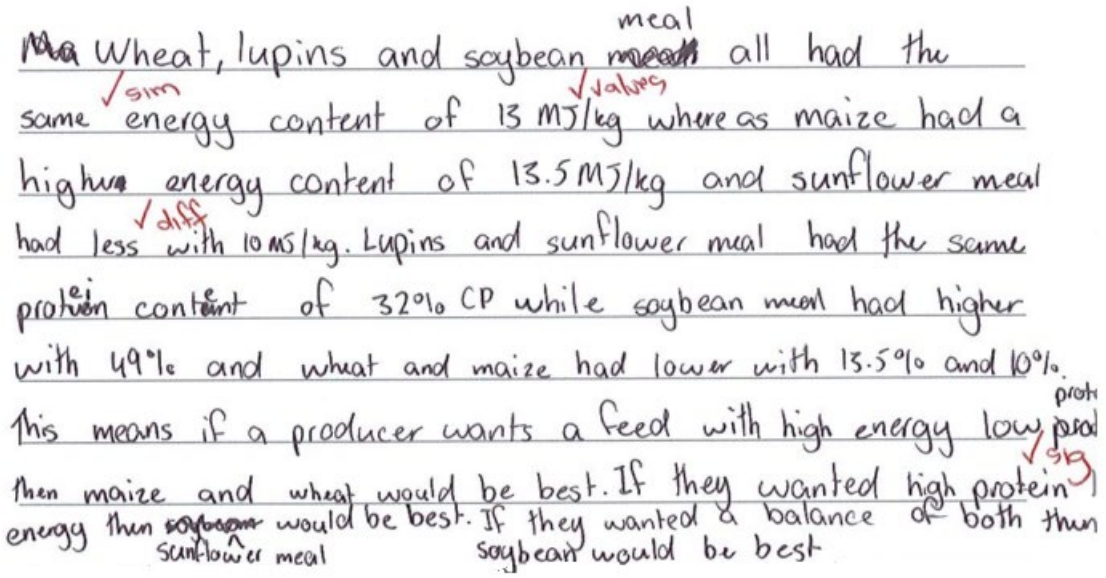
The following excerpts demonstrate clear alignment between the nature of the response and the cognitive verb used for questions assessing Objectives 3 and 4. Annotations on the student response indicate where the evidence is located for each of the marks identified by the marking scheme.

Note: The characteristics identified may not be the only time the characteristics occurred throughout a response.

Excerpt 1



Excerpt 2



Additional advice

- Schools should ensure
  - that any extra information not relevant to the questions is omitted from datasets
  - the marking scheme indicates all appropriate markets that fall within a portion of the market specification graph when asking students to identify suitable markets for an animal, based on a given liveweight and fat score, e.g. where a fat score of 3 and a liveweight of 450 kg could fall into two separate markets, responses that identify either of these markets are appropriate and should be included in the marking scheme
  - that an appropriate marking scheme specific to the instrument is uploaded at confirmation when a comparable assessment is administered. Comparable assessments should be developed in the Endorsement application (app) to ensure the correct examination and matching marking scheme are available for the confirmation review.

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	3
Authentication	0
Authenticity	1
Item construction	1
Scope and scale	0

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- contained consistent information in the conditions and context sections of the task sheet, i.e. the practical listed in the context section must align to the topics identified in the conditions section (Syllabus section 4.6.2)
- contained all the requirements listed in the assessment specifications, including the description paragraph and the asterisks that indicate the requirements that can be completed as a group (Syllabus section 4.6.2)
- 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 an authenticity statement about group work, e.g. the teacher will compare the responses of students who have worked together in groups
- match the requirements of the syllabus, ensuring that the task requirements that can be completed in groups match those marked with an asterisk in the syllabus (Syllabus section

4.6.2), e.g. ‘research relevant background scientific information to inform the modification of the research question and methodology’ is to be completed individually and should not be marked with an asterisk

- contain practicals that allow for a unique student response, e.g. ‘Formulate a ration for a selected animal/s’, not: ‘Formulate a ration for a selected animal and calculate the feed conversion ratio’.

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	3
Layout	0
Transparency	0

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- included clear communication of task elements, using concise language and accurate spelling and grammar
- provided clear instructions that aligned with the specifications of the syllabus, the assessment objectives and the ISMG (Syllabus section 4.6.2)
- 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

- Schools should ensure the
  - subheading ‘Stimulus’ is deleted if a stimulus is not provided
  - assessment item contains relevant formatting features (e.g. dot points when listing the specifications of the task) by using the **Print preview** function in the Endorsement app.

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	69.05	28.57	2.38	0
2	Analysis of evidence	76.19	21.43	2.38	0
3	Interpretation and evaluation	78.57	19.05	2.38	0
4	Communicate	100.00	0.00	0.00	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
  - reliability of the data and validity of the experimental process were evaluated separately through a *justified* discussion that considered a range of differing factors, including strengths and weaknesses of each, e.g. reliability could be evaluated through an examination of the uncertainty of the data, whereas validity could be evaluated according to the success of the methodology in providing evidence to answer the research question
  - *logically derived* improvements and extensions were addressed separately. Improvements focused on enhancing the validity and reliability evaluated earlier in the response, whereas extensions were based upon other, related variables or methodological modifications that would better replicate real-life scenarios, e.g. field trials
- in the Communication criterion
  - findings, arguments and conclusions were *fluently* and *concisely* conveyed through precise and accurate use of
    - discipline-specific language
    - statistical language
    - indicators of uncertainty, e.g. error bars on graphs
    - tables, graphs and diagrams
  - *appropriate* use of genre conventions was demonstrated by the adherence to accepted rules of spelling and punctuation and the expectations of particular generic forms, e.g. for a scientific report — appropriate headings and captions, an appropriately formal tone, use of past tense, etc.
  - *appropriate* referencing conventions acknowledged sources through the consistent use of an accepted referencing system, e.g. APA or Harvard.

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
  - ethical or environmental issues are *considered*, where appropriate, in addition to risks to human safety. This is particularly appropriate where fertilisers, weed seed and chemicals are used. If the methodology does not include any relevant ethical or environmental issues, this should be explicitly stated
  - a *specific and relevant* research question
    - is clearly aligned with Unit 3 subject matter (i.e. yield or production) rather than Unit 1 subject matter (i.e. germination or height)
    - involves only one independent variable to allow students to answer it within the scope of the response
  - *justified* modifications should be based upon an evaluation of the original experiment's method, results and/or background information and should indicate how they will improve the experimental process. This is more evident when the original experiment is explicitly described and allows the modifications to be clearly communicated
- for the Analysis of evidence criterion
  - *correct and relevant* processing of data should be demonstrated using algorithms, statistical analysis tools and graphical representations that align with the research question, e.g. a research question seeking a correlation between two variables should be analysed using a scatterplot and R^2 value, whereas a question seeking a comparison between groups should use a column graph with error bars and t-tests
  - responses identify uncertainty and limitations *thoroughly and appropriately* by addressing these two aspects separately
    - uncertainty may be presented in tabular or graphical form and includes statistical measures of uncertainty such as standard error, standard deviation, confidence intervals or error bars
    - limitations may include outliers, flaws or errors in methodology, unexpected environmental impacts, contextual factors (e.g. inability to re-run failed trials due to time constraints) or external influences (e.g. financial limitations reducing the ability to run large-scale animal trials).

Samples

The following excerpts demonstrate justified modifications to the methodology of a previously conducted experiment. The response clearly outlines the original experiment and considers background research to evaluate the methodology and develop appropriate modifications.

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

Excerpt 1

Original Experiment

The original experiment aimed to study the relationship between the amount of Urea fertiliser and how it directly affected the dry matter production of forage sorghum. The levels of Urea given to the plant were displayed across 5 separate pots with 6 replicates; these are 0g (control), 1g, 1.5g, 2g, and 2.5g. The results from this trial were collected after 5 weeks.

Excerpt 2

Modifications to Methodology

Modifications made to the original experiment	Refined/extended / Redirected?	Reasons why this modification will refine or extend the original experiment
Ryegrass instead of forage sorghum	Redirected	Ryegrass was chosen as it has great seedling vigour so clear observations can be distinguished within the different rates of Urea and short experiment times. Ryegrass is a commonly used high-protein pasture feed within the livestock industry that can withstand heavy grazing, being financially effective long term (Pasture.io, 2023).
Urea level	Refined	The Urea levels applied to each pot were calculated based on the recommended fertiliser application rate per hectare scaled down to the size of the pots. Farmers need to understand the optimal application rate, as applying Urea to pastures can increase dry matter production, allowing more livestock to feed per hectare and improving the farmer's financial well-being.
Drying time	Extended	The drying time will be extended from 24 hours to 48 hours to ensure all moisture is gone from the plant.

The following excerpt demonstrates considered management of risks and environmental issues. The response uses a table to address both environmental issues and risks to humans and provides reasoning behind the management strategies used.

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

Management of Risks & Environmental Considerations

Risk Identified	Management Strategy
Nutrient runoff into the surrounding environment/plants causing nutrient deficiency or nutrient toxicity.	Dispose of potting mix correctly or recycle it; Apply fertiliser indoors to minimize nutrient contamination to the environment.
Urea (Nitrogen) • Identified in Figure 11. Intake of large amounts can cause nausea, vomiting, and diarrhea. • Contact with the eye can instigate irritation and redness.	Use protective glasses and gloves; use a spoon to handle, don't inhale molecules. To protect the body from harmful toxins.
Exposure to soil microbes causing illness or alarming allergies	Appropriate PPE; gloves, long-sleeve shirt, and jeans for protection against infection
Exposure to heat/sun causing sunburn or sunstroke	Appropriate PPE; wide brim hat, long sleeve shirt; sufficient water consumption. To protect the body from heat stroke.

The following excerpts demonstrate correct and relevant processing of data. The research question is based on investigating the difference between groups. Accordingly, in addition to presenting statistical calculations for uncertainty (i.e. standard error and standard deviation), a column graph with standard error bars and several t-tests to compare means are used.

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

Excerpt 1

Research Question:

What effect does sources of ethylene derived from ethylene gas, apples and bananas have on the ripening of tomatoes, measured by the colour, firmness, mass, and sugar content?

Excerpt 2

	Colour							
	Before				After			
	Control	Ethylene gas	Banana	Apple	Control	Ethylene gas	Banana	Apple
1	1	1	1	2	4	3	1	3
2	1	1	1	1	1	4	2	1
3	1	1	1	1	2	2	1	4
4	1	1	1	2	3	2	1	5
5	3	1	1	1	4	2	1	4
Average	1.40	1.00	1.00	1.40	2.80	2.60	1.20	3.40
Standard Error	0.40	0.00	0.00	0.24	0.58	0.40	0.20	0.68
Standard Deviation	0.89	0.00	0.00	0.55	1.30	0.89	0.45	1.52

Trial Groups	Trial Sub Groups	P(T<=t) Value
Sugar Content	*Control (After)/Banana (After)*	0.264287179
	Control (After)/Apple (After)	0.878831662
	Ethylene (After)/ Banana (After)	0.82280466
	Ethylene (After)/ Apple (After)	0.66823104
	Banana (After)/ Apple (After)	0.40219342
Penetrometer	Control (After)/ Banana (After)	0.049037454
Colour	Banana (Before)/ Banana (After)	0.373900966

The following excerpt demonstrates the analysis of evidence by thorough and appropriate identification of uncertainty and the limitations of evidence. The response identifies uncertainty and limitations separately. Uncertainty is identified through calculations of standard error and standard deviation, while limitations are identified through flaws in methodology.

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

When comparing standard errors, trials 2, 3, and 4 had the highest standard errors of 0.356, 0.318, and 0.367, respectively. Although these trials were small, the control trial had a standard error of 0.267, and trial 5 had a standard error of 0.115. This contributes to the low reliability of the data. To assess the deviation of the sample mean from the true population mean, the standard deviation was calculated. The collected data indicated that the 2.5g Urea trial was the most accurate and reliable, as it had the sample mean closest to the true population mean. However, this trial had limitations that could have affected the results, making it unreliable. Although the experiment had no major outliers, the water was not controlled, and the soil used was potentially contaminated. Since the soil was taken from another agricultural plot, there was a possibility of other seeds and fertilisers entering the trial, introducing additional factors that could have influenced the results. Additionally, the trial did not accurately measure the watering of the plants, resulting in inconsistent water distribution among the ryegrass. Inconsistent distribution of water can significantly affect plant growth. Previous research has indicated that nitrogen is the most important nutrient for plant growth (NSW Government, 2024). Therefore, it can be concluded that the high levels of nitrogen, in the form of Urea, used in the trial were excessive for its size. This excessive nitrogen resulted in a weak correlation observed in the Graph, which peaked at 1.5g before decreasing again. This nitrogen may have contributed to the low R^2 value and high standard deviations observed. However, it is important to note that other factors such as environmental conditions, seed quantity (g), pot type, drying oven duration, and nitrogen input through Urea were controlled, thereby mitigating some limitations.

The following excerpt demonstrates interpretation and evaluation by addressing improvement and extensions separately, with improvement focused on improving reliability and validity of the investigation while extensions focus on other aspects and refinements.

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

Improvements:

To reduce the range of collected results and improve the accuracy and precision of the measurements, several steps could be taken, including (but not limited to):

- Higher replication number increases the size of a sample population, reducing the effect of potential outliers, improving the accuracy of the data collected.
- Clipping chicken wings to prevent chickens from flying into other pens and participating in multiple treatments. The replications would be restricted to one protein rate, improving the reliability and accuracy of the data.
- Increasing the regularity of food replenishments reduces the risk of hunger for chickens, therefore increasing the accuracy of data collected.
- Longer investigation period would increase the accuracy of the data collected as it allows for further maturation of chickens and therefore more insightful observations on how quickly they reach their genetic potential.

Extensions:

Further investigation could look at modifying the:

- Protein range by adding extra treatments between 15.5% and 18.5% protein to obtain whether a cheaper feed exists to optimise growth rate for poultry production.
- Domestic species investigated by using different fowl, which would evidence if protein had the same effect on growth rate on layer chickens as it does on a different species of fowl.

Additional advice

- Schools should ensure
  - appendixes only include supplementary material that will not be directly used as evidence when marking the response (*QCE and QCIA policy and procedures handbook v6.0*, Section 8.2.6). If raw data is included in an appendix, there must be evidence of collection of sufficient and relevant raw data in other areas of the response, e.g. methodology, sample calculations and data presentation. Evidence of *considered* management of risks, ethical and environmental issues should be included in the body of the report
  - that where a simulation is used instead of real-life experiments, attention is paid to the ability of students to demonstrate
    - management of risks
    - generation of raw data that can be processed appropriately and aligns to the research question
    - how the original experiment can be modified
  - the use of hyperlinks to external documents (such as data records or Material Safety Data Sheets) is discouraged. All evidence relevant to the investigation should be presented within the report itself. This can either be in the body of the report (preferred) or in the appendix (with appropriate referencing to this section of the report).

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	8
Authentication	3
Authenticity	3
Item construction	2
Scope and scale	1

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that included claims:

- directly aligned with Unit 4, e.g. Dryland salinity is changing agricultural production in Australia
- that allowed the generation of multiple research questions, e.g. Technology assists in mitigating risk in agricultural production systems.

Practices to strengthen

It is recommended that assessment instruments:

- include claims that allow for a unique student response, e.g. 'Free trade agreements will save the Australian agricultural industry' is sufficiently broad and may elicit a wide range of research questions from students when considering different international partners
- contain appropriate authentication strategies that align with the task, i.e. in the IA3, 'students are to work individually throughout this task (Syllabus section 5.5.1); therefore, the authentication strategy 'compare responses of students who have worked together' should not be included
- contain a complete list of task description dot points.

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

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- included clear and concise claims
- provided clear instructions that used cues aligned to the specifications, objectives and ISMG
- were free of errors and modelled accurate spelling, grammar, punctuation and other textural features
- limited the amount of information students were required to process in order to complete the task, e.g. did not include a context paragraph to describe the subject matter taught in Unit 4 because it is not relevant to completing a research investigation.

Practices to strengthen

There were no significant issues identified for improvement.

Additional advice

- Schools should
  - reconsider the inclusion of claims that may lead to student responses not meeting the requirements of the ISMG, e.g. the identification of a trend, pattern or relationship is difficult to demonstrate when analysing an estimated breeding values (EBV) table
  - be aware that claims containing more than one variable, e.g. ‘animal welfare requirements are influenced by social, economic, cultural and ethical perceptions’ may be difficult to answer within the allotted word limit without a highly focused research question that considers an aspect of the claim
  - review instruments each year to ensure claims are still appropriate based on feedback previously received.

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	92.86	4.76	2.38	0
2	Analysis and interpretation	88.10	11.90	0.00	0
3	Conclusion and evaluation	80.95	19.05	0.00	0
4	Communication	100.00	0.00	0.00	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 *specific* and *relevant* research question had a clear focus, was written concisely and was in the form of a question rather than a statement
  - *sufficient* and *relevant* sources were drawn from a variety of scientifically credible sources, including sources that present evidence obtained through observation or experimentation, as well as sources containing background scientific information for the development of the research question
- for the Analysis and interpretation criterion, *thorough* and *appropriate* identification of limitations considered the limitations that would affect the usefulness of the evidence in answering the research question, e.g. sample size, age, methodology and/or statistical significance.

Practices to strengthen

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

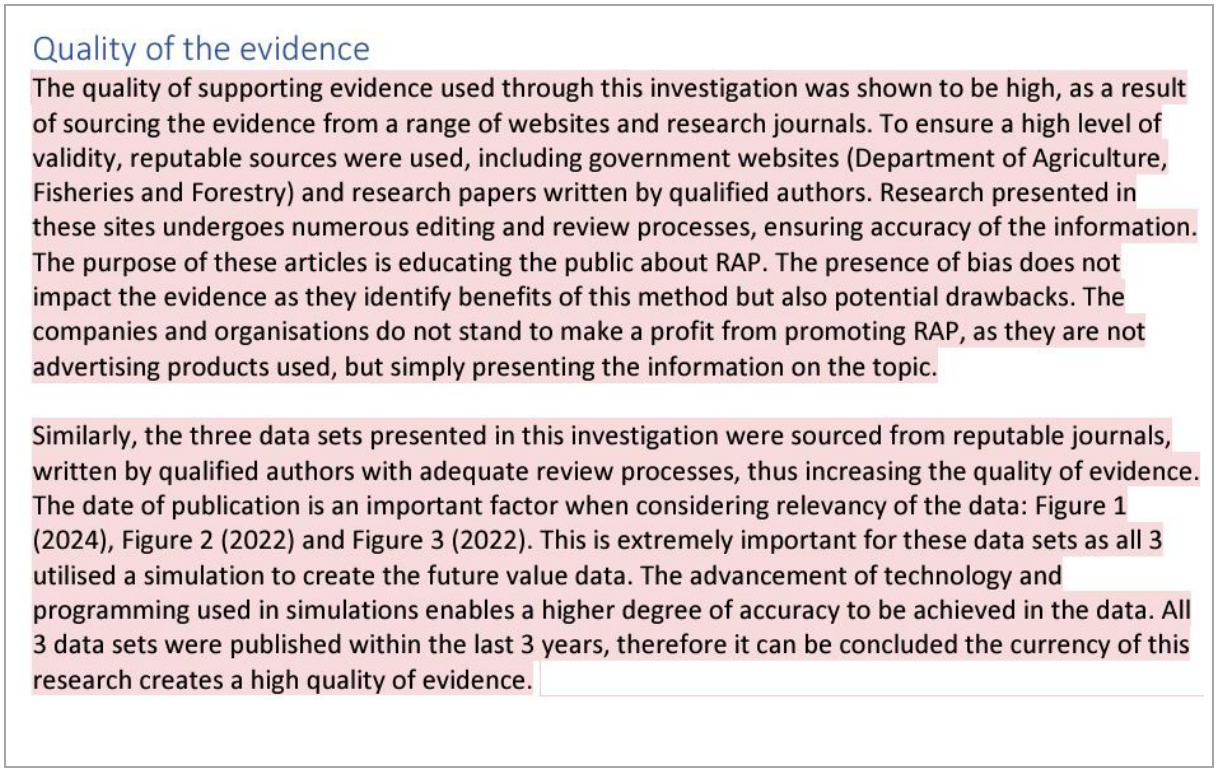
- for the Conclusion and evaluation criterion
  - *justified* conclusions should answer all aspects of the research question by drawing on the evidence presented
  - improvements and extensions are addressed separately and distinctly with
    - *considered* improvements related to the reliability and 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

- *insightful discussion* of the quality of evidence considers several 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) and includes reference to limitations identified earlier in the response
- credible findings of the research to the claim are *extrapolated* by linking conclusions to the investigation of real-life applications that are relevant to Unit 4 subject matter, e.g. drawing on relevant resource management techniques to support the claim, e.g. extrapolating the benefits of hydroponics with regards to yield and water usage to large broadacre crop production.

Samples

The following excerpt has been included to demonstrate a thorough discussion of the quality of evidence. The quality of evidence discussed is based on the credibility of the authors, bias, currency, and methodological limitations.

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



Quality of the evidence

The quality of supporting evidence used through this investigation was shown to be high, as a result of sourcing the evidence from a range of websites and research journals. To ensure a high level of validity, reputable sources were used, including government websites (Department of Agriculture, Fisheries and Forestry) and research papers written by qualified authors. Research presented in these sites undergoes numerous editing and review processes, ensuring accuracy of the information. The purpose of these articles is educating the public about RAP. The presence of bias does not impact the evidence as they identify benefits of this method but also potential drawbacks. The companies and organisations do not stand to make a profit from promoting RAP, as they are not advertising products used, but simply presenting the information on the topic.

Similarly, the three data sets presented in this investigation were sourced from reputable journals, written by qualified authors with adequate review processes, thus increasing the quality of evidence. The date of publication is an important factor when considering relevancy of the data: Figure 1 (2024), Figure 2 (2022) and Figure 3 (2022). This is extremely important for these data sets as all 3 utilised a simulation to create the future value data. The advancement of technology and programming used in simulations enables a higher degree of accuracy to be achieved in the data. All 3 data sets were published within the last 3 years, therefore it can be concluded the currency of this research creates a high quality of evidence.

The following excerpts have been included to demonstrate suggested improvements and extensions to the investigation that are considered and relevant to the claim. The research question describes the investigation.

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

Excerpt 1

Research question

Does the implementation of regenerative agricultural practices (RAP), such as cover crops utilised in cropping and pasture, offer a more sustainable future for Australian agriculture through increased soil health measured by organic soil carbon?

Excerpt 2

Improvements to the investigation

The following improvements for the data sets are:

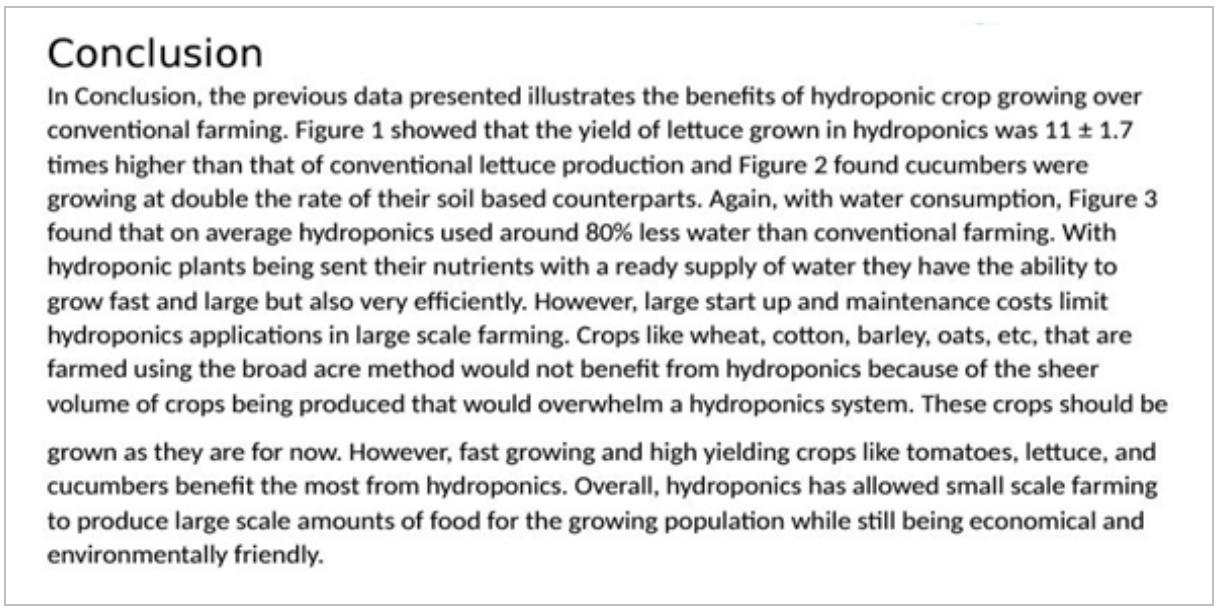
- This experiment could be improved by using real data gathered physically to create the graphs rather than simulated values. Such data would consider current factors and conditions that may change values, instead of being based on previous years.
- The inclusion of descriptive statistics for each data set would be a significant improvement as this would provide a greater insight into the data and how this applies to the research question. Measures such as SD, SE and error bars can allow the cause of error to be shown and analysed.
- Increasing the sample size. Multiple sample sizes noted in Figure 3 were below 10, which is far too small to draw accurate conclusions from the data. Sample sizes of greater than 50 should be a minimum benchmark, as at this value, the data will show outliers and better represent the situation being investigated.

Extensions to the investigation

- An investigation into the use of agroforestry could enable further insight into carbon sequestration and its use on Australian farms. The integration of tree plantation in cropping scenarios is a potential example of this.

The following excerpt has been included to demonstrate justified conclusions which reference the evidence presented earlier in the response. The findings are extrapolated to the claim through a consideration of their application to real-life scenarios of broadacre crop production.

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



Conclusion

In Conclusion, the previous data presented illustrates the benefits of hydroponic crop growing over conventional farming. Figure 1 showed that the yield of lettuce grown in hydroponics was 11 ± 1.7 times higher than that of conventional lettuce production and Figure 2 found cucumbers were growing at double the rate of their soil based counterparts. Again, with water consumption, Figure 3 found that on average hydroponics used around 80% less water than conventional farming. With hydroponic plants being sent their nutrients with a ready supply of water they have the ability to grow fast and large but also very efficiently. However, large start up and maintenance costs limit hydroponics applications in large scale farming. Crops like wheat, cotton, barley, oats, etc, that are farmed using the broad acre method would not benefit from hydroponics because of the sheer volume of crops being produced that would overwhelm a hydroponics system. These crops should be grown as they are for now. However, fast growing and high yielding crops like tomatoes, lettuce, and cucumbers benefit the most from hydroponics. Overall, hydroponics has allowed small scale farming to produce large scale amounts of food for the growing population while still being economical and environmentally friendly.

Additional advice

- Schools should ensure
  - students develop research questions in contexts that directly contribute to agricultural or horticultural production and discourage research questions that do not, e.g. horse or dog racing
  - students understand that scientific arguments should be based on evidence from at least two different sources. Separate arguments can use several pieces of evidence from the same sources (e.g. several graphs or tables of data from the one source); however, this should then be discussed as a limitation of the evidence
  - marked ISMGs indicate the characteristics evident in the student response and the mark awarded for each criterion (*QCE and QCIA policy and procedures handbook v6.0,* Section 9.6.1). Schools should consider evidence throughout the entire response when deciding which characteristics the evidence best matches.
  - accuracy and consistency in judgments when determining grades for each criterion by applying the best-fit approach (see Syllabuses app > QCAA Portal > *Using ISMGs for General Science syllabuses*). After determining the performance level that best fits the evidence matched to characteristics for a criterion within an ISMG, for a two-mark range performance level, the higher mark should only be awarded if there is evidence of all the characteristics in the performance-level descriptor (or better).

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 syllabus.
The examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (15 marks)
- Paper 1, Section 2 consisted of short response questions (33 marks)
- Paper 2, Section 1 consisted of short response questions (36 marks)
- Paper 2, Section 2 consisted of an extended response question (17 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.

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 15 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.

Question	A	B	C	D
1	1.13	0.68	9.28	**88.69**
2	**38.69**	7.24	5.43	48.19
3	**78.05**	10.86	8.82	1.81
4	4.98	28.51	22.40	**43.67**
5	7.92	2.04	**83.71**	6.11
6	7.92	15.84	**51.58**	24.43
7	14.25	8.60	6.56	**70.36**

Question	A	B	C	D
8	7.47	7.01	**73.30**	11.76
9	63.80	13.57	**20.14**	2.04
10	1.81	**73.76**	21.95	2.26
11	6.11	**82.58**	7.92	2.94
12	0.23	3.85	2.26	**93.21**
13	**53.39**	38.01	3.85	4.52
14	**25.34**	16.52	50.00	7.47
15	8.14	**54.75**	26.02	10.86

Effective practices

Overall, students responded well when they:

- identified pests of Australian agricultural animals and plants
- calculated feed utilisation for a selected group of animals
- contrasted the effect of different iterations of an independent variable on measured dependent variables, e.g. different fertilisers on the number of legume nodules and yield
- determined an appropriate sire using breeding value data for improving selected production traits.

Practices to strengthen

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

- using authentic contexts that allow students to demonstrate all aspects of the subject matter statement, e.g. appropriate ration to feed animals at different stages of production
- providing opportunities for students to interpret data to draw a conclusion
  - based only on the evidence provided
  - that is justified using evidence from multiple datasets
- providing students with opportunities to assess financial data for making a judgment about the sustainability of an agricultural enterprise
- reviewing all agricultural concepts within subject matter statements that have multiple parts, e.g. discussing the opportunity for sustainable practices in an agricultural production system using the criteria of
  - physical resource management
  - biological resource management
  - waste management.

Samples

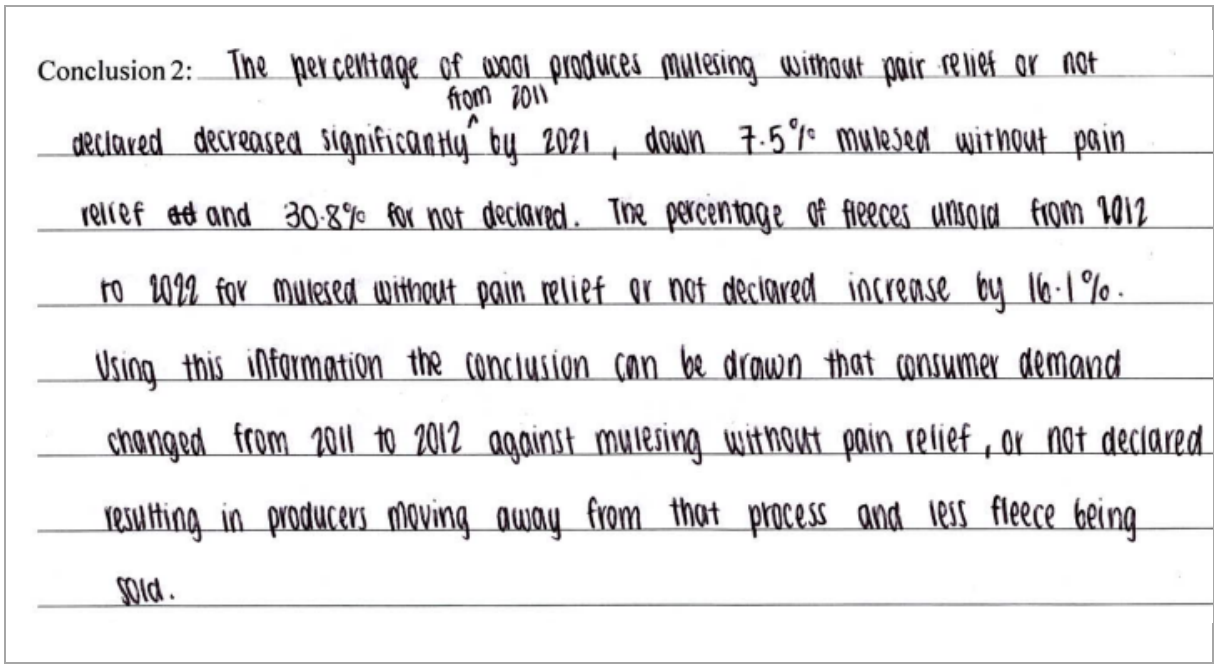
Short response

Paper 1, Question 19

The following excerpt is from Question 19 in Paper 1. It required students to analyse data in two tables to draw two conclusions about the effect of consumer demand on the practice of mulesing sheep.

Effective student responses:

- identified one conclusion
- justified the conclusion using evidence from both tables
- identified a second conclusion
- justified the second conclusion using evidence from both tables.
- This excerpt demonstrates a conclusion about the effect of consumer demand on mulesing practices
- how evidence has been collected from both tables to justify that conclusion.


Conclusion 2: The percentage of wool produces mulesing without pair relief or not declared decreased significantly from 2011 by 2021, down 7.5% mulesed without pain relief ~~ed~~ and 30.8% for not declared. The percentage of fleeces unsold from 2012 to 2022 for mulesed without pain relief or not declared increase by 16.1%. Using this information the conclusion can be drawn that consumer demand changed from 2011 to 2012 against mulesing without pain relief, or not declared resulting in producers moving away from that process and less fleece being sold.

Paper 1, Question 23a)

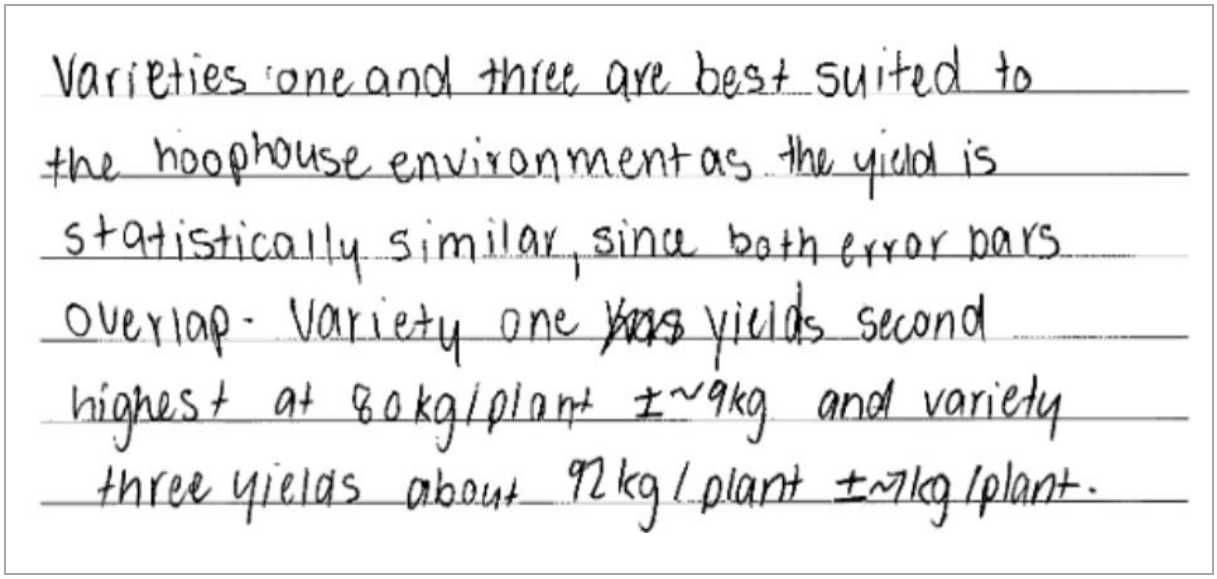
The following excerpt is from Question 23a) in Paper 1. It required students to analyse data in a graph to determine which varieties of tomato grew best in a hoophouse environment.

Effective student responses:

- identified tomato varieties
- justified using one piece of statistical evidence
- justified using a second piece of statistical evidence.

This excerpt demonstrates:

- the accurate determination of the two varieties which grow best in a hoophouse environment
- examples of statistical evidence that could be used to justify the selected varieties.



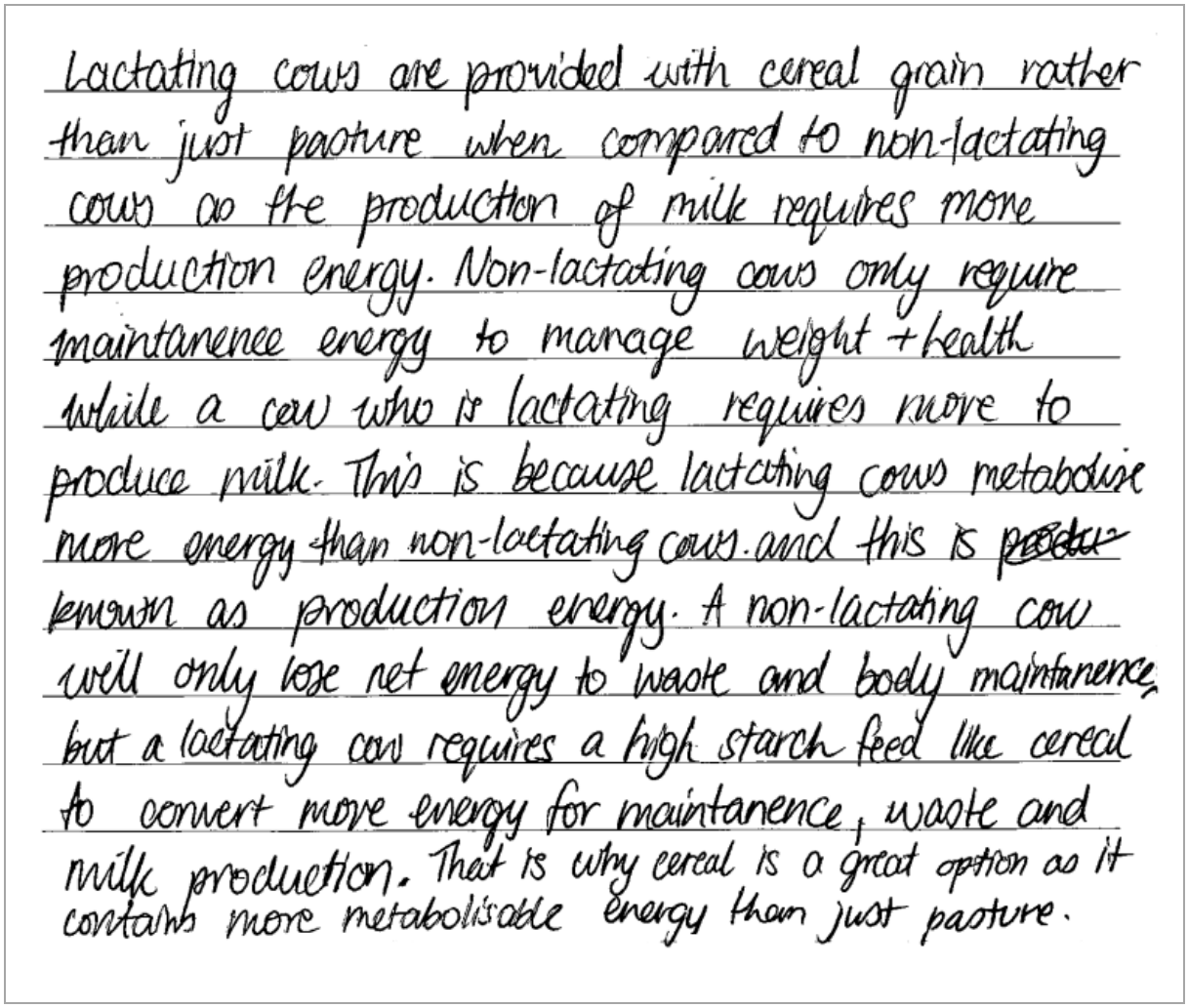
Paper 2, Question 1

The following excerpt is from Question 1 in Paper 2. It required students to explain in terms of energy metabolic pathways why lactating cows are supplemented with cereal grain in contrast to non-lactating cows.

Effective student responses:

- explained the difference in energy requirements between lactating and non-lactating cows
- explained how cereal grain can supply the required additional energy to meet milk production requirements
- identified that pasture will be sufficient to meet the lower energy needs of non-lactating cows.

This excerpt demonstrates how supplementation of high-producing animals with grain may be required to meet production energy requirements in contrast to maintenance energy requirements.


Lactating cows are provided with cereal grain rather than just pasture when compared to non-lactating cows as the production of milk requires more production energy. Non-lactating cows only require maintanence energy to manage weight + health while a cow who is lactating requires more to produce milk. This is because lactating cows metabolise more energy than non-lactating cows and this is ~~produ~~ known as production energy. A non-lactating cow will only lose net energy to waste and body maintanence, but a lactating cow requires a high starch feed like cereal to convert more energy for maintanence, waste and milk production. That is why cereal is a great option as it contains more metabolisable energy than just pasture.

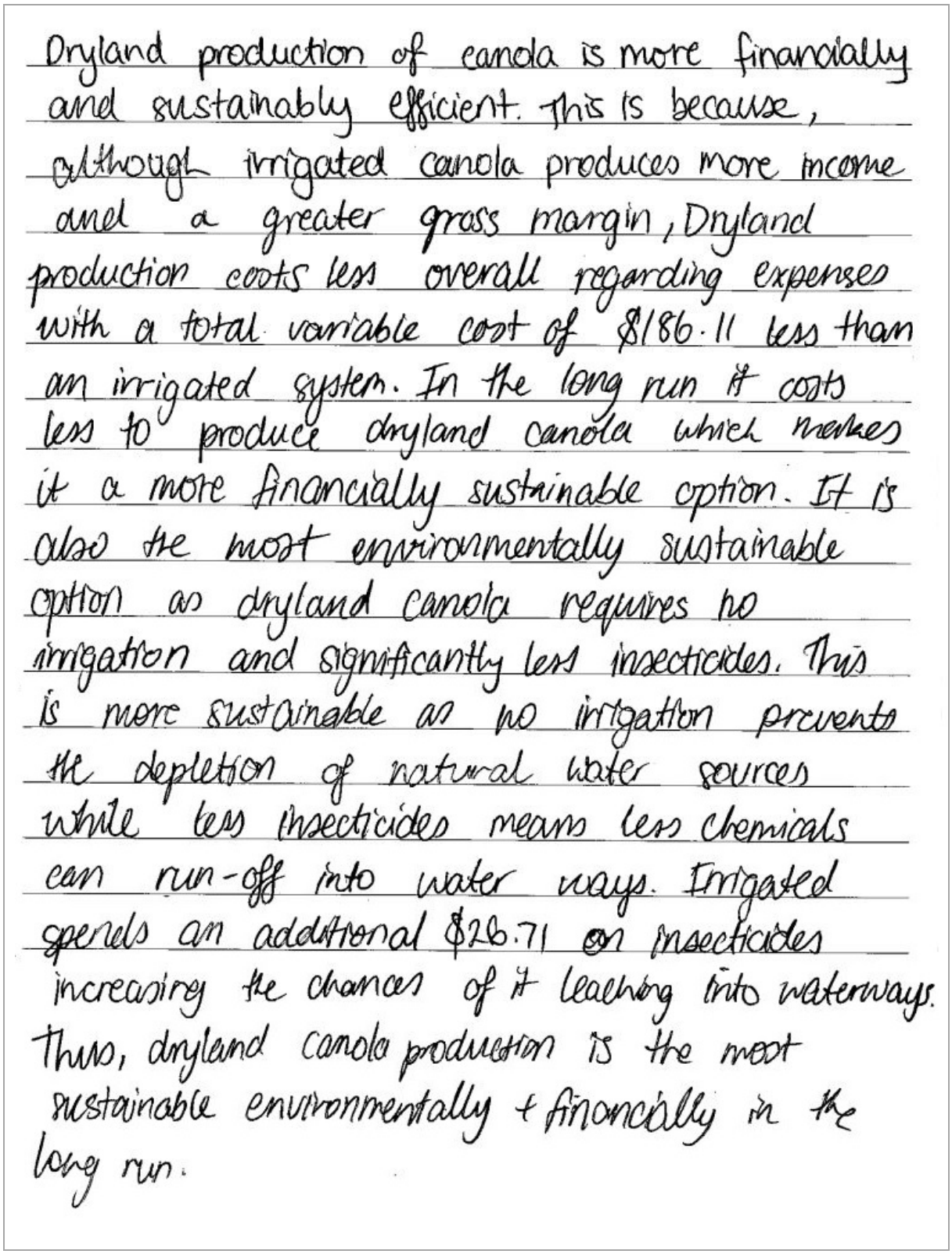
Paper 2, Question 8

The following excerpt is from Question 8 in Paper 2. It required students to assess the financial figures of two enterprises that were growing the same crop to conclude which is the more financially and environmentally sustainable.

Effective student responses:

- identified a difference in yield
- identified higher variable costs for the irrigated system
- identified that less inputs are required for the dryland system
- drew a justified conclusion.

This excerpt demonstrates clear identification of the cropping system, which is more financially and environmentally sustainable after analysis of the financial data.



Dryland production of canola is more financially and sustainably efficient. This is because, although irrigated canola produces more income and a greater gross margin, Dryland production costs less overall regarding expenses with a total variable cost of $186.11 less than an irrigated system. In the long run it costs less to produce dryland canola which makes it a more financially sustainable option. It is also the most environmentally sustainable option as dryland canola requires no irrigation and significantly less insecticides. This is more sustainable as no irrigation prevents the depletion of natural water sources while less insecticides means less chemicals can run-off into water ways. Irrigated spends an additional $26.71 on insecticides increasing the chances of it leaching into waterways. Thus, dryland canola production is the most sustainable environmentally + financially in the long run.

Extended response

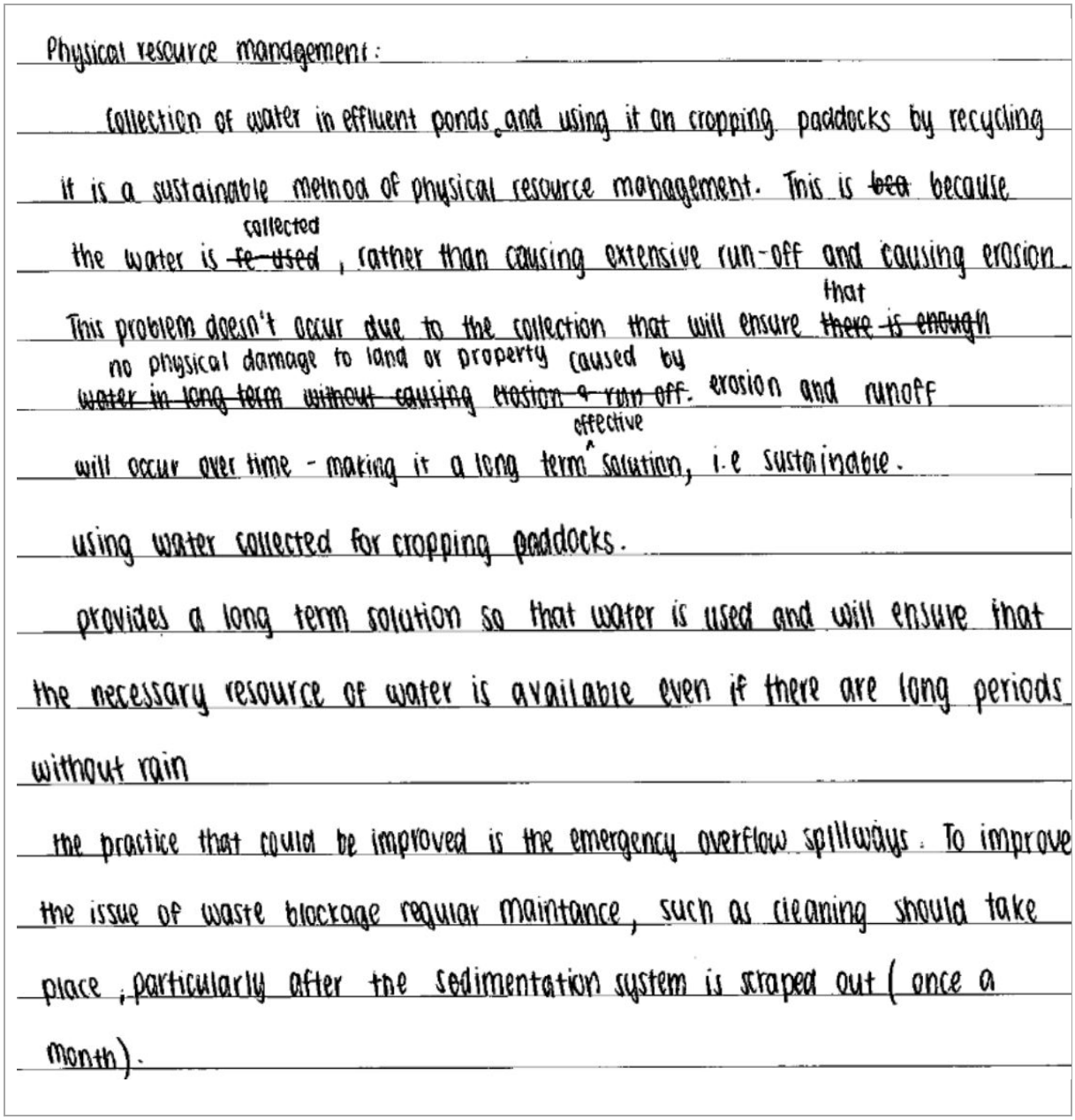
Paper 2, Question 9

The following excerpt is from Question 9 in Paper 2. It required students to assess the environmental sustainability of an enterprise, using three criteria.

Effective student responses:

- assessed the environmental sustainability of the agricultural enterprise, using the three criteria of physical resource management, biological resource management and waste management
- identified and justified two practices that are sustainable for each criterion
- explained how one practice could be improved
- drew a conclusion about the environmental sustainability of the enterprise.

This excerpt demonstrates the identification of two sustainable practices using the criteria of physical resource management.



Physical resource management:

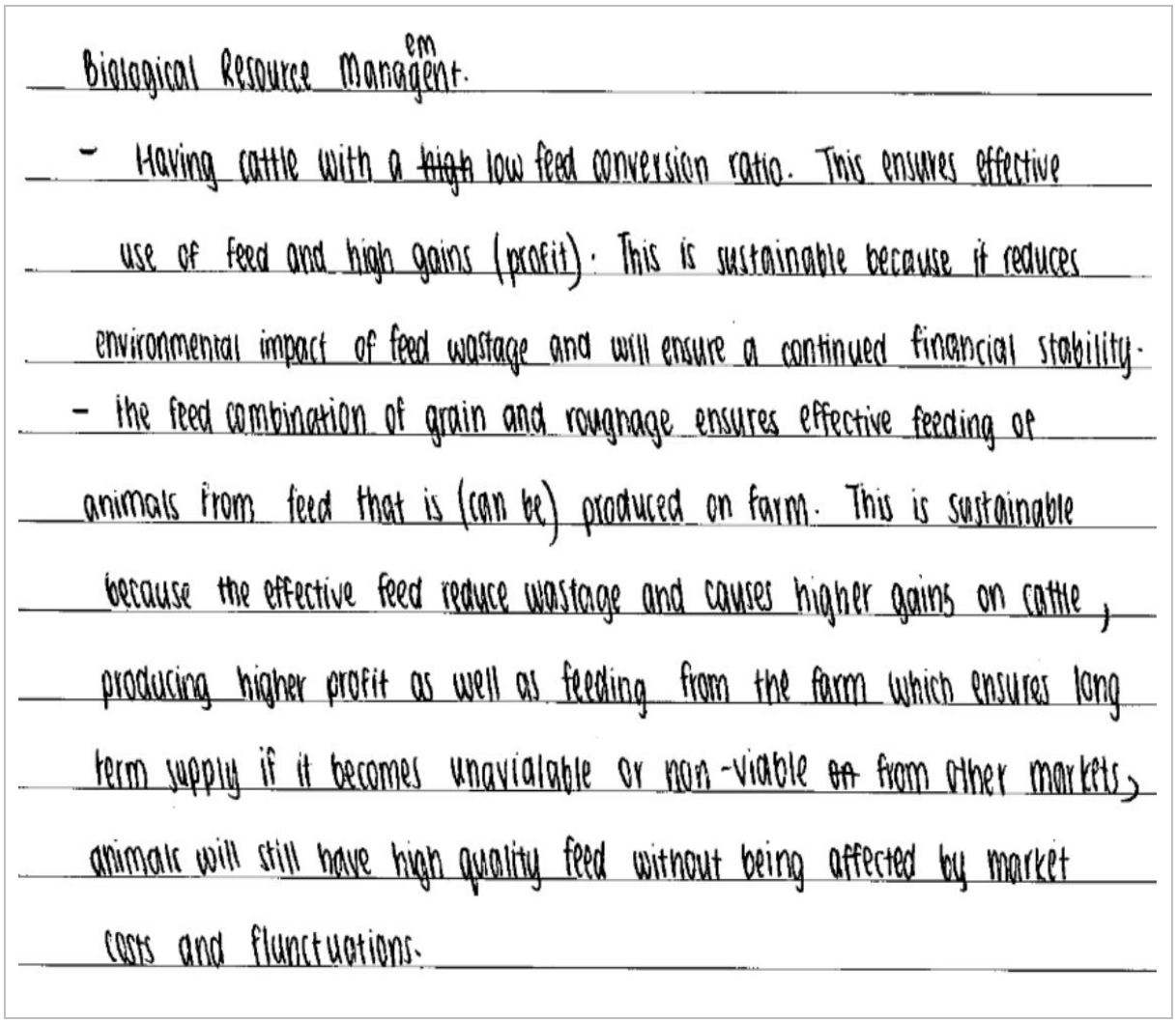
collection of water in effluent ponds and using it on cropping paddocks by recycling it is a sustainable method of physical resource management. This is ~~bea~~ because the water is ~~re-used~~ collected, rather than causing extensive run-off and causing erosion. This problem doesn't occur due to the collection that will ensure ~~there is enough~~ that no physical damage to land or property caused by ~~water in long term without causing erosion & run off.~~ erosion and runoff will occur over time - making it a long term effective solution, i.e sustainable.

using water collected for cropping paddocks.

provides a long term solution so that water is used and will ensure that the necessary resource of water is available even if there are long periods without rain

the practice that could be improved is the emergency overflow spillways. To improve the issue of waste blockage regular maintance, such as cleaning should take place, particularly after the sedimentation system is scraped out (once a month).

This excerpt demonstrates the identification of two sustainable practices using the criteria of biological resource management.



Biological Resource Management.

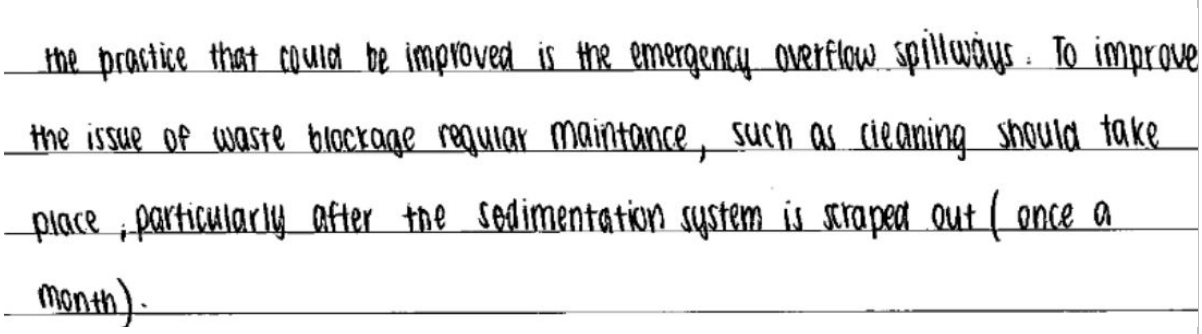
- Having cattle with a ~~high~~ low feed conversion ratio. This ensures effective use of feed and high gains (profit). This is sustainable because it reduces environmental impact of feed wastage and will ensure a continued financial stability.
- the feed combination of grain and roughage ensures effective feeding of animals from feed that is (can be) produced on farm. This is sustainable because the effective feed reduce wastage and causes higher gains on cattle, producing higher profit as well as feeding from the farm which ensures long term supply if it becomes unavialable or non-viable ~~on~~ from other markets, animals will still have high quality feed without being affected by market costs and fluctuations.

This excerpt demonstrates an explanation of how one practice could be improved for each of the identified criteria.

Excerpt 1

- the practice that should be improved is the chemical control of buffalo fly. to improve this alternative methods should be used such as biological controls - use IPM, to reduce chemical air pollution + reduce impact on enviroment.

Excerpt 2



Additional advice

- Teachers should review the multiple choice items where students answered incorrectly to ensure subject matter is sufficiently covered in the future.