24400000 - Written Report

by Niall Meegan

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Table of Contents

1. Introduction

1.1 Overview of intensive dairy systems

Over the last few decades, increasing dairy production systems have led to more milk and greater output from cows (Dallago *et al*., 2021). Most of these progressions are because dairy nutritionists give high-energy grain diets to high-producing cows. At the same time, these feeding methods pose major risks to rumen health, mainly by heightening the chance of ruminal illnesses. Sub-acute ruminal Acidosis (SARA) is a major and growing challenge in intensive dairy systems since it affects how well the animals produce, how healthy they are, and the farm's income (Coppa *et al*., 2023).

1.2 Importance of rumen health in ruminant productivity and welfare

Quantify

SARA is a metabolic disorder that happens when rumen pH is mildly decreased for longer periods, generally within the range of 5.5 to 5.8, and is not as obvious as acute acidosis (Golder and Lean, 2024). Most cases occur whe[illegible] Define first time used too much starch and sugar too quickly, which promotes the buildup of VFAs and, in some cases, leads to lactic acid being produced. When there is too much acid and not enough buffering, the pH stays low for Vague a long time, which disturbs microbes and lowers the ability to digest fibre. Unlike acute acidosis, SARA does not usually bring about sudden disease or death, but it does lead to long-term health problems, below-average performance, and an increase in culling.

1.3 Overview of Sub-Acute Ruminal Acidosis (SARA)

The adoption of high-concentrate, low-fibre feeds by dairy herds, mostly in confined and intense milk-focused farms, raised concerns about SARA (Srivastava *et al*., 2021). Reports suggest that the frequency of SARA in commercial dairy herds can be between 11% and 30% Reference or more, mostly depending on how it is diagnosed and the herd's management style. Even though SARA is not immediately obvious, it can greatly affect the economy by lowering feed efficiency, reducing milk fat, causing lameness, reducing fertility, and making cows more vulnerable to diseases like displaced abomasum and mastitis. Good, but references required to support the point

Because SARA is such a common problem, it is important to fully understand what causes and leads to it for effective management. Making changes to fibre levels, adding rumen buffers, and feeding yeast cultures look promising for reducing rumen pH fluctuations. At the same time, using these measures on the farm must take into account variations in cows and the feeding system of the population. People need to keep researching to create better tools for diagnosing SARA and for managing diets precisely to stop or delay its onset (Fu *et al*., 2022).

2. Literature Review

2.1 Prevalence of SARA in Intensive Dairy Systems

SARA has continued to be a major issue in dairy systems around the world, as shown by recent studies that document its ongoing presence and effects on profitability (Plaizier*et al*., 2022). SARA is marked by extended time with rumen pH between 5.5 and 5.8 because it usually has no obvious symptoms, making it hard to notice and treat. It is most common when dairy operations feed cows high levels of concentrates as part of their rations.

Several recent international studies report that the occurrence of SARA in intensive systems is still significant, being reported in 18-30% of herds based on region, herd practices, and diagnosis. An analysis by Bansod *et al*. (2024) showed that 26% of mid-lactation cows in high-yielding TMR herds had rumen pH reflecting subacute rumen acidosis. Cows kept in less intensive, forage-focused systems have much lower cases of SARA, indicating that how cows are fed plays a major role (Voulgarakis *et al*., 2024).

The FAO's 2022 [illegible] review with input from over 40 farms in Europe, North America, and Asia showed an SARA prevalence of 22% on average, with the highest occurrence in confined herds that depend heavily on corn-based rations. Similarly, Yang *et al*. (2022) found that feeding over 60% concentrates led to SARA o[illegible] in more than 23.3% of cows. According to the study, both poor mixing of feeds and short fibre in the diet increased the risk of SARA.

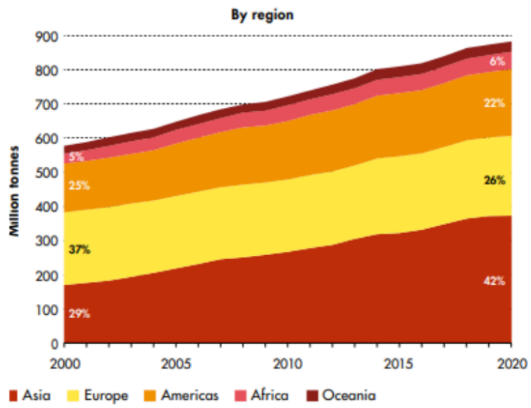

Figure 1: WORLD PRODUCTION OF MILK

Source: (FAO, 2022)

On the other hand, grazing systems in regions such as New Zealand and Ireland show far fewer cases of SARA, with European milk costs decreasing too (Moscovici Joubran *et al*., 2021). This difference points to forage quantity, fibre in the feed, and meal frequency playing key roles in keeping the rumen healthy.

Cows living in intensive systems with little outdoor access have more SARA issues than cows in systems that use a mix of grazing and stall feeding. The study by Romano *et al*. (2023) reveals that cows in AFS have larger swings in rumen pH, likely because of how they feed and sort their rations, increasing the risk of SARA.

Therefore, recent findings show that SARA is a frequent problem in dairy farms around the globe and is often not detected. There is variation in the incidence of SARA due to different feeding routines, the type of housing used, and culture-specific ways of managing dairy cattle. This makes it clear that individuals need to keep checking cows' rumen health and improve feed quality to help prevent and manage this unseen problem.

2.2 Risk Factors for SARA in Intensive Dairy Systems

The effect of sub-acute ruminal acidosis (SARA) in dairy cattle is multifactorial, with nutritional, physiological, and environmental impacts all contributing to its onset. In intensive dairy methods, where production efficiency is prioritised, certain risk factors become particularly noticeable. Understanding these risk factors is essential for planning effective SARA prevention methods. A comprehensive approach—including dietary formulation, cow-level monitoring, and environmental management—is required to decrease SARA incidence in current intensive dairy techniques.

2.3 Pathophysiology of SARA

Sub-acute ruminal acidosis (SARA) is a metabolic disease amongst ruminants, especially in the intensive beef and dairy systems where diets with high levels of grain are fed. It happens when the pH of the rumen drops below 5.5 for a few hours each day and therefore inhibits the normal microbial activities. Due to rapid fermentation of easily digested carbohydrates-starch and sugars, large amounts of volatile fatty acids (VFAs) and lactic acid are produced; hence, this is the condition that comes about. Acids being produced more than saliva's buffering ability, as well as the wall of rumen's wall capacity to absorb acidic substances, leads to a drop in pH.

The acidic environment damages the microbes which digest fibres and promotes the acid-resilient species, such as Streptococcus bovis and Lactobacillus spp, that contribute even more to the acidic content (Morar *et al*. 2022). Unlike the VFAs, lactic acid cannot be absorbed easily and is more acidifying. As a result, the pH of the rumen reduces further, and no further motility of the rumen occurs, resulting in inflammation and damage to the lining of the rumen, whereby bacteria and toxins enter the bloodstream (Petri *et al*. 2021). This may cause systemic inflammation and liver abscesses.

SARA is known to come with non-specific symptoms that include reduced feed intake, loose faeces, lowered milk or growth rates, hence making the diagnosis difficult. Its pathophysiology is important to comprehend as it would guide toward devising effective ways of prevention and treatment in the contemporary ruminant production systems.

3. Dietary Interventions and Management Strategies

3.1 Nutritional Approaches

Nutritional management always plays an important role in the prevention and control of sub-acute ruminal acidosis (SARA) in intensive beef and dairy systems. As SARA is the result of excessive acid produced from fermentable carbs, especially on a high-grain food, alteration of feeding strategy can go a long way to reduce its incidence.

One of the effective ways is to increase the dietary fibre intake, especially physically effective neutral detergent fibre (peNDF). The society of this kind of fibre encourages chewing and saliva generation, which leads to buffering of rumen pH (Elmhadi*et al*. 2022). Adding good quality forages (various forages like long-stem hay or silage) would be beneficial towards meeting rumen motility and a stable rumen environment.

Slow adaptation to diets that have high concentrations is also important. Sudden changes upset the microbial balance of the rumen and increase the concentrations of acid in the rumen. Stepwise changes enable rumen microorganisms to acclimate and acquire the capacity to cope with an increased portion of starch (Grant, 2023). Feeding practices like total mixed rations (TMR) can make certain that there is regular intake and minimisation of selective eating that usually involves excessive intake of grain.

Another important practice is the use of feed additives. Buffers in the form of sodium bicarbonate and magnesium oxide assist to neutralise excess acid; addition of yeast cultures and probiotics maintains the rumen fermentation. Some of the essential oils and extracts from plants have also been found promising for maintaining the microbial population at a check and decreasing the accumulation of lactic acid.

Restriction on excessive consumption of highly fermentable starches – examples of available foods to restrict are finely ground grains – is crucial. Large particles of grains or those steam-flaked grains ferment more slowly and thus will minimise unexpected sharp rumen pH levels. It is possible to replace some of the starches with sources of digestible fibres (beet pulp or soy hulls) and reduce the acid load, without influencing the calorific intake (Bach *et al*. 2023).

Feeding management is equally important. Using several small meals a day, maintaining unlimited feed availability, and minimising competition at feed bunk can lead to more balanced eating habits and help to eliminate episodes of explosive acid releases.

In conclusion, nutritional approaches to handling SARA include balancing energy uptake combined with fibre, keeping the rumen in optimal conditions and ensuring that bacterial populations are stabilised. A vital aspect of enhancing animal health, productivity and efficiency in intensive ruminant systems lies on these approaches.

3.2 Feeding Management

Feeding management is a very important feature in minimising the risk of sub-acute ruminal acidosis (SARA) in production systems. Together with dietary formulation, the way and time of feed delivery are key to the rumen function, animal behaviour, as well as overall health of an animal. Strong feeding techniques can manage to stabilise rumen pH as well as reduce fluctuations that lead to SARA.

One of the greatest strategies includes consistency in the delivery of feed. Any [illegible] of changes in feed composition, time, and quantity can throw off the balance of rumen microbes and cause increased production of acid (Srivastava *et al*. 2021). Animals thrive on routine; hence, uniform feeding at a particular time of the day is facilitating stable intake habits and microbial stability in the rumen.

There is vast recommendations on use of total mixed rations (TMR). TMR mixes forages and concentrates, so as to create a homogeneous mix that b[illegible]annot pick out the tasty, energy rich grains. This helps to control intake of carbohydrates and stabilises the process of fermentation. It also makes sure that all the nutrition is taken in balanced quantities during the day.

Feed bunk space and access are other important management aspects. Competition for a feed, especially for high-density systems, may cause irregular intake and binge feeding (Bai *et al*. 2024). By ensuring that every animal at the feed bunk has enough space, there are peaceful and measured eating behaviours, thus reducing the risk of SARA.

As well key here is routine management of feed bunk system. Bunks should regularly be checked in order to ensure that feed is available always without over-supply. Feeding refusals need to be monitored, and feed pushed up often making the animals eat little but often. This helps ensure slow but consistent rumen fermentation and it helps prevent subsequent pH abrupt drops.

Another factor that is disregarded, but highly important, is the availability of water. Adequate and clean water helps the body produce saliva that is loaded with naturally occurring buffers that assist the body system in neutralising ruminal acids (Galyean and Hales, 2023). Water has to be fresh and readily available all the time for animals.

Also, a gradual adaptation has to be undertaken to facilitate the consumption of high-concentration diets. Gradual introduction of grains over 2-3 weeks enables rumen microbes to adapt to a new substrate and avoids the acidosis threat.

In brief, good feeding management means uniformity, the access to bunk in proportion, the gradual changeover of diet and the employment of TMR systems. With a good sound nutrition, these approaches can set a good basis for lowering the incidence and severity of SARA in the intensive ruminant systems.

3.3 Case Studies or Trials

There are several case studies and controlled trials that have looked into the effectiveness of dietary interventions as a way of minimising cases of sub-acute ruminal acidosis (SARA) in intensive beef and dairy systems. These studies form evidence that can be applied in improving the health of the rumen as well as the performance of the animal concerning different feeding strategies and nutritional modulations.

One of the studies that showed the effects of a high-grain diet on ruminal pH in milk cows is the one done by Antanaitis *et al*. (2024 controlled trial in this study, the cows fed on a diet with more than 60% concentrate showed numerous reductions in rumen pH level below 5.5, thus establishing the relationship between fermentable carbohydrate intake and SARA. The research also indicated that the addition of more fibre to the diet ensured stability in the pH of the rumen, hence reducing acidosis.

Another research carried out by Pires *et al*. (2022) had to do with the use of dairy cows to direct-fed microbials (probiotics). Their findings were that certain cultures of yeast, and most especially Saccharomyces cerevisiae, enhanced the pattern of rumen fermentation and enhanced the pH levels. Cows supplemented with these probiotics had fewer SARA symptoms and better feed efficiency, which implies that the use of microbial additives is a viable strategy for the prevention of SARA.

A practical trial on an intensive beef feedlot by Ramos *et al*. (2021) determined the effect of feeding behaviour on SARA development. The research reported that animals that were fed at

This is unclear: Ramos et al., (2021) examined buffers in vitro and then undertook an in-vivo study with 3 non-lactating dairy cows. Bunk access was not studied.

inconvenient timings with restricted bunk access are likely to have pH fluctuations. Coming to more reliable schedules of the delivery of feed, the incidence of SARA was substantially decreased. It is a point to strengthen feeding management in addition to dietary formulation.

16

In another one, Moonsamy *et al*. (2024) tested different buffering agents in a dairy herd. Sodium bicarbonate and magnesium oxide were capable of alleviating the obvious reduction of rumen pH whenever high-concentrate diets were deployed. The trial established that strategic use of buffers together with the good design of the animals' diet can help reduce the accumulation of acids and take care of rumen health. Too vague

These case studies and trials support the evidence that there is a significant role played by dietary and management techniques, i.e., the use of fibre, inclusion, the use of feed additives, controlled feeding schedules, and the use of buffering agents, that can work in reducing SARA risk. An application of these findings in the real world farming system can translate to better animal welfare and productivity.

4. Conclusion

Sub-acute ruminal acidosis (SARA) is an argued problem that faces very intense production of dairy and beef enterprises. It has an impact on animal health, a loss of production, and huge economic losses among farmers. The condition is largely brought about by feeding strategies that emphasise high-concentrate and low-fibre diets with the view to increasing production, yet at the same time, the strategies undermine rumen health. Rumen pH falling chronically below the desirable levels then causes upsets in the microbial balances, digestion of fibre and more broadly the digestive system. Even though SARA does not, in most cases, bring immediate and visible disease as may be associated with other diseases, its long-term effect on milk production and fertility, breeds, and herd health is devastating.

Knowing how prevalent SARA is and its risk factors is important in providing effective prevention and controls for it. It has been significantly proven at the academic level that in herds that rely significantly on confined feeds, low intake of fibre and deprived feeding patterns, the incidence of SARA is higher. Conversely, the grazing sys 17 nd diets that contain more fibre are related to lower SARA rates. Such issues as sorting of feed, sudden alteration in diet and lack of bunk space increase these risks tremendously.

The pathophysiology of SARA points to the need to pay more attention to the composition of diet and the behaviour of feeding. The process of rapid breakdown of fermentable carbohydrates inside the rumen results consequently into excessive production of volatile fatty acids and lactic acid. This causes acidity to accumulate, reduces the levels of pH in the rumen, and inflames the lining of the rumen. If not checked, this process can also lead to systemic inflammation and liver abscesses, hence necessitating prompt administration.

The solutions that are practically and effectively applicable include dietary interventions and feeding management. Increasing the amount of dietary fibre, particularly physically effective fibre, minimises the rumen motility and further stimulates saliva secretion, which has its natural buffering effect on the rumen pH. Slow diet adjustment, feed use in the form of total mixed rations (TMR) and regulated intake of feeds minimise abrupt fluctuations in pH and ensure rumen stability in fermentation. The incorporation of probiotics, yeast cultures and buffering agents (e.g., sodium bicarbonate) in the feed has proven encouraging results in the trials, making the patterns of fermentation better and the rumen more stable.

Case studies and controlled trials only add up to how effective these strategies had been. Remedially, there should be a multi-faceted approach, adjustment in feeding behaviour or bringing in probiotics to adjust the gut flora, or supplementation with buffering agents. The evidence is supportive. These interventions are not only efficacious in regards to risk of SARA but also increase overall animal welfare and farm profitability.

Finally, the solution to resolving SARA is an integrated approach that will include diet formulation, uniform feeding practices, and individual-level monitoring. Despite the great impediments that face preventing SARA, occurrence that is not only possible, but a necessity to sustain and improve the productivity of ruminant systems. More research work and educating the farmers are crucial in minimising the SARA effects while improving the long-term issues with intensive dairy and beef production.

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24400000 - Written Report

GRADEMARK REPORT

FINAL GRADE

30/100

GENERAL COMMENTS

You have covered a number of the main factors influecing SARA, but at a very general and superficial basis. For level 7 you should focus more on the scientific principles. For example some background information on the formation of organic acids in the rumen and their absorption, along with associated buffer supply across the rumen wall and saliva would have been useful. You must also provide a relevant (and perferably recent) reference for each point made, and include data in the text, table or figure to illustrate, support and quantify your points. For example avoid using phrases such as "good quality forages" and define what you mean from a nutritional/functiional fibre perspective, using data from the literature, or define what "enough feed bunk space" means and provide data from the literature to support this. You do include a figure in the text that relates to world milk production, but do not refer to it in the text.

In a number of instances the references that you have used are not appropriate or do not relate to the point that you have made. For example, Bai et al., (2024) was not investigating bunk space, Gaylean and Hales (2023) focussed on diet and methane and do not mention water and rumen pH in the paper, Ramos et al., (2021) did not do a study on feedlot cattle, whilst Moonsamy et al., 2024 were focussing on human health, not rumen buffers and dairy cows. FAO (2022) is an economic report and does not report the incidence of SARA in dairy cows.

Some information on the diagnosis or identification of SARA from a practical perspective would also have been useful (e.g. Humer et al., 2018).

Please see the text for further comments.

Text Comment. Title?

QM **Quantify**

Quantify

QM **Define first time used**

Define first time used

QM **Vague**

QM **Reference**

Reference required here

QM **Good, but references required to support the point**

Good, but references needed to support point

PAGE 4

QM **Good, but data in a table or figure would be good**

Good, but some data in a table or figure to illustrate and support your points would be useful

QM **Quantify**

Quantify

Comment 1

FAO 2022 is a statistical report on milk production?

QM **Quantify**

Quantify

PAGE 5

Comment 2

Relevance at this point?

Comment 3

What about high sugar grasses?

QM **Data e.g. in a Table would be useful here**

Data e.g. in a Table would be useful here

Comment 4

Explain how?

QM **Reference**

Reference required here

QM

References
Use references correctly

Comment 5

LPS abosprtion: see review of Steele and others

QM

Data required to illustrate this point
Data required to illustrate this point

Comment 6

Explain how this is defined/measured?

QM

Unclear
Unclear: explain more fully

QM

Try and be more specific

Try and be more specific

Comment 7

Do cows not select: see Tayyab et al., 2018?

Comment 8

Rate of inclusion? Difference between buffers in strength? pKa of different buffers and acetic, propionic and lactic acids?

QM

Data required to illustrate this point
Data required to illustrate this point

QM

Quantify
Quantify

QM

Explain

QM

Unclear
Unclear: explain more fully

Comment 9

What do you mean by "Strong feeding techniques"?

Comment 10

Any kind? What about going from a diet formulated for high milk yielding cows (generally higher in starch and lower in fibre), to a low milk yielding diet (lower in starch and hgiher in fibre).

Comment 11

Is this the main purpose of TMR?

Comment 12

This reference is focussing on in-vitro fermentation and does not really support the point made.

QM

Too vague

Too vague

QM

Data required to illustrate this point

Data required to illustrate this point

PAGE 9

Comment 13

This paper is on feeding and methane, and does not mention water; why has it been used to support this point?

Comment 14

The objectives of this study were to detect subclinical acidosis using pH boluses, behaviour and milk composition, not to evaulate the effect of diet per se.

QM

Data e.g. in a Table would be useful here

Data e.g. in a Table would be useful here

Comment 15

But this paper is on dairy cows?

PAGE 10

Text Comment. This is unclear: Ramos et al., (2021) examined buffers in vitro and then undertook an in-vivo study with 3 non-lactating dairy cows. Bunk access was not studied.

Comment 16

This paper is reviewing yeasts for human health, and does not mention dairy cows at all. Why is it used here?

QM

Too vague

Too vague

Comment 17

Some studies undertaken in Ireland on grazing herds also show a relatively high incidence of SARA.

PAGE 11

Comment 18

Some information on the relative rates of breakdown of different starch/cereal sources, and how factors such as grinding and processing may affect this would be useful.

PAGE 12

PAGE 13

PAGE 14

PRESENTATION (10%) 45 / 100

Presentation should be in the style of an article for Recent Advances in Animal Nutrition

90-100 (100)	Exceptional presentation that conforms to guidelines and displays creativity, flair and imagination in both structure and style, using a variety of tools appropriate to the audience and discipline.
80-89 (85)	Excellent presentation that conforms to guidelines and provides a persuasive argument using a logical and coherent structure that displays a mature, articulate and imaginative style, using appropriate tools for the audience and discipline.
70-79 (75)	Very good presentation that conforms to guidelines and provides a reasoned argument using a logical and concise structure that displays a lucid and articulate style, using appropriate tools for the audience and discipline.
60-69 (65)	Good presentation that conforms to guidelines and provides a clear argument using a logical structure that displays a fluent style, using appropriate tools that are correctly applied for the audience and discipline.
50-59 (55)	Presentation conforms to the guidelines with few errors. Accuracy and clarity of expression could be improved by minor changes to structure and/or style. Appropriate tools that are correctly applied for the audience or discipline.
40-49 (45)	Presentation largely conform to guidelines, but has moderate errors. Accuracy and clarity of expression moderately compromised by poor structure and/or style. Tools largely appropriate but may be inconsistently applied for the audience or discipline.
30-39 (35)	Presentation doesn't conform to guidelines. Accuracy and clarity of expression severely compromised by poor structure and/or style. Tools inappropriate and/or incorrectly applied for the audience or discipline.
20-29 (25)	Presentation doesn't conform to guidelines. Illogical structure and/or immature and incoherent style. Tools inappropriate and/or incorrectly applied for the audience or discipline.
10-19 (15)	Limited grasp of communication skills. No structure and immature and incoherent style. Tools inappropriate and incorrectly applied for the audience or discipline.
0-9 (5)	No evidence of academic conventions or the communication skills required at Level 7

CONTENT (45%) 25 / 100

A relevant and topical subject in ruminant nutrition that is researched using relevant and reliable information sources

90-100 (100)	Work based on an excellent understanding and knowledge of ruminant nutrition obtained from specific published literature appropriate for Level 7 that is at the forefront of the discipline through wider reading. Publishable quality.
80-89 (85)	Work based on a full and complete understanding of appropriate knowledge of ruminant nutrition for Level 7. Evidence of specific knowledge from published literature obtained through wider reading. Publishable quality with minimal editing
70-79 (75)	Work based on a comprehensive understanding of appropriate knowledge of ruminant nutrition for Level 7. No omissions. Clear evidence of knowledge derived from outside the teaching programme. Publishable quality with moderate editing
60-69 (65)	Work based on a good understanding of appropriate knowledge of ruminant nutrition for Level 7. No significant omissions. Some evidence of knowledge derived from outside the teaching programme.

50-59 (55)	Work based on a good understanding of appropriate knowledge of ruminant nutrition for Level 7. No significant omissions. Limited to knowledge derived from the teaching programme.
40-49 (45)	Work based on a superficial understanding of appropriate knowledge of ruminant nutrition for Level 7. Limited to knowledge derived from the teaching programme
30-39 (35)	Work based on an incomplete understanding of knowledge of ruminant nutrition for Level 7.
20-29 (25)	Work based on a limited understanding of knowledge of ruminant nutrition, with significant errors or omissions
10-19 (15)	Work suggests limited awareness of knowledge of ruminant nutrition, but largely wrong, contradictory or unsupported.
0-9 (5)	No evidence of knowledge and understanding of ruminant nutrition.

ANALYSIS (25%) 45 / 100

Provides practical advice that can be used by those in the feed industry that is based on sound evidence

90-100 (100)	Exceptional arguments based on a highly critical and perceptive analysis and evaluation of complex knowledge and concepts relating to the topic at Level 7. Excellent practical application that will significantly benefit ruminant nutrition.
80-89 (85)	Excellent arguments based on a critical and perceptive analysis and evaluation of knowledge and concepts relating to the chosen topic at Level 7. Very good practical application that will be of considerable benefit ruminant nutrition.
70-79 (75)	Strong argument based on robust analysis and evaluation of knowledge, and concepts that relate chosen topic at level 7. Very good practical application that will be of major benefit ruminant nutrition.
60-69 (65)	Sound argument based on good analysis, evaluation of knowledge and concepts relating to the topic at Level 7. Good evidence of practical application will improve ruminant nutrition.
50-59 (55)	Work partly descriptive, but logical. An evaluation based on analysis and knowledge of basic concepts that relate to the chosen topic at Level 7. Some evidence of practical application that may assist in improving ruminant nutrition.
40-49 (45)	Work mainly descriptive, and a superficial argument based on limited analysis and evaluation of knowledge related to topic at Level 7. Limited evidence of a practical application that could improve ruminant nutrition.
30-39 (35)	Work descriptive, with little, irrelevant or illogical argument, based on limited understanding of knowledge of the topic at Level 7. Limited evidence of application that could improve ruminant nutrition.
20-29 (25)	Work descriptive with no argument and based on a basic understanding of knowledge of the chosen topic at Level 7. Limited evidence of application that is unlikely to improve ruminant nutrition.
10-19 (15)	Work suggests some basic understanding of knowledge of the topic at Level 7, but largely wrong, contradictory or unsupported. No evidence of application that could improve ruminant nutrition.
0-9 (5)	No evidence of knowledge and understanding of the chosen topic, or application that could improve ruminant nutrition.

REFERENCING (20%) 15 / 100

90-100 (100)	Exceptional use of a variety of reliable, appropriate sources for Level 7, including peer reviewed journals, selected independently. Limitations of sources assessed. References complete and comply with the Guide to Referencing. No errors.
80-89 (85)	Excellent use of a variety of reliable, appropriate sources for Level 7, including peer reviewed journals, most selected independently. Limitations of sources partly assessed. References complete and comply with the Guide to Referencing. No errors.
70-79 (75)	Very good use of reliable, appropriate sources for Level 7, including peer reviewed journals, many selected independently. References are complete and comply with the Guide to Referencing with no errors.
60-69 (65)	Very good use of reliable, appropriate sources for Level 7, with some selected independently. References are complete and mainly comply with the Guide to Referencing, with minor omissions or errors.
50-59 (55)	Good use of reliable, appropriate sources for level 7, with some selected independently. References are complete and largely comply with the Guide to Referencing with minor omissions or recurring presentational errors.
40-49 (45)	Some use of relevant sources for Level 7, but not sourced independently. References mostly complete and mainly comply with the Guide to Referencing, but significant omissions or recurring presentational errors.
30-39 (35)	Little use of relevant sources for Level 7, but indiscriminately selected or largely unreliable or irrelevant; too much reliance on non-peer reviewed sources. Key reference information is largely present and understandable, but has significant presentation errors.
20-29 (25)	Minimal evidence of reading required for Level 7. Sources used are largely inappropriate or irrelevant to the task. References are mainly incomplete and confused.
10-19 (15)	Very limited evidence of wider reading at level 7. No meaningful attempt at referencing.
0-9 (5)	No evidence of reading. No attempt at referencing.