

## Review

# A Proposed Framework for Nutritional Assessment in Compromised Ruminants

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## Simple Summary

This paper proposes a new framework for assessing the nutrition of ruminants (like cows and sheep) that are not well due to illness or other issues. Currently, there are no widely accepted guidelines for evaluating the nutritional needs of these animals, which can lead to poor health outcomes. The authors propose a set of standardized procedures that combine established methods from small animal and horse care with specific considerations for ruminants. The guidelines include various assessments such as checking the animal's body condition, feces quality, and rumen function, along with blood tests. The goal is to help veterinarians identify nutritional problems early and provide better care to improve the animals' health and productivity. The paper emphasizes the importance of understanding each animal's unique needs and environment. It also highlights the need for more research to refine these guidelines and ensure they work across different farming systems. Overall, this framework aims to enhance the welfare of compromised ruminants through effective nutritional assessment and intervention.



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## Abstract

Despite the critical importance of nutritional assessment in veterinary medicine, internationally recognized guidelines for compromised ruminants remain absent. This paper addresses this significant gap by presenting comprehensive nutritional assessment protocols adapted from small animal and equine guidelines, combined with clinical experience and ruminant-specific considerations. Therefore, the objective of this article is to establish standardized nutritional assessment guidelines for compromised ruminants that facilitate early detection of risk factors and nutritional imbalances affecting animal welfare and productivity, while guiding appropriate clinical nutritional interventions. The guidelines integrate systematic screening and extended evaluation protocols encompassing patient signalment, comprehensive health interviews, environmental examination, and nutrition-focused clinical assessments. The framework incorporates validated scoring systems including body condition scoring, fecal consistency and digestibility scores, rumen fill assessment, and muscle scoring. Laboratory evaluations including blood biochemistry, hematology, milk quality records, and metabolite profiling support clinical decision-making. The proposed assessment framework addresses animal-specific factors, diet-related considerations, feeding management practices, and environmental influences on nutritional status. Critical evaluation points include alimentary system function and integrity, forestomach assessment, and detection of malabsorption syndromes. The guidelines emphasize that many

nutritional abnormalities manifest non-specifically, and detection limitations exist, particularly in peracute presentations. In conclusion, successful clinical nutritional interventions require comprehensive assessment protocols that prioritize rumen health maintenance and oral diet delivery whenever possible. The guidelines we suggest will provide veterinary and nutritional practitioners with systematic tools for evaluating compromised ruminants, establishing appropriate interventions, and monitoring outcomes using SMART goals. Further research is warranted to refine specific dietary requirements for compromised ruminants and validate intervention protocols across diverse production systems.

**Keywords:** ruminant livestock production; illness; injury; metabolism; metabolic disorders; recovery

## 1. Introduction

Nutritional assessment represents a fundamental component of veterinary clinical practice, serving as a critical tool for identifying risk factors, detecting nutritional imbalances, and guiding therapeutic interventions that significantly impact animal health, welfare, and productivity. While comprehensive nutritional assessment guidelines have been well-established for companion animals through organizations such as the World Small Animal Veterinary Association (WSAVA) [1] and increasingly refined for equine practice [2–4], a conspicuous gap exists in internationally recognized protocols specifically designed for compromised individuals of ruminant species. This deficiency is particularly problematic given the unique physiological characteristics of ruminants, their diverse production systems, and the complex interplay between nutrition, rumen microbiota, and overall health status.

Ruminants occupy a distinctive position in veterinary medicine due to their specialized digestive physiology, characterized by the symbiotic relationship between the host animal and ruminal microorganisms [5–7]. This intricate system enables the conversion of fibrous plant materials into valuable nutrients through microbial fermentation, but simultaneously creates vulnerabilities when nutritional or health challenges arise. The compromised ruminant presents unique diagnostic and therapeutic challenges, as nutritional interventions must consider not only the nutritional requirements of the animal itself but also the maintenance and restoration of optimal rumen function. Furthermore, the economic considerations inherent in ruminant production systems, ranging from extensive pastoral management to intensive dairy and feedlot operations, necessitate practical, cost-effective assessment protocols that can be applied at both individual and population levels.

The absence of standardized nutritional assessment guidelines for compromised ruminants has resulted in inconsistent approaches to clinical nutrition, potentially compromising patient outcomes and limiting the effectiveness of therapeutic interventions. Many nutritional abnormalities in compromised ruminants manifest with non-specific clinical signs that overlap with other disease processes. This makes systematic assessment protocols essential for accurate diagnosis and appropriate intervention. Additionally, the time-dependent nature of certain nutritional changes means that conventional scoring systems may fail to detect peracute or acute nutritional imbalances. This highlights the need for comprehensive, multi-faceted assessment approaches that integrate clinical examination, environmental evaluation, and laboratory diagnostics.

This paper addresses the critical need for standardized nutritional assessment protocols by presenting comprehensive guidelines specifically developed for compromised

ruminants. These recommendations synthesize existing knowledge from companion animal [1] and equine nutritional [2–4] assessment frameworks, published literature on ruminant clinical nutrition [8–21] and examination techniques [22–26], and extensive clinical experience. The guidelines encompass systematic screening procedures applicable to all patients, extended evaluation protocols for complex cases, and practical tools including validated scoring systems for body condition, fecal quality, rumen function, and muscle mass. By providing veterinary and nutritionist practitioners with structured, evidence-based assessment protocols, these guidelines aim to enhance the detection of nutritional risk factors, facilitate timely and appropriate clinical nutritional interventions, and ultimately improve health outcomes for compromised ruminants across diverse production systems and management contexts.

## 2. Nutritional Assessment Guidelines for Ruminants

With the lack of internationally recommended nutritional assessment guidelines for compromised ruminants, we will present our recommendations for this important area. These guidelines are based on guidelines for dogs and cats [1], publications for horses [2–4,11], and the authors' experiences. Some information comes from clinical books on ruminants or large animals [11,27,28] and, finally, clinical examination of ruminants [24–26]. The aim of the guidelines is to detect risk factors and nutritional imbalances resulting in changes in ruminant comfort and/or wellbeing. As this paper discusses mainly clinical nutrition of compromised ruminants, guidelines will specifically cover aspects important for clinical nutritional interventions.

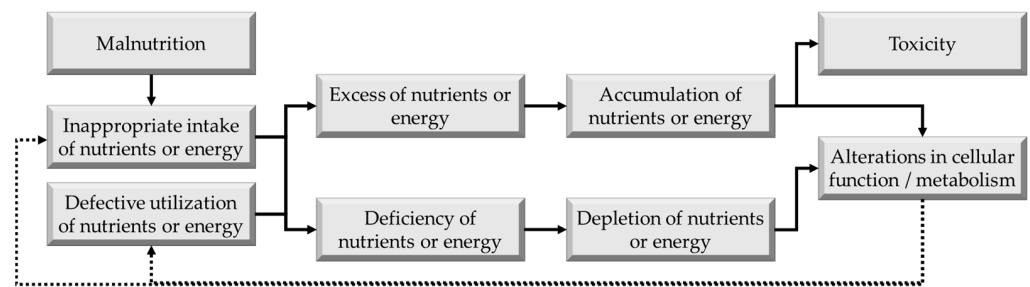
We would like to mention that a large portion of the elements of nutritional assessment in ruminants are not specific enough to provide a diagnosis but will contribute to the overall assessment of the needs of the patient. For example, many of the scores used in the nutritional assessment can detect only those nutritional abnormalities that result in measurable changes in the scoring element. Detection of nutrient imbalances is not always possible using scoring systems, particularly for peracute and occasionally acute changes (e.g., body condition scoring). This also applies to the response to the nutritional intervention. Some scores are slow to improve. Unfortunately, even some biochemical parameters are slow to improve, particularly when intermediary compounds have to be first created. The practitioner should be aware and consider these test limitations.

The World Small Animal Veterinary Association (WSAVA) [1] recommends nutritional assessment to be split into the following:

- Animal-specific factors (signalment), discussed in this paper under a separate heading;
- Diet-specific factors.

Under the headings of Health Interview and Examination of the Environment, we will discuss the following:

- Diet-specific factors (appropriateness and safety of the diet);
- Risk of diet-related morbidity (Figure 1);
- Feeding management and environmental factors;
- Risk of environment-related morbidity (e.g., access to the diet, competitive eating);
- Risk of feeding management morbidity (e.g., over- or underfeeding).

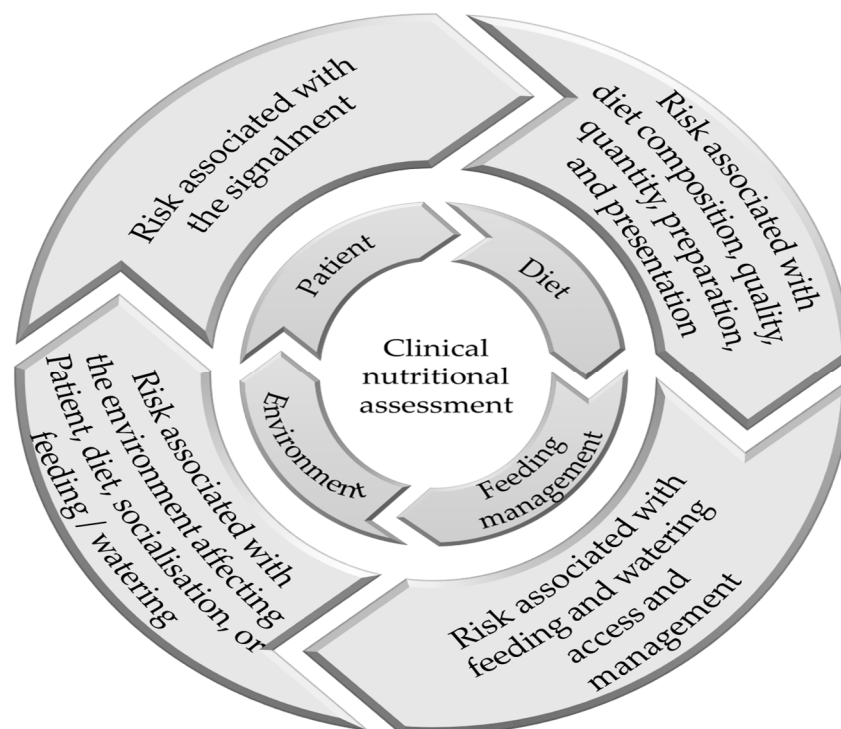


**Figure 1.** Pathways of diet-related morbidities. Malnutrition may lead to inadequate supply of nutrients or energy to the patient, either in excess or insufficient amounts, which, in turn, may result in alterations of metabolism and function. The excess nutrient supply may lead to alterations in cellular function and metabolism and, when in quantities beyond detoxifying capacity, may result in toxicoses. Insufficient nutrient supply may also lead to alterations in cellular function and metabolism. Alterations may further exacerbate the effect of morbidity on nutrient intake but also on utilization. Please note that the alterations in function and metabolism are present in any morbidity, not only those that are diet-related.

WSAVA [1] also recommends splitting nutritional assessment into the following:

- Screening, every patient;
- Extended evaluation, when one or more of nutritional assessment elements during the screening process are found or suspected to have contributed to the morbidity.

As illustrated in Figure 2, the decision on the need and approach to the clinical nutritional intervention should consider the following information.



**Figure 2.** Important considerations when making a decision on the need and approach to the clinical nutritional intervention in compromised ruminants. Risks may be related to the diet (e.g., its composition, quality, quantity, preparation, and presentation), feeding management (e.g., access to the diet, including water), environment (e.g., effects on the patient related to feed intake), and patient (e.g., its age, genetics, stage of production).

### 2.1. Patient Signalment

Some morbidities are related to specific signalment of the patient [23–25,29]. Please note that a ‘patient’ in ruminant clinical settings can be a population (e.g., flock, herd, or mob). The specific signalment may include the following:

- Age;
- Breed;
- Economic value;
- Identification;
- Production level;
- Production class;
- Sex;
- Species (e.g., cattle require less neutral detergent fiber (NDF) compared to sheep, and particularly goats) [30];
- Weight.

### 2.2. Health Interview

Detailed health interviews are essential for detecting many of the risk factors and the creation of an idea of the underlying etiology of the problem/s requiring clinical nutritional intervention. Unfortunately, in many ruminant populations, excluding dairy systems and stud breeders, clients are rarely informed enough of the individual animal and, indeed, may or may not be sufficiently informed of population-level problem/s. This is partly due to the extensive management of many ruminants, associated with irregular and brief observations, or in intensive systems (e.g., dairy and feedlots), where diets are prepared at the population level. Finally, the client may not be the person who is responsible for the diet. The availability of precision technologies could provide opportunities for much more precise data related to an individual animal.

#### 2.2.1. General Health Interview Enquiries Should Include the Following:

- Actions taken (if any) in reaction to the morbidity and the response seen [24,31].
- Any concurrent morbidities of concern [24,31]:
  - a. Has there been any similar previous experience such as the time frame and the threshold for the incidence rate within the same group [24,31,32]?
  - b. What is the chronology of the problem [24,26,31,33]?
  - c. Development of and timing of signs.
- The rate [24,25,31]:
  - a. Proportion of population affected.
  - b. Note: May need to consider that this is the first case, and many others may occur or remain subclinical.

#### 2.2.2. Diet-Related Enquiries Are as Follows:

- Determine access to any supplements (e.g., licks, paddock dusting) [24,25,32,33]:
  - a. Is there a likelihood that appetite changes are due to increased intake of supplements at the detriment of the primary feedstuffs (e.g., pasture) [34]?
- Confirm access and availability of high-quality, fresh drinking water [24,25,31]:
  - a. This is an essential element of any nutrition assessment [21].
- Who prepares and delivers the diet, and have there been any changes?
- Details of the diet composition:
  - a. Any known admixtures (e.g., dust, mold) [24]?

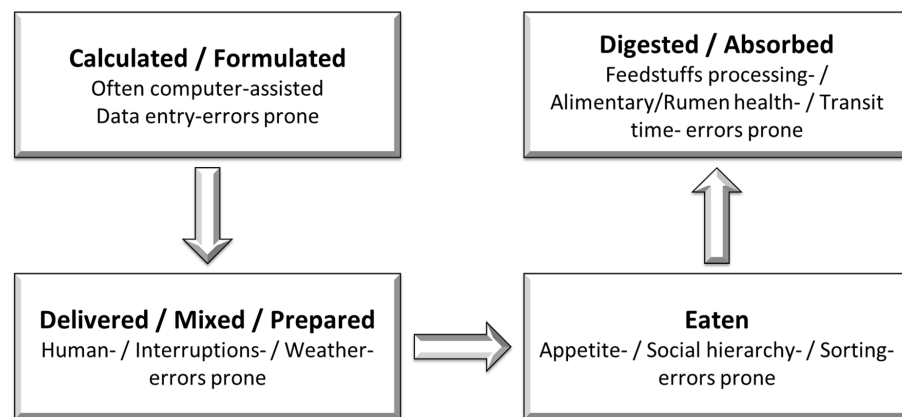
- b. Any additives that may affect the intake, health and productivity, and/or laboratory findings (e.g., essential oils, tannins, and yeasts) [35–37]?
  - c. Is it appropriate for the age, body condition, production expectations, and reproductive status [24,31]?
  - d. Compare the current and any recent diets [1,4,11,24,31,38].
  - e. Important to enquire as to subjectiveness in the diet assessment (e.g., weight or estimate of each diet component).
- Current and recent feeding practices [4]:
  - a. Feeding type (e.g., bunk-fed, fed on ground, feeding rack, pasture-grazed, range-grazed):
    - i. Any known problems (e.g., overcrowding, social interactions)?
- Current and recent grouping strategies (e.g., by age, BCS, production level, stage of reproduction) [29]:
  - a. Is it possible that social interaction has resulted in the morbidity, or will affect the outcome of the clinical nutritional intervention?
- Calculate estimated energy and protein intake relative to current and desired BCS [4].
- Are any adjustments required due to the primary morbidity or comorbidities [1,4,11]?

### 2.3. Examination of the Environment:

- Determine level of exposure to the elements [29] ± availability and suitability of shelter:
  - a. May affect access and quality of the diet/drinking water [31].
- Diet/Feed residual:
  - a. Too much (>7%) may be due to excessive offering, or inappetence to anorexia, at the population level;
  - b. Too small (<3%) is indicative of hungry animals.
- Feedstuffs accessibility, quality, and quantity [1,4,11,21,29]:
  - a. Forages, including pasture [1,4,21,29]:
    - i. Composition, maturity, and varieties;
    - ii. Grazing management (may need to be part of the health interview) [24];
    - iii. Topography [24];
    - iv. Evidence of presence of any admixtures, including potentially toxic plants [11,25,31];
    - v. Note: Climate, fertilization, maturity, soil type, and time of the year significantly affect energy, fiber, mineral, protein, and vitamin content of the plants and preserved forages.
  - b. Concentrates' relation to feed [4,11,21]:
    - i. Are concentrates fed?
    - ii. Maximum quantity may need to be considered, ensuring rumen health is not adversely affected.
  - c. Are complete feeds provided [11]?
  - d. Assess to supplements, including suitability and need for the patient [4,21]:
    - i. The need for provision of supplements should be ensured.
  - e. Partial/total mixed ration (partial mixed ration (PMR)/total mixed ration (TMR); when applicable).
  - f. The four diets (some discussion only applicable for the TMR systems; Figure 3) [39]:

- i. Calculated/formulated diet:
    1. Look for mistakes in calculations;
    2. Examine possible wrong data about the composition of feedstuffs (e.g., assumptions of feedstuff composition, improper sampling technique, new batch delivered, or relying on published tables).
  - ii. Mixed/delivered diet to ruminants to eat:
    1. Is there an accurate weighing of feedstuffs?
    2. Is there a delayed delivery?
    3. Is there a possibility of some feedstuffs being lost after weighing (e.g., strong winds)?
    4. Is there too long/short mixing (allowing for sorting or provision of insufficient physically effective NDF (peNDF))?
  - iii. Eaten diet:
    1. Are there sufficient spaces for all animals, including the submissive, to eat simultaneously (e.g., insufficient space at the feed bunk or a too narrow strip for grazing)?
    2. Environmental conditions may affect DM (e.g., freezing, hot weather, rain).
    3. Is sorting of the diet allowed?
    4. Is there a coordination of the allowed access (at pasture) or delivery (at feed bunk) of the diet with the female's return from the parlor (when applicable)?
    5. Is there a lack of appetite in some animals?
  - iv. Digested/absorbed:
    1. Is low-quality roughage fed?
    2. Has there been improper processing of grain?
    3. Consider altered function/integrity of the alimentary system.
- Housing/shelter availability, hygiene, lighting, usage (e.g., frequency), and ventilation [24,29]:
    - a. May affect diet access and quality;
    - b. May affect water access.
  - Number, timing, and size of meals [4,21,29].
  - Nutrient profile of feedstuffs and the ready (as fed) diet [4,29,40]:
    - a. Nutrient analysis:
      - i. More precise, but highly dependent on a representative sample.
    - b. Olfactory/tactile/visual assessment:
      - i. Color, leaf-to-stem ratio, odor/smell, uniformity;
      - ii. Evidence of spoilage;
      - iii. Presence of admixtures (any foreign material, e.g., dust, metal, plastic);
      - iv. Presence of peNDF [39]:
        1. May be estimated visually but also using the Penn State Forage Particle Separator.
  - Nutritional biosecurity [29]:
    - a. Accidental inclusion of carcasses (e.g., wildlife);
    - b. Protection from vermin/wildlife.
  - Nutritional hygiene [4,40,41].

- Nutrient storage assessment [29].
- Success of processing of feedstuffs (e.g., proportion of non-cracked grains).
- Total diet:
  - a. Balancing/proportions;
  - b. Preparation (e.g., over- or undermixing).
- Transition from one diet to another (if applicable) [24,31]:
  - a. May need to consider a change in supply of a single feedstuff (e.g., hay, silage) or, even for a single feedstuff, opening of a new bale/batch/stack [4,11].
- Water accessibility, quality, and quantity [4,11,21,29,40]:
  - a. Presence of algae in the water trough is indicative of the need for cleaning.



**Figure 3.** The four diets of ruminants. The calculation or formulation of diets are often assisted by software, and the biggest risk of error is related to incorrect data entry, including typing errors, as well as data quality. Mistakes related to the delivered/mixed/prepared diet are usually the most common culprit associated with the feed intake and diet quality, as they are related to human error (e.g., not weighing the components correctly, or mixing the diet excessively), as well as some environmental factors such as weather (e.g., heavy rain after the diet is mixed and before delivery). Mistakes related to the eaten diet may be associated with the patient's appetite, social interaction, and diet presentation, allowing sorting of feedstuffs. Finally, the digested or absorbed diet is affected after intake due to alterations in the alimentary tract, including the rumen, and diet composition and preparation that will influence the fermentation and digestive capacity as well as the transit time.

#### 2.4. Nutrition-Focused Clinical Examination of the Patient

Clinical examination, as a part of the nutritional assessment of the patient, consists of two parts, examination from a distance and up-close examination. Unfortunately, many of the changes related to nutritional assessment and diet-related morbidities are non-specific. The lack of specificity in changes occurring in the body of the patient is due to the involvement of various nutrients in multiple functions or organs (e.g., skeletal defects may occur due to lack of calcium, copper, manganese, phosphorus, or vitamins A and D, but also due to an excess in fluoride or zinc). The lack of specificity in signs may be further exacerbated when a morbidity has been of a prolonged character. However, this is not consistent, and with some chronic diet-related morbidities, signs may become more obvious (e.g., chronic copper deficiency and changes in the color of the haircoat in cattle). Additionally, many of the signs seen in malnutrition are also present in non-nutritional morbidities.

##### 2.4.1. Examination from a Distance

- Ingestive behavior [1,40]:

- a. Observe for appetite [11,29,40], the prehension, mastication, and swallowing:
  - i. For some ruminants, the only sign that they may have partial esophageal blockage may be the presence of appetite still (seems interested in the diet) but just turning away from the diet [4].
- Fecal appearance, output, and evidence of presence of admixtures:
  - a. Color, Odor, and Quantity.
  - b. Use fecal digestibility score (Tables 1 and 2) systems [40] for cattle and buffaloes:
    - i. Unfortunately, the authors of this paper are not aware of similar scoring systems for small ruminants.
  - c. Fecal consistency (assessed by the fecal score; Table 3) is particularly important when considering morbidity associated with the alimentary system in cattle and buffaloes. A similar scoring system has been developed for sheep [42].
  - d. May need to add information on fecal soiling score of the perineal area applicable to cattle (Table 4) [40]:
    - i. A similar scoring system does exist for small ruminants (the so-called ‘dag score’), mainly used as an indication of the existence of internal parasitism [43] (Table 5).
- Rumen fill score is informative regarding rumen function and integrity (Table 6) [40,44]:
  - a. Although presented for cattle, scores are similar for all ruminants.
- Rumination:
  - a. At the population level, anecdotally, >60% of cows idling should be ruminating.

**Table 1.** Scoring of the digestive function by squeezing the bovine feces with a gloved hand.

| Score | Description                                                                                                                                                     | Reasons and Interpretations                                                                                                                                                                                                                                                              |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Creamy homogenous emulsion<br>No visible undigested food particles<br>Shiny surface of fresh feces                                                              | Good passage of ingesta through the alimentary system<br>Good digestion<br>Good food quality<br>Good rumination<br>Ideal score for cattle                                                                                                                                                |
| 2     | Creamy homogenous emulsion<br>A few undigested food particles of small size<br>Shiny surface of fresh feces                                                     | Slightly impaired passage of ingesta through the alimentary system<br>Slightly impaired digestion<br>Less than ideal food quality<br>Slightly impaired rumination<br>Common in lactating and dry cows                                                                                    |
| 3     | Feces are not homogeneous.<br>Some undigested particles<br>On hand squeeze, some undigested fibers stick to the fingers<br>Dull to shiny surface of fresh feces | Higher than normal speed of passage of the ingesta through the alimentary system<br>Poor formation of rumen mat<br>Poor digestion<br>Problems with processing the grain (not broken)<br>Acceptable score for dry cows and heifers fed on a high roughage diet due to slower passage rate |
| 4     | Bigger undigested food particles<br>After squeezing, a ball of undigested food remains in the hand<br>Particles sometimes >2 cm<br>Dull surface of fresh feces  | Higher than normal speed of passage of the ingesta through the alimentary system<br>Poor formation of rumen mat<br>Poor digestion<br>Forages of poor quality<br>Poor rumination<br>Gastro-intestinal parasitism                                                                          |
| 5     | Bigger food particles<br>Undigested components of the feed ration are clearly recognizable<br>Very dull surface of fresh feces                                  | High speed of passage of the ingesta through the alimentary system<br>Poor formation of rumen mat<br>Poor digestion<br>Forages of very poor quality<br>Very poor rumination                                                                                                              |

**Table 2.** Scoring of the digestive function by sieving for 30 s with a gentle ‘massaging’ of the bovine feces.

| Score | Description                                                                                                                                                                                                                               | Reasons and Interpretations                                                                                                                                                                                    |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | After sieving, 0–25% of the original volume is left<br>Fiber left in the sieve of short length and fluffy (<0.5 cm)                                                                                                                       | Excellent fiber digestion<br>Ideal score                                                                                                                                                                       |
| 2     | After sieving, 26–35% of the original volume is left<br>Fiber left in the sieve mainly of short length (<0.5 to 1 cm)<br>Some larger, undigested fiber particles detectable                                                               | Slightly impaired digestion<br>Less than ideal food quality<br>Slightly impaired rumination<br>Common in lactating and dry cows                                                                                |
| 3     | After sieving, 36–50% of original volume is left<br>Some fiber left in the sieve >1 cm long                                                                                                                                               | Poor digestion<br>Problems with processing the grain (not broken)<br>Poor formation of rumen mat<br>Not acceptable for lactating cows<br>May be acceptable for dry cows and heifers due to slower passage time |
| 4     | After sieving, 51–75% of the original volume is left<br>Bigger undigested food particles<br>Fiber particles sometimes >2 cm long                                                                                                          | Poor digestion<br>Poor formation of rumen mat<br>Poor rumination<br>Forages of poor quality<br>Not acceptable for any class of dairy cattle<br>May indicate rumen acidosis                                     |
| 5     | Less than 10–15% reduction after sieving<br>Bigger food particles<br>Rough fiber particles, often >2 cm long<br>Undigested components of the feed ration are clearly recognizable<br>Casts of intestinal mucosa and fibrin may be present | Very poor digestion<br>No formation of rumen mat<br>Very poor rumination<br>Forages of very poor quality<br>Not acceptable for any class of dairy cattle<br>May indicate rumen acidosis or enteritis           |

**Table 3.** Description of the score system of quality of feces in cattle.

| Score | Description                                                                                                                                                                                                                                                    | Reasons and Interpretations                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Very liquid<br>Watery<br>Thin<br>Runs through fingers of a gloved hand<br>Diarrhea<br>Undesirable score                                                                                                                                                        | Various disorders of alimentary system<br>Various generalized disorders<br>Gastro-intestinal parasitism<br>Excess of an osmotic gradient in the intestine<br>Excessive readily fermentable carbohydrates<br>Lack of fiber<br>Some mineral excess or poisonings<br>Moldy feed<br>Acidosis (lighter color and low pH; usually presence of bubbles due to fermenting starch)<br>Hindgut fermentation<br>Very short passage time of ingesta |
| 2     | Runny, custard-like consistency<br>Does not form a distinct pile<br>Splatters moderately when it hits the ground<br>Pat measures less than 2.5 cm in height<br>More watery than optimal                                                                        | Cattle on lush pasture<br>Gastro-intestinal parasitism<br>Excess readily fermentable carbohydrate<br>Lack of functional fiber<br>Excessive intake of sand/soil                                                                                                                                                                                                                                                                          |
| 3     | Porridge-like appearance with several concentric rings, a small depression or dimple in the middle<br>Makes a plopping sound when it hits concrete floors<br>Spreads slightly on impact and settling<br>Feces pat measures up 4 to 5 cm<br>Sticks to the shoes | Cattle on mature pasture<br>Optimal level of total and functional fiber                                                                                                                                                                                                                                                                                                                                                                 |
| 4     | Thick porridge-like consistency<br>Feces pat measures over 5 cm<br>Original form very slightly distorted on impact and settling<br>Firmly sticks to the shoes when touched<br>Concentric rings evident                                                         | The level of total and functional fiber is high<br>Low salt<br>Low water<br>Low protein and/or starch<br>Adding extra grain and/or protein to the diet can decrease the score                                                                                                                                                                                                                                                           |
| 5     | Appears as firm fecal balls<br>Original form not distorted on impact and settling<br>Resembles horse feces<br>Undesirable score                                                                                                                                | Excess of fiber (e.g., straw-based diet)<br>Lack of rumen available starch<br>Lack of rumen available protein/urea<br>Dehydration (e.g., water deprivation)<br>Blockage of the alimentary system                                                                                                                                                                                                                                        |

**Table 4.** Scoring of the fecal soiling of the perineal area in cattle. The percentage (in the brackets) refers to the proportion of the perineal area that is stained. Perineal area in this table refers to the area around the anus, caudal hindlimb and rump, and tail.

| Score | Description                                                                |
|-------|----------------------------------------------------------------------------|
| 1     | No perineal fecal staining                                                 |
| 2     | Mild: Few flecks of perineal fecal staining (2–10%)                        |
| 3     | Moderate: Maximum up to 30% of the perineal area stained by feces (11–30%) |
| 4     | Severe: Large area of the perineal area stained with feces (31–60%)        |
| 5     | Very severe: Nearly the whole perineal area stained with feces (>60%)      |

**Table 5.** Scoring of the fecal soiling of the perineal area in small ruminants (dags or a ‘dag score’). Perineal area in this table refers to the area around the anus, caudal hindlimb and rump, and tail. Adapted from [43].

| Score | Description                                                                              |
|-------|------------------------------------------------------------------------------------------|
| 0     | No perineal fecal staining                                                               |
| 1     | Light perineal fecal staining only around the anus                                       |
| 2     | Mild: Perineal fecal staining around the anus and tail                                   |
| 3     | Moderate: Perineal fecal staining around the anus, tail, and top two thirds of the thigh |
| 4     | Severe: Perineal fecal staining around the anus, tail, and the hindlimbs to the hocks    |
| 5     | Very severe: Nearly the whole perineal area stained with feces                           |

**Table 6.** Description of the scoring system of rumen fill, with causes and interpretations of the findings.

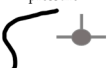
| Score | Description                                                                                                                                                                                                                                                                                             | Causes and Interpretation                                                                                                                                                                                        |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | A deep dip in the left flank<br>More than one hand-width deep<br>Rectangular appearance<br>The skin under the lumbar vertebrae curves inwards<br>The skin fold from the hook bone goes vertically downwards                                                                                             | Cattle have eaten little or nothing<br>Sudden illness<br>Insufficient food<br>Unpalatable food<br>Alarming situation                                                                                             |
| 2     | The skin under the lumbar vertebrae curves inwards for a hand-width behind the last rib<br>Triangular appearance (referred to as ‘danger triangle’)<br>The skin fold from the hook bone runs diagonally forward towards the last rib<br>The paralumbar fossa behind the last rib is one hand-width deep | Common in cattle in the first week after calving<br>In other cattle is an alarming situation<br>May be indicative of acidosis<br>Later in lactation sign of insufficient food intake or too-fast passage of food |
| 3     | The skin under the lumbar vertebrae goes vertically down for less than one hand-width and then curves outward<br>The skin fold from the hook bone is not visible<br>The paralumbar fossa behind the last rib is still just visible                                                                      | Correct score for lactating cows and beef cattle on pasture<br>Good food intake<br>Good timing of the passage of food                                                                                            |
| 4     | The skin under the lumbar vertebrae curves outwards<br>No paralumbar fossa is visible behind the last rib                                                                                                                                                                                               | Correct score for cows in late lactation<br>Correct score for beef cattle in feedlot<br>Correct score for early dry cows                                                                                         |
| 5     | The lumbar vertebrae are not visible as the rumen is very well filled<br>The skin over the whole abdomen is quite tight<br>No visible transition between the flank and ribs<br>No visible transition between the flank and transverse processes                                                         | Correct score for late dry cows<br>Correct score for heifers                                                                                                                                                     |

#### 2.4.2. Examination from Up-Close (The Physical Examination) Investigates the Following:

- Appetite (by offering the diet in a restraining facility, particularly if not assessed during examination from a distance):
  - a. Note that appetite may artificially change after the ruminant individual has been separated from its herd-mates.
- Assessment of the demeanor [22,29,40,45].
- Note the body condition score (Table 7)/lactation status/pregnancy status (as applicable) [4,11,22,29,46]:

- a. Body condition score is a subjective estimate of the body fat coverage in the patient;
- b. May affect the time of initiation of clinical nutrition intervention;
- c. Over-conditioned ruminants are prone to hepatic lipidosis;
- d. Underconditioned ruminants with non-functional rumens require intensive care;
- e. Note: As changes in BCS are slow, for some patients it may be better to use body weight [29], but this may be significantly affected by the fullness of the alimentary system.
- Critical information on the function/gross integrity of the alimentary system [3,23,46]:
  - a. Evidence of affected function/integrity.
  - b. Evidence of altered elimination (e.g., constipation, diarrhea).
  - c. Evidence of malabsorption/maldigestion syndrome.
  - d. Patency (and if blocked, include where).
  - e. Notes:
    - i. In a patient with maintained gross function/integrity of the alimentary system, an oral or enteral approach to clinical nutrition intervention is recommended;
  - f. In a patient with evidence of grossly affected function/integrity of the alimentary system, a parenteral approach to clinical nutrition intervention is recommended initially.

**Table 7.** Summary table for body condition scoring in cattle and buffaloes on a scale of 1 to 5. Drawings adapted from [47].

| Score  | Description                                                                                      | Short Ribs                                                                                                                  | Spinous Processes                                                                                         | Hook and Pin Bones                                                                                                             | Thurl                                                                                                                            | Tail Head                                                                                                                               |
|--------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Figure | Cross-section of hip bones and vertebrae                                                         | Cross-section of vertebrae                                                                                                  | Cross-section of vertebrae                                                                                | NA                                                                                                                             | Transversal section of hip to pin bone                                                                                           | Caudal view                                                                                                                             |
| 1      | Emaciated<br> | Sharp, prominent<br>                     | Prominent<br>          | Sharply defined<br>                         | Deep V-shape<br>                            | Very sunken<br>                                    |
| 2      | Thin<br>      | Sharp, less prominent<br>                | Less prominent<br>     | Prominent<br>                               | V-shaped<br>                                | Sunken<br>                                         |
| 3      | Average<br>   | Felt on light pressure<br>               | Rounded ridge<br>      | Rounded<br>                                 | U-shaped<br>                                | Not sunken, but no fat deposits<br>                |
| 4      | Heavy<br>     | Felt only on firm pressure<br>           | Nearly flattened<br>   | Smoothed over<br>                           | Flat with small amounts of fat deposits<br> | Not sunken, with small amounts of fat deposits<br> |
| 5      | Fat/obese<br> | Not palpable even with firm pressure<br> | Flattened, rounded<br> | Smoothed over with obvious fat deposits<br> | Curved out<br>                              | Round with obvious fat deposits<br>                |

- Critical information on the function of the reticulorumen:
  - a. To evaluate the forestomach function, careful auscultation and assessment of the rumen fluid are essential [22,23,41,48–50]:

- i. Note: In a patient with grossly maintained integrity but affected function, transfaunation and fluid therapy (oral or enteral) may be sufficient to 'restart the rumen'.
- b. Affected function/integrity (e.g., evidence of indigestion/putrefaction):
  - i. Nature of the rumen contents [23,26,51]:
    1. Palpation (external and rectal), rumen fluid assessment,  $\pm$  succussion (e.g., rumen splashing with a severe rumen acidosis);

Including evidence of usual rumen layer stratification (dorsal-to-ventral: gas, mat, rumen liquid/slurry).

## 2. Rumenocentesis [52,53];

Falls out of favor as newer methodologies take over (e.g., precision technologies including automated rumen pH measurements and counting rumination movements).

- ii. Nature of feces [22,26,40,51]:
  1. See Examination from a distance.
- iii. Rate and strength of rumen contractions [26,51]:
  1. Auscultation,  $\pm$  palpation, and, least likely, inspection.
- iv. Rumen volume [26,40,51]:
  1. Inspection (abdominal silhouette, rumen fill score) and  $\pm$  palpation.
- Critical information on the patency of various portions of the alimentary system:
  - a. When patency is interrupted, dependent on the location of blockage, an enteral (blockage cranial to forestomachs) or parenteral (blockage caudal to forestomachs) approach to clinical nutrition intervention is recommended.
- Evidence of comorbidity.
- Likelihood of malabsorption/maldigestion syndrome [3].
- To increase absorption of nutrients, gradual diet composition approach to clinical nutrition intervention is recommended.
- Likelihood of nutrient being delivered to the intestinal mucosa [3]:
  - a. To increase gut integrity and maintain the basic and barrier functions, oral/enteral approach to clinical nutrition intervention is recommended.
- Milk production (in lactating females) [39].
- Muscle score [29]:
  - a. No universally accepted scoring system exists. However, the authors recommend the use of the following scoring system (Table 8). The authors have adjusted the system developed in Australia by the New South Wales Department of Primary Industries.
- Skin  $\pm$  haircoat assessment [1,29,40]:
  - a. Dull, rough, starey hair coat is indicative of altered function of the alimentary system/chronic morbidity/malnutrition [31,40].

**Table 8.** Muscle scoring system for cattle that is independent of the body condition score.

| Score | Definition          | Description                                                                                                                                                                                                                                                                           |
|-------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Light muscling      | Dairy type—very angular<br>Sharp ‘tent topped’ over the top line<br>Virtually no thickness through the stifle<br>Stands with feet together, concave thigh                                                                                                                             |
| 2     | Moderate muscling   | Narrow stance<br>Flat to convex down the thigh<br>Thin through the stifle<br>Sharp, angular over the top line (except when very fat)                                                                                                                                                  |
| 3     | Medium muscling     | Flat down thigh when viewed from behind<br>Flat, tending to be angular over the top line                                                                                                                                                                                              |
| 4     | Heavy muscling      | Thick stifle<br>Rounded thigh viewed from behind<br>Some convexity in the hindquarter from the side view<br>Flat and wide over the top line—the muscle is at the same height as the backbone                                                                                          |
| 5     | Very heavy muscling | Extremely thick through the stifle area<br>Muscle seams or grooves between muscles are evident<br>‘Apple bummed’—when viewed from the side, hindquarters bulge like an apple<br>Butterfly top line—the loin muscles along the top of the animal are actually higher than the backbone |

### 2.5. Laboratory Information

The decision related to the clinical nutrition intervention and choice of the most appropriate diet, mode of administration, and monitoring of the outcome, may require laboratory support [4,29]. Possible laboratory support includes the following:

- Fecal indicators (various compounds in feces, minerals, starch) [23,24].
- Blood biochemistry:
  - a. Acid-base balance;
  - b. Acute phase proteins;
  - c. Glucose levels;
  - d. Insulin reactivity;
  - e. Level of ROS produced:
    - i. In high production of ROS, to minimize their negative effect, pharmacutrients in the clinical nutrition intervention are recommended;
  - f. Lipids content;
  - g. Liver enzymes;
  - h. Metabolite profiling, which is well-established for dairy cows (many others from these are mentioned in the former bullet points, e.g., ketones, NEFAs—non-esterified fatty acids);
  - i. Mineral status (e.g., magnesium, phosphorus, and potassium for signs of refeeding syndrome).
- Hematology:
  - a. Differential white cell counts;
  - b. PCV (packed cell volume);
  - c. Total protein  $\pm$  various protein fractions.
- Milk quality records [39]:
  - a. Milk:
    - i. Fat/protein  $\pm$  lactose;
    - ii. Milk urea nitrogen.
  - b. Various metabolites (e.g., ketones, blood/serum urea nitrogen).
- Urine:

- a. Glucose levels;
- b. Protein levels.

Indeed, an important part of the nutritional assessment is diet evaluation, not only what is covered in the section on examination of the environment, but also, as required, laboratory testing.

### 3. Management Related to the Clinical Nutritional Intervention in Compromised Ruminants

The management process is as follows:

- Establish:
  - a. Economic justification [11,33];
  - b. Prognosis (e.g., recumbent cattle, due to protein/energy malnutrition, very difficult to reverse) [33].
- Primary concern should be addressing the primary morbidity  $\pm$  comorbidities:
  - a. Primary and supportive therapy (as required).
- Secondary concern should be given to the clinical nutritional intervention [3]:
  - a. The need of clinical nutritional intervention;
  - b. Nutritional requirements;
  - c. Mode of delivery of the clinical nutritional intervention:
    - i. How much can be provided and by which mode;
  - d. Diet composition:
    - i. Ensuring requirements are met for energy, fiber, minerals, protein, vitamins, and water:
      - 1. In some compromised ruminants, essential amino acids, such as lysine and methionine, should be considered, which, despite meeting total protein requirements, might induce negative effects on production and even the health status of a ruminant;
  - e. Note: In some morbidities, clinical nutritional intervention addresses the primary morbidity (e.g., rumen acidosis/indigestion).
- Tertiary concern should be given to appropriate nursing care.

### 4. Monitoring of the Clinical Nutritional Intervention for Compromised Ruminants

The monitoring process is as follows:

- Outcomes of the treatment/clinical nutritional intervention should be regularly monitored [1,4,11]:
  - a. Frequency and type of monitoring will depend on the patient characteristics (e.g., age), primary morbidity (e.g., expected prognosis), and the mode of clinical nutritional intervention (e.g., more frequent and more laboratory-based with parenteral feeding).
- Triggers should be established that will allow for timely adjustments to be made (as required):
  - a. Note: Introduction of clinical nutritional diet orally or enterally will need to be gradual.

Goals for the monitoring and the outcome of the intervention should be created using the SMART (specific, measurable, achievable, relevant, and time-bound) goal recommendations.

## 5. Conclusions

Clinical nutritional interventions in compromised ruminants must be grounded in comprehensive understanding of normal and abnormal physiology, with particular emphasis on rumen microbiota function and health maintenance. The proposed nutritional assessment guidelines provide veterinary and nutritionist practitioners with systematic tools for evaluating patient signalment, diet quality, environmental factors, and physiological status through validated scoring systems and laboratory diagnostics. Successful intervention prioritizes oral diet delivery, followed by ruminal feeding, with enteral and parenteral routes reserved as last options. Treatment efficacy should be monitored through improvements in appetite, behavior, and overall health status using SMART goal frameworks. However, further research remains essential to elucidate specific nutritional requirements and optimize clinical protocols for diverse categories of compromised ruminants across various production systems.

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## Glossary

Glossary of terms used in the paper and their meaning.

|                        |                                                                                                                                                                                                                                         |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Acidosis               | Condition characterized by excess acids in the body fluids.                                                                                                                                                                             |
| Anorexia               | A complete absence of appetite (Synonym: aphagia).                                                                                                                                                                                      |
| Appetite               | The desire to eat the offered diet.                                                                                                                                                                                                     |
| Bloat                  | The distention of a portion of the forestomachs (i.e., rumen) resulting from the accumulation of free gas or froth (Synonym: tympany).                                                                                                  |
| Clinical nutrition     | The study and overall analysis of the interaction of nutrition and overall growth, health, and wellbeing of the (ruminant) body/individual.                                                                                             |
| Colostrum              | The first secretion from the mammary gland after calving (giving birth), rich in antibodies, growth stimulating factors, other immune factors, and nutrients.                                                                           |
| Dysphagia              | Difficulty swallowing; in broader terms, it means difficulty in taking feed and/or liquids through the mouth, pharynx, and/or esophagus, therefore preventing entry into the stomach (dys-difficult + phagein-eat = difficulty eating). |
| Dysbiosis              | An imbalance between the types of organism in an animal's natural microbiota, especially that of the alimentary system, thought to contribute to a range of health effects.                                                             |
| Effective fiber (eNDF) | The fraction of fiber (NDF) that stimulates chewing activity, primarily related to the particle size (Synonym: physically effective fiber, peNDF).                                                                                      |
| Forage                 | The most important feed resource for ruminants globally. Representatives are grasses, forage crops, and legumes. May be fed as pastures or preserved forages (e.g., baleage, hay, or silage)                                            |
| Hepatic lipidosis      | A major metabolic disorder, most frequently in very late pregnancy or early lactation in female livestock, resulting from overproduction of fatty acids and accumulation of lipids within the liver (Synonym: fatty liver disease).     |
| Hyperalimentation      | Administration of excess nutrients by enteral/parenteral route, particularly in patients unable to ingest enough diet orally.                                                                                                           |
| Immunocompetence       | The immune system of the individual works properly and its body can mount an appropriate immune response as required.                                                                                                                   |
| Immunostimulant        | A substance of natural or pharmaceutical origin that stimulates the body immune system, usually in a non-specific manner by activating or enhancing any of its components.                                                              |

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inappetence                      | A decreased appetite (Synonym: hypophagia).                                                                                                                                                                                                                                                                                                                                                                                    |
| Indigestion                      | A disruption of the ‘normal’ function of the reticulorumen (main portion of the forestomachs in ruminants) that may affect forestomach motility and/or microbial fermentation.                                                                                                                                                                                                                                                 |
| Morbidity                        | Any illness in an individual. Proportion of the population affected by a particular condition/disorder/problem. State of being affected.                                                                                                                                                                                                                                                                                       |
| Neonate                          | Newborn individual. In ruminants, typically first 3–4 weeks of life before any forestomach activity is present (pre-ruminant stage).                                                                                                                                                                                                                                                                                           |
| Obtundancy                       | A dulled or reduced level of alertness or consciousness of an individual (common misnomer in veterinary medicine is depression, which is a symptom, not a sign).                                                                                                                                                                                                                                                               |
| Parenteral                       | Given/occurring/situated outside the intestines.                                                                                                                                                                                                                                                                                                                                                                               |
| Patency                          | The quality and state of a tubular organ/system being open and the passage being uninterrupted.                                                                                                                                                                                                                                                                                                                                |
| Prebiotic                        | A non-digestible food ingredient that promotes the growth of beneficial gut microbiota.                                                                                                                                                                                                                                                                                                                                        |
| Probiotic                        | Directly fed microbe which stimulates the growth of a particular enteric microbiota, especially those with beneficial properties).                                                                                                                                                                                                                                                                                             |
| Refeeding syndrome               | A potentially fatal shift in electrolytes and fluids that may occur in severe malnourished patients receiving artificial refeeding, whether oral, enteral, or parenteral.                                                                                                                                                                                                                                                      |
| Reperfusion                      | The restoration of the blood flow to an organ or tissue after being significantly to completely blocked.                                                                                                                                                                                                                                                                                                                       |
| Resting energy requirement (RER) | The energy requirement of a livestock individual at rest in a thermoneutral environment.                                                                                                                                                                                                                                                                                                                                       |
| Rumen                            | The first forestomach and the largest in a mature ruminant. It is a muscular sac that contains a large number of microbes involved in fermentation of the ingested diet. Fermented ingesta is passed into the reticulum. The fermentation of diet components unable to be digested by mammalian enzymes makes ruminants valuable in the eco system.                                                                            |
| Rumen acidosis                   | A metabolic disease that affects all ruminants including both feedlot and dairy cattle. Rumen acidosis is usually associated with the ingestion of large amounts of highly fermentable, carbohydrate-rich feeds (e.g., cereal grains), which result in the excessive production and accumulation of acids in the rumen (pH of the rumen contents changes from mildly alkaline [around 7] to acidic [ $<5.6$ down to $<4.5$ ]). |
| Rumenostomy                      | Surgical creation of temporary or permanent (insertion of rumen cannula) opening between the rumen and environment, including incising the skin, subcutaneous tissues, abdominal muscles, peritoneum, and the rumen wall.                                                                                                                                                                                                      |
| Sialorrhoea                      | Excessive flow of saliva (‘drooling’).                                                                                                                                                                                                                                                                                                                                                                                         |
| Splanchnic                       | Related to organ/s within the abdominal cavity.                                                                                                                                                                                                                                                                                                                                                                                |
| Stress                           | A non-specific response of the body to any demand, usually from the environment where the livestock individual resides, management, or nutrition.                                                                                                                                                                                                                                                                              |
| Transfaunation                   | Procedure consisting of removal of rumen fluid with healthy microbiota and good quality from one ruminant, and transfer of the removed fluid into the rumen of another ruminant individual.                                                                                                                                                                                                                                    |

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