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RESEARCH SUMMARY

Improving feed rations for livestock export

The complexities of determining quality and quantity

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THE LIVESTOCK EXPORT PROGRAM

The livestock export supply chain directly impacts both producers and licensed exporters. LiveCorp and Meat & Livestock Australia, as the relevant research and development corporations, run a joint program known as the Livestock Export Program (LEP) to ensure that all stakeholders benefit from industry research.

The LEP RD&E Program focuses on strategic investment to:

- Improve animal health and welfare outcomes across the supply chain
- Improve supply chain efficiency and regulatory performance
- Enhance market access conditions for existing and new markets

LiveCorp and MLA acknowledge the contribution from the Commonwealth of Australia to research and development undertaken in the LEP RD&E Program.

EXECUTIVE SUMMARY

Ensuring sufficient feed (fodder) is available for livestock exported by sea from Australia is a critical component of animal welfare and performance. The Livestock Export Program (LEP) has invested in research to determine the parameters for feed quantity, quality and nutritional requirements.

Exporters are required to deliver animals that are healthy and at the weight required at discharge, so there are several motivations to ensure the feed provided is high in quality and supplied in the required quantity.

There are many variables that impact the amount of feed expected to be consumed by livestock during a voyage. These include liveweight and body condition, differences between species and breeds, age, sex, physiological state, environmental conditions, the need for acclimatisation, the palatability and digestibility of the feed, and even the novelty of the feed and surroundings. Livestock export vessels must also carry fodder reserves to ensure adequate supplies if a voyage is delayed.

Providing feed of sufficient quality is an important factor for animal performance during export. The feed's composition needs to consider the tailored requirements of the animals for energy, protein, roughage (i.e. fibre) and vitamins and/or minerals. Feed is provided to livestock in pellets, which are easier to transport, store and deliver to and within livestock vessels. Pellet quality is essential for minimising animal health and welfare issues during transport and is determined almost entirely by how the pellet is manufactured. Pellet manufacturing is a complex, multifaceted process of formulation, handling and storage. Further, seasonal variations may impact ingredient availability, quality and cost over time, which adds to the complexities of feeding livestock during export.

While substantial work has been conducted into fodder quality and quantity requirements for exported livestock, further refinement of feed formulations, pellet manufacturing, pellet transport and handling, and improved calculations for estimating daily feed intake may be beneficial. In addition, the opportunity remains to investigate how pellet durability and composition may be improved to support animal welfare outcomes and minimise feed wastage during export.

INTRODUCTION

The Australian livestock export industry ships cattle and sheep to multiple countries around the world each year and ensuring sufficient feed (fodder) is available for the duration of the voyage is a critical component of animal welfare and performance.

The Australian Standards for the Export of Livestock (ASEL) regulate the care of animals on vessels. They provide substantial detail on fodder requirements that have been informed by decades of research and practical experience.

There has been considerable investment in research to determine the parameters for livestock fodder quantity, quality and nutritional requirements. In addition, the Livestock Export Program (LEP) has funded research to ensure export fodder rations remain reflective of current industry practices and commercial needs.

PREDICTING HOW MUCH FEED LIVESTOCK NEED ON A VOYAGE

An animals' desire to consume feed is predominately driven by its physical needs, such as hunger, but is limited by natural constraints, such as palatability and digestibility. Research has clarified the numerous factors influencing how much feed and the type and formulation required for each animal being exported.

Liveweight and body condition

A significant indicator of daily feed intake is an animal's liveweight compared to its expected mature weight. Further, an animal's size influences the size of its digestive tract, and therefore the amount of feed that can be eaten.

The daily feed intake required by animals, as a percentage of liveweight, significantly declines as they approach their adult weight. It is also influenced by 'body condition', which refers to the amount of fat and muscle covering the bones of an animal. Regardless of its size, if an animal has a body condition above or below what would be considered 'normal', this influences the amount of feed it can be expected to consume.

Differences between species and breeds

Species type plays a significant role in energy requirements, and therefore expected daily feed intake of an animal. For example, sheep and goats have the potential to eat significantly more as a percentage of their liveweight than cattle or buffalo.

Previous grazing or feeding history will also influence daily feed intake because cattle that have been raised under extensive pastoral conditions will generally graze or forage for longer periods over a day and may have a smaller rumen as a result. Conversely, feedlot cattle will consume their daily requirements over a very short period of time.

Some breeds are naturally leaner and may eat less than animals of a different breed. *Bos indicus* cattle require less energy for maintenance and consume 13 - 35% less than *Bos taurus* cattle, which is thought to result from genetic selection.

Age, sex and physiological state

The physiological state of an animal also influences its feed intake. For example, late pregnant and lactating animals, including dairy cattle, will generally have a higher demand for intake than non-pregnant animals. In addition, females and castrated males generally consume less feed than entire males, and younger animals will consume more than older animals, as a proportion of their liveweight.

Environmental conditions and acclimatisation

Animals expend energy to keep warm or cool, and feed intake increases as energy expenditure increases. In addition, most long-haul livestock export voyages require Australian animals to cross the equator, meaning they may need to become acclimatised to new environmental conditions, especially during the Australian winter.

LEP research has demonstrated how handling and maintenance activities during shipping, and the novelty of new surroundings and new feed, will also influence an animal's daily feed intake. Animals may be reluctant to consume unfamiliar feed and will usually require a period of adaption. There is often a lag in the time required for animals to reach their expected feed intake as the animals adjust to new, unfamiliar feed.

Under ASEL 3.2 requirements, livestock must spend a minimum of 2-5 full days in pre-export quarantine. They are usually given the same feed that they will receive on the vessel so that they are familiar with it and can adapt to their new ration before overseas transport. This helps ensure that animals maintain their optimal liveweight during the first few days of a voyage. On the vessels, cattle must be fed a minimum of 2-2.5% of their liveweight in feed daily and sheep a minimum of 2-3% depending on age.

Palatability and digestibility

Palatability is specific to each animal's preference and relates to the pleasure associated with eating. Palatability and the physical features of the feed are strongly linked to digestibility and influence daily feed intake. To increase the length of time that feed retains its quality, it is given to exported livestock in the form of a pellet, a compressed form of a mix of feed ingredients. Characteristics such as pellet density may provide a higher dry matter intake, reducing the space available in the rumen and the amount of feed that an animal can consume. The digestibility of the feed can also influence daily feed intake, as less digestible feed can lead to bloating, indigestion and other intestinal conditions.

The amount of feed required per animal is an incredibly complex calculation, and there is consensus that it is difficult to predict accurately. However, the quantity of feed needed on a livestock export vessel essentially equates to the average daily feed allowance for the type of livestock being exported, with provision for feed reserves multiplied by the duration of the voyage. Therefore, voyage duration is also a critical determinant of the amount of feed carried on board.

Livestock vessels need adequate storage space for the feed requirements of the animals being transported. While there is unanimous agreement regarding the need to carry feed reserves, there is disagreement regarding how these reserves should be calculated.

Ingredients of feed provided to livestock

Providing fodder of sufficient quality is an important factor for animal performance during export. While substantial work has been conducted in this area, there remain many areas where further information is required.

ASEL has specific requirements related to feed composition, including the percentage of wheat, barley and corn. It also has requirements related to the freshness and storage of feed to maintain its nutritional content.

There are four elements to consider for feed composition: energy, protein, roughage (i.e. fibre) and vitamins and/or minerals. Each of these contributes to the overall quality of animal feed. Feed needs to be formulated so it:

- does not require high rates of metabolism for digestion, which minimises the risk of heat stress
- contains moderate levels of rumen degradable protein to support health and growth and minimise ammonia release
- has high roughage content to minimise health and acclimatisation issues
- has high palatability and adequate nutritional content to maintain health and performance.

Grains

Grains used in feed for exported livestock are predominately added for their starch content, as starches are high in energy. They are typically wheat, barley, or corn but may also

include several other grains that add starch to the diet of animals being exported.

The proportion of grain in the overall feed content needs to be carefully controlled as per the requirements of ASEL. If an animal consumes too much grain, it can cause health issues, particularly in the gastrointestinal tract.

Specifically, acidosis is a disease that can occur when bacteria in the rumen ferment carbohydrates from the starches in the grain instead of digesting it normally. This fermentation leads to the slowing of the gut, dehydration, and sometimes death. To avoid these issues, acclimatisation to the feed used on vessels is required, along with adequate roughage in the diet.

Hay, chaff, and roughage

Dietary fibre (roughage) is usually provided as hay or chaff as the key strategy for supporting digestion and gastrointestinal health in exported livestock. Roughage contributes to rumen health by promoting the contractions of the gastrointestinal tract, the regurgitation of undigested material for further chewing and stimulating saliva production. However, the pellet manufacturing process reduces the fibre quality in the feed components as they are ground to small particle sizes. This can make it challenging to determine how much roughage is needed to supplement fibre deficiencies in the feed. Therefore, it is desirable to have unprocessed hay or chaff as a component of rations on livestock export vessels, particularly for long-haul voyages.

For dairy cattle, feeding high levels of chaff is also believed anecdotally to be an effective way of mitigating the onset of premature lactation. However, the practicalities of storing extra feed on vessels can limit the space available for roughage. Further, while the digestibility of most of the grains is relatively predictable, the digestibility of roughage can vary substantially, complicating the calculations for determining how much is required to maintain the health of animals on board.

Protein

The inclusion of protein needs to meet not just the requirements of the animal for growth, health and replacing protein lost via urine and faeces, but also the need of the bacteria within the rumen.

Maximising the ability of the rumen bacteria to degrade components within the feed is the most efficient method of providing protein to the animal. This requires knowledge of the microbiology of the rumen and an understanding of the complexities of ruminal digestion. However, there remain many knowledge gaps in this area.

Protein is primarily supplied via crude protein sources such as soybean meal, and there are several complicating factors in determining the level required. For example, young or pregnant animals generally require higher crude protein levels due to growth demands, and breed characteristics may mean different expected growth rates. In addition, crude protein sources can be supplemented with nitrogen, which is used for protein synthesis and growth. Inclusion of urea is the most common practice; however, toxicity can occur at levels higher than 0.5% dry matter of the feed.

Ammonia is a waste product of protein degradation, with high protein diets resulting in high levels of ammonia excretion. Therefore, protein levels must match the needs of the animals to minimise the excretion of ammonia and reduce the potential adverse health impacts to humans and animals during a voyage. In addition, good ventilation can address risks from ammonia, and minimum requirements for vessel ventilation are included in the standards for livestock vessels under the Australian Maritime Safety Authority.

Vitamins/trace minerals

To supplement deficiencies in feed, vitamin and trace mineral compounds are usually included in the feed formulation. Deficiencies are likely to be seasonal and/or limited to breeds of livestock depending on the vitamin and trace mineral inclusions in their diets before a voyage. These requirements for livestock are well documented; however, there has been insufficient research conducted on the mineral and vitamin status and needs of livestock during overseas transport and the potential for deficiencies that may cause health issues.

Other feed additives

Many additives are available for inclusion in the shipboard feed formulation, all with different claims, costs, benefits and required inclusion levels. They include ionophores, urinary acidifiers, pellet binders, rumen buffers and electrolytes. Many of these products may only have commercial applications in some situations. Therefore, further industry-specific work is required to determine their cost to benefit ratio in the livestock export supply chain.

HIGH-QUALITY PELLETS ARE ESSENTIAL BUT COMPLEX TO PRODUCE

Feed is provided to livestock in the form of pellets for several reasons. Pelleted feed is easier to transport, store and deliver to livestock vessels. It is denser and therefore requires less storage space. Pellets are also easier to distribute around the vessel and ultimately to the livestock. Further, the process of pelleting potentially initiates the breakdown and release of some nutrients from feed, making nutrients more readily available to livestock, which can improve their health and performance.

Pelleting involves grinding the ingredients, mixing and conditioning, pelleting and then cooling and drying. Each step needs to be carefully managed to maximise the quality of the pellet, which primarily relates to its durability and resistance to being broken down into 'fines', which are smaller particles of the feed that may create dust or powder. LEP research has identified the presence of pellet fines can potentially cause numerous animal health issues, including acidosis, eye irritation and reduced feed intake. In addition, it can produce dust, which negatively impacts the environmental conditions on vessels.

Formulating the ingredients that comprise a pellet is a complex task. It considers numerous factors, including nutritional requirements for the animals, cost, availability and moisture content of ingredients, and compatibility with pelleting. Many of these factors change over time or may be impacted by seasonal variations.

Pellet quality is determined almost entirely by the way it is manufactured. This is a complex, multifaceted process requiring a high level of skill in selecting ingredients. A good quality pellet can be destroyed through poor handling techniques, generally caused by a need to load pellets onto a vessel as quickly as possible. Without strict procedures in place, this can lead to degradation and the production of pellet fines. Conveyor belts and vertical elevators are considered the best way to handle pellets. However, they are not always practical on vessels, so blowers are usually the preferred method. In addition, the pellet storage and delivery systems on livestock vessels vary, making the standardisation of these components difficult.

The production of pellets and prevention of pellet fines is a complex task that is taken very seriously by the pellet manufacturing industry. The suggestion has been made to develop a standardised pellet that ensures nutritional requirements and palatability to livestock. A standardised pellet would also need to be durable to withstand the rigours of handling on export vessels and prevent the incidence of fines. However, given the complexities and considerations involved in feeding livestock during export, the practicality of developing a standardised pellet is limited and may result in unintended adverse consequences, including discouraging innovation.

FODDER IN PRACTICE

A 2020 review of ASEL implemented changes to fodder requirements, including a revised calculation for determining the feed required on a voyage. The aim was to mitigate any potential animal welfare issues resulting from inadequate feed availability.

Livestock export vessels must carry fodder reserves in case a voyage takes longer than anticipated to arrive at its destination or there is a delay in unloading. ASEL 3.2 also requires that feed cannot be stored on a vessel for longer than 90 days, at which time the feed tanks and storage areas must be completely emptied, cleaned, and new fodder supplied for the next voyage.

If the feed is unused, it must be disposed of, or it can be sold at a significantly discounted price to other exporters for subsequent journeys or to facilities in-market. wHowever, exporters may be reluctant to purchase feed from previous voyages as the pellet specifications may not entirely meet the needs of the animals and could cause animal health issues due to changing feed.

NEXT STEPS

The opportunity remains to investigate how pellet durability and composition may be improved to prevent adverse animal welfare outcomes and minimise feed wastage during export.

LIVEXCollect is an industry-owned data collection and management system to support ASEL reporting requirements. It was developed by LiveCorp in consultation with the government and has been adopted as the mandatory reporting tool for animal welfare information and shipboard conditions required by ASEL, including the quality of feed and quantities remaining on board.

The LEP recommends that research into on-board livestock export feed rations be conducted after 18-24 months of information has been collected through LIVEXCollect. The additional data and insights will help determine the quality and quantity requirements of feed given to livestock during export and inform the next steps in research.

CONCLUSION

There are inherent benefits for exporters to deliver healthy animals and at the weight required at discharge, so it is important to ensure the feed provided to the animals is of high quality. As a result, livestock exporters are incentivised to carefully select feed ingredients and pellets.

Further data and potentially additional research may be required to refine approaches to managing feed composition, pellet manufacturing, transport and handling during livestock export, and improved accuracy for estimating daily feed intake calculations.

Further references

G Tudor, J Accioly, D Pethick, N Costa, E Taylor & C White. 2003. *Decreasing shipboard ammonia levels by optimising the nutritional performance of cattle and the environment on ship during live export.* Published by Meat & Livestock Australia Limited, Locked Bag 991, North Sydney, 2059.

G Willis. 2011. *Review of fodder quality and quantity in the livestock export trade.* W.LIV.0256. Published by Meat & Livestock Australia Limited, Locked Bag 991, North Sydney, 2059.

National Academies of Sciences, Engineering, and Medicine. 2016. *Nutrient Requirements of Beef Cattle: Eighth Revised Edition.* Washington, DC: The National Academies Press. https://doi.org/10.17226/19014.

National Research Council. 2001. *Nutrient Requirements of Dairy Cattle: Seventh Revised Edition, 2001.* Washington, DC: The National Academies Press. https://doi.org/10.17226/9825.

National Research Council. 2007. *Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids.* Washington, DC: The National Academies Press. https://doi.org/10.17226/11654.

PD Mansell, DS Beggs, TF Jubb, MFS Pyman & AD Fisher. 2012. *Premature Lactation in Exported Dairy Cattle*. W.LIV.0280. Published by Meat & Livestock Australia Limited, Locked Bag 991, North Sydney, 2059.

PD Mansell, TF Jubb, & S Wilson. 2015. *Zearalenone and Premature Lactation in Exported Dairy Cattle*. W.LIV.0286. Published by Meat & Livestock Australia Limited, Locked Bag 991, North Sydney, 2059.

Primary Industries Standing Committee. 2007. *Nutritional requirements of domesticated ruminants.* CSIRO Publishing