VOL. 1 ISSUE 6 · AUGUST 2021

CATTLECAL NEWSLETTER

ANNOUNCEMENTS

Welcome to the CattleCal newsletter for August 2021! In this issue we have exciting information on shade structures for cattle production, the career and research of UC Davis professor Richard Zinn, and a look at a study supplementing methionine and lysine in the diet of calf-fed Holsteins early in the feedlot. If you would like to hear more detailed conversations about the articles in this issue look for our CattleCal podcast on Spotify. Descriptions of this month's episodes and a link to the podcast can be found on page 3. If you have any questions, comments, or would like to submit a question for our Quiz Zinn segment, feel free to contact us. Our contact information can be found on the last page of the newsletter.

This issue:

THIS MONTH IN RESEARCH

This month we did not weigh the steers due to extreme heat and will not have a performance summary. Though we don't have data on performance for July, we are able to tell that they continue eating and gaining well. We initiated respiration data collection in July. We hope to correlate internal body temperature (measured by temperature boluses) with respiration rate in the heat. We are excited about this new data. In July we saw average maximum temperatures of 106° F and average minimum temperature of 81° F.

July 2021

August 2021

CATTLECAL PODCAST JULY EPISODES

Quiz Zinn - CCP#021

In this episode, we asked Dr. Richard Zinn a question related to the use of shade in Feedlot cattle operations.

Career Call - CCP#022

We had the pleasure to talk with one of the greatest feedlot researchers of our time! A person who inspires and is a mentor to Brooke and Pedro. Dr. Richard Zinn has been working for UC Davis since 1981. Dr. Zinn shared with us amazing stories from his career and personal life!

Research Call - CCP#023

Pedro Carvalho finishes the initial 6 months of conversation on protein nutrition with Dr. Richard Zinn. They discuss past research and what may be coming in the future.

Feedlot Research Call - CCP#024

In this episode, join Pedro Carvalho and Brooke Latack as they discuss a very recent study looking at supplementation of feedlot diets with methionine and lysine.

Listen on Spotify at this link:
https://open.spotify.com/show/6PR02gPnmTSHEgsv09ghjY?si=2zV59nGbSE2mf8DiOqZLhw

Have any questions, comments, or suggestions? Want to send in a Quiz Zinn question? Contact the creators through the below email or through their social media profiles.

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QUIZ ZINN

What are the benefits to using shade in cattle production and what are some top things to think about when installing shade structures for cattle?

Why is shade necessary?

Before we talk about shade itself, let me very briefly explain something the people may not understand. About 80% of the metabolizable energy an animal eats is converted to heat. The animal then needs to dissipate that heat load. The ability of the animal to dissipate that heat load is influenced by ambient conditions. This includes not just the temperature and humidity, but also solar radiation. Something that all of us notice when we step out into the sun is the difference between that and if we're standing under a shade. The actual ambient temperature doesn't change, but we feel cooler. The heat load from solar radiation is going to be maximized from about 11 AM to 1 PM. It really begins to stay elevated, though, between 9 AM and 4 PM during summer months. This is the time that heat load is significant. How big is the heat load? It ranges between 0.5-0.8 MKal per square meter of surface area. You can see that this radiant heat load can be a burden to the animal and it's efforts to dissipate the heat load from feed intake. What the animal is going to do is adapt by eating less feed to reduce the amount of metabolizable energy that it needs to dissipate. Many places, but the desert Southwest in particular, will see a drop in feed intake during the hot summer months even with shade, but the problem becomes worse if shade is not provided. It's important to remember that shade will not overcome issues related to ambient temperature and humidity. When humidity is high the animals will still have a drop in feed intake even if shade is provided.

How beneficial is shade?

The benefit of shade will depend on the genetic potential of the animal. If an animal has a great genetic potential for growth, meaning they need to eat a lot of feed to express that genetic potential, then that animal will be more affected by the quality and quantity of shade than an animal with a lower genetic potential for growth.
Another thing that effect shade efficacy is the color of the animal. Animals with a lighter skin coat will be less affected by solar radiation than an animal with a dark skin coat.
We can't just build shade for one animal. We need to build shade for they different types of cattle entering the feedlot and the different stages of growth those cattle will be in.

How high about the pen should the shade structures be?

About 3-3.7 m above the pen surface. Going higher will be a little more costly, but there is some benefit to building higher shade structures. Heat will accumulate beneath the shade, so the higher the shade the more the animal is free of more of the heat that accumulates beneath the shade.

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QUIZ ZINN

How much shade?

The industry generalization is that there should be about 2 m2 of shade per animal. That should be a minimum if the conditions under the shade are dry. There is research that shows that cattle will benefit from 3-3.5 m2 of shade per animal. The reason for that is because when animal is under the shade they still need space. If there is too little shade, the cattle will be closer together which can impact performance. This is especially important for Holstein cattle as they produce a great deal of urine, so the amount of space under the shade becomes more critical. Not accounting for space under the shade can lead to increased mud, which impacts the animal's ability to dissipate heat. Adequately accounting for shade space can lead to a 5-8% difference in average daily gain. If we think about that, the cost for the additional shade space could be less than the cost of a feed additive to achieve that same improvement in average daily gain.

What materials should be used?

Galvanized steel shading – This material will last a long time. It is great for permanent shade structures. It is more expensive.

Polypropylene woven material or knitted shades – These are thicker and heavier material. They don't hold up long term, especially with a lot of wind. It would be difficult for this material to last longer than 5 years. This is much less expensive than the steel shades.

What should the orientation be?

Most feedlots will have feed alleys oriented north and south. In this setup the shade would run along the length of the feed bunk. As the sun moves east to west, the shade will move. This will make for less mud accumulation under the shade, which is very beneficial. My recommendation is, whenever possible, to orient the shade structure so the shade will always move.

How far should the shade be from the feed bunk?

We do not want the cattle laying doing right in front of the feed bunk, which would disturb animal performance. We would want the shade to be a minimum of 4-5 m from the feed bunk. This will also help with feedlots that need to spray pens for dust control. We don't want to spray water under the shade, so having the shade area set back from the feed bunk will ensure that water is not sprayed in that area.

CAREER CALL WITH RICHARD ZINN

Where are you from and what do you do?

I was born here in El Centro in the Imperial Valley of California. I had the privilege of working my career out where I was born. As far as my work, I am a professor for the University of California, Davis in the department of Animal Science. My area of research is health, nutrition, and management of feedlot cattle.

How did you decide to work in animal science and, specifically, why did you choose to work with feedlot cattle?

My background is in feedlot and dairy. My family owned a small feedlot. I worked on a 200 cow dairy during my high school years. I think everybody can look at pivotal things in their life, things that really changed the direction in a surprising way, see what a great impact it had. In mine it was the University of California. It was Dr. Glen Lofgren. He introduced himself and said that he found out that I had a lot of experience working cattle. He was wondering if I'd be interested in his summer job once I got back from school. Of course I was delighted when he told me where this place was. I was surprised that the research center was actually place that I had delivered the Los Angeles Times to. I thought it was probably a military compound. I had no idea what that place was because it was it was painted green. I'm sure they got surplus paint and that's how they painted that place. I just loved the work. He was doing research on heat stress, looking at energy density of the diet, and looking at supplemental fat and how that might help reduce the heat increment. We had worked with cattle using sprinkling and looking at different kinds of sprinkling. We also had one project where we were looking at refrigerated water. We had one little project where we were looking at cattle in a refrigerated barn vs. sprinkling vs. conventional outdoor pens. I just loved it. Everything I did was just a great experience. With the extension people who came down to do projects, as well. We had meters to measure dust from feedlots at different locations. It was a great, great experience. When the time came to go back to school, I went into his office there at the research center and I said to him "Dr. Lofgren, I want to know what I need to do to have your job. I want you to know that I don't mean a job like yours. I mean your job." He told me, to go to the animal science department when registering for classes. I had never heard of animal science before. So I did that and those people were amazing. I went to the registration table they treated you like a member of the family. I've never experienced anything like that before and it was just amazing. So I ended up getting a degree in animal science.

Where did you go to school for your undergraduate studies?

I went to Brigham Young University. I got my B.S. and my master's degree at Brigham Young University. I went to Kentucky for my PhD.

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CAREER CALL WITH RICHARD ZINN

Why did you decide to go to Kentucky for your PhD?

When I was working on my Masters degree I was in dairy and I was looking at protein. At the time I was looking at non-protein nitrogen and methods of slow release urea and synchronization of urea. Back in those days we didn't know much about rumen and digestive function. It became clear to me that this was an area that would be very, very beneficial for the industry to have a better understanding. This kind of research wasn't being done back in those days. Kentucky was famous at the time because they had been doing quite a bit of research using experimental surgery looking at canulation along the digestive tract. I wanted to get involved in there. I chose Kentucky specifically for that reason. Surprisingly, however, the people that were involved in that had just gone to Florida. But still I got a response back from Kentucky in about two weeks. Leonard Boll, who is relatively new faculty at Kentucky wrote me a nice letter and a nice invitation. I was excited and it was a great opportunity because at Kentucky I was given a full scholarship and didn't really have to be a TA. Which means I only worked on my research. They just gave me carte blanche said just get busy. It was a wonderful time in Kentucky.

You spent time in Oklahoma before coming back to California, right?

Even though my master's and PhD work were largely looking at dairy, my intent was to return back to the Imperial Valley. All of the faculty would tell me "You're wasting your talent," "You souldn't do that," "You should look for something else." I said that it's that or nothing. I'm going back. As I was finishing up my PhD, Dr. Lofgren was leaving El Centro to go to Clayton, New Mexico because they had just started a new research center and he was given the opportunity to start up that Research Center there. He called me that he was leaving, remembering that I was interested in returning back to El Centro. I said it was kind of him to think of me but there is no way I could just start out and go down there and step in. I wouldn't be prepared for something like that. I don't think I'm ready for that. I chose not to. It was a short time after that that Dr. Fred Owens from Oklahoma State called and invited me to come and do a postdoc in Oklahoma. I told him it was so kind but my wife, after all the sacrifices she made, to just continue to be a student for awhile, I don't think that would go over too well. He called back a few days later with an offer with the postdoc salary being the same as the assistant professor salary. I said I'm putting gas in the car I'm on my way. The neat thing was that Fred Owens was so open and so fun to work with because anything and everything was interesting. He was of course anxious to get more involved in digestive function. I was there were almost three years. At a symposium that we had, Lee Baldwin from the University of California was also on the program. He came up to me and told me that that the El Centro position was opening up again and was hoping that I would apply for it. Of course I did. So, October of 1981, my office was the very office that Dr. Lofgren had. When I was engaged to my wife I took her to meet my family. I was just a junior in college at that point. I took her out to the research center and told her this is where we're going live. This is where I'm going to work. It's pretty amazing that everything turned out exactly as I planned.

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CAREER CALL WITH RICHARD ZINN

What are the parts of your job you enjoy the most? What are some of the challenges?

I'm a very independent person and this position was very good for me because I like to work independently. Coming out I was anxious to be involved with the industry. Of course, I grew up here. I had a special attachment to the industry. Many of feedlot operators I knew personally.I felt honored that I would be able to do work that would be beneficial for the feedlot industry. The very first thing that I did when I got there was to go around and visit several of the feedlots and asked them what they thought would be the most beneficial and most interesting for them. At the time it was fat. They wanted to know how they could put more fat in the diet. That became the initial area of focus for me. If you look you'll see that I have published many studies involving different aspects of fat supplementation. In fact, the original work reestablished the true net energy value for fat. The NRC had totally miscalculated that value, and so we did work and we showed how that miscalculation was done. The University of California Research Center here was notable in what we call stressed calf work and how to receive calves. We only fed calves at the time, we didn't feed yearnings or older cattle in the Imperial Valley. They would all come in as calves and newly weaned, so there's a lot of stress not only in marketing and transportation, but just the fact that they were newly weaned. A lot of research was done early on to look at how best to receive the calves. We didn't have the antibiotics that we have today and so mortality and morbidity were very serious issues. Specifically to your question, I like to actually work with the livestock. I like the work with the cattle. When I first came, obviously I didn't have any anything in the past to go with, so I was mostly out at the feedlot looking at the cattle and working. What was surprising to me was that soon I would be spending a lot of time in the office writing manuscripts and then later traveling. This is not what I expected, so that was a little bit of the adjustment for me. I don't think anybody's favorite thing is writing, and yet I've written hundreds of manuscripts for professional journals. I'll say that was not my favorite part. I love the research. I love the discovery and finding out know how things work. But, writing manuscripts was part of the job that I didn't realize how much a part of the job that would be. Another think that a lot of people don't understand is that money is what enables research activity. People wonder why we don't look at this. Why we don't look at that. In reality we can't look at things unless we have the money. That was the other area. The need to constantly be looking for financial support in order to continue the work. That became increasingly difficult over time.

Can you talk about your mentors and the importance of mentors in your career?

We look at mentoring as an intentional responsibility, something where you develop interest and friendship. It's fun to see people that want to work together and accomplish things. In the case of Lofgren, it was initially the direction he gave and the interest that developed. I don't think he did that intentionally. He extended an invitation and I fell in love with his work. I learned a lot from him and from from Doctor Owens and to some extent from Leonard Boll and from my master's work. When I finished my master's work I was looking at nitrogen synchronization in terms of how it affects lactation response in lactating dairy cows. I had measured digestible energy intake.

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CAREER CALL WITH RICHARD ZINN

When I finished that work, for the fun of it, I decided to look at the relationship between digestible energy intake and milk production. I made the plot and it was a perfect plot. It explained almost 100% of the variation in milk production. I can remember I just jumped back. I became very in tune to energetics and I became a believer in energetics. Of all of the nutrition we learn, it's the only one that's held up over time. What we understand about energetics is the same today as before. People try to come up with new models but the fact the matter is that it works and it explains the variation. Lofgren gave me the original inked out manuscript for California net energy system. It was rejected three times by the journal and it took a long time for that to pass review because reviewers were offended by the system itself. You can see that the industry is so dogmatic and research and science. It's very difficult for somebody to come up with something novel. If it goes against pressing dogma today. The net energy system was a very simple approach and I think it was just too simple. What happened was the industry accepted it. Lofgren would go around and got industry using it. I think that's the only reason, in my opinion, the journal finally accepted the California Net Energy system was because industry adopted it. Fortunately for the California Net Energy System computers were just being becoming accessible to feedlots at the time. I became very familiar with that system. When I came here to the Imperial Valley we were doing comparative slaughter research. All of the studies I did in the early days we would actually measure energy retention. We would do specific gravity. We do initial group of 10-12 steer and then we would do specific gravity on all the remainder of the steers at time of harvest. That way we actually measure energy retention. What I did was I began to compare that with the expected based on animal performance. One of the problems for that was that I needed to develop a relationship between net energy for maintenance and net energy for gain. Initially I solved that by a process of iteration. The computer would simply iterate until it came up with a unique solution. That took a long time. Those were really slow computers that I had initially. It would take almost half of night to solve one pen of cattle. It was a very slow process. I would have it beeping just so I would know that it was still working on the problem. One day in my office I began to ponder whether instead of iteration I could make it so that it could go on a spreadsheet and wouldn't need to have an iterative solution. It occurred to me like a light going off that I have the simultaneous equations I can that using the quadratic formula. I developed a formula and looked at the solution and compared that to the iteration and they gave exactly the same answer. That's where that comes from. From all of this what I learned on my work with Lofgren and others that were mentors was to trust the system. It developed in me the idea of expectations. That feed intake should be an expected function of average daily gain and the genetic potential of the animal in terms of its mature weight. The more work I did. The more sure I was that that was the case. It is very important that people recognize that animal performance is very predictable as a group. Individuals can be different but a pen of cattle will be the same. Lofgren would say a pen of animals is one animal. You need about 10 animals as a representative for energetics. That's something I always keep in mind.

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CAREER CALL WITH RICHARD ZINN

What are a few of the industry has adopted over the past 40 years?

The industry itself is very dogmatic. It's hard for the industry to change. The science has made leaps, but the industry has made baby steps in terms of its ability to change. One of the things that has changes, especially in the dairy industry is the change in the animals themselves. We've seen a huge change in growth performance. This is because we've moved away from smaller framed cattle to intermediate or large framed cattle. When I was young, cattle barely came up to your waist. They were smaller mature sized. One of the biggest tools that has helped the industry are the growth implants. There is still nothing to this day that has a greater impact on animal performance than the proper use of implants. Even locally, the feedlots aren't taking sufficient advantage of the implants in terms of animal growth performance. When I was starting out, cattle were harvested at 1025 lbs. There is no way those cattle would have been raised past that because they became so inefficient. Now you can't even sell them until they're at 1325-1340 lbs. Anybody looking back would see that the change in harvest weight and the associated growth performance (not slowing down) would be the biggest changes in the industry. We may be getting to a point that the frame on the animal may not be able to support that weight and so we may see more lame cattle and injuries.

What is your favorite food?

As a general, Mexican food.

What kind of music do you listen to?

I am probably unique in that I don't listen to music. To me, music is a major distraction. I like church music, but I don't really listen to music. I never have had much interest in popular music.

If you could go back to when you were starting your career, what is something you know now that you wish you knew then?

Hopefully there is a lot of things that I know today that I wished I knew back then. We grow. I was taught certain things and I thought that's how things are. Almost without exception (minerals, vitamins, protein, etc) nothing agreed with what I was taught before. I've been increasingly disappointed in not being told in the beginning that these are just ideas and we don't know for sure any of this stuff. That's not how I received the information. Looking back I wish I had known that when I started out. What happens is, when we do studies to evaluate animal performance we're going to have a limiting nutrient. We're going to have something that is first limiting. If we don't solve that then the things that we are looking at aren't going to be able to express themselves. We are always running into this confusion. Even though we know this or that is very important and we need to research it, there are other things that can also have an impact. Over the years, a lot of the work I've done I've had to repeat because I wasn't aware of that maybe there was another nutrient that was first limiting at the time. My caution to students is to look at these things as something you want to understand but don't think that it's correct. Realize that we don't know much about most things. The one thing we do, that we can put a lot of trust into, is energetics.

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CAREER CALL WITH RICHARD ZINN

What is your top tip for our listeners?

The things that would be impactful would be so many impactful things. In all of the publications I've put out, the 2008 paper on energetics would be helpful. It covers all cattle and the topic in so many ways. It's not easy reading but will be very fruitful to read, especially for students.

Performance by feedlot steers and heifers: daily gain, mature weight, dry matter intake, and dietary energetics. Zinn et al. (2008)

Bonus tip:

Looking back over my life, one thing I wish I would have done differently is spend a lot more time with my children. I would have held them in my arms and told them how much I love them a lot more than I did. Life is so precious and it passes so quickly. Those are my parting words.

RESEARCH CALL WITH RICHARD ZINN

As we finish up our six month journey into protein nutrition of feedlot cattle we talked to Dr. Richard Zinn about protein and amino acid nutrition research throughout the past 40 years.

Can you tell us how you started looking at protein nutrition in calf-fed Holsteins and the importance of this research?

Actually, this goes way back. A lot of the early work I did looked at ruminal escape protein, which is the amount of protein that makes it to the small intestine. We looked at many of the supplemental sources of protein we have available. We were interested in how much of it actually makes it to the small intestine. You can see a logical progression because we measured microbial protein as well. We looked at the relationship between the amount of organic matter fermented in the rumen and microbial synthesis for net protein synthesis. We found that it's relatively predictable, although there is a lot of variation among protein sources and the amount of protein that escapes ruminal degradation. We looked at intestinal digestion of protein and saw there's a lot of differences in that. We talked about blood meal. While it has a pretty high feed value, the availability of that protein post-ruminally is not that good. This is especially seen for lysine which is high in blood meal, but is affected by the process of drying the blood meal. After we had looked at that we did a lot of work with lightweight feeder calves, which would be typical for the southwest. We would look at 56 day feeding periods and protein requirements and how cattle would respond to protein supplementation during that receiving period. Obviously, cattle always responded to the protein, but it wasn't very sophisticated. We looked at feeding increasing levels of protein and we found that we could feed almost 40% cottonseed, for example, and still not optimize performance in the calf. In fact, performance went down.

We began to sense the importance of microbial protein and the quality of the ruminal escape protein. This was difficult because we needed a source of ruminal escape protein that was high in what we consider to be limiting amino acids (methionine and lysine). During the very early work we were looking at fish meal. We restricted ruminal available protein so we could manipulate microbial synthesis. Almost at the same time we were looking at non-protein nitrogen supplementation as well as looking at the relationship between the flow of amino acids to the small intestine.

When I was at Oklahoma State University, we determined that the digestibility of amino acids in the small intestine is fairly constant. The NRC picks up on that as metabolizable amino acids. We found that the relationship between methionine and lysine supply to the small intestine is almost perfectly related to the efficiency of energy utilization. We saw that methionine and lysine were limiting amino acids and as we met those requirements we would optimize the efficiency of energy utilization. If you don't pay attention to those specific amino acid requirements, efficiency of energy utilization will be less for at least the first 112 days on feed. This means that the cattle will need more feed to compensate for the insufficient supply of metabolizable amino acids. By meeting those requirements, the efficiency will go from let's say 78-82% all the way to 100% of expected. There are several papers we published to demonstrate that effect. This was not an easy thing to do with natural protein except for fish meal.

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RESEARCH CALL WITH RICHARD ZINN

The problem with fish meal, though, is that you can only feed so much fish meal since it's not very palatable. We looked at different ways to overcome the insufficiencies of natural protein sources. We became interested in protected amino acids since we knew that methionine and lysine were the most limiting. We thought we could just add those and get the same results we would get by adding fishmeal. That's been a struggle because you need to feed quite a bit of these protected amino acids to get the levels up to where they need to be. We have just been able to get the overall response. Natural proteins like fishmeal are an excellent source of other nutrients like calcium and phosphorus, which are not provided with the protected amino acid supplements. Despite these difficulties, we have been able to detect an improvement with the protected amino acids that carries through the entire feeding period.

One of the things that does happen with us taking cattle to heavier and heavier weights is that the time on feed has increased from 280 days to 340 days. Because of that, the effect of protein on the intermediate and final growing phase is great. The initial feeding period is important, but the impact of protein throughout the entire feeding period is very, very important.

We're still doing research on protein. What does the future in protein nutrition look like for you?

We have the concern not only of metabolizable amino acid, but also metabolizable protein. When we feed protected amino acids we can't ignore the potential response to metabolizable protein itself collaterally with specific amino acids themselves. The new NRC has dropped metabolizable amino acids and are just looking at metabolizable protein and even then the estimates are much higher in metabolizable protein requirements early on than the NRC in 1984. I have no idea how they came about them. Most of the cattle on feed are heavy yearlings, but all over the US and Mexico feeding Holsteins has become increasingly popular and important. This topic of protein requirements will not be going away. This is going to be important. There may need to be changes universally with the diets used, especially when only one diet is fed throughout. There is a lot of promise with protected amino acids, we just have a lot more to look at. There are a lot of things we need to consider early on, especially the calcium and magnesium requirements and other nutrients that natural protein sources provide but protected amino acid supplements may not provide. We are going to have to look at metabolizable protein, metabolizable amino acids, macrominerals, and potentially even microminerals.

FEEDLOT RESEARCH BRIEF

Effect of supplementation of calf-fed Holstein steer feedlot diets with rumen protected methionine and lysine on performance

Introduction

- The initial feedlot growing phase is the period where metabolizable methionine and lysine are expected to be the co-limiting amino acids in calves fed a steam-flaked corn-based diet.
- Deficiencies in amino acids early in feeding can lead to negative effects on performance which can lead to economic losses.

Methods

- 72 Holstein steers (282 ± 19 lbs) were blocked by weight and sorted into 12 pens (6 steers/pen) for a 84 day feeding trial.
- Treatments:
  1. Basal diet + 0% rumen protected methionine and lysine
  2. Basal diet + 0.4% rumen protected methionine and lysine
  3. Basal diet + 0.8% rumen protected methionine and lysine
- Basal diet was formulated to meet 105% of metabolizable protein requirement based on NRC values

Results

- The basal diet exceeded metabolizable protein requirements for the Holstein steers, but methionine and lysine were still deficient for the basal diet.
- Supplementation of protected methionine and lysine improved ADG, feed efficiency (ADG/DMI), and estimated dietary NE.
- Supplementation of protected methionine and lysine did not affect DMI.
- Observed metabolizable protein and amino acid supplies to the small intestine of the calves were in close agreement with expected based on NRC values.

	Smartamine ML, %		
Item[1]	**0**	**0.4**	**0.8**
Ingredient composition, % DM			
Sudangrass hay	12.00	12.00	12.00
Tallow	2.50	2.50	2.50
Molasses, cane	4.00	4.00	4.00
Distillers grain	25.00	25.00	25.00
Steam-flaked corn	53.21	52.81	52.41
Urea	0.75	0.75	0.75
Trace-mineral salt	0.40	0.40	0.40
Limestone	1.90	1.90	1.90
Dicalcium phosphate	0.16	0.16	0.16
Magnesium oxide	0.06	0.06	0.06
Smartamine ML	0.00	0.40	0.80
Rumensin 90	0.0165	0.0165	0.0165
Nutrient composition, DM basis (NRC, 1996)			
NE_m, Mcal/kg	2.17	2.16	2.15
NE_g, Mcal/kg	1.51	1.50	1.49
CP, %	15.70	16.10	16.50

Implications

Supplementation of rumen protected methionine and lysine can help satisfy amino acid deficiencies in steam-flaked corn-based diets fed to calf-fed Holstein steers.

CONTACT

Have any questions, comments, or suggestions? Want to send in a Quiz Zinn question? Contact the creators through the below email or through their social media profiles.

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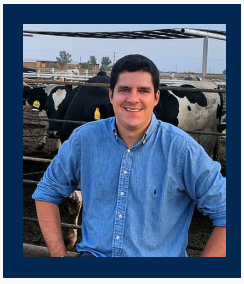

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