

**Volume 1
Edition 1**

Calendar

December 6-8: NE
Cattlemen Annual
Convention and Trade
Show

2023 Feb 1-3: Cattle
Industry Convention
and NCBA Trade Show

Feedlot Pen

USDA ARS USMARC Feedlot Industry
Stakeholder Update

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Welcome from the USMARC Director



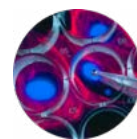
An update from Dr. Boggess regarding our beef programs on the Center and plans for the future.

Meet the USMARC Manager-Chad Engle



USMARC livestock manager Chad Engle provides an update related to the feedlot.

USDA ARS USMARC Research Reports



Research summaries or abstracts regarding the current or recently completed research ARS scientists are performing.

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Director Update - Hello From the Pen!



Hello from USMARC and welcome to the first edition of Feedlot Trails!

It is our great pleasure to be bringing you this first edition of Feedlot Trails, our stakeholder update and research report. Our goal is to provide the beef feedlot industry with new research and news of interest to the beef industry. And, we have a lot of good news to share!

It's a busy time at the feedlot! Heavy cattle are going out while we prepare for 6,000 head to arrive this fall. The weaned calves may be arriving sooner than we had hoped due to drought conditions, so there is lots to do. We have managed the challenging summer weather very well and our cattle are looking great with excellent performance which is a testament to our dedicated feedlot crew. And to keep our crew even busier, we have numerous research projects ongoing.

Please see several outstanding research reports for review in this edition. We are excited about our growing research program and our ARS and external research partners! We are continuing to aggressively build collaborative partnerships with sister ARS locations, academia, and industry stakeholders. We greatly value the stakeholder support we receive, and we have been relying on our very important producer stakeholders a great deal lately as we move forward on several research and program fronts.

For example, we have developed a "Blue Ribbon Panel" (BRP) of industry experts to provide us with a comprehensive program review. Our panel includes producers and industry leaders, scientists, animal care staff, and other USMARC stakeholders. The BRP meets periodically on the Center, with an eye on improving overall animal husbandry, performance, and management. The BRP recommends improvements to all programs and facilities, and monitors progress and implementation. We also contrast USMARC program performance with industry benchmarks to identify areas needing improvement and to monitor progress over time.

To say that the BRP program has been successful would be a gross understatement. The panel meetings have provided valuable guidance and we are using them to promote continuous improvements in both beef and feedlot management and research programs. We look forward to every visit as we look to the future!

However, the BRP effort is only one of our focus areas, which also include continuing education programs, improving overall management, and developing a strategic vision for facilities modernization. All of these efforts are ongoing to be completed when funding is available. Exciting stuff and a bright future!

Together these efforts have supported our proactive and interactive relationship with our colleagues at Animal and Plant Health Inspection (APHIS), who have been charged with providing



(Continued on page 4)

Update from the Livestock Manager



The U.S. Meat Animal Research Center (USMARC) feedyard, often coined “the hill” by the locals is where the largest amount of research data is collected on a daily basis across all of the Center’s 34,000 acres. The 6,400 head feedlot research facility is a unique blend of a typical Midwest cattle feeding operation splashed with the latest in innovations in animal comfort, data collection, and efficiency. Every one of the nearly 6,000 calves born on the Center each year will be housed and cared for in the feedlot at some point during their lifetime, and these time points are often critical data collection times for information: weaning weights, feed efficiency, pathogen shedding, and temperament.

All animals, regardless of species, are tracked on an individual basis at the Center, creating a unique challenge for collection of animal inventories, health, and location records. Commercially available technology for feed tracking, herd health and even animal performance is all geared toward lot systems, where every animal in a pen has the same lot number. In these situations, information is tracked at the pen level, which is the way nearly every cattle feeding operation maintains their records. The need to track animals individually, and the lack of existing software to do so, has led to remarkable innovation at USMARC enabling the capture of an incredible amount of data that would not have otherwise been measurable. These innovations have been implemented in every aspect of production as well to create a synergistic operation where production metrics are merged with research and managed in an industry relevant manner. The bottom line is, USMARC collects data that is not just relevant to scientific discovery and advancement, but it is also valuable to producers who operate their own cattle feeding operations and those who produce calves for those operations. Last but not least, we continue to track a portion of these animals all the way to the grocery stores to ensure the product in the meat case is as safe and tender as we can make it.

Such lofty goals for research, as well as the highest animal care standards, mean there isn’t much down time for the crew at the feedlot. Summertime is the season when our finished cattle are delivered to the meat supply chain and we get instant feedback related to our job performance. This feedback includes final weights to document animal performance along with carcass quality and yield grade data. Each animal harvested is the result of three years of work, as the animals mating decisions are made three years before the animal arrives in the meat case. A lot of teamwork and resources are needed to make this happen and I’m very proud of our team for their tireless dedication both to the animals and the science.



As we grind through the summer months of delivering cattle to market, cleaning pens and making repairs, we are always mindful that our next set of cattle will be arriving in the fall. Each year’s calves are viewed as a new opportunity to advance our research, improve our

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Director Update continued...

annual inspections for the Center. Our interactions with APHIS are considered opportunities to strengthen our already strong programs for animal care and animal husbandry, and APHIS is a partner in our ongoing success.

Of course, we are very excited about our growing research programs and our expanding collaborations. We are working with our sister locations in ARS to describe a Beef Systems Research Consortium and are now putting that effort in motion. The program will include many land grant university partners and others. And, we have many other projects being developed that promise to produce tremendous benefit to the beef industry.

So, we are excited and optimistic for our future! Please join us on our journey forward and let us know how we can make our programs even better. We need your support for our research programs, for our producers and stakeholders, and in Washington DC. Help us help you – we appreciate your support!

All the best!

Mark Boggess



Manager Update continued...

production, and continue to strive for perfection in our operation. It's a responsibility we take very seriously and a privilege to be in this line of work. We welcome visitors to our facility and it doesn't matter if you've never been to a feedyard or if you are like me and think they should make cologne from cow manure, we hope you will consider learning more about our operation and help us to better serve you in the future.

Chad Engle



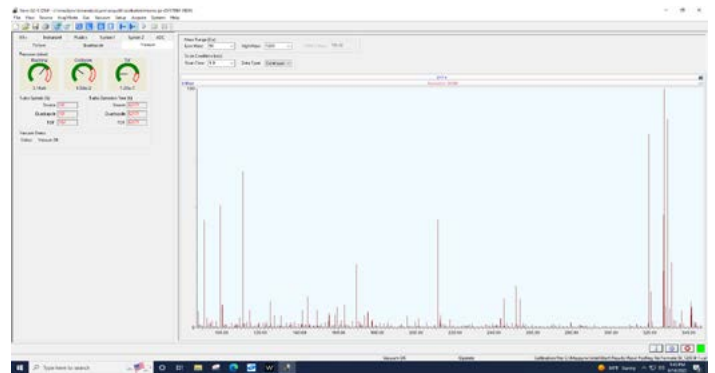
Research Reports

The astric (*) represents the author contact found on page 9.

Non-invasive metabolomics biomarkers of production efficiency and beef carcass quality traits

Artegoitia, V.M., Newman, J.W., Foote, A.P., Shackelford, S.D., King, D.A., Wheeler, T.L., Lewis, R.M., Freetly, H.C.* 2022. Non-invasive metabolomics biomarkers of production efficiency and beef carcass quality traits. *Scientific Reports*. 12. Article 231. <https://doi.org/10.1038/s41598-021-04049-2>.

Animals differ in their growth rates. Growth rate is dictated by the regulation of many physiological processes making their metabolites potential markers to identify animals that will have superior or inferior growth rates. A non-invasive approach for sample collection combined with non-targeted and targeted metabolomics was investigated as a method to predict growth. Urine samples were collected from steers when they were fed a high-forage growing diet and when they were fed a high-grain finishing diet. Mass spectrometry was used to identify urine metabolites that correlated with differences in growth. Overall, 85 metabolites segregated between the steers classified as having the least or greatest average daily body weight gain. From the 85 metabolites, 18 bile acids and five steroids were quantified and associated with growth and carcass quality. There is potential for using metabolites in urine to predict performance of fed cattle which could be used as a management tool and provide insight into potential biological mechanisms associated with differences in performance. The next step will be to evaluate these markers in new populations of cattle.



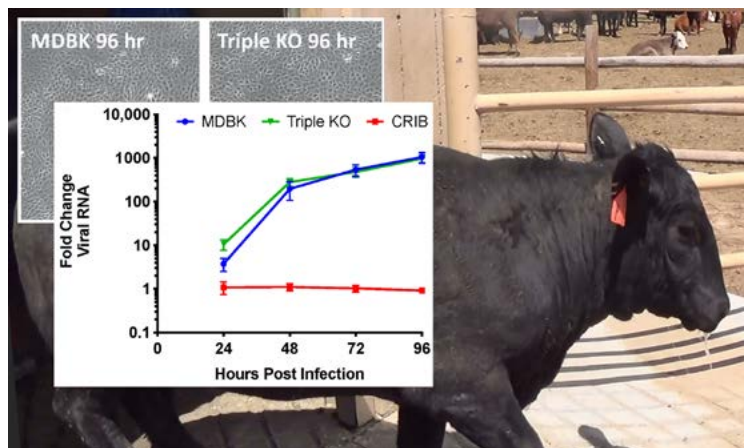
Data analysis received from a mass spectrometer showing the ratio of compounds in the sample.

Evaluating large spontaneous deletions in a bovine cell line selected for bovine viral diarrhea virus resistance

Workman, A.M.*, Heaton, M.P., Webster, D.A., Harhay, G.P., Kalbfleisch, T.S., Smith, T.P.L., Falkenberg, S.M., Carlson, D.F., Sonstegard, T.S. 2021. Evaluating large spontaneous deletions in a bovine cell line selected for bovine viral diarrhea virus resistance. *Viruses*. 13(11). Article 2147. <https://doi.org/10.3390/v13112147>.

Bovine viral diarrhea virus (BVDV) is an important pathogen of cattle that causes significant morbidity and mortality, despite 50 years of vaccine availability. BVDV entry into susceptible host cells involves attachment of virions to cellular receptors, internalization, and fusion with host membranes. The primary host receptor for BVDV is CD46; however, the complete set of host factors required for virus entry is unknown. Thus, to identify novel factors essential for BVDV entry and find potential therapeutic targets, we sequenced and compared the complete genomes of two commercially available bovine cell lines: Madin-Darby bovine kidney (MDBK) cells which are susceptible to BVDV infection and CRIB cells, an MDBK clone resistant to BVDV infection at the level of virus entry. Comparative genome analyses identified three large deletions in the BVDV-resistant CRIB cell line that were predicted to disrupt the function or expression of the genes PTPN12, GRID2, and RABGAP1L. CRISPR/Cas9 was then used to knockout these three genes, individually or in combination, in the parental MDBK cell line to evaluate the role of these

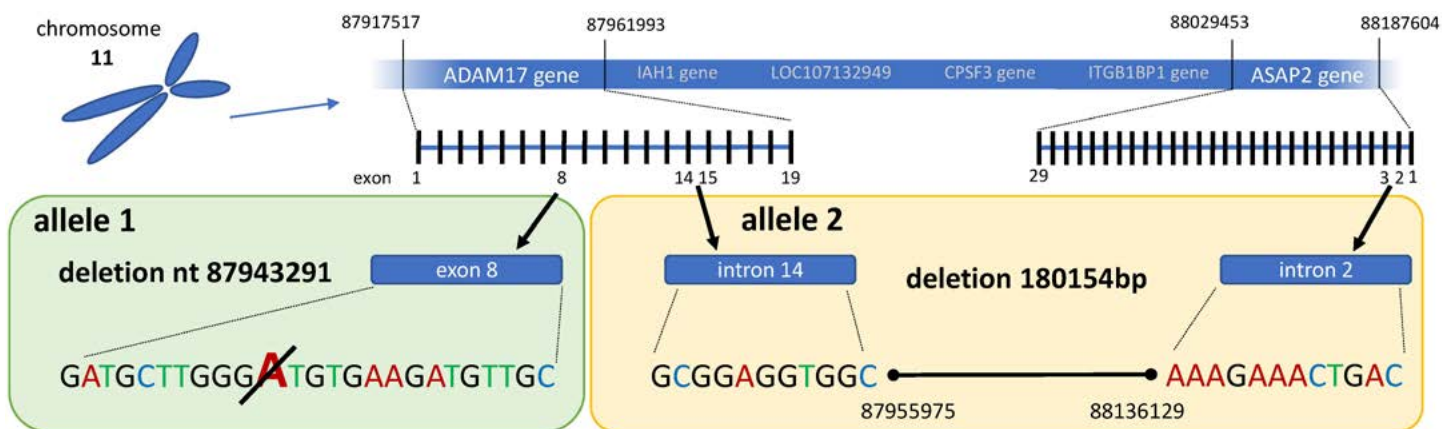
genes in virus entry and replication. Infection studies showed that these three genes were not necessary for viral infection in MDBK cells. More complex analyses of smaller deletions, insertions, and loss-of-function mutations combined with global RNA expression data will be needed to reveal and rank additional candidate genes that may play a role in BVDV resistance. Ultimately, this approach is expected to identify cellular targets for novel intervention strategies to help alleviate the impact of this important viral pathogen of cattle.



ADAM17 is an essential factor for the infection of bovine cells with pestiviruses

Zaruba, M., Chen, H., Pietsch, O.F., Szakmary-Braendle, K., Auer, A., Motz, M., Seitz, K., Dusterhoft, S., Workman, A.M.*, Rumenapf, T., Riedel, C. 2022. ADAM17 is an essential factor for the infection of bovine cells with pestiviruses. *Viruses*. 14(2). Article 381. <https://doi.org/10.3390/v14020381>.

Bovine viral diarrhea virus (BVDV) is an important pathogen of cattle that causes significant morbidity and mortality. BVDV entry into susceptible host cells is a multi-step process and the complete set of host factors required for virus entry is unknown. ADAM17 was recently reported to be an essential cellular attachment factor for the closely related classical swine fever virus. To determine whether ADAM17 might be involved in BVDV entry, ADAM17 mRNA and protein expression was measured in two closely related cell lines: Madin-Darby bovine kidney cells (MDBK; fully susceptible to BVDV infection) and CRIB-1 cells (a derivative of MDBK cells resistant to BVDV infection at the level of virus entry). ADAM17 was detectable in MDBK cells but not CRIB-1 cells. Restoring ADAM17 expression in CRIB-1 cells rendered the once resistant cell line susceptible to BVDV infection. Thus, this study demonstrated that ADAM17 is a key cellular factor missing in CRIB-1 cells leading to BVDV resistance and establishes an essential role for ADAM17 in the entry of BVDV and related viruses into bovine cells. The identification of cellular factors involved in BVDV entry helps our understanding of cellular tropism and could facilitate the development of novel intervention strategies against BVDV.



Genetic alterations of the ADAM17 gene in CRIB-1 cells. Nucleotide positions relative to the ARS-UCD1.2 reference bovine genome. Alignments of reads in the modified regions are shown.

Effects of increasing calcium propionate in a finishing diet on dry matter intake and glucose metabolism in steers

Rathert-Williams, A.R., Salisbury, C.M., Lindholm-Perry, A.K.*, Pezeshki, A., Lalman, D.L., Foote, A.P. 2021. Effects of increasing calcium propionate in a finishing diet on dry matter intake and glucose metabolism in steers. *Journal of Animal Science*. 99(12):1-10. <https://doi.org/10.1093/jas/skab314>.

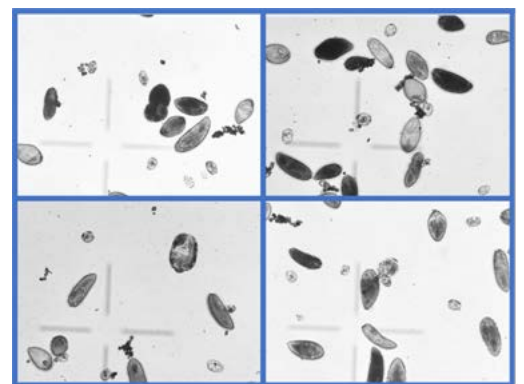
Cattle fed a high concentrate diet produce a greater concentration of ruminal propionate than cattle fed a high forage diet and propionate makes up most of the substrate for liver gluconeogenesis and may improve cattle feed efficiency. The objective of this study was to increase propionate in the diet and determine whether this altered dry matter intake, glucose clearance rate, blood metabolites, insulin concentrations, and hepatic gene expression in steers. Animals fed a control diet were compared to those fed either 100 g/d or 300 g/d of calcium propionate. Animals on the control diet had higher feed intake and body weight gain than either of the groups fed calcium propionate. Animals fed 300 g/d calcium propionate had greater insulin response than the other groups and also had greater expression of SLC16A1, with a tendency for greater expression of SLC2A2. The data from this study suggests that increasing calcium propionate for steers fed a finishing ration alters glucose metabolism. Calcium propionate did not influence basal circulating blood glucose but did decrease feed intake and insulin sensitivity.



Ruminal protozoal populations of Angus steers differing in feed efficiency

Clemmons, B.A., Shin, S.B., Smith, T.P.L.*, Embree, M.M., Voy, B.H., Schneider, L.G., Donohoe, D.R., McLean, K.J., Myer, P. 2021. Ruminal protozoal populations of Angus steers differing in feed efficiency. *Animals*. 11(6). Article 1561. <https://doi.org/10.3390/ani11061561>.

The rumen of cattle are specialized to break down the components of plants into digestible materials for the nutrition of the animal. A key aspect of rumen function is the contribution of the microbial component which acts to perform many of the degradation steps to provide the animal with a variety of nutrients. Numerous studies have examined the bacterial species present in rumen and identified associations of microbial community composition with the efficiency of converting feed to growth in the animal. However, another non-bacterial type of organism called protists make up as much as 50% of the total microbial mass of the rumen, but are not characterized by the methods used for bacteria. The present study examines the protists, or “protozoal” content of the rumen in animals that have been characterized for feed efficiency and other measures of rumen function. The study found that there were specific protozoal species associated with higher feed efficiency, but that those species have not previously been identified, indicating a need for further experiments to characterize these potentially important microbes.



Microscope images of single-cell eukaryotes (protozoa) enriched from a sample of steer rumen fluid.

Association of *ARRDC3* and *NFIA* variants with bovine congestive heart failure in feedlot cattle

Heaton, M.P.*, Harhay, G.P., Bassett, A.S., Clark, H.J., Carlson, J.M., Jobman, E.E., Sadd, H.R., Pelster, M.C., Workman, A.M., Kuehn, L.A., Kalbfleisch, T.S., Piscatelli, H., Carrie, M., Krafur, G.M., Grotelueschen, D.M., Vander Ley, B.L. 2022. Association of *ARRDC3* and *NFIA* variants with bovine congestive heart failure in feedlot cattle. *F1000Research*. 11. Article 385. <https://doi.org/10.12688/f1000research.109488.1>.

Bovine congestive heart failure (BCHF) in feedlot cattle has become increasingly common in the Western Great Plains of North America at moderate elevations (3000 to 4500 ft). This disease is an untreatable, complex condition involving high blood pressure in the lungs, which leads to subsequent heart failure and death. BCHF is fundamentally distinct from the “brisket disease” observed in the high elevations of the Rocky Mountains (>7000 ft), since BCHF occurs at much lower elevations where animals with brisket disease were previously sent to recover. Individual feedlot operations have reported losses from BCHF exceeding \$250,000 annually, which are comparable to losses from bovine respiratory disease at similar locations. Cattle herds affected with BCHF are typically bred and managed with the aim of achieving high-quality carcasses. Consequently, reducing the impact of BCHF is a priority for the beef industry. In the present report, animals with end-stage heart failure from 30 different ranch sources were evaluated

Day 1 (bull)



Day 30 (heifer)



Day 238 (steer)



Bovine congestive heart failure (BCHF) clinical cases at different stages of fattening. Heaton et al. F1000Research 2019, 8:1189

together with their healthy penmates. DNA sequence variation in two major genes (*ARRDC3* and *NFIA*) was discovered to be associated with BCHF, and thus, these genes may play a role in disease development. Feedlot animals in this study, that were homozygous for the DNA risk markers in both genes, were 28-fold more likely to develop heart failure than those without. A DNA-based test with two markers showed 29% of diseased cattle had homozygous risk alleles in both genes, compared to less than 2.5% in similar unaffected feedlot cattle. This type of testing may be useful for identifying feedlot animals at the highest risk for BCHF in the Western Great Plains of North America. In herds suffering from BCHF, knowledge of which cattle have the highest and lowest genetic risk for disease allows producers to make informed decisions for selective breeding and animal health management.

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