W-3010 **Multistate Research Activity Accomplishments Report**

**Project/Activity Number:** W-3010

## Project/Activity Title: Integrated Approach to Enhance Efficiency of Feed Utilization in Beef Production Systems

**Period Covered:** January 2022- January 2023

**Date of This Report:** 03/24/2023

**Annual Meeting Date:** 01/26/2023

**Participants:** Dr. Ibukun Ogunade – West Virginia University, Dr. Matthew Wilson- West Virginia University, Dr. Jennifer Thomson – Montana State University, Dr. Gordon Carstens, Texas A and M University, Dr. Phillip Myer, University of Tennessee, Dr. James Woltjen, University of California, Davis, Dr. Jerad Jaborek, Michigan State University, Dr. Robert Smith – USDA -NIFA

**Brief summary of minutes of annual meeting**:

Meeting was called to order at 1:00 pm EST.

Participants introduced themselves

Dr. Ibukun Ogunade provided a brief background of the group and the status of the project.

Dr. Robert Smith- NIFA representative presented an update on NIFA activities and staffing, the NIFA budget and competitive programs.

Station reports were provided by Dr. Jennifer Thomson (Montana State University), Dr. Ibukun Ogunade and Dr. Matt Wilson (West Virginia University), Dr. James Oltjen (University of California – Davis), Dr. Phillip Myer (University of Tennessee), Dr. Gordon Carstens (Texas A and M University), Dr. Jerad Jaborek (Michigan State University).

The group decided to hold our next meeting in conjunction with the ASAS meeting in Albuquerque, NM. Dr. Ibukun agreed to compile the results from the different stations for submission to NIMSS.

The meeting was adjourned at approximately 3:30 pm EST.

**Accomplishments:**

1. **To understand biological sources of variation in the efficiency of nutrient utilization in beef cattle.**

Research at Texas A and M is focusing on understanding how variation in feeding behavior patterns, digestibility and methane emissions differs between animals with divergent residual feed intake in beef cattle. Publications and conference abstracts and presentations have been developed.

At West Virginia University, they are evaluating how hepatic metabolism is associated with divergent residual feed intake phenotype, the research is focused on evaluating the mRNA expression of genes involved in hepatic fatty acid, amino acid, and mitochondrial energy metabolism in crossbred growing beef steers with low- or high-RFI fed a high forage diet using pathway-focused PCR-based arrays to give more insight into the biological mechanisms associated with RFI divergence. Additionally, they are evaluating how measures of feed efficiency can affect response to feed additive supplementation. This is to understand if and how animal-related factors affect response to feed additive supplementation which is essential to improving the sustainable use of microbial feed additive as an alternative to antibiotics with the ultimate goal of curbing antibiotic resistance in livestock production.

Also, at West Virginia University, they are also working on analyzing the plasma metabolome as well as rumen metabolome and bacterial community of beef steers with positive or negative residual body weight gain (RADG) to determine how divergent RADG phenotype is associated with the host and ruminal metabolism. The results demonstrate that beef steers with divergent RADG phenotype exhibit differences in the relative abundance of some ruminal bacterial taxa and plasma metabolic profiles.

Current research at Michigan State University is focused on understanding the biological differences between native beef and dairy cattle, and their crossbreed contemporaries in a beef × dairy cross breeding scheme. This research aims to identify differences in the efficiency of beef production due to animal health, feedlot growth, and carcass composition. They are completing a study comparing the feedlot performance and carcass traits of Holstein steers and Beef x Holstein steers. They currently have funds to compare Holstein steers with SimAngus x Holstein steers, SimAngus x Holstein heifers, and SimAngus steers to investigate differences in feedlot performance, carcass traits, and red meat yield.

At the University of California Davis, they are extending work on beef finishing systems, they determined maintenance of individual and pen-fed steers. Also, they measured feeding behavior of the two groups. Their work showed that apparent maintenance requirements depend on feed availability in feedlot systems, and that time of eating between steers is not correlated to feed intake but is within a steer.

Research at Montana State University is evaluating muscle and adipose tissue gene expression and metabolites during the late feedlot fattening period in steers. This will be used to better understand how fattening is regulated so a specific carcass quality grade can be achieved and to allow precision management of feedlot cattle. They have a project evaluating metabolic rate, body temperature, heart rate, circulating metabolites and liver gene expression throughout two yearly production cycles with samples taken in each season and three samples taken during the winter in both supplemented and grazing cows.

1. **To discover and develop biomarkers and genetic markers for the genetic improvement of nutrient utilization efficiency.**

**At Michigan State University,** there is an ongoing discussion about the possibility of collecting samples from beef cattle in an upcoming study to identify genetic biomarkers related to marbling deposition.

In Montana, Dr. Thomson is working on a research to identify metabolite and transcript expression biomarkers for USDA quality grade, temperament, feed efficiency, and response to changing environments.

**In West Virginia, research is identifying metabolomic biomarkers for measures of feed efficiency (residual feed intake and residual body weight gain) that could become targets for genetic markers of feed efficiency.**

1. **To evaluate life-cycle efficiency of nutrient utilization in beef cattle to improve economic/environmental sustainability**

Montana has a project evaluating metabolic rate, body temperature, heart rate, circulating metabolites and liver gene expression throughout two yearly production cycles with samples taken in each season and three samples taken during the winter in both supplemented and grazing cows.

In Texas, research is focused on the evaluation of Holstein heifers with divergent genomic residual feed intake on feed efficiency, methane emissions and ruminal fermentation and microbiome classification.

In West Virginia, researchers have collected data on over 1200 animals in confinement to calibrate predictive algorithms to reliably predict dry matter intake in a situation where we are able to easily measure it accurately.  To date, they have been able to reliably predict daily dry matter intake to within 1 kg/day and average dry matter intake throughout the test period to within 0.3 kg/day.  We will continue to refine the predictive algorithms in the next fiscal year, including more animals, additional breeds, incremental daily gain to replace average daily gain and more.  They have collected three seasons of data in the grazing complex and are analyzing forage and fecal samples so that they can begin to use that data in the predictive algorithm effort.  They have also demonstrated that the residual water intake (RWI) for a given test group varies by as much as -6 to +10 liters below or above the predicted intake for groups of animals.  In a 49-day test, that equates to 784-liter differences in water consumption between the least and most efficient animals.  On an annualized basis, that is a 5,844-liter (1,546 gallons) difference in water consumption between the least and most efficient animals.

1. **To develop and propagate EPDs, selection indices, and decision-support tools to facilitate selection for improved nutrient utilization efficiency.**

**In West Virginia, the work on biological water use efficiency is likely to ultimately lead to EPDs of water use efficiency.**

**In Michigan,** results from the currently ongoing research that is focused on comparing the feedlot performance and carcass traits of Holstein steers and Beef x Holstein steers could be used for decision-support tools to facilitate improved sire selection for more efficient beef production from the dairy industry.

1. **To develop producer educational programs to enhance technology adoption by the beef industry.**

**In Michigan,** research results are being shared with producers and stakeholders at Extension meetings, and fellow scientists to inform them of the best management practices regarding beef × dairy crossbreeding for more efficient beef production.

In Texas, work was presented as invited talks on the following topics *“*Selection strategies to improve feed efficiency in beef cattle*”* at the XXIII Feedlot Cattle Symposium, Monterrey, Mexico in May 2022. “EcoFeed for profitable and sustainable beef systems” at the STgenetics Beef on Dairy Elite Producer Symposium in June 2022, and “The merits of genetic selection for RFI to improve cow efficiency” at Brazos county Texas beef producers meeting in 2022.

In West Virginia, results were presented at the National Cattlemen’s Beef Association meeting in February and the American Society of Animal Science meeting in June 2022.  In addition, data was presented at a meeting organized in advance of the National Cattlemens Beef Association.

**Short-term Outcomes:**Short-term outcomes include 12 publications and 17 abstracts/presentations along with producer outreach in West Virginia, Texas, Michigan, and California during the current reporting period.

**Outputs:**Outputs include increased knowledge and understanding of nutrient utilization and efficiency in livestock species as evidenced by 11 publications and 20 research abstracts that were published and presented at meetings and some new or ongoing grants supporting research in this area.

**Impacts:** Increased knowledge and understanding of nutrient utilization and efficiency in livestock species as evidenced by 11 publications, 20 research abstracts and several extension presentations that were published and presented at meetings and some new or ongoing grants supporting research in this area.

**Publications:**

**Peer-Reviewed Publications:**

1. Godstime Taiwo, Modoluwamu Idowu, Mathew Wilson, and Ibukun M. Ogunade\*. 2022. Residual feed intake in beef cattle is associated with differences in hepatic expression of amino acid, fatty acid, and mitochondrial energy metabolism genes. Frontiers in Animal Sci. <https://doi.org/10.3389/fanim.2022.828591>.
2. Godstime Taiwo, Taylor Sidney, Modoluwamu Idowu, Francisca Eichie, Theodore Karnezos, and Ibukun M. Ogunade. 2022. Dietary fenugreek seed extract improves dry matter intake, apparent total-tract nutrient digestibility and alters whole blood transcriptome of Holstein dairy heifers. Translational Anim. Sci. 6:132. DOI: 10.1093/tas/txac132.
3. Modoluwamu Idowu, Godstime Taiwo, and Ibukun M. Ogunade. 2022. Effects of a multi-component microbial feed additive containing prebiotics and probiotics on health, immune status, metabolism, and performance of newly weaned beef steers during a 35-d receiving period. Translational Animal Sci. 6:txac053. doi: 10.1093/tas/txac053.
4. Hubbart, J., N. Blake, I. Holásková, D. Mata Padrino, M. Walker and M. E. Wilson. 2023. Challenges in Sustainable Beef Cattle Production: A Subset of Needed Advancements. Challenges 14:1. 10.3390/challe14010014.
5. Godstime Taiwo, Modoluwamu Idowu, and Ibukun M. Ogunade. 2022. Identification of key pathways associated with residual feed intake in beef cattle via whole blood transcriptome data analyzed using gene set enrichment analysis. Frontiers in Vet. Sci. 10.3389/fvets.2022.848027.
6. Golder, Helen, Stephen LeBlanc, Todd Duffield, Heidi Rossow, Rebecca Bogdanich, Laura Hernandez, Elliot Block, Josh Rehberger, Alexandra Smith, Jennifer Thomson, Ian Lean. 2022. Characterizing ruminal acidosis: A multi-herd, multi-country study. Accepted for publication. 19-Nov-2022. Journal of Dairy Sci. doi: 10.3168/jds.2022-22571.
7. Golder, Helen, Jennifer Thomson, Josh Rehberger, Alexandra Smith, Elliot Block, Ian Lean. 2022. Associations among the genome, rumen metabolome, ruminal bacteria, and milk production in early lactation Holsteins. Accepted for publication. 19-Nov-2022. Journal of Dairy Sci. doi: 10.3168/jds.2022-22573.
8. Thomson, Jennifer. (2022) Sustainability of Wild Populations: A Conservation Genetics Perspective in Encyclopedia of Sustainability Science and Technology ed. Matt Spangler DOI: [10.1007/978-1-4939-2493-6\_1125-1](https://doi.org/10.1007/978-1-4939-2493-6_1125-1) *Part of* ISBN: [9781493924936](https://www.worldcat.org/isbn/9781493924936)
9. Schumacher, M., DelCurto-Wyffels, H., Thomson, J., & Boles, J. (2022). Fat Deposition and Fat Effects on Meat Quality—A Review. *Animals*, 12:1550.
10. Flesch, E., Graves, T., Thomson, J., Proffitt, K., & Garrott, R. (2022). Average kinship within bighorn sheep populations is associated with connectivity, augmentation, and bottlenecks. *Ecosphere*, *13*(3), e3972.
11. Jaborek, J. R., P. H. V. Carvalho, and T. L. Felix. 2023. Post-weaning management of modern dairy cattle genetics for beef production: a review. J. Anim. Sci. 101: skac345.

**Abstracts, Proceedings, and Presentations:**

1. Schaff, N., Dafoe, J., Boss, D., Boles, J., Thomson, J. (2022). PSIII-5 Late-Breaking: Genetic Evaluation of Energy Efficiency in Bos taurus Cows Classified by Residual Feed Intake (100 Supplement 4 ed., pp. 35-36). J. Anim. Sci. <https://academic.oup.com/jas/article/100/Supplement_4/35/6769372?login=false>
2. Adeyemi, J., Toussaint, L., Copie, V., O'Shea, G., Boles, J., Thomson, J. (2022). Utilizing 1H NMR Spectroscopy to Quantify and Identify Biomarkers in Finishing Sheep (vol. 100 Supplement 4). Journal of Animal Science.
3. Thomson, J., Schumacher, M. L., Boles, J. (2022). O43 Utilizing RNAseq to investigate molecular mechanisms impacting meat quality and carcass characteristics in beef steers (2nd ed., vol. 13, pp. 2). Animal - Science Proceedings. <https://www.sciencedirect.com/science/article/pii/S2772283X22007142?via%3Dihub>.
4. Yost, T., N. Blake, M. Walker, I. Holaskova, J. Hubbart, D. J. Mata-Padrino, I. Ogunade, K. Sanders and M. E. Wilson.  2022. Individual Water Use Efficiency in Beef Cattle.  Journal of Animal Science.
5. Blake, N., M. Walker, I. Holaskova, J. Hubbart, D. J. Mata-Padrino, I. Ogunade, K. Sanders, T. Yost and M. E. Wilson. 2022. Predicting Beef Cattle Dry Matter Intake. Journal of Animal Science.
6. Mata-Padrino, D. J., M. E. Wilson and I. M. Ogunade. 2022. The effect of residual feed intake phenotype on herbage disappearance of a permanent pasture. ASA, CSSA, SSSA International Annual Meeting.
7. Carstens, G.E. 2022. Selection strategies to improve feed efficiency in beef cattle. Proc. XXIII Feedlot Cattle Symposium, Monterrey, Mexico.
8. Carstens, G.E. and K. O’Reilly. 2022. EcoFeed for profitable and sustainable beef systems. Proc. STgenetics Beef on Dairy Elite Producer Symposium.
9. Carstens, G.E. 2022. Impact of cold stress on neonatal death losses in beef cattle. Proc. Winter Academy of Veterinary Consultants Conference, Kansas City, KS.
10. O’Reilly, K., G.E. Carstens, J.R. Johnson, N. Deeb and P. Ross. 2022. Effects of genomic residual feed intake on performance, feed efficiency and greenhouse gas emissions in Holstein heifers. J. Anim. Sci. 100:S4.
11. O’Reilly, K., G.E. Carstens, J.R. Johnson, N. Deeb and P. Ross. 2023. Evaluating the utility of genomically enhanced RFI as a selection criterion to improve feed efficiency in growing Holstein heifers. J. Dairy Sci. 106 (Suppl. 1). (Abstr.)
12. Pimentel-Concepción, M., J. R. Jaborek, J. P. Schweihofer, A. J. Garmyn, M. J. McKendree, B. J. Bradford, A. F. Hentschl, and D. B. Buskirk. 2023. Feedlot performance, carcass traits, and feeder calf value of beef x Holstein and Holstein steers. ASAS Midwest Meeting. Madison, Wisconsin.
13. Godstime Taiwo, Modoluwamu Idowu, Taylor Sidney, Francisca Eichie, Emily Treon, Mathew Wilson, Andres Pech-Cervantes and I. M. Ogunade. 2022. Chemical Group-Based Metabolome Analysis Identifies Candidate Plasma Biomarkers Associated with Residual Feed Intake in Beef Steers.
14. Modoluwamu Idowu, Godstime Taiwo, Taylor Sidney, Francisca Eichie, and Ibukun M. Ogunade. 2022. Effects of a multicomponent microbial feed additive containing prebiotics and probiotics on health, immune status, metabolism, and performance of newly weaned beef steers during a 35-d receiving period.
15. Taylor Sidney, Godstime Taiwo, Modoluwamu Idowu, and I. M. Ogunade. 2022. Selection for low or high residual feed intake is associated with altered rumen fluid amine/phenol metabolome of beef cattle.
16. Godstime Taiwo, Modoluwamu Idowu, Shelby Collins, Taylor Sidney, Mathew Wilson, Andres Pech-Cervantes and I. M. Ogunade. 2022. Candidate plasma biomarkers associated with residual feed intake in beef steers. J. Animal Sci.100:155-156.
17. Godstime Taiwo, Modoluwamu D. Idowu, Andres Pech-Cervantes, Zaira M. Estrada-Reyes and I. M. Ogunade. 2022. Hepatic mRNA expression of nutrient and mitochondrial energy metabolism genes in beef steers selected for low or high residual feed intake. J. Animal Sci.100:384-384.
18. Modoluwamu Idowu, Godstime Taiwo and I. M. Ogunade 2022. Effects of dietary supplementation of *Saccharomyces cerevisiae*-based microbial additive containing fermentation products on health, and performance of weaned beef steers during a 35-d receiving period. J. Animal Sci.100:163-163.
19. Taylor Sidney, Godstime Taiwo, Modoluwamu D. Idowu, Mata Padrino Domingo, James Denvir and I. M. Ogunade. 2022. Urine metabolome and whole blood transcriptome of beef steers with low or high residual feed intake. J. Animal Sci.100:372-372.
20. Godstime A. Taiwo, Oyebade, A.O. Modoluwamu Idowu, Diwakar Vyas, and I. M. Ogunade. 2022. A multi-species direct fed microbial supplement alters the milk lipidome of dairy cows. J. Animal Sci.4:0244.

**Extension Publications:**

1. Schaff, N., Dafoe, J., Boss, D., Boles, J., Thomson, J. Hepatic gene expression related to production efficiency in Bos taurus cows classified by residual feed intake as heifers and maternal efficiency. College of Agriculture Extension Research Report 2022.
2. Schumacher, M., Bouffiou, J., Boles, J., Thomson, J. Molecular mechanisms affecting carcass characteristics can be refined by comparative approach between animals at different times in the finishing phase. College of Agriculture Extension Research Report 2022.
3. Adeyemi, J., O'Shea-Stone, G., Toussaint, L., Copié, V., Boles, J., Thomson, J. Utilizing 1h nmr spectroscopy to quantify and identify biomarkers in finishing sheep. College of Agriculture Extension Research Report 2022.
4. Hieber, J. K., Dafoe, J. M., Parsons, C. T., Don, A. C., Boss, D., Boles, J., Thomson, J. Inbreeding levels of the Line 4 Hereford cattle population. College of Agriculture Extension Research Report 2022.
5. Bouffiou, J. J., Hieber, J. K., Boles, J., Thomson, J. Investigating the Relationship Between Temperament and Performance Traits in Feedlot Cattle. College of Agriculture Extension Report 2022.

**Additional Presentations:**

1. Selection strategies to improve feed efficiency in beef cattle” at the XXIII Feedlot Cattle Symposium, Monterrey, Mexico in May 2022.
2. “EcoFeed for profitable and sustainable beef systems” at the STgenetics Beef on Dairy Elite Producer Symposium in June 2022.
3. The merits of genetic selection for RFI to improve cow efficiency” at Brazos county Texas beef producers meeting.