Improving the Production Efficiency of Beef Cows through Mathematical Modeling and Genomics

For decades, the “efficient cow” has been the holy grail of the beef cattle seedstock industry. Increases in beef production have often been possible due to improvements in reproduction, nutrition, genetics, and management, or their combination. Yet beef production is still perceived as a relatively inefficient process from the standpoint of energy utilization. Modeling is a tool that allows researchers to integrate and apply scientific knowledge of biology. Models can be used to identify optimal solutions for diverse production scenarios. We have developed a cow/calf nutrition model that can be used to simulate scenarios of production on a herd basis to identify optimum management practices and systems. Our model utilizes equations developed from data generated from individuals that were sampled from the population (a macro level modeling), showing the impact of known relationships of key variables in determining energy and nutrient requirements of beef cows. We have used this model to evaluate the efficiency of cows in a herd in New Mexico. Simulations of the energy efficiency index (EEI) indicated that cows with less than 36.8 Mcal of energy requirement per kg of calf weaning weight would be extremely efficient, and they represent only 5% of the population. Based on this, we concluded that integrating recent advances in genomics, the identification of intrinsic genetic factors that determine the phenotype of an individual into our nutrition model, could result in a model that more closely mimics requirements and performance of a particular individual. This model could be used to answer questions such as

- Which type of cows is more productive/profitable under specific conditions?
- What is the best supplementation under these conditions?
- When should the sire specifications be changed to improve EEI?
- To which side will the EEI distribution likely shift if a given sire is used?

Objectives

- To develop and evaluate the individual-based model for production efficiency of beef cows using genomic and biomarker information,
- To unveil the distribution of the production efficiency of different cattle herds,
- To determine seasonal and long-term changes in production efficiency of different simulated scenarios to maximize the utilization of the land and feed resources available in each ranch,
- To evaluate the accuracy of the individual-based model to identify efficient grazing cows, and to incorporate specific submodels into our core model to account for proprietary information (genomic panels) from different providers

Outcomes

- The individual-based model will assist ranchers in decision-making process to identify efficient cows and strategize on supplemental feeding to maximize profitability.
- Stochastic modeling will facilitate selection of desired sire characteristics for the herd in order to maximize production efficiency under specific ranch conditions.
- Supportive third-party companies that process genetic markers will be able to provide customers with specific panels of genetic markers that would instruct individual-based models (core model) to perform additional calculations, based on their unique information. These calculations would be proprietary to the third-party companies and will be available only for their customers.

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