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Feed Efficiency:

Unlocking Genetic Secrets

University researchers take on Angus challenge to find answers.

by ***Barb Baylor Anderson***

Feed costs account for 65%-70% of total beef production costs. And with grain prices at some of the highest levels in recent memory, the American Angus Association is looking for ways to help producers manage those costs. By selecting genetics for the best feed efficiency, producers may someday be able to lower the feed line item in the ledger.

"The American Angus Association has agreements in place with principal investigators from the University of Illinois (U of I) and North Carolina State University (NCSU) to take a multidisciplinary approach to studying feed efficiency," says Sally Northcutt, genetic research director for the Association. "We hope that this research will spearhead future practical data collection and analysis for genetic selection tool development."

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Through multi-year studies at both universities, the Association hopes to better understand genetic, hormonal and physical trait differences that affect feed efficiency between animals, and develop animal selection procedures that will improve efficiency.

Integrated feed efficiency

The U of I study is a four-year study that includes a three-year breeding project with 800 fall-calving cows bred to Angus sires. During the study, individual feed intake data will be collected on 450 progeny per feeding period, and a research database developed for live animal performance, ultrasound, carcass and behavioral traits.

GrowSafe units will be used to study feed efficiency. The wireless, radio frequency identification (RFID) units measure feed intake between animal and bunk with less that 2% error.

"The future of the industry depends on the success of producers developing cattle that can be produced economically and that consistently yield high-quality beef products," says Dan Faulkner, U of I animal science professor and project leader.

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"Research shows considerable individual variation in feed intake above and below that predicted on the basis of size and growth rate," he says.

That difference, Faulkner explains, is calculated as residual feed intake (RFI). Genetic selection for lower RFI has the potential to lead to a reduction in feed intake by young cattle and cows with no compromise in performance or increase in cow size. By evaluating the genetic relationships between RFI and other production traits, Illinois researchers hope to determine any economic effect of using high-RFI value bulls.

The first set of cows involved in the study calved in fall 2007, and cows were being bred to begin the second year of the study. Faulkner says all of the cows are artificially inseminated (AIed) twice and then placed with a bull for natural service. The bulls represent much of the current genetic material available and are mated to purebred and commercial cows.

"We have sires used in both purebred and crossbred populations within each year. Common bulls will be used between years as reference sires within the database," Faulkner says. "Two blood samples are collected on each calf, all of the cows and bulls. One of the samples is frozen for future DNA analysis. The second is processed to extract DNA and provide duplicate samples

to ensure quantity and integrity of the samples."

Faulkner says the genetic library amassed during the study will serve as a test data set for future genetic markers. For example, if a marker is developed for marbling, researchers can look at its effects on carcass quality grade, daily gain, feed efficiency, retail yield, tenderness and carcass value with different Choice-Select spreads. If a marker is developed for net feed intake, data will show effect on gains and carcass measurements.

Faulkner hopes the research will allow for detection of quantitative trait loci (QTLs) influencing economically important traits. Once commercialized, more accurate expected progeny differences (EPDs) could be developed by the Association. The data could also be used to determine the merits of combining EPDs, genetic markers, ultrasound and/or live performance data to sort cattle for marketing in different grids and to develop sire indexes for different grids.

"By combining performance, carcass data and cow feed costs, we can determine the relative importance of the information in predicting profitability," he says. "We can compare sires at a constant age, back fat and marbling score to evaluate if sire rankings for carcass merit and performance change when compared. We can look at marbling rate per unit of back fat to select sires that marble well while putting down less back fat."

Others involved in the project include Jonathan Beever, Larry Berger, Darrel Kesler, John Killefer, Juan Loor, Doug Parrett and Sandra Rodriguez-Zas. As part of the process to collect performance, efficiency and carcass data to help assess high-use Angus bulls, researchers will evaluate calving ease; birth, weaning and yearling weights; individual average daily gain (ADG); feed intake and efficiency; and net feed efficiency. Researchers will also measure frame score,

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composition and muscle score, along with such behavioral measurements as chute score and feeding behavior.

Angus cow biological efficiency

The research at NCSU will take a different approach. The five-year project will look at variations in efficiency and identify bulls with efficient daughters and replacement heifers.

"Biological efficiency is defined as the capacity to convert feed into marketable beef under prevailing production conditions and determine overall profitability of a beef production system," says Joe Cassady, NCSU animal science professor and project lead. "Our objective is to identify strategies for improving biological efficiency by considering the genetic, nutritional and reproductive aspects of the problem."

Others involved in the project include NCSU ruminant nutritionists Gerald Huntington and Matt Poore and reproductive physiologist Scott Whisnant.

The NCSU project has four objectives. The first part of the study is already under way to determine the relationship between bull performance during an 84-day, postweaning test and the biological efficiency of each bull's female relatives as brood cows. Researchers are measuring individual bull calf feed intake and body weight to calculate ADG, feed conversion rate and RFI. The measurements are correlated with information that will be collected on cows as part of the second objective to determine which measurements may be used to identify bulls that will produce biologically efficient daughters.

"The key to improving beef cow efficiency is to identify bulls whose daughters will have lower maintenance requirements relative to productivity," he says. "If traits measured in developing bulls and/or heifers and genetically correlated with biological efficiency can be identified, then indirect selection could be applied to improve biological efficiency."

NCSU constructed a new 204-foot cattle barn to house the necessary Calan gates to collect individual feed intake on 54 cows, developing heifers and bulls at a time.

"The exact biological mechanisms responsible for variation in RFI among individual animals are unknown. If these mechanisms are identified, then specific parameters can be used to select individual animals [that] are more efficient," he says. "Improving the accuracy of estimating feed utilization efficiency by individual animals and selecting those individuals [that] are most efficient will decrease feed per unit of gain."

Bulls in the first phase of the study have shown dramatic differences in RFI and no correlations between efficiency and body size, body composition and behavior. Variation is found among bull sires, signaling a genetic component influences animal efficiency.

"The data give further evidence that selecting for efficiency will have little to no effect on growth, behavior or quality," Cassady says. "Heifers show somewhat different results. A significant difference was found in ADG between the most efficient and least efficient heifers, which could be due to other factors. Heifers were not allowed to grow at their genetic potential, which likely resulted in a reduction in genetic variation."

The next study objective is to estimate differences among cows for the amount of feed consumed per pound of calf weaned. Researchers will collect feed intake on lactating cows, calculate megacalories (Mcal) energy consumed and compare it to adjusted 205-day calf weights.

In the third part of the research, the relationship between measures of growth and body composition in developing heifers and their subsequent performance in terms of biological efficiency as cows will be measured. Heifers will be tested during postweaning development, and individual feed intake and weight data will be collected. ADG, feed conversion rate and RFI will be calculated and correlated with performance as a cow.

Finally, researchers will test the effects of different heifer development programs on the biological efficiency of brood cows. Heifers will be subjected to different development programs and their biological efficiency as brood cows measured.

"Ultimately, NCSU hopes to provide guidelines on how to select bulls [that] produce biologically efficient heifers and identify which developing heifers will have the greatest biological efficiency as brood cows," Cassady says. "We also hope to formulate recommendations on how to develop heifers in a manner that maximizes their biological efficiency as cows. We are looking at phenotypic and genetic correlations among measures of developing Angus bull performance and measures of genetic and phenotypic variation in biological efficiency among Angus cows."

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