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Environmental and Economic Benefits of Selecting Beef Cattle for Feed Efficiency[1]

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The Relationship between Feed Efficiency and Costs of Production

Most livestock producers know that feed costs represent a major portion of the total costs in a livestock operation. Depending on forage availability and the duration and severity of the winter, the feed cost of maintaining a cow in the herd can range from $120/year in south Florida to $290/year in North Dakota (Hughes, 2011). The total operating cost of maintaining a cow in the herd (including labor, fuel, interest, etc.) plus all other direct costs **excluding** feed is less variable and was an average of $175/year for 2010 (Hughes, 2011). Considering that figure ($175/year) as the average for all direct costs minus feed, the annual feed cost of maintaining a cow in the herd can represent 41%–62% of the total costs on a yearly basis, depending on location and other factors. In the finishing segment of the beef industry, the proportion of feed costs to total costs of production is even greater because nutrient-dense diets cost more than the diets used in stockers or cow/calf operations.

As grain and fertilizer prices continue to increase, beef producers and researchers are placing more emphasis on tools and strategies that help reduce total feed cost for the beef industry. Improving the efficiency of converting feed into animal protein (i.e., pounds of weight gained, milk produced) is one of the best tools we have to dilute the overhead costs of production and make better use of direct costs such as feed. As a result, in recent years beef cattle producers have become interested in calculating the cost per pound of weight gained and other variables in order to measure how efficiently their cattle use feed.

The Concept of Residual Feed Intake

Typical measurements of feed efficiency are based on simple calculations such as dividing the amount of feed consumed by a measurement of productivity such as the weight gained or milk produced. When both units are on the same scale, we obtain the feed-to-gain ratio (F:G), or its inverse, the gain-to-feed ratio (G:F). These ratios are the most popular measures of feed efficiency used by the beef cattle industry. One disadvantage of using F:G or G:F as a selection criteria to improve the efficiency of the cowherd is that these traits are influenced by growth rate and composition of gain (Herd et al., 2003; Nkrumah et al., 2004). Thus, selecting animals based on lower F:G (or conversely higher G:F) can lead to an increase in mature body weight and maintenance costs. To some extent, it has been argued that continued selection of animals with improved (reduced) F:G has led to a sustained increase in cow mature body weight (Herd et al., 2003).

The search for new methods to measure feed efficiency in cattle led to the development of Residual Feed Intake (RFI), a concept that was first proposed in 1963 and is

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now becoming more widely accepted as a selection tool. A simple definition of RFI is that it measures the difference in feed intake between two animals at the same production level (Koch et al., 1963). In simpler terms, RFI is the difference between an animal's actual average daily feed intake and its predicted daily feed intake for maintenance or production (Basarab et al., 2003). Measuring RFI implies that the intake of each individual animal needs to be measured, and this might be the main reason why its adoption as a selection tool has been delayed for several years.

Equipment has been developed to help facilitate the use of RFI as a measure of efficiency. Such equipment uses electronic identification and automated weight recordings of the feed bunk to collect information about the individual intake of cattle grouped together in pens. However, this equipment is expensive and often only owned by research institutions such as universities or USDA research facilities.

The exact mechanisms that explain why two animals with the same average daily gain (ADG) and average body weight consume different amounts of feed are still under investigation. Several factors have been identified to cause variations in intake responses, and variations are likely a result of a combination of these factors. Some of those factors include the following:

- Differences in breed (Carstens et al., 1989; Elzo et al., 2009).
- Methane production (Nkrumah et al., 2006; Hegarty et al., 2007).
- Digestibility (Richardson and Herd, 2004).
- Maintenance requirements (Herd and Arthur, 2009).
- Carcass composition (Richardson et al., 2001).
- Hormonal profile (Moore et al., 2009).

Impact of Feed Efficiency on Nutrient Excretion

The benefits of selecting for feed-efficient animals in a world of increasing feed costs are obvious, and they have been discussed on numerous occasions. However, one aspect that remains unexplored is the potential environmental benefits of reduced nutrient excretion.

By definition, a more "feed-efficient" animal consumes less feed per pound of beef produced and thus should excrete less manure. While this is true, consider the discussion above in which the traditional feed-to-gain (F:G) was related to cow size and a more efficient cow often was a bigger cow. This means that if an animal is more efficient in terms of F:G, the animal will tend to eat more. While such an animal may produce more beef in relative terms (per lb of feed consumed), the absolute excretion of nutrients (total lb of manure) can be increased. Thus, if we select for efficiency based on F:G, it can lead to choosing animals that produce more beef but that also eat more food and excrete more waste.

Selecting more efficient animals based on RFI provides an alternative with added environmental benefits. Animals selected for lower RFI (more feed-efficient animals) will gain weight at the same rate and should have equal mature weights as those with higher RFI (less feed-efficient animals). The only difference between these animals is the lower feed intake of animals with the lower RFI (more feed-efficient), which should lead to lower nutrient excretions. Figure 1 illustrates the potential environmental benefits through decreased manure excretion of selecting for RFI using data collected at the University of Florida Feed Efficiency Facility in Marianna, FL (Black, 2011). For simplicity of calculations, Figure 1 assumes an equal digestibility of the forage consumed for both high and low RFI cows. In reality, a few studies show that one of the factors contributing to the differences in RFI among animals of the same breed can be the digestibility of feed (Richardson and Herd, 2004; Nkrumah et al., 2006). The improvement in digestibility can be as much as 6%, which can provide an added advantage in terms of reduced nutrient excretion in more feed-efficient cows.

Another factor that has been shown to contribute to RFI differences is the variation of methane production among animals. Methane production by ruminants represents both a waste of energy and an environmental concern. Steers with a lower RFI (more efficient) have been shown to produce 24%–28% less methane than their cohorts (Nkrumah et al., 2006; Hegarty et al., 2007), further indicating the environmental advantage of selecting for lower RFI cattle.

Conclusions

Selecting for feed efficiency based on RFI can significantly impact the amount of nutrients consumed and excreted per cow without compromising animal performance. Fresh manure output and excretions of phosphorous and nitrogen could be reduced by 29%, while methane emissions can be reduced by as much as 28% when selecting more feed-efficient animals. As the beef industry continues

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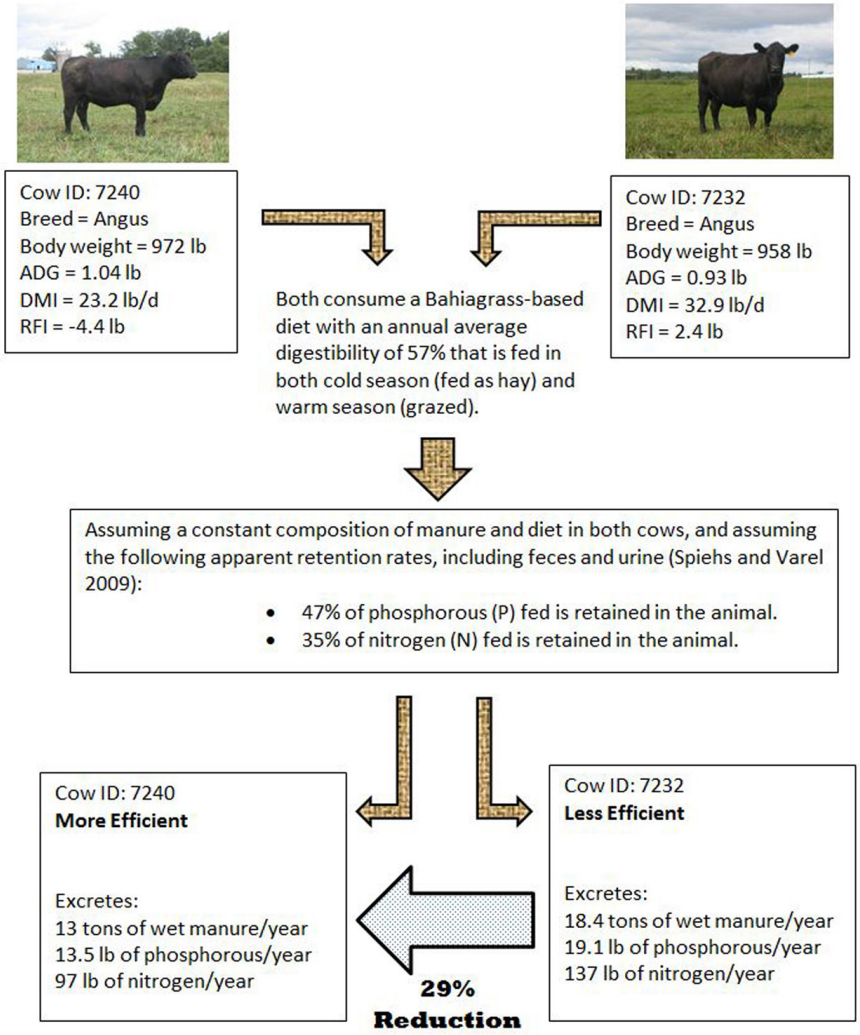

Figure 1. Effect of feed efficiency measured as Residual Feed Intake (RFI) on nutrient excretion by suckled Angus beef cows. A positive RFI indicates a less efficient cow, while a negative RFI indicates a more efficient cow. Both cows are evaluated under the same diet and environmental conditions. (ADG = Average Daily Gain; DMI = Dry Matter Intake).

to face increasing environmental regulations, producers and researchers need to evaluate technologies to continue producing beef efficiently while minimizing the effect on the environment. Using RFI as another selection criterion along with production traits can be an effective tool to achieve that goal.

References

Basarab, J. A., M. A. Price, J. L. Aalhus, E. K. Okine, W. M. Snelling, and K. L. Lyle. 2003. Residual feed intake and body composition in young growing cattle. Can. J. Anim. Sci. 83:189-204.

Black, T. E. 2011. The relationship between performance, residual feed intake, and temperament assessed in growing heifers and subsequently as three-year-old suckled beef cows. M.S. Thesis. University of Florida, Gainesville.

Carstens, G. E., D. E. Johnson, and M. A. Ellenberger. 1989. Energy metabolism and composition of gain in beef steers exhibiting normal and compensatory growth. Energy Metab. Proc. Symp. 43:131-134.

Elzo, M. A., D. G. Riley, G. R. Hansen, D. D. Johnson, R. O. Meyer, S. W. Coleman, C. C. Chase, J. G. Wasdin, and J. D. Driver. 2009. Effect of breed composition on phenotypic residual feed intake and growth in Angus, Brahman, and Angus x Brahman crossbred cattle. J. Anim. Sci. 87:3877-3886.

Hegarty, R. S., J. P. Goopy, R. M. Herd, and B. McCorkell. 2007. Cattle selected for lower residual feed intake

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have reduced daily methane production. J. Anim. Sci. 85:1479-1486.

Herd, R. M., J. A. Archer, and P. F. Arthur. 2003. Reducing the cost of beef production through genetic improvement in residual feed intake: Opportunity and challenges to application. J. Anim. Sci. 81:E9-E17.

Herd, R. M. and P. F. Arthur. 2009. Physiological basis for residual feed intake. J Anim. Sci. 87:E64-E71.

Hughes, H. 2011. The "new normal" - part II. Beef Magazine. August, 12-14.

Koch, R. M., L. A. Swiger, D. Chambers, and K. E. Gregory. 1963. Efficiency of feed use in beef cattle. J. Anim. Sci. 22:486-494.

Moore, S. S., F. D. Mujibi, and E. L. Sherman. 2009. Molecular basis for residual feed intake in beef cattle. J. Anim. Sci. 87:E41-E47.

Nkrumah, J. D., J. A. Basarab, M. A. Price, E. K. Okine, A. Ammoura, S. Guercio, C. Hansen, C. Li, B. Benkel, B. Murdoch, and S. S. Moore. 2004. Different measures of energetic efficiency and their phenotypic relationships with growth, feed intake, and ultrasound and carcass merit in hybrid cattle. J. Anim. Sci. 82:2451-2459.

Nkrumah, J. D., E. K. Okine, G. W. Mathison, K. Schmid, C. Li, J. A. Basarab, M. A. Price, Z. Wang, and S. S. Moore. 2006. Relationships of feedlot feed efficiency, performance, and feeding behavior with metabolic rate, methane production, and energy partitioning in beef cattle. J. Anim. Sci. 84:145-153.

Richardson, E. C., R. M. Herd, V. H. Oddy, J. M. Thompson, J. H. Archer, and P. F. Arthur. 2001. Body composition and implications for heat production of Angus steer progeny of parents selected for and against residual feed intake. Aust. J. Exp. Agric. 41:1065-1072.

Richardson, E. C., and R. M. Herd. 2004. Biological basis for variation in residual feed intake in beef cattle. 2. Synthesis of results following divergent selection. Aust. J. Exp. Agric. 44:431-440.

Spiehs, M. J., and V. H. Varel. 2009. Nutrient excretion and odorant production in manure from cattle fed corn wet distillers grains with solubles. J. Anim. Sci. 87:2977-2984.