

Genetics for Producing Grass-Fed Beef

Scott M. Barao, Ph.D.

Executive Director, The Jorgensen Family Foundation/Hedgeapple Farm, Buckeystown,
MD

The demand for and acceptance of grass-fed and -finished beef has increased rapidly in the last 5 to 8 years due in part to increased public (consumer) awareness of how and where their food is produced. As our food systems have become increasingly globalized, consumers are asking more and more questions about the source of, and production practices behind, the food they purchase and feed their families. Grass-fed beef is viewed as a valuable source of specific nutrients beneficial to human health. In addition, grass-fed beef is perceived to be a more “local” product, raised in a way that is more environmentally and animal friendly. As a result, a growing segment of consumers see greater value in the product and are willing to expend more of their food dollars toward the purchase of the product.

Producers considering a venture into the grass-fed beef production and marketing system are well advised to first assess the local and regional demand for the product and seek out viable marketing opportunities with real opportunity for sustained profitability before ever getting started. In addition, the specific infrastructure needs such as those for slaughter, processing, packaging and labeling must be in place prior to investing in what is truly a niche production and marketing system.

Once a producer has determined that either a change in production or a new grass-fed and -finishing start-up system makes sense, he/she must realize that the production of high-quality, consistent, profitable and sustainable grass-fed beef requires a long-term focus and careful attention to detail across several key beef management areas. Attention must be directed first toward the establishment, maintenance and grazing management of a year-round and high-quality pasture and forage nutrition system. Next, producers must choose the genetic base, the breed or breeds of cattle, best matched to both the pasture/forage system in place as well as the production environment of the operation, and then further, the specific animal type within the breed or breeds of choice. Producers must understand that regardless of breed choice, significant variation in type (mature size, structure, body composition etc.) will exist across bloodlines within a breed. Subsequent selection and breeding decisions must account for this variation if any degree of animal and carcass uniformity is to be achieved, ultimately resulting in a beef product that will be consistently consumer acceptable. The purpose of this paper is to examine specific aspects of beef cattle genetics and type related to the production of grass-fed beef in the mid-Atlantic region.

Overall, when considering genetic and type selection of beef cows for a year-round, pasture-based production system emphasis must be placed on cow efficiency. Many

factors can affect production efficiency in the cow herd such as cow size, milking ability, and reproductive performance. Efficiency may best be defined as the optimum use of resources toward a sustainable level of production. Most often, within the cow-calf segment, production efficiency is expressed as the total pounds of calf weaned per pound of female exposed to a bull. This measure combines both the reproductive performance of the cow herd and the growth characteristics of the calves relative to the total weight of cows in the breeding herd. Fortunately, research indicates the genetic variation for maintenance energy requirement of beef cows is moderate to high, meaning that opportunities do exist to select for more biologically efficient cows.

Cow Size

In a grass-fed production system, pasture/forage establishment, maintenance and management is one of the largest fixed costs. It is vitally important to match cow type to the forage supply to achieve maximum efficiency in harvesting the forage and converting it to a saleable product. Intuitively, we would select for moderate sized cows with high reproductive rates in a short breeding season (45-60 days) producing a high percentage of maternal body weight as weaned calf on a grazing/hay system with no additional nutrient inputs. This cow will carry a smaller frame (3 to 4.5), deeper body, and higher capacity with a moderate milk yield. She will maintain sufficient body condition to achieve superior reproductive performance while consuming only available pasture and hay within the environment (system) she is raised.

Researchers from Wisconsin have shown that smaller cows can wean more pounds of calf per pound of feed consumed than can larger cows (Davis et al., 1983a). The same research group in a different study found that feeding larger cows a higher-energy diet did not increase enough the number and total weight of calves weaned to offset the higher level of energy intake (Davis et al., 1983b). In other words, supplying larger cows with more energy did not increase their production efficiency.

More specifically, cow selection must focus on keeping the energy requirements for maintenance as low as possible across the cow herd. Over the yearly production cycle, the daily maintenance requirement of the animal is most influenced by mature cow size followed by level of milk production. As cow size and milk production potential increases due to genetic selection decisions, cows in a grazing-based production system where nutrient availability may fluctuate throughout the year, will lose weight until their body weight (condition) matches the feed availability. Both reproductive efficiency and milk production may suffer as a result.

There is evidence however that certain genetic difference does exist in the ability of cows to adjust their metabolic activity to changes in nutrient intake. This may account for the observed ability of certain animals to maintain their body condition and production efficiency over a production year while others of similar size and composition cannot. Selective pressure toward these more efficient cattle, either systematically or through the costlier resultant reproductive failure, will improve the overall uniformity and efficiency of the cow herd. Also, multi-generation selection within a total pasture/forage system will result in significant progress toward retaining replacement females carrying both the

longevity and genetic traits needed to reduce overall cow herd maintenance costs and improve system profitability.

Milk Production

In addition to cow size, cow maintenance requirements are impacted by level of milk production. Higher milk production potential (genetically) requires more metabolic machinery with a higher demand for both energy and protein. But, the expression of the added genetics for higher milk production will be limited by the availability of nutrients to support the higher milk potential. When nutrient supply fluctuates or is limited, milk production and cow body condition will decrease and subsequent calf performance will suffer as well. Thus, when the capability of selected genetic traits is not matched to the available resources, expected expression of those traits will be limited.

Milk yield is also related to pre-weaning calf growth so increased milk yield often is considered an advantage in a cow-calf operation. But milk production requires high levels of energy input by the cow, and, if feed resources are limited, milk production can have a negative effect on the overall efficiency of the beef production system.

When calculated for cows of equal body weight, the maintenance requirement for lower-milking cows compared with higher-milking cows is approximately 0.8 pounds less total digestible nutrients (TDN; an estimate of energy intake by the animal) per day during gestation (6.4 vs. 7.2 pounds TDN) and 0.9 pounds less TDN per day during lactation (8.3 vs. 9.2 pounds TDN). When considered across a production cycle so that energy use for gestation and lactation are both included in the estimates of energy requirements, the differences are even larger. When production efficiency is estimated as weight of calf weaned per unit of energy intake, lower-milking cows are more efficient producers to weaning and the calves retain this efficiency advantage through the finishing period. This efficiency advantage to weaning appears to remain throughout the lifetime production of the lower-milking cows.

Reproductive Performance

Reproductive performance is the single most influential factor determining profitability of a cow-calf operation. Improving reproductive performance can influence profitability independent of other measures. The energy status (feed supply, nutrition) of the cow has a significant effect on reproduction and reproductive performance is of paramount importance to the production efficiency of the cow herd.

Research strongly indicates a physiological priority of energy use by the beef cow as shown in the table below. Hence, the energy required to initiate estrous cycling after calving is only available if the requirements for all the previously listed functions (including lactation) have been fulfilled. Therefore, it is important that adequate energy (pasture /forage) is available and matched to the cow such that there is adequate energy left to support cycling and rebreeding.

Table 1. Priority of energy use by the cow

1. Basal metabolism
2. Grazing and other physical activities
3. Growth
4. Supporting basic energy reserves
5. Maintaining an existing pregnancy
6. Milk production
7. Adding to energy reserves
8. Estrous cycling and initiating pregnancy
9. Storing excess energy

Source: Short et al. 1990

Scientists at the Meat Animal Research Center also evaluated the combined effects of body size, genetic differences in milking ability, and reproductive performance on beef cow efficiency (Ferrell & Jenkins, 1985a). Their research clearly demonstrates that at restricted levels of energy intake, such as can be expected periodically within a pasture/forage-based system, smaller cows with lower levels of milk production are more efficient than larger, higher-milking cows (Ferrell & Jenkins, 1984a).

Carcass Characteristics

It is best to start the selection and breeding process in the carcass area by first describing the desired carcass characteristics necessary to produce a consistent consumer acceptable eating experience. The holy grail of system sustainability and long-term profitability is customer acceptance and ultimately repeat buying experiences. Many first-time customers may be attracted to the product for any of the number of reasons mentioned at the outset in this paper, but only an acceptable eating experience will bring them back. Even the demographic that buys this product will carefully assess the perceived value of their shopping experience with both product price and eating performance influencing their future shopping decisions.

A desirable market weight range should be a major consideration when decisions are made regarding breed and within breed type, size and composition selection. Extremes in carcass characteristics, especially ribeye area and intramuscular fat, must be avoided. Ribeye size will ultimately impact the way a carcass is cut for retail sale with very large ribeyes (more than 11.5 square inches) needing to be cut thinner than smaller ribeyes to achieve a consumer acceptable serving size. The demographic purchasing grass-fed beef is not generally looking for 16+ ounce steaks. If your goal is to brag about weight gain or ribeye size or lean tissue growth, you have chosen the wrong cattle and the wrong system to produce them.

Carcass composition is affected by sex, age, genotype, level of nutrition and daily weight gain. Early maturing cattle fed to gain at least 1.9 pounds per day (weaning to finish) with moderate ribeye and intramuscular fat projections are generally recommended to produce acceptable carcasses within an age range of 18-22 months. It is also important to understand that as days on grass increases, the goal should be to deposit intramuscular fat

without expecting significant increase in ribeye area. In other words, the objective becomes increasing the overall carcass quality while achieving an acceptable ribeye size as genetically selected (Highlighted in carcass EPD chart below).

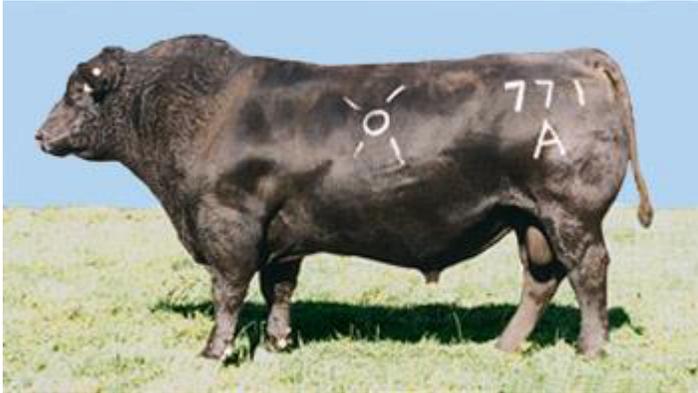
Much data exists on differences in genetic potential for growth rate, mature size, maternal traits and lean-to-fat ratio across several biological types of cattle. Breed associations have used these differences to compile relatively accurate projections of future performance in the growth, maternal and carcass areas. In addition, some breeds now present economic index values for traits such as cow energy value, weaned calf value and feedlot value. The larger the breed and hence the larger the database of information and selection tools, the higher the probability of success in the selection and breeding for specific growth, maternal and carcass targets, even in the grass-based production system. Producers should take advantage of all opportunities, including breed-specific database tools that allow sorting by specific traits of interest, to evaluate and select prospective herd sires.

For example, the American Angus Association publishes data on growth, maternal, carcass and economic traits and allows sorting across the spectrum of data to help producers quickly focus in on traits of interest. A simple sort on Cow Energy Value (\$EN) (Highlighted in maternal EPD chart), a trait that assesses differences in cow energy requirements as an expected dollar savings difference in daughters of individual sires and considers both lactation energy requirements and the energy costs associated with different mature cow size, will yield a great starting point in the search for sires that will produce moderate frame, easy fleshing and moderate milk producing daughters. The search can be refined by sorting further on traits such as maternal mature weight and/or maternal height, yearling height (Highlighted below), or milk. Finally, consideration can be given to the carcass trait Expected Progeny Difference (EPD) data and the sorting process will be further refined. Clearly, this is a simplistic example meant only to highlight the selection power available through a breed specific database, but it does serve to bring focus on traits of interest and refine the breeding and selection decision process to a more manageable task. Data, such as accuracy or reliability of the specific EPD presented, the number of herds in which a sire has been used and the number of daughters in production from a given sire, must also be considered in the context of the breeding and selection decision (American Angus Association, 2017).

Below are several bulls along with their most recent American Angus EPD data. In my opinion, they represent a sampling of the phenotype (size, type, and structure) of cattle that would produce offspring to fit a grass-based production system across a variety of production environments. In addition, they carry the genetic EPD data that supports the phenotype goal of moderate size, moderate milk, deep bodied, easy fleshing and energetically efficient cattle best matched to a total pasture/forage production system across the mid-Atlantic region.

In summary, the sustainable and profitable production of high quality grass-fed and -finished beef is inextricably linked to the genetics of both the cow herd and the resultant feeder calves. Many tools and much data exists to help beef producers select and breed

cattle that will thrive in a pasture/forage-based system when emphasis is placed on a breed or breed type, both phenotypically and genetically, that consistently produces cattle that are moderate in frame, growth, milk and carcass traits and are thick and deep-bodied in their conformation. These are not the cattle that stand high in the show ring, but they are the cattle that stand out in the meat case and will have your customers coming back for more.



Carcass					
CW	Marb	RE	Fat	Carc	Usnd
Acc	Acc	Acc	Acc	Grp/Pg	Grp/Pg
-4	+.05	+.08	-.018	3	180
.51	.56	.56	.50	22	325

Expected Progeny Differences

Production						Maternal					\$EN
CED	BW	WW	YW	YH	SC	CEM	Milk	MkH	MW	MH	
Acc	Acc	Acc	Acc	Acc	Acc	Acc	Acc	MkD	Acc	Acc	
+6	+2.6	+28	+50	-.9	-.58	+1	+7	242	-.55	-1.0	+36.27
.77	.94	.91	.87	.77	.83	.76	.86	599	.69	.70	



Carcass				
CW	Marb	RE	Fat	
Acc	Acc	Acc	Acc	
-14	+12	+17	-.004	
.18	.28	.35	.21	

Expected Progeny Differences

Production						Maternal					
CED	BW	WW	YW	YH	SC	CEM	Milk	MkH	MW	MH	\$EN
Acc	Acc	Acc	Acc	Acc	Acc	Acc	Acc	MkD	Acc	Acc	
+16	-3.4	+31	+58	-.8	-.25	+6	+14	62	-33	-1.0	+26.29
.83	.92	.88	.82	.75	.76	.66	.76	271	.62	.62	



Carcass				
CW	Marb	RE	Fat	
Acc	Acc	Acc	Acc	
-40	+.39	+.02	+.051	
.46	.50	.45	.44	

Expected Progeny Differences

Production						Maternal					
CED	BW	WW	YW	YH	SC	CEM	Milk	MkH	MW	MH	\$EN
Acc	Acc	Acc	Acc	Acc	Acc	Acc	Acc	MkD	Acc	Acc	
+11	-2.2	+7	+20	-.2	-.06	+4	+9	17	-61	-.7	+36.98
.64	.83	.88	.68	.62	.67	.66	.63	62	.62	.65	

Acc – accuracy: An accuracy of close to 1.0 indicates higher reliability; BW – birth weight, CW – carcass weight, MW, mature daughter weight, WW – weaning weight, and YW – yearling weight; CED - calving ease direct, CEM - calving ease maternal; \$EN - differences in cow energy requirements as an expected dollar savings difference in

daughters of sires; Carc Grp/ Pg and Usnd Grp/Pg - the number of contemporary groups and number of carcass and ultrasound progeny included in the analysis; Fat - external fat thickness at the 12th rib; MH – mature daughter height, YH – yearling height; Marb – marbling; Milk - part of a calf's weaning weight attributed to milk and mothering ability of its dam; MkD - number of daughters that have progeny weaning weight records, Mkh - number of herds from which daughters are reported; RE – ribeye area in square inches; SC – scrotal circumference measured in centimeters. (From American Angus Association website: <https://www.angus.org/Nce/Definitions.aspx>)

References:

- American Angus Association. 2017. EPD and \$Value Definitions: How to Read the Report. 3201 Frederick Avenue, Saint Joseph, MO 64506.
- Davis, M.E., J.J. Rutledge, L.V. Cundiff, and E.R. Hauser. 1983a. Life cycle efficiency of beef production: I. Cow efficiency ratios for progeny weaned. *J. Anim. Sci.* 57:832–851.
- Davis, M.E., J.J. Rutledge, L.V. Cundiff, and E.R., Hauser. 1983b. Life cycle efficiency of beef production: II. Relationship of cow efficiency ratios to traits of the dam and progeny weaned. *J. Anim. Sci.* 57:852–866
- Ferrell, C. L., and T. G. Jenkins. 1984a. Energy utilization by mature, non-pregnant, non-lactating cows of different types. *J. Anim. Sci.* 58:234-243.
- Ferrell, C. L., and T. G. Jenkins. 1985a. Cow type and the nutritional environment: Nutritional aspects. *J. Anim. Sci.* 61:3:725-741.
- Short, R.E., R.A. Bellows, R.B. Staigmiller, J.G. Berardinelli, and E.E. Custer. 1990. Physiological mechanisms controlling anestrus and infertility in postpartum beef cattle. *J. Anim. Sci.* 68:799-816.