# Proceedings of the Beef Improvement Federation 38th Annual Research Symposium and Annual Meeting

MISSISSIPPI
BIF 2006

**April 18 – 21, 2006**
**Pearl River Resort**
**Choctaw, Mississippi**

*Hosted by*

Mississippi State University Extension Service

Mississippi Cattlemen's Association

BCIA Productivity and Quality

*Sponsored by the National Cattlemen's Beef Association*

BEEF USA

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# Beef Improvement Federation
# 38th Annual Research Symposium and Annual Meeting

***Pearl River Resort, Choctaw, Mississippi***
***April 18-21, 2006***

## Tuesday, April 18, 2006

| | |
|---|---|
| 10:00 a.m. | Beef Improvement Federation Golf Tournament, Dancing Rabbit Golf Club, Choctaw, MS |
| 6:00 p.m. | Mississippi Opening Reception |
| 7:30 p.m. | Symposium sponsored by the Ultrasound Guidelines Council<br>"Basics of Ultrasounding Beef Cattle for Genetic Improvement" |

## Wednesday, April 19, 2006

| | |
|---|---|
| 7:00 a.m. | Spouses/ Family Tour departs for Meridian, MS |
| 8:00 a.m. | Welcome comments |
| 8:15 a.m. | General session - Where do I as a Cow-Calf Producer Fit in Retail and Consumer Targets?<br>*Moderator - Tommy Brown, BIF Board of Directors, Clanton, AL* |
| 8:15 a.m. | Identifying the 21st Century Beef Consumer - *Kevin Murphy, Vance Publishing Corporation* |
| 9:00 a.m. | How to Satisfy the 21st Century Beef Consumer - *Paul Heinrich, SYSCO Corporation* |
| 9:45 a.m. | Break |
| 10:30 a.m. | How do I Satisfy the 21st Century Beef Consumer?<br>A Cattle Feeder's Perspective - *Tom Brink, Five Rivers Ranch Cattle Feeding*<br>A Cattle Marketer's Perspective - *Jackie Moore, Joplin Regional Stockyards* |
| 11:15 a.m. | 2005 National Beef Quality Audit Results - What are the Challenges for the Future of Beef Production? –<br>*Brad Morgan, Oklahoma State University* |
| 12:00 p.m. | BIF Recognition Luncheon |
| 2:00 p.m. | Committee Meetings<br>Genetic Prediction – *Chair, Larry Cundiff, USDA MARC*<br>Live Animal, Carcass, and Endpoint – *Chair, Robert Williams, American Int'l Charolais Association*<br>Producer Applications – *Chair, Sally Northcutt, American Angus Association* |
| 5:30 p.m. | Spouses/ Family Tour arrives back at Pearl River Resort |
| 6:30 p.m. | Southern Style Supper and Entertainment (Neshoba County Coliseum) |

## Thursday, April 20, 2006

| | |
|---|---|
| 8:00 a.m. | General Session - Where do I Fit with My Production Environment?<br>*Moderator - Joe Roybal, BEEF Magazine* |
| 8:00 a.m. | Defining Feed Efficiency - *Gordon Carstens, Texas A&M University* |
| 8:30 a.m. | Genetics of Feed Efficiency in Beef Cattle - *Denny Crews, Agriculture and Agri-Food Canada* |
| 9:00 a.m. | Development of Feed Efficiency Genetic Evaluation and Decision Support –<br>*Dorian Garrick, Colorado State University* |
| 9:30 a.m. | Break |
| 10:00 a.m. | Matching Beef Genetics with Production Environment - *Dr. Tom Jenkins, USDA MARC* |
| 10:45 a.m. | Heterosis - Ignored or Forgotten? - *Dave Daley, California State University, Chico* |
| 11:30 a.m. | Annual Meeting and Director Elections |
| 12:00 p.m. | BIF Awards Luncheon |
| 2:00 p.m. | Committee Meetings<br>Cowherd Efficiency and Adaptability – *Chair, Mark Enns, Colorado State University*<br>Emerging Technology – *Chair, Craig Huffhines, American Hereford Association*<br>Selection Decisions – *Chair, Darrh Bullock, University of Kentucky* |

## Friday, April 21, 2006

| | |
|---|---|
| 7:00 a.m. | Producer Tour - buses depart |
| 8:00 a.m. | Mississippi Agricultural and Forestry Experiment Station, Mississippi State, MS |
| 11:00 a.m. | EE Ranches, Inc., Winona, MS (Lunch) |
| 4:00 p.m. | The Gaddis Farms, Bolton, MS |
| 6:00 p.m. | Mississippi Ag Museum, Jackson, MS (Supper) |

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# Satisfying the 21st Century Beef Consumer: A Cattle Feeder's Perspective

***J. Tom Brink***
***Senior Vice President, Cattle Ownership and Risk Management***
***Five Rivers Ranch Cattle Feeding, LLC.***

## Introduction

Five Rivers is a new name in the beef industry. However, the two firms that merged to form the new company have been feeding cattle for many years. This joint venture between ContiGroup Companies, Inc. and Smithfield Foods operates ten feedyards with a total one-time feeding capacity of 811,000 head. We are the largest cattle feeder in the world, with feedyards located in Colorado, Kansas, Oklahoma, Texas and Idaho. Our yards range in size from 52,000 to 125,000 head of capacity. Production efficiency and economies of scale are clearly an important part of the operation.

We adhere to "commodity" principles as the foundation of our business strategy. Profitably feeding cattle is dependent upon competitive procurement of feeder cattle and corn, excellent operational efficiency, and effective risk management. But those things are just the foundation. The rest of our strategy involves segmenting our cattle inventory and managing cattle to attain grid premiums, and increasingly, premiums associated with branded beef programs. To thrive in the modern-day beef business, we must be both low-cost producers, effective managers of risk…AND good at generating greater top-line revenue through various value-added programs. The beef market is segmenting rapidly at the consumer level, so we must increasingly sort and segment our cattle inventory to fit these programs and reduce variation---all the while maintaining a high level of production efficiency. Being a large operation has some advantages, but it does not guarantee success. We must compete effectively every day to stay in business and generate acceptable returns for our shareholders.

## Through a Cattle Feeder Lens

To satisfy the 21st century beef consumer, we need to address a few major industry problems. We can then look forward and carve out new and better methods for doing business in the future.

***Health.*** The first problem is the health and immunity of cattle entering feedyards. I asked our feedyard managers to identify the biggest challenges they experience with cattle they receive, and health issues topped the list. Despite years of work, there is still much more to do in the area of health. Cattle simply need stronger immunity at the time they leave their farm or ranch origin, and this problem is more about producer education and implementation than it is about technology or know-how. Industry trends toward a greater number of Vac-45 type programs are favorable and have helped put a dent in the problem. However, there are still way too many cattle entering feedyards with naïve immune systems. One of the ways Five Rivers deals with this challenge is by feeding mostly yearling cattle. We certainly feed calves and lighter cattle too, but we emphasize older, heavier cattle because they have greater immunity to disease. We staff only 0.8 people per 1,000 head on feed, so there's little time to deal with problem animals.

The economic impact of sickness and death loss is easy to quantify in the feedyard. And it is sizable as shown in the table below. Keep in mind that these steers are yearling-feds, and overall they had a death loss of 0.79%, which is considered quite acceptable by industry standards.

**February 2006 Steer Closeout Results**

| Death Loss Group | Average Death Loss | Profit per head* |
|---|---|---|
| 0% | 0% | $87.16 |
| 0 - 1% | 0.43% | $81.82 |
| 1 - 2% | 1.39% | $62.10 |
| 2 - 5% | 2.46% | $47.54 |

*Pre-interest profits on 75,206 total head.

A similar evaluation of calf-fed cattle would be even more dramatic in terms of the range in death loss percentage and profit/loss impact. We also know that morbidity has a big impact on meat quality, so this is not just a production matter. It is a consumer issue too.

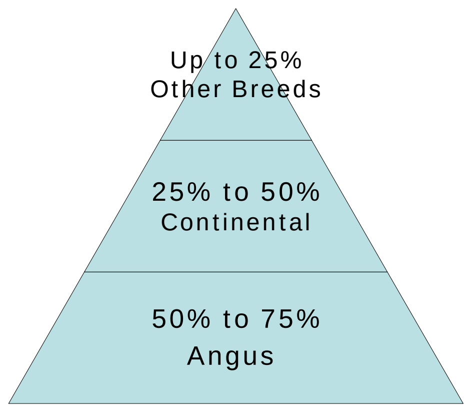
***Breed Composition.*** Another problem we face is the fact that huge numbers of cattle are designed wrong genetically. We've all heard the argument that there is more difference within breeds than between breeds. This statement has been used for decades in the name of political correctness---to the detriment of our industry. Breeds are different. They have different strengths and weaknesses, and some bring more desirable traits to the table than others. As cattle feeders, we see this everyday. Unfortunately, my segment of the industry has remained too quiet in speaking up and telling cow-calf producers what we want. Nobody wants to offend anybody else, and the result is that our industry is not as prosperous as it could be.

I am not going to remain quiet. I will tell you exactly what Five Rivers wants from a breed composition standpoint. And the reason we have a preference is because cattle that are well-designed genetically do a good job meeting the needs of the cattle feeder, packer, and consumer. The right breed combination alone does not guarantee a perfect animal. But it is the right place to start. Furthermore, cow-calf producers understand breeds. So if we identify and communicate the most desired breed combinations to them, they can and will produce more cattle with the right breed mix.

What does Five Rivers want? Our first choice is an Angus x Continental animal that is 50% to 75% Angus and 25% to 50% Continental. This combination makes a right-sized, good-feeding, good-grading, good-yielding animal that covers a lot of important bases. Higher percentage Angus cattle (Black and Red) will grade very well, but are weaker in red meat yield, sometimes producing excess Yield Grade 4s. High-percentage Continental cattle produce high red-meat yields, but they don't grade Choice often enough and often fail to finish before they get too big in the feedyard. A balanced combination of Angus and Continental breeding is tough to beat.

Now let's discuss heat-tolerant genetics. Cattle feeders understand that producers need a cow with some "ear" in Southern States, like Mississippi. This reality is well understood by those of us who feed southern cattle in our Texas and Kansas feedyards. However, to make a desirable southern feeder animal, the heat tolerant genetic component needs to be 25% or less. This enables the southern cow-calf producer to have up to a 50% ear-influenced cow, as long as the bulls being used are not carrying Bos Indicus genes. I have another rule of thumb about what makes a desirable Southern feeder animal. These cattle need to have twice as much Angus as they have eared-breed influence. Secondly, they need to have an equal amount of Continental breed influence as they have ear. In other words, a ½ Angus, ¼ Continental, ¼ heat-tolerant breed animal would fit the bill very well, and would still enable the southern producer to keep enough heat-tolerant genetics in his cow herd.

Breed Composition Pyramid: Ideal Feeder Animal




A useful way to package these thoughts is in the form of a pyramid for breed composition. Black and Red Angus fit at the bottom of the pyramid and should be incorporated into the ideal feeder animal at 50% to 75%. Continental breeds merit a 25% to 50% inclusion rate. Any other breed can be incorporated at up to 25%, provided that the bottom two sections of the pyramid are satisfied. Obviously, high-quality genetics from each contributing breed will result in a more desirable final product. So the pyramid addresses breed composition, without replacing the need to make wise genetic selection decisions within each breed being used.

One of the glaring problems we have in our industry is chronically low quality grades in Texas and Kansas packing plants (averaging only 40% to 45%). This is largely a genetic problem with Southern-origin cattle that simply don't have enough genetic potential to grade Choice. If we breed more cattle according to the Breed Composition Pyramid, much of this problem could be solved. We need to add more Angus to the Southern cattle population. Conversely, in some Northern-origin cattle, Yield Grade 4s have become a problem due to the high-percentage of British breeding. Again, the solution is a more balanced composition of breeds. Cattle with well-designed genetics also fit a variety of branded beef programs, which makes them worth more to everyone in the supply chain.

**Progressing in the 21st Century**

We've discussed health and genetics which are actually hold-over problems from the past century. Now it's time to peer forward. Let's look at a few quotes from Five Rivers' feedyard managers:

***"Embrace individual animal I.D. and maintain verifiable age and source records on your calf crop."***

***"In today's industry, with source and age verification being on the consumer's mind, I think this would be one of the easiest and most rewarding steps any cow-calf producer could take.***

***"If we in the industry want to give consumers what they are willing to pay for, then cow-calf producers should begin to shift their mental paradigms to the age and source verification process."***

It is trendy to talk about age and source verification, but is there any real opportunity here? Our answer is YES, even if the Japanese do not re-enter our beef market in the near future. Here's why. Segmentation in the U.S. beef market is creating a host of niche marketing programs, some of which are economically viable for producers to become involved in. The largest niche is natural beef, which by some accounts already exceeds $1 billion annually. Premiums of $25 to $75 per head (depending on specifications) are currently being paid for calves that are verifiably natural. Requirements for verification vary, but you'll need complete and accurate calving records and a good tagging system to get your calves certified. It takes work and organization, but natural beef is here to stay. We'll see a lot more natural cattle in the years ahead, because consumer demand for natural beef is growing rapidly. There are other beef market niches that require other types of certification, but the foundation of all these programs is a complete, verifiable set of information on each calf crop.

Another manager quote worth emphasizing it this:

***"Cow-calf producers should shift their mindset to more cooperative integration within the overall production chain."***

If we as beef producers are going to satisfy the consuming public, we need to work together and share information. Of course, saying that is nothing new. We have all heard it before. What's different today is that there are REAL economic opportunities available to cow-calf producers who are willing to develop relationships with producers in other segments of the industry, most notably, with feedyards. Those who work at their genetics, manage their cattle well---and then link up with feedyards who can help them capture value-added premiums---can realistically garner $50 to $80 per head over the commodity cattle market. We see it happen all the time. And we believe those value-added dollars will be especially important in the years ahead when calf prices lower cyclically lower. Sustainable premiums are possible today, and will be in the future.

A big part of the benefit of working with people in other segments of the beef industry is the learning that takes place. As beef production becomes more complicated (and it does every year), there is a constant need for every producer to remain on a positive mental growth curve. We in the cattle feeding industry must also remain "life-long learners." Our world is changing rapidly too. The exciting thing is that much of what we talked about as theory for many years in this industry is actually happening. There are real economic opportunities available to those willing to work at the process and approach their business with an open mind. We have the tools, technology, and marketing system to make it happen.

# Report of the June-September, 2005 National Beef Quality Audit: A New Benchmark for the U. S. Beef Industry*

*This is a Preliminary Report covering those portions of the National Beef Quality Audit—2005 that had been conducted as of December 31, 2005. Phase II of the Audit (additional Face-To-Face Interviews, In-Plant Audits and Economic Assessments) is being conducted now (January through June 2006). The Final Report of the National Beef Quality Audit—2005 will be released in the Fall of 2006. All of the information in this Report is "preliminary" and subject to change when the Final Report is completed.

**Conducted By:**

| | |
|---|---|
| **Colorado State University** | **Texas A&M University** |
| **Oklahoma State University** | **West Texas A&M University** |

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**National Cattlemen's Beef Association**

# Report of the June-September, 2005
# National Beef Quality Audit:
# A New Benchmark for the U. S. Beef Industry

***Gary C. Smith, J.W. Savell, J.B. Morgan and T.E. Lawrence***
***Colorado State University (Fort Collins, CO); Texas A&M University (College Station, TX); Oklahoma State University (Stillwater, OK) and West Texas A&M University, (Canyon, TX)***

"In truth, it is the value of our product to our consumers that determines what beef is worth—and our profitability. The National Beef Quality Audit provides valuable information to industry stakeholders regarding the monetary consequences of not truly delivering the quality and value to our consumers" (Terry Stokes, NCBA). "The forces shaping the beef industry in the 21st century (Daryl Tatum, Colorado State University) are: (a) continued consolidation in all beef sectors; (b) loss of export markets; (c) greater competition from other countries in the global market; (d) development and implementation of traceability/data-management systems, and; (e) growth of markets for natural and organic food products." "Beef in the US is now being sold based upon USDA grades, USDA brands, and industry brands; tremendous growth has occurred in the last ten years in USDA certified brands and USDA process verified brands, causing progressively greater emphasis on verifying marketing claims and on authenticity management for processes and products" (Cara Gerken, IMI Global, Inc.)." "Tracking cattle from the ranch to the packer is essential because export markets will require it, Wal-Mart and McDonald's want it, and producers can benefit from it" (John Paterson, Montana State University). "A partnership for quality (PFQ) can be formed between a beef finishing/ harvesting company and progressive producers who are strongly focused on the production of a consistent, high quality, consumer-driven product, with the strictest standards for food safety, environmental stewardship, economic sustainability and animal welfare. A PFQ makes possible PFQ Program Incentives for genetics, vaccination, weaning, seasonality, natural (hormone/antibiotic constraints) and carcass characteristics" (Mike Smith, Harris Ranch Beef). "Involvement in alliances allows beef supply-chain focus upon today's and tomorrow's targets—(a) a safe beef supply, (b) electronic IAID with age records, (c) balance in production performance and carcass merit, (d) management based upon individuals rather than on pen/lot averages, (e) avoidance of 'out cattle' (dark cutters, advanced maturity, etc.), (f) control of carcass weight (target=600 to 949 lb), (g) production of High Select or better, and Yield Grade 2 or better, carcasses with ribeye areas of 10.0 to 15.9 sq in, (h) adoption of instrument grading, and (i) tenderness testing to avoid tough beef" (Glen Dolezal, Cargill Meat Solutions). "Major trends and opportunities in the US beef industry include: (1) Globalization, and thus increased competition. (2) Retail and foodservice consolidation. (3) Coordinated production systems. (4) Increased product branding and value differentiation. (5) Accelerated development of new consumer-friendly and convenience-orientated beef products" (Randy Blach, Cattle·FAX).

"The National Beef Quality Audits provide: (1) A snapshot of the industry's current 'Quality Status.' (b) A 'Benchmarking Tool' for the industry's quality improvement strategy. (c) A 'Driver' for the industry's Beef Quality Assurance, Producer Education Programs" (Ran Smith, Smith Farms, Chairman of BQA Advisory Board). "The National Beef Quality Audits of 1991, 1995 and 2000 have provided valuable industry benchmarks for use by beef industry stakeholders, and identified areas on which to place emphasis in local, state and national Beef Quality Assurance endeavors" (Gary C. Smith, Colorado State University). "Previous National Beef Quality Audits have identified Strategies, Tactics and Goals as vision directives for those in the production sector who wish to be more competitive and find marketing options—now or in the future, in domestic and/or international venues" (Tom Field, Colorado State University). "A panel of industry professionals assessed beef-industry progress in achieving the twelve 'Goals' identified by the National Beef Quality Audit—2000; individually, grades as low as D-plus (develop and implement electronic cattle identification) and as high as B-plus (eliminate injection-site lesions; 100% of seedstock producers have genetic data) were assigned, and the overall average grade for the beef industry was B-minus" (Clint Peck, Beef Magazine).

Based on questionnaires returned by those in the seedstock generation, cow/calf production, stocking/backgrounding and feedlot finishing sectors, the "Top Ten Greatest Quality Challenges," in NBQA—2005, ranked according to aggregated responses by those in all four production sectors were: (1st) Insufficient Marbling & Low Quality Grades; (2nd) Lack Of Uniformity In Cattle; (3rd) Inadequate Tenderness Of Beef; (4th) Yield Grades Too High; (5th-Tie) Low Cutability; (5th-Tie) Carcass Weights Too Heavy; (7th) Injection-Site Lesions; (8th) Inadequate Flavor; (9th) Inadequate Muscling, and; (10th) Excess Fat Cover (Deb Roeber, Oklahoma State University). Aggregated responses by those in all four production sectors revealed that 26.5%, 55.4% and 18.1% believed that past NBQAs had "strong," "moderate" or "weak" impact, respectively, on "changes made since 1991."

Questionnaires returned by packers revealed that: (a) 92.1% of their carcasses weighed 600 to 1,000 lb; (b) 66.2% of their carcasses graded Prime or Choice; (c) 86.5% of their carcasses were of Yield Grades 1, 2 plus 3; (d) Incidences of "calloused ribeye," "dark cutter" and "blood splash" were 0.3%, 1.5% and 1.7%, respectively; (e) 31.5% of their purchased harvest-cattle were individually identified; (f) the average number of branded-beef programs marketed by these packers was 5.3, with 37%, 62%, 48% and 42% of those programs having specifications for breed, marbling, hide color and Yield Grade, respectively, and; (g) percentages of packers using specific food-safety interventions of hide-on carcass washing, steam pasteurization of carcasses, hot (>165°F) water carcass washing, pre-evisceration carcass washing, steam vacuuming of carcasses, and organic-acid rinsing/washing of carcasses were 16.7, 16.7, 66.7, 83.3, 100.0 and 100.0, respectively (Deb Roeber, Oklahoma State University). The "Top Five Greatest Quality Challenges," in NBQA-2005, identified by packers were: (1st) Reduced Grade & Tenderness Due To Use Of Implants; (2nd) Lack Of Uniformity In Live Cattle; (3rd-Tie) Carcass Weights Too Heavy; (3rd-Tie) Yield Grades Too High; (5th-Tie) Presence Of Bruises On Carcasses, and; (5th-Tie) Hide Damage Due To Hot-Iron Brands. Among packers, 33%, 67%, and none (0.0%) believed that past NBQAs had "strong," "moderate" or "weak" impact, respectively, on "changes made since 1991."

Based on questionnaires returned by those in the purveyor, restaurateur and supermarket operator sectors, "Special Concerns/Desires Of Customers/Consumers" were: (1st) *E. coli* O157:H7; (2nd) Hormone Residues; (3rd) Desire For "Natural" Products; (4th) Antibiotic Residues; (5th) Desire For Traceback; (6th) Concerns About Animal Welfare; (7th) *Salmonella*; (8th) *Listeria monocytogenes*; (9th) Desire For "Organic" Products; (10th) Price; (11th) Concerns About The Environment, and; (12th) BSE (Deb Roeber, Oklahoma State University). The "Top Ten Greatest Quality Challenges," in NCBA—2005, ranked according to aggregated responses by those in the three end-user sectors were; (1st) Insufficient Marbling; (2nd) Cut Weights Too Heavy; (3rd)

Lack Of Uniformity In Cuts; (4th) Inadequate Tenderness; (5th) Excess Fat Cover; (6th) Inadequate Juiciness; (7th) Inadequate Flavor; (8th) Inadequate Overall Palatability; (9th) Low Cutability, and; (10th) Too Large Ribeyes. Among end-users, 15%, 85% and none (0.0%) believed that past NBQAs had "strong," "moderate" or "weak" impact, respectively, on "changes made since 1991."

Brad Morgan (Oklahoma State University) reported results of a US Meat Case Benchmark Study which determined that: (1) 68% of the average self-service meat case was comprised of "fresh" meat items; fresh beef (29%), chicken (16%) and pork (14%) had the highest proportions of meat department case footage. (2) 43% of fresh beef cut packages and 34% of ground beef packages had cooking instructions on the package; 9% of all fresh beef packages had nutrition labels. (3) Of the 87% of all fresh beef packages (13% was as offals, ingredients, miscellaneous), 43 percentage points (pp) was steaks, 30 pp was ground and 14 pp was roasts. (4) 3% of beef packages were "value added" compared to 14%, 10% and 7% for chicken, pork and turkey, respectively. (5) 1.5% of beef packages were "Natural" or "Organic," compared to 6.5% for chicken. (6) 82% of beef steak packages, and 93% of beef roast packages, were "boneless." (7) 62%, 21%, 6% and 10% of ground beef packages were designated by leanness percentage (e.g., 85% lean), by cut source (e.g., ground round), by both leanness percentage and cut source, and as just "ground beef" with no designation/source, respectively. (8) Beef had the lowest case-ready penetration at 27%; pork, chicken and turkey had 37%, 83% and 85%, respectively, case-ready penetration. (9) 46%, 56% and 20% of all steak, roast and ground beef items (SKUs), respectively, were out-of-stock (00S); for all three kinds of fresh beef products, case-ready products were less likely to be OOS than store-wrapped products.

Face-To-Face Interviews of representatives of six government agencies (FSIS, AMS, GIPSA, FAS, APHIS, FDA/CVM) and representatives of eight trade organizations (AMI, USMEF, FMI, NAMP, NRA, SMA, NMA, NBCA) identified the following "Quality Defects/Challenges": (1st) Lack Of Mandatory Traceability, ID System And NAIS Compliance; (2nd-Tie) Product Inconsistency; (2nd-Tie) Food Safety: Pathogens/Bacteria/EHEC/*Salmonella*/*Listeria monocytogenes*; (4th-Tie) BSE; (4th-Tie) Growing Concern About Humane Handling, Animal Welfare/Husbandry, And The Environment; (6th-Tie) Inadequate Tenderness/Palatability, & Too Low Quality Grade; (6th-Tie) Appropriate SRM Removal/Disposal & Lack Of 4-D Animal Disposal; (8th-Tie) Growing Concern About Chemical Residues; (8th-Tie) Carcass/Cut Weights Too Heavy And Inconsistent; (10th-Tie) Shelf-Life; (10th-Tie) Lack Of Age/Source Verified Cattle; (10th-Tie) Growing Concern About Antimicrobial Resistance; (10th-Tie) Poor Meat Color And pH Variation In Ground Beef And Beef Trimmings, and; (10th-Tie) Susceptibility To Foreign Animal Disease, Agroterrorism And Bioterrorism (Keith E. Belk, Colorado State University).

Martin E. O'Connor (Standardization Branch, AMS-USDA) reported that, of all beef carcasses officially graded by AMS-USDA (not all of the total carcass population), percentages of Prime, Choice, Select and Standard were 5%, 79%, 15% and 0.7%, respectively, in 1975 and 3%, 57.5%, 39% and 0.4%, respectively, in 2004. Percentages *per se* of carcasses officially graded as Prime or Choice have decreased over time—from 1975 to 2004. However, in 1975 only about 30% of the carcasses that would have qualified for Select—had they been officially stamped—were actually graded Select (then named "Good")—the remainder were sold ungraded (as "No Rolls").

Once "Good" was changed to "Select," a market developed for beef of that grade and, now, almost all beef qualifying for Select is officially graded as such. If percentages of carcasses qualifying for Prime or Choice in the two index years are adjusted to account for the fact that the numerators are not equivalent (use of "all carcasses officially graded" as numerators, to determine percentages, results in an apples vs. oranges contrast in 1975 vs. 2004), the apparent differences of a 2 percentage point (pp) decline in Prime and a 21.5 pp decline in Choice, from 1975 to 2004, become 1 pp in Prime and 6.2 pp in Choice. Martin E. O'Connor (Standardization Branch, AMS, USDA) also reported that of all beef carcasses officially graded by AMS-USDA, percentages of Yield Grades 1, 2, 3, 4 and 5 were 2%, 31%, 64%, 3% and 0.2%, respectively, in 1975 and 10%, 42%, 41%, 7% and 0.3%, respectively, in 2004. Again though, not all carcasses are officially assigned Yield Grades so the meaning of such comparisons is unclear. For example, AMS-USDA performed a "consist study," covering parts of 1973 and 1974, in which the percentages (based upon grading a random population of carcasses) of Yield Grades 1, 2, 3, 4 and 5 were 0.4%, 26%, 43%, 21% and 6%, respectively.

John Scanga (Colorado State University) presented results of carcass data contributed by cooperating packing companies, which demonstrated that from 1995 to 2005 YTD: (a) Average hot carcass weight increased from 740, to 749 lb; (b) Average number of branded-beef programs increased from 1.33, to 6.25; (c) Average number of "Angus" programs increased from 0.67, to 3.00; (d) Average number of grade-based, but not Angus-based, programs increased from 0.33, to 1.25; (e) Average number of "Natural"/"Grass-Fed" programs increased from 0.50, to 2.25; (f) Percentage of harvest cattle purchased on a "grid" increased from 15%, to 34%; (g) Percentage of harvest cattle purchased "in the beef" increased from 20%, to 26%; (h) Percentage of harvest cattle purchased as "source verified" increased from 0.4%, to 1.5%; (i) Percentage of harvest cattle purchased as "age verified" increased from none, to 1.0%; (j) Percentages of carcasses grading Prime, Upper Two-Thirds Choice and Lower One-Third Choice changed from 1.7%, 21.7% and 35.3%, respectively, in 1995, to 7.3%, 27.9% and 34.9%, respectively, in 2005; (k) Percentages of carcasses grading Yield Grade 1, 2, 3, 4 and 5 changed from 7.2%, 44.1%, 41.1%, 7.4% and 0.2%, respectively, in 1995, to 9.4%, 37.7%, 41.6%, 9.9% and 1.6%, respectively, in 2005, and; (l) Percentages of carcasses that were A vs. B maturity were 97.8% and 2.2%, respectively, in 1995, and 86.1% and 13.9%, respectively, in 2005.

Brad Morgan (Oklahoma State University) summarized assessments of cattle on harvest floors—hide on, reporting that: (a) 49.5%, 39.5%, 13.8% and 2.6% had no brands, butt brands, side brands, and shoulder brands, respectively; (b) 49.5%, 42.5%, 6.5% and 1.5% had 0, 1, 2 and 3 or more brands, respectively; (c) 76.3% of cattle had no horns; (b) Percentages of cattle with predominant (≥51%) hide color of black, red, yellow, Holstein, grey, white, brown and brindle were 56.2%, 18.1%, 5.1%, 8.7%, 5.2%, 2.1%, 3.7% and 1.0%, respectively; (e) Cattle with no manure on their body vs. manure on their legs, belly, side, topline or tail were 19.6% vs. 69.8%, 61.9%, 21.4%, 10.5% and 20.8%, respectively; (f) Amounts of manure on the bodies of cattle characterized as "none," "small," "moderate," "large" or "extreme" were 19.6%, 63.9%, 16.4%, 2.7% and 0.1%, respectively. (g) Cattle with manure in 1, 2, 3, 4, 5 or 6 locations were 18.9%, 18.7%, 34.2%, 18.6%, 6.8% and 2.9%, respectively, and; (h) 11.3% of harvest cattle had no visible form of identification, while 2.5%, 0.5%, 33.5%, 62.4%, 12.7% and 3.3% had electronic, barcode, individual visual, lot tag, metal clip or "other" forms of identification.

Jeff Savell (Texas A&M University) summarized assessments of carcass and offal on harvest floors, reporting that: (a) 24.8%, 10.6%, 7.8%, 4.8%, 8.9% and none (0.0%) of livers, lungs, tripe, heads, tongues and carcasses, respectively, were condemned on the harvest floor; (b) 0.47% of all cattle contained a fetus; (c) 54.2%, 18.5%, 0.3%, 6.6% and 20.3% of condemned livers were due to abscess, flukes, >30 MOA, contamination or "other" causes, respectively; (d) 40.7%, 2.9%, 0.4%, 20.5% and 35.6% of condemned lungs were due to pneumonia, abscess, >30 MOA, contamination or "other" causes, respectively; (e) 28.4%, 2.8%, 0.8%, 24.0% and 43.9% of tripe condemnations were due to abscess, ulcer, >30 MOA, contamination or "other" causes, respectively; (f) 19.3%, 0.4%, 3.2%, 9.0% and 68.1% of head condemnations were due to inflamed lymph nodes, abscess, >30 MOA, contamination or "other" causes, respectively; (g) 12.3%, 27.8%, 22.5%, 2.5%, 0.3% and 34.7% of tongue condemnations were due to inflamed lymph nodes, hair sores, cactus tongues, contamination, >30 MOA or "other" causes, respectively; (h) 64.2%, 25.4%, 7.9%, 1.9%, 0.5% and 0.01% of cattle had no, 1, 2, 3, 4 or 5 or more bruise(s), respectively; (i) Of bruises on carcasses, 9.9%, 35.5%, 21.2%, 23.6% and 9.3% were located on the round, loin, rib, chuck or flank/plate/brisket, respectively; (j) Percentages of cattle with 0, 1, 2, 3, 4, 5, 6, 7 or 8 permanent incisors were 83.1%, 5.5%, 8.7%, 0.6%, 1.5%, 0.1%, 0.3%, 0.03% and 0.05%, respectively.

Ty Lawrence (West Texas A&M University) summarized assessments of carcasses in coolers, reporting that: (a) 92.0%, 7.2% and 0.8% of carcasses were characterized as of native, dairy or Brahman (>4 in hump) genetic type, respectively; (b) 62.7%, 37.3% and 0.06% of carcasses were of steer, heifer or bullock gender, respectively; (c) No (0.0%), no, 2%, 5%, 14%, 37%, 37%, 2% and no carcasses had USDA marbling scores of abundant, moderately abundant, slightly abundant, moderate, modest, small, slight, traces, or practically devoid, respectively; (d) 97%, 2%, 1%, no (0.0%) and no carcasses had USDA maturity scores of A, B, C, D or E, respectively; (e) Of A maturity carcasses, no (0.0%), no, 1%, 13%, 30%, 25%, 18%, 6% and 3% were $A^{10}$, $A^{20}$, $A^{30}$, $A^{40}$, $A^{50}$, $A^{60}$, $A^{70}$, $A^{80}$ or $A^{90}$, respectively; (f) 2.9%, 17.0%, 36.2%, 38.5%, 4.2%, 0.7% and 0.5% of carcasses had USDA quality grades of Prime, Upper Two-Thirds Choice, Lower One-Third Choice, Select, Standard, Commercial or Utility, respectively; (g) 0.2%, 0.4%, 1.4%, 84.3%, 8.9%, 3.7% and 1.1% of carcasses had hot carcass weights of <500, 501 to 550, 551 to 600, 601 to 900, 901 to 950, 951 to 1,000 or >1,000 lb, respectively; (h) 15%, 37%, 33%, 13% and 2% of carcasses were assigned Yield Grades of 1, 2, 3, 4 or 5, respectively; (i) 70.0% of all carcasses had no discounts; (j) 1.1%, 13.0%, 5.4%, 2.6%, 2.2%, 2.0%, 1.4%, 1.1%, 0.8% and 0.5% of all carcasses had discounts for excess weight, Yield Grade 4, Standard or lower, dark cutter, Yield Grade 5, insufficient weight, >30 MOA, C maturity, blood splash or yellow fat, respectively.

At the Strategy Workshop, industry representatives offered suggestions regarding Strategies, Tactics and Goals for reducing quality defects and nonconformities; contributing ideas were Jeff Windett (Circle A Ranches), John Edwards (Express Ranches), Tom Woodward (Broseco Ranches), Charles Nichols (Nichols Ranches), Mike Engler (Cactus Feeders), Tony Bryant (Five Rivers Cattle Feeders), Rod Bowling (Smithfield Beef Company), Bruce Bass (Tyson, Inc.), Paul Heinrich (Sysco, Inc.), Fred Ray (OutWest Meat Company), Molly McAdams (HEB Supermarkets) and Greg Henderson (Drovers Journal).

Participants ranked "Quality Challenges," periodically, during conduction of the Strategy Workshop and ultimately identified the industry's "Top Ten Quality Challenges" as: (1st) Lack Of Traceability/Individual Animal ID/Source & Age Verification/Chronological Age. (2nd) Low Overall Uniformity Of Cattle, Carcasses & Cuts. (3rd) Need For Implementation Of Instrument Grading. (4th) Inappropriate Market Signals. (5th) Segmentation Of Groups Within The Beef Industry. (6th) Carcass & Cut Weights Too Heavy. (7th) Yield Grades Too High/Low Cutability. (8th) Inappropriate Ribeye Size (Too Small Or Too Large). (9th) Reduced Quality

Grade & Tenderness Due To Use Of Implants. (10th) Insufficient Marbling (Deb Roeber, Oklahoma State University).

With regard to "What Is The Beef Industry Doing Well?", Ty Lawrence (West Texas A&M University) reported that the beef industry was doing a good job of: (a) Developing "story" beef. (b) Reducing *E. coli* O157:H7, (c) Merchandising "quick" (to prepare) beef. (d) Merchandising new beef "value" cuts. (e) Reducing excess fat cover, at the end-user level. (f) Developing "brands" of beef. (g) Increasing beef demand. (h) Making the industry profitable.

Daryl Tatum (Colorado State University) described "Key Messages From The NBQA—2005 Strategy Workshop" as: (1) Deliver product attributes that meet consumer needs/expectations for safety, taste, color and convenience. (2) Improve the cattle supply by implementing instrument grading; reducing numbers of carcass grading Yield Grade 4 or 5; controlling weight; increasing marbling; decreasing variation, and; maximizing profitability. (3) Expand marketing opportunities (in domestic and global markets) by developing traceability systems; verifying source and age; reducing costs and waste in the beef value chain, and; continuing new product development. (4) Strengthen connections among segments of the beef supply chain via communication and targeted educational programs.

Tom Field (Colorado State University) described the "Goals" for improving the quality of beef as: (1) Deliver Product Attributes That Meet Consumer Needs and Expectations & Build Global Beef Demand. (2) Improve The Market Cattle Supply. (3) Expand Market Opportunities For US Beef. He also described the means for increasing beef's competitiveness as: (a) Prevent food safety and animal disease problems, (b) Maximize quality; eliminate variation, and (c) Optimize net consumer value; eliminate waste.

# Defining Feed Efficiency in Beef Cattle

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## Introduction

Most breeding programs have focused on improving economically relevant output traits such as growth, carcass quality and fertility to enhance the economic viability of beef production systems. Generally absent from current breeding programs in the U.S. are avenues for exploiting genetic variation in feed efficiency, even though reductions in feed inputs would substantially improve profitability of beef operations. While the expense of measuring feed intake has no doubt curtailed the implementation of genetic strategies focused on feed efficiency in the past, emerging commercialization of technologies to more cost effectively measure intake has helped to renew interest in this area. The National Beef Cattle Evaluation Consortium recently formed a working group to assess current knowledge regarding genetic and phenotypic variation of various feed efficiency traits, and to consider alternative methods to advance industry adoption of breeding programs that seek to improve genetic merit for efficient utilization of feed resources. The purpose of this paper is to characterize various feed efficiency traits for post-weaning beef cattle, focusing on phenotypic relationships with performance and carcass traits.

## Feed Efficiency Traits

It is not feasible to measure the efficiency of beef production from an integrated system, as this would require measurements of multiple outputs and inputs of breeding and replacement females as well as their slaughter progeny. Thus, for genetic evaluation purposes, we are forced to measure feed inputs and outputs in targeted stages of the production cycle. Given that the vast majority of feed inputs are used by the breeding herd compared to slaughter progeny, and that substantial animal variation exist in maintenance energy requirements (Johnson et al., 2003), it would seem logical to directly target reductions in feed inputs of breeding females to improve the efficiency of integrated production systems. Unfortunately, large-scale measurement of forage intake by mature cows is not practical, which necessitates the need to focus on feed inputs of growing animals. Expectations are that appropriate use of a feed efficiency trait in growing cattle, which accounts for genetic variation in efficiency of feed utilization to support maintenance and growth requirements, will generate progeny that are efficient in all segments of the industry. With the exception of Archer et al. (2002), few studies have examined genetic relationships between efficiency of growing and mature beef cattle to validate this expectation—more studies are clearly warranted.

The term *efficiency* implies a ratio of outputs to inputs. Liveweight gain and daily dry matter feed intake are typically used to measure ratio-based feed efficiency traits like gross feed efficiency (or its inverse feed conversion ratio; **FCR**), although output traits can also be expressed as carcass or lean product, and input traits as digestible or metabolizable energy intake. While FCR (feed/gain ratio) is useful to evaluate the effects of diet quality, environment, and management practices (e.g., implants, ionophores) on production efficiency in growing and finishing cattle, FCR has limited value as an efficiency trait for genetic improvement, even though FCR is moderately heritable (Crews, 2005). Firstly, FCR is strongly correlated ($r_g > 0.50$) with growth traits (Arthur et al., 2001a, Schenkel et al., 2004), such that selection to reduce post-weaning FCR (improved efficiency) would increase genetic merit for growth and mature size of breeding females (Herd and Bishop, 2000). Secondly, FCR is a *gross* measure of feed efficiency in that it does not attempt to partition feed intake between maintenance and growth requirements. Because FCR is a *gross* measure of efficiency that is strongly associated with growth traits, post-weaning selection for FCR will not necessarily lead to improvements in feed efficiency of breeding females. In fact, Archer et al. (2002) found that the genetic correlation between FCR measured in post-weaning heifers and mature cows was only 0.20, even though feed intake and average daily gain (**ADG**) of heifers was strongly correlated to feed intake ($r_g$ = 0.94) and ADG ($r_g$ = 0.72) of mature cows. Thirdly, as discussed by Crews (2005), selection based on ratio traits like FCR can result in divergent and unpredictable genetic responses of the component traits (growth and intake) if the genetic variances of the component traits are different. For example, Bishop et al. (1991) found that feed intake was not reduced, but that ADG was higher in progeny from Angus sires selected for low compared to high FCR. Collectively, these studies suggest that selection to reduce post-weaning FCR will increase cow mature size and have minimal affects on feed inputs, and thus efficiency of feed utilization in integrated beef production systems.

Alternative approaches to defining feed efficiency traits involve partitioning of feed inputs into portions needed to support maintenance and growth requirements. Examples include maintenance efficiency, which is defined as a ratio of feed intake used for maintenance (actual feed intake minus predicted feed for growth) per unit of metabolic body size ($BW^{0.75}$), and partial efficiency of growth (**PEG**), which is the ratio of ADG per unit of feed used for growth (actual feed intake minus predicted feed for maintenance; see Table 1). For both traits, the predictions of feed inputs for maintenance or growth are derived from feeding standards (e.g., NRC, 1994). For PEG,

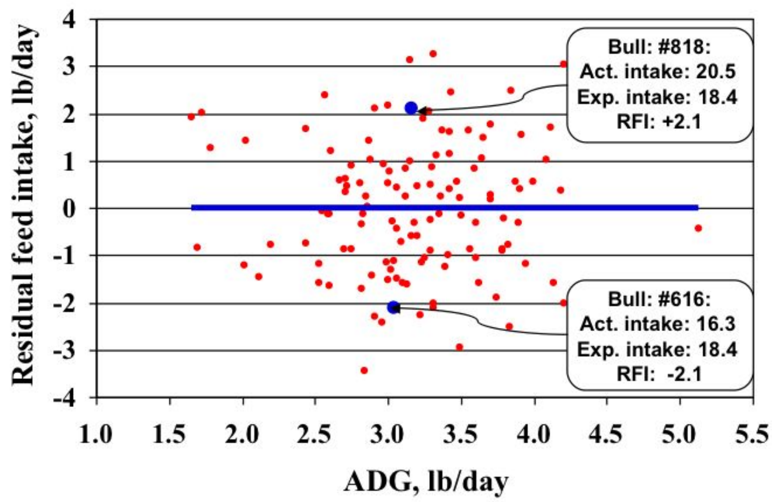


**Figure 1.** Residual feed intake data from a performance test conducted at the Beef Development Center (Test 1; 115 Angus and Brangus bulls; Lancaster et al., 2005).

feed input for maintenance is derived from a population estimate of maintenance energy requirements in beef cattle, and this amount subtracted from actual feed intake to estimate feed available for growth. Therefore, PEG will not capture inherent animal variation in energetic efficiencies associated with maintenance. Despite this shortcoming, PEG has an apparent advantage over FCR as a feed efficiency trait, as genetic (Arthur et al., 2001b) and phenotypic correlations (Nkrumah et al., 2004; Lancaster et al., 2005) between ADG and PEG are substantially lower compared to those between ADG and FCR. Moreover, feed intake is more strongly associated with PEG in a favorable direction compared to FCR (see section below).

## Residual Feed Intake

A third approach to defining feed efficiency involves using an animal's weight and growth rate to partition feed inputs into maintenance and growth components. A phenotypic linear regression equation, computed using intake and performance data from a contemporary set of animals, is used to determine an animal's expected feed intake based on its weight and growth rate over a given test period. The animal's actual feed intake net (more or less) its expected feed intake is referred to as residual feed intake (**RFI**). Efficient animals are those that consume less feed then expected based on their size and growth rate, thus efficient animals will have negative RFI. Conversely, inefficient animals will consume more feed than expected and have positive RFI.

A notable feature that distinguishes RFI from other feed efficiency traits is that it is phenotypically independent of the production traits used to compute expected intake. This is demonstrated in Figure 1 using data from 115 Angus and Brangus bulls. Despite considerable variation in ADG of bulls on this test, there was (as expected) an equal number of slow and fast gaining bulls with low (efficient) and high (inefficient) RFI. The two bulls (#616 vs #818) highlighted in Figure 1 had divergent RFI (-2.1 vs +2.1 lb/d) even though expected feed intakes were similar (18.4 lb/d), because bull #818 consume 4.2 lb more feed per day than bull #616. Expected feed intakes were similar because the two bulls had similar ADG (3.04 vs 3.16 lb/d) and final BW (1102 and 1077 lb) at the end of the test. Bull #616 was also more efficient than bull #818 as determined by FCR (5.37 vs 6.49). In fact, RFI is highly correlated phenotypically with FCR (Nkrumah et al., 2004; Lancaster et al., 2005; see section below), even though FCR is negatively correlated with grow traits. These results demonstrate that RFI is a more suitable trait to use in comparing animals during post-weaning tests that differ in production.

As with other feed efficiency traits, RFI has been shown to be moderately heritable (see Crews, 2006; this proceedings). Australian research has demonstrated that progeny from parents selected for low RFI after almost two generations were similar in yearling weight (845 vs 838 lb) and ADG (3.17 vs 3.08 lb/d), but consumed less feed (20.7 vs 23.3 lb/d) and had lower FCR (6.6 vs 7.8) compared to progeny from parents selected for high RFI (Arthur et al., 2001a). Additionally, Archer et al. (2002) reported that RFI in post-weaning heifers was strongly correlated ($r_g > 0.90$) to RFI measured in the same females as mature cows. These results suggest that selection for improved post-weaning RFI has the potential to produce progeny that are efficient in all segments of the industry.

## Further Merits of Residual Feed Intake

Based on Australian research, Herd et al. (2004) estimated that approximately one third of the biological variation in RFI could be explained by differences in digestion, heat increment of feeding and activity, and that the other two thirds was likely due to differences in heat production (mechanisms unknown). Nkrumah et al. (2006) recently reported that RFI was correlated with methane (0.44) and heat production (0.68) in growing calves. Moreover, we have found that digestibility was negatively correlated with RFI (-0.33), but not FCR in growing steers (Brown, unpublished), and that feeding duration was positively correlated with RFI (0.43), but not FCR in growing bulls (Lancaster et al., 2005). Collectively, these studies indicate that RFI is a trait that appears to reflect inherent variation in biologically relevant processes that are related to feed efficiency, but not growth.

**Table 1.** Traits used to assess efficiency of feed utilization in growing beef cattle

| **Trait** | **Definition** | **Formula** | **Favorable phenotype** |
|---|---|---|---|
| **FCR** | Actual DMI per unit weight gain | DMI ÷ ADG | low |
| **Maintenance efficiency** | Metabolizable energy intake (**MEI**) for maintenance per MBW | MEI - (fat gain ÷ $k_f$) - (protein gain ÷ $k_p$) ÷ MBW† | low |
| **Partial efficiency of growth; PEG** | ADG per unit of DMI available for growth | ADG ÷ (DMI - DMIm); DMIm = expected DMI required for maintenance (NRC, 1984) | high |
| **Residual feed intake; RFI** | Actual DMI net expected DMI based on MBW and ADG | Expected DMI from regression of ADG on MBW and DMI | low |
| **RFI adjusted for composition; RFIc** | Actual DMI net expected DMI based on MBW, ADG and carcass composition traits | Expected DMI from regression of DMI on MBW, ADG and carcass composition traits | Low |
| **Model-predicted Feed conversion ratio; R:G** | DMI required (**DMR**) from CVDS model per unit gain | DMR computed from growth, composition & environmental traits (CVDS model) ÷ ADG | low |

†$k_f$ and $k_p$ are standard partial efficiencies of ME use for fat and protein deposition, respectively.

**Model Assisted Selection**

A fourth approach to identifying efficient animals is through the use of mathematical models. The Cornell/Cattle Value Discovery System (**CVDS**) was developed to allocate feed inputs to individual animals fed in group pens (Fox et al., 2001). An enhanced, dynamic version of the CVDS model was developed (Tedeschi et al., 2004) to improve accuracy of prediction of individual dry matter feed required (**DMR**) and FCR of group-fed cattle. Fox et al. (2004) evaluated the use of CVDS to compute individual DMR of group-fed bulls. Results from a three-year test conducted in New York demonstrated that the sum of model-predicted DMR for individual bulls was within 2% of the actual pen feed intakes. Jorgensen Angus (Ideal, SD) has used the CVDS to predict feed efficiency in 867 bulls from 56 sires over the past 5 years—the sum of model-predicted DMR has been within 3 to 5% of actual pen feed intakes. Tedeschi et al. (2006) recently reported phenotypic correlations between DMR, and DMI and ADG of 0.75 and 0.65, respectively, in steers fed high-grain diets.

Additional studies have been conducted to determine heritability estimates of model-predicted DMR, and genetic correlations with actual feed intakes. Williams et al. (2005) used the Decision Evaluator for the Cattle Industry (**DECI**) and the CVDS models to compare model-predicted DMR with actual feed intakes in 504 steers and 52 sires. Heritability estimates of DMR were about 0.33 for both models, and genetic correlations between DMI and DMR were greater than 0.95. Similarly, Kirschten et al. (2006) reported heritability estimates of 0.35 for CVDS-predicted DMR, and strong genetic correlations of 0.98 between DMI and DMR. These authors suggested that model-predicted DMR may be useful in genetic evaluations with minimal differences between DECI and CVDS models in predicting DMR.

Despite the strong genetic correlations found between model-predicted DMR and actual feed intakes (Williams et al., 2005, Kirschten et al., 2006), phenotypic correlations are lower and indicate that about 50 to 70% of the variation in actual intakes can be explained by these models. Predictions of DMR for individual animals are based on diet (chemical analysis), environment, and individual animal data (weight, ADG, maturity, composition). Thus, DMR predictions are similar to feed intake predictions derived from phenotypic linear regression models that use weight and ADG to calculate RFI. Therefore, current models used to predict DMR have limited capability to account for individual animal variation in actual feed intake associated with inherent animal differences in efficiency, as defined by RFI.

It is envisioned that future models can be developed to more accurately quantify individual animal variation in feed intake associated with biological processes (e.g., feeding behavior, heat production, digestibility) that are linked to animal variation in feed efficiency. Successful parameterization of models that incorporate the input of easily-measured biologically relevant traits (e.g., feeding behavior) or genetic markers linked to RFI, should be more accurate and useful in identifying individuals with improved feed efficiency.

**Phenotypic Relationships Among Feed Efficiency Traits in Growing and Finishing Calves**

We recently performed a Meta analysis of eight studies to characterize the feed efficiency traits defined in Table 1, and to examine their correlations with performance and carcass traits in growing and finishing calves. An additional objective was to evaluate the effectiveness of the CVDS (Tedeschi et al., 2004) to predict DMR and DMR:ADG ratio (**R:G**) in growing and finishing calves. Two databases were assembled and analyzed separately. The first database consisted of four studies that included growing steers and heifers (N = 514) fed high-roughage diets (0.93 to 0.97 Mcal ME/lb), with initial body weights averaging 604 lb. The second database consisted of four studies that included finishing steers (N = 320) fed high-grain diets (1.24 to 1.36 Mcal ME/lb), with initial body weights of 789 lb. Within studies, cattle were individually fed and managed in a similar manner. For CVDS-model predictions, carcass traits were used to compute adjusted final weights at 28% empty body fat (**AFBW**) in the finishing studies, whereas, in the growing studies ultrasound measurements at the end of the test were used to compute AFBW.

The model $R^2$ of the multiple regression equations used to compute RFI were 0.68 and 0.67 for growing and finishing studies, respectively, indicating that about two thirds of the variation in feed intake was explained by variation in weight and ADG in both studies. In both growing and finishing studies, FCR was strongly correlated with ADG (-0.60 and -0.58) and initial weight (0.28 and 0.40), but weakly correlated with feed intake (0.12 and 0.25), demonstrating that favorable FCR phenotypes had substantially lighter initial weights and higher ADG, and consumed slightly less feed. In contrast, RFI was strongly correlated with intake (≈ 0.65) in growing and finishing calves, but as expected, RFI was not correlated phenotypically with initial weights or ADG. In both growing and finishing calves, PEG was weakly correlated with ADG (0.20 and 0.11) and initial weights (0.14 and 0.10), but strongly correlated with feed intake (-0.57 and -0.64), showing that favorable PEG phenotypes ate substantially less feed and had slightly higher ADG and initial weights. The phenotypic correlations between these three feed efficiency traits and their component traits (growth and intake) were comparable to those reported in previous studies (Arthur et al., 2001a,b; Nkrumah et al., 2004; Lancaster et al., 2005).

All feed efficiency traits were strongly correlated to each other (±0.50) in favorable directions. In general, phenotypic correlations between efficiency, intake and growth traits in growing calves were remarkably similar to those found in finishing calves. Phenotypic correlations between all three of the feed efficiency traits and final rib fat thickness were weak (±0.11 to 0.15) for growing calves and moderate (±0.21 to 0.38) for finishing calves, such that the favorable phenotypes tended to be leaner. In general, correlations between feed efficiency traits and final ribeye area were either weak or not different from zero.

**Table 2.** Pearson correlation of adjusted traits for growing (above diagonal) and finishing (below diagonal) calves

| | | Growing studies | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trait | ADG | iBW | DMI | RFI | PEG | FCR | DMR | R:G | BF | REA |
| Finishing studies | ADG | -- | **0.14** | **0.61** | 0.00 | **0.20** | **-0.60** | **0.93** | **-0.71** | 0.06 | 0.08 |
| | iBW | 0.10 | -- | **0.53** | 0.00 | **-0.25** | **0.28** | **0.65** | **0.29** | **0.28** | **0.45** |
| | DMI | **0.62** | **0.51** | -- | **0.65** | **-0.57** | **0.12** | **0.73** | -0.14 | **0.24** | **0.25** |
| | RFI | 0.03 | 0.06 | **0.67** | -- | **-0.87** | **0.56** | **0.54** | 0.04 | **0.11** | 0.00 |
| | PEG | **0.11** | **-0.38** | **-0.64** | **-0.84** | -- | **-0.77** | **0.27** | **-0.52** | **-0.15** | -0.10 |
| | FCR | **-0.58** | **0.40** | **0.25** | **0.63** | **-0.79** | -- | **-0.29** | **0.81** | **0.11** | **0.11** |
| | DMR | **0.84** | **0.64** | **0.71** | 0.04 | **0.27** | **-0.51** | --- | **-0.43** | **0.22** | **0.25** |
| | R:G | **-0.52** | **0.32** | -0.04 | 0.06 | **-0.52** | **0.61** | 0.01 | -- | **0.19** | **0.14** |
| | BF | **0.20** | **0.22** | **0.44** | **0.33** | **-0.38** | **0.21** | **0.47** | **0.26** | -- | **0.22** |
| | REA | **0.24** | **0.32** | **0.19** | **-0.14** | 0.02 | **-0.11** | **0.20** | -0.09 | **-0.20** | -- |

[a] Correlations in bold are significantly greater then zero; $P < 0.05$. ADG is average daily gain, iBW is initial body weight, DMI is dry matter intake, RFI is residual feed intake, DMR is dry matter required (model predicted), PEG is partial efficiency for gain, FCR is feed conversion ratio, R:G is DMR to ADG ratio (model predicted), BF is back fat, and REA is ribeye area.

Model-predicted DMR were highly correlated with ADG (> 0.80) and actual intake (≈ 0.70) in both growing and finishing calves. In addition, DMR were negatively correlated with actual FCR in both growing (-0.29) and finishing (-0.51) calves, and positively correlated with RFI (0.54) in growing calves. However, model-predicted DMR were not correlated with RFI in finishing (0.04) calves, and were negatively correlated with R:G in growing (-0.43), but not finishing (0.01) calves. These results demonstrate that phenotypic correlations with model predictions of DMR and R:G were at times inconsistent across growing and finishing calves in this study.

To illustrate the phenotypic variation in RFI and relationships with other component traits, calves within growing and finishing studies were separated into low and high RFI groups (Table 3); low RFI calves being those that ranked less than 0.5 SD from the mean RFI of 0.0 ± 1.80 and 0.0 ± 1.96 lb/d for growing and finishing calves, respectively. For growing studies, calves with low RFI consumed 18% less feed and had 18% lower FCR and 44% higher PEG compared to calves with high RFI. In the finishing studies, low RFI calves consumed 20% less feed and had 21% lower FCR and 48% higher PEG than high RFI calves. Initial and final body weights and ADG were similar for low and high RFI phenotypes in both the growing and finishing calves. Thus, similar phenotypic variations in RFI were observed in growing and finishing calves. *In economic terms, the difference in feed costs between finishing calves with low and high RFI equates to $0.32/day or $38.00 during a 120-day feeding period, assuming ration costs of $0.07/lb (dry matter basis).*

There were no differences in ultrasound estimates of carcass composition (rib fat thickness or ribeye area) between calves with low and high RFI in the growing studies, however, in the finishing studies calves with low RFI had less carcass fat and larger REA than calves with high RFI. Clearly, there was larger differential in carcass fatness between low and high RFI phenotypes in finishing vs growing studies, which likely reflects greater expression of genetic potential for fat tissue deposition, due to the fact that these calves were fed a high-grain diet and were older during the RFI measurement period. These results suggests that selection for improved RFI may potentially impact carcass quality traits (e.g., marbling) in an antagonistic manner, especially if selection for RFI were applied to earlier maturing cattle on moderate- to high-energy diets. A number of studies have reported weak to moderate genetic correlations between RFI and carcass fat (Arthur et al., 2001a,b; Schenkel et al., 2004). The inclusion of carcass fat traits along with ADG and weight to compute RFI may be warranted to minimize unfavorable responses in carcass quality traits (see Crews, 2006; this proceedings).

**Table 3.** Characterization of performance, ultrasound composition, and feeding efficiency traits in growing and finishing animals with low and high residual feed intake [a]

| Traits | *Growing Studies* | | | | *Finishing Studies* | | | |
|---|---|---|---|---|---|---|---|---|
| | Low RFI | High RFI | SE | *P*-value | Low RFI | High RFI | SE | *P*-value |
| Number of calves | 155 | 156 | | | 93 | 87 | | |
| *Growth traits* | | | | | | | | |
| Initial BW, lb | 611 | 611 | 7.12 | 0.99 | 721 | 734 | 12.8 | 0.56 |
| Final BW, lb | 780 | 780 | 8.35 | 0.98 | 1142 | 1150 | 15.9 | 0.32 |
| Daily gain, lb/d | 2.34 | 2.34 | 0.04 | 0.90 | 3.11 | 3.13 | 0.09 | 0.38 |
| *Feed efficiency traits* | | | | | | | | |
| Dry matter intake, lb/d | 19.2 | 23.4 | 0.26 | < 0.01 | 18.6 | 23.4 | 0.37 | < 0.01 |
| Residual feed intake, | -2.03 | 2.09 | 0.11 | < 0.01 | -2.25 | 2.36 | 0.18 | < 0.01 |
| Partial eff. of growth [b] | 0.26 | 0.18 | .004 | < 0.01 | 0.31 | 0.21 | 0.01 | < 0.01 |
| Feed conversion ratio | 8.44 | 10.28 | 0.15 | < 0.01 | 6.05 | 7.63 | 0.13 | < 0.01 |
| *Ultrasound/carcass traits* | | | | | | | | |
| $12^{th}$ rib fat, in | 0.20 | 0.21 | 0.01 | 0.20 | 0.40 | 0.56 | 0.02 | < 0.01 |
| Ribeye area, $in^2$ | 10.17 | 10.20 | 0.12 | 0.65 | 12.25 | 11.84 | 0.15 | < 0.05 |

[a] Animals with low and high RFI were < 0.50 and > 0.50 SD from average RFI, respectively (RFI SD was 1.80 and 1.96 lb/d for growing and finishing studies, respectively).
[b] ADG/DMI for growth.

**Measuring Feed Efficiency in Commercial Bull-Test Facilities—Case Study**

A feed-intake and feeding behavior system (GrowSafe System Ltd.) was recently installed at the Beef Development Center (Millican, TX), in partnership with the Animal Science Department at Texas A&M University. This was the first installation of a GrowSafe® feed-intake system in a U.S. commercial bull-test facility. The protocol used to measure performance and feed intake of bulls at the Beef Development Center is similar to that established by Archer et al. (1997). Bulls are assigned to one of two pens each equipped with nine GrowSafe® feed bunks, and adapted to the test diet (30% silage-based ration) for 28 d prior to measuring feed intake and feeding behavior traits (feeding duration, meal frequency) for 70 d. During the 70-d test period, bulls are weighed at 14-d intervals, and linear regression of weights on day of test used to compute growth rates. Scrotal circumference and ultrasound measurements of rib fat thickness, ribeye area and marbling are obtained at the start and end of the tests. To date, feed intake, growth and ultrasound carcass data have been successfully measured, and producer reports generated for almost 500 bulls and heifers. Our results demonstrate that this feed-intake measurement technology is robust and accurate enough to function in a commercial cattle-feeding operation.

As biological efficiency, however defined, does not always equate to profitability it will be critical to develop selection tools that also incorporate economic inputs to facilitate industry adoption. Crews et al. (2006) developed a three-trait selection index with the objective to improve feedlot profitability of market progeny from bulls tested for feed efficiency. Economic weights were derived from net revenue projections of Charolais crossbred steers individually fed a high-grain diet, and an index generated to compute weighting factors for bull RFI, ADG and yearling weight. Index values typically range from 80 to 120. We have recently started providing this index data to producers along with performance and feed efficiency data. Shown in Figure 2 are RFI data from a test involving 125 Angus and Brangus bulls. For this test, bulls with index values greater than 105 (n = 38) had 17% higher ADG, consumed 9% less feed, and had 22% lower FCR compared to bulls with index values less than 95 (n = 37). The high-index bulls had lower RFI (-1.7 vs + 1.6 lb/d), but similar yearling weights (1035 vs 1045 lb) compared to the low-index bulls.

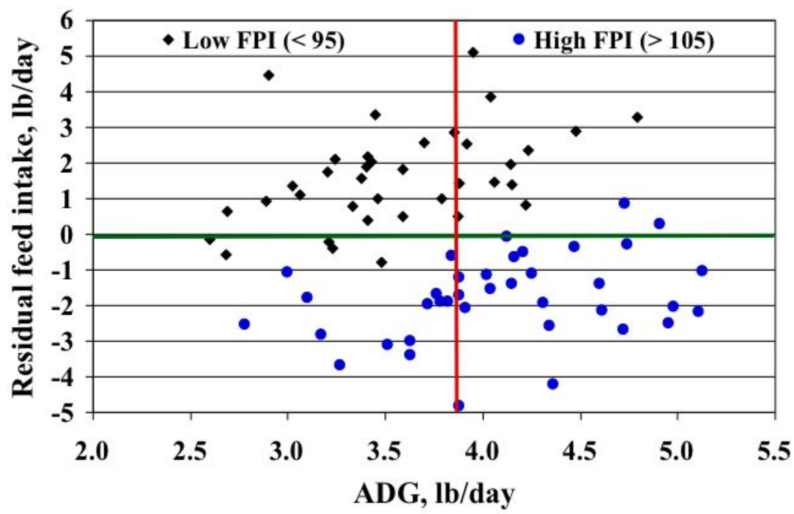


**Figure 2.** Residual feed intake data from a performance test conducted at the Beef Development Center (Test 2; 125 Angus and Brangus bulls; Lancaster et al., 2005). Only data for low (< 95) and high (> 105) feedlot profit index (FPI) bulls are plotted.

**Summary**

Considerable genetic variation exists in beef cattle for feed intake unaccounted for by differences in weight and growth rate—residual feed intake, thereby providing opportunities to improve profitability of beef production systems through reductions in feed inputs, with minimal influences on growth or mature size. To facilitate industry adoption, it will be critical to establish BIF guidelines for the collection of data (intake, growth, ultrasound) required to appropriately measure feed efficiency traits, and to develop selection tools that incorporate both biological and economic parameters to support profit-driven breeding programs.

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# The Genetics of Feed Efficiency in Beef Cattle

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## Introduction

Whereas it is well established that feed supplementation accounts for a large majority of the non-fixed costs of beef production, there has recently been renewed interest in the design and implementation of genetic evaluation and improvement programs for efficient feed utilization. The National Beef Cattle Evaluation Consortium (NBCEC) working group on efficiency and feedlot traits has been formed among scientists across North America to make recommendations for improved methods for genetic evaluation of feed efficiency. The development of such procedures requires knowledge of phenotypic and genetic properties among the numerous measures of feed efficiency that have been proposed in the scientific literature. As such, this paper will address issues related to the genetics of efficient feed utilization in beef cattle. The discussion will draw heavily on recent scientific reports and reviews (Archer et al., 1999; Crews, 2005).

## Why Efficiency?

Selection for the wide range of traits for which most beef breed associations calculate expected progeny differences (EPD) focus on increasing the outputs of the production system, thereby increasing the genetic potential of cattle for reproductive rates, weights, growth rates, and end-product yield. Feed costs, however, represent the largest portion of the variable cost of beef production and genetic improvement programs for reducing input costs should include traits related to feed utilization. Beyond the usual prediction of response to selection which involves genetic variation and parameters, selection intensity and generation interval, considerations for optimal selection programs also include several issues, including biological significance, the potential for antagonism with other traits under selection, and costs of data collection. Within the context of economic relevance, feed intake is the input or cost stream, whereas growth or other outputs are the revenue streams. To relate production efficiency to profitability, both streams must be considered.

## Traditional Measures of Efficiency

In their review, Archer et al. (1999) summarized that more than two dozen measures of "efficiency" have been proposed in the scientific literature in the last 40 or more years, and to varying extent, characterized phenotypically and genetically in the literature. Most of these have been reported to have at least moderate heritability (i.e., $h^2 = 0.20$ to 0.40), and as with most phenotypes or traits, have various genetic correlations with other traits. Historically, the most common measure of efficiency has been gross efficiency, or its inverse, feed conversion ratio (FCR), which is defined as the ratio of some measure of feed intake to some measure of output. Several papers have reviewed the definitions of numerous other so-called efficiency measurements (e.g., Arthur et al., 2001b). Much of the difference among these measures relates to whether or not individual feed intake must be recorded which has been a major time and cost limitation to large-scale efficiency research in cattle.

In addition to the fact that most early work described efficiency as the ratio of inputs to outputs (i.e., similar to FCR), studies were generally limited within a specific industry segment or stage of animal production. This led to only limited insight into efficiency of the total production system. A more desirable measure of efficiency would not only describe differences in individual animals, but also be highly repeatable across industry segments and animal classes. Differences in the energy status of animals (e.g., growing, lactating, mature, etc.) across segments and through time make it difficult to compare their efficiencies unless the traits measured have similar biological and genetic properties.

Feed intake and FCR are well known to be phenotypically and genetically correlated with measures of growth and therefore mature size. For example, in their meta-analytic review of published parameter estimates for beef production traits, Koots et al. (1994b) summarized numerous estimates of the genetic correlation of FCR with weights and gains ranging from -0.24 to -0.95, which clearly indicate that increased genetic potential for performance and size is negatively correlated with FCR. Therefore, selection for improved (i.e., decreased) FCR would result in increased correlated genetic responses for growth rates, mature size, and presumably, mature maintenance requirements. Koots et al. (1994b) also showed strong evidence that the genetic associations of feed intake with measures of growth rate and weight were positive, with estimated genetic correlations ranging from 0.25 to 0.79. Of particular note are estimates of the genetic correlation of mature weight with FCR (-0.14) and feed intake (0.92). These results underscore two intuitive principles: 1) cattle with larger mature size have higher intake requirements, and 2) decreasing selection for FCR is expected to result in larger mature size.

An antagonistic implication of these generally moderate to high genetic correlations among intake, growth, size, and FCR is that favorable decreases in FCR due to selection do not necessarily translate specifically to improvements in efficiency of feed utilization. Because FCR is defined as inputs divided by outputs, changes in FCR could be due to decreases in feed intake or increases in growth rate (e.g., average daily gain). In fact, the mean genetic potential of cattle for FCR has probably been changing along with the general trend for increasing selection on growth for as long as large-scale growth trait genetic evaluations have been available. Therefore, growth rates and age-specific weights have been increasing for the past 25 years in beef cattle, feed conversion ratios have probably also been decreasing, but true efficiency remains relatively unchanged.

To summarize, ratios and other measures of efficiency generally suffer from similar limitations: they are "too related" to other economically important traits. Using well-established selection index theory, it is possible to design selection programs that moderate or even eliminate antagonistic response. However, a more desirable measure of efficiency would be preferred, at least to the extent that unfavorable genetic correlations could be moderated or eliminated.

## Residual Feed Intake

Residual feed intake (RFI), sometimes referred to as net feed intake or net feed efficiency, was first proposed for beef cattle by Koch et al. (1963), and is traditionally defined as the difference between actual feed intake and that predicted on the basis of mean requirements for body weight maintenance and level of production. Koch et al. (1963) realized that a robust measure of efficiency would allow for adjustment of feed intake for any of the various requirements, or "energy sinks" that differentiate cattle in different industry segments and stages of production. For example, whereas growth may be the major energy sink for growing cattle, the requirements for the mature cow herd may be maintenance of body weight and condition for reproductive fitness and lactation. RFI relies simply on partitioning feed intake into portions required for stage and level of production, and a residual or left-over portion that would be comparable across animals of varying age, industry segment, and stage of production.

Recent research (e.g., Archer et al., 1999; Crews, 2005) has focused on characterization of RFI in the feeding segment of the beef industry. Therefore, most of the remaining discussion will be focused on young, growing cattle although the concept of RFI is not so limited. Computation of RFI phenotypes for individual animals is simply an application of a statistical procedure referred to as multiple linear regression. What I refer to as the "base" RFI model can be represented as

$$\text{INTAKE} = \mu + \text{ADG} + \text{WT} + \text{RFI}$$

where feed intake is simply the sum of some common overall or group average ($\mu$), requirements for average daily gain (ADG), requirements related to body weight (WT) and RFI. This leads to a more functional definition of RFI as *that portion of feed intake that is not accounted for by measurable factors*.

The properties of this regression procedure can be used to show several phenotypic attributes of residual feed intake. First, the mean RFI value within a group is zero. Secondly, by definition, RFI is *uncorrelated* to those measurable factors included in the base model. This has important and desirable implications with respect to the design of selection programs. This important result has been verified in several recent reports (Arthur et al., 2001a,b; Basarab et al., 2003), at least in phenotypic terms. The implication here is that approximately equal numbers of animals within a group will have RFI values above and below zero. Efficient animals (i.e., with RFI < 0) have daily feed intake values that are less than what would be expected on the basis of their growth rate and body weight, whereas the converse is true of the less efficient animals (i.e., RFI > 0). Given that RFI may be thought of as that part of feed intake that is not explained by growth and(or) body weight, RFI is independent of growth rate and body weight, and may offer the potential to selection for improved efficiency regardless of animal size. If it were possible to perfectly estimate feed intake for individual animals using indicator traits, the variance of RFI would be zero.

**Variation in RFI**

Traits that are candidates for selection must have several properties, the most important of which is that for any specific trait or phenotype, observed differences among animals must be due in part to additive genetic effects. All studies that have estimated genetic variance for RFI have reported this parameter to be significant and heritability estimates for RFI have ranged from 0.26 to 0.58 (Koch et al., 1963; Arthur et al., 2001a,b; Crews et al., 2003; Schenkel et al., 2004). These estimates generally fall within the moderate heritability range and are similar to estimates for traditional growth traits. Table 1 summarizes published heritability estimates for residual feed intake. We can therefore expect that given a sufficiency of data, selection would be effective for RFI.

Heritability alone may be misleading for predicting response to selection for RFI. The variability in the phenotype underlying RFI (daily feed intake) should also be considered. In recent studies, considerable variation has been reported for various measures of daily feed and(or) dry matter intake (Arthur et al., 2001a,b; Basarab et al., 2003; Crews et al., 2006). The partitioning of feed intake into "measurable energy sinks" plus RFI dictates that residual feed intake will have lower variance than feed intake. In these same recent studies, the base model accounts for 55 to 70% of the variance in feed intake, which implies that after adjustment for growth rate and proxy measurements of maintenance requirements, approximately 30 to 45 % of the variance in feed intake remains as RFI.

**Table 1.** Summary of heritability estimates for residual feed intake

| **Breed** | **N** | **$h^2 \pm SE$** | **Source** |
|---|---|---|---|
| British | 1,324 | 0.28 ± 0.11 | Koch et al. (1963) |
| British | 966 | 0.44 ± 0.07 | Arthur et al. (1997) |
| Angus | 1,177 | 0.39 ± 0.03 | Arthur et al. (2001a) |
| Charolais | 792 | 0.39 ± 0.03 | Arthur et al. (2001b) |
| Multiple | 2,284 | 0.38 ± 0.07 | Schenkel et al. (2004) |
| Charolais-sired | 641 | 0.58 ± 0.20 | Crews et al. (2003) |
| **Weighted avg. $h^2$** | | **0.39 ± 0.09** | **Koots et al. (1994a) method** |

## Genetic Correlations Involving RFI

Selection for single, component traits is never recommended in beef cattle due to the potential for correlated response which may affect more than one economically important trait, particularly if genetic correlations are antagonistic or unfavorable. Recent studies have reported strongly positive genetic correlations for RFI with FCR (0.70, Herd and Bishop, 2000; 0.85, Arthur et al., 2001a; 0.66, Arthur et al., 2001b). Similarly, positive genetic correlations of 0.64 (herd and Bishop, 2000), 0.69 (Arthur et al., 2001a), and 0.79 (Arthur et al., 2001b) have been reported for RFI with feed intake. These results suggest that selection for improved (i.e., decreased) RFI will be associated with a corresponding declining genetic trend in feed intake. A sample of reported genetic correlations of RFI with other traits is listed in Table 2.

**Table 2.** Genetic correlations involving residual feed intake

| Correlated trait | Genetic correlation | Source |
|---|---|---|
| FCR | 0.70 | Herd and Bishop, 2000 |
| | 0.85 | Arthur et al., 2001a |
| | 0.66 | Arthur et al., 2001b |
| | 0.69 | Schenkel et al., 2004 |
| Feed intake | 0.64 | Herd and Bishop, 2000 |
| | 0.69 | Arthur et al., 2001a |
| | 0.79 | Arthur et al., 2001b |
| | 0.81 | Schenkel et al., 2004 |
| Subcutaneous fat | 0.17 | Arthur et al., 2001a |
| | 0.16 | Schenkel et al., 2004 |
| Longissimus muscle area | -0.17 | Schenkel et al., 2004 |

Some reports have estimated genetic correlations of RFI with measures of body composition and reported these to be generally small with the exception of ultrasound rib fat ($r_g$ = 0.17, Arthur et al., 2001a; $r_g$ = 0.16, Schenkel et al., 2004), which are small in magnitude, but do indicate that genetic effects for feed intake are related to those for subcutaneous fat deposition. Supporting phenotypic evidence for a positive association between RFI and carcass fatness has been reported by Basarab et al. (2003), wherein crossbred steers with lower RFI tended to also be leaner to the extent that carcass fat depth was slightly lower. It is important to note, however, that any covariance or association between intake and body composition can be accommodated in the RFI computation model, thereby increasing the numbers of traits to which RFI is uncorrelated. Computation of a body composition-adjusted has been discussed, for example, in Schenkel et al. (2004), Crews (2005), and Crews et al. (2006).

**Refining Residual Feed Intake by Adjustment for Body Composition**

Variation in RFI reflects variance in feed intake after adjustment in the base model for average daily gain (growth rate) and body weight (maintenance requirements). However, differences in efficiency of growth may also be due to differences in composition of gain. In other words, easily-measured body composition traits may be another "energy sink" which explains daily feed intake. Ferrell and Jenkins (1998), for example, showed that differences in rate of water, protein and fat deposition influence efficiency and rate of body weight gain primarily because fat has higher energy density than either protein or water. Although more energy expenditure is required for fat versus protein deposition, maintenance of protein requires more energy than maintenance of fat. Several researchers have noted a weak, positive phenotypic correlation between RFI and measures of body fat content, and similarly weak but negative correlations between RFI and carcass lean content (Herd and Bishop, 2000; Arthur et al., 2001a; Basarab et al., 2003). Basarab et al. (2003) reported that approximately 4% of the variation in daily feed intake was attributable to differences in empty body fat, compared to 67.9 and 8.6% attributable to body weight and daily gain, respectively. Generally, additional adjustment of RFI for body composition accounts for approximately 5% or less of the variance in feed intake. Additional evidence was offered by Richardson et al. (2001), who reported that a single generation of selection for RFI resulted in reduced carcass fat content. RFI computed with adjustment for body fat and(or) lean content would have similar variance to that from a base model due to the relatively small increase in model $R^2$ of the "body composition" versus the "base" models. However, it is important to note that the increase in total model fit due to the additional adjustment for body composition only reflects the variance in feed intake due to fat and(or) lean *after* adjustment for terms in the base model, which to some extent share a part-whole relationship. Therefore, the advantages of an RFI phenotype that is completely independent of body composition should be considered. The relative importance of adjusting RFI for measures of fat versus lean body composition may be dependent on the application. For example, Basarab et al. (2003) showed that after adjustment for live weight and daily gain, on-test gains in ultrasound fat were relatively more important in steers than adjustment for on-test gains in muscle area. Conversely, Crews et al. (2006) reported that in yearling Angus bulls, on-test changes in ultrasound muscle area were more highly correlated to base-model RFI than changes in on-test ultrasound fat thickness.

**Potential Diet × Genotype Interactions for Residual Feed Intake**

Considering the costs associated with collection of individual feed intake data that is required to compute RFI, the amount of data likely to be available in the short- and medium-term will be relatively small. The relative lack of commercial test facilities capable of individual feed intake recording may in fact restrict such data collection to centralized bull tests, and perhaps to a lesser extent, on-farm programs where investment in equipment can be justified. Crews et al. (2003) studied differences in RFI between two common diet regimes. Weaned calves are often placed on roughage-based growing (i.e., backgrounding) diets prior to the finishing period wherein diets are grain-based with higher energy density. In this study, we calculated RFI separately for 84-d growing and 112-d finishing periods. Estimates of phenotypic and additive genetic variance for RFI in the growing period were greater than corresponding estimates for the finishing period. The estimate of the genetic correlation between growing- and finishing-period RFI was high and positive ($r_g$ = 0.55 ± 0.30). These results led us to suggest that cattle would be ranked similarly for RFI measured on roughage versus grain diets, but further study is needed to confirm the genetic equivalence of RFI across different diets. This preliminary study involved only a very limited number of animals. These results have implications for genetic evaluation of efficiency where the most likely source of data will be postweaning bull tests but where the selection objective will be improvement in efficiency of market progeny and(or) replacement heifers. In other words, more study is needed to confirm that bulls selected on the basis of RFI computed from intake, growth and body composition data when on a relatively low-energy test diet will be the same bulls that will sire more efficient replacement daughters and market progeny in the feedlot.

**Implications of Selection on Replacement Females**

Optimal genetic improvement schemes place appropriate relative economic weights on several to many component traits that directly impact either costs or revenues of production. It is always important to consider what impact sire selection will have across the various industry segments and animal types. Relatively little information is available regarding the genetic association between intake and efficiency measures in the mature cow herd and similar measures from the postweaning periods at or near yearling age, when selection decisions are commonly made. Archer et al. (1999) hypothesized that because RFI was uncorrelated with growth rate and body size, the genetic correlation between RFI during postweaning test and a corresponding measure on mature cows would be an indication of the biological similarity between the measurements at distinct ages. They found that both feed intake and RFI during the postweaning period and at maturity had genetic correlations greater than 0.90. This result suggests selection decisions made on the basis of RFI EPD during the postweaning (i.e., pre-breeding) period would translate nearly perfectly to genetic improvement in efficiency of the cow herd. Archer et al. (2002) concluded that these strong genetic correlations present an opportunity to improve efficiency in growing animals and mature cows simultaneously, based on measurements taken during the postweaning period prior to when selection decisions are made.

**Economics of Phenotypic and Genetic Differences in Residual Feed Intake**

Direct selection for RFI would be expected to result in genetic trend similar to that obtained with other with similarly moderate heritability. Recent reports have been variable with respect to the phenotypic range in computed RFI. Basarab et al. (2003) reported that RFI (mean = 0.00, SD = 1.46 lb/d) ranged from an efficient -4.30 lb/d to an inefficient +4.01 lb/d among composite steers fed 120 days (i.e., 8.31 lb/d dry matter intake difference between the most and least efficient steers). Archer et al. (1998) identified efficient bulls which consumed 5.51 lb/d less feed over a 120-d test period while maintaining similar live weights and rates of gain compared to less efficient bulls. Crews et al. (2003) calculated mean differences in daily feed intake in Charolais-sired steers and concluded that the more efficient steers consumed 3.73 lb less feed per day during a 112-d finishing period than the less efficient steers. In these comparisons, steers in the high-efficiency (RFI < 0) and low-efficiency (RFI > 0) groups produced similar live weight gains, carcass yield, and marbling scores. Assuming a finishing ration cost of $0.05/lb, a daily intake difference of 3.50 lbs translates to feed cost savings of $0.18 per animal per day, or $26.25 per animal over a typical 150-d feeding period. The economic implications of these differences in the large-scale cattle feeding regions of North America should be readily apparent, especially given that these potential feed savings would not be associated with reduced performance or carcass merit with RFI.

Herring and Bertrand (2002) pointed out that a 2% reduction in consumption (while holding other performance traits constant) would provide an increase of $111 million in net return to beef producers. This result and other studies imply that the potential to maintain performance (e.g., postweaning gain) while decreasing intake (through selection) by 0.30 lb per day (assuming average daily intake of 30 lb and 1% annual genetic improvement), or total 150-d finishing period intake by 45 lb per animal per year. The genetic gains from this simulation translate to very large feed cost savings in the feedlot sector alone. It is important to note that such genetic improvement could be predicted for longer periods of selection in an additive manner. Further, based on results reported by Archer et al. (2002), improvement in cow herd efficiency would be similar to that obtained the feedlot sector, based on genetic correlation estimates suggesting the biological equivalence of RFI following weaning with RFI measured closer to maturity. Given the limitations associated with measuring forage intake in cows, the value of these savings remains difficult to predict accurately.

## Multiple Trait Selection with Residual Feed Intake

There has been little research on the potential implementation of multiple trait selection programs which include RFI. There is a relative lack of published estimates of genetic (co)variances of RFI with other economically relevant traits (Archer et al., 1999). Also, the cost associated with large-scale collection of individual feed intake data makes well-designed studies rare. Recent technological developments have reduced the cost of measuring intake in cattle, thus providing opportunities to measure feed efficiency in growing bulls in postweaning test centers.

Crews et al. (2006) proposed a three trait selection index with the objective to increase profitability during the feedlot phase of the market progeny of centrally-tested Angus bulls. We reported that a large majority of net revenue differences in steers on feed could be explained by feed intake, average daily gain on feed, and final live weight, which were defined as traits in the breeding objective. Then, traits commonly measured on centrally-tested bulls were added to the index and included RFI (adjusted for body composition), daily gain on test, and adjusted 365-d weight. The steer traits to be improved in the objective were linked to the information on bulls in the index by approximating genetic correlations among all six traits. Using routine selection index procedures, bull index value was defined as

$$\text{INDEX} = -10.12(\text{RFI}) + 24.79\ (\text{ADG}) + -0.09\ (\text{YWT})$$

which incorporated RFI, daily gain (ADG), and yearling weight (YWT) of bulls on test with their appropriate weighting factors. These factors show that index value placed a negative weight on RFI (i.e., decreasing) and a positive weight on gain (i.e., increasing). The small weight placed on yearling weight reflects that RFI is relatively unrelated to live weight. Phenotypic correlation estimates for index values with bull daily intake, ADG, and RFI were -0.22, 0.53, and -0.74, respectively. In addition to providing a single index value on which bulls may be selected to increase profitability of their market progeny in the feedlot, bulls with higher index values consumed less feed, had higher ADG, and were more efficient on central test. Index value was not related to YWT, which suggests that selection could be practiced independent of yearling weight. Further, index value had a low, but favorable, phenotypic association ($r_p = 0.16$) with yearling scrotal circumference. This may suggest that such an index would not be antagonistic to indicators of bull fertility. We recognize the limited profit objective of this index (i.e., feedlot sector), however, this approach illustrates one application of RFI in a multiple trait selection program. Other indexes could be developed with different profit or improvement objectives (e.g., heifer development), and other, equivalent index calculations could be applied using EPD.

## Challenges to (Inter)national Evaluation of Efficiency with Residual Feed Intake

Traits related to efficient feed utilization, primarily reducing input costs while optimizing output traits such as growth, have been identified in the NBCEC as next-generation EPD for the beef industry. Advances in large-scale genetic prediction combined with decision support will enable reporting of EPD for efficiency-related traits. However, (inter)national cattle evaluation systems (NCE) require three essential components: 1) data acquisition, 2) model development, 3) estimation of relevant genetic parameters, and 4) routine genetic evaluation runs.

In this paper, all but the first of these essential requirements have been addressed. Therefore, the current limitation of an efficiency evaluation is data acquisition. In addition to the added cost of recording individual animal intake, the suitability of data for NCE systems must be considered. In the case of commercial feedlot animals, parentage identity is usually unknown. With the exception of central test station programs and a limited number of progeny testing programs currently in place for evaluation of carcass merit, most calves destined for slaughter are somewhat anonymous with regard to parentage and pedigree. Pollak and Kirschten (2002) mentioned studies underway to combine DNA-based parentage testing with individual intake recording to maximize the information gained per dollar invested in data acquisition.

Some procedures exist to predict EPD for efficiency that do not require recording of individual animal intake. It is important to note that these procedures are not equivalent to RFI. The accuracy of these predictions depends on the genetic correlation between traits for which phenotypes are available (e.g., indicator traits) and the trait of interest (i.e., feed intake). Ultimately, there is always a less than 1.0 upper limit on the accuracy of EPD for an unmeasured trait. While animals can be very accurately evaluated for traits where phenotypic data acquisition is straightforward, few strongly correlated indicator traits are likely to be identified for RFI. This is partially due to the forced independence of RFI with other performance traits that have an association with feed intake.

The implementation of NCE for efficiency will require facilities with intake recording equipment. Given the current lack of widespread availability of such facilities, it may be reasonable to question whether commercial testing of progeny will be on a scale sufficient to support NCE. Existing central bull test stations may be retrofit to collect individual intake and efficiency phenotypes on bulls. Cost analyses need to be conducted to establish the cost effectiveness of these options.

## Future Research Requirements

Significant gaps exist in the understanding of the genetics of efficient feed utilization. RFI is an alternative to older, ratio-type efficiency traits. Animals appear to be ranked equivalently on the basis of RFI whether measured early in life or near maturity. Directional (decreasing) selection for RFI is associated with reduction in feed required to produce market-ready animals. The EPD for RFI during finishing have been similar. Therefore, improvement of feedlot RFI should also result in improvement in efficiency of the cow herd.

Opportunities also exist for identification of major genes which account for significant portions of variation in RFI and therefore efficiency. Studies in North America and Australia are underway using molecular and(or) single gene approaches with candidate genes to identify potential markers for various measures of efficiency. Once identified, such markers can be incorporated into genetic evaluation models, resulting in marker- or gene-assisted evaluations. The EPD resulting from marker-assisted evaluation will contain a genomic value corresponding to the effect linked to the marker and a polygenic portion due to remaining polygenic effects. For example, the Alberta (Canada) bovine genomics research group has completed several studies wherein candidate genes have been identified and association studies conducted to determine the usefulness of various single nucleotide polymorphisms (SNP) and multiple SNP haplotypes for prediction of RFI and related measures. Other, similar studies are also ongoing across North America.

**Summary**

Feed costs represent a significant fraction of the total cost of beef production, therefore genetic improvement programs for reducing input costs will likely include traits related to feed utilization. In contrast to traditional ratio-type measure of efficiency, residual feed intake is uncorrelated with body weight, growth rate, and other “energy sinks” which at least partially alleviates concerns over the long-term implications of selection and antagonistic correlated responses for mature size and maintenance requirements. The expense associated with collection of individual feed intake dictates the use of optimal data acquisition schemes and models for prediction of EPD. The incorporation of candidate gene or marker information into genetic evaluation models has promise, but more in-depth marker-association studies will be required.

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# Development of Genetic Evaluations and Decision Support to Improve Feed Efficiency

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## Introduction

The National Beef Cattle Evaluation Consortium (NBCEC) receives federal funding from a USDA special grant in order *to develop and implement improved methodologies for genetic evaluation of beef cattle*. The intent of such research is *to maximize the impact genetic programs have on the economic viability, international competitiveness and sustainability of U.S. beef cattle producers*. An important component of NBCEC endeavors include actively seeking out new traits and technologies to include in breeding programs. Many breeders and producers comment on the fact that there are no existing tools for improving feed efficiency. This paper considers the current scope for improving cow-calf and feedlot feed efficiency and identifies some opportunities for near- and long-term developments.

### *Breeding Goals and Breeding Objectives*

The first step in the logical development of a breeding program is to determine the goal or *purpose toward which an endeavor is directed*. What is the goal for the nation's cow-calf herds, or for all the feedlots, or for the total production system? The answer is probably not straightforward, nor is it something that should be solely developed by a commentator such as myself. However, it will have something to do with *satisfaction* and will typically include profit. One thing is for sure, the goal is unlikely to be biological efficiency per se.

Given a profit-based goal, the next logical step in developing a breeding program is to consider the list of traits that influence the goal (Harris *et al*., 1984). Broadly speaking, these traits will influence income, or costs, or perhaps both income and costs. This will be the case for the cow-calf sector, the feedlot sector, or both sectors considered as an integrated system. Different spectators may come up with different lists of traits, according to their particular perspective. Some lists might focus on concrete factors such as heifer pregnancy, rebreeding success, calving ease, calf survival, growth rate, feed costs, veterinary costs that have direct relevance to output or input line items in financial budgets or accounts. Others might construct lists that include *cow efficiency* or *feed efficiency*. One problem in the development of such lists of traits is that it is easy to double count. More on this later.

The next consideration in a breeding program is determination of the relative importance of each of the traits in the list. The naïve breeder might hope to avoid this step and simply identify individuals that are perfect for every attribute. However, in real life, this does not occur unless you have a very low definition of perfection. In practice, individuals may be outstanding for some attributes, and average or even inferior for others, especially if some traits are antagonistic. Most livestock breeding programs include a number of antagonistic relationships.

The formal means of determining the relative emphasis for a profit-based goal is to quantify *the partial derivative of the profit function*. This statement probably doesn't mean much unless you are mathematically or econometrically inclined. It involves answering the question, one at a time for each of the traits in your list that influence the goal, *what is the value of a unit change in that trait, all other traits held constant?*

Suppose our list of traits includes output, input and efficiency, defined as either the ratio of output per unit of input or the ratio of input per unit of output. We would need the answer to the question, *how does profit change with a unit increase in output, with no changes in input or efficiency*. The answer would be the value of the output, for example, the beef price. We would then ask *what is the change in profit for a unit change in input, with no change in output or efficiency*. The answer would be the cost of the input, for example the feed price. We would then ask *what is the change in profit for a unit change in efficiency, with no change in output or input*. The answer would be that there is no change in profit. Accordingly, the economic value of efficiency is zero, if input and output traits are already in the objective. Of course, it is not possible for a change in input or output without a change in efficiency, but this simply reflects that fact that we are double-counting when we attempt to have all three traits, namely output, input and efficiency simultaneously in the objective. We would therefore determine that only output and input traits are required in the objective, and therefore we only require EPDs for output and input traits.

In contrast, suppose our list of traits included only output and a measure of efficiency, but not input. In that case, we could determine an economic value for output and an economic value for efficiency and would conclude that we need EPDs for output and for efficiency, but not for input. Determining an economic value for efficiency is not as straightforward as determining economic values for output and for input in the previous paragraph. Suppose our existing feed conversion ratio is 6 lb feed intake per 1 lb gain. We need to answer the question *what will happen to profit if conversion ratio improves by say one unit, to 5 lb feed per 1 lb gain*? We can't answer that question without knowing how much gain we make. This is the case because the value of efficiency is not independent of the actual output or input. This just further reflects some of the difficulties of using ratio traits.

Finally, suppose our list of traits included only input and a measure of efficiency. We would conclude we need EPDs for input and efficiency, but not output. I doubt that many readers would be comfortable with such an approach, but it is just as logical (or illogical) as the former suggestion of only output and efficiency.

There are therefore four possible scenarios for the national evaluation system, as given in Table 1. Any of these scenarios could be adopted. Scenario 1 would involve the national generation of EPDs that could be used to predict outputs and inputs and therefore be very naturally used to generate predictions of profit. Scenario 2 may appeal to those more interested in biological rather than economic efficiency. Scenario 3 may appeal to those who believe in low inputs. Scenario 4 would appeal to those who like more EPDs than are needed. I will argue that scenario 1 is the most sensible approach as it allows selection to readily account for the value of changes in output and the costs of changes in inputs. The difference between the value of outputs and the cost of inputs is the profit. Selection for profit is likely to change the outputs and the inputs, with the amount of change in each being determined by the extent of genetic variation in outputs and inputs, the covariation between outputs and inputs and the relative ratios of beef returns to feed costs. Typically, selection on profit would increase both outputs and inputs, while improving biological and economic efficiency.

**Table 1.** Alternative lists of traits in the national breeding objective.

| | Outputs[A] | Inputs[B] | Efficiency[C] |
|---|---|---|---|
| Scenario 1 | Yes | Yes | |
| Scenario 2 | Yes | | Yes |
| Scenario 3 | | Yes | Yes |
| Scenario 3 | Yes | Yes | Yes |

[A]Outputs can be predicted from EPDs for sale weights, reproductive performance and carcass attributes.
[B]Inputs can be predicted from EPDs for maintenance energy, growth, feed intake and residual feed intake.
[C]Efficiency could be defined as ratios of either inputs per unit output or outputs per unit input.

In contrast to selection on profit, where the breeder can select the emphasis to be placed on outputs and the emphasis on inputs, selection on efficiency leaves the emphasis on these two components to be determined biologically, without any regard to the ratio of the value of outputs to the cost of inputs (Gunsett, 1987). Table 2 demonstrates some of the problems with EPDs for efficiency, as can be shown by comparing the two bulls Oscar and Papa. Papa is much more efficient than Oscar, but no more profitable. Selection on efficiency could increase efficiency without changing profit. Furthermore, animals that vary in profit may share the same efficiency. For example the bulls Oscar and Romeo have the same efficiency, but Romeo has greater profit.

**Table 2.** Output, input, profit and efficiency ratios of three candidate sires for selection.

| Bull ID | Output ($/dtr[A]) | Input ($/dtr) | Net Income[B] | Efficiency[C] |
|---|---|---|---|---|
| Oscar | $500 | $200 | $300 | 2.5 |
| Papa | $400 | $100 | $300 | 4.0 |
| Romeo | $750 | $300 | $450 | 2.5 |

[A]Output and input are expressed in financial terms, per daughter (dtr).
[B]Net income is the value of the outputs column less the cost of inputs column and may not be the same as profit which typically includes other fixed costs.
[C]Efficiency is defined here as the ratio of outputs to inputs ($/$). In this case, higher ratios are desirable. It could equally be defined in other units such as lb/lb or as its reciprocal, inputs/outputs, in which case lower values would be desirable.

The distinction between selection towards a profit-based goal derived from an index of EPDs on inputs and outputs, as compared to selection using an efficiency EPD can be graphically demonstrated in a more thorough manner than the simple example in Table 2. Consider a graph depicting the amount of output (e.g. sale weight) on the y-axis and the amount of input (e.g. feed provided or consumed) on the x-axis. Suppose this figure is populated with progeny averages for various sires. It might appear as depicted in Figure 1, with a positive (economically antagonistic) relationship reflecting the fact that getting offspring to heavier sale weights typically requires greater feed inputs. However, the relationship is not strong for several reasons. First, some animal get to heavier weights by growing faster than others and therefore require less maintenance feed up until the point of harvest than do slower growing animals. Second, animals vary in the composition of their gain, and the feed costs associated with laying down lean and laying down fat are not identical. Third, animals may vary in the extent of feed wastage. Fourth, animals do not all exhibit identical levels of activity. Fifth, there is inherent variation in the efficiency of energy utilization, after accounting for the four previous factors. The physiological and biochemical mechanism for such variation is still unknown, but the existence of such a phenomenon is the basis for heritable so-called "residual feed intake" or RFI.

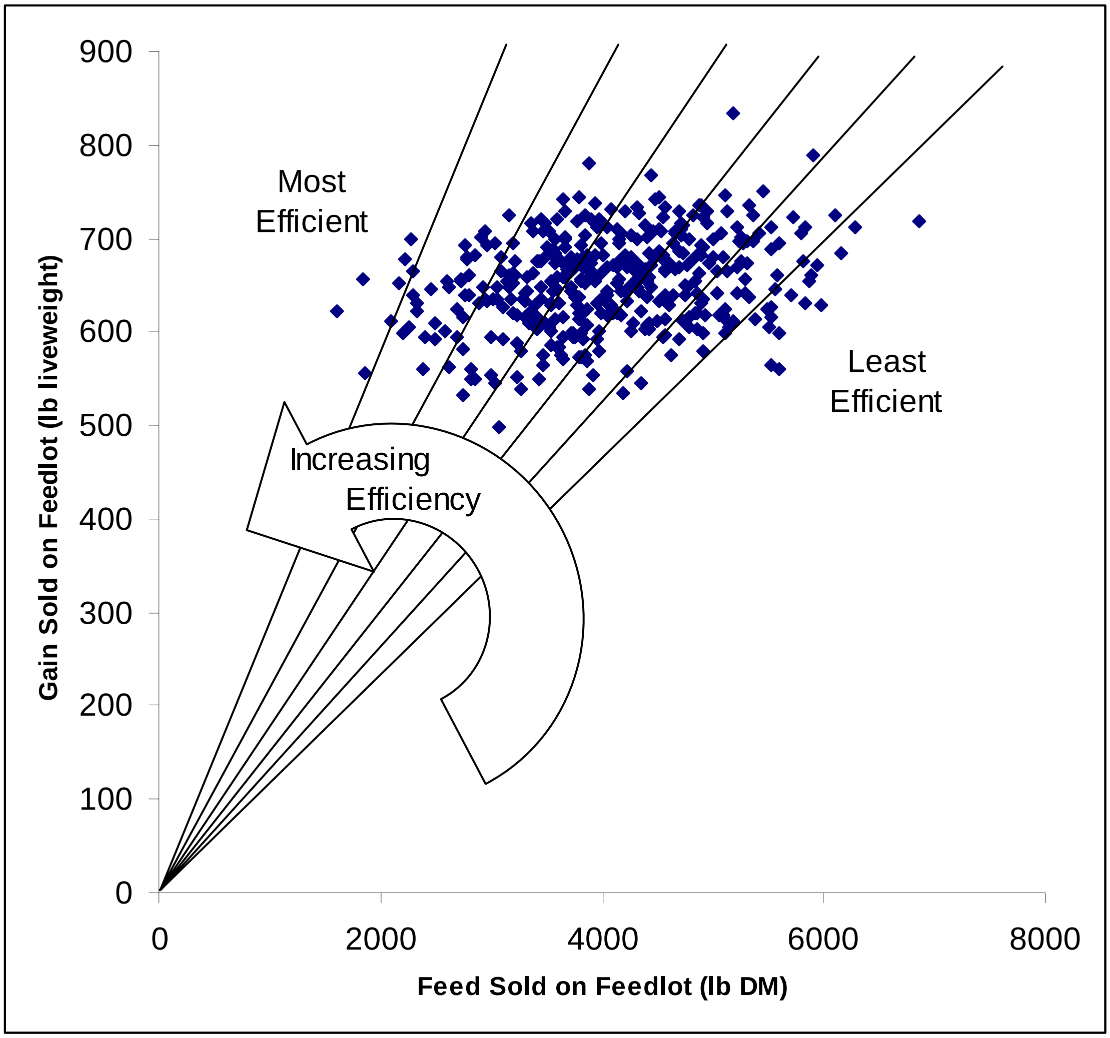


**Figure 1.** Outputs, inputs and iso-efficiency lines for progeny groups of a number of sires.

Superimposed on Figure 1 are iso-efficiency lines, where every point on the line has identical feed efficiency. These lines can be drawn without any consideration of the value of outputs (i.e., the beef price) or the cost of inputs (i.e., feed costs), nor their relativity. The lines are not parallel as they all pass through the origin and become progressively steeper to the left of the Figure. The large arrow indicates the direction of increasing efficiency, and the animals in the top left-hand corner represent the progeny groups with the highest biological efficiency.

The same sire groups are shown on Figure 2, with iso-profit lines superimposed. These lines represent the net income of each sire group, defined as the value of the gain, less the cost of the feed. Suppose the beef price was $1.38 per lb carcass weight. At a dressing out percentage of 62.5%, this relates to a price of $0.86/lb liveweight. At that price, a 116 lb increase of liveweight would correspond to a $100 increase in per head return. Suppose the feed cost was $5.70 per 100 lb on a dry matter (DM) basis. An increase in feed inputs of 1750 lb would decrease per head return by $100. Compared to an average progeny group, a sire whose progeny weighed 116 lb more at harvest, but had consumed 1750 lb more feed, would have the same profit as the average sire group. In contrast to the iso-efficiency lines, the iso-profit lines are parallel. The beef price to feed price index determines the slope of the iso-profit lines. These lines have a horizontal increase of 1750 lb feed for every vertical increase of 116 lb weight.

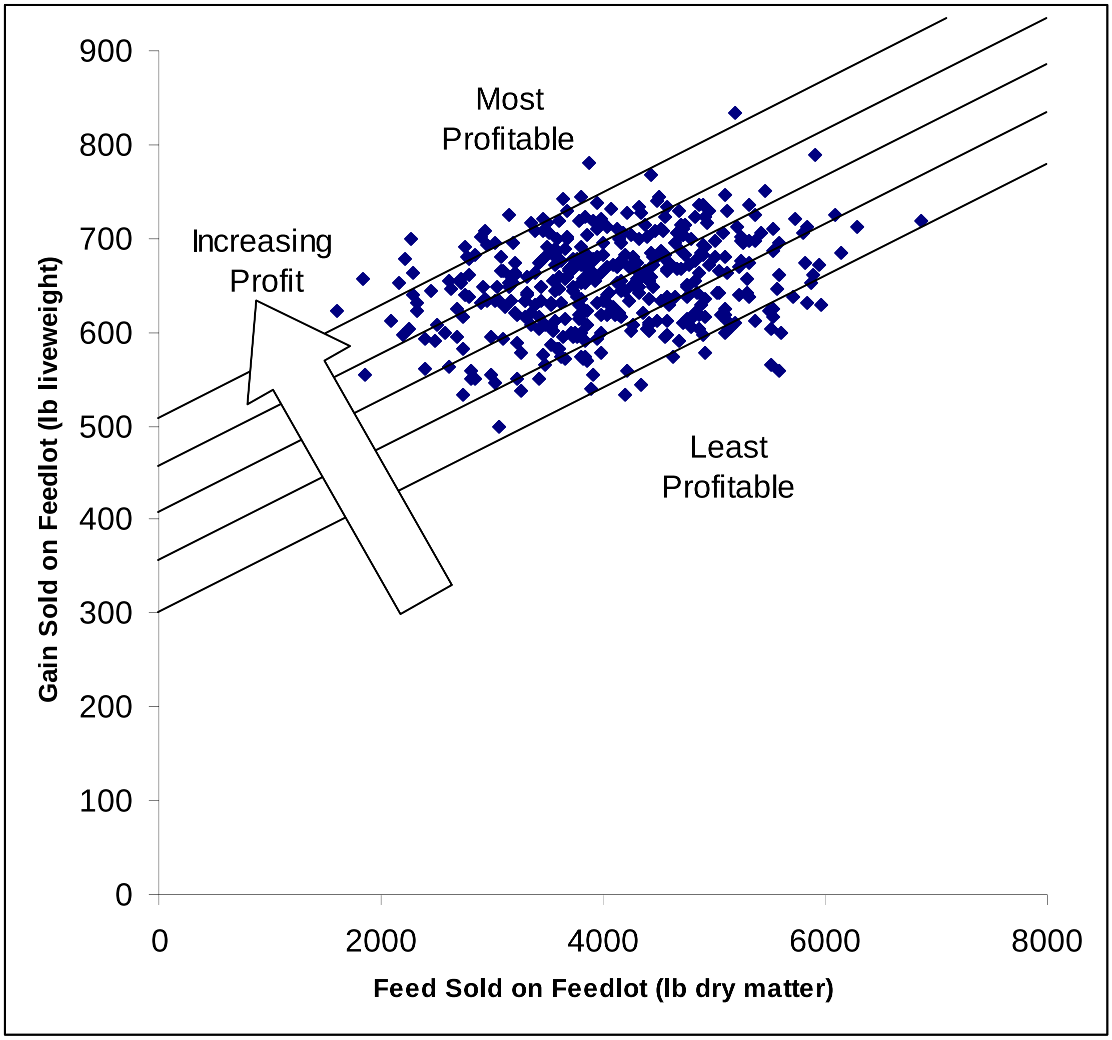


**Figure 2.** Outputs, inputs and iso-profit lines for progeny groups of a number of sires.

Comparing Figure 1 and Figure 2 it is apparent that although there is overlap, the sires with the highest efficiency identified on Figure 1 are not the same sires as those with the highest profit identified on Figure 2. Some of the sires with the highest profitability have intermediate efficiency. Conversely, the sires with the lowest efficiency do not coincide with the sires with the lowest profit. Some of the least profitable sires have moderate efficiency. Whereas the efficiency lines are unaffected by the economics associated with beef to feed price-cost ratios, the most profitable animals require some knowledge of this relativity. At certain price-cost ratios, the most efficient sires may correspond to the most profitable. However, because the iso-profit lines are parallel whereas the iso-efficiency lines represent rotations, it is not generally possible for an efficiency index to simultaneously correctly identify both the most and the least profitable groups of sires.

Some commentators find appeal in efficiency measures because of the vagaries of costs and prices and the difficulties in assessing what these might be in the future. However, it is not the actual values for beef or feed but the price-cost relativity that is important. Trends in price-cost relativity may be more consistent than actual prices and costs. Using biological efficiency does not get around the problem that economics determines profit. Unless biological efficiency rather than profit is the goal for selection, livestock managers would make better decisions using predictions of output value less input value rather than using predictions of efficiency.

### Current Status for Predicting Outputs, Inputs, Efficiency and Profit

***Predicting Outputs.*** National evaluation has long been based on some measures of outputs, notably weaning and yearling weights, and more recently measures of carcass attributes that relate to output value. However, system outputs are determined by the number of animals available for sale, as well as their sale weights. Although the prediction of sale weights is well advanced, prediction of sale numbers leaves considerable room for improvement. In a herd breeding their own replacements, the heifer pregnancy rate, cow fertility, length of productive life and calf survival rate are critical factors. The length of productive life has a major impact on the number of first calvers required. Herds whose cows stay longer (for more parities) need a smaller fraction of first calvers than do herds where the cows have a higher probability of being open and are therefore culled at a younger age. The heifer pregnancy rate determines the number of weanlings that need to be retained in order to meet the requirements for first calvers. The fertility of the cow herd determines the number of calves produced and the calf survival rate dictates the proportion that survive to sale. Heifer pregnancy and stayability represent two EPDs that can be used to predict sale numbers in a system context. However, many breeds are yet to adopt these EPDs, or even to modify their performance recording practices in order to ensure they collect data that can be meaningfully used for such predictions. Inventory recording systems are prerequisite for reliably predicting some output factors.

Predicting outputs in a feedlot setting on the basis of existing EPDs is probably more difficult that predicting outputs in a cow-calf system. Animals with higher yearling weight EPDs typically have higher mature sizes and can therefore grow faster and to heavier weights before achieving the same level of fatness as animals with lower yearling EPDs. EPDs for carcass fatness and for carcass marbling can be used to get some idea of the relative abilities of offspring of different sires to lay down fat or to marble, but prediction of the actual weight at which this will be achieved is not obvious from EPDs. Additional decision support tools that utilize growth and carcass EPDs in the context of a feedlot model is currently being developed at Colorado State University. Such models need to simultaenously account for the growth trajectories of alternative sires in terms of liveweight and its components, including, total fat, fat thickness and marbling. The desired outputs from such models need to include *value at finish*, *days to finish* and *feed to finish*.

***Predicting Inputs.*** Feed requirements represent the most important input in the beef industry although inputs related to veterinary needs (e.g. based on calving difficulty) and animal health (e.g. pink eye, shipping fever etc) should not be overlooked. In a cow-calf system, feed inputs are required for replacements (maintenance and growth), the cow herd (maintenance, gestation, lactation and growth) and for the calves from birth to sale (maintenance and gain). In mature cows, most of the annual requirements are for maintenance. In growing animals, the relative importance of maintenance and gain varies with the growth rate and the composition of the gain. The amount of feed required by the cow herd and its replacements can be predicted from knowledge of the numbers, weights, rate of gain and milk production potential. This is achieved by determining the feed requirements for maintenance, for gestation, for lactation, and for growth (e.g. using NRC, 1996).

Maintenance requirements are principally determined by the weight, fat content and lactation potential of the cow. Lactation potential can be determined from the weaning weight maternal EPD, whereas cow weight and fatness can be predicted from weighing and condition scoring mature cows, preferably at weaning. The Red Angus Association of America uses this information to predict mature weight and maintenance energy EPDs. The American Simmental Association and the North American Limousin Foundation are also developing maintenance energy EPDs.

Gestation requirements can be predicted from birth weight EPDs. Lactation requirements can be predicted from weaning weight maternal EPDs. Growth requirements can be predicted from body weights, including birth, weaning and yearling weight EPDs. Requirements for replacements can be predicted from the age structure of the herds, influenced by heifer pregnancy and stayability.

Some individual animals consume more than we expect them to require, based on their maintenance and growth and, in the case of breeding cows, requirements for gestation and lactation. Such differences often result from variation in activity between animals, or variation in requirements to maintain temperature, for example in very cold conditions. However, even when all these factors are taken into account, some animals eat more or less than we would expect them to given their level of production. This difference is known as residual feed intake. Differences in residual feed intake will give the impression that some animals have lower maintenance requirements or higher efficiencies of gain, although it is technically problematic to determine the underlying cause of variation in residual feed intake. The only way to phenotypically determine residual feed intake is to measure individual feed intake.

Measuring feed intake is not altogether informative, as much of the variation in feed intake between animals can be predicted from their weight, growth rate and composition of gain. Furthermore, measuring feed intake is prone to a number of errors, from animals selecting among their feed, and wasting feed, for example dropping it on the ground or in the water trough. It is particularly problematic to measure it in grazing circumstances, although various methods do exist based on indigestible compounds such as alkanes or chromate. The real value of measuring feed intake is to predict residual feed intake, because that is the only component of feed intake that cannot be predicted from performance alone.

In order to generate measures of residual feed intake, not only is intake required, but also a method of predicting the amount of feed that should have been required. This can be achieved in two broad ways, from regression of intake on weight, gain and perhaps composition (e.g. ultrasound measures of backfat) or from prior knowledge using feed tables or nutritional models (Tedeschi *et al.*, 2004).

Prediction of inputs from a cow-calf perspective could be considerably improved if we had better predictions of certain outputs, principally, mature weights, condition scores, heifer pregnancy, fertility and stayability. Collecting more of these phenotypes represents an obvious opportunity that we should be exploiting. Measuring residual feed intake accurately and cost-effectively on these extensively managed foraging animals is technically some way off. In contrast, in feedlots, individual intake for at least a portion of the growing period is technically much more straightforward.

Pooled records on intake, for example from a small pen of animals may be more cost-effective to obtain than attempting individual observations. Pooled records can be used in genetic evaluations (Olson *et al.*, 2006), and can contribute to EPDs for RFI. However, whereas a considerable infrastructure exists for collecting growth and ultrasound information, the infrastructure to collect feed intake measures is sadly lacking. This will need to be remedied.

Guidelines for collecting feed intake data and corresponding performance need to be developed or adopted from existing guidelines elsewhere in the world and incorporated in the BIF guidelines.

***Predicting Efficiency.*** Efficiency measures are useful key performance indicators for comparing the management of alternative feedlots or cow-calf production systems. However, as a tool to improve efficiency by selection, EPDs for measures of input and for measures of output are more effective than a new EPD based on some ratio of inputs and outputs. Genetic trend estimates for outputs and for inputs could be used to predict the genetic trend in biological efficiency. Decision support models that predict output and input could readily predict current and future efficiency, but the use of such measures as the basis for selection is not advisable for profit-based goals for the reasons demonstrated in Figures 1 and 2. Accordingly, the NBCEC has no current plans to develop an EPD for cow-calf or feedlot biological efficiency per se.

**Predicting Profit.** Given a profit-based goal, the most effective means of selection is based on an index that predicts profit. One approach to this problem would be to measure phenotypic profit on every animal, and then undertake genetic evaluation to construct an EPD for profit. However, the components of profit vary greatly in the extent of non-genetic effects (e.g. sex or age of dam). Furthermore, the heritability of the records after accounting for non-genetic effects also varies greatly. The consequence of varying heritability is that individual measurement is more informative of EPD for some traits than it is for others. The preferred approach to generate an EPD for profit is to combine the EPDs for economically relevant traits according to their contribution to profit, known as their relative economic value. Such an index is a great selection tool if the index is properly constructed and the user has a high level of confidence in the underlying assumptions. An equivalent method is to use EPDs to predict phenotypic performance, and then to combine predicted phenotypic performance with expected costs and prices in order to generate index values. This approach, known as sire selection by simulation (Bourdon, 1998), has the advantage that it can readily demonstrate the ramifications of selection (Garrick, 2006), can provide justification of the basis for the animals' index values and readily extends to mating systems that involve both pure- and cross-bred individuals (Garrick, 2005). The NBCEC web-based tools for predicting profit from predicted outputs and predicted inputs on the basis of existing national EPDs are available at *http://ert.agsci.colostate.edu*. The current version supports multiple breeds of sires in the context of a cow-calf model. A prototype feedlot model will be added to the software over the next twelve months.

**Summary**

Selection to improve profit will be more effective when based on predicted outputs and predicted inputs than on ratios such as efficiency. Predicted outputs and inputs can be used in conjunction with economic information to predict expected financial outcomes. Short- and long-term opportunities exist to improve the prediction of both outputs and inputs in cow-calf and feedlot scenarios.

In the cow-calf system, improved prediction of reproductive performance is needed. In most cases, modified recording practices will be required to generate phenotypes or inventory information that will enable a broader portfolio of economically relevant traits (heifer pregnancy, stayability, mature size and maintenance energy) to be evaluated. This will take some time and will therefore provide long- rather than short-term benefits. In the immediate future, better use needs to be made of correlated information (weights, scrotal circumference, condition scores) to predict such EPDs while breeders need to be educated as to the industry benefit of improved recording practices.

In the feedlot system, improved predictions of both inputs and outputs are required. Existing phenotypes (primarily ultrasound measures of live animal composition) need to be used in more innovative ways, accounting for knowledge of growth and composition trajectories. That information needs to be used in order to predict phenotypic outcomes (value at finish, days to finish and feed to finish) in the context of particular user-defined feeding strategies. New but not novel phenotypes, such as feed intake, may provide opportunities for faster rates of improvement in selection for feedlot performance. Collecting these phenotypes may not be cost-effective from the sole viewpoint of genetic improvement but should be harnessed when being collected in the context of monitoring and improving feedlot management. However, guidelines and infrastructure for collecting such intake data in national performance databases will need to be developed.

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# Matching Beef Genetics with Production Environment

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***"….. thus environmental conditions existing at any given time will lead to the natural selection of genes giving rise to characters in harmony with the environment concerned." Hammond, 1947***

## Introduction

Producers' concerns about the level genetic potential for performance in cattle and the production environment are not new to the cattle industry. Remley (2000) chronicled the history of the Bell Ranch in New Mexico from 1824-1947. To meet market demands, ranch managers during this time period imported improved germplasm into the ranch's indigenous cattle population creating a disconnect with the production environment. Implementing genetic improvements, moving English breeds of "short leg and heavy muscle" to the western range, to meet market guidelines set by a meat packing industry resulted in repopulation of the cow herd with heifers whose genetics "… were not in harmony.." with the production environment. To insure a harmonious state, the managers modified the production environment by adopting innovative new technologies available during that time period including fences, wells, windmills, irrigated pastures, etc.

In comments made during the symposia: *Breeding Beef Cattle for Unfavorable Environments* (1955*)* held to commemorate the King Ranch's centennial celebration, the Vice Chancellor of the then Agriculture and Mechanical College of Texas, Dr. D. W. Williams, described the environment using the wisdom of commercial cattle producers of that and previous eras. The cattlemen's envisioned environment was made up of the raw resources "…grass, weeds, browse, water, and labor..." of the ranch. Dr. Williams further states that when matching cattle to the environment, the commercial cattleman "...knows that a first consideration is that these cattle must be capable of converting to beef the kinds of range and field feeds *he* produces under the temperature and humidity conditions of *his* ranch, and they must be resistant to the diseases and parasites of *his* particular area…". This suggests defining an animal's genetic merit in terms of forces exogenous to the production environment could result in a disconnect between the genetic potential of the animals expected to produce and the production environment. This disconnect creates a need to alter the environment to sustain indexes of previous levels of production. Attempting to sustain desired levels of production may be counter to the profitability of the commercial rancher. In both books, the authors document the paradox faced by many commercial producers, to produce calves to meet the day's marketing standards using cattle germplasm not suited to the production environment of that producer.

## Targeting the Production Environment

Broadly defined, the production environment is made up of all non-genetic drivers from all segments of the horizontally integrated United States beef cattle industry. The mobility of cattle in today's beef industry challenges the commercial cow/calf producer to identify the cattle genetics appropriate to meet all the demands of various environments encountered. Meeting this goal is not feasible, but the producer can develop priorities and use these priorities to established boundaries for genetic potentials suitable for traits that affect productivity in the production environments their cattle are expected to perform. The key to matching cattle genetics with the production environment is to correctly identify the drivers of the production environment(s). Using the appropriate genetics would minimize the need to modify environment; i.e., cost of environmental modification would not exceed the gain in income associated with genetic change. Once characteristics of the production system are well defined, genetic variation within the U.S. beef cattle germplasm base enables producers to match the genetics to the production environment using either genetic improvement programs or by structured mating systems.

Typically producers' discussions about the environment focus on issues such as green grass days, temperature, humidity, forage types and availabilities, water availability, endo and ecto-parasites, need for nutrient supplementation, etc. Another environmental component that should be considered when making a decision making about cattle genetics is: what is the primary product and how will the product be merchandised i.e., what is the market endpoint? The primary product for the commercial farm/ranch is animal weight. Cull cows and market calves contribute to the total weight with the latter being the primary revenue generator. (Some commercial ranches also market breeding stock but this marketing system will not be considered in the discussion). An early question to address is how will the weight from market calves be merchandized: at weaning- product weaning weight, following background period- product weight at end of background period, following stocking- product weight at end of the stocking period, or is ownership retained through the finishing period. If the latter, the product is still weight but the value could be on a live basis or, a carcass basis, that includes simple carcass weight or increasing unit value through other assessments of carcass value; e.g., quality grade, yield grade or in niche markets such grass fed, grass fed natural, organic, etc. Identification of the market endpoint is the first critical step in determining the level of genetic potential for production traits.

Once the decision regarding the market endpoint is made, producer's need to consider the physical environment where production takes place. What are normal features of the environment where the animals are expected to produce? Can breeds or breed crosses be identified with the desired genetic potentials for traits contributing directly or indirectly to production of the primary product. What environmental constraints must be offset to insure this expression of the genetic potential of the identified germplasm? What management interventions will be needed to offset environmental constraints, e.g., replacement heifers purchased, early weaning, use of AI, capital accessibility, labor, grazing management, etc? Will this intervention be cost effective?

**Options for Matching Cattle Genetics**

Matching cattle genetics to the production environment can be accomplished by using breeding programs. Management decisions regarding breeding programs can be made once a phenotype(s) is identified that increases profitability of the ranch through cost effective modification of the production environment. Questions to ask include- what is the cow inventory required to attain production goals, what is the desired phenotype, what is the frequency of the favorable phenotype(s) in the present cow herd, are replacement heifers raised or purchased, is on ranch testing feasible, is pedigree information available on individual animals, is within herd genetic improvement a viable option, etc. Mating decisions can be made to alter the genetic make up of cowherd by deciding how the individuals will be mated. Use of decision support software such as the Decision Evaluator for the Cattle Industry (DECI) coupled with financial information allows managers to make these evaluations.

Genetic variation in the cattle (Mason, 1971), within and between breeds, provides producers the opportunity to 1) create progeny appropriate for the merchandising program and 2) produce females that genetically are suited to the local production environment (i.e., cost effective intervention). This variation may be utilized by mating systems designed to exploit breed differences and increasing the fit to the environment by using heterosis (Gregory and Cundiff, 1980) or implementation of within herd or geographic location breeding programs of selective matings to enhance gene frequencies for phenotypes deemed advantageous in the environment.

Breed options for use in mating systems increased with the cattle importations of the 20th century. The "green revolution" beginning in the 1960's altered the structure of the feedlot industry by reducing the cost per unit of feed during the finishing period and modifications in the packing industry facilitated adoption of heavier slaughter weights. This upstream merchandising change motivated commercial cow/calf producers to want heavier weights at weaning and owners of postweaning animals to have higher average daily gains. These changes, coupled with a consumer's desire for a leaner product, stimulated the impetus for the importations from Europe beginning in the 70's and 80's. We now collectively reference these breeds from this round of importation as the "Continental breeds". Producers' need to have beef cattle capable of producing in a unique environment; e.g., the challenge of producing in the Gulf Coast- heat, humidity, and parasite problems provided impetus for these importations resulting in the importation of *Bos indicus* breeds that contributed to the formation of the American Brahman. The National Beef Quality Audit (1995) stimulated producers' interest in an alternative to Brahman or Brahman cross cattle in this Gulf Coast environment resulting in the importations of breeds of *Bos taurus* cattle that had evolved in tropical environments (e.g., Tuli, Romosinuano).

However, besides carrying the genes for the desired phenotypes, introduced breeds carried genes affecting other traits which might not be desirable or create problems under current production environment. Because the genetic potentials for these additional traits were established in environments with differing resource availability, under different management protocols, and driven by a different market demand, these genetic potentials often do not fit with "normal" management protocol in the U.S. cattle industry. For example, the desire for high yields of lean in some European countries has resulted in the phenotype of "double muscling" which we now know is the result of a single point mutation at approximately seven different locations within the gene affecting myostatin. Matings involving breeds having the mutated form of this gene resulting in a homozygous genotype in the calf results in a calf phenotype that produces a high incidence of severe dystocia resulting in a high frequency of caesarian births. Management protocols in these countries where the frequency of the mutated gene was increased consider caesarian delivery as "normal management" but certainly would not be the case under most management protocols in the U.S.

Characterization of breed performance potentials for all relevant production traits is needed to implement a sound mating system. The Germ Plasm Evaluation project at the Meat Animal Research Center led by Dr. L. V. Cundiff provides the cattle industry with an assessment of breed potentials in a common environment. Breed means for many production traits, including growth, carcass attributes, age at puberty, reproductive rate, and mature weight are available from the 23 reports available at the MARC web site:
*http://www.ars.usda.gov/npa/marc*.

By coupling breed potentials with a merchandising plan and knowledge of key physical environmental factors such as number of green days, forage production (type and quantity), typical weather patterns, labor resources, etc a producer can establish the phenotype of cow needed for his/her local production environment and produce market progeny capable of producing at desired levels in other types of production environments. Two breeding programs provide producers an effective way to utilize breed differences to fit "cattle genetics" to their production environment: rotational mating systems or composites. Both systems provide the additional benefit of heterosis, especially for those associated with lowly heritable traits. The former has been described as needing a relatively large herd size and high level of management. If a producer's operation falls outside of these parameters, use of composites represents an effective mating system strategy to use breed differences and retain some heterosis. This option has resulted in new breed formation such as the Braford, Murray Grey, Barzona, Belmont Red, Beefmaster and Santa Gertrudis to name a few. This process is ongoing today with composites being created that seek both a marketable product and ability to produce in challenging environments.

Within breed, herd or geographical area breeding programs designed to increase frequency of desired phenotypes for a ranch/farm or geographical area within the existing population represents another option. Again, the producer's merchandising plan must be in place and the production environment characterized prior to using genetic improvement programs. For seedstock producers, this means they must have knowledge of their commercial cattle producer customer's environment). Once these environments are characterized, traits that directly or indirectly impede performance must be identified, measured, and it must be determined if observed variation for this trait has a genetic component. Recording information on traits associated with annual production of a calf, i.e. annual calving and successful weaning of a calf, etc. are examples of a comprehensive indicator traits measured on individual cows that will work over time. Once the desired phenotype established within the cowherd (or if it is already present) genetic improvement programs based on phenotypic selection may be implemented to increase the frequency of the desired gene(s) in the population. However, improvement based on EPDs or marker information for indicator traits may require an extensive amount of time to increase the frequencies of desired genes controlling the traits of interests within the population.

**What is the Contribution of Seed Stock Producers?**

Reflecting over the technological advances occurring in the five decades since William's remarks one can question if his remarks have relevance in today's cattle production industry. Innovative technology provides the opportunity to transfer genetic improvements in production traits deemed economically relevant to seedstock cattle producers. Have breed organizations adopted the philosophy expressed in the children's book "Me to, Iguana" (Reinach, 1977)? In this story, an iguana seeks to alter her features (phenotype) to be just like the other animals that inhabit her neighborhood because it thinks the other animals phenotype are more acceptable. In trying to become like the other, not only does the iguana cover up the very feature that allow her to survive but the community loses as well by the loss of the iguana's unique characteristics that contributed to the community's (industry) wellbeing.

Breed associations need to make a firm commitment to sustain genetic variation both among and within breeds. It is imperative that the resource of between and within breed genetic variation for production traits relevant to the beef cattle industry be sustained by the industry (Cundiff et al., 1986 a,b). Cattle producers are aware of marketing and production challenges faced within the industry today. Factors grouped together under the heading of environment are not static, rather many are transitory and frequently beyond the producers' control; e.g., markets, consumer demand, government policy, and global warming. The ability to institute change within the cattle population exists only if sufficient genetic variation to exists to allow these challenges to be met.

## Summary

In conversation with commercial cow/calf producers a favorite topic of conversation is to describe an "ideal cow". This cow is designed to express desired performance under their local production conditions, and would be described as an "easy keeper", a "good doer", or simply "matched" to the environment. From a limited number of "easy keepers" the problem faced is how to expand the numbers of this kind of cows. If the production environment of the cow herd needs "upgrading" to insure heifers produced from matings with "improved" sires and are retained as replacements are reproductively successful, the result for commercial cow/calf producers may be an increase in gross income but not net profit (Jenkins and Ferrell, 2002).

To successfully match cattle genetics with the production environment the following steps need consideration (Jenkins, 2004):

*1) Identify merchandising plan*

*2) Identify the most limiting environmental feature (constraint or bottleneck)*

*3) Identify phenotype(s) that directly or indirectly provide an advantage*

*4) Identify breed(s) or animals with phenotypes that overcome the constraint*

*5) Define an objective measure of the identified trait(s) to overcome the constraint*

*6) Determine if trait is under genetic control*

*7) Design and implement a breeding program to increase the frequency of the desired genotypes in the inventory*

*8) Sustain genetic diversity*

Implementation of these steps reflects a commitment to an underlying philosophy of management to improve profitability through optimizing resource use rather than one of maximizing revenue through environment modification by a commercial cattle producer. Steps 1, 2 and 3 are among the most critical. If neither the merchandizing plan nor the environmental constraints are fully understood, the cattle genetics can not be identified.

Step 8 represents an industry commitment to maintaining a diverse genetic base in the total population of cattle thus providing the industry access to genes that are needed for infusion into local breeds or breed crosses to relieve new environmental constraints.

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# Heterosis - Ignored or Forgotten?

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So why are we still talking about heterosis? I remember attending a cattlemen's meeting in 1967 in Bangor, California (population of 194!) when I was 9 years old. Our Farm Advisor gave this very clear, simplistic report on crossbreeding---and the data was irrefutable. Crossbreeding generated economic returns for commercial beef producers. The following spring, my Dad purchased the first Angus bulls to be used on a herd that ran very heavy to Hereford, with a smattering of "Durham" (Shorthorn) influence. It was not necessarily a popular decision with all of the neighbors!

Yet, forty years later, I think that as an industry we have ignored or forgotten the value of heterosis. The classical work conducted at Fort Robinson in the early 1960's provided the scientific dcoumentation for heterosis (Gregory et al., 1965). The elegant and truly remarkable germ plasm evaluation and germ plasm utilitization studies at the United States Meat Animal Research Center provided substantive and meaningful data on the value of crossbreeding (Cundiff, 1970; Gregory et al., 1978). If we design breeding programs that capture direct and maternal heterosis, we can increase lifetime productivity by over 20% (Ritchie et al.,1999). The literature is clear, overwhelming and consistent regarding the benefits of capturing heterosis in beef production systems.

I think back to my first animal breeding classes studying crossbreeding systems and discovering that nature was good to us…… we were able to use both selection and crossbreeding to make genetic progress! Not only could we effectively utilize selection within breed for highly heritable traits, we could also make significant improvement in lowly heritable traits with crossbreeding. In graduate school in the early 1980's I had the very fortunate experience to work with people like Dr. Bob Taylor and Dr. Jim Brinks----practical, skilled animal breeders---- who had the ability to clearly elucidate the importance of designed breeding programs. From that experience, I was one of a handful of people who met in Denver in 1990 to form a group that worked on the utilization of "composite" seedstock. What I particularly appreciated about those "out of the box" thinkers is that it was not about protecting territory but about making progress.

Heterosis (hybrid vigor) is the amount (percent) by which the crossbred average exceeds the average of the two (or more) parental purebreds for a measured trait. From an economic perspective, the most important gains are made in lowly heritable traits that are often difficult to measure. Traits like calf livability, survival to weaning, conception rate, age at puberty and many others, all benefit from heterosis. The individual change in one trait is small, but the cumulative effect on total productivity and lifetime productivity is tremendous, ranging well over 20% (Taylor, 1994).

In this paper, I do not believe it is necessary to revisit the scientific evidence regarding hybrid vigor, but more importantly to address the failure of our industry to effectively utilize the powerful tool that nature has provided. For some reason, poultry and pork have seemed to figure out how to take advantage of genetic diversity and produce a consistent product. The beef industry has not done so on a widespread basis.

After participating in this industry at many levels (educator, cow-calf and stocker producer, purebred breeder), I thought it appropriate to summarize ten reasons that we have ignored or forgotten about heterosis in our quest to make genetic progress. If assigning blame is important there is plenty to go around, including much of it directed to the historical direction of our research and education at Universities:

1) **A cultural bias that clearly reflects "purebreds are better!,** if for no other reason than they have a registration paper. Society, at many levels, rewards purity. Is your dog registered? Does your quarter horse *gelding* have papers? How far can you trace your ancestry? Please don't misunderstand---there is certainly value associated with that record, particularly our ability to track performance and predict genetic potential of purebreds. But being purebred should not be a presumption of superiority.

2) **Our predilection for single trait selection focusing on "bigger is better".** This industry seems to choose a trait of importance and then put an inordinate amount of pressure on that trait, ignoring genetic antagonisms. If a 90 pound yearling EPD is good, 100 must be better! It is intuitive! We have already done frame, growth (weight of all kinds), milk, and carcass traits (both ribeye and marbling). I sometimes have to ask myself, "so what is the trait of the year this time?". It is akin to the "flavor of the month" at the local ice cream shop. And because often have chosen relatively highly heritable traits, we have not needed to crossbreed to achieve those goals. The subtle, and cumulative improvement that heterosis provides does not lend itself to maximums.

3) **We have decided that measuring outputs is more meaningful than measuring inputs**, as well as easier to do. It is certainly easier to measure calf performance on an individual basis, rather than all costs associated with that production. " I can weigh them at weaning quicker than I can determine differences in treatment costs over time."

4) **Uniform phenotypes for qualitative traits (color) have a distinct and real marketing advantage that is difficult to ignore**. That does not mean you cannot have uniformity of color within a crossbreeding program, but the widespread and indiscriminate planning (or lack thereof) of many crossbreeding programs certainly gave us some interesting marketing challenges. Generally, it is easier to produce a uniform color in straightbred programs.

5) **Heterosis is very difficult to visualize and even more difficult to measure**. Because heterosis is expressed as a small net positive in many traits we do not know it when we see it. Slight changes in morbidity, age at puberty, conception rate and significant changes in longevity are not easily observed. However, we all know when calves gain faster in the feedlot.

6) **The presentation of complicated crossbreeding systems as a "normal practice" to diverse cattle operations, especially the countless small beef herds in the United States**. Many of the systems that we teach as part of standard animal breeding or beef production courses have very limited application in the real world. Most beef herds are too small to implement the "standard systems".

7) **Our penchant for telling people how to modify their environment in order to "get heavier calves, higher percent calf crop and more total pounds",** rather than how to increase net return. How many new supplementation

programs can you develop in order to get your heifers bred or wean bigger calves? In fact, we can recommend programs for non-cycling females…..you just have to pay for it and then pass those genetics to the next generation! Heterosis provides some improvement in traits at relatively little cost. However, we have obscured the opportunity for producers to focus on those traits, because they are so busy masking differences with artificial environments.

8) **Historically, there has been active resistance to crossbreeding from some traditional marketing outlets, some purebred producers and (in some cases) breed associations.** I would like to commend many of the associations who, quite recently, have taken the risk of suggesting where their animals fit most effectively in crossbreeding programs.

9) **Inappropriate use of breed diversity.** Nothing undermines crossbreeding more quickly than the unplanned "Heinz 57" or "Breed of the Month Club" approach. For those who were willing to experiment in crossbreeding, there was often very poor planning of the combination of breeds and the selection within those breeds.

10) **Our industry and University systems have focused on individual trait measurement for over fifty years.** We have done a very poor job of incorporating real world economics into our models. We have EPD's for a plethora of traits ….and we are adding more! Economic indices are starting to catch up, but we are still behind. Has anyone thought about measuring return per acre or return on investment? We have had a disconnect between agricultural economists and animal science that has not been well bridged. We tend to think lineally rather than laterally, which has reduced the application of innovative crossbreeding.

So, where are we now? In the far west (as in much of the United States), we have seen a move towards less crossbreeding and more reliance on a single breed. Generally, that has been quite positive, because many of the herds were crossbred and had high levels of heterosis. Therefore five to eight years of one breed has reduced heterosis, but provided a consistent, highly marketable product, with some maternal heterosis still present in the cow herd. Recently, I am hearing concern from some very large, progressive producers as their cows become more straightbred in a tough environment. Longevity, rebreeding, calf survivability all become important issues. I don't think it is because they have bought the wrong bulls or managed their ranch incorrectly. It is because they have forgotten or ignored heterosis.

It is time for many producers to design long term, simplistic plans that capture maternal heterosis. I would not want to manage cattle in any environment without that incredible value. And the tougher the environment the more critical hybrid vigor becomes. For those of us who are educators, we need to work more effectively in presenting straight forward workable solutions. We need to renew our efforts in educating producers that selection is not about maximums----other than sustained profit. Animal breeders do not need to give us one more individual EPD that measures outputs. We need to incorporate dollars and we need to measure inputs.

With all of the potential pitfalls in utilizing heterosis, I have observed success in pockets of the industry. Producers who have developed a plan, targeted a market, understand their resources and environment and are focused on profit are successfully capitalizing on heterosis. I see terminal systems with moderate crossbred cows under limited feed producing a successful product that performs in the feedlot. I see other ranches that are highly focused on quality, using moderate crossbred cows, mated to produce ¾ blood calves for specific markets---the heterosis is lower, but the market rewards are real.

There is no single solution. However, as we turn the corner in the cattle cycle and begin to experience somewhat lower prices, I am confident that we can no longer forget how to reduce input costs---and heterosis has to be part of that equation.

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# Genetic Selection for Disease Resistance: Challenges and Opportunities

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Animal health and well being have become increasingly important issues for animal producers and consumers. Animal diseases causing morbidity and mortality significantly decrease profitability of animal production. Antibiotics that were once widely used to prevent or treat animal diseases are now administered more judiciously because of consumer fears of residual drugs in meat products and microbial resistance to commonly used antibiotics. Because no new class of antibiotics has been developed in the past three decades, the continued use of antibiotics may become more limited. Also, there has been an emergence of previously unknown diseases such as BSE (Binder et al., 1999) and emergence of infectious diseases in domestic livestock related to climatic changes, more intensive production, and transmission of diseases from wildlife to livestock and vice versa (Daszak et al., 2000). Current fear of a worldwide human influenza pandemic caused by transmission of avian influenza virus to humans has increased public awareness of a need to control animal diseases (Wong and Yuen, 2006). Therapeutic treatment costs for sick animals have continued to increase. Animal well being has become a significant concern among consumers who expect food animals to be well treated, raised in idyllic environments, and free of disease. Consumers also expect their meat products to be free of residual antibiotics and therapeutic drugs.

For these reasons, new approaches or alternatives to addressing animal diseases are needed. One approach is genetic selection for animals resistant to disease. It has been well established that rarely will all animals in a population, when exposed to an infectious disease, exhibit clinical symptoms. Breed differences for disease related traits have been documented in many different species (i.e., pinkeye incidence in cattle, Snowder et al., 2005a; bovine respiratory disease (BRD) incidence in cattle, Muggli-Cockett et al., 1992; Snowder et al., 2005b, 2006; *Bordetella bronchiseptica* infection in swine, Rothschild et al., 1984; immune response in chickens, Zekarias et al., 2002). However, it is difficult to determine why some animals become sick while others remain healthy. Animal health is influenced by many factors including genetics, nutrition, age, stress, management system, season, pathogen dosage, immunological background, epidemiology, animal biological status, and many other variables. These factors interact, thus confounding our ability to understand the mechanisms of disease resistance.

## Challenges of Selecting for Disease Resistance

Identifying the phenotype for disease resistance is difficult. It is a false assumption that in a population of sick and healthy animals all healthy animals are disease resistant. Some susceptible animals may not have been sufficiently exposed to the disease organism to get sick. Animals that appear healthy may have sub-clinical infections and represent pathogen reservoirs. Often the clinical expression of a disease can be confounded with a similar disease; for example pneumonia can be confused with bronchitis, emphysema, pleuritis, pulmonary adenomatosis, upper respiratory infection, and pleural fibrosis. Accurate disease diagnosis is costly and time consuming. The success of selection for disease resistance is dependent on correctly identifying the phenotype for disease resistance.

Selection for disease resistance is much more complicated than selecting for production traits which can be measured directly or indirectly on each animal. In regards to selecting for disease resistance in livestock, it may not be ethical or cost efficient to challenge each animal with a pathogen to determine its level of disease resistance. (Alternatives to this selection approach will be discussed later.) Before breeding schemes for disease resistance can be developed, consideration of many different scientific areas such as microbiology, epidemiology, immunology, host-pathogen interaction, host biology, livestock production systems, etc., must be understood. For example, selection for animals resistant to a particular pathogen may result in indirect selection for a more virulent pathogen or, development of highly resistant animals to one specific pathogen may make the animals more susceptible to another pathogen. Keeping the host's immune defense system in homeostasis may be difficult. Also, selection for immunity without leading to autoimmunity may be a difficult balance to achieve.

Justification for including disease resistance in breeding programs can be challenging to establish. Most importantly, the economical cost of the disease must be sufficiently high to rationalize selecting for resistance. Certainly, if consumers shun a product because of its potential health threat from antibiotic residue or non-treatable communicable diseases (i.e., BSE, Avian Influenza) then selection may be a favorable alternative. If antibiotics and other drugs have become inefficient because of microbial resistance, selection for disease resistance may be logical. Genetic selection for disease resistance may be useful against diseases for which neither vaccines nor therapeutics have been found. Selection may also be of interest for diseases due to a variety of pathogens infecting the host in a similar manner or pathway. Organic meat production systems that cannot use vaccines or therapeutics may also find it economically important to select for disease resistance.

However, selection for disease resistance may be unfavorable for animal production. If the genetic factors that improve disease resistance reduce production traits such as growth or feed efficiency then selection for disease resistance will decrease production. There is sufficient evidence that such negative genetic correlations do exist. Milk yield in dairy cattle has a positive correlation with many disease traits (Simianer et al., 1991; van Dorp et al., 1998). Selection for growth rate in turkeys increased their susceptibility to Newcastle disease (Sacco et al., 1994). In beef cattle, the genetic correlations of disease resistance with growth and feed efficiency traits are unknown. If these genetic correlations are unfavorable, then a selection index for total merit may be feasible to maintain production levels while selecting for disease resistance.

Perhaps, the biggest challenge of selecting for disease resistance is to accurately identify the phenotype for disease resistance and/or to have reliable genetic markers with high predictive values for a disease phenotype. For some diseases, disease resistance may include sub clinical and clinical infection while for other diseases only the clinical expression may be considered.

The objective of this review is to briefly summarize the genetics of disease resistance and to offer a broad understanding as to whether it is feasible to select for disease resistance or not.

## Understanding the Immune System

Knowledge of the mode of disease infection and host response is essential to comprehend the complexity of selecting for disease resistance. A simplistic explanation is given here. First, the pathogen must be present in the host's environment. The pathogen must penetrate host cell barriers in sufficient numbers, attack target cells and replicate. Sub-clinical or clinical expression of the disease is dependent on the pathogen's virulence and the interaction between pathogen and host characteristics.

The host has three immune defenses against infection: natural, innate, and acquired immunity. To maintain health all three must be present and functioning.

Natural immunity is the first barrier and is comprised of skin, hair, mucous membranes, secretions (tears, urine, stomach, saliva, mucous, skin secretions, etc.), grooming behavior (licking, dust rolling, tail swishing, etc.) and favorable microorganisms that compete directly or indirectly against pathogens. There are also nutritional components to natural immunity. Dehydration and malnutrition can decrease natural secretions making some tissue more susceptible to infection. Vitamin and mineral deficiencies result in suppressed immune systems. Genetic components to natural immunity are being identified as well. For example, some pigs are fully resistant to bacteria-induced diarrhea (E. coli) because they lack an intestinal cell receptor for the bacteria to attach (Gibbons et al., 1977). Fly infestation of livestock can be affected by hair/wool length, skin secretions, and hide thickness.

Innate and acquired immunity are co-dependent and form a complex network of cells and tissues that interact to detect and attack pathogens or associated antigens. The innate immunity refers to the immune system one is born with and is the initial response by the body to eliminate microbes and prevent infection. It commonly involves white blood cells (natural killer cells, neutrophils, eosinophils, monocytes, and macrophages), complement proteins (C1 - C4) that adhere to pathogens, and cytokines (interferons and chemokines) that attract immune cells to the site of infection. The innate immune system constantly searches for antigens (bacteria, fungi, and viruses). When an antigen is discovered, the innate system can attack it or illicit inflammation to attract immune cells. The innate system is not specific to any one type of pathogen and has no memory of previous exposure to a pathogen or antigen. Breed differences in the innate immune system have been reported. A higher haemolytic complement activity in *Bos indicus* breeds was associated with their higher resistance to tick infestation and subsequent tick borne diseases when compared to *Bos taurus* breeds (Wambura et al., 1998).

The acquired immune system is developed from previous exposure to pathogens or vaccines and can recognize pathogens previously exposed to. Acquired immunity is antigen specific. There are two types of acquired immunity: the cell-mediated immunity is comprised of immune cells that directly attack pathogen infected cells, and the humoral immunity which is made up of antibodies (specific immune proteins) that are directed at the pathogens themselves. The acquired immune system is comprised of T and B cells, which are specialized white blood cells. The T cells destroy pathogen-infected cells. The B cells develop into specific antibody-producing cells.

Acquired immunity occurs in two forms: passive and active. Passive or maternal immunity is passed from the cow to the calf via colostrum containing high levels of antibodies. Passive immunity is temporary. Disease resistance of very young calves is highly dependent on passive immunity. This type of protection is short lived because soon after birth, the calf's intestinal tract has a significant reduction in its ability to absorb immunoglobulins (antibodies), and the cow's production of colostrum decreases as lactation progresses. Half of the colostrum antibodies absorbed by the calf will be excreted, broken down, or absorbed at 8 to 16 days postpartum and most will be gone by 30 to 60 days postpartum (Besser et al., 1988). There are genetic components of passive immunity in cattle and recently, DNA markers associated with failure of passive immunity have been reported (Laegreid et al., 2002; Clawson et al., 2004). Therefore, it is important that the calf's own immune system (active immune system) develops at an early age to produce cell-mediated immunity and antibodies in response to antigens and vaccines to take over when passive or maternal immunity diminishes.

**Genetic Selection for Disease Resistance**

From a genetic perspective, understanding the natural, innate, and acquired immune systems is crucial in developing selection programs for disease resistance. For example, if the breeding goal is to reduce bacterial diarrhea in young calves, then selection traits might include the dam's genetic potential for producing specific colostrum antibodies (passive immunity) and the calf's genetic potential for developing an innate and acquired immune system early in life that responds to the diarrhea causing pathogen. There may be further problems because negative genetic correlations between the dam and calf resistance to some diseases have been estimated (i.e., BRD, Snowder et al., 2005b).

Selection for disease resistance is costly. Potential costs associated with measuring disease resistance include reduced production, mortality, decreased longevity, diagnostic costs, and therapeutic expenses.

**Direct selection** for disease resistance can occur in three different scenarios (Rothschild, 1998). First, animals may be observed in a given production system or environment for lack of clinical expression of a disease. Under this selection approach, it is assumed that the disease pathogen is constantly present. However, the expression of disease resistance is questionable. Animals with clinical expression of the disease may be identified with relative accuracy but not all healthy animals may be exposed to the pathogen or challenged equally. Also, disease exposure in natural environments is subject to temporal and spatial clustering of disease incidence. Diseases often occur in clusters of time (years, seasons, production cycles, etc.) and space (herd, pasture, farm, region, etc.). In years when the disease incidence is high, there can be an increase in the accuracy of identifying animals with a high probability of being disease resistant but in years of low incidence the accuracy will be diminished (Snowder et al., 2005b). The second direct approach is to uniformly challenge all breeding stock with infection. This approach can be costly depending upon the pathogen's virulence and clinical expression of the disease but is a reliable measure of disease resistance. This may require isolation of the population to prevent transmission to non-breeding stock. A third approach is to challenge relatives or clones of the breeding stock, especially if the disease has a high mortality rate. This latter approach is also a reliable method of determining genetic resistance. The latter two approaches are not without error because immunological background (previous exposure to the pathogen) may vary among animals. Researchers will have to determine the significance of immunological background for biasing the observed animal response to a disease challenge. In cattle, direct selection for reducing brucellosis had a favorable response. Templeton et al., (1990) increased natural resistance to brucellosis in calves from 20% to 59% after breeding cows to a naturally resistant bull.

Ideally, such direct approaches of phenotyping animals for disease resistance would take place in a highly controlled and isolated environment. This is probably not practical for cattle associations but publicly funded institutions may develop such testing facilities in the future.

**Indirect selection** for disease resistance can also be achieved by selecting for indicators of disease resistance. Indicators of disease resistance include pathogen products (i.e., pathogen reproductive rates, pathogen by-products), and biological or immunological responses of the host. One of the most successful approaches of indirect selection for disease resistance has been reported in sheep by selecting for low fecal internal parasite egg count (Woolaston et al., 1992). In dairy cattle, somatic cell count has been used as a selection criteria for reducing mastitis (Shook and Schutz, 1994). Immune responsiveness, challenging an animal with an antigen or vaccine and measuring antibody response or production, has been useful in poultry (Lamont et al., 2003) and swine (Mallard et al., 1992). Hernandez et al. (2003) suggested that immune responsiveness would be a useful indicator of disease resistance in cattle. Selection for immune response is generally beneficial when a single disease is targeted. However, studies in swine have indicated that selection for immune responsiveness can improve disease resistance to other diseases while, at the same time, increasing susceptibility to others (Wilkie and Mallard, 1998). For effective selection, indicator traits must be heritable, highly genetically correlated with resistance to the disease or diseases of interest, accurate to measure, and affordable.

Interactions between the genetics of the animal and the environment commonly exist. If the genetic by environmental interaction is significant, animals selected for improved disease resistance in one environment may be more susceptible to the same disease in a different environment. Therefore, selection programs may have to be environment specific with the selection environment matching the commercial production environment.

## Gene Mapping

Sequencing of the mice and human genomes, and construction of similar maps in livestock have led to discovery of several genetic markers and even genes related to the immune system. Most genes related to disease resistance have been discovered using inbred strains of mice. Only a few genes have been linked to disease resistance in cattle. The Nramp1 gene (natural resistance-associated macrophage protein) is associated with the innate immune system. Nramp1 has been linked with resistance to brucellosis (Harmon et al., 1989), tuberculosis, and salmonellosis (Qureshi et al. 1996). Homologues for Nramp1 have been identified, sequenced and/or mapped in chickens, swine, and sheep (Adams and Templeton, 1998).

The major histocompatibility complex (MHC) genes are linked to specific immunological responses. MHC genes were some of the first mapped and sequenced genes related to disease resistance. The MHC have a high degree of polymorphism, more than one variant (allele) for a gene exists in a population. Over 50 MHC alleles have been identified (Adams and Templeton, 1998). The high degree of polymorphisms for MHC genes which is unique for each individual (over 100 million combinations possible) partially explains how the host immune system can attack such a great number of antigens which requires the ability to distinguish self from foreign. In dairy cattle, the bovine MHC complex has been linked to disease resistance of economically important traits (Batra et al., 1989). In chickens, MHC has been linked to resistance to Marek's disease and fowl cholera (Lamont, 1989).

Other examples of recently discovered single genes influencing disease resistance in livestock include the fimbriae F4 (K88) gene in swine for reducing *e. coli* intestinal infection (Moon et al., 1999), the prion protein (PrP) gene related to scrapie susceptibility in sheep (Bossers et al., 1996), and the TNC gene related to salmonellosis in chickens (Hu et al., 1997).

## Polygenic Effects

The complexity of the immune system clearly infers that many genes are involved in disease resistance. It is highly doubtful that many single genes will be discovered and associated with major diseases. Chromosome mapping may lead to quantitative trait loci or regions related to disease resistance. Most recently, a region on chromosome 1 was associated with infectious keratoconjunctivitis (pinkeye) in cattle (Casas et al., 2006).

As the human and mice genomes are further investigated for disease related genes, it is highly plausible that quantitative trait loci (QTL) associated with disease resistant in livestock may also be identified in the near future. New and novel gene mapping approaches are being developed specifically for detection of complex disease loci (Pareek et al., 2002). Micro array technology is advancing rapidly to enable association of livestock DNA with human (Chitko-McKown et al., 2004) and mice DNA. Comparative genomics may make the identification of disease loci easier and more affordable. It may be possible to identify similar genes associated with disease susceptibility/resistance among human, mice, and livestock.

## The Near Future

We do not know at this time to predict whether or not selection for disease resistance can be effective in livestock. Basic research into the complexities underlying diseases will likely reveal effective approaches for many disease problems. For example, the discovery that contagious keratoconjunctivitis (pinkeye) is heritable (Snowder et al., 2005) led to the discovery of a chromosomal region associated with it disease incidence (Casas and Stone, 2006) In the near future, it is likely that selection for disease resistance in most livestock species, especially cattle, will not be widely accepted by industry because of the lack of knowledge about how best to select for disease resistance and poorly understood genetic correlations between disease resistance and economically important production traits. Selection for disease resistance will be disease dependent. It may be possible to select directly against the disease, select for indicator traits (indirect selection), to select directly for the gene(s) that confer resistance or some combination of these approaches. The potential seems great for identifying breeding stock that is healthier because of their immune responsiveness. Although it may be difficult to select for animals resistant to a wide range of diseases, it may be possible to breed or identify animals that are genetically more responsive to anti-viral vaccines or other therapies.

Certainly, genetic selection will not solve all of our livestock disease problems. Therefore, management, nutrition, vaccination, culling, therapeutic treatment, stress reduction practices and other measures must accompany genetic approaches to reduce the impact of livestock disease on profitability and animal well being.

## Other Research Efforts by Immunologists, Bacteriologists and Virologists

Because of the complexity of the immune system, many researchers in the field of immunology, bacteriology, and virology believe that gene sequencing of the pathogen will lead to a more rapid method of reducing disease incidence than genetic selection of livestock. Identifying and sequencing pathogen genomes may help identify pathways in the pathogen or host that can be interrupted to prevent disease or the development of a new antibiotic. Although this paper has been focused on the genetics of disease resistance in the host, genetic research on the pathogen may lead to the pathogen's Achilles heel.

For further reading on the genetics of disease resistance readers are referred to previous reviews (Warner et al., 1987; Malo and Skamene, 1994; Muller and Brem, 1994; Adams and Templeton, 1998; Rothschild, 1998; Detilleux, 2001; Stear et al., 2001; Pareek et al., 2002).

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# Mean EPDs Reported by Different Breeds

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Expected progeny differences (EPDs) have provided the beef industry with an effective tool to impact genetic improvement in beef cattle. The mean non-parent EPDs for each trait included in the most recent genetic evaluations for breeds of British and American origin are shown in Table 1 and those for breeds of Continental European Origin are shown in Table 2. Means for non-parent EPDs are shown for the birth year of 2004. The 2004 birth year was chosen because most cattle are yearlings when they are selected for use in seedstock or commercial production. In the most recent genetic evaluations yearling weights would have been available for only a limited number of calves born in 2005. The mean EPDs should not be used to compare animals of different breeds because EPDs are estimated from separate analyses for each breed. To compare animals from different breeds, across breed EPD factors must first be added to EPDs estimated separately for different breeds (see Across Breed EPD Tables reported by Van Vleck and Cundiff in these proceedings). However, mean EPDs are relevant for within breed comparisons. It is important to know how animals being considered for use as herd sires or as replacement females compare to their respective breed average. The mean EPDs shown in Tables 1 and 2 also show the traits included in genetic evaluations of seventeen different breeds.

EPDs have had a much greater impact on growth traits than other traits because they have been available over a longer period of time. Many breeds have improved calving ease through use of birth weight EPDs. Simmental and Gelbvieh have estimated EPDs for calving ease based on both birth weight and calving difficulty scores for more than 20 years, and a number of breeds have added calving ease EPDs more recently. By the mid-1990's EPDs for scrotal circumference were included in genetic evaluations by the Hereford and Limousin breeds and have been included in more recent genetic evaluations by a number of breeds.

For many years records and EPDs for carcass traits were available for only a limited number of sires and progeny. However, with development and increased use of ultrasound estimates for ribeye area, fat thickness and intramuscular fat (marbling) estimates of EPDs for fat thickness, ribeye area and marbling have been provided for at least three years by 11 breeds. Recent research indicates that significant change can be made by use of EPDs for carcass traits based primarily upon live animal ultrasound estimation of marbling, fat thickness, and ribeye area. For example in a recent analyses (Van Vleck and Cundiff, *unpublished*), we estimated coefficients of regression for carcass traits in steers (n = 2,602) produced in our Germplasm Evaluation Program at the U.S. Meat Animal Research Center (MARC) on EPDs for their sires (402 sires) from 2005 genetic evaluations of 11 breeds. Regression coefficients of 1.07 for marbling, 2.8 for fat thickness, and 0.88 for ribeye area suggest that EPDs can predict with reasonable accuracy differences due to sires in carcass traits of steers fed and managed to relatively heavy slaughter weights (1250 lbs) and degrees of fatness (means of 0.43 in for fat thickness) typical of commercial production systems in the U.S. It is not surprising that the regression coefficient for fat thickness (2.8) was greater than unity since the EPDs were based primarily on ultrasound estimates taken in seedstock herds on yearling bulls or yearling heifers developed for use as replacements.

The EPDs for stayability, docility, mature weight, and mature height have been introduced in recent years by a few breeds. In the very recent past a number of breeds have been introducing EPDs for use in various of selection indices to facilitate selection to target specific portions of the industry (e.g., maternal populations, terminal sire populations, feedlot niches, or carcass grids).

**Table 1.** Birth year 2004 average EPD's from 2006 genetic evaluations for breeds of British and American origin

| Trait | Angus | Beef-master | Brahman | Brangus | Hereford | Red Angus | Short-horn | South Devon |
|---|---|---|---|---|---|---|---|---|
| Birth weight (lb) | 2.3 | 0.43 | 1.81 | 2.0 | 3.7 | 0.4 | 1.8 | 0.2 |
| Weaning weight (lb) | 38.5 | 7 | 14.1 | 22.7 | 37 | 29 | 13 | 19.1 |
| Yearling weight (lb) | 71.5 | 12 | 23.1 | 37.8 | 63 | 51 | 21 | 26.4 |
| Yearling height (in) | 0.4 | | | | | | | |
| Milk (lb) | 19.0 | 2 | 6.1 | 9.9 | 14 | 15 | 2 | 7.1 |
| Total maternal (lb) | | 5.5 | | 21.3 | 33 | 30 | 9 | 16.6 |
| Calving ease direct (%) | 4.0 | | | | -.2 | 4 | 0.1 | |
| Calving ease maternal (%) | 6.0 | | | | 0.5 | 3 | 0.0 | |
| Scrotal circumference (cm) | 0.33 | 0.11 | | 0.59 | 0.6 | | | |
| Heifer pregnancy (%) | | | | | | 8 | | |
| Mature weight, lb | 31.5 | | | | | | | |
| Mature height, in | .5 | | | | | | | |
| Current sire cow energy, savings, ($EN, $/cow/yr) | 8.19 | | | | | | | |
| Mature cow maintenance, (Mcal/mo) | | | | | | 3 | | |
| Stayability (%) | | | | | | 10 | | |
| Carcass wt (lb) | 5 | | | | | | -3 | 0 |
| Carcass marbling score | .14 | | | | | | -.02 | |
| Carcass ribeye area (sq in) | .13 | | | | | | -.04 | |
| Carcass fat thickness (in) | -.001 | | | | | 0.0 | 0.0 | |
| Carcass retail product (%) | | | | | | | -.02 | |
| Ultrasound intra muscular fat (%) | .115 | | | .021 | .00 | | | |
| Ultrasound fat thickness (in) | .004 | | | -.001 | .001 | | | |

**Table 1.** Birth year 2004 average EPD's from 2006 genetic evaluations for breeds of British and American origin (continued)

| Trait | Angus | Beef-master | Brahman | Brangus | Hereford | Red Angus | Short-horn | South Devon |
|---|---|---|---|---|---|---|---|---|
| Ultrasound rib-eye area (sq in) | .195 | | | .032 | .08 | | | |
| Carcass and ultrasound marbling | | | | | | .08 | | 0 |
| Carcass and ultrasound ribeye area (sq in) | | | | | | .03 | | 0 |
| Carcass and ultrasound fat thickness (in) | | | | | | | | 0 |
| Current sire weaning value ($) | 22.45 | | | | | | | |
| Current sire feedlot value ($) | 16.48 | | | | | | | |
| Current sire grid value ($) | 14.15 | | | | | | | |
| Current sire beef value ($) | 30.08 | | | | | | | |
| Maternal index ($) | | | | | 15 | | | |
| Calving ease index ($) | | | | | 14 | | | |
| Brahman influ-enced index ($) | | | | | 16 | | | |
| Certified Hereford Beef Index ($) | | | | | 16 | | | |

**Table 2.** Birth year 2004 average EPD's from 2006 genetic evaluations for breeds of Continental European origin

| Trait | Braun-vieh | Char-olais | Chia-nina | Gelb-vieh | Lim-ousin | Maine Anjou | Salers | Simm-ental | Taren-taise |
|---|---|---|---|---|---|---|---|---|---|
| Birth weight (lb) | 1.1 | 1.3 | 1.1 | 1.9 | 2.05 | 2.49 | 1.1 | 1.8 | 1.5 |
| Weaning weight (lb) | 7 | 20.0 | 34.2 | 41 | 36.3 | 39.6 | 15.5 | 34.1 | 4 |
| Yearling weight (lb) | 8 | 35.2 | 61.0 | 73 | 68.2 | 78.2 | 25.8 | 59.5 | 11 |
| Milk (lb) | 0 | 6.2 | 10.6 | 18 | 18.3 | 18.4 | 8.7 | 5.4 | 1 |
| Total maternal (lb) | 4 | 16.2 | 27.7 | 37 | | 38.1 | 16.4 | 22.4 | |
| Calving ease direct (%) | -.02 | | | 104 | 6.0 | | | 5.6 | 0 |
| Calving ease maternal (%) | -.9 | | | | 2.7 | | | 2.4 | 1 |
| Scrotal cir-cumference (cm) | | 0.58 | | 0.4 | 0.25 | | 0.3 | | |
| Dolicity score | | | | | 12.6 | | 0.7 | | |
| Gestation length, d | | | | -1.4 | | | | | |
| Stayability (%) | | | | 5 | 16.4 | | 16.3 | 17.3 | |
| Carcass weight (lb) | | 13.06 | 3.5 | 0.9 | 15.2 | | 18.3 | -2.1 | |
| Carcass marbling score | | -.01 | | -.04 | | | | | |
| Carcass ribeye area (sq in) | | 0.18 | | 0.07 | | | | | |
| Carcass fat thickness (in) | | -.001 | | 0.00 | | | | | |
| Ultrasound fat thickness (in) | | | .01 | | | | | | |
| Ultrasound ribeye area (sq in) | | | -.02 | | | | | | |

**Table 2.** Birth year 2004 average EPD's from 2006 genetic evaluations for breeds of Continental European origin (Continued)

| Trait | Braun-vieh | Char-olais | Chia-nina | Gelb-vieh | Lim-ousin | Maine Anjou | Salers | Simm-ental | Taren-taise |
|---|---|---|---|---|---|---|---|---|---|
| Carcass and ultrasound marbling | | | .02 | | -.01 | | -0.1 | 0.07 | |
| Carcass and ultrasound ribeye area (sq in) | | | | | .11 | | .01 | | |
| Carcass and ultrasound fat thickness (in) | | | | | | | 0.0 | 0.01 | |
| Carcass and ultrasound retail product (%) | | | -.03 | | | | 0.1 | | |
| Carcass and ultrasound yield grade | | | | | 0.03 | | | -.02 | |
| Current sire feedlot value ($) | | | | 13.88 | | | | | |
| Current sire grid value ($) | | | | 11.59 | | | | | |
| Maternal index ($) | | | | | 41.4 | | | | |
| All purpose index ($) | | | | | | | | 89.3 | |
| Terminal index ($) | | | | | | | | 60.2 | |

# Live Animal, Carcass, and Endpoint Committee

***Robert Williams, Chair***

**Scrotal Circumference in Bulls: Should We Adjust for Age or Weight?**
*Janice Rumph, Montana State University*

**Relationships Between Carcass Quality and Temperament in Beef Cattle**
*Rhonda Vann, Mississippi State University*

**Effects of Two Measures of Disposition on Post-Weaning Gain of Beef Calves**
*Robert Weaber, University of Missouri*

**Improving the Health and Healthfulness of Beef**
*James Reecy, Iowa State University*

# Relationships between Carcass Quality and Temperament in Beef Cattle

*Rhonda C. Vann, Brown Loam Branch Experiment Station, Mississippi State University, Raymond, MS*

Economic implications associated with livestock temperament have not been fully determined (Grandin, 1994). Some producers do, in fact, consider temperament to be an important trait when selecting cattle for purchase (Elder et al., 1980). However, in some instances, genetic trait selection is often one-sided in the quest for improvement in a specific trait. Human-animal interactions in cattle production commonly occur through handling coupled with various management practices. Many concerns can arise, which include animal handler safety, damage to equipment and facilities, injury of the animal and etc. Cattle with wilder temperaments exhibit lower weight gain (Burrow et al., 1997; Voisinet et al., 1997b), produce tougher meat (Voisinet et al., 1997a), and yield increased amounts of bruise trim due to injuries acquired during transportation (Fordyce et al., 1988). Assessments of cattle temperament can be evaluated utilizing subjective measures (chute and pen scores) and an objective measure utilizing exit velocity. Establishment of a reliable and repeatable method to assess an animal's stress responsiveness is important for discerning cattle temperament. Producer and industry exposure to subjective and objective temperament assessments and recognition of the correlation between temperament with future growth performance, meat quality and health status is needed to encourage assessments of cattle temperament as a common selection tool.

The following studies were conducted utilizing three methodologies of temperament assessment, which included two subjective: chute (CS) and pen scores (PS) and one objective measure, exit velocity (EV). Chute scoring was adapted from Grandin (1993) where visual appraisal of each animal, while confined but not restrained in a working chute, were the basis of our scoring. Pen scores (Kunkle et al., 1986) were based on visual assessments of each animal while being confined to a pen with a small group of animals (n = 3 to 5 head). Exit velocity (Burrow et al., 1988) was determined as the rate at which the animals exited the working chute and transversed a fixed distance (1.83 m). Infrared sensors were used to remotely trigger the start and stop of a timing apparatus (Farm Tek Inc., North Wylie, TX).

The objectives of the following studies were to evaluate the effects of exit velocity (EV, m/s), chute temperament score (CS) and pen temperament score (PS) and measure the relationships between EV, CS and PS at weaning and prior to departure to the feedlot with carcass traits and Warner-Bratzler shear force values in Angus crossbred steers. Chute temperament scores are assigned as follows: 1 = calm, no movement; 2 = restless, shifting; 3 = squirming, occasional shaking of the squeeze chute or scale; 4 = continuous vigorous movement and shaking of the device; and 5 = continuous vigorous movement and shaking of the device, plus rearing, twisting or violently struggling (Voisinet et al., 1997a). Pen temperament scores were assigned as follows: 1 = non-aggressive, docile, walks slowly, can approach slowly, not excited by humans or facilities; 2 = slightly aggressive, runs along fences, will stand in corner if humans stay away, may pace fence; 3 = moderately aggressive, runs along fences, head up and will run if humans come closer, stops before hitting gates and fences, avoids humans; 4 = aggressive, runs away, stays in back of group, head high and very aware of humans, may run into fences and gates even with some distance, will likely run into fences if alone in pen; 5 = very aggressive, excited runs into fences, runs over humans and anything else in path, “crazy”.

**Study 1:** Angus crossbred steers (n = 58) were assigned a pen score, then calves were weighed on a platform scale and assigned a chute score. Calves were then released into a hydraulic squeeze chute and restrained. While in the squeeze chute a blood sample was collected from the tail vessel and then serum harvested for analysis of circulating cortisol concentrations. Exit velocity from the squeeze chute was measured by a laser timing device over a distance of 1.83 m from the chute (m/s). Assessments of temperament were performed at weaning (PS, CS and EV 1) and again prior to departure to the feedlot (PS, CS and EV 2). Steers were harvested at the completion of the feedlot feeding period and carcass data collected as well as steaks collected for analysis of shear force after a 14 day aging period. Sire consisted of one Brangus sire and several Angus sires. Lease square means were obtained from the PROC MIXED procedure of SAS (SAS Institute, Inc. Cary, NC) with main effects of sire breed, harvest date and age of dam. Partial correlation coefficients were obtained using the Manova option of the PROC GLM procedure of SAS (SAS Institute, Inc. Cary, NC) accounting for sire breed, calf breed, and harvest date. Sire breed was not a significant source of variation for EV, CS, PS or carcass traits of longissmus muscle area (LMA) and rib fat (BF); however, Brangus-sired steers had greater intramuscular fat (%IMF; $P < 0.06$) at weaning and greater carcass LMA per hundred weight (LMACWT; $P = 0.03$) and a higher USDA yield grade ($P < 0.05$). The correlation between EV and PS at T2 was 0.61 ($P < 0.001$). The correlation between EV and CS at T2 was 0.43 ($P < 0.008$). The correlation between PS at T1 and WBS as 0.24 ($P < 0.07$) and at T2 was 0.35 ($P < 0.08$). The regression coefficient between EV and WBS at T1 was 0.37 ($P < 0.04$) and at T2 was 0.57 ($P < 0.0095$) and PS and WBS at T1 were 0.39 ($P < 0.07$) and at T2 was 0.47 ($P < 0.008$). In conclusion, sire breed was not a significant source of variation in exit velocity. Although the correlation coefficients between exit velocity and temperament scores were significantly different from zero the magnitudes were only moderate, however, they were consistent across the various measures of temperament. As exit velocity (Table 1) and pen score increased WBS values also increased (Figure 1; Vann et al., 2004)).

**Table 1.** Means for Warner-Bratzler Shear force, exit velocity and Cortisol as reflected by pen score

| Pen score 2 | WBS (kg)* | EV (m/s)* | Cortisol (mg/ml) |
|---|---|---|---|
| 1 | 2.38 ± 0.27 | 1.17 ± 0.37 | 23.19 ± 8.04 |
| 2 | 2.69 ± 0.15 | 2.08 ± 0.20 | 19.01 ± 4.42 |
| 3 | 2.97 ± 0.17 | 2.43 ± 0.22 | 27.67 ± 4.87 |
| 4 | 3.13 ± 0.27 | 3.85 ± 0.37 | 40.07 ± 8.04 |
| | P = 0.07 | P < 0.001 | P = 0.05 |

*WBS=Warner-Bratzler shear force and EV = exit velocity.

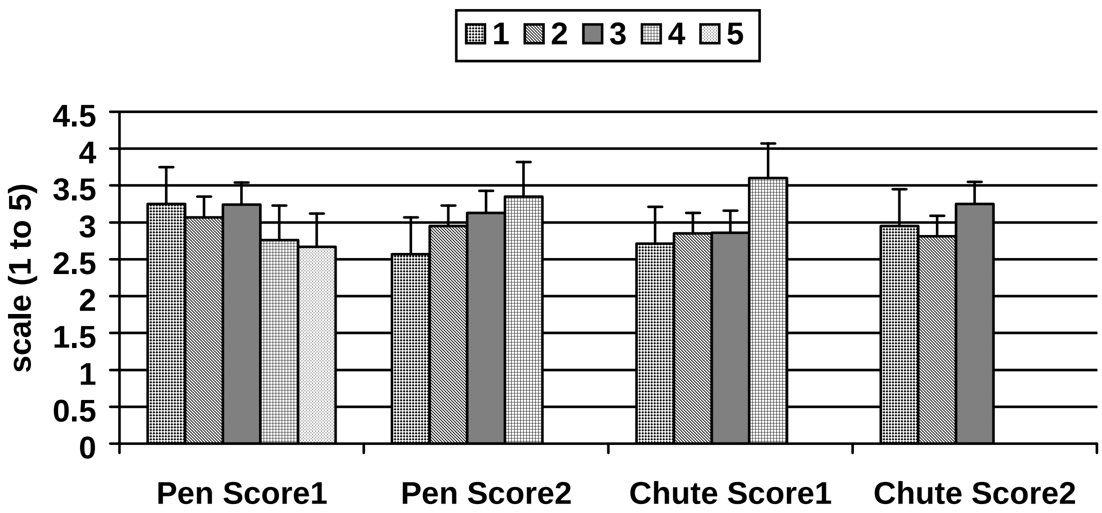


**Figure 1.** Warner-Bratzler shear force values for pen and chute scores at weaning and prior to shipment to the feedlot.

**Three year data compilation:** Angus crossbred steers (n = 220) were assigned a pen score, then calves were weighed on a platform scale and assigned a chute score. Calves were then released into a hydraulic squeeze chute and restrained. While in the squeeze chute a blood sample was collected from the tail vessel and then serum harvested for analysis of circulating cortisol concentrations. Exit velocity from the squeeze chute was measured by a laser timing device over a distance of 1.83 m from the chute (m/s). Assessments of temperament were performed at weaning (PS, CS and EV 1) and again prior to departure to the feedlot (PS, CS and EV 2). Steers were harvested at the completion of the feedlot feeding period and carcass data collected as well as steaks collected for analysis of shear force after a 14 day aging period. An overall temperament score, which is comprised of all measures of temperament, both subjective and objective was created [(EV+PS+CS)/3] and utilized in the statistical analysis. This compiled temperament score was divided into three categories: 1 = calm, 2 = intermediate, and 3 = temperamental or excitable. Sire breeds consisted of Brangus, Angus and Hereford. Least square means were obtained from the PROC MIXED procedure of SAS (SAS Institute, Inc. Cary, NC) with main effects of sire breed, individual sire, calf breed, and previous grazing regimen. Partial correlation coefficients were obtained using the Manova option of the PROC GLM procedure of SAS (SAS Institute, Inc. Cary, NC) accounting for sire breed, individual sire, calf breed, and previous grazing regimen. Individual sire influenced ($P < 0.04$) pen and chute score, exit velocity and cortisol concentrations at weaning, pen score ($P < 0.02$) and exit velocity ($P = 0.076$) prior to departure to the feedlot, yield grade ($P < 0.03$), carcass marbling score and quality grade ($P < 0.001$). Breed of sire influenced carcass weight and kidney, pelvic and heart fat ($P = 0.08$), and carcass rib fat and yield grade ($P < 0.03$). Breed of sire also influenced pen score at weaning and prior to departure to the feedlot ($P < 0.03$). The correlation between weaning temperament and shear force values were 0.23 ($P = 0.065$); pen and chute scores prior to shipment to the feedlot and shear force values were 0.22 ($P = 0.069$; Figure 2) and 0.23 ($P = 0.062$), respectively. As the compiled temperament score at weaning increased shear force values increased ($P =$

0.033; Figure 3). Pen scores at weaning were highly correlated with pen scores prior to shipment to the feedlot 0.45 ($P$ = 0.0002); exit velocity at weaning was correlated with exit velocity prior to shipment to the feedlot 0.388 ($P$ = 0.0015); chute scores at weaning were correlated with chute scores prior to shipment to the feedlot 0.311 ($P$ = 0.012). Individual sires have direct effects on temperament scores of calves as assessed by the subjective and objective measures of temperament at weaning and prior to shipment to the feedlot. In addition, individual sire has direct effects on carcass quality as assessed by marbling score and quality grade and carcass yield grade. Measures of temperament whether subjective (pen and chute scores) or objective (exit velocity) are repeatable and moderately correlated at different management time points.

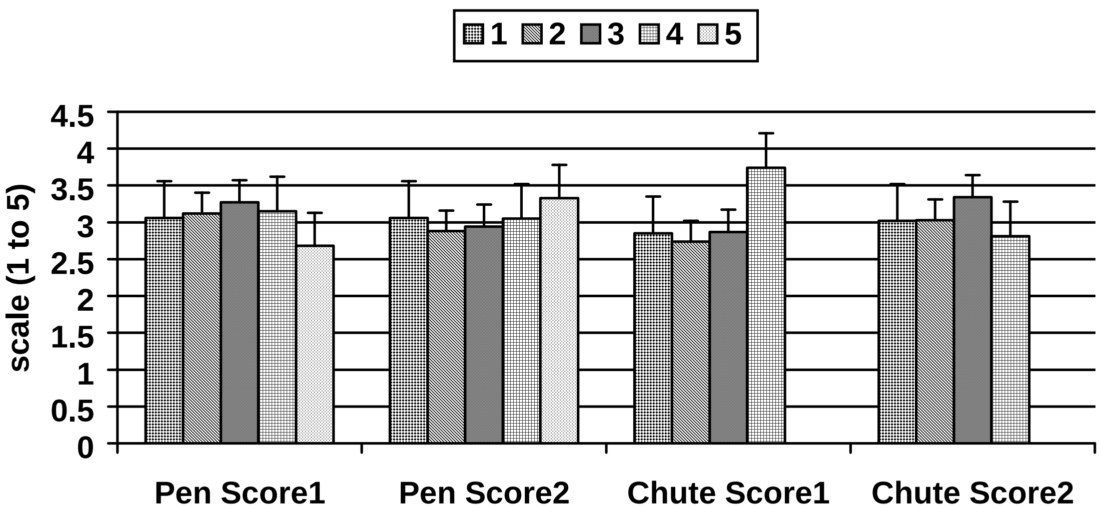


**Figure 2.** Warner-Bratzler shear force values for pen and chute scores at weaning and prior to shipment to the feedlot.

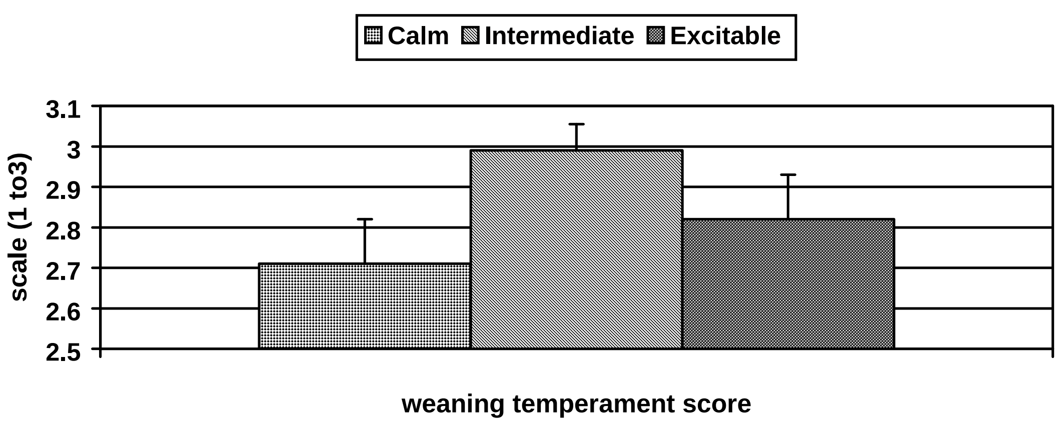


**Figure 3.** Warner-Bratzler shear force values for compiled weaning temperament score.

Individual sire did influence all measurements of temperament and carcass quality and yield grade. These studies as well as other data (not reported here) indicate that disposition needs to be a consideration along with the other selection traits when making bull or mature cow or replacement heifer purchases which bring new animals into your cattle operation. This research is ongoing and in the near future we will be including investigations on the effects of temperament on immunity and health status of the animal as well as effects on reproductive efficiency in beef cattle. Our hope is that producers and the cattle industry will utilize disposition in selection of animals, which will be more productive in their respective environments (i.e. choose which steers will perform better in a feedlot situation, choose replacement heifers, and etc.).

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# Producer Applications Committee

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**How a QSA Program Works Under a Packer Umbrella**
*Darrell Busby, Iowa State University*

**CalfAID Process Verified Program**
*Kris Ringwall, North Dakota State University*

**Applying Feed Intake Monitoring Systems into Producer Testing Programs**
*Daryl Strohbehn, Iowa State University*

# Cow Herd Efficiency and Adaptability Committee

***Mark Enns, Chair***

**Evaluating Longevity: 10 Years of Using Stayability EPD**
*Larry Keenan, Red Angus Association of America*

**Experiences with Implementation of Stayability EPD**
*Wade Shafer, American Simmental Association*

**Alternative Definitions of Stayability**
*Brian Brigham, Colorado State University*

# Alternative Definitions of Stayability

***B.W. Brigham, S.E. Speidel and R.M. Enns***
***Colorado State University, Fort Collins, Colorado, 80523***

Beef cow stayability been defined as the probability a cow will remain in the herd until six years of age given she first calved as a two year old. As an economically relevant trait, stayability typically has a large influence on herd profitability. For a herd to be profitable the number of cows remaining in production past their break even age must compensate the number of cows who are culled before this age is reached (Snelling et. al, 1995).

Recently, this traditional definition of stayability has been questioned for different reasons. First of all, are the concerns that young sires remain low accuracy until their daughters have reached this six year benchmark. Waiting for sires to increase in accuracy can slow genetic progress by increasing their generation interval. Second, producers have indicated that if a cow calves as a four year old the probability she will conceive two more times is high. The additional years it required for a cow to obtain a stayability observation are not very informative of her reproductive capability. Martinez et. al. (2004) showed if a cow conceives and then subsequently calves as a two year old, the probability of her remaining in the herd at four and six years of age is 83 and 74 percent respectively. Lastly, stayability has been criticized for being biased with all of the other non-reproductive reasons a cow can be culled. If stayability is to be a prediction of reproductive ability, culling on the basis of non-reproductive reasons can affect the interpretation of stayability. These reasons include but are not limited to disposition, structural soundness, pedigree or even color. During periods of drought herds may be dispersed regardless of performance, conversely during expansion phases of the cattle cycle cow numbers may be increased with less stringent culling guidelines. As a result, stayability may not always be interpreted as predictor of reproductive performance.

Snelling et. al. (1995) reported heritabilities for stayability for ages three, six, nine and twelve years in two purebred herds. These within herd estimates showed stayability to six years of age to have a sufficiently high heritability as well as representing the economic break-even point for a cow. This definition was subsequently adopted as the general definition for many national cattle evaluations.

Economically, the cattle industry is constantly changing. During the early-1990's the breakeven point for individual cows was between 3 and 9 years old (Dalsted and Gutierrez, 1989). However since then calf prices have increased. This increase in calf prices have pushed the industry into a time of expansion with fewer heifers being sold. Smaller differences between replacement heifer prices and salvage cow prices coupled with higher returns per cow have likely shifted the true breakeven age.

To better align the stayability genetic prediction with market prices and to address some of the practical problems, such as the time it takes young sires to increase in accuracy, the objective of this study was to evaluate using younger ages as stayability observation benchmarks. As a basis for this investigation performance data from two different breed associations have been used to investigate heritability and sire re-rankings when stayability is redefined as probability of staying in the herd to younger ages. The first data set, obtained from the American Gelbvieh Association (AGA), was used only to estimate variance components for stayability to four years of age. The second data set, obtained from the American Simmintal Association (ASA), estimates of heritability to three years of age, rather than four years of age, and six years of age was calculated.

**Materials and methods:**

*Data set one:*

Raw data received from the AGA included a total of 838,128 pedigree records with 73,706 individuals having useful stayability observations. A three generation pedigree was generated based on only those animals with data and their ancestors. Defining stayability at two different ages with the same data, under the same sifting guidelines resulted in the following distributions:

| | Stayability Definition | |
|---|---|---|
| Observation | 4 years | 6 years |
| No | 20,532 | 21,861 |
| Yes | 53,174 | 33,372 |

*Data set two:*

Raw data supplied by the ASA contained 3,820,059 pedigree records with 447,928 usable records. The following table illustrates the number of observations for the 2 definitions of stayability.

| | Stayability Definition | |
|---|---|---|
| Observation | 3 years | 6 years |
| No | 20,862 | 32,129 |
| Yes | 40,454 | 29,608 |

**Variance component estimation:**

*Data set one:*

Method R was used to estimate heritability for stayability at 4 years. For comparative purposes the genetic variance and heritability currently used to for EPD calculations is summarized in the following table.

| Stayability Definition | 4 yrs. | 6 yrs. |
|---|---|---|
| Genetic Variance | 0.3465 | 0.1602 |
| Residual Variance | 1 | 1 |
| Heritability | 0.26 | 0.14 |

*Data set two:*

Heritability estimates from the second data set were as follows:

| Stayability Definition | 3 yrs. | 6 yrs. |
|---|---|---|
| Genetic Variance | 0.2691 | 0.2526 |
| Residual Variance | 1 | 1 |
| Heritability | 0.21 | 0.20 |

**Expect Progeny Difference Calculation:**

*Data set one:*

The EPD were calculated using the current statistical model for stayability to six years of age only changing the genetic variance and contemporary group definition to define stayability to four years of age. Stayability EPD can be interpreted as the increase (or decrease) in the probability a bull daughters will remain in the herd at a given age. EPD summary statistics for each definition of stayability for sires were:

| | N | Mean | Variance | Minimum | Maximum |
|---|---|---|---|---|---|
| Stayability to 6 | 7,123 | 1.045 | 9.811 | -11.8 | 17.2 |
| Stayability to 4 | 8,935 | 0.906 | 19.878 | -21.1 | 20.9 |

As a way of comparing the stayability EPD resulting from each of the two differing definitions, Spearman's rank correlation was calculated for the 6,783 sires with EPD for both 6 and 4 years of age. The rank correlation between the two different definitions of stayability EPD is 0.66 which shows a less than perfect relationship. A rank correlation of one would mean all bulls rank the same in each analysis.

*Data set two:*

EPD were calculated using each of the estimated variances components, stayability to three years rather than four, or six years of age. A model identical to the one used for data set one was used with the different heritability estimates. The resulting sire EPD for each definition of stayability are summarized in the table below:

| | N | Mean | Variance | Minimum | Maximum |
|---|---|---|---|---|---|
| Stayability to 6 | 6,615 | 1.57 | 24.02 | -19.23 | 25.30 |
| Stayability to 3 | 5,721 | 1.58 | 20.59 | -17.53 | 23.03 |

Results similar to those in data set one were found. Comparing sire EPD from stayability at 6 years to stayability at 3 years yielded a rank correlation of 0.59.

**Discussion / Conclusion**

From this analysis we have found that heritability estimates for stayability to younger ages is at least as heritable if not more heritable than the currently excepted six year benchmark. A younger definition of stayability may alleviate some problems associated with current definitions of stayability. Lowering the required age by two years would increase young sire's accuracy quicker. If cows are truly culled more often in their fifth and sixth year because of non-reproductive issues lowering the benchmark for stayability may lead to a more accurate prediction of a cow's reproductive performance. However before changing an economically important trait like stayability a complete economic study using current market values should be conducted. Another issue which emerges if stayability were to be redefined is the use of stayability EPD in decision support software. Breed associations must come to a consensus of which age all stayability EPD would be reported if it is to be used properly in decision support software. Further research should be focused in the area of exactly why cows are culled at different ages and when cows truly pay for themselves.

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# Emerging Technology Committee

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**Validation of Gene Markers**
*Richard Quass, Cornell University*

**Future Genomic Technology from DNA Companies**
*MMI Genomics, Inc.*

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**Marker Assisted Selection**
*Alison Van Eenannaam, University of California, Davis*

**Selection Indexes**
*Sally Northcutt, American Angus Association*
*Robert Williams, American International Charolais Association*
*Wade Shafer, American Simmental Association*

**Selection Decision Software**
*Dorian Garrick, Colorado State University*

# FRANK H. BAKER

***Born: May 2, 1923, Stroud, Oklahoma***
***Died: February 15, 1993, Little Rock, Arkansas***

**Frank H. Baker**
*photograph of portrait in Saddle and Sirloin Club Gallery – Everett Raymond Kinstler, Artist*

Dr. Frank Baker is widely recognized as the "Founding Father" of the Beef Improvement Federation (BIF). Frank played a key leadership role in helping establish BIF in 1968, while he was Animal Science Department Chairman at the University of Nebraska, Lincoln, 1966-74. The Frank Baker Memorial Scholarship Award Essay competition for graduate students provides an opportunity to recognize outstanding student research and competitive writing in honor of Dr. Baker.

Frank H. Baker was born May 2, 1923, at Stroud, Oklahoma, and was reared on a farm in northeastern Oklahoma. He received his B.S. degree, with distinction, in Animal Husbandry from Oklahoma State University (OSU) in 1947, after 2½ years of military service with the US Army as a paratrooper in Europe, for which he was awarded the Purple Heart. After serving three years as county extension agent and veterans agriculture instructor in Oklahoma, Frank returned to OSU to complete his M.S. and Ph.D. degrees in Animal Nutrition.

Frank's professional positions included teaching and research positions at Kansas State University, 1953-55; the University of Kentucky, 1955-58; Extension Livestock Specialist at OSU, 1958-62; and Extension Animal Science Programs Coordinator, USDA, Washington, D.C., 1962-66. Frank left Nebraska in 1974 to become Dean of Agriculture at Oklahoma State University, a position he held until 1979, when he began service as International Agricultural Programs Officer and Professor of Animal Science at OSU. Frank joined Winrock International, Morrilton, Arkansas, in 1981, as Senior Program Officer and Director of the International Stockmen's School, where he remained until his retirement.

Frank served on advisory committees for Angus, Hereford, and Polled Hereford beef breed associations, the National Cattlemen's Association, Performance Registry International, and the Livestock Conservation, Inc. His service and leadership to the American Society of Animal Science (ASAS) included many committees, election as vice-president and as president, 1973-74. Frank was elected an ASAS Honorary Fellow in 1977, he was a Fellow of the American Association for the Advancement of Science, and served the Council for Agricultural Science and Technology (CAST) as president in 1979.

Frank Baker received many awards in his career, crowned by having his portrait hung in the Saddle and Sirloin Club Gallery at the International Livestock Exposition, Louisville, Kentucky, on November 16, 1986. His ability as a statesman and diplomat for the livestock industry was to use his vision to call forth the collective best from all those around him. Frank was a "mover and shaker" who was skillful in turning "Ideas into Action" in the beef cattle performance movement. His unique leadership abilities earned him great respect among breeders and scientists alike. Frank died February 15, 1993, in Little Rock, Arkansas.

# Frank Baker Memorial Scholarship Recipients

| | | |
|---|---|---|
| Kelly W. Bruns | Michigan State University | 1994 |
| William Herring | University of Georgia | 1994 |
| D. H. "Denny" Crews, Jr. | Louisiana State University | 1995 |
| Dan Moser | University of Georgia | 1995 |
| D. H. "Denny" Crews, Jr. | Louisiana State University | 1996 |
| Lowell S. Gould | University of Nebraska | 1996 |
| Rebecca K. Splan | University of Nebraska | 1997 |
| Robert Williams | University of Georgia | 1997 |
| Patrick Doyle | Colorado State University | 1998 |
| Shannon M. Schafer | Cornell University | 1998 |
| Janice M. Rumph | University of Nebraska | 1999 |
| Bruce C. Shanks | Montana State University | 1999 |
| Paul L. Charteris | Colorado State University | 2000 |
| Katherine A. Donoghue | University of Georgia | 2000 |
| Khathutshelo A. Nephawe | University of Nebraska | 2001 |
| Janice M. Rumph | University of Nebraska | 2001 |
| Katherine A. Donoghue | University of Georgia | 2002 |
| Khathutshelo A. Nephawe | University of Nebraska | 2002 |
| Fernando F. Cardoso | Michigan State University | 2003 |
| Charles Andrew McPeake | Michigan State University | 2003 |
| Reynold Bergen | University of Guelph | 2004 |
| Angel Ríos-Utrera | University of Nebraska | 2004 |
| Matthew A. Cleveland | Colorado State University | 2005 |
| David P. Kirschten | Cornell University | 2005 |
| Amy Kelley | Montana State University | 2006 |
| Jamie L. Williams | Colorado State University | 2006 |

# 2005 Frank Baker Memorial Scholarship Recipients

*Mark Enns accepts a Frank Baker Memorial Scholarship Award for Colorado State University student Matthew Cleveland. Cleveland won the honor with his essay, "Using Days to Finish EPDs to Identify Optimum Finish Endpoints for Profit Optimization in Postweaning Beef Production.*

*David Kirschten (right), Cornell University, receives a Frank Baker Memorial Scholarship Award from 2005 BIF President Jimmy Holliman. Kirschten won the honor with his essay entitled "Pathways to Change: Efficiency of Feed Utilization."*

# The Relationship of Genetics and Nutrition and Their Influence on Animal Performance

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## Introduction

The beef cattle industry relies heavily on both genetics and nutrition to achieve its production goals and to contend with other industries. However, it is important to understand how these two aspects correspond with one another and the effect they have on each other. Nutrition can be considered not only the most expensive input of animal rearing, but also the most critical. If animals do not receive proper levels of nutrition, no matter how genetically superior they are, they will not perform to their optimum level. To truly understand the impact genetics and nutrition have on one another it is important to look at how they both play roles in body condition score and body weight; energy requirements; maintenance energy requirements; feed efficiency, feed conversion and feed intake; residual feed intake; and the development of EPDs.

## Review of Literature

***Introduction of the Continental Breeds.*** Historically, it is important to consider the introduction of the Continental breeds of cattle and their tremendous impact on both nutrition and genetics. Beginning in the 1960's, the genetic growth rate potential of beef cattle in the United States was increased by the introduction of Continental breeds of cattle (Johnson et al., 2003). Plus, the introduction of Continental breeds changed how nutrition for beef cattle was viewed. The prior method of determining energy requirements of cattle, commonly referred to as the California system, was done strictly on British breeds (Lofgreen and Garrett, 1968). The differences between British and Continental breeds, such as mature size, milking ability, etc., caused researchers to identify more current energy requirements. The intention of utilizing Continental breeds was to increase growth potential leading to increased weaning weights and heavier post-weaning gains. Also, Continental breeds provided an answer for a consumer driven market that desired a leaner product. However, the incorporation of Continental breeds also led to an increase in body size. This led to correlated increases in mature cow size, and increased feed intake, increased maintenance requirements, and decreased fat.

***Body Condition Scores and Body Weight.*** Nutrition has a tremendous impact on body condition score and body weight. Nutrition and related body condition, specifically the effect they have on reproductive performance, are considered the most studied-environmental factors (West et al., 1991). They both, in turn, have a large impact on not only reproductive performance, but animal performance in general. Numerous studies have shown that the performance of beef cows varies according to their total body energy reserves, or what is better known as body condition, during specific stages of the production cycle (Spitzer et al., 1995). It is important for producers to realize the need for adequate nutrition in order for animals to be at their peak performance. If a cow does not receive her nutritional requirements during gestation and lactation, no matter how genetically superior her and her calf are, chances are that the calf will not perform as expected. Additionally, when cows calved in body condition scores of 4, 5, or 6, respectively, the birth weight of the calves was progressively higher ($P < 0.05$) (Spitzer et al., 1995).

***Energy Requirements.*** A very important aspect of livestock production involves energy requirements and the ability of producers to meet these requirements. In terms of beef cows, the NRC has produced energy requirements that are based on body weight, days after calving to peak milk yield, and maximum daily milk produced (NRC, 1996). While EPDs have been developed for traits relating to the energy requirements of beef cows, they are inconsistent with the unit of measure used by the NRC (MacNeil and Mott, 2000). Certainly the opportunity for research to genetically predict energy requirements would be beneficial to the beef industry. MacNeil and Mott (2000) found that for every 1-kg increase in predicted maternal breeding value for calf gain (from birth to weaning) there was an increase of 10.3 ± 4.6% in a lactation curve associated with unit increases in maternal breeding value for gain from birth to weaning and age of cow. Also, there was a decrease of 1.0 ± 0.6% in a lactation curve associated with a unit increase in maternal breeding value for calf gain from birth to weaning. Furthermore, a strong genetic correlation between maternal gain from birth to weaning and total milk yield exists, with it being approximately 0.8 (Miller and Wilton, 1999). Thus, it is important to meet the energy requirements of lactating females in order to provide an adequate level of milk production for the calf to achieve its genetic potential for gain.

***Maintenance Energy Requirements.*** Improving production efficiency will allow the United States beef cattle industry to remain competitive with alternative products (Shuey et al., 1993). However, to improve production efficiency it is critical to consider factors affecting it. One major factor is maintenance energy requirements. Maintenance energy requirements can be thought of as the amount of energy intake required for zero body energy change, or in other words, the amount of energy the animal requires to maintain homeostasis. The primary way of determining maintenance energy requirements is through the monitoring of fasting heat production. Genetic potentials for milk production and growth rate are positively correlated with maintenance energy requirements (Shuey et al., 1993). A change in the intake of dairy cows can affect maternal energy retention and milk production at the same time, but milk production will have a small response if it is expressed near its genetic potential (Broster and Broster, 1984).

Shuey et al. (1993) found that by selecting for a lower maintenance energy requirement, it is unlikely that the production efficiency of heifers will be improved unless the heifers are fed above their requirements. Plus, maintenance energy requirements are important in determining production efficiency only when nutrition is restricted. As well, it was determined that maintenance energy requirements are closely related to fasting heat production ($r^2 = 0.73$) (Shuey et al., 1993). Therefore, it would be possible to use fasting heat production to determine maintenance energy requirements.

***Feed Efficiency, Feed Conversion and Feed Intake.*** Perhaps the most important aspect of nutrition is feed efficiency and feed intake. The single largest expense in most commercial beef production operations is feed costs, and therefore it is important to improve feed efficiency to lower the cost of feeding (Arthur et al., 2001). It may also be possible to select animals that are more efficient, which will also help lower production costs (Fan et al., 1995). However, this may be difficult as wide variation in heritability and genetic correlation exists when looking at feed efficiency (Bishop et al., 1991). This makes the calculations of genetic predictions more difficult. Fan et al. (1995) estimated various heritabilities for both Hereford and Angus bulls, and found them to be, respectively, 0.08 and 0.35 for gross feed efficiency and 0.14 and 0.28 for net feed efficiency (Table 1). Moreover, gross and net feed efficiency were moderate to high and positive in terms of genetic correlation. It was also found that as average daily gain increased, not only did gross feed efficiency increase, but so did metabolizable energy intake and yearling weight. This indicates that more efficient animals will have greater average daily gain leading to greater body weight, weigh more at yearling age, and unfortunately, require more feed intake.

Gregory et al. (1994) reported that gain efficiency differed significantly among all cattle breeds, which were Red Poll, Hereford, Angus, Limousin, Braunvieh, Pinzgauer, Gelbvieh, Simmental, and Charolais. Breeds with the smallest weight to maintain were more efficient over a constant period of time, while breeds with the highest rate of gain were more efficient when a constant level of gain was reached. When cattle were fed to a specific marbling score, breeds with lower amounts of marbling, specifically the Continental breeds, were less efficient, while the breeds with the most marbling were the most efficient. Breeds with the most retail product were more efficient when retail product weight was the endpoint. Feeding a higher energy density diet resulted in steers that were more efficient when live weight gain to time was constant, live weight gain was constant, marbling score was constant, and to a certain retail product end point. Plus, composites of the nine breeds previously mentioned were found to have retained heterosis that wasn't consistent for measures of gain efficiency. Finally, the study found that a higher initial body weight increased the feed requirement for maintenance, which resulted in a negative effect on the measures of gain efficiency.

Feed conversion has widely been used to genetically improve feed utilization. Feed conversion is determined by the ratio of feed consumed to live weight gain. Feed conversion has a direct heritability estimate of 0.29 ± 0.04 based on records of 1,180 Angus bulls and heifers from a performance test were looked at (Arthur et al., 2001). Feed conversion was negatively correlated (r = -0.62 and -0.74, respectively), both genotypically and phenotypically, with average daily gain. Also, feed intake and feed conversion were positively correlated (r = 0.31and r = 0.23, respectively) genotypically and phenotypically. As well, feed intake was positively correlated, both genetically and phenotypically, with scrotal circumference, $12^{th}/13^{th}$ rib fat depth, rump fat depth, and both 200 and 400 d weights. It is suggested that selection will allow for genetic improvements in feed efficiency (Arthur et al., 2001).

The genetic parameters for feed intake, feeding behavior, and average daily gain were estimated in composite ram lambs that were ½ Columbia, ¼ Hampshire, and ¼ Suffolk. The intent was to investigate the possibility of genetically improving feed conversion by selection, utilizing estimates of heritability of feed intake and the genetic correlations between feed intake measurements. Daily feed intake had an estimated heritability of 0.25 and event feed intake had a heritability of 0.33. Those two measures of feed intake had a positive genetic correlation. It was concluded that including feed intake into selection criteria would result in a more overall desirable terminal sire breed (Cammack et al., 2005). If this study were extrapolated to cattle, a producer utilizing terminal should consider their EPDs for feed intake to reduce feed costs.

Jensen et al. (1991) investigated the genetic parameters of feed intake and feed conversion. They reported no significant interaction between genotype and amount of roughage in the diet. Also, they reported daily gain to be negatively correlated with feed conversion, but positively correlated with daily energy intake. Calf weight at 28 d of age was positively correlated to daily gain but negatively correlated to both total energy intake and total dry matter intake. It was suggested that the negative reaction was a result of heavier weights at 28 d of age, which d1ecreased weight gain and thus decreased the amount of energy required to reach a set live weight of 200 kg.

***Residual Feed Intake.*** Residual Feed Intake **(RFI)** is an indirect measurement of metabolism, which combines both maintenance and gain. It can also be considered the difference in feed intake, based on size and growth rate (Herd et al., 2003). Koch et al. (1963) defines RFI as the difference between an animal's actual feed intake and its expected feed requirements for maintenance and growth. A positive RFI is not desirable, as it indicates that an animal has greater intake than what was predicted. An RFI of zero means that the animal is consuming exactly to meet its requirements. A negative RFI is very desirable, and means that an animal is eating less energy than predicted, suggesting that either their requirements are less than what was predicted or they require less feed to meet their requirements. Genetic variation in RFI exists during growth and for adult cattle (Herd et al., 2003) (Table 2). The heritability of RFI ranged from 0.16 to 0.39 (Johnson et al., 2003). Utilizing the records of 1,180 Angus bulls and heifers found a direct heritability estimate of 0.39 ± 0.03. Moreover, it was discovered that RFI and average daily gain were independent of one another (r = -0.04 and -0.06), respectively for genotype and phenotype. RFI and feed conversion ratio were correlated (r = 0.31 and 0.23, respectively), for genotype and phenotype, as was RFI and feed intake (r = 0.69 and 0.72) (Arthur et al., 2001). Another study looked at variations in RFI and other production traits of Hereford cattle and found that RFI was not correlated to average daily gain. Additionally, this same study found that RFI and feed conversion were highly correlated both genotypically and phenotypically (r = 0.61 and r = 0.70, respectively) (Herd and Bishop, 2000). Lastly, Nkrumah et al. (2004) found that animals having a more positive RFI (being less desirable) would be less efficient than animals with a lower RFI. More research is needed into the use of RFI in selection and the effect it will have genetically before it becomes a more practical production tool.

***Expected Progeny Differences Concerning Nutrition.*** The idea of producers being able to genetically select for animals that will nutritionally perform to the standards of each individual operation is desired. The development of EPDs to predict differences in nutritional requirements between animals will result in selection to lower feed requirements (or improve feed efficiency). The American Red Angus Association, in conjunction with Colorado State University, has done so by creating the Mature Cow Maintenance Energy Requirement EPD **(ME)**. The intent of this EPD is to allow cattle producers to select animals for increased feed efficiency, more correctly pair cattle to their forage and production environment, and provide additional insurance against harsh weather conditions. The ME EPD is based upon the energy required to maintain body tissues with no net change in body tissue. The two factors that contribute to the ME EPD are mature cow weight and milk. Cattle having a lower ME EPD should have lower energy requirements (Evans et al., 2001). Research used to create the ME EPD found that there is a moderate to strong additive genetic relationship between weaning weight and mature weight. There was also an additive genetic relationship between post-weaning weight and mature weight in cows between 2 and 9 years of age. Additionally, heritability estimates for weaning weight ranged from 0.35 to 0.36 (Evans et al., 2000).

## Conclusion and Implications to Genetic Improvement of Beef Cattle

The beef cattle industry is constantly undergoing changes that will benefit its producers. However, with all the improvements that have occurred over time there is still no doubt that nutrition and genetics still play critical roles in the industry. Many of the industry changes have impacted or been impacted by these two items. Thus, it is important to understand the relationship the two share.

To best analyze nutrition and genetics it is important to first look back at the introduction of Continental breeds into the US cow herd. They had a tremendous impact on not only genetics, but also nutrition. After they were introduced and research was conducted, many changes were made not only to the nutritional requirements used by numerous producers, but how the Continental breeds were used, such as using them for terminal crossbreeding situations.

Body condition score and body weight of cattle are dictated by both the level of nutrition an animal is provided and the genetic make-up of that animal. Being able to predict an animal's mature body size allows for the appropriate nutritional environment to be provided, so the desired body condition score and body weight can be achieved.

Energy requirements and maintenance energy requirements are critically important, especially when considering gestation and lactation of beef cows. Therefore, research should be focused on understanding how genetics play a role in these requirements. As well, nutrition is very important, because no matter how genetically superior an animal is supposed to be, if their energy requirements are above what they are being fed, chances are they will perform below their optimum level.

Feed efficiency, feed conversion and feed intake, along with residual feed intake may be well understood from a nutrition standpoint, but it is once again important to understand how genetics impacts them. The intent of knowing the role of genetics is to allow for more intelligent selection.

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**Table 1.** Estimates of heritability ($h^2$) with standard errors (± SE) for postweaning traits for Hereford and Angus bulls, and pooled $h^2$ (Fan et al., 1995)

| | **Hereford** | **Angus** | **Pooled** |
|---|---|---|---|
| Trait[a] | **$h^2$ ± SE** | **$h^2$ ± SE** | **$h^2$ ± SE** |
| **WWT, kg** | 0.46 ± 0.25 | 0.16 ± 0.13 | 0.36 ± 0.12 |
| **ADG, kg/d** | 0.16 ± 0.15 | 0.43 ± 0.24 | 0.26 ± 0.20 |
| **DMI, kg/d** | 0.18 ± 0.10 | 0.27 ± 0.15 | 0.24 ± 0.11 |
| **MEI, Mcal ME/d** | 0.19 ± 0.10 | 0.31 ± 0.15 | 0.25 ± 0.13 |
| **YWT, kg** | 0.43 ± 0.22 | 0.45 ± 0.22 | 0.42 ± 0.22 |
| **RFC, Mcal ME/d** | 0.07 ± 0.13 | 0.23 ± 0.12 | 0.14 ± 0.12 |
| **FE, kg/Mcal ME** | 0.08 ± 0.09 | 0.35 ± 0.22 | 0.16 ± 0.14 |
| **NFE, kg/Mcal ME** | 0.14 ± 0.16 | 0.28 ± 0.17 | 0.21 ± 0.17 |

[a] WWT=weaning weight, ADG = average daily gain, DMI=dry matter intake, MEI=metabolizable energy intake, YWT=yearling weight, RFC=residual feed consumption, FE=gross feed efficiency, NFE=net feed efficiency

**Table 2.** Published estimates for the heritability of Residual Feed Intake **(RFI)** in growing beef cattle and genetic correlations with selected mature cow traits (Herd et al., 2003)

| | | | **Genetic Correlation Mature Cow** | |
|---|---|---|---|---|
| **Breed** | **Number** | **Heritability** | **RFI** | **BW** |
| **Hereford** | 540 | 0.16 ± 0.08 | -- | -0.09 ± 0.26 |
| **Limousin & Charolais**[a] | 1,629 | 0.21 ± 0.39 | -- | -- |
| **Beef & Dairy** | 282 | 0.29 | -- | -- |
| **British** | 1,180 | 0.39 ± 0.09 | -- | -- |
| **British** | 751 | 0.23[b] | 0.98 | -0.22 |
| **Charolais** | 792 | 0.39 ± 0.04 to 0.43 ± 0.06 | -- | -- |
| **British & Tropically Adapted** | 2,155 | 0.18 | -- | -- |

[a] Two ages/feeding regimen and two methods for estimating RFI were used
[b] Mature cow RFI

# Selection to Improve Performance of Cattle in Subtropical Regions Using Heat Tolerance EPD

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## Introduction

Subtropical regions such as the South-Eastern United States as well as places like Brazil are characterized by average year round temperatures of 27˚C (80°F). In the summer months temperatures can rise to 43°C (110°F). These temperatures are usually associated with high humidity and low forage quality and it is imperative that beef cattle in these regions be able to withstand these warm, harsh environments without sacrificing their productivity. Beef cattle populations in these areas are largely made up of Brahman and various Brahman composite breeds due to their adaptation to such harsh, warm environments (Hammond et al., 1994). Brahman, a *Bos indicus* breed of cattle, perform better in subtropical regions than *Bos taurus* cattle however, they lack some of the positive production attributes *Bos taurus* cattle possess such as high grading carcasses and high milk production.

Brahman and zebu cattle have some disadvantages that come along with their thermotolerance and efficiency at digesting poor quality forages when compared to *Bos taurus*. Poor meat tenderness is associated with carcasses of *Bos indicus* cattle (Sherbeck et al., 1996; Ferrell and Jenkins, 1998; Crouse et al., 1989). *Bos indicus* have lower milk yields and decreased lactation persistency (McDowell et al., 1996). They have a longer prepubertal period (Rodrigues et al., 2002; McDowell et al., 1996), a shorter duration of estrus (Rae et al., 1999), and they have poor temperaments (Hammond et al., 1996; Voisinet et al., 1997). Due to these negative aspects cattle buyers often discount crossbred calves displaying the Brahman phenotype.

*Bos taurus* cattle, on the other hand, in general have higher marbling scores, higher milk yields, good temperaments, and a short prepubertal period. It would be economically beneficial for people in these tropical and subtropical regions to raise *Bos taurus* breeds of cattle because of their potential to increase revenues for the producer, whether they are in the feedlot or cow/calf business. Current research has begun to look at the existence of a gene(s) associated with heat tolerance in slick haired *Bos taurus* cattle. Trials were conducted in Brooksville, Florida to observe the ratio of slick haired to normal haired progeny from a Senepol (slick haired) x Hereford (normal haired) dam and an Angus (normal haired) sire. The objective of this study was to see if the resulting normal and slick haired cattle differed in rectal temperature and respiration rate, both of which are indicators of heat tolerance.

The presence of such a gene would allow the beef industry in subtropical climates to select for heat tolerant cattle that are easier to manage as well as favorable in their carcass characteristics. Genetic prediction of heat tolerance is necessary for maximizing profitability in areas with high ambient temperature. The following will detail the differences in performance between *Bos taurus* and *Bos indicus* cattle in subtropical regions, as well as suggest the use of heat tolerance predictions on sire selection for maximum profit in subtropical climates.

## Review of Literature

***Defining Heat Tolerance.*** The ability of an animal to tolerate heat is very important to their productive capabilities. An animal that is heat tolerant has the ability to maintain a normal body temperature under high ambient temperatures (Hammond et al., 1994). High ambient temperatures are often considered to be 24°C and higher (Fuquay, 1981) and an animal's ability to maintain normal body temperature is determined through measurement of rectal temperature (RT). Cattle that are not heat tolerant often suffer from heat stress in locations with temperatures exceeding 24°C.

*Bos taurus* breeds of beef cattle are extremely heat-susceptible compared to their *Bos indicus* counterparts. Zebu (a type of *Bos indicus*) cattle acquired genes that conferred thermotolerance at some point during their separate evolution from *Bos taurus* cattle making them more suitable for harsh, warm climates. Zebu cattle exhibit less severe reductions in their overall productivity when compared to European *Bos taurus* breeds (Hansen, 2004). A common response in heat stressed cattle is to decrease metabolic heat production by lowering feed intake (Mitlohner, 2001). Decreases in feed intake generally begin occurring once ambient temperatures exceed 25°C (Morrison, 1983) and can be the cause of negative effects on both reproductive and growth performance (Gaughan et al., 1999).

***Heat Stress Effects on Reproduction in Bos Taurus Cattle.*** Heat stress affects many different aspects of reproduction including embryo development and survival, pregnancy rate, and sperm quality. Rocha et al. (1998) reported a marked decline in the number of oocytes collected as well as the quality of the oocytes from *Bos taurus* compared to *Bos indicus* cows during the hot season. A total of 89 oocytes were collected from Brahman cows while a total of only 28 were collected from *Bos taurus* cows. The percentage of these oocytes considered normal was 24.6% for *Bos taurus* cows and 77% for the Brahman cows. A different study found that Angus (*Bos taurus*) embryos exposed to 41°C developed slower than those of Brahman (Hernandez-Ceron et al., 2004). Another heat shock study determined that the total number of cells per embryo for Holstein and Angus cows was reduced compared to those for Brahman cows exposed to 38.5°C (Paula-Lopes et al., 2003). Brahman cows and their embryos tend to be affected less severely by heat stress than cattle of the *Bos taurus* influence.

Olson et al. (1991) found that heat stress also had an effect on pregnancy rate. Evaluating *Bos indicus* x *Bos taurus* and *Bos taurus* x *Bos taurus* cows for pregnancy rate they found the *Bos taurus* x *Bos taurus* to be 5.8% lower in Florida compared to the *Bos indicus* x *Bos taurus* cows. However, this difference decreased to 1.8% when the two crosses were evaluated in Nebraska. This evidence leads to the assumption that pregnancy rate in *Bos taurus* cattle is negatively affected by the heat stress associated with tropical environments.

Heat stress has also been reported to have negative affects on sperm quality (Meyerhoeffer et al., 1985). The percentage of motile sperm in Angus bulls subjected to 35°C was decreased compared to the controls. Ax et al. (1987) found similar results in dairy bulls exposed to 29.4°C and also noted a high frequency of abnormal sperm. Another study reported a 4.9% increased incidence of primary abnormalities in the sperm of *Bos taurus* bulls when compared to *Bos indicus* bulls following exposure to 40°C (Skinner and Louw, 1966). The work reviewed in this section shows that heat stress impacts both males and females and that both sexes are equally impacted.

***Heat Stress Effects on Growth in Bos Taurus Cattle.*** Growth potential is a very important factor to the beef producer because the more quickly an animal grows, the less time it will spend in the feedlot. This saves the feedlot a great deal of time and money; however, a heat stressed animal will cost additional time and money resulting in a reduction in profit. This is because heat stressed cattle consume less feed than those under normal conditions. Brahman cattle subjected to a temperature of 38°C have been found to gain 670 g/day while Friesian cattle gain only 590 g/day (Colditz, 1972). In addition, it was noted that the Brahman cattle were able to accomplish this higher gain on less feed than the Friesian cattle. This work implies that in addition to gaining more weight, the Brahman cattle were also more feed efficient under heat stress.

***Anatomical Differences.*** It has been proposed that the appendages on Zebu cattle are an important reason for their superior thermoregulatory ability because they increase the surface area of these animals. These appendages, such as the hump or the ears, are some of the defining characteristics of Zebu cattle. McDowell (1958) demonstrated that surgical removal of the dewlap or hump of Red Sindhi bulls had no significant effect on thermoregulatory ability. Therefore, some other unknown physiological aspect in these animals is responsible for their ability to regulate deep body temperature.

Ledger (1959) suggested that differences in the method of fat deposition could be a physiological difference that accounts for the differences in heat tolerance between these two species of cattle. He reports that as *Bos taurus* cattle increase in fatness during the feeding period they are incapable of reducing the amount of subcutaneous fat deposited. This in turn causes heat stress, which also causes a reduction in feed intake. *Bos indicus* on the other hand, do not deposit a large amount of subcutaneous fat and therefore, do not suffer from heat stress as severely. Although some research has been focused on physiological causes, most of the research behind heat tolerance has mainly focused on coat types.

***Coat Type Differences.*** The coat types of *Bos indicus* and *Bos taurus* cattle are very different from one another and have been studied to explain some of the properties of thermoregulation in *Bos indicus*. Zebu cattle have a light-colored hair coat that is sleek and shiny while European type cattle have a denser, wooly coat typically darker in color (Hansen, 1990). The sleek and shiny hair coats of the Zebu cattle reflect a greater proportion of incident solar radiation than those of *Bos taurus*. The coats of European type cattle reduce heat flow via conduction and convection and increase the effects of heat stress (Finch et al., 1984). Finch (1985) demonstrated that the wooly coats of Shorthorn cattle (a *Bos taurus breed)* prevent them from sweating under conditions of high humidity while those of Zebu cattle allow them to sweat efficiently. This was thought to be due to the trapping of humidified air in the wooly coats of the Shorthorn cattle.

Mader et al. (2002) demonstrated that coat color also had a large impact on the heat tolerance of cattle. They noted that the dark-colored group of cattle had the greatest percentage of individuals showing moderate to excessive panting as well as bunching behavior under thermoneutral climatic conditions. Increased panting and bunching behavior have been shown to be associated with heat exposure in previous experiments (Lefcourt and Schmidtmann, 1989) and these findings demonstrate that darker coated animals are less tolerant to increases in temperature than lighter coated animals. In addition, Mader and colleagues noted that dark coated cattle had mean tympanic (ear) temperatures that were significantly higher than cattle with light hair coats when subjected to a temperature of 28.6°C.

***Evidence of Coat Type Importance.*** Olson et al. (2003) compared Senepol/Hereford x Angus calves with purebred Senepol calves in their rectal temperature (RT) and respiration rates. This cross was used because previous studies had shown that Senepol (a tropically adapted *Bos taurus* breed) are equal in heat tolerance to Brahman cattle (Hammond et al., 1994). The offspring produced from this cross were either slick haired or normal haired. Slick haired heifers showed a lower respiration rate than normal haired heifers, which shows evidence for the importance of coat type in thermoregulation (Olson et al, 2003). These same researchers also found that RT increased with higher quantities of hair. Animals with a hair score of 4 (normal haired) showed a significant increase in RT when compared to animals with a hair score of 1 (slick haired). In addition, it was discovered that the resulting calves of these crosses had a ratio of slick hair to normal hair not much different from the 1:1 ratio you would expect assuming that all of the dams were heterozygous for a slick hair gene. This was an important observation because it points to the possibility that there is a slick hair gene that is dominant in mode of inheritance.

Hammond et al. (1994) investigated rectal temperature as an index of heat tolerance in Senepol, Brahman, Angus, Hereford, and crossbred Senepol cattle under summer conditions in subtropical Florida. This study found that Angus females always had the highest RT and Senepol cows the lowest. Angus and Hereford heifers had the highest RT, Brahman intermediate, and Senepol the lowest. These findings imply that cattle with heavier, thicker coats (Angus and Hereford) exhibit higher RT levels than those with slicker coats (Senepol and Brahman). In addition, this same study compared grazing times of Senepol and Hereford cows and found that mean daily grazing time was longer for Senepol than Hereford. Senepol showed the tendency to graze more in the late morning while Herefords tended to graze more at night when the temperature was cooler. When RT level and grazing time were looked at, it was discovered that total grazing time was negatively correlated with rectal temperature across all cows throughout the trial. Animals with higher RT temperatures responded to heat stress less favorably than those with lower RT, which resulted in reduced feed consumption.

Dowling (1959) compared the RT of Shorthorns with medullated coats to Shorthorns with highly insulating hair coats, made often of long silky unmedullated hairs. A medullated hair coat is often shorter and stiffer than a nonmedullated coat and is thought to enhance air movement and heat dissipation. Significant differences in heat tolerance were observed between these two groups. Those animals with more medullation exhibited more heat tolerance than those with less medullation.

Some experiments have also been performed in which longhaired cattle were clipped to simulate a shorthaired animal in order to observe the effects on RT. Hammond et al. (1994) did this as part of their experiment and noted that the clipped Hereford calves had rectal temperatures intermediate between the unclipped Hereford calves and the Senepol calves. Vajrabukka et al. (1984) also observed that wooly-coated heifers had higher rectal temperatures than clipped heifers under climate chamber conditions. The results of these two studies indicate that heat tolerance is improved once the animal is clipped; however, the RT of these clipped individuals is still not the same as a slick haired individual. This leads to the idea that a short hair coat is partially responsible for an animal being thermotolerant, but that there must also be some other genetic effect involved.

***Performance Differences.*** After reviewing the effects that slick hair has on the ability of an animal to tolerate heat the next logical step is to look at the performance in these animals compared to those with normal hair. Olson et al. (2003) documented that the mean marbling score for slick-haired calves corresponded to Low Choice while that of normal-haired steers of the same breed composition corresponded to High Select. These differences raise the question as to whether this is due to the slick hair condition or some other phenomenon. If in fact it is due to the slick hair condition this implies that the slick hair gene could be linked to marbling genes.

In order to look at the growth differences in heat tolerant cattle and temperate cattle, Frisch (1981) developed two closed lines of Hereford X Shorthorn crosses, one which was selected principally for growth rate under conditions of moderate to high environmental stress and the other which was an unselected control line. Frisch measured the growth rate of both groups when they were exposed to high ambient temperatures and observed that the selected line had consistently higher live weights from weaning onwards. In addition, he discovered that bulls in the selected line had a higher gain per day, a larger feed intake per day, a higher final live weight, as well as a lower rectal temperature than those in the control group. These results imply that it is possible to select for heat tolerant *Bos taurus* cattle that are presently considered temperate type cattle.

A great deal of research has been performed on cattle in the dairy industry due to the substantial economic losses associated with heat stress in these animals. Bohmanova et al. (2006) evaluated the female progeny of a set of sires in order to determine those sires transmitting the most heat tolerance. They concluded those bulls transmitting the highest tolerance to heat stress produced daughters with lower milk yields, longer productive lives, and worse dairy form when compared to daughters of less heat tolerant bulls. Although daughters of high heat tolerant bulls have lower milk yields, these cows will be more consistent in their milk yields throughout an entire year while the milk yield of daughters of less heat tolerant bulls will fluctuate with temperature. The current trend centers around selection of the highest milk producing individuals, which at the same time may be compounding problems associated with heat stress. Selection in favor of heat tolerance will result in a lower culling rate and an increase in profit because of the lack of need to replace older individuals in their peak lactation. This evidence in favor of selection for heat tolerance in temperate dairy cattle implies the possibility for selection of heat tolerance in *Bos taurus* beef breeds.

**Conclusions and Implications to Genetic Improvement of Beef Cattle**

Currently subtropical regions are at a disadvantage when it comes to beef production. Producers in these regions predominately raise heat tolerant breeds such as Brahman or other breeds of Zebu cattle because they are efficient digesters of poor quality forage and able to withstand hot, humid climates without compromising their production. Although they are hearty, they are also known for their inferior meat tenderness and poor temperament. In addition, these breeds are difficult to manage due to their long prepubertal period and short duration of estrus. Temperate breeds, however, are known for their superior meat tenderness and palatability, shorter prepubertal period, and longer duration of estrus. Incorporating temperate breeds of cattle into their production systems would allow producers in subtropical regions to produce a more profitable carcass while enabling them to manage their cattle more easily. Although these temperate breeds will require some supplemental feed due to the poor quality forage in these areas, the returns will compensate for any losses associated with the additional feed.

The review of literature in this paper has provided evidence in favor of the idea that the slick hair coat type plays an important role in the heat tolerance of cattle. Although there are probably other factors at work in determining heat tolerance, a shorter hair coat does have an effect on thermotolerance. Evidence has been provided that implies the existence of a single, major gene that is dominant in mode of inheritance. If there were a way of genetically predicting thermotolerance in temperate *Bos taurus* cattle, the beef industry in subtropical climates would benefit by being better able to compete in the United States beef market. In addition, these cattle producers would have the heat resistance required by the hot environment along with the superior carcass characteristics and favorable temperaments that temperate breeds bring to the industry.

There has not been an effort described thus far for genetically predicting thermotolerance, nevertheless, a great deal of evidence has been presented in favor of the need for a prediction. Hot, humid climates have been shown to induce heat stress in temperate cattle, which has negative effects on their reproductive and growth performances. Extreme care must be taken to develop an expected progeny difference (EPD) for heat tolerance that is clearly separate from predictions for carcass traits and milk yield since deficiencies in these traits are often characteristic of heat tolerant cattle. This will ensure the production of high producing, high grading animals in tropical regions.

Developing an EPD for heat tolerance for each *Bos taurus* breed will enable producers in subtropical climates to raise purebred *Bos taurus* cattle successfully without compromising their performance. The incorporation of genetic prediction for heat tolerance in *Bos taurus* breeds would allow them to be raised in areas with very high ambient temperatures where they could not be optimally raised before. *Bos taurus* breeds in subtropical regions would be able to produce up to their full potential as well as yield a more profitable, desirable carcass that would allow beef producers in these regions to be more competitive in the world beef market.

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# Seedstock Producer Honor Roll of Excellence

| | | |
|---|---|---|
| Billy L. Easley | KY | 1972 |
| Dale H. Davis | MT | 1972 |
| Elliot Humphrey | AZ | 1972 |
| Harold A. Demorest | OH | 1972 |
| James D. Bennett | VA | 1972 |
| Jerry Moore | OH | 1972 |
| John Crowe | CA | 1972 |
| Marshall A. Mohler | IN | 1972 |
| Albert West III | TX | 1973 |
| C. Scott Holden | MT | 1973 |
| Carlton Corbin | OK | 1973 |
| Clyde Barks | ND | 1973 |
| Heathman Herefords | WA | 1973 |
| James D. Hemmingsen | IA | 1973 |
| Messersmith Herefords | NE | 1973 |
| Mrs. R. W. Jones, Jr. | GA | 1973 |
| Raymond Meyer | SD | 1973 |
| Robert Miller | MN | 1973 |
| William F. Borrow | CA | 1973 |
| Bert Crame | CA | 1974 |
| Bert Sackman | ND | 1974 |
| Dover Sindelar | MT | 1974 |
| Burwell M. Bates | OK | 1974 |
| Charles Descheemacher | MT | 1974 |
| J. David Nichols | IA | 1974 |
| Jorgensen Brothers | SD | 1974 |
| Marvin Bohmont | NE | 1974 |
| Maurice Mitchell | MN | 1974 |
| Wilfred Dugan | MO | 1974 |
| Dale Engler | KS | 1975 |
| Frank Kubik, Jr. | ND | 1975 |
| George Chiga | OK | 1975 |
| Glenn Burrows | NM | 1975 |
| Howard Collins | MO | 1975 |
| Jack Cooper | MT | 1975 |
| Joseph P. Dittmer | IA | 1975 |
| Leslie J. Holden | MT | 1975 |
| Licking Angus Ranch | NE | 1975 |
| Louis Chestnut | WA | 1975 |
| Robert Arbuthnot | KS | 1975 |
| Robert D. Keefer | MT | 1975 |
| Walter S. Markham | CA | 1975 |
| Ancel Armstrong | VA | 1976 |
| Gerhard Mittnes | KS | 1976 |
| Healey Brothers | OK | 1976 |
| Jackie Davis | CA | 1976 |
| Jay Pearson | ID | 1976 |
| L. Dale Porter | IA | 1976 |
| Lowellyn Tewksbury | ND | 1976 |
| M.D. Shepherd | ND | 1976 |
| Robert Sallstrom | MN | 1976 |
| Sam Friend | MO | 1976 |
| Stan Lund | MT | 1976 |
| Bill Wolfe | OR | 1977 |
| Bob Sitz | MT | 1977 |
| Clair Percel | KS | 1977 |
| Floyd Hawkins | MO | 1977 |
| Frank Ramackers, Jr. | NE | 1977 |
| Glen Burrows | NM | 1977 |
| Henry and Jeanette Chitty | NM | 1977 |
| Hubert R. Freise | ND | 1977 |
| James Volz | MN | 1977 |
| Lloyd DeBruycker | ND | 1977 |
| Loren Schlipf | IL | 1977 |
| Marshall A. Mohler | IN | 1977 |
| Robert Brown | TX | 1977 |
| Tom and Mary Shaw | ID | 1977 |
| Tom Dashiell | WA | 1977 |
| Wayne Eshelman | WA | 1977 |
| Harold Anderson | SD | 1977 |
| William Borror | CA | 1977 |
| A.L. Frau | | 1978 |
| Bill Wolfe | OR | 1978 |
| Bill Womack, Jr. | AL | 1978 |
| Buddy Cobb | MT | 1978 |
| Frank Harpster | MO | 1978 |
| George Becker | ND | 1978 |
| Healey Brothers | OK | 1978 |
| Jack Delaney | MN | 1978 |
| James D. Bennett | VA | 1978 |
| Larry Berg | IA | 1978 |
| Roy Hunst | PA | 1978 |
| Bill Wolfe | OR | 1979 |
| Del Krumweid | ND | 1979 |
| Floyd Metter | MO | 1979 |
| Frank & Jim Wilson | SD | 1979 |
| Glenn & David Gibb | IL | 1979 |
| Jack Ragsdale | KY | 1979 |
| Jim Wolf | NE | 1979 |
| Leo Schuster Family | MN | 1979 |
| Peg Allen | MT | 1979 |
| Rex & Joann James | IA | 1979 |
| Bill Wolfe | OR | 1980 |
| Blythe Gardner | UT | 1980 |
| Bob Laflin | KS | 1980 |
| Charlie Richards | IA | 1980 |
| Donald Barton | UR | 1980 |
| Floyd Dominy | VA | 1980 |
| Frank Felton | MO | 1980 |
| Frank Hay | CAN | 1980 |
| James Bryany | MN | 1980 |
| John Masters | KY | 1980 |
| Mark Keffeler | SD | 1980 |
| Paul Mydland | MT | 1980 |
| Richard McLaughlin | IL | 1980 |
| Richard Tokach | ND | 1980 |
| Roy and Don Udelhoven | WI | 1980 |
| Bob & Gloria Thomas | OR | 1981 |
| Bob Dickinson | KS | 1981 |
| Clarence Burch | OK | 1981 |
| Clayton Canning | CAN | 1981 |
| Dwight Houff | VA | 1981 |
| G.W. Cronwell | IA | 1981 |
| Harold Thompson | WA | 1981 |
| Herman Schaefer | IL | 1981 |
| J. Morgan Donelson | MO | 1981 |
| Jack Ragsdale | KY | 1981 |
| James Leachman | MT | 1981 |
| Lynn Frey | ND | 1981 |
| Myron Autfathr | MN | 1981 |
| Roy Beeby | OK | 1981 |
| Russ Denowh | MT | 1981 |
| Bob Thomas | OR | 1982 |
| Clare Geddes | CAN | 1982 |
| David A. Breiner | KS | 1982 |
| Frankie Flint | NM | 1982 |
| Garold Parks | IA | 1982 |
| Gary & Gerald Carlson | NS | 1982 |
| Harlin Hecht | MN | 1982 |
| Howard Krog | MN | 1982 |
| Joseph S. Bray | KY | 1982 |
| Larry Leonhardt | MT | 1982 |
| Orville Stangl | SD | 1982 |
| W.B. Williams | IL | 1982 |
| William Kottwitz | MO | 1982 |
| Alex Stauffer | WI | 1983 |
| Bill Borror | CA | 1983 |
| C. Ancel Armstrong | KS | 1983 |
| Charles E. Boyd | KY | 1983 |
| D. John & Lebert Schultz | MO | 1983 |
| E.A. Keithley | MO | 1983 |
| Frank Myatt | IA | 1983 |
| Harvey Lemmon | GA | 1983 |
| J. Earl Kindig | MO | 1983 |
| Jake Larson | ND | 1983 |
| John Bruner | SD | 1983 |
| Leness Hall | WA | 1983 |
| Ric Hoyt | OR | 1983 |
| Robert H. Schafer | MN | 1983 |
| Russ Pepper | MT | 1983 |
| Stanley Nesemeier | IL | 1983 |
| A. Harvey Lemmon | GA | 1984 |
| Charles W. Druin | KY | 1984 |
| Clair K. Parcel | KS | 1984 |
| Donn & Sylvia Mitchell | CAN | 1984 |
| Earl Kindig | VA | 1984 |
| Floyd Richard | ND | 1984 |
| Fred H. Johnson | OH | 1984 |
| Glen Klippenstein | MO | 1984 |
| Jack Farmer | CA | 1984 |
| Jerry Chappel | VA | 1984 |
| Joe C. Powell | NC | 1984 |
| John B. Green | LA | 1984 |
| Lawrence Meyer | IL | 1984 |
| Lee Nichols | IA | 1984 |
| Phillip A. Abrahamson | MN | 1984 |
| Ric Hoyt | OR | 1984 |
| Robert L. Sitz | MT | 1984 |
| Ron Beiber | SD | 1984 |
| Arnold Wienk | SD | 1985 |
| Bernard F. Pedretti | WI | 1985 |
| David McGehee | KY | 1985 |
| Don W. Schoene | MO | 1985 |
| Earl Schafer | MN | 1985 |
| Everett & Ron Batho | CAN | 1985 |
| Fred Killam | IL | 1985 |
| George B. Halternan | WV | 1985 |

| | | |
|---|---|---|
| Glenn L. Brinkman | TX | 1985 |
| Gordon Booth | WY | 1985 |
| J. Newbill Miller | VA | 1985 |
| Marvin Knowles | CA | 1985 |
| R.C. Price | AL | 1985 |
| Tom Perrier | KS | 1985 |
| A. Lloyd Grau | NM | 1986 |
| Clarence VanDyke | MT | 1986 |
| Clifford & Bruce Betzold | IL | 1986 |
| Delton W. Hubert | KS | 1986 |
| Dick & Ellie Larson | WI | 1986 |
| Evin & Verne Dunn | CAN | 1986 |
| Gerald Hoffman | SD | 1986 |
| Glenn L. Brinkman | TX | 1986 |
| Henry & Jeanette Chitty | FL | 1986 |
| J.H. Steward/P.C. Morrissey | PA | 1986 |
| Jack & Gini Chase | WY | 1986 |
| John H. Wood | SC | 1986 |
| Lawrence H. Graham | KY | 1986 |
| Leonard Lodden | ND | 1986 |
| Leonard Wulf | MN | 1986 |
| Matthew Warren Hall | AL | 1986 |
| Ralph McDanolds | VA | 1986 |
| Richard J. Putnam | NC | 1986 |
| Roy D. McPhee | CA | 1986 |
| W.D. Morris/James Pipkin | MO | 1986 |
| Charles & Wynder Smith | GA | 1987 |
| Clayton Canning | CAN | 1987 |
| Eldon & Richard Wiese | MN | 1987 |
| Forrest Byergo | MO | 1987 |
| Gary Klein | ND | 1987 |
| Harold E. Pate | IL | 1987 |
| Henry Gardiner | KS | 1987 |
| Ivan & Frank Rincker | IL | 1987 |
| James Bush | SD | 1987 |
| Larry D. Leonhardt | WY | 1987 |
| Lyall Edgerton | CAN | 1987 |
| R.J. Steward/P.C. Morrisey | MN | 1987 |
| Tommy Brandenberger | TX | 1987 |
| Bill Bennett | WA | 1988 |
| Darold Bauman | WY | 1988 |
| David and Carol Guilford | CAN | 1988 |
| David Luhman | MN | 1988 |
| Don and Dian Guilford | CAN | 1988 |
| Donn & Sylvia Mitchell | CAN | 1988 |
| Douglas D. Bennett | TX | 1988 |
| George Schlickau | KS | 1988 |
| Gino Pedretti | CA | 1988 |
| Glann Debter | AL | 1988 |
| Hansell Pile | KY | 1988 |
| Jay P. Book | IL | 1988 |
| Kans Ulrich | CAN | 1988 |
| Kenneth Gillig | MO | 1988 |
| Leonard Lorenzen | OR | 1988 |
| Robert E. Walton | WA | 1988 |
| Scott Burtner | VA | 1988 |
| William Glanz | WY | 1988 |
| Bob R. Whitmire | GA | 1989 |
| Donald Fawcett | SD | 1989 |
| Ed Albaugh | CA | 1989 |
| Glynn Debter | AL | 1989 |
| Harry Airey | CAN | 1989 |
| Jack & Nancy Baker | MO | 1989 |
| Jerry Allen Burner | VA | 1989 |
| Kenneth D. Lowe | KY | 1989 |
| Leonard A. Lorenzen | OR | 1989 |
| Lester H. Schafer | MN | 1989 |
| Lynn Pelton | KS | 1989 |
| Orrin Hart | CAN | 1989 |
| Ron Bowman | ND | 1989 |
| Sherm & Charlie Ewing | CAN | 1989 |
| Tom Mercer | WY | 1989 |
| Bob Thomas Family | OR | 1990 |
| Boyd Broyles | KY | 1990 |
| Charles & Rudy Simpson | CAN | 1990 |
| Doug Fraser | CAN | 1990 |
| Douglas & Molly Hoff | SD | 1990 |
| Dr. Burleigh Anderson | PA | 1990 |
| Gerhard Gueggenberger | CA | 1990 |
| John & Chris Oltman | WI | 1990 |
| John Ragsdale | KY | 1990 |
| Larry Erahart | WY | 1990 |
| Otto & Otis Rincker | IL | 1990 |
| Paul E. Keffaber | IN | 1990 |
| Richard Janssen | KS | 1990 |
| Steven Forrester | MI | 1990 |
| T.D. & Roger Steele | VA | 1990 |
| Ann Upchurch | AL | 1991 |
| Dave & Carol Guilford | CAN | 1991 |
| Jack & Gini Chase | WY | 1991 |
| Jack Cowley | CA | 1991 |
| James Burnes & Sons | WI | 1991 |
| James R. O'Neill | IA | 1991 |
| Jim Taylor | KS | 1991 |
| John Bruner | SD | 1991 |
| Larry Wakefield | MN | 1991 |
| N. Wehrmann/R. McClung | VA | 1991 |
| R.A. Brown | TX | 1991 |
| R.M. Felts & Son Farm | TN | 1991 |
| Ralph Bridges | GA | 1991 |
| Richard & Sharon Beitelspacher | SD | 1991 |
| Rob & Gloria Thomas | OR | 1991 |
| Steve & Bill Florschcuetz | IL | 1991 |
| Summitcrest Farms | OH | 1991 |
| Tom Sonderup | NE | 1991 |
| A.W. Compton, Jr. | AL | 1992 |
| Bill Rea | PA | 1992 |
| Bob Buchanan Family | OR | 1992 |
| Calvin & Gary Sandmeier | SD | 1992 |
| Dennis, David, & Danny Geffert | WI | 1992 |
| Dick Montague | CA | 1992 |
| Eugene B. Hook | MN | 1992 |
| Francis & Karol Bormann | IA | 1992 |
| Glenn Brinkman | TX | 1992 |
| Harold Dickson | MO | 1992 |
| Leonard Wulf & Sons | MN | 1992 |
| Robert Elliot & Sons | TN | 1992 |
| Tom & Ruth Clark | VA | 1992 |
| Tom Drake | OK | 1992 |
| Bob Zarn | MN | 1993 |
| Clarence, Elaine, & Adam Dean | SC | 1993 |
| Collin Sander | SD | 1993 |
| D. Eldridge & Y. Aycock | OK | 1993 |
| Harrell Watts | AL | 1993 |
| J. David Nichols | IA | 1993 |
| J. Newbill Miller | VA | 1993 |
| Joseph Freund | CO | 1993 |
| Lynn Pelton | KS | 1993 |
| Miles P. "Buck" Pangburn | IA | 1993 |
| Norman Bruce | IL | 1993 |
| R.A. Brown | TX | 1993 |
| R.B. Jarrell | TN | 1993 |
| Rueben, Leroy, & Bob Littau | SD | 1993 |
| Ted Seely | WY | 1993 |
| Wes & Fran Cook | NC | 1993 |
| Bobby F. Hayes | AL | 1994 |
| Bruce Orvis | CA | 1994 |
| Buell Jackson | IA | 1994 |
| Calvin & Gary Sandmeier | SD | 1994 |
| Dave Taylor & Gary Parker | WY | 1994 |
| Jere Caldwell | KY | 1994 |
| John Blankers | MN | 1994 |
| John Pfeiffer Family | OK | 1994 |
| Ken & Bonnie Bieber | SD | 1994 |
| Mary Howe di'Zerega | VA | 1994 |
| Richard Janssen | KS | 1994 |
| Ron & Wayne Hanson | CAN | 1994 |
| Bobby Aldridge | NC | 1995 |
| Chris & John Christensen | SD | 1995 |
| Donald J. Hargrave | CAN | 1995 |
| Gene Bedwell | IA | 1995 |
| Gordon & Mary Ann Booth | WY | 1995 |
| Howard & JoAnne Hillman | SD | 1995 |
| John Robbins | MT | 1995 |
| Mack, Billy, & Tom Maples | AL | 1995 |
| Mary Howe de'Zerega | VA | 1995 |
| Maurice Grogan | MN | 1995 |
| Thomas Simmons | VA | 1995 |
| Tom Perrier | KS | 1995 |
| Ward Burroughs | CA | 1995 |
| C. Knight & B. Jacobs | OK | 1996 |
| C.W. Pratt | VA | 1996 |
| Cam, Spike, & Sally Forbes | WY | 1996 |
| Chris and John Christensen | SD | 1996 |
| D. Borgen and B. McCulloh | WI | 1996 |
| Frank Felton | MO | 1996 |
| Frank Schiefelbein | MN | 1996 |
| Galen & Lori Fink | KS | 1996 |
| Gerald & Lois Neher | IL | 1996 |
| Ingrid & Willy Volk | NC | 1996 |
| Mose & Dave Hebbert | NE | 1996 |
| Robert C. Miller | MN | 1996 |
| William A. Womack, Jr. | AL | 1996 |
| Alan Albers | KS | 1997 |
| Blaine & Pauline Canning | CAN | 1997 |
| Bob & Gloria Thomas | OR | 1997 |
| Darel Spader | SD | 1997 |
| E. David Pease | CAN | 1997 |
| Gregg & Diane Butman | MN | 1997 |
| Harold Pate | AL | 1997 |
| James I. Smith | NC | 1997 |
| Jim & JoAnn Enos | IL | 1997 |

Juan Reyes............................. WY .. 1997
Nicholas Wehrmann.............. VA ... 1997
Richard McClung.................. VA ... 1997
Abilgail & Mark Nelson......... CA ... 1998
Adrian Weaver & Family....... CO ... 1998
Airey Family ......................... MB .. 1998
Dallis & Tammy Basel........... SD.... 1998
Dave & Cindy Judd............... KS.... 1998
Dick & Bonnie Helms............ NE ... 1998
Duane L. Kruse Family .......... IL..... 1998
Earl & Nedra McKarns........... OH ... 1998
James D. Bennett Family........ VA ... 1998
Tom Shaw ............................. ID .... 1998
Wilbur & Melva Stewart ........ AB ... 1998
Duane Schieffer...................... MT ... 1999
John Kluge ............................ VA ... 1999
Kelly & Lori Darr.................. WY .. 1999
Kent Klineman ...................... SD.... 1999
Kramer Farms......................... IL..... 1999
Lynn & Gary Pelton .............. KS.... 1999
Noller & Frank Charolais ....... IA .... 1999
Rausch Herefords .................. SD.... 1999
Steve Munger ........................ SD.... 1999
Terry O'Neill ......................... MT ... 1999
Tony Walden.......................... AL ... 1999
Alan & Deb Vedvei................ SD.... 2000
Banks & Margo Herndon ....... AL ... 2000
Blane & Cindy Nagel ............ SD.... 2000
Galen, Lori & Megan Fink ..... KS.... 2000
Harlin & Susan Hecht............ MN .. 2000
Jim & Janet Listen................. WY .. 2000
John & Betty Botert................ MO .. 2000
John C. Curtin ....................... IL..... 2000
Kent Klineman &
Steve Munger ....................... SD.... 2000
Larry & Jean Croissant........... CO ... 2000
Mike & T.K. McDowell......... VA ... 2000
Ralph Blalock, Sr. Blalock, Jr. &
David Blalock......................... NC ... 2000
Vaughn Meyer & Family........ SD.... 2000
Blane & Cindy Nagel ............ SD.... 2001
Bob & Nedra Funk ................ OK ... 2001
Dale, Don, & Mike Spencer ... NE ... 2001
Don & Priscilla Nielsen.......... CO ... 2001
Eddie L. Sydenstricker ........... MO .. 2001
George W. Lemm.................. VA ... 2001
Ken Stielow & Family........... KS.... 2001
Kevin, Jessica, &
Emily Moore ......................... TX ... 2001
Marvin &
Katheryn Robertson............... VA ... 2001
McAllen Ranch ..................... TX ... 2001
Steve Hillman & Family......... IL..... 2001
Tom Lovell............................ AL ... 2001
DeBruycker Charolais ............ MT ... 2002
Ellis Farms ............................ IL..... 2002
Holly Hill Farm ..................... VA ... 2002
Isa Cattle Co., Inc. ................. TX ... 2002
Lyons Ranch.......................... KS.... 2002
Noller and Frank Charolais .... IA .... 2002
Rishel Angus ......................... NE ... 2002
Running Creek Ranch ............ CO ... 2002
Shamrock Angus ....................WY .. 2002
Stewart Angus ........................IN .... 2002
Triple "M" Farm.....................AL ... 2002
Bedwell Charolais ..................IA ... 2003
Boyd Farm..............................AL .. 2003
Camp Cooley Ranch...............TX ... 2003
Hilltop Ranch .........................TX ... 2003
Moser Ranch ..........................KS ... 2003
Mystic Hill Farms ..................VA... 2003
Pingetzer's Six Iron Ranch......WY .. 2003
San Isabel Ranch ....................CO ... 2003
Shamrock Vale Farms ............OH... 2003
Adams Angus Farm................AL ... 2004
Byland Polled Shorthorns........OH... 2004
Camp Cooley Ranch...............TX ... 2004
Eaton Charolais.......................MT... 2004
Flat Branch Cattle Company ...IL..... 2004
Judd Ranch, Inc. ......................KS ... 2004
Rausch Herefords ...................SD ... 2004
Reynolds Ranch .....................CO ... 2004
Silveira Brothers Angus and Diversified
Farming .................................CA ... 2004
Symens Brothers Limousin .....SD ... 2004
Touchstone Angus..................WY .. 2004
Triple U Ranch.......................IA .... 2004
Altenburg Super Baldy...........CO ... 2005
Bar S Ranch ...........................KS ... 2005
Ellis Farms .............................IL..... 2005
Ingram Cattle Company ..........MS... 2005
Moore Farms ..........................AL ... 2005
Morrison Stock Farm .............OH... 2005
Pangburn Stock Farm.............IA .... 2005
Rishel Angus ..........................NE ... 2005
Rogers Bar HR .......................MS... 2005
Soldiers' Hill Angus Farm ......VA... 2005
Sunnyhill Angus Farm ...........IL..... 2005
Waukaru Farms, Inc. ...............IN .... 2005

## Seedstock Producer of the Year

| | | |
|---|---|---|
| John Crowe | California | 1972 |
| Mrs. R. W. Jones, Jr. | Georgia | 1973 |
| Carlton Corbin | Oklahoma | 1974 |
| Jack Cooper | Montana | 1975 |
| Leslie J. Holden | Montana | 1975 |
| Jorgenson Brothers | South Dakota | 1976 |
| Glenn Burrows | New Mexico | 1977 |
| James D. Bennett | Virginia | 1978 |
| Jim Wolf | Nebraska | 1979 |
| Bill Wolfe | Oregon | 1980 |
| Bob Dickinson | Kansas | 1981 |
| A.F. “Frankie” Flint | New Mexico | 1982 |
| Bill Borror | California | 1983 |
| Lee Nichols | Iowa | 1984 |
| Ric Hoyt | Oregon | 1985 |
| Leonard Lodoen | North Dakota | 1986 |
| Henry Gardiner | Kansas | 1987 |
| W.T. “Bill” Bennett | Washington | 1988 |
| Glynn Debter | Alabama | 1989 |
| Douglas & Molly Hoff | South Dakota | 1990 |
| Summitcrest Farms | Ohio | 1991 |
| Leonard Wulf & Sons | Minnesota | 1992 |
| J. David Nichols | Iowa | 1993 |
| R.A. “Rob” Brown | Texas | 1993 |
| Richard Janssen | Kansas | 1994 |
| Tom & Carolyn Perrier | Kansas | 1995 |
| Frank Felton | Missouri | 1996 |
| Bob & Gloria Thomas | Oregon | 1997 |
| Wehrmann Angus Ranch | Virginia | 1997 |
| Flying H Genetics | Nebraska | 1998 |
| Knoll Crest Farms | Virginia | 1998 |
| Morven Farms | Virginia | 1999 |
| Fink Beef Genetics | Kansas | 2000 |
| Sydenstricker Angus Farms | Missouri | 2001 |
| Circle A Ranch | Missouri | 2002 |
| Moser Ranch | Kansas | 2003 |
| Camp Cooley Ranch | Texas | 2004 |
| Rishel Angus | Nebraska | 2005 |

# 2005 Seedstock Producer of the Year
# Rishel Angus - Nebraska

The Beef Improvement Federation awarded the 2005 Seedstock Producer of the Year award to Rishel Angus, North Platte, Neb. Rishel Angus is a family-owned purebred Angus operation that has been in business since 1966.

*Rishel Angus of North Platte, Neb., was named the 2005 Seedstock Producer of the Year by the Beef Improvement Federation. Accepting the award are Barb and Bill Rishel.*

The Rishel Angus mission statement reads: "to produce superior Angus genetics based on economically important traits that provide profit for our customers, create value for all segments of the beef industry, and ensure a satisfying eating experience for the consumer."
Rishel Angus is known in the seedstock industry as one of the very first breeders of Angus cattle to make a substantial commitment to identifying and improving carcass merit. The belief at Rishel Angus, then and now, is that the real focus should be directed toward the acceptance of the consuming public for beef's end product. Because of these efforts, many of the leading sires for carcass merit in the Angus breed now carry Rishel Angus', "B/R" prefix. In fact, currently, 40 proven sires and 9 young sires listed in the National Angus Sire Evaluation Report are Rishel Angus bred bulls. One of these sires, B/R New Design 036, ranks third among all proven Angus sires for Pathfinder daughters and has the top 10 Pathfinder sons in the breed, and maintains the highest percentage of Pathfinder daughters of those eligible.

Rishel Angus has collected and used complete performance records on all cattle since the inception of the herd. These records have allowed them to not only identify many outstanding sires, but also to identify and perpetuate numerous outstanding cow families and individual cows.

The Rishel Angus herd consists of 300 Angus cows and 100 Angus heifers. For the last 23 years, a yearling bull sale has taken place on the fourth Monday in March, and for the last 26 years a female sale has taken place on the first Sunday in October. Rishel Angus operates on a combination of 11,000 deeded and leased acres, with wintering and calving at the headquarters located 10 miles south of North Platte.

Rishel Angus was nominated by the Nebraska Cattlemen and the University of Nebraska.

# 2006 BIF Seedstock Producer Award Nominees

**Benoit Angus Ranch**
**Owner: Everett and Bonnie Benoit**
**Manager: Everett, Doug and Chad Benoit**
**Kansas**

Benoit Angus Ranch got its start in 1962 with the purchase of six registered Angus heifers. Located near Esbon, Kansas, the ranch is owned and operated by Everett and Bonnie Benoit, their sons Chad and Doug and Doug's wife, Michelle. The goal of this family operation has been to provide genetics that enhance the profit potential of commercial producers.

An intensive breeding program has helped them attain many goals. Artificial insemination (AI) has been part of the management plan for years, with all the AI work done at home using proven Angus genetics. They also use embryo transfer (ET) and, as a result, more than 100 ET calves are born each year. ET and AI calves make up about 85% of those born on the ranch, with that number rising annually.

The breeding program maintains its commercial trait focus through emphasis on carcass quality, maintaining an average birth weight and producing cows with longevity. Most females are marketed by private treaty. Bulls are sold through an annual production sale held the third Monday in March.

All cattle on the ranch are individually identified with ear tags, tattoos and freeze brands. Records are maintained through the American Angus Association (AAA) using Angus Information Management System (AIMS). The ranch's database includes everything from mating records to carcass quality information.

Because their breeding program is targeted toward commercial producers, they strive to raise cattle in an environment similar to that of their customers. For example, the cowherd is kept on pastures and stock fields throughout the year and calves are never creep fed.

In addition to the cattle operation, they have a sizeable farming operation that raises cash crops and provides supplemental feed for the cowherd during the winter months.

The Benoit Angus Ranch is proudly nominated by the Kansas Livestock Association.

**Champion Hill**
**Owner: Paul Hill and Marshall Reynolds**
**Ohio**

Champion Hill is located in southeastern Ohio coal country, where the rolling hills are ideal for raising beef cattle. Marshall Reynolds, who owned the land, formed Champion Hill Inc. in 1993, with Paul Hill as president. The farm includes more than 4,000 acres of owned and leased land spread over Gallia County. There are roughly 200 breeding-age registered Angus females and 800 mostly half-blood Angus females that are used as recipients. Eight times a year Champion Hill flushes 20-30 proven Angus females, utilizing embryo transfer to produce 90% of its animals.

In putting together the foundation of the herd, their main focus was to purchase superior females that, with the use of artificial insemination and embryo transfer, would produce progeny to perform well in the field and feedlot while having the eye appeal to win in the showring. Females are selected on the basis of their performance, EPDs, udder quality, and structural correctness.

The Champion Hill prefix has become a fixture in the nation's top Angus shows. "Where winning is only the beginning" truly emphasizes the philosophy of breeding cattle that also perform well after their show careers. Each year, Champion Hill sells about 300 females in two production sales at the farm and 200 bulls in a genetic partnership with Schaff Angus Valley in North Dakota. The farm currently has 12 bulls – superior in growth and feedlot value ($F) – leased by AI studs.

They also strongly believe in developing productive young people. They have always encouraged talented men and women to work at the farm. While they gain valuable experience, their energy and adventurous nature keep Champion Hill on the leading edge of technology and the beef industry.

The Ohio Cattlemen's Association is proud to nominate Champion Hill.

**EE Ranches, Inc.**
**Owner: Bill and Jo Ellard**
**Manager: Jack and Cheryl Evans**
**Mississippi**

EE Ranches, Inc. of Winona, Mississippi, has been in operation for 23 years. This 2500-acre ranch currently runs 106 Hereford, 160 Angus, and 103 commercial cows. An intensive, multi-stage forage plan works to achieve the best forage system for efficient production in their environment.

The EE Ranches herds consist of approximately 90% fall-calving and 10% spring-calving females with each calving season being only 50 days in length. Artificial insemination and embryo transfer are heavily used in EE's breeding programs. Performance ratios, ultrasound body composition scan results, Expected Progeny Differences, index values, environmental adaptability, reproductive efficiency, and functional soundness are essential selection criteria. A high percentage of herd sires are raised on farm, revealing the depth of quality at EE Ranches and the emphasis on effective linebreeding.

Today's herds are the results of line-bred predictability with emphasis on stacking great cow families. While the Hereford herd is intense in L1 Domino genetics, the Angus herd is extremely line bred to Rito 149. Approximately one-half to two-thirds of the entire bull crop is usually sold by weaning to repeat customers. EE is offering 50 to 60 Angus bulls and 40 to 50 Hereford bulls private treaty each year and markets a high percentage of these bulls through a branded beef program. Annually, EE consistently receives feedback from customers on feedlot and carcass performance on approximately 800 calves out of EE bulls. Getting to know each customer's herd is considered paramount in making sure that the right product is provided to each buyer.

EE Ranches, Inc. is proudly nominated by the Mississippi Beef Cattle Improvement Association and the American Hereford Association.

**Earhart Farms**
**Owner: Larry Earhart**
**Wyoming**

In 1929, Jesse Earhart moved his family from Nebraska, to file on a homestead in the new Willwood Irrigation Project south of Powell, Wyoming. Earhart Farms is the family corporation that now operates the original homestead and other land that has been added over the years.

Larry Earhart is the third generation to farm the land and Andrea Earhart-Cooper will be the fourth.

The farm now consists of 600 acres of irrigated cropland and another 500 acres of river bottom grazing land.

The first feeder cattle were purchased in 1944 and the registered Angus herd was started in 1958. The breeding herd now consists of 150 cows with a February-March calving season. The feedlot component is now devoted to custom heifer development for outside cattle. The heifers are wintered, synchronized, and artificially bred before returning to the ranch in the spring.

The cattle enterprise is instrumental to the success of the farm in that it is a value added method of marketing the feed produced by the farm.

In addition to the feed to support the cattle enterprise the farm produces certified seed beans.

The Wyoming Beef Cattle Association is proud to nominate Earhart Farms.

**Figure 4 Cattle Company**
**Volk Ranch LLLP**
**Owner: Gary, Gail and George Volk**
**Colorado**

The Volk family – George, Gary and Gail Volk – began raising cattle at the base of Ragged Mountain in the northwest corner of Gunnison County nearly a century ago. Their ancestors homesteaded 20 miles north of Paonia in 1911, where they cleared brush for fields and pasture and set in motion a tradition of commitment to land, livestock and family still in place today.

In 1982, the Volk family began building one of America's top registered Salers cow herds. Their goal has always been to produce functional cattle that could withstand the harsh production realities of our environment, while exceeding industry standards for reproduction performance, production and carcass quality.

Today, Figure 4 Cattle Company ranks among the largest registered Salers operations in America, with more than 450 females. While historically they've been a commercial cow/calf operation, they continue to raise registered cattle under the same rigorous, commercial production system. Nothing gets special treatment.

They are also keenly aware that their customers cannot compete unless the genetics they purchase from them are aggressively tested and proven. They realize that in order to bolster their economic competitiveness, they must produce proven cattle that balance a combination of production traits.

They weigh and measure every animal on the place, every chance we get. They report every bit of performance data to the American Salers Association, and have been rewarded for their efforts. The Volk Family has achieved a notable track record for its commitment to performance. During the last decade, they have ranked each year among the top five "Performance Breeders of the Year" by the American Salers Association. The past two years, they have been the National winner of the award, making five total times they have won the award since 1994.

They typically begin calving late February in large open fields at 5,000 feet elevation. By mid-April, they pasture pairs on semi-desert range until the middle of May, when they truck the cow herd to the Ragged Mountain Ranch. The herd spends most of the summer between 7,000 and 10,000 feet elevation on both private and federal pasture. When autumn snows begin to arrive, the herd is moved back to the lower ranch for winter.

They wean calves in November and move them to the Figure 4 Development Center in Eckert, CO, where they develop the bull and heifer calves in preparation for the March Production Sale. The calves that don't meet their quality and performance specifications for the sale or herd replacements are placed on feed and finished for the branded beef program or sold on a grid as many of their customers do.

The Colorado Cattlemen's Association is proud to nominate the Figure 4 Cattle Company.

**Lawler Farm**
**Owner: Charles Lawler**
**Manager: Bruce Randall**
**Alabama**

Lawler Farm is located eleven miles south of Opelika, AL and consists of 750 acres, of which 650 are comprised of pasture and woodland and approximately 100 acres are dedicated to hay production. Owner Charles

Lawler has been involved in the cattle business for many years; however, the current purebred Angus operation began in earnest in 1999 with the addition of Bruce Randall as manager. Lawler's son-in-law, Bob Dudley and his grandson, Tillman Dudley, are also involved with the operation.

Cows calve in the fall, with 92% of the fall 2005 calf crop being the result of artificial insemination and embryo transfer and 8% the result of natural service sires. Artificial insemination, using proven sires from the American Angus Association Sire Evaluation, has been the key to herd improvement since 1999. Lawler Farm is a core member and host of the Southeast Angus Classic, one of the most progressive Angus sales in the region. The sale guidelines require phenotypic excellence, at least two generations of AI sires in the sale-eligible females, an AI sired calf at side, and subsequent AI breeding of the cow. These stringent requirements complement the Lawler Farm goals of significant genetic improvement.

Lawler Farm is active in Alabama BCIA Bull Evaluations to provide an unbiased comparison of performance and an important advertising and marketing tool. The farm has produced several top performing bulls, most recently the highest indexing bull at the 2005 North Alabama Bull Evaluation and the second highest indexing bull at the 2005 Auburn University Bull Test. Lawler Farm was also recognized by the Alabama Angus Association as their 2005 Progressive Breeder of the Year.

Lawler Farm is proudly nominated by the Alabama Beef Cattle Improvement Association.

**Powder Creek Simmentals**
**Owner: Rodney and Gail Hilley**
**Georgia**

Powder Creek Simmentals is located near Molena, Georgia. The operation was begun in 1974 with the purchase of a half-blood Simmental bull from the Rollins Beef Research Center at Berry College in Rome, Georgia, to cross on a herd of Polled Hereford cattle. After college, Rodney and Gail purchased a group of half-blood Simmental cows and began to upgrade the herd through artificial insemination. Through the years, the herd has evolved to a black, purebred Simmental herd of around 70 cows. They currently utilize artificial insemination on all heifers and at least 1 time on most of the cowherd. Embryo Transfer has been utilized at various times. The Hilleys also utilize technologies such as DNA testing and carcass ultrasound.

The calving season runs from November thru December. The herd is run on year round grazing most years. Temporary winter grazing is planted in the fall, so that the cows have high quality grazing during the winter months, during early lactation. Bulls are marketed through the 2 Georgia Bull Test Stations, in which they have produced the top indexing bull several times. They also test and market most of our bulls through the Canoochee Forage Bull Development Center in Glennville, Georgia. Other marketing avenues include consignment sales and private treaty. Many females from the herd have been shown by the Hilley children in 4-H and FFA shows, as well as various open shows.

Powder Creek Simmentals are proudly nominated by the Georgia Cattleman's Association.

**Quaker Hill Farm LLC**
**Owner: Charles S., Lee C., and Charles A. Rosson**
**Virginia**

Quaker Hill Farm is a diverse operation located in Louisa County, Virginia. The herd presently consists of 400 cows of purebred Angus, Hereford, Limousin, and Simmental as well as commercial and composite SimAngus cows. In addition to the cattle operation, the farm grows about 550 acres of corn and soybeans each year. The Rossons manage both a 60 day fall and spring calving season. Embryo transfer and artificial insemination are used extensively to accelerate the genetic program. The farm sells approximately 75 to 100 bulls per year through the Virginia BCIA Bull Test, cooperator agreements and on-farm private treaty sales.

Quaker Hill Farm is the 4th generation home of the Rosson family as well as the home of some of the most progressive Angus genetics in the nation. The family farm has maintained its commitment to commercial cattle production. The purebred cattle exist to make the commercial herd more profitable. Selection is based on finding bulls that defy genetic antagonisms by producing profitable cows and superior performance at end-user venues. The Rossons have been lifetime members of the American Angus Association since 1957. In the late 1950's, Quaker Hill management sought opportunities in diverse genetic pools by crossbreeding a predominant Hereford herd to Angus bulls. In the 1980's, Continental genetics were introduced to accelerate progeny growth rate of commercial calves and participate in the increased demand in the marketplace for purebred Limousin cattle. After the Limousin dispersal in the early 1990's, Quaker Hill committed capital to begin a registered Angus program. From the beginning, the family has been committed to strict performance standards and used extensive artificial insemination to the top bulls in the Angus breed. Through extensive research efforts, Quaker Hill management used the genetics from breed leading bulls such as EXT, 6807, and Precision early in their careers.

Quaker Hill has been very competitive in the VA BCIA Culpeper Performance Test Station, either having the top indexing or top sale order bull four out of the last six years. Two Quaker Hill bulls currently hold the record as the top selling Angus bulls in the history of the Culpeper Test Station. Both went on to be leased by major AI studs. Currently, seven of Quaker Hill's Angus herd sires are leased to major AI organizations. Cattle have been sold to breeders in over 20 states across the county as well as semen and embryos in many foreign countries. The success enjoyed by Quaker Hill is due to adhering to sound genetic and business principles plus being committed to producing products that perform as expected.

The Virginia Beef Cattle Improvement Association is proud to nominate Quaker Hill Farm.

**Sauk Valley Angus**
**Owner: Gary and Kathy Sandrock**
**Manager: Jay King, Ben Sandrock and Matt Sandrock**
**Illinois**

The Sandrock Farms/Sauk Valley Angus, LLC headquarter is located six miles south and two miles west of Rock Falls, Illinois in Whiteside county. The family owned and operated seedstock and row crop operation has been at the current location for seven generations. They currently have 480 registered Angus cattle and 190 commercial Angus females that are used as embryo recipients. The cows are synchronized and then artificially inseminated to calve within a 45-day window in January and February. In the spring of 2006, Sauk Valley Angus will hold its 10th annual Bull Sale, followed by the 10th annual Production Sale in the fall.

The farming operation consists of over 10,000 acres of row crop ground, 75% of which is irrigated. They grow corn, soybeans, sweet corn, wheat, peas, rye, lima beans, alfalfa, pasja and native grasses. The implementation of conservation practices, including a pasture establishment program, planting wind breaks, construction of ponds, CRP areas, rotational grazing, and double cropping, have allowed them to maximize production while minimizing impact on the land. At Sauk Valley, all of their income is derived from the sale of Angus seedstock and cash crops.

The Sauk Valley breeding program is focused on the production of functional, balanced trait cattle that are designed to create value every segment of the beef industry, while yielding an end product that will exceed consumer expectations. The Sesame database and internet service on their computer system allow them to rapidly access and utilize AHIR performance data, EPDs, production records and ultrasound scan data to assist in making objective culling and selection decisions. In recent years the inception and growth of their embryo program has enabled them to propogate our most elite cow families, while expediating genetic improvements to provide our customers with the cutting edge genetics they demand.

Sauk Valley Angus is proudly nominated by the Illinois Beef Cattle Improvement Association.

**Thomas Charolais, Inc.**
**Owner: Billy and Claudette Thomas**
**Texas**

Thomas Charolais, Inc. is located in deep South Texas, just north of Raymondville. The Thomas family began with the Charolais breed when Harl and Maria Thomas became interested in the big white cattle and purchased Charolais from the Pubiget herd in Mexico in 1936. Harl Thomas is credited with being one of the original importers of Charolais Cattle and one of the founders of the American International Charolais Association. Billy Thomas has spent a lifetime raising Charolais cattle and nurturing the ranching heritage along with his wife Claduette. The love of ranching and Charolais cattle is now possessed by the third and fourth generations. Mitch and Linda and their three girls, Morgan, Logan and Lauren, along with David and Tonnyre and their two kids Royse and baby Claudette all live and work on the ranch. It is unique that an operation would continue with the same family, in the same location and the same breed for so long. Thomas Ranch has been designated a Family Land Heritage ranch for its 150 years of continuity.

Thomas Charolais, Inc. is currently running approximately 1,500 registered Charolais cows. Their ranching operation is spread over four locations covering 5,000 acres, and they are continually looking for the best avenues to grow and carry on their operation.

The American International Charolais Association is proud to nominate Thomas Charolais, Inc.

**Vorthmann Limousin**
**Owner: Roger and Ann Vorthmann**
**Iowa**

Vorthmann Limousin is a small family operation that is run by Roger and Ann Vorthmann and their three children, Chad, Deb and Erica. Roger and Ann have been in the cattle business for 45 years, starting as young 4-Hers.

They live on a farm near Treynor in southwest Iowa that was originally owned by Roger's great-grandfather more than 100 years ago. They moved to the farm 30 years ago and in 1993 purchased the land. They also farm the cropland of Roger's father. Their farm is nestled in prime farm country, and the Vorthmanns grow corn and soybeans, along with their Limousin cow herd.

The Vorthmanns currently have 53 bred females. In the early years of their operation, they phased out their commercial cow herd and replaced them with all registered Limousin cows and heifers. Their main calving season is March and April. Due to limited inside calving facilities, they artificially inseminate (AI) a few cows and calve any embryo transfer (ET) calves in January and February. They like calving in January because it offers their bull customers an older bull that can cover more cows.

The Vorthmanns involvement in the Limousin breed grew from "a love of the cattle industry and breeding heifer projects that our children had while growing up in 4-H and junior Limousin activities." They are firm believers in breeding heifer projects for youth.

"It teaches them the responsibility of caring for something special and gives them decision making skills as the heifer becomes a cow. There are so many life lessons learned during this process, some good and some not so good, that we think it is priceless," say the Vorthmanns.

The Vorthmann children started their 4-H careers with Limousin breeding heifer projects. They grew their cow herds and showed many of their own cattle, using the income from their cows to further their education. They paid expenses, mated their cattle and helped with chores, calving and other farm related activities. They showed at every National Junior Limousin show from 1988 through 2004 as well as Midwestern state fairs, breed field days, regional shows and Iowa Junior Beef Breeds shows.

"The friends we have all made across the country and the experiences we've gained mean so much to us. We feel so blessed to have raised three great children who have grown into successful, responsible adults, as well as all the wonderful friends we've made over the years in the cattle industry and the Limousin breed," say the Vorthmanns.

The Iowa Cattlemen's Association is proud to nominate Vorthmann Limousin.

**Waukaru Farms, Inc.**
**Owner: Carl Jordan and Families**
**Indiana**

Waukaru Farms, Inc. has been incorporated for nearly thirty years; however, the Jordan family has been raising purebred Shorthorn cattle in northwestern Indiana for over 100 years since Walter Jordan first purchased Shorthorn bulls in 1902. Presently, Waukaru consists of 250 purebred Shorthorn and Durham Red composite breeding females, 1,400 acres of cropland, and 360 acres of pasture and hay ground. Seventy-five percent of the cows calve in the spring and the remainder in the first 60 days following the first of September. Waukaru genetics can be found in 38 U.S. states, 4 Canadian provinces, Mexico, Argentina, Brazil, Uruguay, China, Australia, New Zealand, South Africa, and Ireland. Waukaru is currently involved in sire tests in Australia, Argentina, and the United States with the purpose of objectively quantifying the profitability of Waukaru genetics.

The breeding objective of the Waukaru program is to produce profitable, efficient genetics that can flourish on minimal inputs, reap profits for their customers and subsequent phases of the beef industry and provide a valuable eating experience for consumers. They meet this objective through performance-based management and objective decision making. Aggressive usage of artificial insemination and embryo transfer facilitated by the natural service of AI sires creates a mass propagation of superior genetics. Waukaru enhances the adaptability of their cattle by utilizing a rotational, forage-based production system in which cows are wintered on crop residue and growing cattle are supplemented with a high-fiber ration. Waukaru strives to be a full-service genetic provider by building personal relationships with each client and prides themselves in profitably matching the correct genetics with their customers' needs.

Waukaru Farms, Inc. was proudly nominated by the American Shorthorn Association and the Indiana Beef Evaluation Program.

# Commercial Producer Honor Roll of Excellence

| | | |
|---|---|---|
| Chan Cooper | MT | 1972 |
| Alfred B Cobb, Jr | MT | 1972 |
| Lyle Eivens | IA | 1972 |
| Broadbent Brothers | KY | 1972 |
| Jess Kilgote | MT | 1972 |
| Clifford Ouse | MN | 1973 |
| Pat Wilson | FL | 1973 |
| John Glaus | SD | 1973 |
| Sig Peterson | ND | 1973 |
| Max Kiner | WA | 1973 |
| Donald Schott | MT | 1973 |
| Stephen Garst | IA | 1973 |
| J.K. Sexton | CA | 1973 |
| Elmer Maddox | OK | 1973 |
| Marshall McGregor | MO | 1974 |
| Dave Matti | MT | 1974 |
| Lloyd DeBruycker | MT | 1974 |
| Gene Rambo | CA | 1974 |
| Jim Wolf | NE | 1974 |
| Henry Gardiner | KS | 1974 |
| Johnson Brothers | SD | 1974 |
| John Blankers | MN | 1975 |
| Paul Burdett | MT | 1975 |
| Oscar Burroughs | CA | 1975 |
| John R. Dahl | ND | 1975 |
| Eugene Duckworth | MO | 1975 |
| Gene Gates | KS | 1975 |
| V.A. Hills | KS | 1975 |
| Robert D. Keefer | MT | 1975 |
| Kenneth E. Leistritz | NE | 1975 |
| Ron Baker | OR | 1976 |
| Dick Boyle | ID | 1976 |
| James Hackworth | MO | 1976 |
| John Hilgendorf | MN | 1976 |
| Kahau Ranch | HI | 1976 |
| Milton Mallery | CA | 1976 |
| Robert Rawson | IA | 1976 |
| William A. Stegner | ND | 1976 |
| U.S. Range Exp. Stat. | MT | 1976 |
| Maynard Crees | KS | 1977 |
| Ray Franz | MT | 1977 |
| Forrest H. Ireland | SD | 1977 |
| John A. Jameson | IL | 1977 |
| Leo Knoblauch | MN | 1977 |
| Jack Pierce | ID | 1977 |
| Mary & Stephen Garst | IA | 1977 |
| Todd Osteross | ND | 1978 |
| Charles M. Jarecki | MT | 1978 |
| Jimmy G McDonnal | NC | 1978 |
| Victor Arnaud | MO | 1978 |
| Ron & Malcom McGregor | IA | 1978 |
| Otto Uhrig | NE | 1978 |
| Arnold Wyffels | MN | 1978 |
| Bert Hawkins | OR | 1978 |
| Mose Tucker | AL | 1978 |
| Dean Haddock | KS | 1978 |
| Myron Hoeckle | ND | 1979 |
| Harold & Wesley Arnold | SD | 1979 |
| Ralph Neill | IA | 1979 |
| Morris Kuschel | MN | 1979 |
| Bert Hawkins | OR | 1979 |
| Dick Coon | WA | 1979 |
| Jerry Northcutt | MO | 1979 |
| Steve McDonnell | MT | 1979 |
| Doug Vandermyde | IL | 1979 |
| Norman, Denton, & Calvin Thompson | SD | 1979 |

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|---|---|---|
| Jess Kilgore | MT | 1980 |
| Robert & Lloyd Simon | IL | 1980 |
| Lee Eaton | MT | 1980 |
| Leo & Eddie Grubl | SD | 1980 |
| Roger Winn, Jr. | VA | 1980 |
| Gordon McLean | ND | 1980 |
| Ed Disterhaupt | MN | 1980 |
| Thad Snow | CAN | 1980 |
| Oren & Jerry Raburn | OR | 1980 |
| Bill Lee | KS | 1980 |
| Paul Moyer | MO | 1980 |
| G.W. Campbell | IL | 1981 |
| J.J. Feldmann | IA | 1981 |
| Henry Gardiner | KS | 1981 |
| Dan L. Weppler | MT | 1981 |
| Harvey P. Wehri | ND | 1981 |
| Dannie O'Connell | SD | 1981 |
| Wesley & Harold Arnold | SD | 1981 |
| Jim Russell & Rick Turner | MO | 1981 |
| Oren & Jerry Raburn | OR | 1981 |
| Orin Lamport | SD | 1981 |
| Leonard Wulf | MN | 1981 |
| Wm. H. Romersberter | IL | 1982 |
| Milton Krueger | MO | 1982 |
| Carl Odegard | MT | 1982 |
| Marvin & Donald Stoker | IA | 1982 |
| Sam Hands | KS | 1982 |
| Larry Campbel | KY | 1982 |
| Earl Schmidt | MN | 1982 |
| Raymond Josephson | ND | 1982 |
| Clarence Reutter | SD | 1982 |
| Leonard Bergen | CAN | 1982 |
| Kent Brunner | KS | 1983 |
| Tom Chrystal | IA | 1983 |
| John Freltag | WI | 1983 |
| Eddie Hamilton | KY | 1983 |
| Bill Jones | MT | 1983 |
| Harry & Rick Kline | IL | 1983 |
| Charlie Kopp | OR | 1983 |
| Duwayne Olson | SD | 1983 |
| Ralph Pederson | SD | 1983 |
| Ernest & Helen Schaller | MO | 1983 |
| Al Smith | VA | 1983 |
| John Spencer | CA | 1983 |
| Bud Wishard | MN | 1983 |
| Bob & Sharon Beck | OR | 1984 |
| Leonard Fawcett | SD | 1984 |
| Fred & Lee Kummerfeld | WY | 1984 |
| Norman Coyner & Sons | VA | 1984 |
| Franklyn Esser | MO | 1984 |
| Edgar Lewis | MT | 1984 |
| Boyd Mahrt | CA | 1984 |
| Neil Moffat | CAN | 1984 |
| William H. Moss, Jr. | GA | 1984 |
| Dennis P. Solvie | MN | 1984 |
| Robert P. Stewart | KS | 1984 |
| Charlie Stokes | NC | 1984 |
| Milton Wendland | AL | 1984 |
| Bob & Sheri Schmidt | MN | 1985 |
| Delmer & Joyce Nelson | IL | 1985 |
| Harley Brockel | SD | 1985 |
| Kent Brunner | KS | 1985 |
| Glenn Havery | OR | 1985 |
| John Maino | CA | 1985 |
| Ernie Reeves | VA | 1985 |
| John R. Rouse | WY | 1985 |
| George & Thelma Boucher | CAN | 1985 |

| | | |
|---|---|---|
| Kenneth Bentz | OR | 1986 |
| Gary Johnson | KS | 1986 |
| Ralph G. Lovelady | AL | 1986 |
| Ramon H. Oliver | KY | 1986 |
| Kay Richarson | FL | 1986 |
| Mr. & Mrs. Clyde Watts | NC | 1986 |
| David & Bev Lischka | CAN | 1986 |
| Dennis & Nancy Daly | WY | 1986 |
| Carl & Fran Dobitz | SD | 1986 |
| Charles Fariss | VA | 1986 |
| David Forster | CA | 1986 |
| Danny Geersen | SD | 1986 |
| Oscar Bradford | AL | 1987 |
| R.J. Mawer | CAN | 1987 |
| Rodney G. Oliphant | KS | 1987 |
| David Reed | OR | 1987 |
| Jerry Adamson | NE | 1987 |
| Gene Adams | GA | 1987 |
| Hugh & Pauline Maize | SD | 1987 |
| P.T. McIntire & Sons | VA | 1987 |
| Frank Disterhaupt | MN | 1987 |
| Mac, Don, & Joe Griffith | GA | 1988 |
| Jerry Adamson | NE | 1988 |
| Ken, Wayne, & Bruce Gardiner | CAN | 1988 |
| C.L. Cook | MO | 1988 |
| C.J. and D.A. McGee | IL | 1988 |
| William E. White | KY | 1988 |
| Frederick M. Mallory | CA | 1988 |
| Stevenson Family | OR | 1988 |
| Gary Johnson | KS | 1988 |
| John McDaniel | AL | 1988 |
| William Stegner | ND | 1988 |
| Lee Eaton | MT | 1988 |
| Larry D. Cundall | WY | 1988 |
| Dick & Phyllis Henze | MN | 1988 |
| Jerry Adamson | NE | 1989 |
| J.W. Aylor | VA | 1989 |
| Jerry Bailey | ND | 1989 |
| James G. Guyton | WY | 1989 |
| Kent Koostra | KY | 1989 |
| Ralph G. Lovelady | AL | 1989 |
| Thomas McAvory, Jr. | GA | 1989 |
| Bill Salton | IA | 1989 |
| Lauren & Mel Schuman | CA | 1989 |
| Jim Tesher | ND | 1989 |
| Joe Thielen | KS | 1989 |
| Eugene & Ylene Williams | MO | 1989 |
| Phillip, Patty, & Greg Bartz | MO | 1990 |
| John C. Chrisman | WY | 1990 |
| Les Herbst | KY | 1990 |
| Jon C. Ferguson | KS | 1990 |
| Mike & Dianna Hooper | OR | 1990 |
| James & Joan McKinlay | CAN | 1990 |
| Gilbert Meyer | SD | 1990 |
| DuWayne Olson | SD | 1990 |
| Raymond R. Peugh | IL | 1990 |
| Lewis T. Pratt | VA | 1990 |
| Ken and Wendy Sweetland | CAN | 1990 |
| Swen R. Swenson Cattle | TX | 1990 |
| Robert A Nixon & Sons | VA | 1991 |
| Murray A. Greaves | CAN | 1991 |
| James Hauff | ND | 1991 |
| J.R. Anderson | WI | 1991 |
| Ed and Rich Blair | SD | 1991 |
| Reuben & Connee Quinn | SD | 1991 |
| Dave & Sandy Umbarger | OR | 1991 |
| James A. Theeck | TX | 1991 |

James Hauff ................................. ND ..... 1991
J.R. Anderson .............................. WI ...... 1991
Ed and Rich Blair ......................... SD ...... 1991
Reuben & Connee Quinn .............. SD ...... 1991
Dave & Sandy Umbarger .............. OR ..... 1991
James A. Theeck .......................... TX ...... 1991
Ken Stielow ................................. KS ...... 1991
John E. Hanson, Jr. ....................... CA ..... 1991
Charles & Clyde Henderson ......... MO ..... 1991
Russ Green .................................. WY .... 1991
Bollman Farms ............................ IL ....... 1991
Craig Utesch ................................ IA ....... 1991
Mark Barenthsen .......................... ND ..... 1991
Rary Boyd ................................... AL ...... 1992
Charles Daniel ............................. MO ..... 1992
Jed Dillard ................................... FL ...... 1992
John & Ingrid Fairhead ................ NE ...... 1992
Dale J. Fischer ............................. IA ....... 1992
E. Allen Grimes Family ................ ND ..... 1992
Kopp Family ................................ OR ..... 1992
Harold, Barbara, & Jeff Marshall . PA ...... 1992
Clinton E. Martin & Sons ............ VA ..... 1992
Loyd and Pat Mitchell ................. CAN ... 1992
William Van Tassel ..................... CAN ... 1992
James A. Theeck .......................... TX ...... 1992
Aquilla M. Ward .......................... WV .... 1992
Albert Wiggins ............................ KS ...... 1992
Ron Wiltshire .............................. CAN ... 1992
Andy Bailey ................................. WY .... 1993
Leroy Beiterspacher ..................... SD ...... 1993
Glenn Valbaugh ........................... WY .... 1993
Oscho Deal .................................. NC ..... 1993
Jed Dillard ................................... FL ...... 1993
Art Farley .................................... IL ....... 1993
Jon Ferguson ................................ KS ...... 1993
Walter Hunsuker .......................... CA ..... 1993
Nola & Steve Kielboeker ............. MO ..... 1993
Jim Maier ..................................... SD ...... 1993
Bill & Jim Martin ........................ WV .... 1993
Ian & Adam McKillop .................. ON ..... 1993
George & Robert Pingetzer ........... WY .... 1993
Timothy D. Sufphin ..................... VA ..... 1993
James A. Theeck .......................... TX ...... 1993
Gene Thiry ................................... MB ..... 1993
Fran & Beth Dobitz ..................... SD ...... 1994
Bruce Hall ................................... SD ...... 1994
Lamar Ivey .................................. Al ....... 1994
Gordon Mau ................................ IA ....... 1994
Randy Mills ................................. KS ...... 1994
W.W. Oliver ................................ VA ..... 1994
Clint Reed .................................... WY .... 1994
Stan Sears .................................... CA ..... 1994
Walter Carlee ............................... AL ...... 1995
Nicholas Lee Carter ..................... KY ..... 1995
Charles C. Clark, Jr. ..................... VA ..... 1995
Greg & Mary Cunningham ........... WY .... 1995
Robert & Cindy Hine .................... SD ...... 1995
Walter Jr. & Evidean Major .......... KY ..... 1995
Delhert Ohnemus .......................... IA ....... 1995
Henry Stone ................................. CA ..... 1995
Joe Thielen .................................. KS ...... 1995
Jack Turnell ................................. WY .... 1995
Tom Woodard ............................... TX ...... 1995
Jerry and Linda Bailey .................. ND ..... 1996
Kory M. Bierle ............................ SD ...... 1996
Mavis Dummermuth ..................... IA ....... 1996
Terry Stuard Forst ......................... OK ..... 1996
Don W. Freeman .......................... AL ...... 1996
Lois & Frank Herbst ..................... WY .... 1996
Mr. & Mrs.George A. Horkan, Jr.. VA ..... 1996
David Howard .............................. IL ........ 1996
Virgil & Mary Jo Huseman ........... KS ...... 1996
Q.S. Leonard ................................ NC ...... 1996
Ken & Rosemary Mitchell ............ CAN ... 1996
James Sr., Jerry, & James Petlik ... SD ...... 1996
Ken Risler .................................... WI ...... 1996
Merlin Anderson .......................... KS ...... 1997
Joe C. Bailey ................................ NC ...... 1997
William R. "Bill" Brockett ............ VA ...... 1997
Howard McAdams, Sr.
Howard McAdams, Jr. ................. NC ...... 1997
Rob Orchard ................................. WY ..... 1997
David Petty .................................. IA ....... 1997
Rosemary Rounds &
Marc & Pam Scarborough ............. SD ...... 1997
Morey and Pat Van Hoecke .......... MN ..... 1997
Randy and Judy Mills .................. KS ...... 1998
Mike and Priscille Kasten ............ MO ..... 1998
Amana Farms, Inc. ........................ IA ....... 1998
Terry and Dianne Crisp ................ AB ...... 1998
Jim and Carol Faulstich ................ SD ...... 1998
James Gordon Fitzhugh ............... WY ..... 1998
John B. Mitchell ........................... VA ...... 1998
Holzapfel Family .......................... CA ...... 1998
Mike Kitley .................................. IL ........ 1998
Wallace & Donald Schilke ........... ND ...... 1998
Doug & Ann Deane &
Patricia R. Spearman .................... CO ...... 1998
Glenn Baumann ............................ ND ...... 1999
Bill Boston ................................... IL ........ 1999
C-J-R- Christensen Ranches .......... WY ..... 1999
Ken Fear, Jr. ................................. WY ..... 1999
Giles Family ................................. KS ...... 1999
Burt Guerrieri ............................... CO ...... 1999
Karlen Family ............................... SD ...... 1999
Deseret Ranches of Alberta ........... CAN ... 1999
Nick and Mary Klintworth ............ ND ...... 1999
MW Hereford Ranch .................... NE ...... 1999
Mossy Creek Farm ........................ VA ...... 1999
Iris, Bill, & Linda Lipscomb ......... AL ...... 1999
Amana Farms, Inc. ........................ IA ....... 2000
Tony Boothe ................................. AL ...... 2000
Glenn Clabaugh ............................ WY ..... 2000
Connie, John, & Terri Griffith .... KS ...... 2000
Frank B. Labato ........................... CO ...... 2000
Roger & Sharon Lamont &
Doug Shawn Lamont ................... SD ...... 2000
Bill and Claudia Tucker ................ VA ...... 2000
Wayne and Chip Unsicker ............ IL ........ 2000
Billy H. Bolding ........................... AL ...... 2001
Mike and Tom Endress ................. IL ........ 2001
Henry and Hank Maxey ................ VA ...... 2001
Paul McKee ................................. KS ...... 2001
3-R Ranch .................................... CO ...... 2002
Agri-Services Division, Oklahoma
Department of Corrections ........... OK ...... 2002
Alpine Farms ............................... VA ...... 2002
Amana Farms ............................... IA ....... 2002
Griffin Seedstock ......................... KS ...... 2002
Indian Knoll Cattle Co. ................. IL ........ 2002
Miles Land and Livestock ............ WY ..... 2002
Shovel Dot Ranch ......................... NE ...... 2002
Torbert Farms .............................. AL ...... 2002
White Farms ................................. IA ....... 2002
Voyles Farms ............................... IN ....... 2002
Clear Creek Cattle Company ......... WY ..... 2003
Crider Salers ................................ ND ...... 2003
Mike Goldwasser .......................... VA ...... 2003
Patterson Ranch ........................... CO ...... 2003
W.S. Roberts and Sons ................. IN ....... 2003
Shriver Farms .............................. OH ..... 2003
Stroud Farms ............................... AL ..... 2003
Tailgate Ranch Company ............. KS ...... 2003
Burkhalter Cattle .......................... AL ..... 2004
Doler Farm .................................. MS ..... 2004
LU Ranch .................................... WY .... 2004
Namminga Angus ......................... SD ...... 2004
Nellwood Farms ........................... GA ..... 2004
Olsen Ranches, Inc. ...................... NE ..... 2004
Prather Ranch
(Ralphs Ranches Inc.) ................... CA ..... 2004
Blair Porteus and Sons ................. OH ..... 2004
Rx Ranch ..................................... MO .... 2004
Schuette Farms ............................ Il ........ 2004
Valdez Ranches ........................... CO ..... 2004
Wickstrum Farms, Inc. ................. KS ...... 2004
CK Ranch .................................... KS ...... 2005
Diamond V Ranch. ....................... ND ..... 2005
Dover Ranch ................................ MT ..... 2005
Gaines Ranch .............................. AL ..... 2005
Hillwinds Farm ............................ VA ..... 2005
Krupps Farm ................................ IL ....... 2005
Jack & Ila Mae Larson ................. CO ..... 2005
Mule Creek Ranch ........................ KS ...... 2005
Paxton Ranch .............................. NE ..... 2005
Pontious Farms ............................ OH ..... 2005
Prather Ranch .............................. CA ..... 2005
Shovel Dot Ranch ......................... NE ..... 2005
Wintergreen Farm ........................ IA ....... 2005

# Commercial Producer of the Year

| | | |
|---|---|---|
| Chan Cooper | Montana | 1972 |
| Pat Wilson | Florida | 1973 |
| Lloyd Nygard | North Dakota | 1974 |
| Gene Gates | Kansas | 1975 |
| Ron Baker | Oregon | 1976 |
| Mary & Stephen Garst | Iowa | 1977 |
| Mose Tucker | Alabama | 1978 |
| Bert Hawkins | Oregon | 1979 |
| Jess Kilgore | Montana | 1980 |
| Henry Gardiner | Kansas | 1981 |
| Sam Hands | Kansas | 1982 |
| Al Smith | Virginia | 1983 |
| Bob & Sharon Beck | Oregon | 1984 |
| Glenn Harvey | Oregon | 1985 |
| Charles Fariss | Virginia | 1986 |
| Rodney G. Oliphant | Kansas | 1987 |
| Gary Johnson | Kansas | 1988 |
| Jerry Adamson | Nebraska | 1989 |
| Mike & Diana Hopper | Oregon | 1990 |
| Dave & Sandy Umbarger | Oregon | 1991 |
| Kopp Family | Oregon | 1992 |
| Jon Ferguson | Kansas | 1993 |
| Fran & Beth Dobitz | South Dakota | 1994 |
| Joe & Susan Thielen | Kansas | 1995 |
| Virgil & Mary Jo Huseman | Kansas | 1996 |
| Merlin & Bonnie Anderson | Kansas | 1997 |
| Mike & Priscilla Kasten | Missouri | 1998 |
| Randy & Judy Mills | Kansas | 1998 |
| Giles Family | Kansas | 1999 |
| Mossy Creek Farm | Virginia | 1999 |
| Bill & Claudia Tucker | Virginia | 2000 |
| Maxey Farms | Virginia | 2001 |
| Griffith Seedstock | Kansas | 2002 |
| Tailgate Ranch | Kansas | 2003 |
| Olsen Ranches, Inc. | Nebraska | 2004 |
| Prather Ranch. | California | 2005 |

# 2005 Commercial Producer of the Year
# Prather Ranch - California

*Prather Ranch is named the 2005 BIF Commercial Producer of the Year. Receiving the honor are (from left) Tom and Pat Hill, Philomath, Ore.; Mary and Jim Rickart, Fall River Mills, Calif.; and Daniel Drake, University of California.*

The Beef Improvement Federation honored Prather Ranch, Fall River Mills, Calif., with the 2005 Commercial Producer of the Year Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont.

The Prather Ranch is a vertically integrated cattle business that operates in five northern California counties. The ranch headquarters was founded in the 1870s and acquired by Walter Ralphs in 1964. Jim and Mary Rickert formed an association with the ranch in 1979.

The ranch operates a "closed herd" of 1,550 English crossbred cows. The cow herd is about 20% Angus, 20% Hereford and 60% black baldies. About 60% of the cows calve in the spring near Macdoel, Calif., for a natural beef program. The remaining 40% calve in the fall and are certified organic. The organic herd is maintained separately, summering in the Fall River Valley and wintering in the northern Sacramento Valley. This facilitates the unique marketing programs of the Prather Ranch.

This "closed herd" concept is based on the need to maximize biosecurity. Prather Ranch supplied bovine raw materials to various pharmaceutical companies and, as a requirement, extensive recordkeeping and standard operating procedures are in place. On the cow side, the herd was closed in 1975.

Since 1990, the herd has been bred by artificial insemination (AI) or ranch-raised bulls. The ranch has implemented and participates in a young sire progeny-testing program, known as Gen-Scan, by working with purebred breeders and the American Hereford and American Angus associations.

In 1995, the ranch built a USDA inspected on-site packinghouse and meat processing facility. The ranch direct-markets natural and organic dry-aged beef in southern Oregon and northern California. Prather Ranch Meat Co. also maintains a storefront in the San Francisco Ferry Building.

Prather Ranch was nominated by the University of California Agriculture and Natural Resources Cooperative Extension, Siskiyou County.

# 2006 BIF Commercial Producer Award Nominees

**Duck Farm, Inc.**
**Owner: Samuel and Nadine Wohlstadter**
**Manager: Kevin Powell, Cattle Manager**
**Virginia**

Duck Farm Inc. is located in the Hebron Valley of Madison County, Virginia and owned by Samuel and Nadine Wohlstadter. The cattle operation is managed by Kevin Powell of Somerset, Virginia; and Charlie Thornton of Radiant, Virginia, serves as consulting general manager for the operation. Mr. and Mrs. Wohlstatder started the operation in 1991 with the purchase of a 725 acre tract. The farm currently consists of 3,400 acres total with 2,000 acres of open land of which 1,600 acres is in pasture and hay production. Approximately, 1800 acres are set aside for wildlife habitat development and timber management. The cattle operation consists of 660 commercial Angus cows with approximately 230 cows calving in a 70 day season between February to April and 430 cows calving in a 70-day season from August to October.

Since the operation began in 1991, Duck Farm has focused on producing cattle that are consistently similar in growth, size, type, and have superior carcass traits. The utilization of the latest technology has been a major factor in Duck Farm's overall success in the area of computer records, electronic tags and ultrasound. These tools have been instrumental in making management decisions on a day to day basis. Duck Farm continually strives for improvement in all areas of the cattle operation such as optimizing weaning weights, conception rates, carcass traits, cow profitability and overall management.

Duck Farm Inc. was proudly nominated by the Virginia Beef Cattle Improvement Association.

**Hunt Hill Cattle Company**
**Owner: Cooper and Katie Hurst**
**Mississippi**

Cooper and Katie Hurst established Hunt Hill Cattle Company in 1995 south of Woodville, Mississippi in Wilkinson County. The 1,200-acre, cow-calf operation currently consists of approximately 400 commercial cows and first-calf heifers, which are based on high performance Angus, Hereford and Brahman genetics. Raised replacement heifers are bred to Angus bulls to produce 1/8 blood Brahman-influence calves that are shipped to feeding facilities. Retained ownership marketing programs incorporate the determinations of optimum harvest end points, grid marketing and risk management strategies. Calves are weaned in August and preconditioned for a minimum of 45 days on the ranch before being sent to a feed yard in September.

Extensive cow-calf production and financial records are kept to continually monitor and make needed management changes. Feedlot performance, carcass performance and associated financial data are collected and used to refine production and marketing practices. Intensive forage management results in a successful average stocking rate at Hunt Hill of 1.5 acres per cow over 550 acres of pasture.

Cooper and Katie Hurst's business plan for Hunt Hill Cattle Company places heavy emphasis on production and financial performance measures and benchmarks. Their initiation of progressive production and marketing alliances with area landowners and beef producers sets them apart as leaders in the commercial cattle business. Development of strong working relationships with partners throughout the production chain is an essential focus of Hunt Hill Cattle Company.

Hunt Hill Cattle Company was proudly nominated by the Mississippi Beef Cattle Improvement Association.

**McDorman Farms**
**Owners: Louis J., Louis H., and Janelle McDorman**
**Ohio**

McDorman Farms is located in Clark County in Southwestern Ohio. Previous generations of McDorman's (Louis J.'s grandfather) purchased the present homestead consisting of 625 acres in the 1920s. Additional acres were purchased in the 1960s and 1980s to make a total of 985 acres. Until the late 1950s, McDorman Farms fed feeder lambs and had a sow/pig operation. The farm had a small cow herd and fed out their own calves.

In the early 1960s Louis J McDorman began working for Sucher Packing Co. in Dayton, Ohio as a yard foreman, where he became interested in feeding cattle. For the next five years, Louis J. was a cattle buyer for Sucher Packing Company, gaining valuable cattle experience.

In the late 1960s Louis J. came back to the home farm and increased the cow herd and started feeding feeder calves. He increased the cow herd to 100 cows. The farm now has a Charolais/Angus/Hereford cross cow herd bred to purebred Angus Bulls. The calves are born in the spring and weaned in September. From initially feeding our own calves, the farm evolved into buying more and more feeder calves from sales in West Virginia. Then in the 1990s the farm started a retained ownership program, which is still utilized today. The farm feeds about 1,800 to 2,000 head yearly. About 1/3 to 1/2 of the cattle are fed under the retained ownership program. In the last few years the farm has been working with several cow-calf operators in Tennessee to develop an electronic identification program. This enables the producer to get data on the performance of their calves so the former owners in Tennessee can better manage and improve their herds.

Following graduation from Wilmington College in Ohio in the early 1990s, McDorman's son Louis H. was employed by the Henry C. Hitch Feedlot in Guymon, Oklahoma as a feed caller for five years. He then returned to the home farm and McDorman Farms increased their custom feeding program.

Today, the cows are an Angus based commercial herd of approximately 245 head that is rotationally grazed on 450 acres of managed pasture. In addition to the cattle, corn and soybeans are planted on 1,100 acres of the bottom ground located between the rolling pasture lands and there is another 200 acres in alfalfa hay raised on the farm.

The Ohio Cattlemen's Association are proud to nominate McDorman Farms.

**Pitchfork Farm**
**Owner: Ken and Sara Nimrick**
**Illinois**

Ken and Sara Nimrick of Stronghurst, Illinois, were the recipients of the Illinois Beef Association Commercial Producer of the Year Award at the IBA Annual Meeting held near Deer Grove, Illinois on Saturday, July 24. The Nimricks run a grain and commercial beef cattle operation consisting of 220 cow-calf pairs and 35 replacement heifers on 340 acres of permanent and rotational pasture. They have been on the same farm in Henderson County since 1971 on land that has been in Sara's family since 1852.

An area in which the herd excels is reproduction management through the use of estrus synchronization, AI of their replacement heifers, and limiting the length of the breeding season for the mature cowherd. Whereas many herds have continued to move their calving dates earlier, the Nimricks calve in the late spring from late April to late June. This results in a number of their heifers and all their cows calving strictly on pasture. Their genetic program for the past ten years have centered around the use of composite bulls consisting of 50-75% Angus or Red Angus and 25-50% Simmental or Gelbvieh. This has resulted in a majority of the cowherd being of similar genetic composition and greatly simplified their crossbreeding program.

Individuals who have had the opportunity to visit the Nimrick beef cattle operation realize that Ken is extremely knowledgeable about his operation and the overall goals of a successful cow-calf enterprise. Ken Nimrick summarizes the goals of his operations in what could be identified as a "mission statement." Areas he concentrates on are *"To maintain reproductive rates, while controlling feed and overhead expenses by improving and managing pastures, minimizing machinery and building expenses, utilizing a low cost wintering program, and grazing as many days of the year as possible."*

He further elaborates that , "*Investments in pastures, genetics, and preventive health have been the most cost effective."* Also his efforts in genetics are geared toward, *"Improving convenience and carcass traits since the reproductive and growth traits are now adequate."*

Ken Nimrick is also known as Dr. Nimrick to his students at Western Illinois University where he serves as Beef Cattle Professor in the Agriculture Department. Since Ken is gone a number of days, assistance is provided by the Nimrick's daughter and son-in-law, Kristin and Alan Durkee of Stronghurst. This help allows him to share his many years of practical experience and expertise with future producers and leaders of the Illinois beef cattle industry.

The Illinois Beef Association and the University of Illinois Extension are proud to nominate the Pitchfork Farm.

**Rock Creek Ranch**
**Owners: Jim and Jean Houck & Jeff and Lori Houck**
**Kansas**

Rock Creek Ranch has been owned and operated by the Houck family since 1909, when Roy C. Houck purchased 600 acres in northwest Lyon County. Additional land since has been added to the ranch, but the original acreage remains the headquarters and is the home of Roy Houck's grandson, Jim and his wife, Jean. Jim and Jean and their son and daughter-in-law, Jeff and Lori, manage Rock Creek Ranch. Jeff and Lori live south of Bushong, KS, where Jeff's grandfather, DeWitt Houck, was raised.

Rock Creek Ranch now consists of mainly black Simmental cattle and encompasses 3,800 acres of family-owned native Flint Hills grassland. The cowherd consists of 500 head of Simmental and SimAngus females. The 360 spring cows begin calving March 1 and are targeted for an October weaning date. The spring herd is run on grass year round with limited protein supplementation. The 140 fall cows begin calving September 1 and are targeted for an early June weaning date. All females are developed and bred. Those not retained by the ranch are marketed as bred females. Fifty to 60 head of bulls are sold by private treaty to area commercial breeders. The steer calves are sold in load lots to progressive feeders.

Rock Creek Ranch strives to maximize production of the cowherd while keeping net profit in mind. The grass quality has been, and will continue to be, one of the top priorities. Conservation of land and grass, along with water quality and wildlife management also are top-of-mind issues for the ranch.

The Rock Creek Ranch was proudly nominated by the Kansas Livestock Association.

**Sutherland Ranches**
**Owner: Virginia and Lynn Sutherland**
**Colorado**

The Sutherland Ranch is owned and has been operated by a mother/daughter team since the death of husband /father, Vinis H. Sutherland in April of 1990. Originally, the 3,000 deeded acres were part of the William and May Whitten 7000+ acre Ranch. Virginia is the second generation operator, and her daughter, Lynn is the third. The base herd of 250 cows was drastically cut to 60 cows and 30 heifers in July, 2003 due to the years of drought. This year they have rebuilt to 120 cows and 30 heifers. This herd has been a closed herd since the 1920's, using only home-raised heifers for replacements, and buying registered bulls. The old Whitten Ranch was predominently a sheep ranch, and Virgina became the cowhand at the age of l7,when her brothers went to fight in WWII. After graduation from University of Colorado, she worked in Denver and in 1950, married Vinis "Sut " Sutherland, who had come to Saguache to work for the US Forest Service after being wounded at Tarawa. In 1951, they began managing the 200 mother cow herd that ran on part of the Whitten ranch, southeast of Saguache, and summered on ranges west of Saguache. Lynn grew up around cattle, moving from summer to winter ranch. In 1972, Virginia and her brother, George divided the Whitten ranch, and the Sutherland Ranch was born. In 1988, they purchased some Gelbvieh bulls and a few cows, after feeling forced to crossbreed to gain more marketable calf pounds. Calving is February-April, and Lynn tags and moves every new calf to another pasture. Calves are marketed through local salebarns after a preconditioning program.

The Colorado Cattlemen’s Association are proud to nominate the Sutherland Ranches.

**Van Waardhuizen, Inc.**
**Owner: Keith and Julie Van Waardhuizen**
**Iowa**

Van Waardhuizen, Inc. is a first-generation livestock and crops farm located in south central Iowa near Oskaloosa. The operation was started in 1984 by Keith and Julie Van Waardhuizen. They presently have an Angus-based commercial cow herd, 700 crop acres, 150 acres of alfalfa and grass hay, 350 acres of timber and pasture, and a custom hog feeding enterprise.

The cow herd consists of 135 commercial Angus cows, which are bred to Angus bulls that are all full-blood brothers. The Van Waardhuizens strive for a consistent and uniform calf crop. AI-bred heifers from the same sire are purchased as replacements from the same ranch each year. The cow herd calves in February.

Cool-season grass pastures are rotationally grazed and stocked at 25 to 30 head at each location in the summer. The calves are weaned late summer in the pasture and the cows are gathered in the fall and pastured on cornstalks until it snows. The cows are then brought to the home farm for calving and kept in a dry lot until spring green up of pastures.

All the calves are sold on a high quality grid after being finished in the Van Waardhuizens’ feedlot. In addition they feed about 1,000 head of purchased cattle per year. Keith and Julie use EID tags to track their cattle and receive carcass data on each year’s calf crop to help with improvements in their beef herd.

The Van Waardhuizens are active in their community and church. They have hosted many visitors to their cattle operation and participated in several NRCS projects to protect their land and water resources.

The Iowa Cattlemen’s Association is proud to nominate Van Waardhuizen, Inc.

# BIF Ambassador Award Recipients

| | | |
|---|---|---|
| Warren Kester | BEEF Magazine, *Minnesota* | 1986 |
| Chester Peterson | Simmental Shield, *Kansas* | 1987 |
| Fred Knop | Drovers Journal, *Kansas* | 1988 |
| Forrest Bassford | Western Livestock Journal, *Colorado* | 1989 |
| Robert C. DeBaca | The Ideal Beef Memo, *Iowa* | 1990 |
| Dick Crow | Western Livestock Journal, *Colorado* | 1991 |
| J.T. "Johnny" Jenkins | Livestock Breeder Journal, *Georgia* | 1993 |
| Hayes Walker, III | America's Beef Cattleman, *Kansas* | 1994 |
| Nita Effertz | Beef Today, *Idaho* | 1995 |
| Ed Bible | Hereford World, *Missouri* | 1996 |
| Bill Miller | Beef Today, *Kansas* | 1997 |
| Keith Evans | American Angus Association, *Missouri* | 1998 |
| Shauna Rose Hermel | Angus Journal & BEEF Magazine, *Missouri* | 1999 |
| Wes Ishmael | Clear Point Communications, *Texas* | 2000 |
| Greg Hendersen | Drovers, *Kansas* | 2001 |
| Joe Roybal | BEEF Magazine, *Minnesota* | 2002 |
| Troy Marshall | Seedstock Digest, *Missouri* | 2003 |
| Kindra Gordon | Freelance Writer, *South Dakota* | 2004 |
| Steve Suther | Certified Angus Beef, LLC, *Kansas* | 2005 |

# 2005 BIF Ambassador Award
# Steve Suther – Kansas

*Steve Suther (right), director of industry information for Certified Angus Beef LLC, receives the Ambassador Award from 2005 BIF President Jimmy Holliman.*

The Beef Improvement Federation named Steve Suther recipient of its 2005 Ambassador Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The honor is given to a member of the media each year for that individual's efforts to help cattle producers understand cattle performance testing and genetic prediction tools.

Suther, director of industry information for Certified Angus Beef LLC (CAB), has almost 30 years of experience as an agricultural journalist and is a regular contributor to numerous beef industry publications. In addition to feature articles on beef producers and production issues, Suther authors a monthly column called "Black Ink" that focuses on profitable cattle production through the use of genetic selection tools, as well as through proper management and marketing. His column is regularly carried by more than 50 publications and reaches approximately 650,000 U.S. beef producers each month.

Suther has long championed the use of performance testing as a means of improving beef cow productivity and efficiency, often practicing what he writes on the farm he and his wife, Anne, own and operate near Onaga, Kan. A 1976 graduate of Kansas State University (K-State), Suther began his career writing for Grass & Grain, a regional publication in Manhattan, Kan. He completed his master's degree in journalism from K-State in 1984 and continued to write about the beef industry for numerous national publications, including Farm Journal's Beef Today, of which he became editor in 1996.

Throughout his career, Suther has strived to deliver information to producers that would help them increase profitability by improving efficiency. Suther was the first beef journalist to create and host a beef discussion site on the Internet, allowing producers from around the world to share information to improve land and cattle management to more efficiently and profitably produce beef. He continues to host a similar site for producers in his current position with CAB.

Suther's writing ability hasn't gone unrecognized. He has received at least one first-place writing award from the Livestock Publications Council (LPC) each year since 1997. Suther currently serves on the LPC board of directors.

Today, Suther and his family manage 125 Angus-based cows on their farm, using artificial insemination (AI) to improve the quality of replacement heifers selected for their cow herd. Since 1999, calves have been retained and finished in a commercial feedlot, which provides individual animal carcass performance. Proof that what he writes actually works in the real world is the fact that 46% of his retained calves qualified for the CAB program last year, compared to only 10% in 1999.

Steve and Anne have three children: Shea, 21; Frankie, 15; and Tom, 12.

# BIF Continuing Service Award Recipients

| | | |
|---|---|---|
| Clarence Burch | Oklahoma | 1972 |
| F. R. Carpenter | Colorado | 1973 |
| Robert DeBaca | Iowa | 1973 |
| E.J. Warwick | Washington, D.C. | 1973 |
| Frank H. Baker | Oklahoma | 1974 |
| D.D. Bennett | Oregon | 1974 |
| Richard Willham | Iowa | 1974 |
| Larry V. Cundiff | Nebraska | 1975 |
| Dixon D. Hubbard | Washington, D.C. | 1975 |
| J. David Nichols | Iowa | 1975 |
| A.L. Eller, Jr. | Virginia | 1976 |
| Ray Meyer | South Dakota | 1976 |
| Lloyd Schmitt | Montana | 1977 |
| Don Vaniman | Montana | 1977 |
| James S. Brinks | Colorado | 1978 |
| Martin Jorgensen | South Dakota | 1978 |
| Paul D. Miller | Wisconsin | 1978 |
| C.K. Allen | Missouri | 1979 |
| William Durfey | NAAB | 1979 |
| Glenn Butts | PRI | 1980 |
| Jim Gosey | Nebraska | 1980 |
| Mark Keffeler | South Dakota | 1981 |
| J.D. Mankin | Idaho | 1982 |
| Art Linton | Montana | 1983 |
| James Bennett | Virginia | 1984 |
| M.K. Cook | Georgia | 1984 |
| Craig Ludwig | Missouri | 1984 |
| Jim Glenn | IBIA | 1985 |
| Dick Spader | Missouri | 1985 |
| Roy Wallace | Ohio | 1985 |
| Larry Benyshek | Georgia | 1986 |
| Ken W. Ellis | California | 1986 |
| Earl Peterson | Montana | 1986 |
| Bill Borror | California | 1987 |
| Jim Gibb | Missouri | 1987 |
| Daryl Strohbehn | Iowa | 1987 |
| Bruce Howard | Canada | 1988 |
| Roger McCraw | North Carolina | 1989 |
| Robert Dickinson | Kansas | 1990 |
| John Crouch | Missouri | 1991 |
| Jack Chase | Wyoming | 1992 |
| Leonard Wulf | Minnesota | 1992 |
| Robert McGuire | Alabama | 1993 |
| Charles McPeake | Georgia | 1993 |
| Henry W. Webster | South Carolina | 1993 |

| | | |
|---|---|---|
| Bruce E. Cunningham | Montana | 1994 |
| Loren Jackson | Texas | 1994 |
| Marvin D. Nichols | Iowa | 1994 |
| Steve Radakovich | Iowa | 1994 |
| Doyle Wilson | Iowa | 1994 |
| Paul Bennett | Virginia | 1995 |
| Pat Goggins | Montana | 1995 |
| Brian Pogue | Canada | 1995 |
| Doug L. Hixon | Wyoming | 1996 |
| Harlan D. Ritchie | Michigan | 1996 |
| Glenn Brinkman | Texas | 1997 |
| Russell Danielson | North Dakota | 1997 |
| Gene Rouse | Iowa | 1997 |
| Keith Bertrand | Georgia | 1998 |
| Richard Gilbert | Texas | 1998 |
| Burke Healey | Oklahoma | 1998 |
| Bruce Golden | Colorado | 1999 |
| John Hough | Georgia | 1999 |
| Gary Johnson | Kansas | 1999 |
| Norman Vincil | Virginia | 1999 |
| Ron Bolze | Kansas | 2000 |
| Jed Dillard | Florida | 2000 |
| William Altenburg | Colorado | 2001 |
| Kent Andersen | Colorado | 2001 |
| Don Boggs | South Dakota | 2001 |
| S.R. Evans | Mississippi | 2002 |
| Galen Fink | Kansas | 2002 |
| Bill Hohenboken | Virginia | 2002 |
| Sherry Doubet | Colorado | 2003 |
| Ronnie Green | Virginia | 2003 |
| Connee Quinn | Nebraska | 2003 |
| Ronnie Silcox | Georgia | 2003 |
| Chris Christensen | South Dakota | 2004 |
| Robert "Bob" Hough | Texas | 2004 |
| Steven M. Kappes | Nebraska | 2004 |
| Richard McClung | Virginia | 2004 |
| Jerry Lipsey | Montana | 2005 |
| Micheal MacNeil | Montana | 2005 |
| Terry O'Neill | Montana | 2005 |
| Robert Williams | Missouri | 2005 |

# 2005 BIF Continuing Service Award
# Jerry Lipsey – Montana

The Beef Improvement Federation honored Jerry Lipsey with its Continuing Service Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals for their service to the organization and to the beef industry.

*Jerry Lipsey (right), ASA executive vice president, receives a Continuing Service Award from 2005 BIF President Jimmy Holliman.*

Jerry Lipsey has made a significant impact on the beef industry as a highly respected animal scientist and college professor, diligent and skilled breed association executive, innovator, and loyal friend of seedstock and commercial cattlemen.

As executive vice president of the American Simmental Association (ASA) since 1996, Lipsey has provided thoughtful and effective leadership at a critical time to the organization's future. He has worked tirelessly to open lines of communication with researchers, universities, feeders, packers and other entities involved in beef production. The fact that the ASA continues to be widely respected as a leader and trailblazer clearly illustrates his effectiveness. He is credited for positioning ASA on the forefront of the beef industry, particularly in areas of carcass merit and calving ease.

Raised on a Shorthorn operation in Michigan, Lipsey followed his dream to study at Michigan State University and Kansas State University and then to be a faculty member at the University of Missouri. As a judging team coach and teacher, he became a trusted friend to thousands of students, many of whom remain in touch.

During a four-year term with the American Angus Association, he directed the Association's youth program and was instrumental in establishing the highly successful Certified Angus Beef (CAB) program.

Lipsey has been a strong supporter of BIF, participating in the annual meeting as speaker or moderator on several occasions.

A devoted family man, Lipsey and his wife, Peggy, are proud parents of two married children, Jason and Amanda.

# 2005 BIF Continuing Service Award
# Michael MacNeil – Montana

*Michael MacNeil (right) of the USDA-ARS Fort Keogh Livestock and Range Research Laboratory, Miles City, Mont., receives a Continuing Service Award from 2005 BIF President Jimmy Holliman.*

The Beef Improvement Federation honored Michael MacNeil with its Continuing Service Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals for their service to the organization and to the beef industry.

Currently an animal research geneticist at the U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) Fort Keogh Livestock and Range Research Laboratory located near Miles City, Mont., MacNeil was born in Warsaw, N.Y., in 1952. He and his two sisters and brother grew up in Ithaca, N.Y., where his father served as men's basketball coach at Cornell University.

MacNeil's college received a bachelor's degree in agriculture science from Cornell in 1974, a master's degree in animal science from Montana State University in 1977, and a doctorate in animal breeding from South Dakota State University in 1982. Prior to arriving at Fort Keogh in 1989, MacNeil served as a statistician and research animal scientist at the USDA-ARS Roman L. Hruska U.S. Meat Animal Research Center (MARC) near Clay Center, Neb. He and his wife, Betty, have two children, Megan and Brendon.

Throughout his career, MacNeil's work has focused on developing genetic selection technologies that assist the beef cattle industry in their continuing quest to improve quality of beef products produced and economic efficiencies and profitability of production.

MacNeil has worked closely with numerous breed associations, groups such as BIF, BeefBoosters Cattle Ltd., Circle A Angus Sire Alliance, and several state university Extension services, as well as a host of international agencies and universities in his quest to provide scientifically sound, user-friendly technologies for beef improvement.

# 2005 BIF Continuing Service Award
# Terry O'Neill – Montana

The Beef Improvement Federation honored Terry O'Neill with its Continuing Service Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals for their service to the organization and to the beef industry.

*Terry O'Neill (right), Tomahawk Land and Cattle, receives a Continuing Service Award from 2005 BIF President Jimmy Holliman.*

O'Neill started Tomahawk Land and Cattle in 1979. The operation prides itself on being a one-stop source for profitable crossbreeding, with sales of Limousin, Lim-Flex and Angus bulls approaching 200 head per year. Most recently, Piedmontese have been added to the breeding program.

The mission statement of Tomahawk Land and Cattle is to offer focus, direction and opportunity to forward-thinking, profit-minded producers interested in breeding and growing ideal feeder calves and replacement females for consumer-driven niche markets. Through "planned genetics" based on accurate expected progeny differences (EPDs) for performance and carcass traits, Tomahawk provides specific genetics for crossbreeding to consistently help customers achieve efficient production of profitable, high-yielding, tender, palatable beef products.

Along with owning Tomahawk Land and Cattle, O'Neill serves as vice president of cattle procurement for Montana Ranch Brand Natural Meats. In his current position, O'Neill oversees acquisition of more than 10,000 head of Lim-Flex feeder cattle annually. Terry's background as co-owner and founding board member of the Western Beef Alliance makes him ideally suited for his position with Montana Ranch Brand.

O'Neill is is a graduate of Virginia Tech, with a bachelor's degree in industrial engineering and an MBA. In 1998, he was named Commercial Marketing Booster of the Year by the North American Limousin Foundation (NALF), where he also currently serves as a member of the board of directors. Through the years, O'Neill has been an active member of the Montana and Wyoming Stockgrowers' associations. He is a retiring member of the BIF board of directors.

# 2005 BIF Continuing Service Award
# Robert Williams – Missouri

*Robert Williams (right), AICA director of breed improvement and foreign marketing, receives a Continuing Service Award from 2005 BIF President Jimmy Holliman.*

The Beef Improvement Federation honored Robert Williams with its Continuing Service Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals for their service to the organization and to the beef industry.

Williams, who serves as director of breed improvement and foreign marketing for the American-International Charolais Association (AICA), was raised on a diversified family ranching operation at Freedom, Okla. The operation included a commercial cow herd in addition to wheat and other crops.

He attended Oklahoma State University (OSU), where he was a member of Block and Bridle, the horse judging team and a national champion livestock judging team. He received his bachelor's in animal science in 1982. In 1992, after spending 10 years employed in the livestock industry, he entered the graduate program in Animal Breeding and Genetics in the Department of Animal Sciences at the University of Georgia. He completed his M.S. degree in 1995 under co-advisors Keith Bertrand, Ph.D. and Larry Benyshek, Ph.D. and completed his Ph.D. under the supervision of Bertrand in 2002.

After graduation from Oklahoma State University he served as a Classifier and Director of Junior Programs for Beefmaster Breeders Universal, San Antonio, Texas, until 1987 when he accepted the manager position at Still Hills Beefmasters, Fort Payne, Alabama. In addition to his management duties at Still Hills he maintained his own registered herd and was recognized as the 1991 and 1996 Southeastern Breeder of the Year.

Williams joined the staff of the American-International Charolais Association in 1998 as Director of Breed Improvement and Foreign Marketing Programs. Through a joint agreement, Williams also served as Director of Breed Improvement Programs for the Canadian Charolais Association from 1998 through 2001. He is responsible for the development of programs aimed at enhancing the genetic evaluation of measurable phenotypic traits. Under his leadership, AICA has doubled the number of traits for which EPD are published and introduced the beef industry's first web-based interactive and customizable Selection Index in North America. Other duties include oversight for structured sire evaluation programs and international marketing programs for the association. He was instrumental in the development of whole herd registration and performance guidelines for AICA.

He has served BIF as a board of director and also as a member or chairman of several committees including current Chairman of the Live Animal, Carcass and End Product Committee and Chairman of the committee for the most recent revision (8th Edition) of the BIF Standardized Guidelines. He is currently serving on the committee to write DNA Standardized Guidelines for BIF. Williams was also a recipient of the Frank Baker Memorial Scholarship Award in 1997.

An active, certified ultrasound technician from 1993 through 1998 Williams later served on the APTC Ultrasound Certification committee from 1999 through 2001. He was instrumental in the organization of the Ultrasound Guidelines Council which is currently responsible for the certification of field and laboratory ultrasound technicians for the beef industry and has served as its chairman since 2003.

Williams has spent his career in pursuit of genetic improvement of livestock and is a vocal supporter for the core principles of the Beef Improvement Federation. Dr. Williams and his wife, Nancy, have been married 15 years, and have four children, Eric, Shannon and twins Shane and Grant.

# BIF Pioneer Award Recipients

| | | |
|---|---|---|
| Jay L. Lush | Iowa | 1973 |
| Reuben Albaugh | California | 1974 |
| Charles E. Bell, Jr. | USDA | 1974 |
| John H. Knox | New Mexico | 1974 |
| Paul Pattengale | Colorado | 1974 |
| Fred Wilson | Montana | 1974 |
| Ray Woodward | ABS | 1974 |
| Glenn Butts | PRT | 1975 |
| Keith Gregory | MARC | 1975 |
| Braford Knapp, Jr. | USDA | 1975 |
| Forrest Bassford | Western Livestock Journal | 1976 |
| Doyle Chambers | Louisiana | 1976 |
| Mrs. Waldo Emerson Forbes | Wyoming | 1976 |
| C. Curtis Mast | Virginia | 1976 |
| Ralph Bogart | Oregon | 1977 |
| Henry Holsman | South Dakota | 1977 |
| Marvin Koger | Florida | 1977 |
| John Lasley | Florida | 1977 |
| W. L. McCormick | Georgia | 1977 |
| Paul Orcutt | Montana | 1977 |
| J.P. Smith | Performance Registry Int'l | 1977 |
| H.H. Stonaker | Colorado | 1977 |
| James B. Lingle | Wye Plantation | 1978 |
| R. Henry Mathiessen | Virginia | 1978 |
| Bob Priode | Virginia | 1978 |
| Robert Koch | MARC | 1979 |
| Mr. & Mrs. Carl Roubicek | Arizona | 1979 |
| Joseph J. Urick | USDA | 1979 |
| Richard T. "Scotty" Clark | USDA | 1980 |
| Bryon L. Southwell | Georgia | 1980 |
| F.R. "Ferry" Carpenter | Colorado | 1981 |
| Otha Grimes | Oklahoma | 1981 |
| Milton England | Texas | 1981 |
| L.A. Moddox | Texas | 1981 |
| Charles Pratt | Oklahoma | 1981 |
| Clyde Reed | Oklahoma | 1981 |
| Gordon Dickerson | Nebraska | 1982 |
| Mr. & Mrs. Percy Powers | Texas | 1982 |
| Jim Elings | California | 1983 |
| W. Dean Frischknecht | Oregon | 1983 |
| Ben Kettle | Colorado | 1983 |
| Jim Sanders | Nevada | 1983 |
| Carroll O. Schoonover | Wyoming | 1983 |
| Bill Graham | Georgia | 1984 |
| Max Hammond | Florida | 1984 |

| | | |
|---|---|---|
| Thomas J. Marlowe | Virginia | 1984 |
| Mick Crandell | South Dakota | 1985 |
| Mel Kirkiede | North Dakota | 1985 |
| Charles R. Henderson | New York | 1986 |
| Everett J. Warwick | USDA | 1986 |
| Glenn Burrows | New Mexico | 1987 |
| Carlton Corbin | Oklahoma | 1987 |
| Murray Corbin | Oklahoma | 1987 |
| Max Deets | Kansas | 1987 |
| Christian A. Dinkle | South Dakota | 1988 |
| George F. & Mattie Ellis | New Mexico | 1988 |
| A.F. "Frankie" Flint | New Mexico | 1988 |
| Roy Beeby | Oklahoma | 1989 |
| Will Butts | Tennessee | 1989 |
| John W. Massey | Missouri | 1989 |
| Donn & Sylvia Mitchell | Canada | 1990 |
| Hoon Song | Canada | 1990 |
| Jim Wilton | Canada | 1990 |
| Bill Long | Texas | 1991 |
| Bill Turner | Texas | 1991 |
| Frank Baker | Arkansas | 1992 |
| Ron Baker | Oregon | 1992 |
| Bill Borror | California | 1992 |
| Walter Rowden | Arkansas | 1992 |
| James D. Bennett | Virginia | 1993 |
| M.K. "Curly" Cook | Georgia | 1993 |
| O'Dell G. Daniel | Georgia | 1993 |
| Hayes Gregory | North Carolina | 1993 |
| Dixon Hubbard | USDA | 1993 |
| James W. "Pete" Patterson | North Dakota | 1993 |
| Richard Willham | Iowa | 1993 |
| Tom Chrystal | Iowa | 1994 |
| Robert C. DeBaca | Iowa | 1994 |
| Roy A. Wallace | Ohio | 1994 |
| James S. Brinks | Colorado | 1995 |
| Robert E. Taylor | Colorado | 1995 |
| A.L. "Ike" Eller | Virginia | 1996 |
| Glynn Debter | Alabama | 1996 |
| Larry V. Cundiff | Nebraska | 1997 |
| Henry Gardiner | Kansas | 1997 |
| Jim Leachman | Montana | 1997 |
| John Crouch | Missouri | 1998 |
| Bob Dickinson | Kansas | 1998 |
| Douglas MacKenzie Fraser | Alberta | 1998 |
| Joseph Graham | Virginia | 1999 |
| John Pollak | New York | 1999 |
| Richard Quaas | New York | 1999 |
| J. David Nichols | Iowa | 2000 |

| | | |
|---|---|---|
| Harlan Ritchie | Michigan | 2000 |
| Robert R. Schalles | Kansas | 2000 |
| Larry Benyshek | Georgia | 2001 |
| Minnie Lou Bradley | Texas | 2001 |
| Tom Cartwright | Texas | 2001 |
| H.H. “Hop” Dickenson | Kansas | 2002 |
| Martin & Mary Jorgensen | South Dakota | 2002 |
| L. Dale Van Vleck | Nebraska | 2002 |
| George Chiga | Oklahoma | 2003 |
| Burke Healey | Oklahoma | 2003 |
| Keith Zoellner | Kansas | 2003 |
| Frank Felton | Missouri | 2004 |
| Tom Jenkins | Nebraska | 2004 |
| Joe Minyard | South Dakota | 2004 |
| Jack and Gini Chase | Wyoming | 2005 |
| Jack Cooper | Montana | 2005 |
| Dale Davis | Montana | 2005 |
| Les Holden | Montana | 2005 |
| Don Kress | Montana | 2005 |

# 2005 BIF Pioneer Award
# Jack and Gini Chase – Wyoming


*BIF President Jimmy Holliman (left) presents the Pioneer Award to Gini and Jack Chase of Buffalo Creek Red Angus, Leiter, Wyo.*

The Beef Improvement Federation honored Jack and Gini Chase, Leiter, Wyo., with the Pioneer Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals who have made lasting contributions to the improvement of beef cattle.

Jack and Gini Chase own and operate Buffalo Creek Red Angus. Initially run as a commercial cow-calf operation, Jack took over management of the 34,000-acre ranch in spring 1961, with Gini joining him in 1963 upon their marriage. Their first Red Angus bulls were purchased from Beckton Stock Farm, Sheridan, Wyo. One of these bulls was put in a single-sire pasture with a group of black cows. The next fall the resulting calves outweighed everything else on the ranch, and the course was set for Buffalo Creek.

Buffalo Creek's purebred program began in 1972, when Gini purchased a small number of purebred cows from Morris Dixon. Later, cows were purchased from Landrey's, Beckton and Mid-America. The Chases' management and philosophy is dictated by their commercial origins, and they consider the commercial producer their primary customer.

The Buffalo Creek program is to raise the most productive cattle possible with the least amount of inputs. Cattle have to be well-balanced for calving ease, growth (which includes mature size) and carcass traits. They must be fertile, reaching sexual maturity at an early age. Females must conceive within a 45-day breeding season every year in order to stay in the herd. All bred females calve out in the pastures in May and June, with the Chases checking the herd twice a day to weigh and tag newborns. Except very old cows and cows known to be carrying twins, females are wintered out, with no supplemental feed except minerals.

"We intend to keep within the profitable boundaries and to produce a product that is consistently uniform, easy and efficient to raise, maintain and feed out, with an end result that is tender and delicious for the consumer," the Chases say.

Both Jack and Gini are active leaders in the beef industry. Both have served on the board of directors of BIF and the Red Angus Association of America (RAAA), with Jack serving as president of both organizations and Gini as vice president of RAAA. Gini was also on the RAAA Strategic Planning Committee that recommended the implementation of Total Herd Reporting and a Commercial Marketing Program. The Chases were founding members of the Wyoming Beef Cattle Improvement Association (WBCIA), with Jack serving as president. From the RAAA, they have twice been named Breeder of the Year, received the Distinguished Service Award and were named Pioneer Breeder of the Year.

# 2005 BIF Pioneer Award
# Jack Cooper – Montana

*Montana Hereford breeders Jack Cooper and Les Holden receive Pioneer awards from 2005 BIF President Jimmy Holliman (left). Receiving the awards are (continuing from left) Jack Holden, Jack Cooper, Christy Cooper and Mark Cooper.*

The Beef Improvement Federation honored Jack Cooper, Willow Creek, Mont., with the Pioneer Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals who have made lasting contributions to the improvement of beef cattle.

In 1946 Jack Cooper inherited the ranch near Willow Creek that his father, Frank, had purchased in 1913. Growing hay and grain, Jack also ran commercial cattle and sheep for a time. In 1947, at the encouragement of his brother-in-law Ray Woodward, he purchased 40 Line One Hereford heifers from the Fort Keogh Livestock and Range Research Laboratory in Miles City, Mont. At the time, Line One Herefords were either little known or frowned upon, but performance traits were the main factor of the breed. For 15 years, the station had been breeding the line from Advance Domino 13th, the progenitor of Line One Herefords. Woodward was project leader.

In 1948, Jack married Phyllis Garcelon. Their children are Robert, Mark and Lois.

Jack began number-branding and performance testing his cattle, using his precise records to breed animals with desirable traits. By the time the Montana Beef Performance Association (MBPA) was formed in the late 1950s, with Jack as a charter member, he had 10 years of experience with Line One Herefords and performance testing. Jack later joined the American Hereford Association (AHA) Total Performance Records (TPR) program in 1960.

After receiving considerable recognition for their dedication to performance testing, Jack and his half-brother Les Holden hosted a joint auction in April 1967 to market their bull calves. At that first sale in Great Falls, Mont., they sold 38 yearling bulls for an average of $664 each. By the time of the last joint auction, in 1979, their sale averaged $12,887, setting a new record for a Hereford bull sale. They began to host their sales individually in 1980.

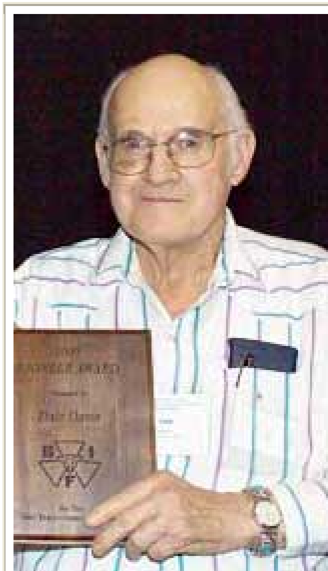
Performance testing has been a vital tool for the Coopers. In 1975 the average 205-day weight on all calves (without creep-feeding) was 563 pounds (lb.), while the average 365-day weight was 958 lb. By 2005, the 205-day average and the 365-day average grew to 700 lb. and 1,277 lb., respectively. Today, the cattle are still being selected for model birth weight, and Mark Cooper continues to add performance, milk and positive carcass traits to his herd.

The Cooper-Holden influence has spread. Recent AHA sire summaries show 16% of the highest-ranking Hereford sires tested in the United States are from the Cooper and Holden herds.

Jack Cooper has served six years on the MBPA board of directors. He has received a number of awards, including 1975 Outstanding Cattleman by Gallatin Beef Producers, 1975 BIF Seedstock Breeder of the Year, 1979 Agriculture Recognition Award by Bozeman Chamber of Commerce and 1980 Outstanding Agriculturist by Bozeman Chapter of Alpha Zeta. In 1980 he was inducted into AHA's Hereford Heritage Hall Honor Gallery, and he was named Livestock Man of the Year in 1981 by the Fort Keogh Livestock and Range Research Laboratory.

Throughout the years, the Coopers have purchased several neighboring farms and ranches. Today, Cooper Hereford Ranch is managed by Mark and Cristy Cooper and has more than 5,000 acres, with 600 acres of grain, 1,000 acres of sprinkle-irrigated cropland, and the remainder in pasture for their 200 head of registered livestock. Goals for the ranch are very similar to when Jack started, with a strong emphasis on performance testing and selection pressure on calving ease and positive carcass traits.

# 2005 BIF Pioneer Award
# Dale Davis – Montana



*Dale Davis, Rollin' Rock Angus, receives a Pioneer Award.*

The Beef Improvement Federation honored Dale Davis, Belgrade, Mont., with the Pioneer Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals who have made lasting contributions to the improvement of beef cattle.

Dale Davis was born in North Dakota in 1925. When he was 11 years old, he and his family moved to Montana, where they settled in Bridger Canyon, east of Bozeman. His first venture with the beef business involved the purchase of Angus heifers as 4-H and FFA projects in the late 1930s.

He had to sell his 4-H and FFA project animals prior to entering military service. But, upon completion of his World War II duties, he returned to Montana and began his involvement in the cattle industry in earnest. In 1956 Davis purchased his foundation Angus seedstock and named his herd Rollin' Rock Angus.

After attending a seminar sponsored by the Montana Beef Performance Association (MBPA), Davis became fascinated with the concept of growth heritability and how this related to economics. After successfully applying these principles in his own program, Davis became an early advocate of performance testing. He served multiple terms as director and president of MBPA.

Davis served two terms as a director of the American Angus Association, chairing the Association's Breed Improvement Committee during a time of tremendous expansion in performance programs. He was instrumental in establishing the basic structure of Angus Herd Improvement Records (AHIR) and was and continues to be an avid spokesman for performance evaluation in the beef industry.

Davis always practiced what he preached. He is often referred to as the breeder of RR Rito 707, a foundation Angus sire of the modern-day line of Rito cattle. Davis will go down in history as an icon in the evolution of the Angus breed. His ideas and concepts were visionary, he was unwavering in his commitment to the application of scientific principles to beef cattle improvement, and the success he observed in his own program proved he was right.

# 2005 BIF Pioneer Award
# Les Holden – Montana

*Montana Hereford breeders Jack Cooper and Les Holden receive Pioneer awards from 2005 BIF President Jimmy Holliman (left). Receiving the awards are (continuing from left) Jack Holden, Jack Cooper, Christy Cooper and Mark Cooper.*

The Beef Improvement Federation posthumously honored Les Holden with the Pioneer Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals who have made lasting contributions to the improvement of beef cattle.

Les Holden was born in 1911 in Reno, Nev. Upon his father's death, his mother moved to Montana, where she married widower and cattleman Frank Cooper. Les attended Montana State University-Bozeman, later transferring to Billings Polytechnic Institute, now called Montana State University-Billings. There he met Ethel Everson, a student at Western Montana College. They were married in 1936 and had two sons, John and Scott.

Because he liked working outdoors and with cattle, he resigned a position as a loan supervisor to go back to ranch with the Coopers in 1938. A few years later, they leased a ranch on Willow Creek. In 1945 they sold Les' share in the Cooper ranch to his half brother, Jack Cooper, and moved to an irrigated farm leased just south of Townsend, Mont., where they raised commercial Hereford cattle.

The inception of their registered herd began with the purchase of a Line One Hereford sire from the Fort Keogh Livestock and Range Research Laboratory at Miles City in 1947. Their son John got a registered Hereford heifer for a 4-H project in 1952, after which they acquired two consecutive heifer calf crops from Carl Keickbush of Townsend. The dams of these heifers were of Advance Domino descent, and they were sired by Advance Mixer 60th, who traced back to Advance Domino 13th, the basic grandsire of the Line One Herefords at the Fort Keogh research station.

In 1954, Les and Ethel sold all of their older grade cows, using the proceeds as a down payment for two adjacent irrigated farms southwest of Valier, Mont.

Les joined the Montana Beef Performance Association (MBPA) in the late 1950s as a charter member. He served as president in 1965 and 1966. He was a great believer in measuring traits and in producing problem-free cattle. He culled extremely hard on the cow herd, concentrating on udders and soundness. When pushing performance negatively affected herd fertility, he instituted a 55-day breeding season to find cows that could milk, produce and still breed back in a timely manner. When he noticed birth weights increased as performance increased, he started selecting bulls that were moderate on birth and still high in growth. This was the start of a consistent commitment to multi-trait selection.

The First Annual Cooper-Holden Bull Sale took place in 1967 at Great Falls. The sales didn't make headlines the first few years, but that changed following the high-dollar sale of a bull to a prominent breeder and as the trend changed to longer, taller Herefords in the 1970s.

The computer era helped continue the pace of genetic improvement, especially when the American Hereford Association (AHA) came out with its Total Performance Records (TPR) program. Les started to select for scrotal circumference and pigmentation on eyes, scrotums and udders. Always looking for new ways to measure and improve his cattle, he attended as many BIF meetings and seminars as he could, monitored research at Miles City, and constantly read about performance testing.

Holden Herefords incorporated in 1975, with Les continuing to manage the ranch until 1987, at which time his grandson Jack became the manager.

Les was the BIF Beef Performance Breeder of the Year in 1975; Montana Hereford Man of the Year in 1978; and Record Stockman Livestock Man of the Year in 1981. He was selected for the Honor Gallery in Heritage Hall in 1980 by AHA and received the Producer Recognition Award from the Fort Keogh research station. He died June 30, 2004.

# 2005 BIF Pioneer Award
# Don Kress – Montana

BILLINGS, Mont. (July 7, 2005) — The Beef Improvement Federation (BIF) honored Don Kress with the Pioneer Award during the organization's 37th annual meeting July 6-9, 2005, in Billings, Mont. The award recognizes individuals who have made lasting contributions to the improvement of beef cattle.

*Don Kress (right), emeritus professor in the department of animal and range sciences at Montana State University, receives a Pioneer Award from 2005 BIF President Jimmy Holliman.*

Born in 1942, Kress was raised on a beef cattle, hay and small grains operation in southeastern Idaho. He obtained a bachelor's degree in animal science from the University of Idaho, where he was recognized as outstanding senior. He received his master's degree in 1966 and his doctorate in 1969, both from the University of Wisconsin, in animal science, genetics and statistics. He became a postdoctoral fellow at the University of Minnesota in 1969.

In 1970 he started his career as an assistant professor at Montana State University (MSU) in the department of animal and range sciences, where he subsequently became associate professor in 1975 and full professor in 1980. Kress taught courses focusing on beef cattle and genetics at both the undergraduate and graduate levels. He mentored more than two dozen graduate students and established a cooperative beef cattle research program with the Northern Agricultural Research Center near Havre, Mont.

His research emphasized beef cattle genetics and breeding, genetics of beef cow size and cow efficiency, crossbreeding systems, maternal and paternal heterosis, selection for scrotal circumference and antagonistic traits, and genetics of carcass characteristics. He is the author or co-author of more than 200 scientific and technical publications and more than 100 abstracts.

Kress is a recipient of the Outstanding Teacher Award in the College of Agriculture and the Teaching Excellence Award from MSU Alumni and Bozeman Chamber of Commerce. He received the prestigious Rockefeller Prentice Memorial Award, recognizing animal breeding and genetics research, from the American Society of Animal Science (ASAS). He also authored a first-place paper in the Best Applied Research Paper competition of the ASAS Western Section.

In 1999 he became associate dean of the MSU College of Agriculture, where he provided leadership and coordination of the resident instruction programs. He retired March 31, 2005, after 35 years of service to MSU and the beef cattle industry. He is currently emeritus professor in the department of animal and range sciences.

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